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STR. SITE No. 10-45

HWY. No. 401

LOCATION Hwy 401 & Sixteen Mile Creek

No of PAGES - ~

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

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FOUNDATION INVESTIGATION REPORT

W.P. 93-90-01/94-90-01 Bridge Site 10-45

Proposed Structure Addition

Hwy. 401 and Sixteen Mile Creek

District 4, (Burlington)

Ministry of Transportation, Ontario

CONT 93-07

Submission Date: 1991 05 21

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TABLE OF CONTENTS

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1.0 INTRODUCTION

Strata Engineering Corp. has been retained by the Foundation Design Section of the Ministry of Transportation, Ontario, under Consultant Agreement No: 4240-9190-193, to conduct a foundation investigation for a proposed inside widening of Highway 401 at Sixteen Mile Creek. The widening is to be accomplished with a deck in the median gap between existing twin structures. The terms of reference were to investigate the subsurface conditions for the support of the deck widening and for any road protection requirements.

This report is submitted in compliance with these terms of reference.

2.0 SITE AND GEOLOGY

The site is located 5.7km west of Highway 25 in the Regional Municipality of Halton.

At this site, Highway 401 crosses Sixteen Mile Creek on a 25° skew angle on twin overpasses, one each for the eastbound and westbound lanes. Highway 401 is built up on fill some 7.5m above prevailing ground level. The clear transverse distance between the twin structures is 4.2m.

The median fill between the twin overpass structures is retained by means of vertical concrete slabs cast in line with the ballast walls of the abutments. Archival drawings show the present twin structures to be supported on steel H piles.

Along the median, a concrete guide rail protects the open gap between the twin structures. Inertia absorbtion barriers are located on either side of the guide rail.

The terrain in this area is gently undulating, and a number of gravel pits are evident within a

radius of 1km of the site.

The dominant geological feature of the area is the Niagara Escarpment. Stream deposits of gravel, sand, and silt are likely present above glacial outwash deposits of sands and gravels.

Drift thickness and bedrock topography maps indicate a bedrock depth in this area of 30±m below prevailing ground surface.

3.0 FIELD AND LABORATORY WORK

Boreholes were drilled between 1991 01 29 and 1991 01 31 using two bombardier mounted CME 55 drill rigs, each drilling two boreholes. Each borehole was accompanied by a dynamic cone penetration resistance test. In Borehole 2 the cone test was done after augering to a depth of 6m in order to overcome the frictional resistance on the rods encountered in the fill. The boreholes were advanced with hollow stem augers.

Maintenance staff of the MTO Burlington District provided traffic protection assistance when the drill rigs were moved to and from the Highway 401 median.

Four boreholes were drilled along the median of the highway to depths ranging from 12.7m to 24.8m below ground surface, at locations shown on Drawing No: 93/949001-A appended. Boreholes 2 and 3 for the new abutment footings were located as close as practical to the vertical concrete slabs, within the constraints of underground structures and services.

Borehole elevations are referenced to geodetic datum.

Recovered soil samples were transported to our Don Mills laboratory where they were visually classified according to the USC system. Index property tests such as moisture contents, grain size analyses and Atterberg limits were performed on selected samples. The results are shown on the Record of Borehole Sheets as well as on Figures 1 to 4 in the Appendix.

4.0 SUBSURFACE AND GROUNDWATER CONDITIONS

4.1 General

Fill material was encountered to depths some 7m below prevailing ground surface. The fill is underlain by silty sand with gravel above silty sand and a sand and gravel deposit at depth. The groundwater table was some 10m below the median ground surface and is consistent with the water level in the creek.

4.2 Het. Mixture of Gravel, Sand and Clayey Silt (Road Fill)

Frozen road fill comprising brown gravelly sand with trace silt was found from the surface to depths of from 1.2m to 2.0m.

Below the frozen zone the material consists of a heterogenous mixture of gravel, sand and

clayey silt.

The material is quite variable in composition, being slightly cohesive in some locations and being clean non cohesive sand and gravel in other locations. Overall the material is classified as noncohesive.

The moisture content ranged from 8 to 12 per cent. Grain size curves for representative samples are shown on Figure 1 (Gravelly Sand with Silt). Atterberg Limit tests on the portion of the samples finer than 425μm are shown on Figure 2 indicating the fines to be clayey silt.

N values within the fill range from 57 blows/0.3m to 6 blows/0.3m. being on average about 22 blows/0.3m, indicating the material to be loose to very dense , generally being compact.

4.3 Silty Sand with Gravel, Trace Clay

Brown silty sand with gravel and traces of clay is found below the road fill material. The thickness of this deposit within the boreholes is 1.2m to 1.9m.

The moisture content ranged from 14 to 24 per cent. One grain size curve shown on Figure 4 indicates the material to be well graded. Two atterberg limit tests were attempted on the fraction of soil finer than 425μm to check for the presence of clay. One of the soil samples was non-plastic, whereas the other showed some plasticity (Figure 3).

"N" values ranging from 6 blows/0.3m to 19 blows/0.3m indicate the deposit to be loose to compact.

4.4 Silty Sand, Trace Clay

A brown silty sand stratum some 2m thick was found below the silty sand with gravel. The moisture content was approximately 24%. One grain size curve (Figure 5) shows the sample to be mostly fine sand with 18% silt. N values of 3 blows/0.3m to 9 blows/0.3m indicate a very loose to loose relative density.

4.5 Sand and Gravel with some Silt

Brown sand and gravel with some silt was found below elevation of 258.6m. This deposit was not fully penetrated in any Borehole.

The moisture content of this deposit ranged from 10 to 25%, the average being about 15%. Samples with high silt contents tended to have higher moisture contents.

The grain size distribution of this material is shown in envelope form on Figure 6A. Samples with higher gravel contents are shown on Figure 6B. The material is generally well graded.

N values ranged from 10 blows/0.3m to 88 blows/0.3m. One value of 155 blows/0.15m is likely due to the presence of cobbles. The dynamic cone penetration tests all terminated within this

deposit. These N values indicate the deposit to be compact to very dense.

4.6 Groundwater Conditions

The phreatic level at this site corresponds more or less to the creek level which was 258.5m on 1991 01 29. Observations are listed below.

Borehole	Elevation	Date
1	258.5	1991 01 29
2	258.5	1991 02 04
3	258.5	1991 01 30
4	258.6	1991 02 04

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 General

It is proposed to widen Highway 401 from 4 to 6 lanes between Highway 25 and Guelph Line by the construction of two additional lanes in the existing median. The construction of the additional lanes will require the closing of the gap between twin overpasses carrying Highway 401 across Sixteen Mile Creek.

Archival drawings indicate the existing twin structures are supported on steel H piles.

The present bridges show some signs of deterioration. There is a hairline crack visible from below on the base of the deck slab of the EBL bridge parallel to the direction of traffic flow. There is also similar cracking on the east abutment wall of the same bridge continuous with the crack in the deck slab. Corrosion of the reinforcement of the deck slab is evident from the rust stains on the bottom surface of the slab. There is tilting of the southeast wing wall away from the EBL bridge. The metal drains which exit through the deck slabs of the bridge are also badly corroded.

The construction of the additional lanes will entail closing the gap between the twin bridge abutments. This will require the removal of the existing concrete vertical slabs. Road protection will be required if the new abutments are placed on footings to match the existing footings.

The site investigation shows the presence of about 7m of road fill material (heterogenous mixture of gravel , sand and clayey silt overlying a silty sand with gravel above silty sand and a sand and gravel deposit at depth. The groundwater table was some 10m below the median ground surface and is consistent with the water level in the creek.

5.2 Structure Foundations

The presence of a pile foundation for the existing twin structures precludes the use of conventional spread footings for the proposed bridge extensions. Hence a deep foundation is recommended.

The groundwater level being above the competent lower bearing stratum precludes the use of caissons. Therefore steel H piles are recommended as the most suitable deep foundation alternative for this site.

Steel H piles (eg HP 310x110), equipped with driving shoes, and driven with an energy not less than 40kJ to toe elevations of about 243.5m for the west abutment and 245.0m for the east abutment may be designed for the following load capacities:

Axial Factored Capacity at ULS	1000kN
Axial Capacity at SLS Type II	750kN

Due to the likely presence of cobbles at depth within the sand and gravel deposit, it is

recommended that the pile toes be reinforced. Pile driving should be monitored using the Hiley Formula.

5.3 Earth Pressures

Earth pressures should be computed as per subsection 6-6.1.2.2 of the OHBD Code. A yielding foundation condition may be assumed. The granular A or B backfill should be in accordance with special provision No.109F03 (latest revision). The following parameters are recommended for granular backfill.

	Gran "A"	Gran "B"
Angle of internal friction ϕ'	35.0°	30.0°
Unit weight (kN/m^3) γ	22.8	21.2

Surcharge effects should be computed as per Clause 6-6.1.2.4 of the OHBD Code.

5.4 Construction Considerations

The spread footing option will require roadway protection by means of a shoring system placed inside the excavation adjacent to the travelled highway. The very dense nature of the sand and gravel stratum precludes driven interlocking steel sheet piling as a viable option. Therefore, soldier piles and timber lagging may be the most practical alternative for excavation shoring. Soldier piles would need to be augered down at least 1m into natural soil and concreted in place. The depth of soldier pile toe embedment below the base of the excavation will depend on the shoring design used (whether cantilever, braced or tied back).

For the design of an internally braced system, use a rectangular distribution of earth pressure with a base width of $0.65\gamma Hk_a$ where H is the internal braced height. The granular B earth pressure and unit weight values given in section 5.3 above may be used in design.

Roadway protection, if required, should be of such length parallel to the highway that the angle, measured with the horizontal, from the end of the protection scheme to the new footings is 30° or less.

Excavated material may be re-used as general backfill to the new abutments.

Dewatering may not be needed for the construction of the pile caps since the groundwater table is some 0.5m below the base of the pile caps for the twin structures (obtained from archival drawings provided). Provision should however be made for the removal of any surface runoff by pumping from strategically located sumps within any open excavation.

6.0 CLOSURE

The field work for this investigation was carried out by Ms. Andrea C. Abel and Mr. Zareh Dervichian.

Drilling equipment and crew was provided by Master Soil Investigation Ltd. of Weston, Ontario.

Mr. Jim McLean of the MTO Burlington District kindly provided traffic protection services for this investigation.

Respectfully Submitted:
STRATA ENGINEERING CORP.

A.C. Abel, M.Sc.
Project Engineer

for C. Mirza, P.Eng.
Senior Principal

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APPENDIX

Explanation of Terms Used in Report

Record of Boreholes 1 to 4

Figures 1 to 6

Drawing 93/949001-A

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:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

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

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

Ministry of Transportation Ontario

RECORD OF BOREHOLE No1

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 214.0 ; E: 266 932.0 ORIGINATED BY Z.D.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 29 CHECKED BY A.A.

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
268.4	Ground Surface						
0.0	Frozen Zone		1	SS	-		
	Het. mixture of Gravel, Sand and Clayey Silt (Road Fill) Loose Brown		2	SS	9		
	Dense		3	SS	30		
	Reddish Brown		4	SS	37		
	Loose		5	SS	6		26 45 (29)
261.5	Brown						
6.9	Silty Sand with Gravel trace Clay Loose		6	SS	6		
260.1	Brown						
8.3	Silty Sand trace Clay Very Loose Brown		7	SS	3		0 77 13 10 W.L. on 1991 01 29
258.6							
9.8	Sand and Gravel with Silt		8	SS	21		36 31 (33)
	Compact						
255.7	Reddish Brown		9	SS	26		
12.7	End of Sampled Borehole Probable Sand and Gravel with some Silt						
253.4	Cont. on Sheet 2						
15.0							

ELEVATION SCALE: 268, 267, 266, 265, 264, 263, 262, 261, 260, 259, 258, 257, 256, 255, 254

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ

Augered

NP

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No1 cont'd

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 214.0 ; E: 266 932.0 ORIGINATED BY Z.D.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 29 CHECKED BY A.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
253.4	Cont. from Sheet 1										
15.0	Probable Sand and Gravel with some Silt						253				
							252				
							251				
250.1											
18.3	End of Cone test										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 [%] STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 218.0 ; E: 266 941.7 ORIGINATED BY Z.D.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 30 & 31 CHECKED BY A.A.

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
268.3 / 0.0	Gound Surface						268				
	Frozen Zone		1	SS	-				○		
			2	SS	-		267				
	Het. Mixture of Gravel, Sand, and Clayey Silt (Road Fill)		3	SS	10	Seal	266				
	Compact						265				
			4	SS	11		264		○		
	Reddish Brown						263				
261.4 / 6.9			5	SS	18		262				
	Silty Sand with Gravel trace Clay						261	Augered			
	Compact		6	SS	19				○NP		22 47 (31)
	Reddish Brown						260				
259.5 / 8.8	Silty Sand trace Clay		7	SS	7	▼	259				W.L. on 1991 02 04
	Loose						258				
257.8 / 10.5	Brown										
	Gravelly Zone		8	SS	18		257		○ NP		71 26 (3)
	Compact										
	Sand and Gravel trace Silt		9	SS	26		256				
	Compact to Dense						255				
	Reddish Brown		10	SS	32		254		○		8 88 (4)
253.3 / 15.0	Cont. on Sheet 2										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 [%] STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 2 cont'd

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 218.0 ; E: 266 941.7 ORIGINATED BY Z.D.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 30 & 31 CHECKED BY A.A.

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
253.3	Cont. from Sheet 1										
15.0	Sand and Gravel some silt		11	SS	39		253				
							252				
	Dense to Very Dense		12	SS	43		251				18 64 (18)
			13	SS	34		250				
	Reddish Brown		14	SS	55		249				
			15	SS	41		248				
	very Dense		16	SS	68		247				
	Grey					Standpipe	246				44 53 (3)
243.5			17	SS	89		245				
24.8	End of Borehole						244				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 217.8 ; E: 266 971.0 ORIGINATED BY A.A.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 29 & 30 CHECKED BY A.A.

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
268.0	Ground Surface										
0.0	Frozen Zone		1	SS	-		267				
			2	SS	-		266		○		
	Het. mixture of Gravel, Sand and Clayey Silt (Road Fill)		3	SS	57/16cm		265				
							264				
	Very Dense to Compact		4	SS	50		263				
							262				
	Reddish Brown		5	SS	23				○ NP		
261.0							261				
7.0	Silty Sand with Gravel trace Clay										
259.8	Compact Brown		6	SS	18		260				See Note on Figure 3
8.2	Silty Sand trace Clay Loose						259				
	Reddish Brown		7	SS	9	▼					W. L. on 1991 01 30
257.7							258				
10.3	Sand and Gravel Some Silt		8	SS	37		257		○ NP		43 34 18 5
	Dense to Compact		9	SS	16		256		○		2 94 (4)
							255				
	Very Dense		10	SS	155/15cm		254				
253.0	Cont. on Sheet 2										
15.0											

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 3 cont'd

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 217.8 ; E: 266 971.0 ORIGINATED BY A.A.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 29 & 30 CHECKED BY A.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
253.0	Cont. from Sheet 1										
15.0	Sand and Gravel trace Silt Dense		11	SS	46		252				21 75 (4)
			12	SS	45		251				
			13	SS	33		250				
	Grey Very Dense		14	SS	81		249				
							248				
246.2			15	SS	88		247	Start of Cone test			9 88 (3)
21.8	End of Sampled Borehole Probable Sand and Gravel						246				
244.8							245				
23.2	End of Cone test										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 93-90-01 & 94-90-01 LOCATION N: 4 817 221.4 ; E: 266 979.6 ORIGINATED BY A.A.

DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.

DATUM Geodetic DATE 1991 01 30 CHECKED BY A.A.

OFFICE REPORT ON SOIL EXPLORATION

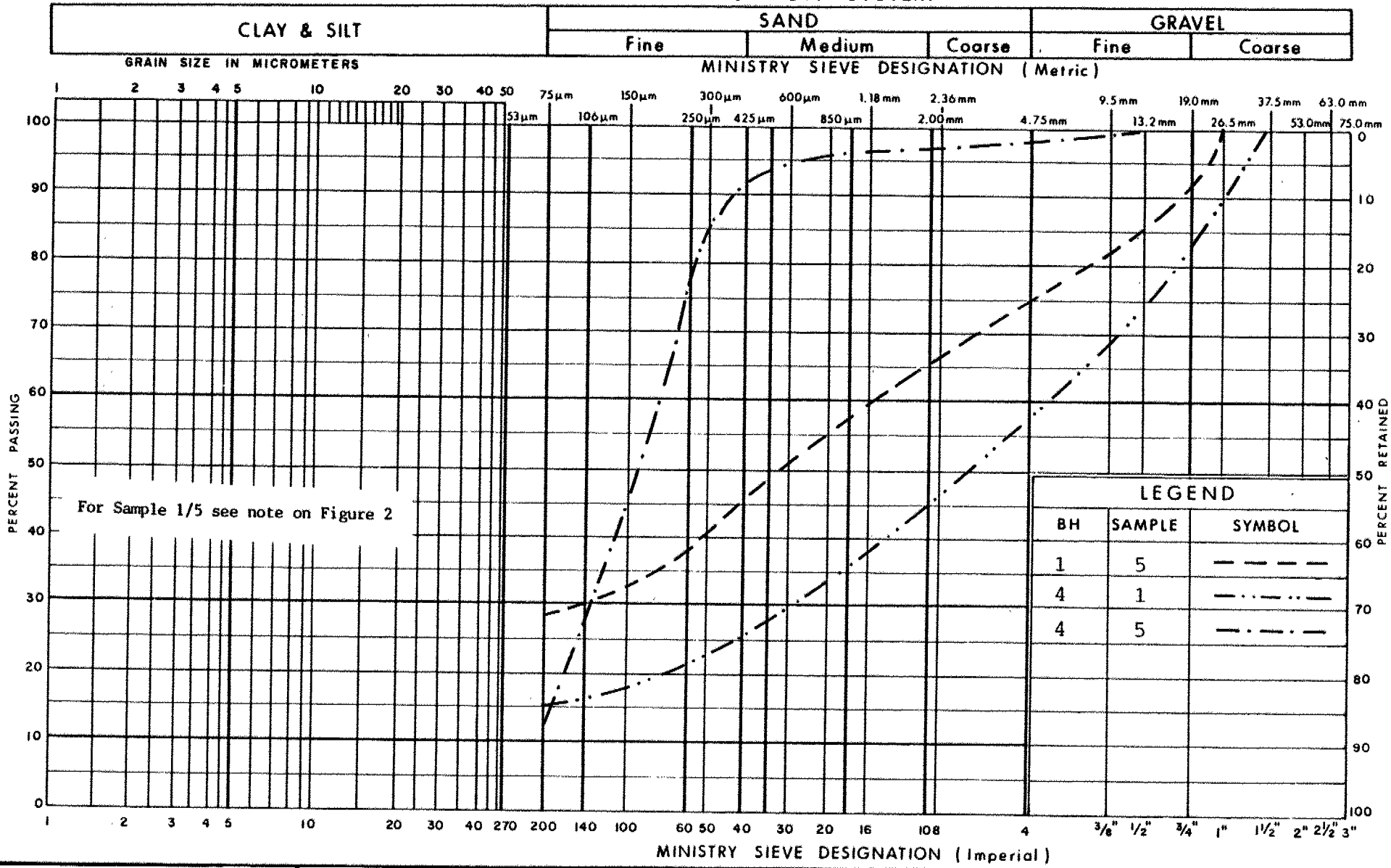
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
267.6	Ground Surface										
0.0	Frozen Zone		1	SS	-		267	Augered			43 42 (15)
	Het. mixture of Gravel, Sand and Clayey Silt (Road Fill) Loose		2	SS	15		266				
			3	SS	8		265				
							264				
	Clayey Silt Zone Very Stiff		4	SS	17		263				
							262				
	Compact		5	SS	18		261				2 85 (13)
260.9											
6.7	Silty Sand with Gravel trace Clay Loose					Seal	260				
259.3	Brown		6	SS	6						
8.3	Silty Sand Trace Clay Loose		7	SS	8		259				W.L. on 1991 02 04
257.3	Reddish Brown						258				
10.3	Sand and Gravel some Silt		8	SS	10		257				
	Loose to Compact					Standpipe	256				
254.9	Reddish Brown		9	SS	16		255				5 76 (19)
12.7	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

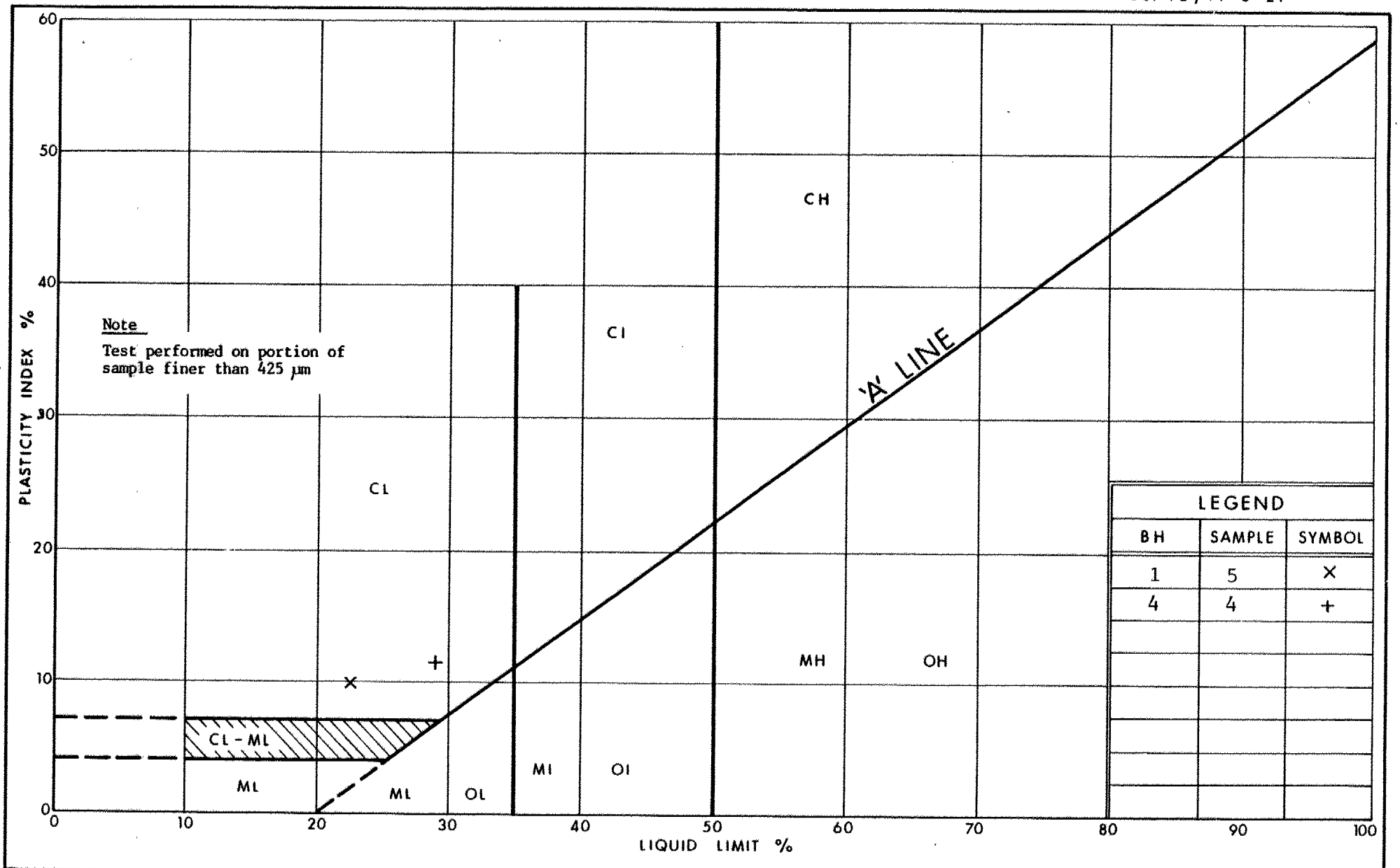
Gravelly Sand with Silt
(Road Fill)

FIG No 1

W P 93-90-01 & 94-90-01

Hwy.401/Sixteen Mile Creek

Oct 75, FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART

Clayey Silt

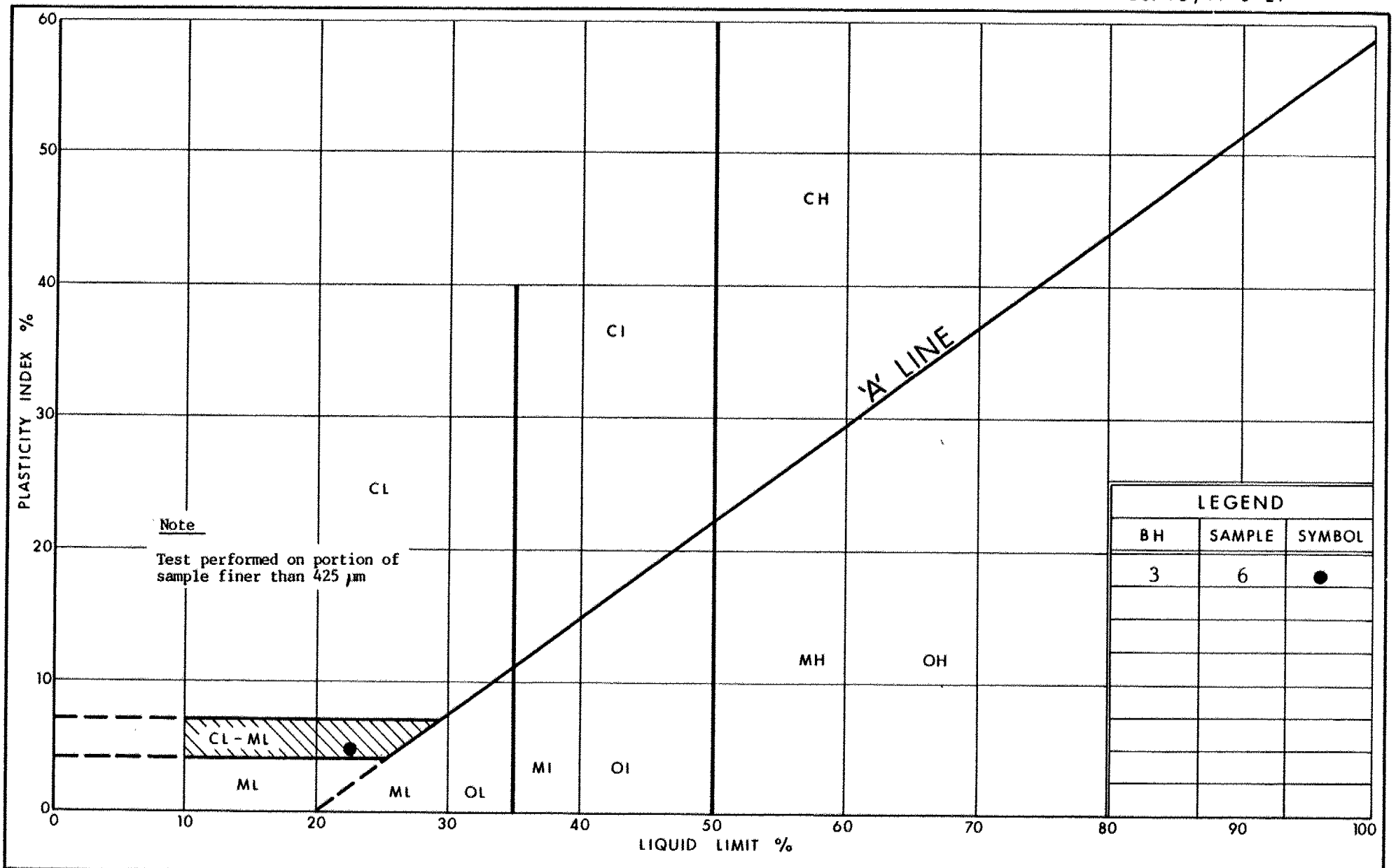
(Road Fill)

FIG No 2

W P 93-90-01 & 94-90-01

Hwy.401/Sixteen Mile Creek

Oct 75, FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART

Silty Sand with Gravel trace Clay
(Glacial Till)

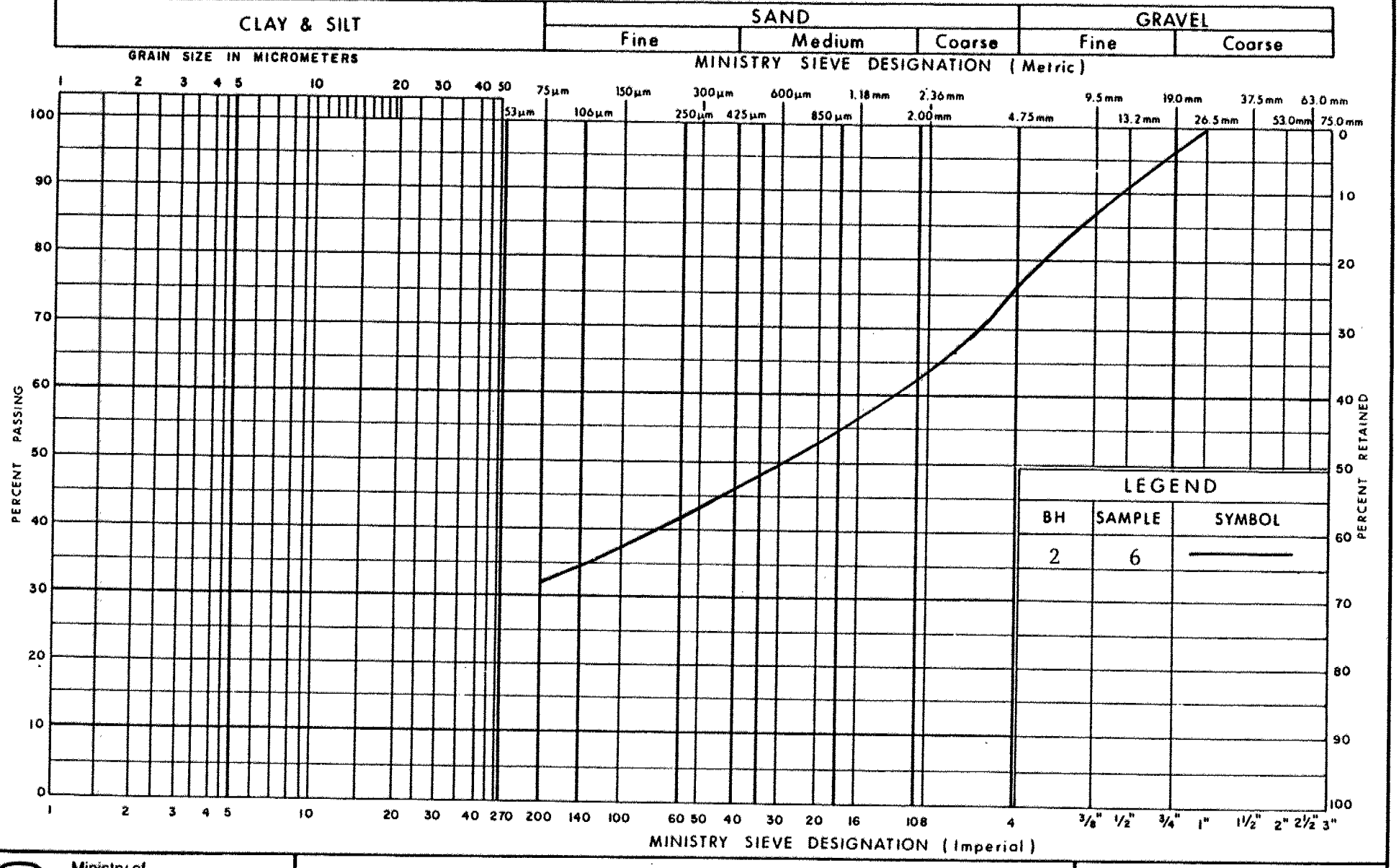
FIG No 3

W P 93-90-01 & 94-90-01

Hwy.401/ Sixteen Mile Creek

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty Sand with Gravel trace Clay

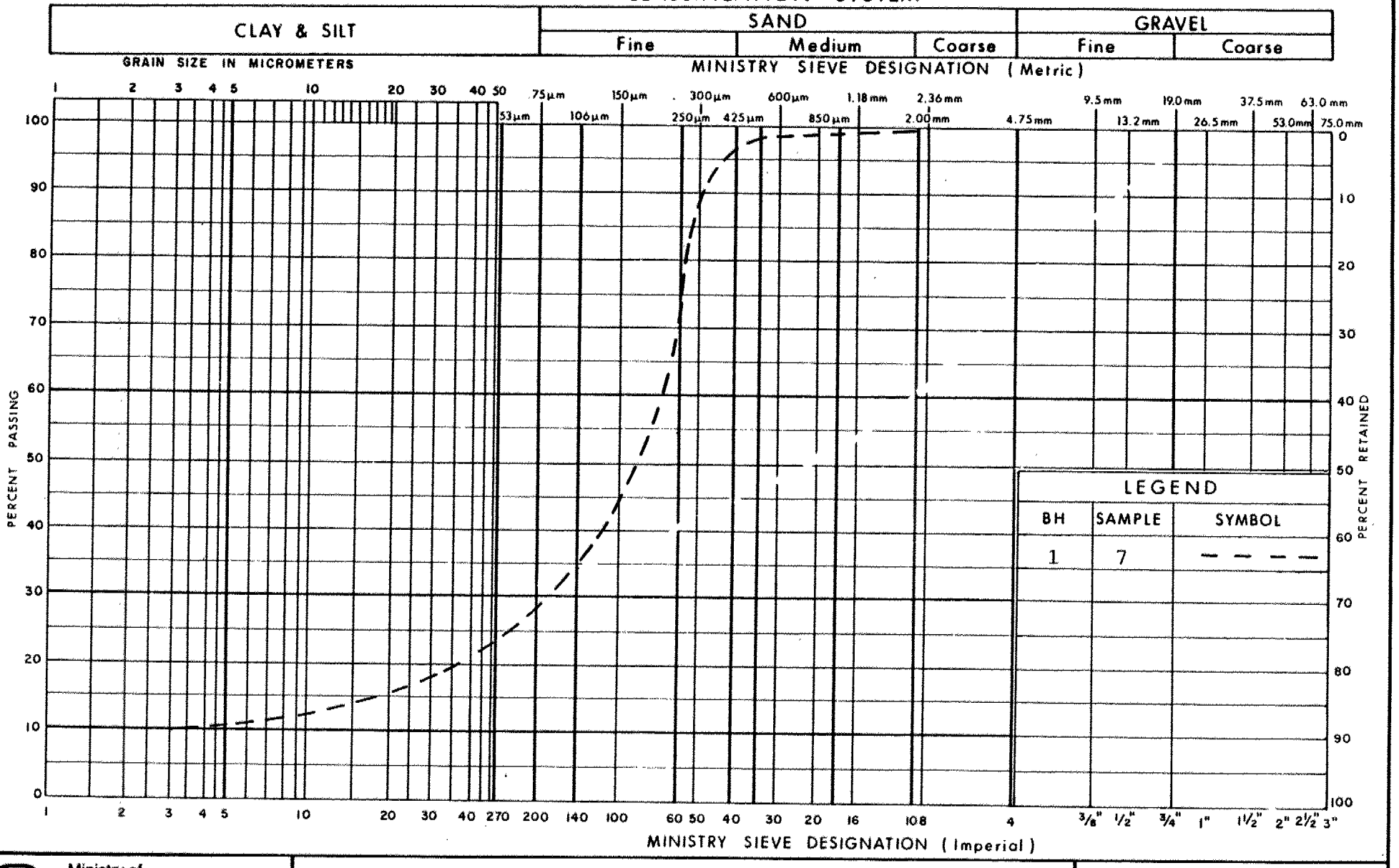
FIG No 4

W P 93-90-01 & 94-90-01

Hwy. 401/ Sixteen Mile Crk.

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty Sand

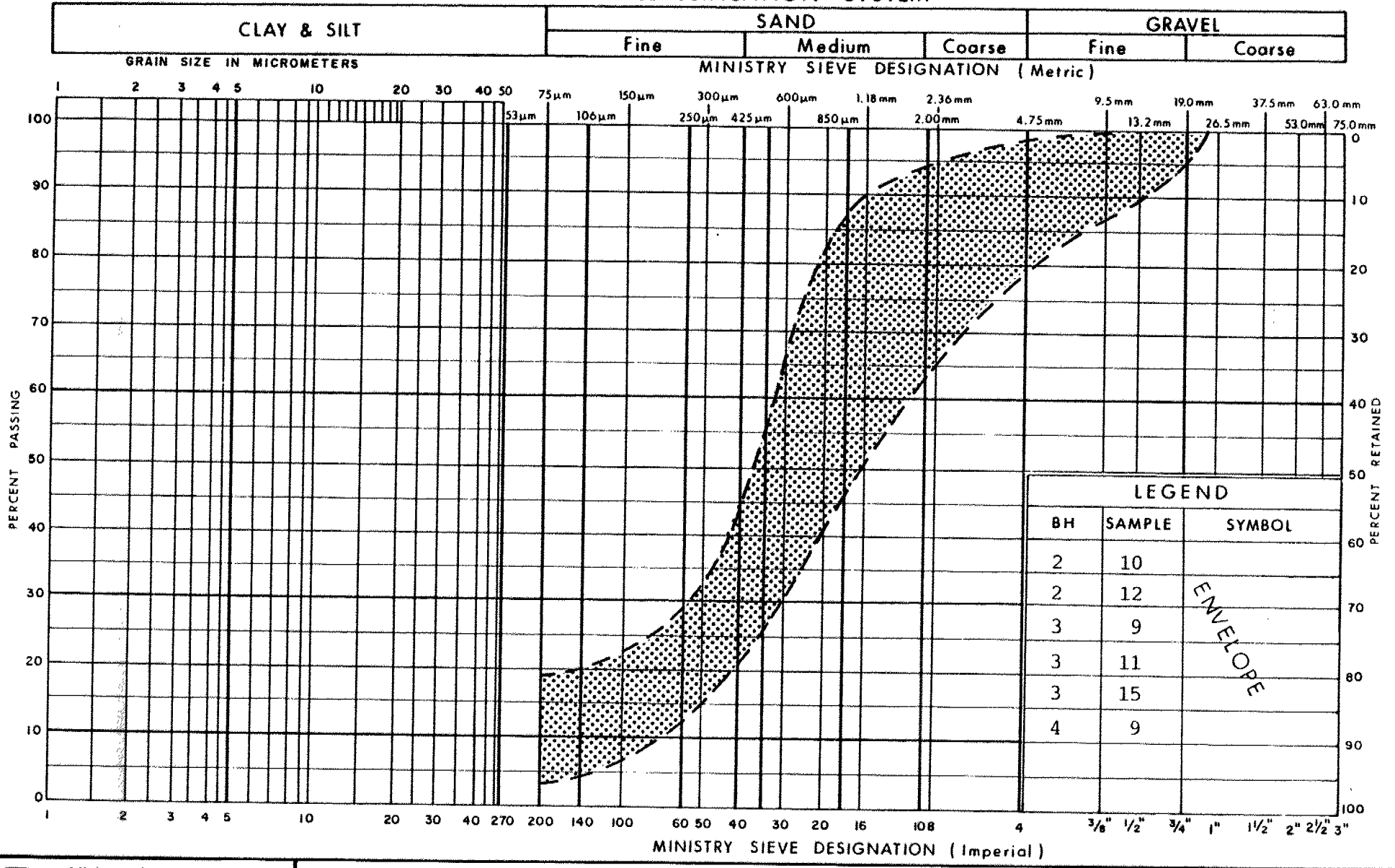
FIG No 5

W P93-90-01 & 94-90-01

Hwy.401/ Sixteen Mile Creek

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

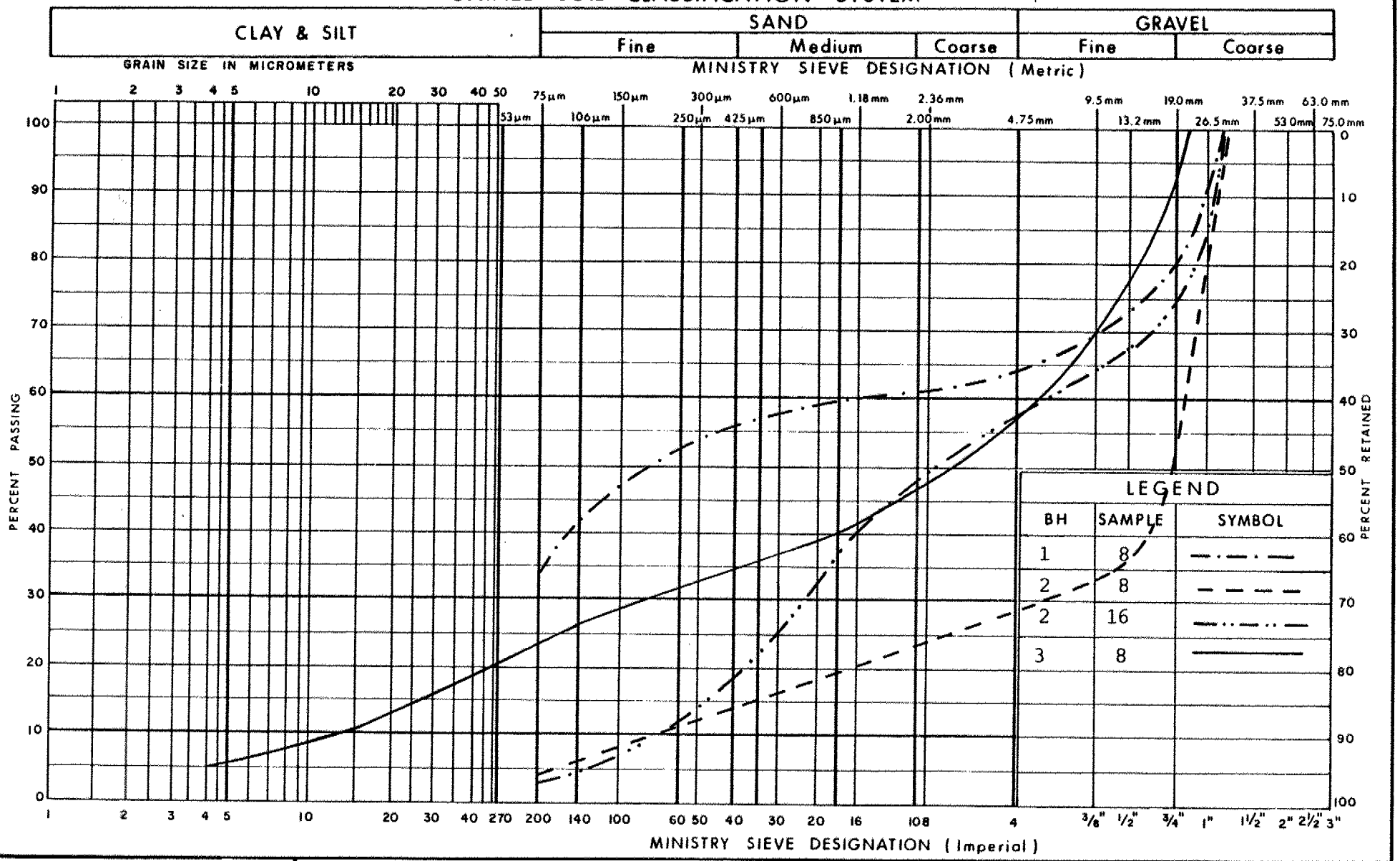
GRAIN SIZE DISTRIBUTION

Sand and Gravel
trace to some Silt

FIG No 6 A
W P 93-90-01 & 94-90-01
Hwy. 401/Sixteen Mile Creek

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

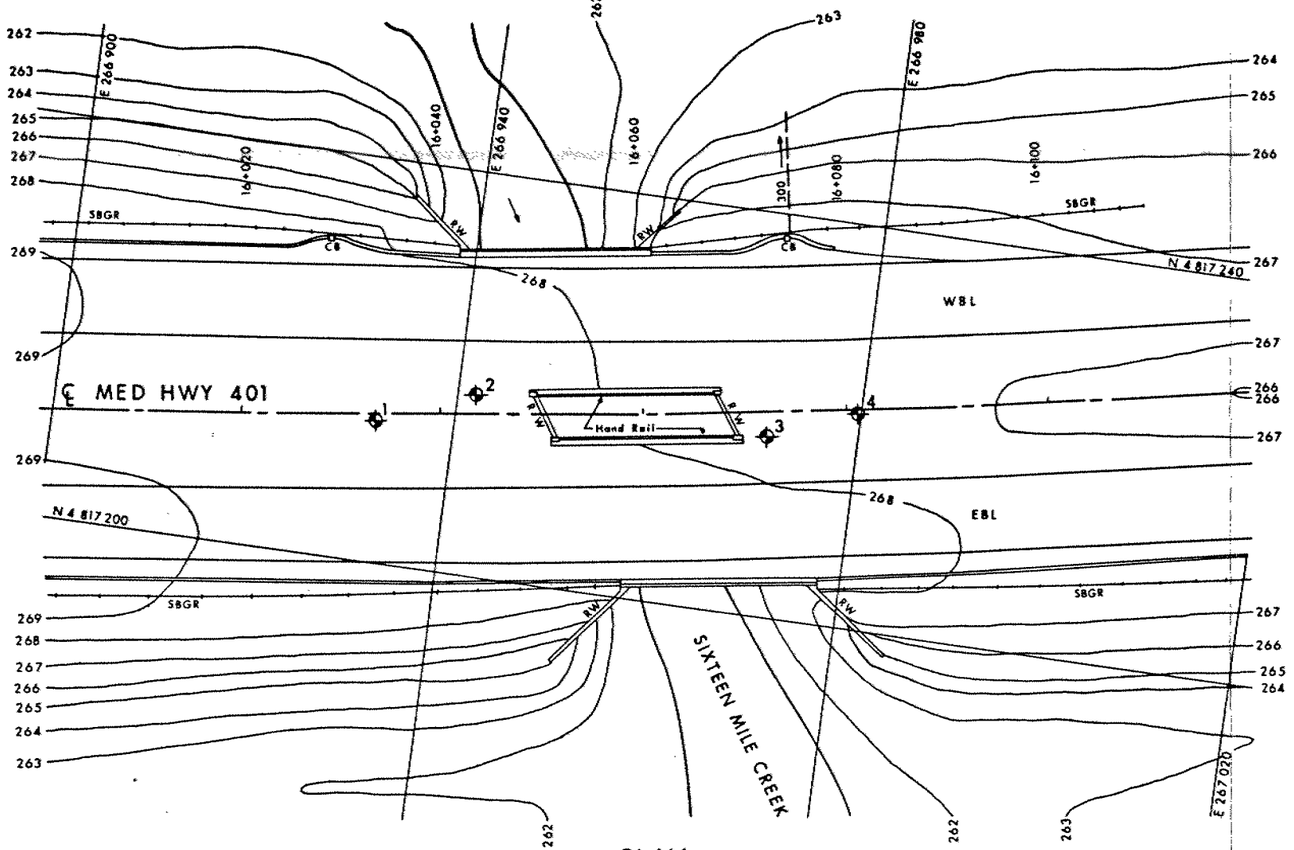
Gravelly Sand with Silt

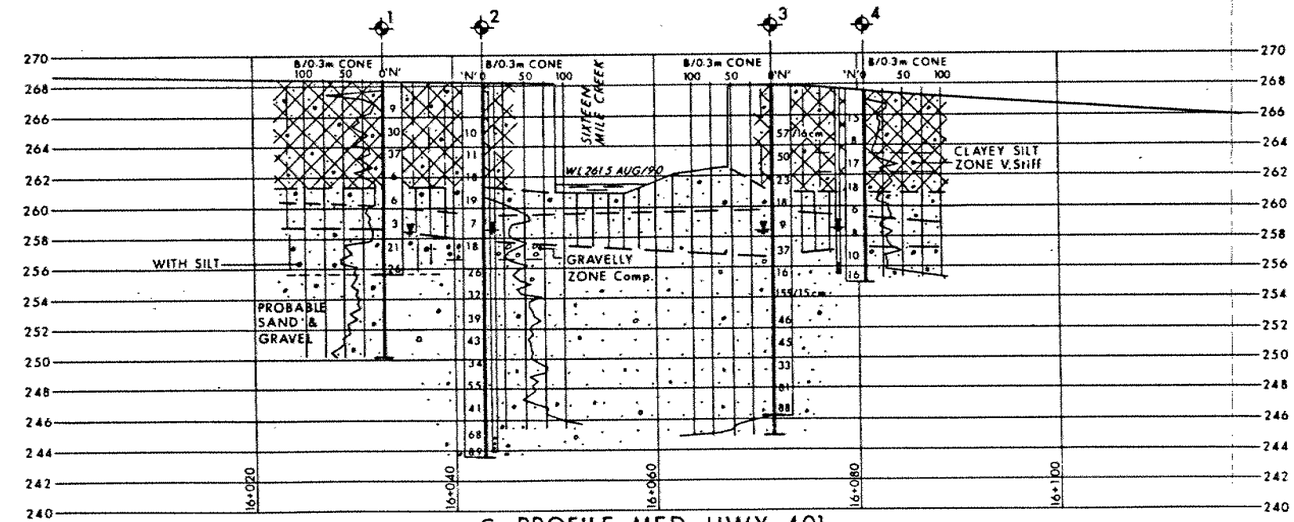
FIG No 6B

W P 93-90-01 & 94-90-01

Hwy. 401/ Sixteen Mile Crk.

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10





SOIL STRATIGRAPHY LEGEND

- HET. MIXTURE OF GRAVEL SAND & CLAYEY SILT (ROAD FILL) Loose to V.Dense
- SILTY SAND WITH GRAVEL TRACE CLAY Loose to Compact
- SILTY SAND TRACE CLAY V.Loose to Loose
- SAND & GRAVEL TRACE to SOME SILT Loose to V.Dense

REF No E-162-401-2, 90 11

METRIC

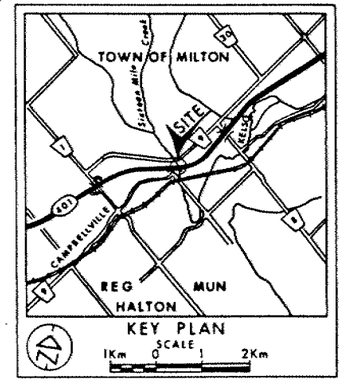
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No93&94-90-01

SHEET

SIXTEEN MILE CREEK
BORE HOLE LOCATIONS & SOIL STRATA

STRATA ENGINEERING CORP.



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L at time of investigation Jan. & Feb 1991
- Stand Pipe

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	268.4	4 817 214.0	266 932.0
2	268.3	4 817 218.0	266 941.7
3	268.0	4 817 217.8	266 971.0
4	267.6	4 817 221.4	266 979.6

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100

REV	DATE	BY	DESCRIPTION

Geocres No 30M5-181

HWY No 401			DIST 4
SUBM'D AA	CHECKED AR	DATE Mar 07 1991	SITE 10-45
DRAWN AK	CHECKED AR	APPROVED	DWG 93&949001-A

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

NOTE: MINISTRY DENOTES MINISTRY OF TRANSPORTATION, ONTARIO.

DIST. Nº 4 - HWY. Nº 401

CONT No 93-90-01 (E.B.L.)

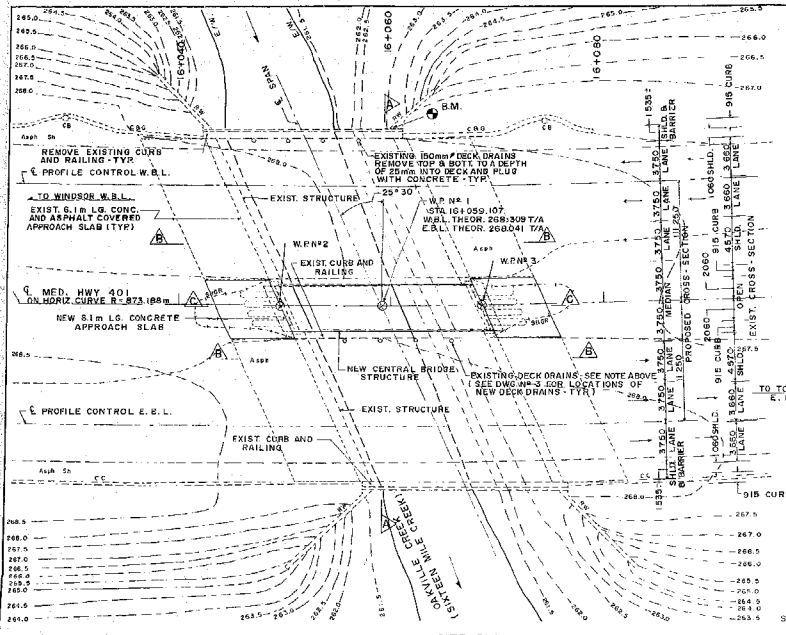
WP No 94-90-01 (W.B.L.)

SHEET

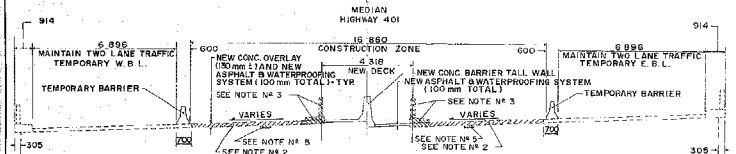
OAKVILLE CREEK BRIDGE
WIDENING & REHABILITATION
6.7 km WEST OF HWY. Nº 25
GENERAL ARRANGEMENT

B.M. ROSS AND ASSOCIATES LIMITED
Consulting Civil Engineers
GODERICH, ONTARIO

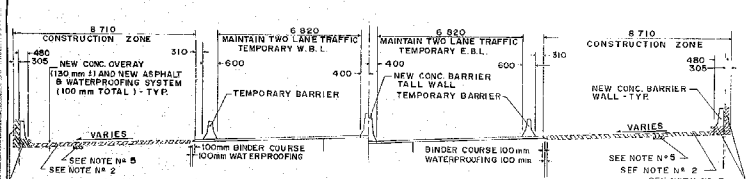
88-568



SITE PLAN
1:200

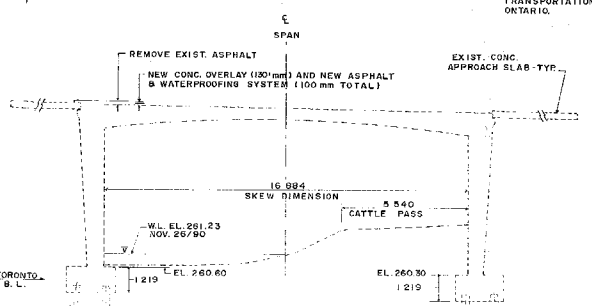


SECTION A STAGE I
1:100

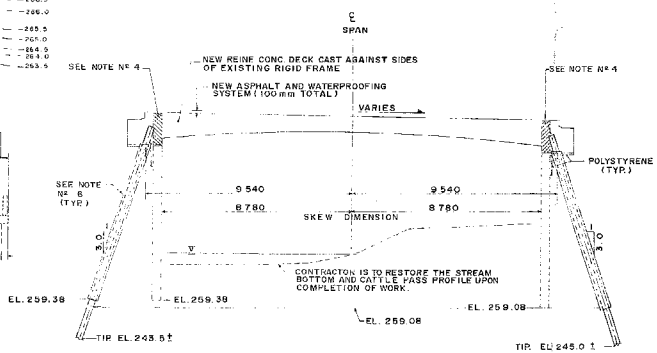


SECTION A STAGE II
1:100

HIGHWAY 401 TRAFFIC STAGING DURING CONSTRUCTION



SECTION B
1:100



SECTION C
1:100

B.M. EL. 267.552
GEODETIC DATUM
Cut Cross on S.W. Corner of NE W.W. of Bridge over Creek 17.2 Lt. 16+061.1

GENERAL NOTES

CLASS OF CONCRETE

ALL CONCRETE 30 MPa

CLEAR COVER TO REINFORCING STEEL

. HAUNCH (BOTTOM AND BACK)	80± 20mm
. DECK (TOP)	70± 10mm
. DECK (BOTTOM)	50± 10mm
. REMAINDER	70± 20mm UNLESS OTHERWISE NOTED

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH SUFFIX 'C' DENOTE COATED BARS.

CONSTRUCTION NOTES

1. THE CONTRACTOR SHALL CHECK AND ENSURE THAT ALL RELEVENT EXISTING STRUCTURE DIMENSIONS AND ELEVATIONS SHOWN ON THE DRAWINGS ARE CORRECT AND ADJUST THEM AS REQUIRED TO MATCH THOSE OF THE EXISTING STRUCTURE AND APPROVED BY THE ENGINEER.
2. IT IS NOT NECESSARY TO REMOVE THE FALSEWORK SUPPORTING THE DECK PRIOR TO CONSTRUCTING THE MEDIAN BARRIER TALL WALL. AREAS OF REMOVAL SHALL BE DELINEATED BY A SAWCUT 25mm DEEP OR TO FIRST LAYER OF REINFORCING STEEL, WHICHEVER IS LESS.

CONSTRUCTION STAGING

1. CLOSE OFF TRAFFIC FROM STAGE I CONSTRUCTION AREA AND PLACE TEMPORARY CONCRETE BARRIERS FOR STAGE I CONSTRUCTION.
2. REMOVE EXISTING ASPHALT AND WATERPROOFING FROM CLOSED PORTION OF BRIDGE INCLUDING 300mm ONTO ABUTMENT END AND INSIDE FACE OF APPROACH SLABS.
3. REMOVE EXISTING CONCRETE CURB AND RAIL SYSTEM FROM CLOSED PORTION OF BRIDGE.
4. REMOVE TOP PORTION OF RETAINING WALLS FROM CLOSED PORTION OF BRIDGE.
5. REMOVE CONCRETE FROM AREAS OF BRIDGE DECK AND DECK SLAB REQUIRING RESTORATION. AREAS TO BE IDENTIFIED BY MINISTRY. SCARIFY EXISTING DECK SURFACE 6-10mm DEPTH.
6. CONSTRUCT PRE-AUGERED 508mm O.D. STEEL TUBE CASING TO EL. 259.08 EAST SUPPORT AND EL. 259.38 WEST SUPPORT. AUGERING TO NOT PRECEDE TUBING BY MORE THAN 150mm DEPTH. DRIVE STEEL PILING-HP 310x110 INSIDE TUBING. FOUR PILING-CASING UNITS REQUIRED AT EACH SUPPORT END. TUBE CASING TO BE FILLED WITH 10mm ø CLEAR STONE BELOW EL. 261.50, PUMPED GROUT TO EL. 264.30 AND 30 MPa CONCRETE ABOVE EL. 264.30.
7. CONSTRUCT CENTRAL BRIDGE STRUCTURE CAST AGAINST SIDES OF EXISTING RIGID FRAME.
8. CONSTRUCT NEW 30 MPa CONCRETE DECK OVERLAY.
9. CONSTRUCT NEW MEDIAN CONCRETE BARRIER TALL WALL.
10. WATERPROOF AND PAVE AS SHOWN ON DWG. STAGE I.
11. RELOCATE TRAFFIC TO COMPLETED PORTION OF THE BRIDGE AND RELOCATE TEMPORARY CONCRETE BARRIERS FOR STAGE II CONSTRUCTION.
12. REPEAT STEPS - 2, 3, 5 AND 8.
13. REPAIR THE DECK SOFFIT AND AREAS OF THE SUBSTRUCTURE NEEDING RESTORATION AS IDENTIFIED BY THE MINISTRY.
14. CONSTRUCT NEW CONCRETE BARRIER WALL.
15. WATERPROOF AND PAVE AS SHOWN ON DWG. STAGE II.
16. REMOVE TEMPORARY CONCRETE BARRIERS AND OPEN TOTAL BRIDGE TO TRAFFIC.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION AND SOIL STRATA
3. PLAN AND FINISHED GRADES
4. DECK WIDENING
5. BARRIER WALL
6. 6190mm APPROACH SLAB
7. AS CONSTRUCTED ELEV. & DIM.
8. STANDARD DETAILS

APPLICABLE STANDARD DRAWINGS

LICENSED PROFESSIONAL ENGINEER A. I. ROSS PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER CIVIL K. G. DUNN PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN K.G.D.	CHK A.I.R.	CODE O.H.B.D.C.-93	LOAD CLASS A	DATE 91-03	
DRAWN J.O.	CHK	SITE 10-46/RI	STRUCT	SCHEME	DWG 1