

G.I.-30 SEPT. 1976

GEOCRES No. 31B-60DIST. 9 REGION W.P. No. 177-89-03/06CONT. No. 94-28W. O. No. STR. SITE No. 18-309HWY. No. 416LOCATION Hwy 416 at Glen Smail RdNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 94-28**



Ministry of  
Transportation

INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 47	Foundation Investigation Report for  Glen Smail Road Underpass W.P. 177-89-03, Site 16-309 Hwy. 416, District 9, Ottawa  County Road 44 Underpass W.P. 177--89-04, Site 16-310 Hwy. 416, District 9, Ottawa

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

# EXPLANATION OF TERMS USED IN REPORT

2

**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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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 = $\frac{c_u}{\tau_r}$

### 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 INVESTIGATION REPORT  
for  
Proposed Glen Smail Road Underpass  
Hwy. 416  
W.P. 177-89-03, Site 16-309  
District #9 (Ottawa)

## 1. INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates, consultants to the Ministry of Transportation Ontario (MTO), to carry out a subsurface investigation at the site of a proposed underpass for Glen Smail Road at Highway 416 (see Key Plan, Figure 1). The purpose of the investigation was to determine the subsurface conditions at the site and, based on the factual information obtained, to provide recommendations on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The proposed underpass structure and realigned Glen Smail Road are to be located about 40 to 50 metres north of the present roadway alignment. The underpass will consist of two single span bridges crossing the north bound and south bound lanes of Highway 416. Each bridge will have a length of about 34 metres. The approach embankments and the embankment between the two structures will have a maximum height of about 8.5 to 9.0 metres above ground surface. The abutments for the proposed bridges are to be perched above existing ground surface.

## 2. SITE DESCRIPTION AND GEOLOGY

The site is located along existing Highway 16 some 4 kilometres south of Spencerville, Ontario. The topography across the site is relatively flat. Ponded water was present west of Highway 16 at the time of the investigation. The west bridge area is presently treed.

Geology maps suggest that this area is underlain by deposits of marine sand. Bedrock is expected to consist of Oxford

formation dolostone. Drift thickness maps suggest that the overburden thickness may be about 12 metres.

### 3. PROCEDURE

The field work for this investigation was carried out between April 16 and 24, 1990. During this time, boreholes were advanced at each of the abutment locations for foundation design purposes. In addition two shallow boreholes were advanced about 30 metres from both the east abutment of the east bridge (north bound lanes) and the west abutment of the west bridge (south bound lanes) to evaluate the subgrade conditions for the approach embankments near the bridges. Two boreholes put down in the abutment areas were advanced to bedrock and the bedrock cored using BXL size diamond drilling equipment; the other boreholes were advanced to practical auger refusal. The boreholes advanced in the embankment area were taken to a depth of about 5.8 metres below existing ground surface. Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using drive open sampling equipment. In situ vane testing was carried out where possible to determine the undrained shear strength characteristics of the silty clay. Standpipes were sealed into all of the boreholes to determine the groundwater conditions at the site. One sample of groundwater was obtained from borehole 1-5 and was sent to a laboratory for basic chemical testing to evaluate the corrosivity of the groundwater on exposed concrete and unprotected steel. The field work was supervised throughout by a member of our engineering staff.

Logs of the soil, bedrock and groundwater conditions encountered in the borings are shown on the Record of Borehole sheets following the text of this report. The locations of

October 1990

891-2582-1

the boreholes are given on the Borehole Locations and Soil Strata, Drawing 1778903-A.\*

Samples of the soils encountered were taken to our laboratory for examination and classification testing. Samples of the soil were tested for moisture content, liquid and plastic limit, and grain size distribution. The results of the laboratory testing are given on the Record of Borehole sheets and on Figures 2 to 4.

The borehole locations and elevations were determined by Totten Sims Hubicki Associates personnel. The elevations are referenced to Geodetic datum.

#### 4. SUBSURFACE CONDITIONS

##### 4.1 General

The borehole logs indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling and the uniformity of the subsurface conditions.

Subsurface conditions between the boreholes may vary significantly from conditions encountered at the boreholes.

Groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities.

\* Dwg. No. 2 (Sheet No's 209 & 227) of the Contract Drawings.



The soil and bedrock descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil and bedrock involves judgement and Golder Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The soil and rock conditions described in this report are those observed at the time of the study. Unless otherwise noted, those conditions form the basis of the recommendations in this report. The condition of the soil may be significantly altered by construction activities such as construction traffic, excavation, pile driving, etc. Excavation may expose the soils to changes due to wetting, drying, or frost.

As previously indicated, the detailed soil, bedrock and groundwater conditions determined from the boreholes are given on the Record of Borehole sheets following the text of this report. The following sections present descriptions of the soil and groundwater conditions encountered in the boreholes.

#### 4.2 Topsoil, Fill

All of the boreholes encountered surficial deposits of topsoil. The topsoil has a thickness of between about 0.1 to 0.4 metres.

Borehole 1-5, advanced on the east side of the north bound lane bridge, encountered about 0.4 metres of fill composed of brown sand and gravel. This fill is in turn underlain by a 0.3 metre thick layer of topsoil.

#### 4.3 Silty Sand, Sand

Deposits of silty sand and sand with some silt were encountered beneath the surficial topsoil and/or fill deposits. These sandy deposits were found to have a thickness ranging from 0.3 metres (borehole 1-6) to 1.7 metres (borehole 1-3) and extend to depths ranging from 0.7 to 1.9 metres below ground surface (elevation 85.0 to 86.3 metres). Standard penetration N values obtained within this deposit range from 4 to 15 blows per 0.3 metres, which reflect a loose to compact relative density.

Grain size distribution curves for samples of the sand with some silt recovered from boreholes 1-2 and 1-5, respectively, are given on Figure 3. The natural water content of the silty sand and sand ranges from 20 to 26 percent.

#### 4.4 Sensitive Silty Clay

The surficial fill, topsoil and silty sand/sand are underlain at all of the borehole locations by a relatively thick deposit of sensitive grey silty clay. The silty clay deposit was found to have a thickness ranging from about 3.7 to 8.2 metres from east to west across the underpass site. Except for the silty clay encountered at depth in borehole 1-2, the silty clay deposit was found to be mottled with black organic matter. In situ vane testing carried out within the silty clay gave shear strengths ranging from about 68 kilopascals to more than 144 kilopascals, which reflect a stiff to very stiff consistency. The standard penetration N values within this deposit range from 2 to 7 blows per 0.3 metres. Atterberg limit tests on the silty clay gave liquid limit values of 47 and 51 and plastic limit values of about 25; these results are summarized on the Plasticity Chart, Figure 2. The moisture content of the silty clay is generally about midway between

the liquid and plastic limits, ranging from about 28 to 40 percent.

#### 4.5 Glacial Till

The silty clay is underlain by a deposit of glacial till. The glacial till was encountered at depths of 5.3 to 9.9 metres below ground surface (elevation 77.4 to 81.9 metres) and has a thickness of at least 4.9 to 10.5 metres.

The glacial till consists of a heterogeneous mixture of all grain sizes but may be generally described as a sandy silt with some gravel, clay, cobbles, and boulders. The results of a grain size distribution test carried out on a sample of the glacial till are given on Figure 4. It should be noted that the gradation test was carried out on a 38 millimetre I.D. split barrel sample and so does not reflect the presence of cobbles or boulders. In borehole 1-5, it was necessary to use diamond drilling techniques to penetrate the dense and bouldery glacial till.

Standard penetration tests carried out within the glacial till gave N values of 11 to 87 blows per 0.3 metres, which reflect a compact to very dense relative density.

The moisture content of the glacial till ranges from about 8 to 9 percent.

#### 4.6 Bedrock

The two cored boreholes encountered thinly to thickly bedded dolomitic limestone bedrock at depths of about 14.8 to 16.0 metres below ground surface (elevation 71.4 to 72.5 metres). Auger refusal was encountered at depths of 15.1 and 15.4

October 1990891-2582-1

metres in the remaining borings (elevation 71.9 to 72.0 metres).

A measure of the quality of the bedrock retrieved from the boreholes is shown on the respective Record of Borehole sheets as the percent recovery (REC) and Rock Quality Designation (RQD); for definitions of these parameters, reference should be made to the Explanation of Terms sheet following the text of this report. The amount of core lost during coring was very low, resulting in core recovery values of 95 to 100 percent. For the most part, the RQD values range from 42 to 100 percent (average of 65 percent), which reflect the fair quality of the bedrock. Fractured bedrock was encountered between 15.9 and 16.5 metres depth in borehole 1-2 and this is reflected in RQD values of between 0 and 18 percent. Thin mud seams were encountered in the bedrock.

#### 4.7 Groundwater

Groundwater levels were obtained from standpipes sealed in the completed borings. On May 12, 1990 the groundwater level was found to range from ground surface to 1.7 metres below ground surface. The groundwater levels are expected to be higher during wet periods of the year or after periods of heavy rain.

Groundwater samples from this site and other bridge sites along Highway 416 were submitted to Accutest Laboratories Ltd. for chemical analysis related to potential corrosion, the results of which are shown on the attached Report of Analyses No. A0-0708.

The results of the chemical analysis on the groundwater sample from this site are as follows:

pH	-	7.80
Conductivity	-	483 umhos/cm
Sulphate (SO <sub>4</sub> )	-	12 mg/L
Chloride (Cl)	-	48 mg/L

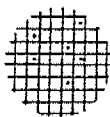
Note: The preceding report is a copy of the factual information from the Foundation Investigation and Design Report prepared by Golder Associates Ltd. (Consulting Geotechnical Engineers for this project for Totten Sims Hubicki Associates, the supervising consultant retained by M.T.O. The information contained in this report is the full responsibility of the consultants.



*P. Payer*  
P. Payer, P. Eng.  
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LAB REPORT NO.: A0-0708

13

**REPORT OF ANALYSES**Client: Golder AssociatesDate: May 8, 1990Project: 891-2582P. O. 15001

Report      Report      Report  
891-2582-2   891-2582-3   891-2582-1  
BH 2-5      BH 3-3      BH 1-5

Parameter	Units	Sample	Sample	Sample	Sample	Sample
		6' - 8'	10' -12'	± 12'		
Fe	mg/L					
Mn	mg/L					
Hardness	mg/L CaCO <sub>3</sub>					
Alkalinity	mg/L CaCO <sub>3</sub>					
pH		7.06	7.58	7.80		
Conductivity	umhos /cm	3020	546	483		
F	mg/L					
Na	mg/L					
N-NO <sub>3</sub>	mg/L					
N-NO <sub>2</sub>	mg/L					
N-NH <sub>3</sub>	mg/L					
SO <sub>4</sub>	mg/L	25	39	12		
CL	mg/L	812	5	48		
Phenols	mg/L					
Turbidity	NTU					
Colour	Pt/Co Units					
Ca	mg/L					
Mg	mg/L					
Tannin & Lignin	mg/L					
Total Nitrogen	mg/L					
K	mg/L					

ANALYST: 

# RECORD OF BOREHOLE No 1-1

METRIC

W P 177-89-03 LOCATION Sta. 9 + 887.3 2.0 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 24, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		UNIT WEIGHT Y	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	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
85.8	Ground Surface												
0.0	Topsoil												
0.3	Sand, fine to medium, trace silt and shells		1	SS	4		86						
25.0	Loose Brown to grey		2	SS	6		85						
1.8	Silty clay, trace black organic mottling		3	SR	5		84						
							83						
	Very Stiff Grey		4	SS	7		82						
81.0							81						
5.8	End of Borehole						80						

OFFICE REPORT ON SOIL EXPLORATION

\*3, x5: Numbers refer to  
Consistency

20  
15-25 (%) STRAIN AT FAILURE  
10



## METRIC

ORIGINATED BY D.J.S.

COMPILED BY A.C.

CHECKED BY     A.C.    

OFFICE REPORT ON SOIL EXPLORATION

20  
15  $\phi$  S (%) STRAIN AT FAILURE  
10

## METRIC

OFFICE REPORT ON SOIL EXPLORATION

[illegible]

## METRIC

OFFICE REPORT ON SOIL EXPLORATION

[illegible]

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 1-3

METRIC

W.P. 177-R9-03 LOCATION Sta. 9 + 949.5 2.7 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 23, 1990 CHECKED BY A.C.

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					
	Continued																
	Sandy silt, some gravel and clay, occasional cobble (glacial till)		10	SS	42		74										
	Compact to dense	Grey					73										
71.9							72										
15.4	End of Borehole Auger Refusal						71										

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 1-4

METRIC

W P 177-80-03 LOCATION Sta. 9 + 982.1 7.9 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 20, 1990 CHECKED BY A.C.

OFFICE REPORT ON SOIL EXPLORATION

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					
87.1	Ground Surface												
86.9	Topsoil												
85.8	Loose Brown Sand, fine, some silt		1	SS	9								
1.3	Sand, fine to coarse Brown												
1.4	Silty sand Grey		2	SS	3								
84	Silty clay, trace black organic mottling		3	TP	PH								
83	Stiff to very stiff Grey		4	SS	5								
82													
81			5	SS	12								
80	Sandy silt, some gravel, clay and cobbles, occasional boulder (glacial till)		6	SS	13								
79													
78			7	SS	12								
77													
76	Compact to very dense Grey		8	SS	24								
75													
74			9	SS	55								
73													

Continued

## METRIC

ELEV. DEPTH	SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION [%]				
	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES							W <sub>p</sub>	W	W <sub>L</sub>	
							20 40 60 80 100										
							SHEAR STRENGTH kPa										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
							20 40 60 80 100										
									WATER CONTENT (%)								
									20	40	60						

SOIL PROFILE										UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION [%] GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT					
			NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					W <sub>p</sub>	W	W <sub>L</sub>		
								20 40 60 80 100									
	Continued																
	Sandy silt, some gravel, clay and cobbles, occasional boulder (glacial till)						Bentonite Seal										
			10	SS	49		71										
	Compact to very dense Grey						Standpipe										
72.0							72										
15.1	End of Borehole Auger Refusal						73										

OFFICE REPORT ON SOIL EXPLORATION

Numbers refer to  
sitivity



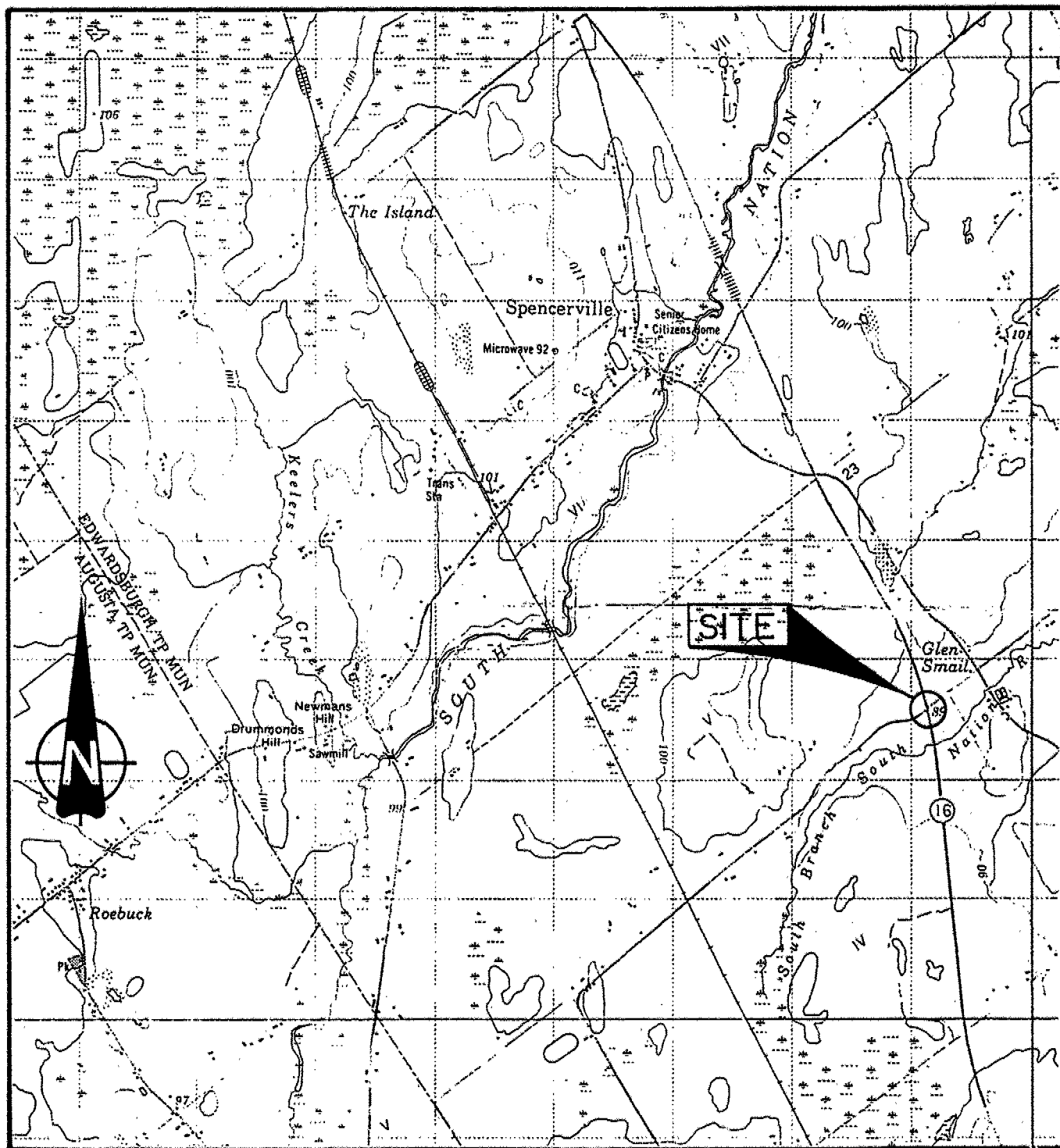




## METRIC

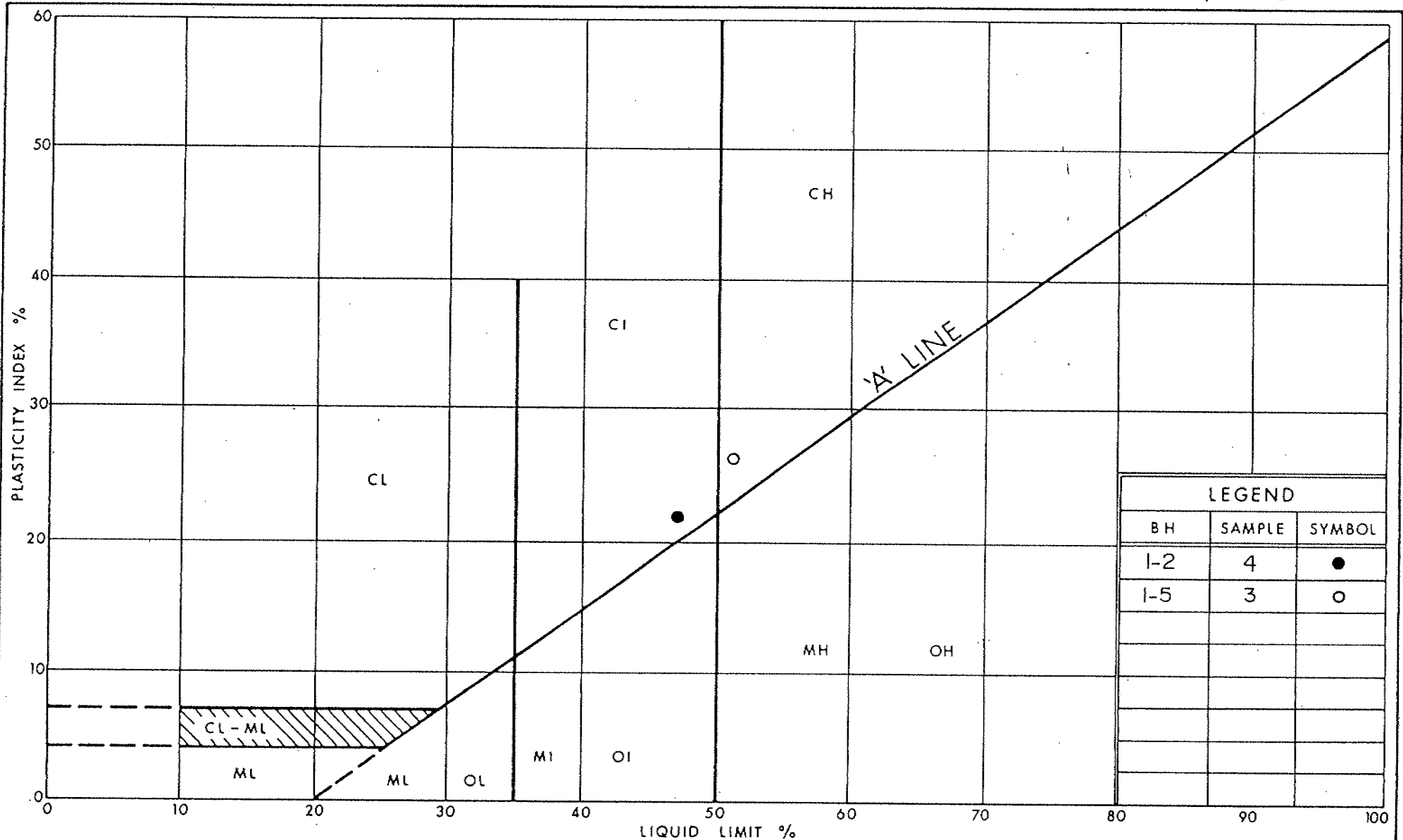
20  
 $\phi$  5 (%) STRAIN AT FAILURE  
 10

## KEY PLAN

FIGURE I  
WP 177-89-03SCALE  
1: 50,000Date AUG. 1, 1990  
Project 89I-2582

Golder Associates

Drawn JC  
Chkd. AC



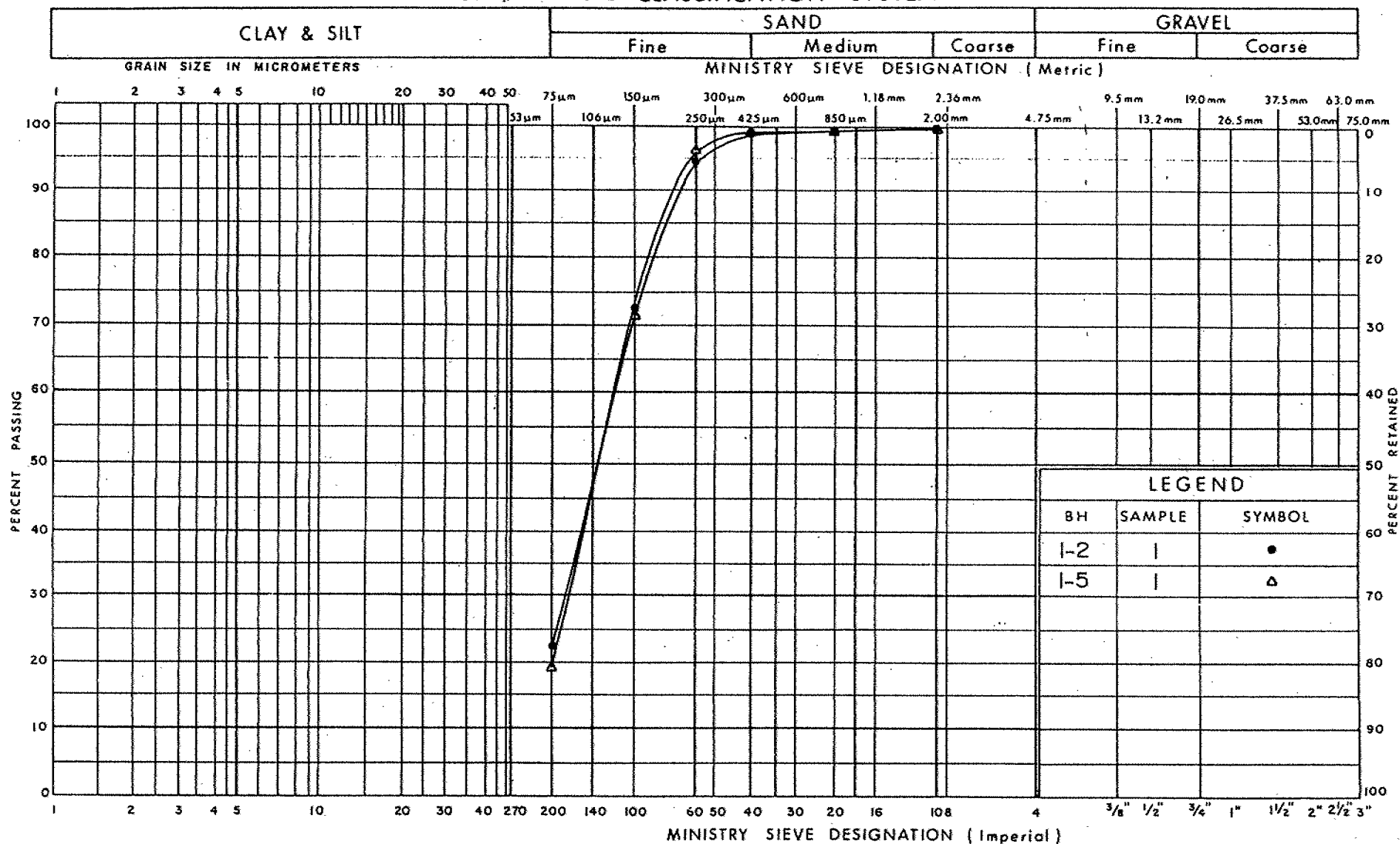
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# PLASTICITY CHART SILTY CLAY

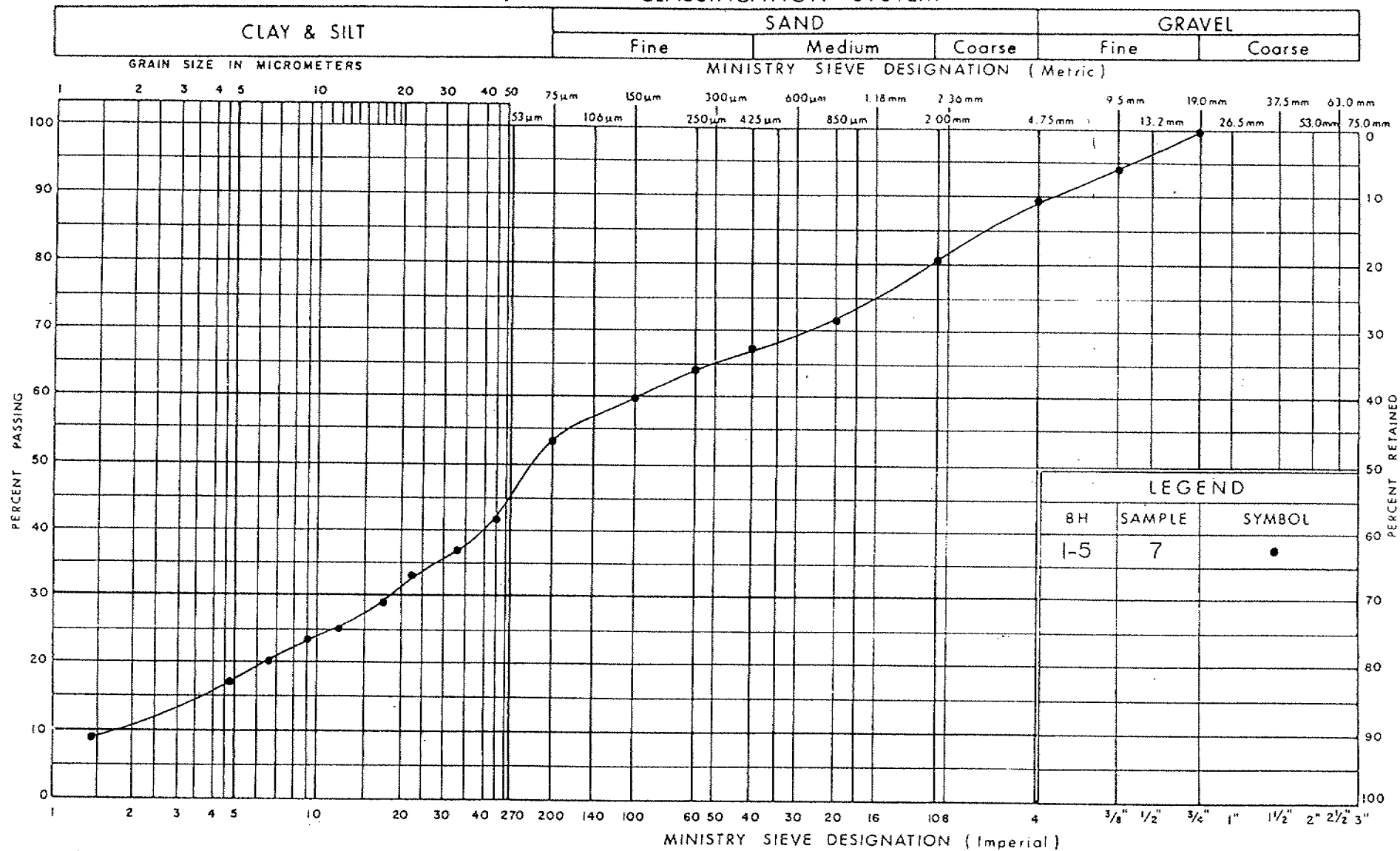
FIG No 2

W P 177-89-03

## UNIFIED SOIL CLASSIFICATION SYSTEM



## UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

## GRAIN SIZE DISTRIBUTION GLACIAL TILL

FIG No 4

W P 177-89-03

FOUNDATION INVESTIGATION REPORT  
for  
Proposed County Road 44 Underpass  
Hwy. 416  
W.P. 177-89-04, Site 16-310  
District #9 (Ottawa)

## 1. INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates, consultants to the Ministry of Transportation Ontario (MTO), to carry out a subsurface investigation at the site of a proposed underpass for County Road 44 at Highway 416 (see Key Plan, Figure 1). The purpose of the investigation was to determine the subsurface conditions at the site and, based on the factual information obtained, to provide recommendations on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The proposed underpass structure and realigned County Road 44 are to be located about 40 metres north of the present roadway alignment. The underpass will consist of two single span bridges crossing the northbound and southbound lanes of Highway 416. Each bridge will have a length of about 37 metres. The approach embankments and the embankment between the two structures will have a maximum height of about 8 to 10 metres above ground surface. The abutments for the proposed bridges are to be perched above existing ground surface.

## 2. SITE DESCRIPTION AND GEOLOGY

The site is located along the existing Highway 16 about 1.0 to 1.5 kilometres south of Spencerville, Ontario. The topography across the site is relatively flat, rising slightly to the west of the proposed south bound lane bridge. Ponded water was present west of Highway 16 at the time of the investigation. The bridge area west of Highway 16 is presently treed.

Geology maps suggest that this area is underlain by deposits of marine sand. Bedrock is expected to consist of Oxford formation dolostone. Drift thickness maps suggest that the overburden thickness may be about 9 metres.

### 3. PROCEDURE

The field work for this investigation was carried out between April 17 and 23, 1990. During this time, one borehole was advanced at each of the four bridge abutment locations for foundation design purposes. In addition, two shallow boreholes were advanced about 30 metres from both the east abutment of the east bridge (north bound lanes) and the west abutment of the west bridge (south bound lanes) to evaluate the subgrade conditions for the approach embankments near the bridges. Three of the boreholes put down in the abutment areas were advanced to bedrock and the bedrock was cored using BXL size diamond drilling equipment; the remaining borehole was advanced to practical auger refusal. The boreholes advanced in the embankment area were taken to depths of between about 5.2 and 5.5 metres below existing ground surface. Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using drive open sampling equipment. In situ vane testing was carried out where possible to determine the undrained shear strength characteristics of the silty clay. Standpipes were sealed into most of the boreholes to determine the groundwater conditions at the site. One sample of groundwater was obtained from borehole 2-5 and was submitted for basic chemical testing to evaluate the corrosivity of the groundwater on exposed concrete and unprotected steel. The field work was supervised throughout by a member of our engineering staff.

Logs of the soil bedrock and groundwater conditions encountered in the borings are shown on the Record of Borehole sheets following the text of this report.

The locations of the boreholes are given on the Borehole Locations and Soil Strata, Drawing 1778904-A.\*

\* Dwg. No. 2 (Sheet No's 245 & 268) of the Contract Drawings.



Samples of the soils encountered were taken to our laboratory for examination and classification testing. Samples of the soil were tested for moisture content, liquid and plastic limit, and grain size distribution. The results of the laboratory testing are given on the Record of Borehole sheets and on Figures 2 to 4.

The borehole locations and elevations were determined by Totten Sims Hubicki Associates personnel. The elevations are referenced to Geodetic datum.

#### 4. SUBSURFACE CONDITIONS

##### 4.1 General

The borehole logs indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling and the uniformity of the subsurface conditions.

Subsurface conditions between the boreholes may vary significantly from conditions encountered at the boreholes.

Groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities.

The soil and bedrock descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil and bedrock involves judgement and Golder Associates Ltd. does not guarantee descriptions as exact, but

infers accuracy to the extent that is common in current geotechnical practice.

The soil and rock conditions described in this report are those observed at the time of the study. Unless otherwise noted, those conditions form the basis of the recommendations in this report.

The condition of the soil may be significantly altered by construction activities such as construction traffic, excavation, pile driving, etc. Excavation may expose the soils to changes due to wetting, drying, or frost.

As previously indicated, the detailed soil, bedrock and groundwater conditions determined from the boreholes are given on the Record of Borehole sheets following the text of this report. The following sections present descriptions of the soil bedrock and groundwater conditions encountered in the boreholes.

#### 4.2 Topsoil, Fill, Silt

With the exception of borehole 2-6, all of the boreholes encountered surficial deposits of topsoil. The topsoil has a thickness of between 0.1 to 0.3 metres.

Borehole 2-5, advanced on the east side of the north bound lane bridge, encountered about 1.0 metre of fill composed of brown sand with some gravel, silt and cobbles.

At borehole 2-6 and beneath the topsoil and fill at borehole 2-5, a layer of dark brown silt containing trace amounts of organic matter was encountered. The thickness of this deposit ranges from 0.4 metres (borehole 2-5) to 1.5 metres (borehole 2-6). One standard penetration test carried out at borehole 2-6 showed that the split spoon sank under the weight of the hammer, which reflects a very loose relative density. The organic content of one sample

of this material was found to be 3.6 percent. The water content was determined to be 45 percent.

#### 4.3 Sandy Silt, Silty Sand, Sand

Deposits of sandy silt, silty sand and sand were encountered beneath the surficial topsoil, silt and/or fill deposits. These deposits were found to have a thickness ranging from 0.2 metres (borehole 2-1) to 3.6 metres (borehole 2-4) and to extend to depths ranging from 0.4 to 4.0 metres below ground surface (elevation 90.4 to 94.7 metres). Standard penetration N values obtained within these deposits range from 2 to 11 blows per 0.3 metres, which reflect a very loose to compact relative density.

Grain size distribution curves for samples of the sandy silt and sand recovered from borehole 2-4 are given on Figures 2 and 3. The natural water content of the sandy silt, silty sand and sand ranges from about 23 to 26 percent.

#### 4.4 Silty Clay

The sandy silty, silty sand, and sand deposits at boreholes 2-3 to 2-6, inclusive are underlain by a deposit of sensitive grey silty clay. The silty clay was found to have a thickness ranging from 1.5 to 4.1 metres. Except for the silty clay encountered in borehole 2-6, the silty clay deposit was found to be mottled with black organic matter. Standard penetration testing in this deposit gave N values ranging from 1 to 8 blows per 0.3 metres. In situ vane testing carried out within the silty clay gave shear strengths ranging from about 78 kilopascals to more than 120 kilopascals, which reflect a stiff to very stiff consistency. One Atterberg limit test on the silty clay gave a liquid limit value of 50 and a plastic limit of 25, which is characteristic of a clay having medium to high plasticity. The moisture content of the silty clay is about 33 to 39 percent.

#### 4.5 Glacial Till

Deposits of glacial till were encountered beneath the surficial silty sand and sand deposits at boreholes 2-1 and 2-2, and beneath the silty clay at boreholes 2-3, 2-4 and 2-5. The glacial till was encountered at depths ranging from 0.4 metres at borehole 2-1 to 8.1 metres at borehole 2-5 (elevation 86.3 to 94.7 metres).

The glacial till consists of a heterogeneous mixture of all grain sizes but may be generally described as a sandy silt with gravel, clay and cobbles; boulders should also be expected. The results of grain size distribution tests carried out on samples of the glacial till are given on Figure 4. It should be noted that the gradation tests were carried out on 38 millimetre I.D. split barrel samples and so do not reflect the presence of cobbles or boulders.

Standard penetration tests carried out within the glacial till gave N values of 11 to 116 blows per 0.3 metres, which reflect a compact to very dense relative density.

The moisture content of the glacial till ranges from about 8 to 9 percent.

#### 4.6 Bedrock

Bedrock was encountered and proven by coring at boreholes 2-3, 2-4 and 2-5. The bedrock consists of medium to thickly bedded grey dolomitic limestone and was encountered at depths of between about 7.7 and 8.9 metres below ground surface (elevation 85.0 to 86.6 metres). Auger refusal was encountered in borehole 2-2 at 8.3 metres below ground surface (elevation 85.6 metres).

A measure of the quality of the bedrock retrieved from the boreholes is shown on the Record of Borehole sheets as the percent recovery (REC) and Rock Quality Designation (RQD); for definitions

of these parameters, reference should be made to the Explanation of Terms sheet following the text of this report. The amount of core lost during coring was very low, resulting in core recovery values of 99 to 100 percent. The RQD values range from 40 to 96 percent (average of 76 percent) which reflect, on average, a good quality bedrock.

#### 4.7 Groundwater

Groundwater levels were obtained from standpipes sealed in the completed borings and by observing the water level in the open holes at the completion of drilling. Details on the standpipe installations and the groundwater information (elevation and time of measurement) are given on the Record of Borehole sheets. The boreholes advanced in the proposed underpass area showed water levels of between 0.3 and 1.2 metres below ground surface (elevation 93.1 to 93.6 metres). The groundwater level in borehole 2-1 was found to be somewhat higher (elevation 94.8 metres), which reflects a rise in ground surface elevation west of the overpass.

Groundwater samples from this site and other bridge sites along Highway 416 are submitted to Accutest Laboratories Ltd. for chemical analysis related to potential corrosion, the results of which are shown on the attached Report of Analyses No. A0-0708.

The results of the chemical analysis on the groundwater sample from this site are as follows:

pH	-	7.06
Conductivity	-	3020 umhos/cm
Sulphate (SO <sub>4</sub> )	-	25 mg/L
Chloride (Cl)	-	48 mg/L

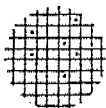
Note: The preceding report is a copy of the factual information from the Foundation Investigation and Design Report prepared by Golder Associates Ltd. (Consulting Geotechnical Engineers for this project for Totten Sims Hubicki Associates, the supervising consultant retained by M.T.O. The information contained in this report is the full responsibility of the consultants.



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LAB REPORT NO.: A0-0708

37

**REPORT OF ANALYSES**Client: Golder AssociatesDate: May 8, 1990Project: 891-2582P. O. 15001

Report      Report      Report  
891-2582-2   891-2582-3   891-2582-1  
BH 2-5      BH 3-3      BH 1-5

Parameter	Units	Sample	Sample	Sample	Sample	Sample
		6' - 8'	10' -12'	± 12'		
Fe	mg/L					
Mn	mg/L					
Hardness	mg/L CaCO <sub>3</sub>					
Alkalinity	mg/L CaCO <sub>3</sub>					
pH		7.06	7.58	7.80		
Conductivity	umhos /cm	3020	546	483		
F	mg/L					
Na	mg/L					
N-NO <sub>3</sub>	mg/L					
N-NO <sub>2</sub>	mg/L					
N-NH <sub>3</sub>	mg/L					
SO <sub>4</sub>	mg/L	25	39	12		
CL	mg/L	812	5	48		
Phenols	mg/L					
Turbidity	NTU					
Colour	Pl/Co Units					
Ca	mg/L					
Mg	mg/L					
Tannin & Lignin	mg/L					
Total Nitrogen	mg/L					
K	mg/L					

ANALYST: 

# RECORD OF BOREHOLE No 2-1

METRIC

W.P. 177-89-04 LOCATION Sta. 9 + 873.7 0.1 Rt. ORIGINATED BY P.H.  
 DIST 9 HWY. 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
05.1	Ground Surface															
0.0	Topsoil						95									
0.2	Silty sand Gray brown															
0.4	Sandy silt, some gravel, trace clay, occasional cobble (glacial till)		1	SS	27		94									
			2	SS	60											
			3	SS	15		93									
			4	SS	28		92									
			5	SS	25		91									
89.9	Compact Brown to grey		6	SS	11		90									
5.2	End of Borehole						89									

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 2-2

METRIC

W.P. 177-R9-04 LOCATION Sta. 9 + 903.9 0.2 Lt. ORIGINATED BY P.H.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

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 Y	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					
93.0	Ground Surface																
0.0	Topsoil																
0.2 93.4	Sand, fine, some silt Brown		1	AS*	-												
0.5	Sandy silt and gravel, trace clay (glacial till)																
0.5	Compact Brown		2	SS	23												
1.4	Sandy silt, and gravel, trace clay, some cobbles (glacial till)		3	SS	116												
			4	SS	54												
			5	SS	47												
0.3 89.3	Dense to very dense Brown to grey		6	SS	36												
4.6	Sandy silt, some gravel, trace to some clay (glacial till)		7	SS	19												
			8	SS	19												
			9	SS	15												
			10	SS	13												
	Compact Grey		11	SS	59												
8.3 85.6	End of Borehole Auger Refusal																
	* AS: Auger Sample																

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2-3

METRIC

W P 177-R9-04 LOCATION Sta. 9 + 942.4 4.7 Rt. ORIGINATED BY P.H.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.  
 DATUM Geodetic DATE April 18 and 19, 1990 CHECKED BY A.C.

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
93.6	Ground Surface																
0.0	Topsoil																
0.3	Sand, fine to medium, trace silt	Brown															
0.8	Sandy silt, some clayey silt and silty sand seams		1	SS	5												
0.9	Very loose	Grey brown to grey	2	SS	2												
2.1	Silty clay, some silty sand seams, trace black organic mottling		3	SS	1												
4.0	Stiff	Grey	4	SS	3												
7.6	Sandy silt and gravel, trace clay occasional cobble (glacial till)		5	SS	26												
			6	SS	19												
			7	SS	17												
			8	SS	13												
			9	SS	18												
	Compact	Grey															
15.0			10	SS	75 for 80 mm												
18.5	Dolomitic limestone bedrock, fresh, medium to thickly bedded, bedding horizontal, thin mud seam at 11.0 metres depth		11	RC BXL	REC=100% RQD=86%												
			12	RC BXL	REC=100% RQD=96%												
22.1																	
11.5	End of Borehole																

\* REC: Recovery  
 RQD: Rock Quality  
 Designation

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

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2-4

METRIC

W P 177-R9-04 LOCATION Sta. 9 + 976.2 0.4 Lt. ORIGINATED BY P.H.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.  
 DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

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					
94.3	Ground Surface																
94.0	Topsoil																
92.2	Sand, fine to medium, some silt Loose to very loose	Brown	1	SS	9												0 89 (11)
92.2			2	SS	2												
90.5	Sandy silt to silty sand, some silty clay seams Loose	Grey	3	SS	5												0 36 56 8
90.5			4	SS	5												
89.8	Silty clay, trace black organic mottling, sand and gravel layer at 4.0 metre depth		5	SS	3												
89.8			6	SS	3												
89.8			7	SS	3												
88.9	Very stiff to stiff	Grey															
88.6	Sandy silt (glacial till) grey																
88.6																	
87.7	Dolomite limestone fresh to faintly weathered, medium to thickly bedded, some near vertical joints			RC	REC= 100%												
87.7				BXL	RQD= 40%												
87.7				RC	REC= 100%												
87.7				BXL	RQD= 68%												
83.5	End of Borehole																
83.5																	

+3, x5: Numbers refer to Sensitivity  
 20  
 15 ÷ 5 (%) STRAIN AT FAILURE  
 10



## METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV (DEPTH)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							
								SHEAR STRENGTH kPa							
							○ UNCONFINED • QUICK TRIAXIAL	+ FIELD VANE x LAB VANE							
							20 40 60 80 100			20 40 60					

[illegible]

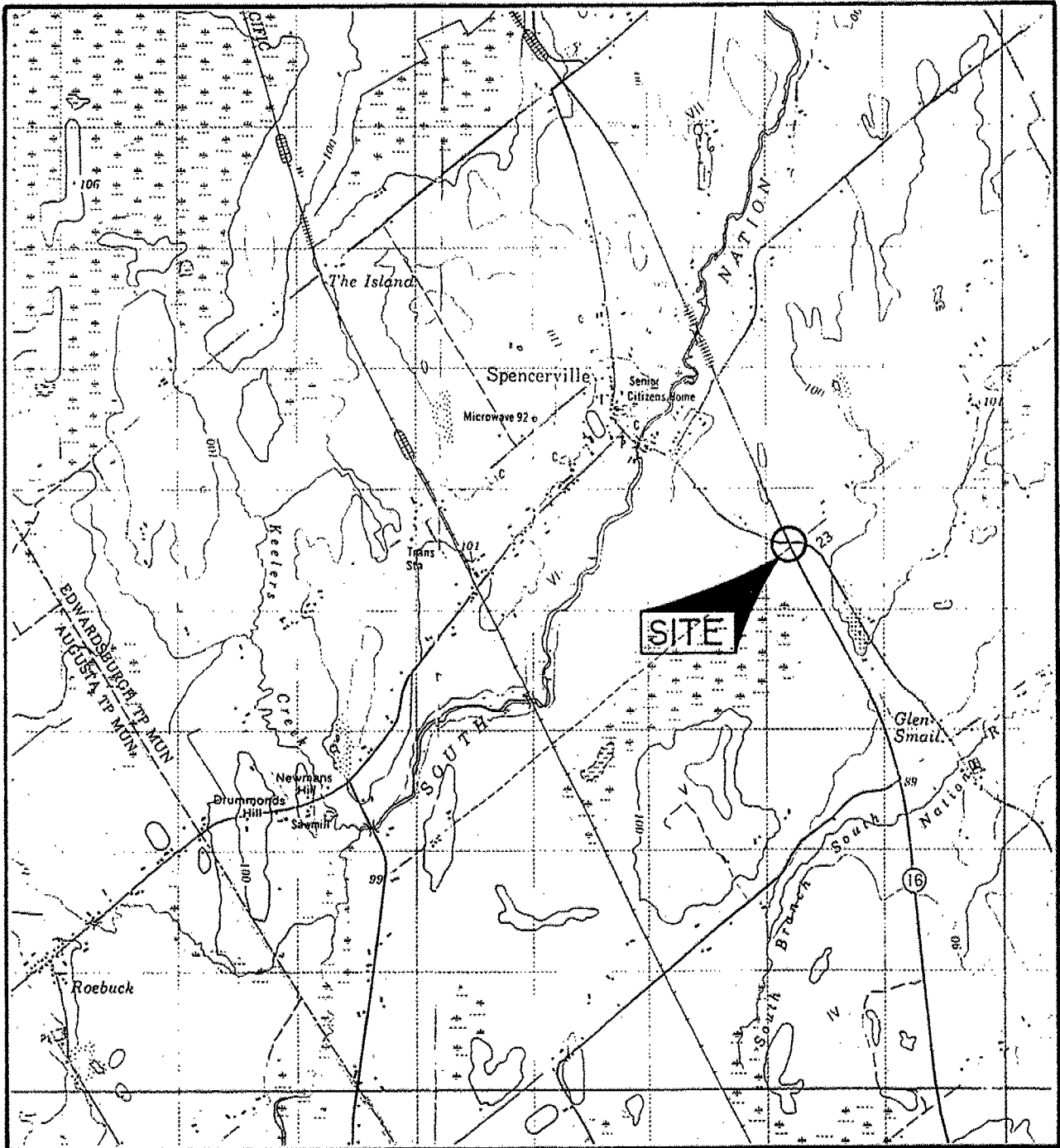
OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15   
10

# KEY PLAN

44  
FIGURE 1  
WP 177-89-04



SCALE  
1: 50,000

Date AUG. 2, 1990

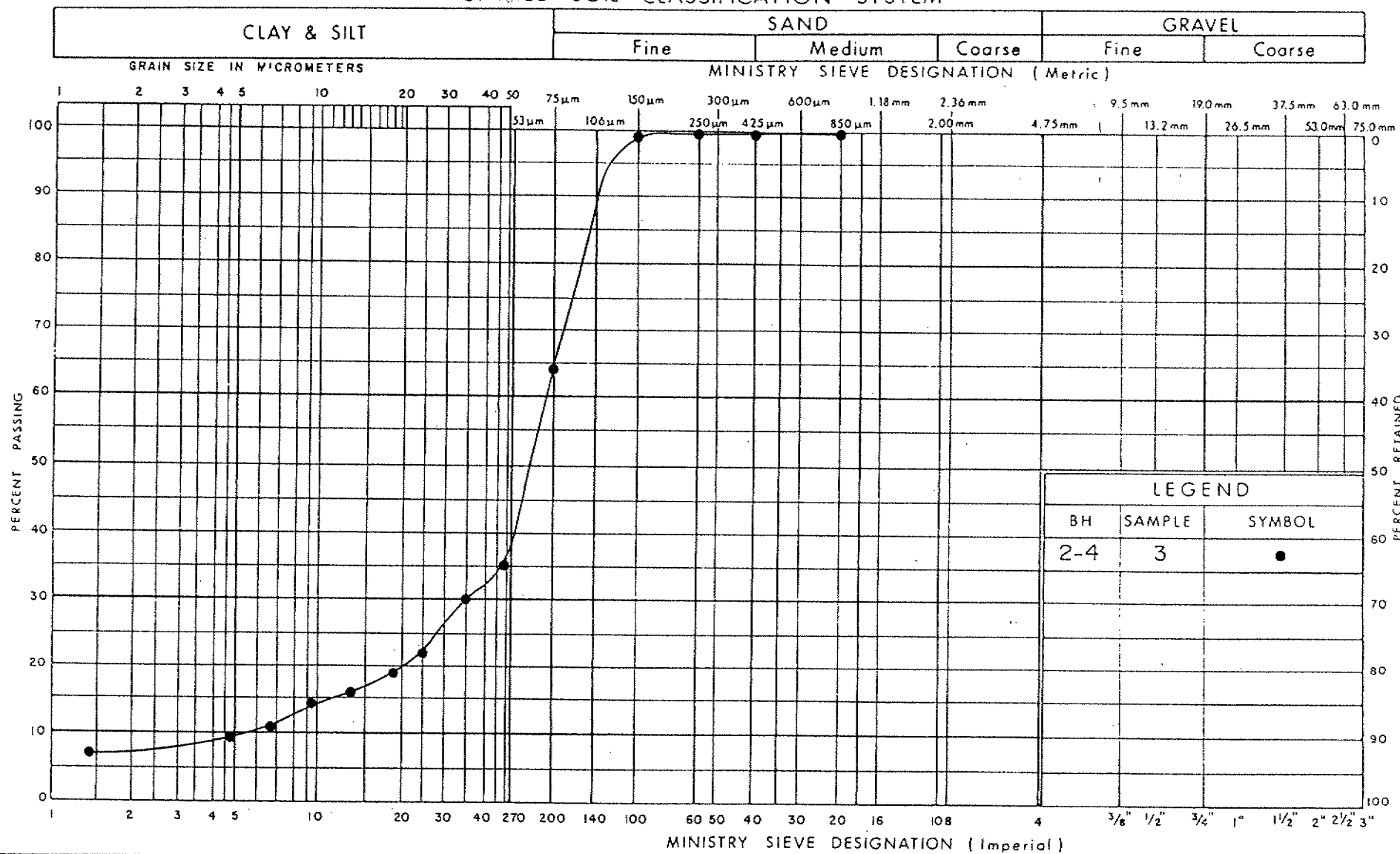
Project 891-2582-2

Golder Associates

Drawn JC

Chkd. AC

## UNIFIED SOIL CLASSIFICATION SYSTEM



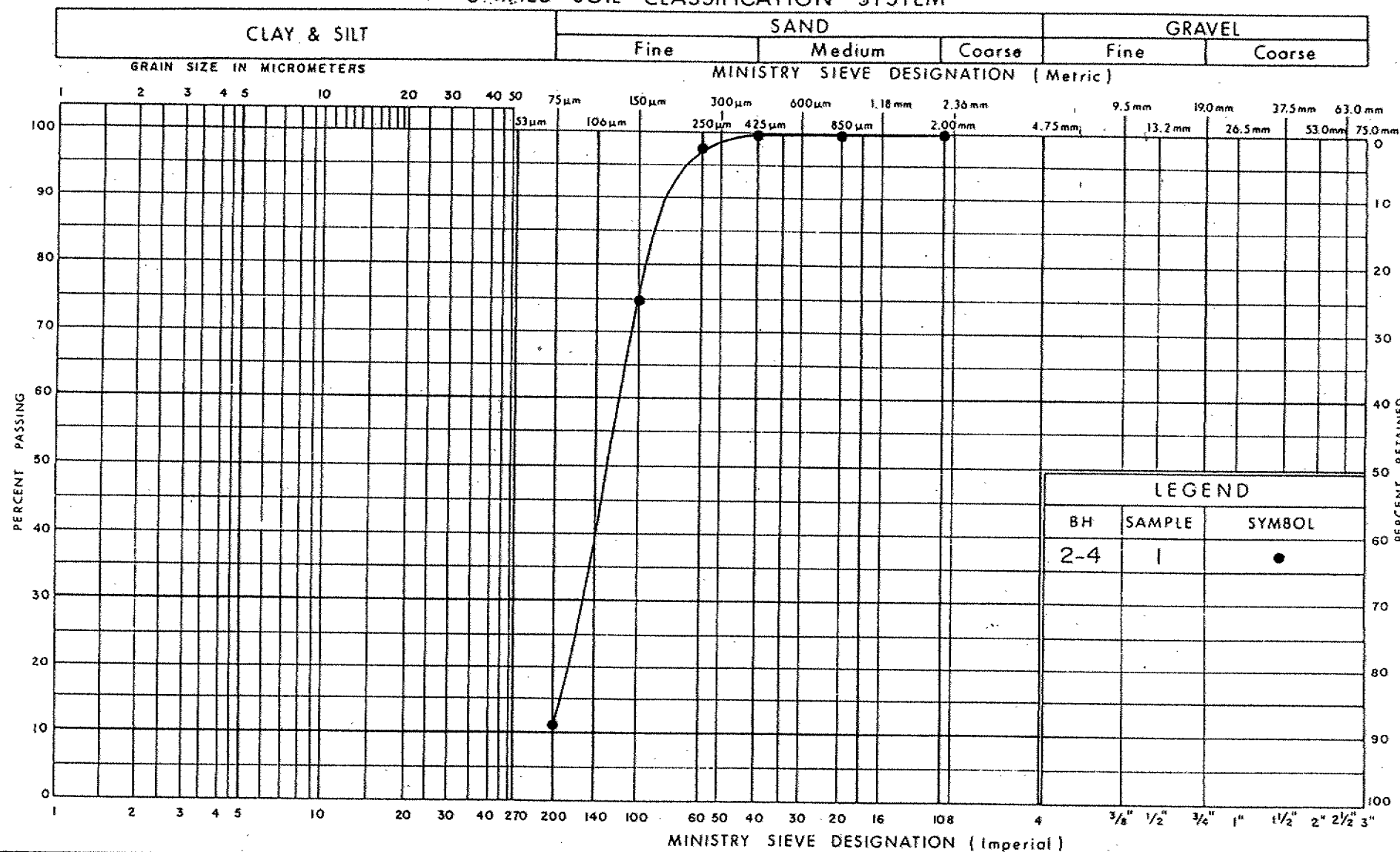
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SANDY SILT, SILTY SAND

FIG No 2

W P 177-89-04

## UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of  
Transportation

 GRAIN SIZE DISTRIBUTION  
SAND, some silt

FIG No 3

W P 177-89-04



## UNIFIED SOIL CLASSIFICATION SYSTEM

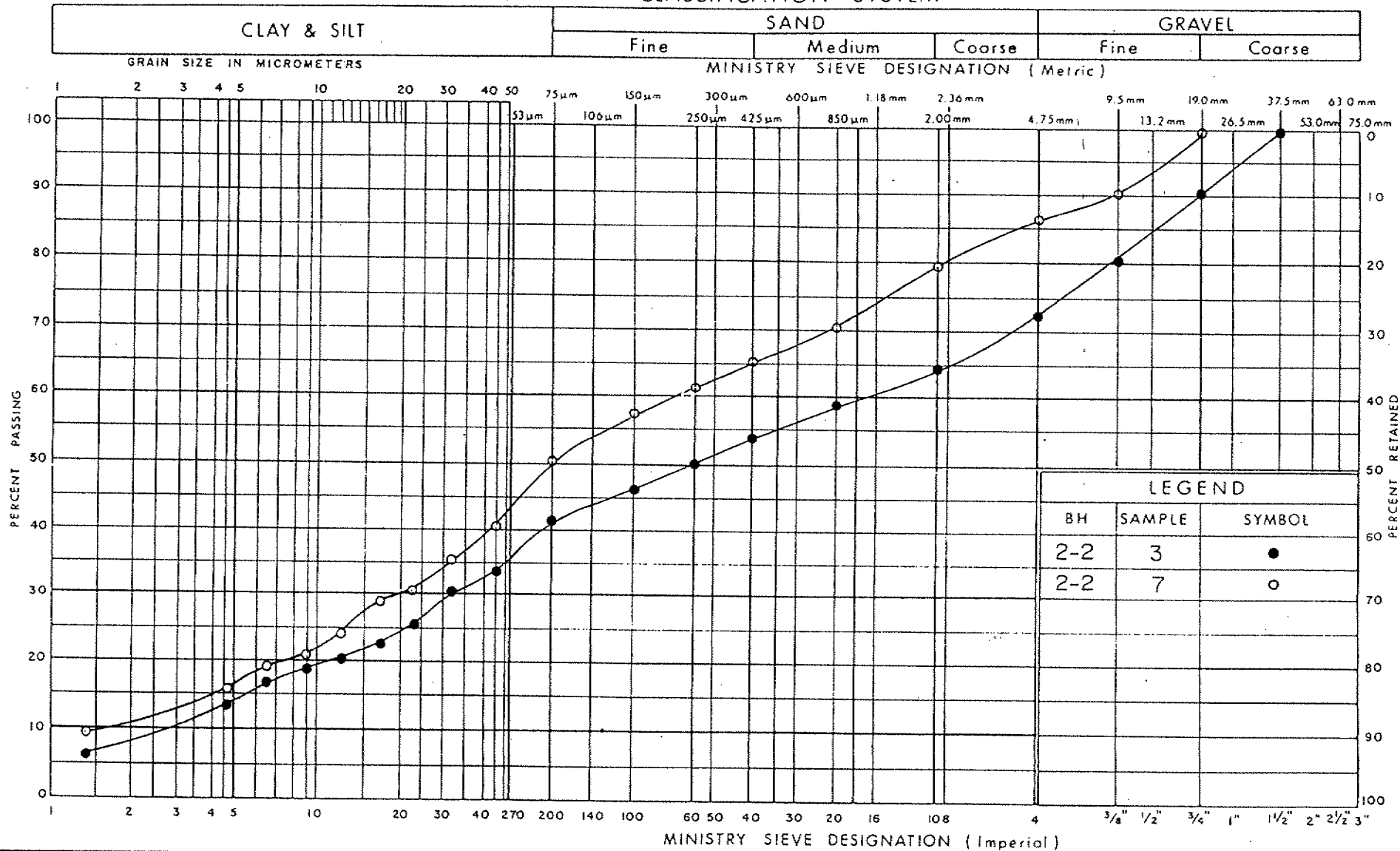
GRAIN SIZE DISTRIBUTION  
GLACIAL TILL

FIG No 4

W P 177-89-04

Ministry of  
Transportation

Ontario



# Golder Associates Ltd.

CONSULTING ENGINEERS

REPORT TO

TOTTEN SIMS HUBICKI ASSOCIATES

FOUNDATION INVESTIGATION  
PROPOSED GLEN SMALL ROAD UNDERPASS  
HIGHWAY 416  
W.P. 177-89-03, SITE 16-309  
DISTRICT 9 (OTTAWA) EASTERN REGION

*CONT. 94-28*  
*GEOCRE# 31B-60*

## Distribution:

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Ottawa, Ontario

October 1990

891-2582-1

TABLE OF CONTENTS

	<u>Page No.</u>
1. INTRODUCTION	1
2. SITE DESCRIPTION AND GEOLOGY	1
3. PROCEDURE	2
4. SUBSURFACE CONDITIONS	3
4.1 General	3
4.2 Topsoil, Fill	4
4.3 Silty Sand, Sand	5
4.4 Sensitive Silty Clay	5
4.5 Glacial Till	6
4.6 Bedrock	6
4.7 Groundwater	7
5. PROPOSED GLEN SMAIL ROAD UNDERPASS	9
5.1 Bridge Foundations	9
5.2 Abutment Wall Backfill and Earth Pressures	11
5.3 Embankment Stability and Settlement	12
5.4 Corrosion of Buried Structures	13
5.5 Construction Considerations	13
ACCUTEST LABORATORIES REPORT NO. A0-0708	In order following
EXPLANATION OF TERMS USED IN THE REPORT	page 14
RECORD OF BOREHOLE SHEETS	
FIGURES 1 TO 4 AND DRAWING 1778903-A	

## 1. INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates, consultants to the Ministry of Transportation Ontario (MTO), to carry out a subsurface investigation at the site of a proposed underpass for Glen Smail Road at Highway 416 (see Key Plan, Figure 1). The purpose of the investigation was to determine the subsurface conditions at the site and, based on the factual information obtained, to provide recommendations on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The proposed underpass structure and realigned Glen Smail Road are to be located about 40 to 50 metres north of the present roadway alignment. The underpass will consist of two single span bridges crossing the north bound and south bound lanes of Highway 416. Each bridge will have a length of about 34 metres. The approach embankments and the embankment between the two structures will have a maximum height of about 8.5 to 9.0 metres above ground surface. The abutments for the proposed bridges are to be perched above existing ground surface.

## 2. SITE DESCRIPTION AND GEOLOGY

The site is located along existing Highway 16 some 4 kilometres south of Spencerville, Ontario. The topography across the site is relatively flat. Ponded water was present west of Highway 16 at the time of the investigation. The west bridge area is presently treed.

Geology maps suggest that this area is underlain by deposits of marine sand. Bedrock is expected to consist of Oxford

formation dolostone. Drift thickness maps suggest that the overburden thickness may be about 12 metres.

### 3. PROCEDURE

The field work for this investigation was carried out between April 16 and 24, 1990. During this time, boreholes were advanced at each of the abutment locations for foundation design purposes. In addition two shallow boreholes were advanced about 30 metres from both the east abutment of the east bridge (north bound lanes) and the west abutment of the west bridge (south bound lanes) to evaluate the subgrade conditions for the approach embankments near the bridges. Two boreholes put down in the abutment areas were advanced to bedrock and the bedrock cored using BXL size diamond drilling equipment; the other boreholes were advanced to practical auger refusal. The boreholes advanced in the embankment area were taken to a depth of about 5.8 metres below existing ground surface. Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using drive open sampling equipment. In situ vane testing was carried out where possible to determine the undrained shear strength characteristics of the silty clay. Standpipes were sealed into all of the boreholes to determine the groundwater conditions at the site. One sample of groundwater was obtained from borehole 1-5 and was sent to a laboratory for basic chemical testing to evaluate the corrosivity of the groundwater on exposed concrete and unprotected steel. The field work was supervised throughout by a member of our engineering staff.

Logs of the soil, bedrock and groundwater conditions encountered in the borings are shown on the Record of Borehole sheets following the text of this report. The locations of

the boreholes are given on the Borehole Locations and Soil Strata, Drawing 1778903-A.

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Groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities.

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As previously indicated, the detailed soil, bedrock and groundwater conditions determined from the boreholes are given on the Record of Borehole sheets following the text of this report. The following sections present descriptions of the soil and groundwater conditions encountered in the boreholes.

#### 4.2 Topsoil, Fill

All of the boreholes encountered surficial deposits of topsoil. The topsoil has a thickness of between about 0.1 to 0.4 metres.

Borehole 1-5, advanced on the east side of the north bound lane bridge, encountered about 0.4 metres of fill composed of brown sand and gravel. This fill is in turn underlain by a 0.3 metre thick layer of topsoil.

#### 4.3 Silty Sand, Sand

Deposits of silty sand and sand with some silt were encountered beneath the surficial topsoil and/or fill deposits. These sandy deposits were found to have a thickness ranging from 0.3 metres (borehole 1-6) to 1.7 metres (borehole 1-3) and extend to depths ranging from 0.7 to 1.9 metres below ground surface (elevation 85.0 to 86.3 metres). Standard penetration N values obtained within this deposit range from 4 to 15 blows per 0.3 metres, which reflect a loose to compact relative density.

Grain size distribution curves for samples of the sand with some silt recovered from boreholes 1-2 and 1-5, respectively, are given on Figure 3. The natural water content of the silty sand and sand ranges from 20 to 26 percent.

#### 4.4 Sensitive Silty Clay

The surficial fill, topsoil and silty sand/sand are underlain at all of the borehole locations by a relatively thick deposit of sensitive grey silty clay. The silty clay deposit was found to have a thickness ranging from about 3.7 to 8.2 metres from east to west across the underpass site. Except for the silty clay encountered at depth in borehole 1-2, the silty clay deposit was found to be mottled with black organic matter. In situ vane testing carried out within the silty clay gave shear strengths ranging from about 68 kilopascals to more than 144 kilopascals, which reflect a stiff to very stiff consistency. The standard penetration N values within this deposit range from 2 to 7 blows per 0.3 metres. Atterberg limit tests on the silty clay gave liquid limit values of 47 and 51 and plastic limit values of about 25; these results are summarized on the Plasticity Chart, Figure 2. The moisture content of the silty clay is generally about midway between



the liquid and plastic limits, ranging from about 28 to 40 percent.

#### 4.5 Glacial Till

The silty clay is underlain by a deposit of glacial till. The glacial till was encountered at depths of 5.3 to 9.9 metres below ground surface (elevation 77.4 to 81.9 metres) and has a thickness of at least 4.9 to 10.5 metres.

The glacial till consists of a heterogeneous mixture of all grain sizes but may be generally described as a sandy silt with some gravel, clay, cobbles, and boulders. The results of a grain size distribution test carried out on a sample of the glacial till are given on Figure 4. It should be noted that the gradation test was carried out on a 38 millimetre I.D. split barrel sample and so does not reflect the presence of cobbles or boulders. In borehole 1-5, it was necessary to use diamond drilling techniques to penetrate the dense and bouldery glacial till.

Standard penetration tests carried out within the glacial till gave N values of 11 to 87 blows per 0.3 metres, which reflect a compact to very dense relative density.

The moisture content of the glacial till ranges from about 8 to 9 percent.

#### 4.6 Bedrock

The two cored boreholes encountered thinly to thickly bedded dolomitic limestone bedrock at depths of about 14.8 to 16.0 metres below ground surface (elevation 71.4 to 72.5 metres). Auger refusal was encountered at depths of 15.1 and 15.4

metres in the remaining borings (elevation 71.9 to 72.0 metres).

A measure of the quality of the bedrock retrieved from the boreholes is shown on the respective Record of Borehole sheets as the percent recovery (REC) and Rock Quality Designation (RQD); for definitions of these parameters, reference should be made to the Explanation of Terms sheet following the text of this report. The amount of core lost during coring was very low, resulting in core recovery values of 95 to 100 percent. For the most part, the RQD values range from 42 to 100 percent (average of 65 percent), which reflect the fair quality of the bedrock. Fractured bedrock was encountered between 15.9 and 16.5 metres depth in borehole 1-2 and this is reflected in RQD values of between 0 and 18 percent. Thin mud seams were encountered in the bedrock.

#### 4.7 Groundwater

Groundwater levels were obtained from standpipes sealed in the completed borings. On May 12, 1990 the groundwater level was found to range from ground surface to 1.7 metres below ground surface. The groundwater levels are expected to be higher during wet periods of the year or after periods of heavy rain.

Groundwater samples from this site and other bridge sites along Highway 416 were submitted to Accutest Laboratories Ltd. for chemical analysis related to potential corrosion, the results of which are shown on the attached Report of Analyses No. A0-0708.

The results of the chemical analysis on the groundwater sample from this site are as follows:

pH	-	7.80
Conductivity	-	483 umhos/cm
Sulphate (SO <sub>4</sub> )	-	12 mg/L
Chloride (Cl)	-	48 mg/L

## 5. PROPOSED GLEN SMAIL ROAD UNDERPASS

### 5.1 Bridge Foundations

The proposed single span bridge structures are to be supported on abutments perched above existing ground surface. It is understood that these structures will be relatively insensitive to post construction differential movement. For a standard size conventional spread footing foundation, it is understood that the required bearing capacity would be about 300 to 400 kilopascals.

If conventional spread footings are used for the bridge abutments, the significant founding surface is the thick deposit of sensitive silty clay. Based on the shear strength information obtained from the borings, the Serviceability Limit States (SLS) and Ultimate Limit States (ULS) bearing pressures would be limited to 160 and 300 kilopascals, respectively. Similar bearing pressures could be used for footings bearing on a pad of granular material placed above the silty clay and surficial sandy deposits.

Based on these bearing pressures, it is understood that conventional spread footings may not be feasible and/or economic for these structures. Therefore, it is recommended that the proposed bridge structure be founded on driven end bearing steel piles. The piles could consist of either concrete filled steel pipe piles or steel H-piles. Based on the boring results, piles at this site should terminate at between about elevation 71.4 and 72.5 metres (average of about elevation 71.9 metres at four borehole locations), provided that large boulders are not encountered by the piles during driving within the glacial till.

As a design example, the Serviceability Limit States (SLS) load for a 245 millimetre diameter steel pipe pile having a wall thickness of 12 millimetres may be taken as 1150 kilonewtons; the factored capacity at Ultimate Limit States (ULS) can be taken as 1350 kilonewtons. These values assume that 350 megapascal strength steel and 30 megapascal concrete are used. The pipe piles should be set to a final refusal of 10 blows for the last 12 millimetres of penetration using a hammer transferring about 40 kilojoules of energy per blow.

Alternatively, for a HP 310x110 steel H pile, the SLS and ULS loads could be taken as 1150 and 1600 kilonewtons, respectively. In this case, the H-pile should be set to a termination of 10 blows for the last 12 millimetres of penetration using a hammer transferring about 60 kilojoules of energy per blow to the pile.

Based on piling experience in this area, it is possible that several rounds of restriking could be required to achieve permanence of the final set. Therefore, provision should be made for restriking all of the piles at least once to confirm the set. Piles that do not meet the design set criteria on the first or subsequent restrike would require additional restriking. A minimum of two days should be allowed before restriking a pile.

It is recommended that the piles be battered in a direction away from the structure, as well as in the normal direction towards the roadway.

Since the glacial till contains boulders, the piles should be equipped with a cast steel driving shoe. Some pile alignment and driving difficulties should be expected due to the bouldery nature of the glacial till; some of the piles may be driven off plumb, or bend, or may terminate erratically in the

glacial till. Additional piles may be required where piles are damaged or bent. In this regard, pipe piles offer some advantage over H-piles since they can be inspected for damage following installation and can be checked for plumbness and curvature.

Allowance should be made for pile load testing at the time of construction.

The pile caps, in snow cleared or protected areas, should be provided with at least 1.8 metres of earth cover for frost protection purposes.

#### 5.2 Abutment Wall Backfill and Earth Pressures

The abutments should be backfilled with compacted non frost susceptible, free draining backfill such as that meeting Ontario Provincial Standard Specifications (OPSS) for Granular B Type I or II. The granular fill should extend at least 1.5 metres beyond the inside face of the abutments and should be compacted in thin lifts to at least 95 percent of standard Proctor density. If lateral movement at the top of the abutment of about 0.05 percent of the retained height is expected to occur, "active" earth pressure coefficients ( $K_a$ ) should be used in determining the horizontal load on the abutments. If the wall movement is expected to be less, then "at rest" pressure coefficients ( $K_o$ ) should be used.

Assuming that a well graded sand and gravel backfill material meeting OPSS Granular B Type I material is used behind the abutments, a material unit weight of 21.2 kilonewtons per cubic metre may be used together with the following earth pressure coefficients in determining the lateral load on the abutments.

Earth Pressure  
Coefficient

## At Ultimate Limit States

"at rest" condition	0.55
"active" condition	0.38

## At Serviceability Limit States

"at rest" condition	0.47
"active" condition	0.31

Earth pressure parameters for other materials could be provided if necessary.

To reduce compaction induced stress on the abutment walls, the granular fill near the abutments should be compacted with walk behind compaction equipment.

Highway live loads should be considered on the abutments unless approach slabs are used.

### 5.3 Embankment Stability and Settlement

The approach embankments and the centre embankment will have a maximum height of about 8.5 to 9.0 metres above ground surface. Since the silty clay soils at this site have a stiff to very stiff consistency, no short or long term stability or settlement problems are expected for the embankments within 30 metres of the abutments. Embankment fill should meet the requirements of OPSS 212 for borrow material, and should be placed and compacted in accordance with OPSS 206. If sandy earth borrow, rock borrow, or select subgrade material is used, embankment side slopes may be constructed at 2 horizontal to 1 vertical. If silty or clayey earth borrow is used, embankment side slopes should be 2.5 horizontal to 1 vertical or flatter.

Seeding and mulching should be considered to reduce surficial erosion and gullyng of the embankment slopes.

Provided that all surficial organic materials are removed prior to placing fill material, the settlement of the embankments should be less than 25 millimetres.

#### 5.4 Corrosion of Buried Structures

As previously indicated, the sulphate content of the groundwater was found to be 12 milligrams per litre. According to CSA CAN 3 A23.1-M77, the measured level of sulphate should not be corrosive to concrete where normal Portland Type 10 cement is used.

The groundwater should not be significantly corrosive to steel piles driven through native undisturbed soils.

#### 5.5 Construction Considerations

It is recommended that the pile driving equipment proposed by the contractor be reviewed in light of the contract pile type and set criteria and accepted by the geotechnical engineer well in advance of any pile driving operations. Also, all piling operations should be inspected throughout by qualified geotechnical personnel.

Groundwater and surface water control may be required while placing and compacting the lower lifts of fill for the embankments. To facilitate pile driving, the fill material used beneath the abutments should not contain cobble or boulder size material (i.e. not large than 75 millimetres).



The soils at this site are highly susceptible to frost heaving. Therefore, the native soils around the piles should be protected from freezing during construction to prevent pile jacking due to adfreeze effects.

A licensed welding inspector should be retained during the pile driving to periodically inspect the welding procedures used by the contractor if welded pile splices are used.

We trust that this report contains sufficient information for your purposes. Should you have any questions, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.



A.F. Chevrier, P. Eng.



R.A. Montgomery, P. Eng.



AFC:RAM:cr:jf  
Disk 15

Att.

## REPORT OF ANALYSES

Client: Golder Associates

Date: May 8, 1990

Project: 891-2582

P. O. 15001

Report	Report	Report
891-2582-2	891-2582-3	891-2582-1
BH 2-5	BH 3-3	BH 1-5

[illegible]

ANALYST.

## 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

### 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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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 = $\frac{c_u}{\tau_r}$

### 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						

# RECORD OF BOREHOLE No 1-1

METRIC

W P 177-89-03 LOCATION Sta. 9 + 887.3 2.0 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 24, 1990 CHECKED BY A.C.

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										
86.8	Ground Surface																	
0.0	Topsoil																	
0.3	Sand, fine to medium, trace silt and shells		1	SS	4		86											
0.5	Loose Brown to grey		2	SS	6		85											
1.8	Silty clay, trace black organic mottling		3	SS	5		84											
							83											
	Very Stiff Grey		4	SS	7		82											
81.0							81											
5.8	End of Borehole						80											

OFFICE REPORT ON SOIL EXPLORATION



## METRIC

W P 177-89-03 LOCATION Sta. 9 + 916.4 2.9 Lt. ORIGINATED BY D.J.S.  
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.  
DATUM Geodetic DATE April 16, 1990 CHECKED BY A.C.

[illegible]

+3, x5; Numbers refer to  
Sensitivity



# RECORD OF BOREHOLE No 1-2

METRIC

W P 177-89-03 LOCATION Sta. 9 + 916.4 2.9 Lt. ORIGINATED BY D.V.S.  
DIST a HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.  
DATUM Geodetic DATE April 16, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					PLASTIC LIMIT W <sub>p</sub>	W		
						20 40 60 80 100					20 40 60					
						O UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)					
						20 40 60 80 100					20 40 60					
	Continued															
	Sandy silt some gravel and clay, occasional cobble and boulder (glacial till)		12	SS	73											
72.5	Very dense	Grey														
14.8	Dolomitic limestone bedrock, fresh to faintly weathered, thinly to thickly bedded, some sandy layers, fractured core from 15.9 to 16.5 metres depth, thin mud seam at 16.4 metres depth		13	RC BXL	REC=100% ROD=42%											
			14	RC BXL	REC=95% ROD=81%											
			15	RC BXL	REC=100% ROD=0%											
			16	RC BXL	REC=100% ROD=100%											
67.9		Grey														
19.4	End of Borehole															
	* REC: Recovery ROD: Rock Quality Designation															

OFFICE REPORT ON SOIL EXPLORATION

## METRIC

W P 177-89-03 LOCATION Sta. 9 + 949.5 2.7 Lt. ORIGINATED BY D.J.S.  
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
DATUM Geodetic DATE April 23, 1990 CHECKED BY A.C.

[illegible]

# RECORD OF BOREHOLE No 1-3

METRIC

W.P. 177-89-03 LOCATION Sta. 9 + 949.5 2.7 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 23, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa					W <sub>p</sub>	W	W <sub>L</sub>		
	Continued																
	Sandy silt, some gravel and clay, occasional cobble (glacial till)		10	SS	42		74										
	Compact to dense	Grev					73										
71.9							72										
15.4	End of Borehole Auger Refusal						71										

OFFICE REPORT ON SOIL EXPLORATION





# RECORD OF BOREHOLE No 1-4

METRIC

W P 177-R9-03 LOCATION Sta. 9 + 982.1 7.9 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 20, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT Y	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					W <sub>p</sub>	W	W <sub>L</sub>		
	Continued																
	Sandy silt, some gravel, clay and cobbles, occasional boulder (glacial till)		10	SS	49		71										
72.0	Compact to very dense Grey						72										
15.1	End of Borehole Auger Refusal						73										

OFFICE REPORT ON SOIL EXPLORATION

## METRIC

W P 177-89-03 LOCATION Sta. 10 + 015.5 2.4 Lt. ORIGINATED BY D.J.S.  
DIST 9 HWY 416 BOREHOLE TYPE Hollow stem Auger, BXL Rock Core COMPILED BY A.C.  
DATUM Geodetic DATE April 17 and 18, 1990 CHECKED BY A.C.

[illegible]

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 1-6

METRIC

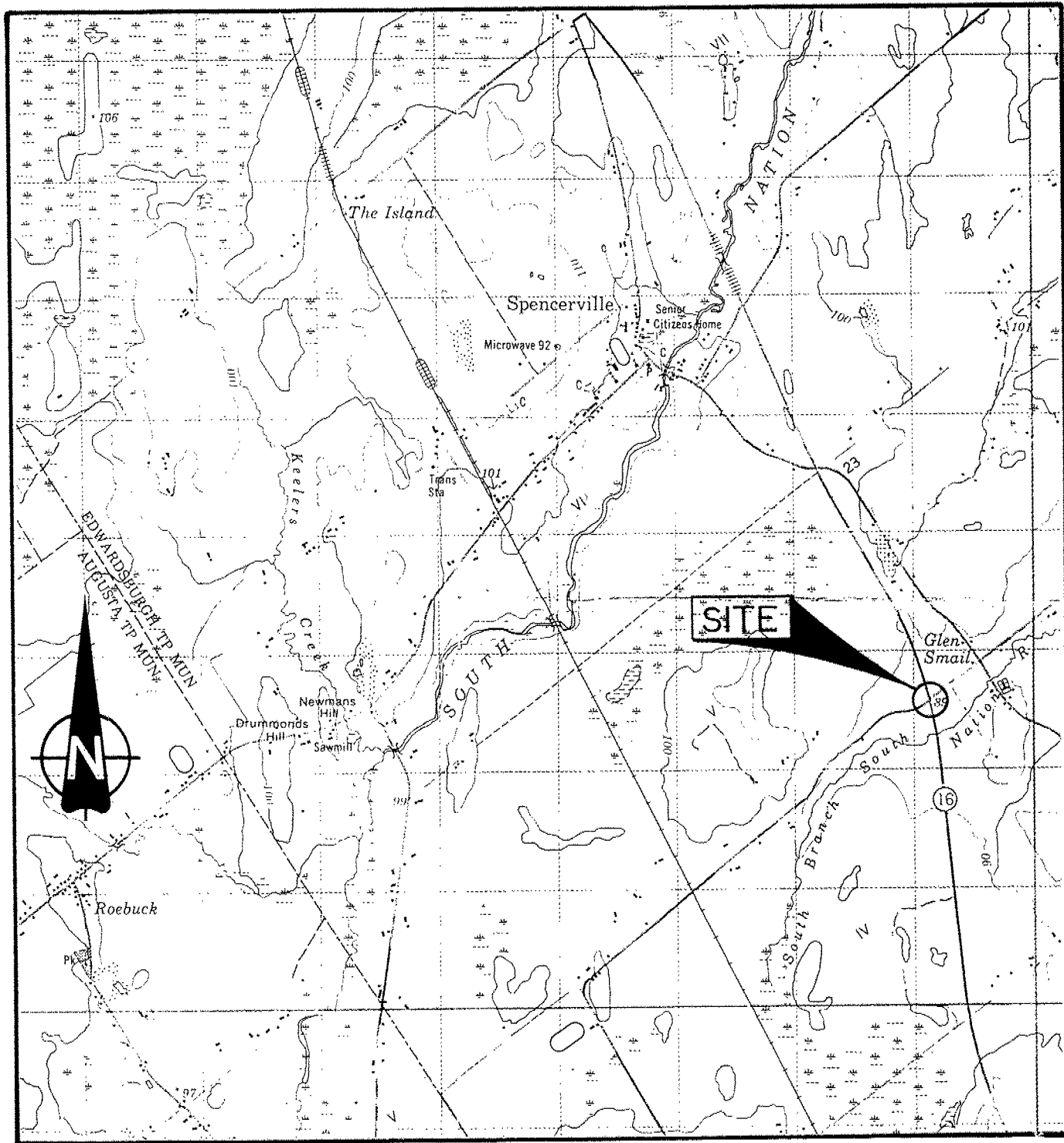
W.P. 177-89-03 LOCATION Sta. 10 + 046.2 5.1 Lt. ORIGINATED BY D.J.S.  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.  
 DATUM Geodetic DATE April 18 and 19, 1990 CHECKED BY A.C.

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										20 40 60		
87.0	Ground Surface																GR SA SI CL			
0.6	Topsoil																			
0.6																				
0.4	Silty Sand	Brown																		
0.7	Silty clay (weathered crust)		1	SS	4															
85.2	Very stiff	Grey Brown																		
			2	SS	7															
1.8	Silty clay, trace black organic mottling																			

OFFICE REPORT ON SOIL EXPLORATION

# KEY PLAN

FIGURE 1  
WP 177-89-03

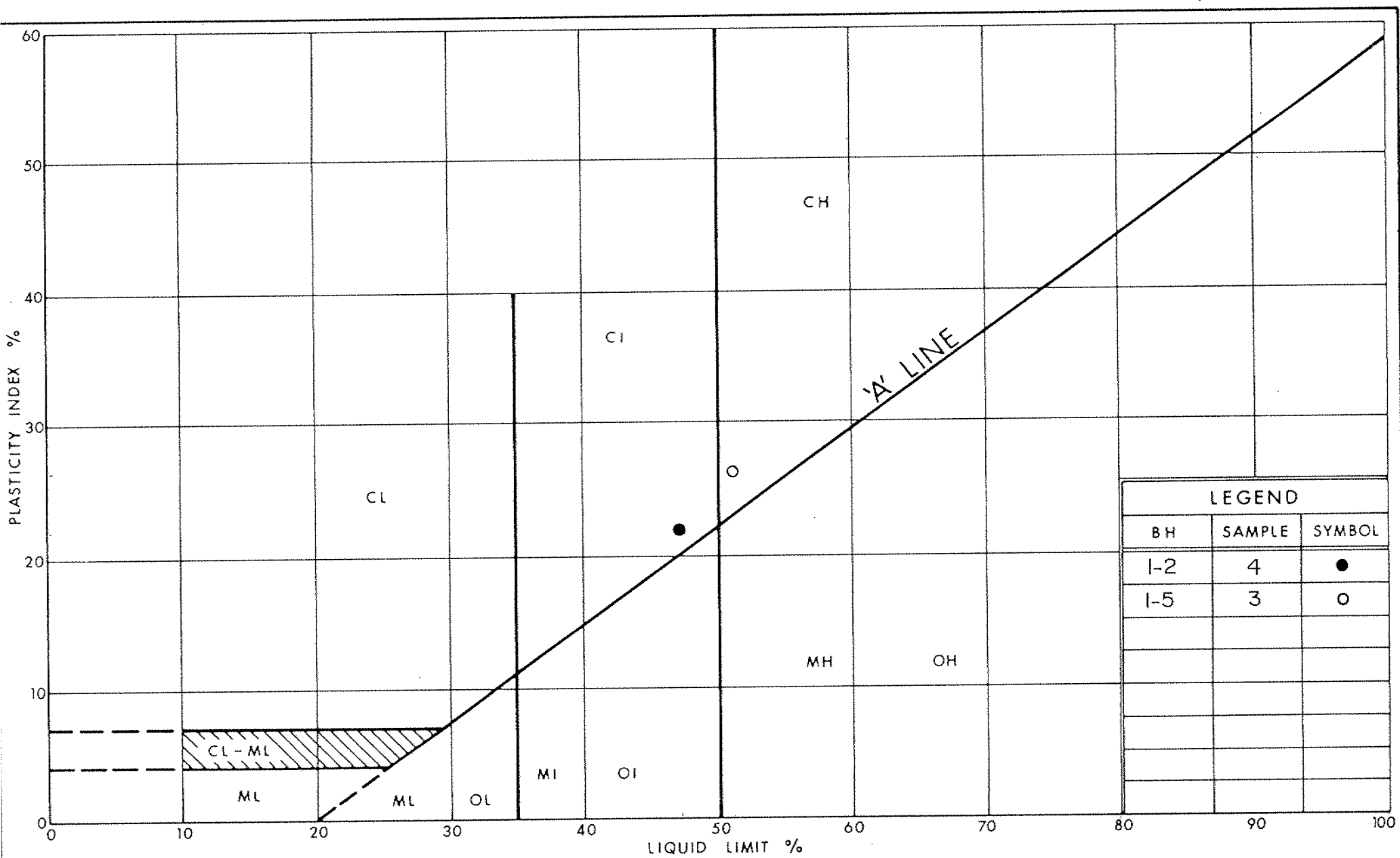


SCALE  
1: 50,000

Date AUG. 1, 1990  
Project 891-2582

Golder Associates

Drawn JC  
Chkd. AC



Ministry of  
Transportation

# PLASTICITY CHART SILTY CLAY

FIG No 2

W P 177-89-03

## UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY &amp; SILT

SAND

GRAVEL

Fine

Medium

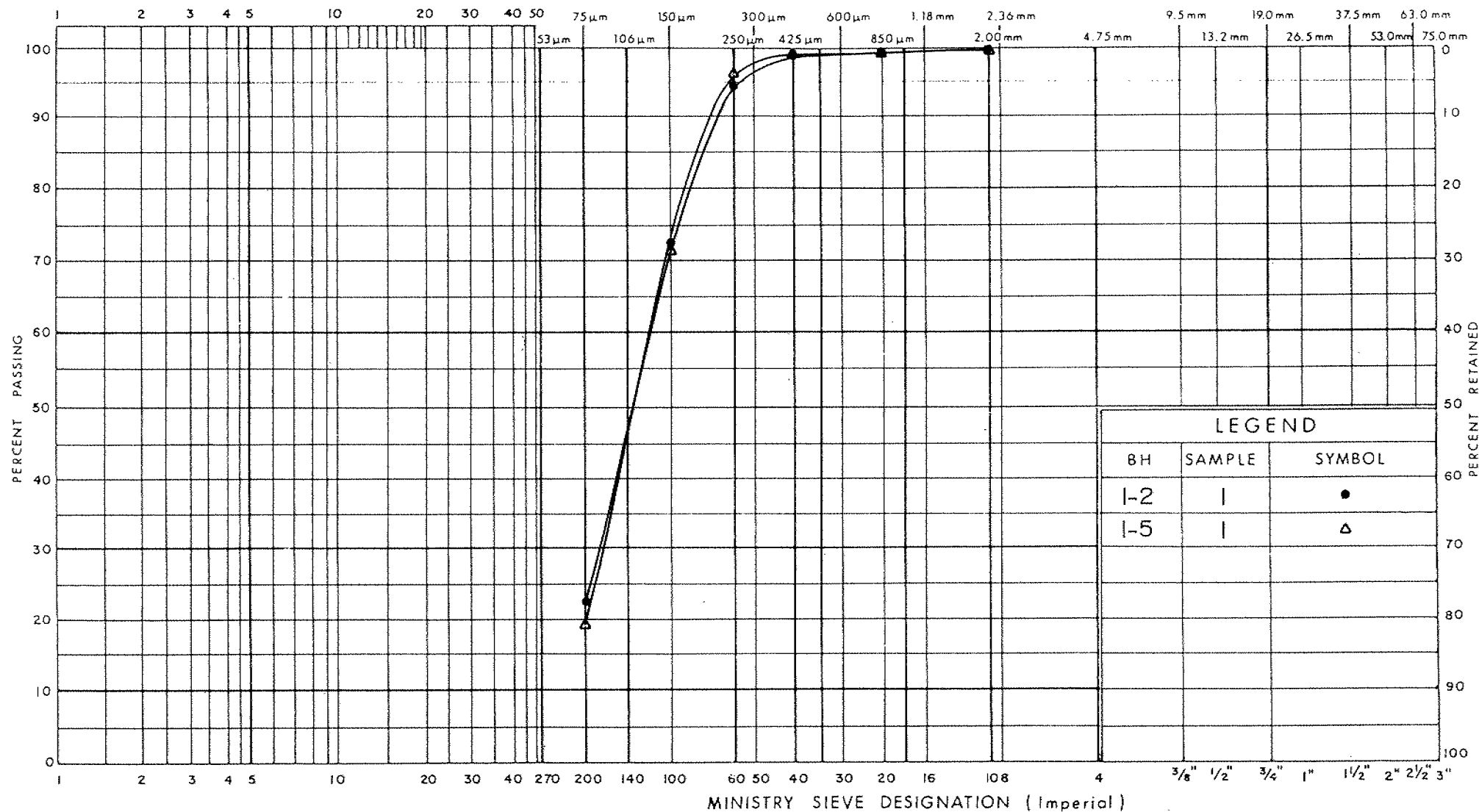
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



GRAIN SIZE DISTRIBUTION

SAND, some silt

FIG No 3

W P 177-89-Q3

Ministry of  
Transportation

Ontario



## UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY &amp; SILT

SAND

GRAVEL

Fine

Medium

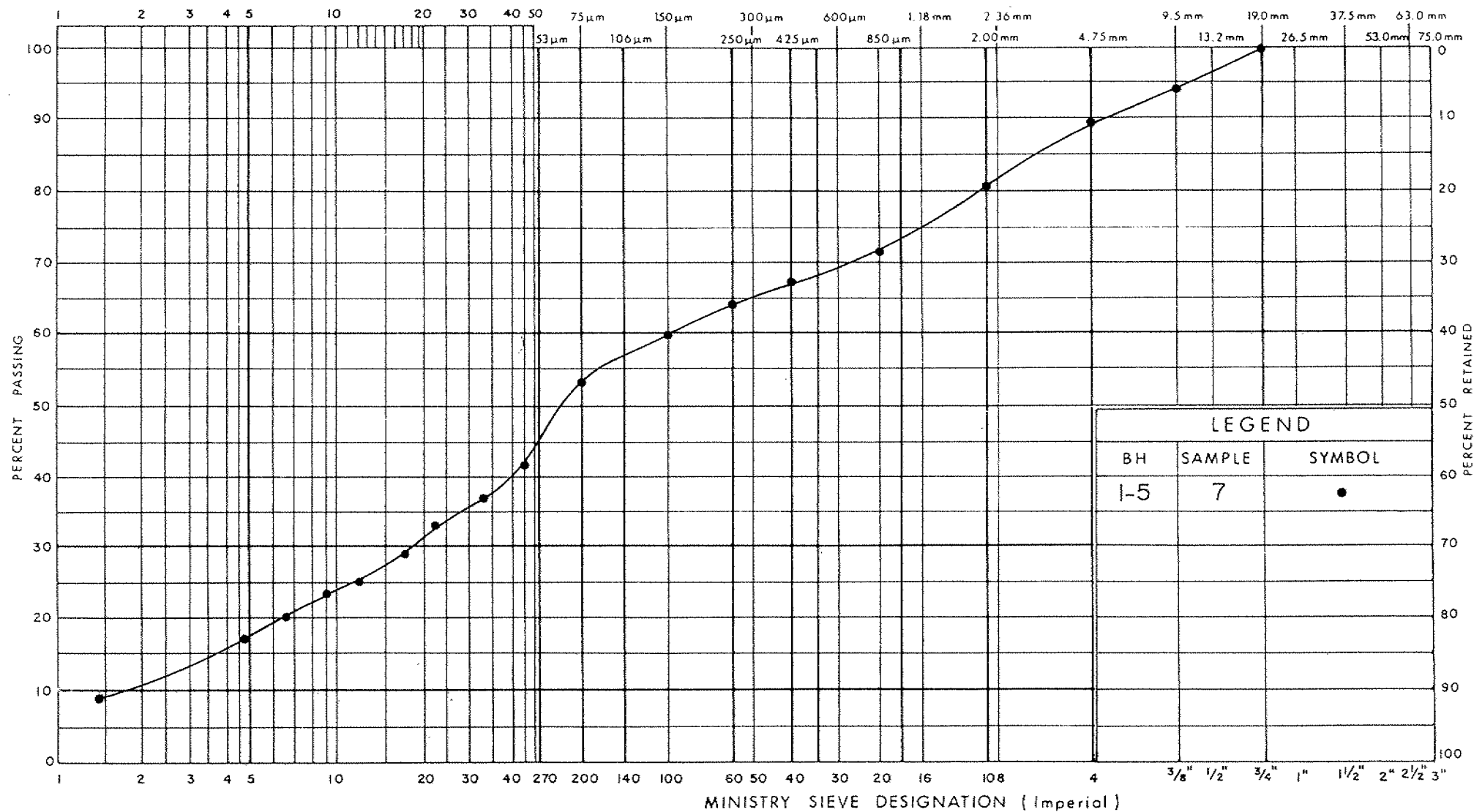
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



## LEGEND

BH	SAMPLE	SYMBOL
I-5	7	•

GRAIN SIZE DISTRIBUTION  
GLACIAL TILL

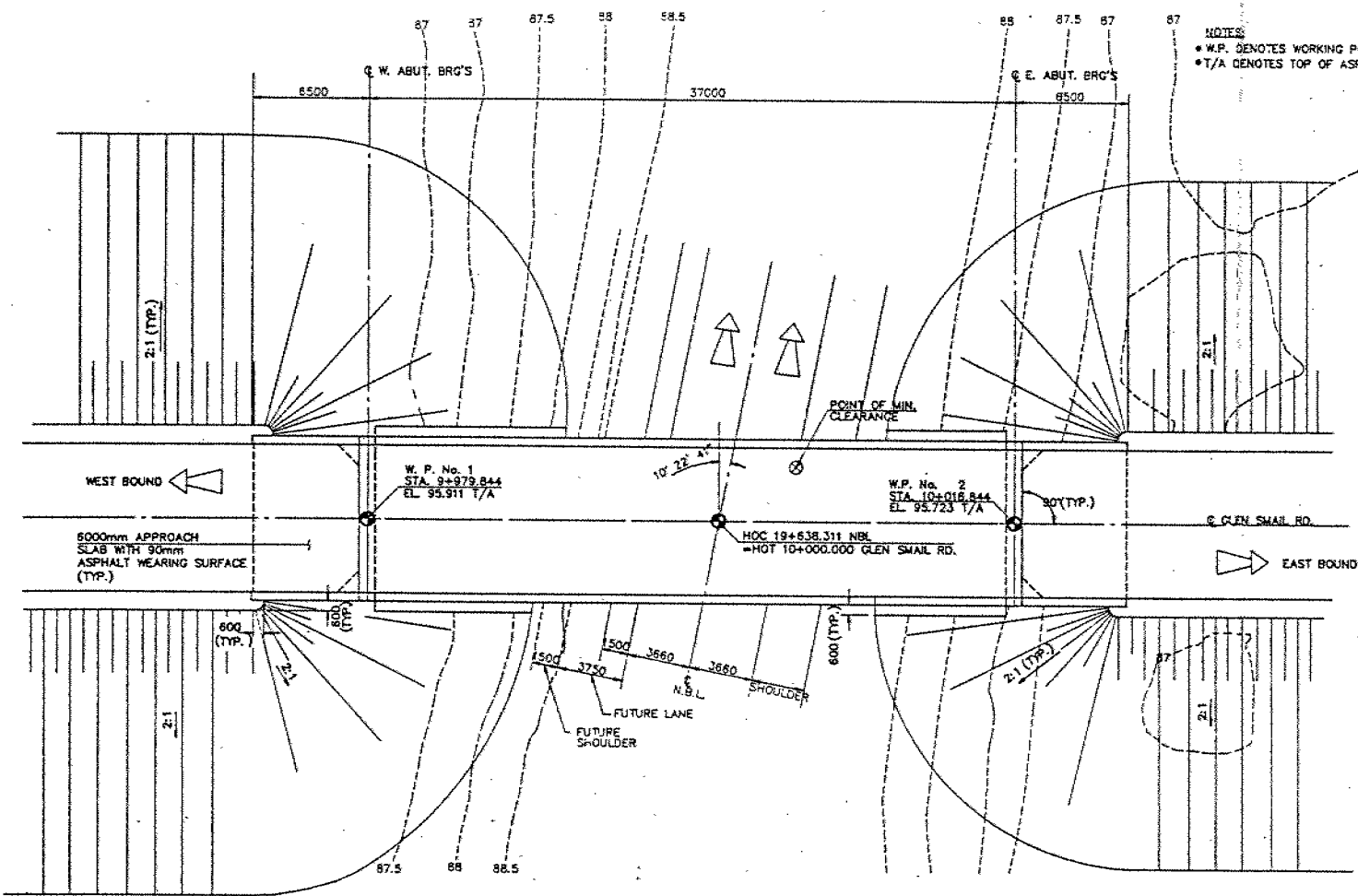
FIG No 4

W P 177-89-03



Ministry of  
Transportation

# OVERSIZE DRAWING



W. ABUT. BRG'S

E. ABUT. BRG'S

8500 37000 8500

CONCRETE BARRIER WALL

GUIDERAIL AND CHANNEL ANCHORAGE (TYP.)

EL. 90.500

EL. 90.723

APPROX. ORIGINAL GROUND LINE AT THE SOUTH SIDE OF THE STRUCTURE

150mm # SUB-DRAIN (TYP.)

1000 BEAM (TYP.)

FIX.

2.4%

53.5F MIN. VERT. CLEARANCE

SLOPE PAVING (TYP.)

FUTURE LANE EXISTING TRAFFIC LANES

PREAUGER 500mm # HOLES 3m DEEP AND FILL WITH DRY SAND BEFORE PILE DRIVING (TYP.)

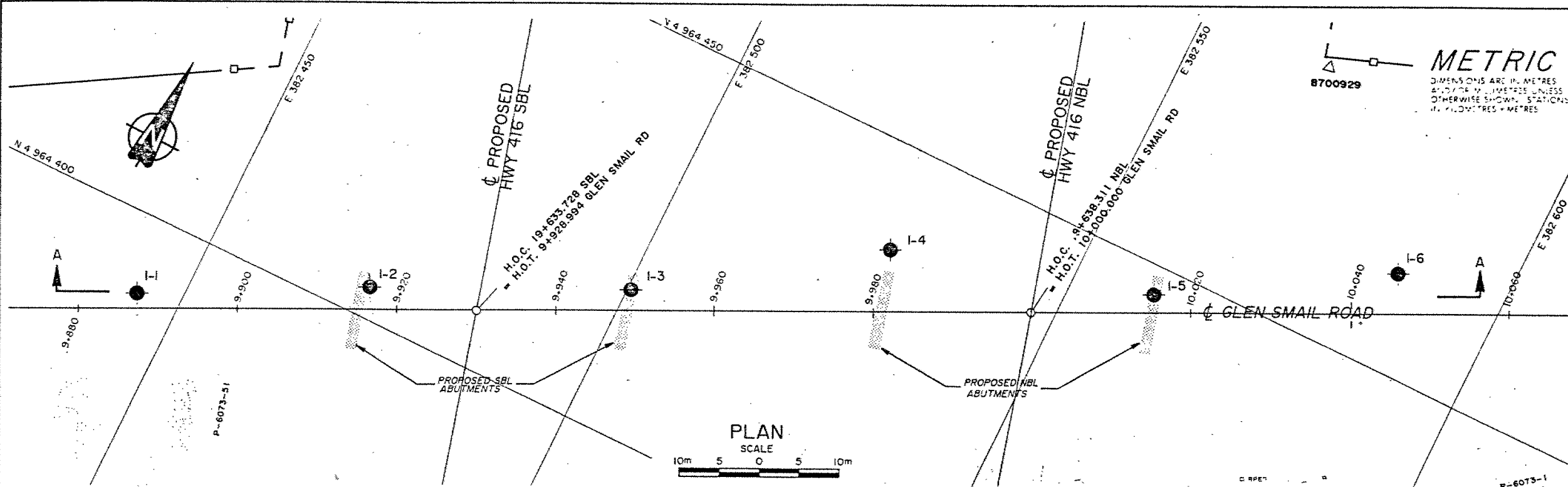
H.P. 310 X 110 PILES WITH DRIVING SHOES

FIRST STAGE FILL (MAX. PARTICLE SIZE 75mm) (TYP.)

2" SQ. 11" SQ.

SHEET  
208

42-25-3707-16

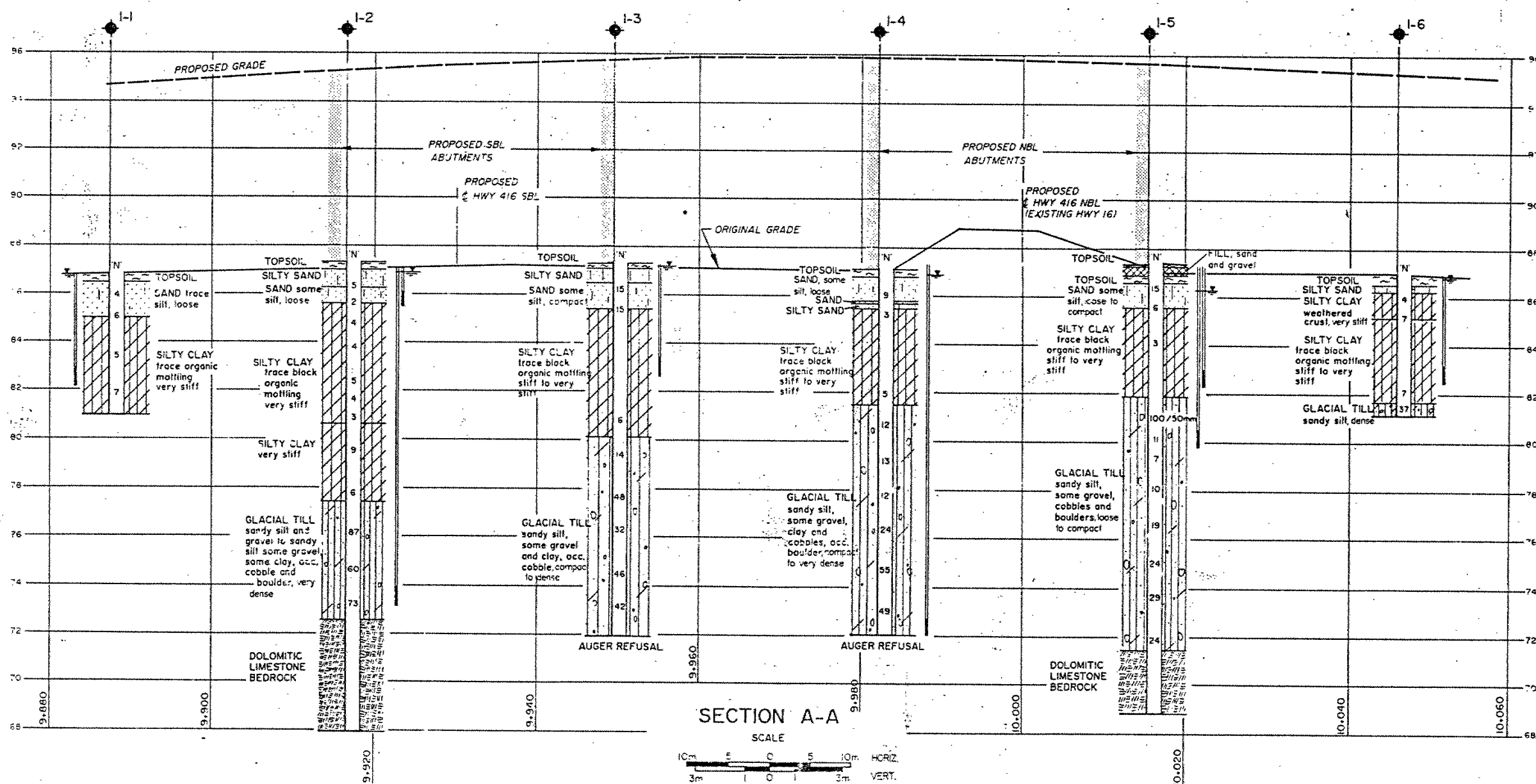
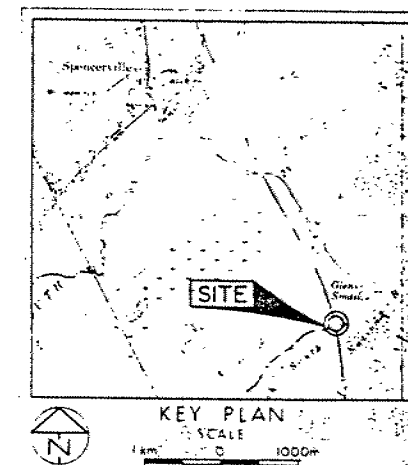


CONT No 94-28  
WP No 177-89-03

GLEN SMAIL ROAD  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET  
209

Golder Associates Ltd.



#### 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 (MAY 1990)
- Standpipe

No	ELEVATION	STATION	OFFSET
I-1	86.8	9+887.3	2.0m LI
I-2	87.3	9+916.4	2.9m LI
I-3	87.3	9+949.5	2.7m LI
I-4	87.1	9+982.1	7.9m LI
I-5	87.4	10+015.5	2.4m LI
I-6	87.0	10+046.2	5.1m LI

#### 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
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Geocres No 318-60

HWY No 416 DIST 9  
SHEW AC CHECKED AC DATE 90/08/01 SITE 16-309

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

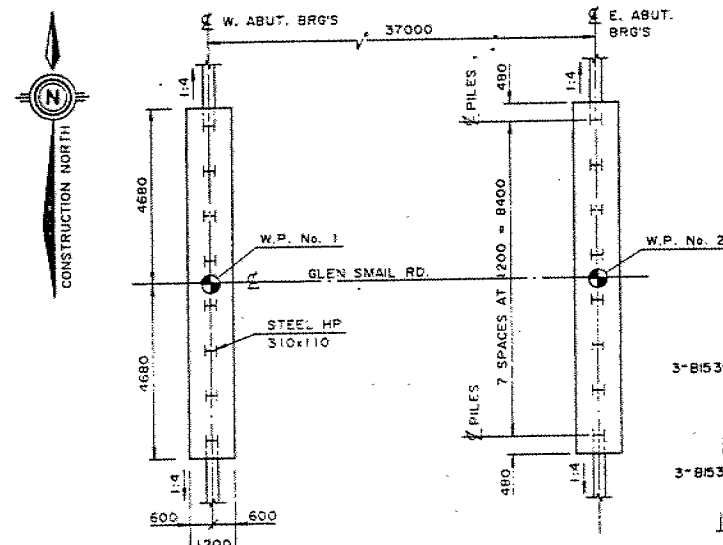
CONT No 94-28  
WP No 177-89-03

GLEN SMAIL ROAD UNDERPASS  
BRIDGE 1A(N.B.L.)  
HWY. 416  
WEST ABUTMENT & PILE DETAILS

totten sims hubicki associates  
ENGINEERS ARCHITECTS AND PLANNERS



SHEET  
210

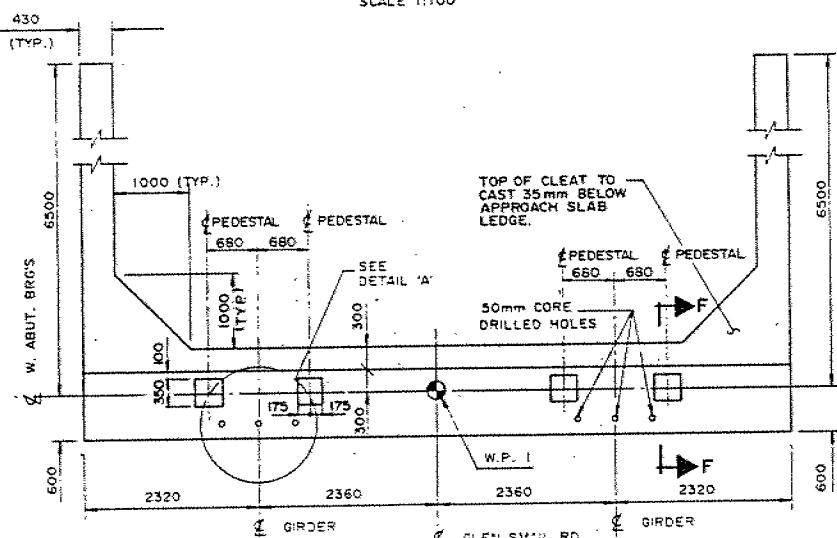
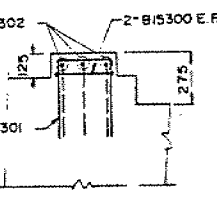


DIMENSIONS

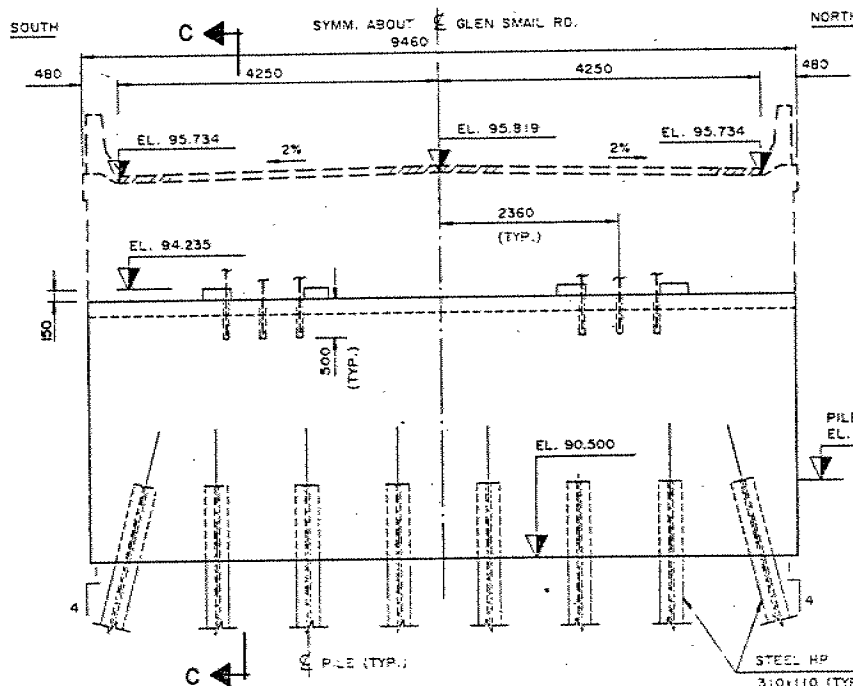
PLAN  
SCALE 1:100

PILE LAYOUT

SECTION F-F  
SCALE 1:20



PLAN  
SCALE 1:50

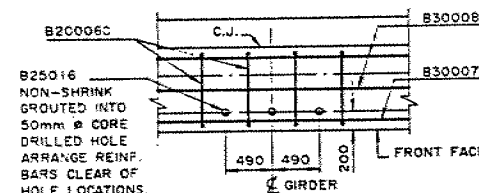


DIMENSIONS

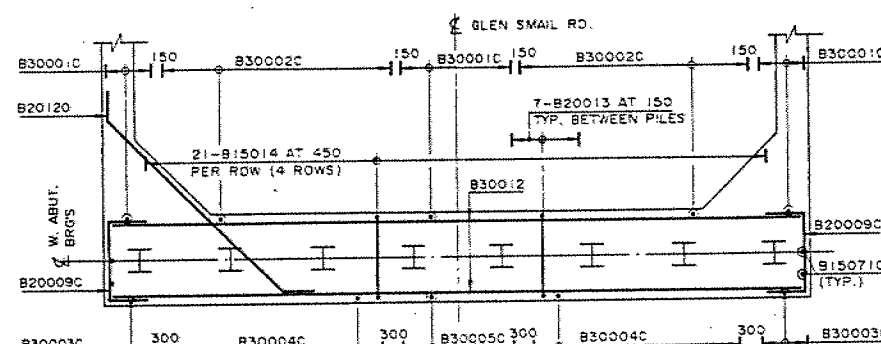
PILE LAYOUT

SECTION F-F

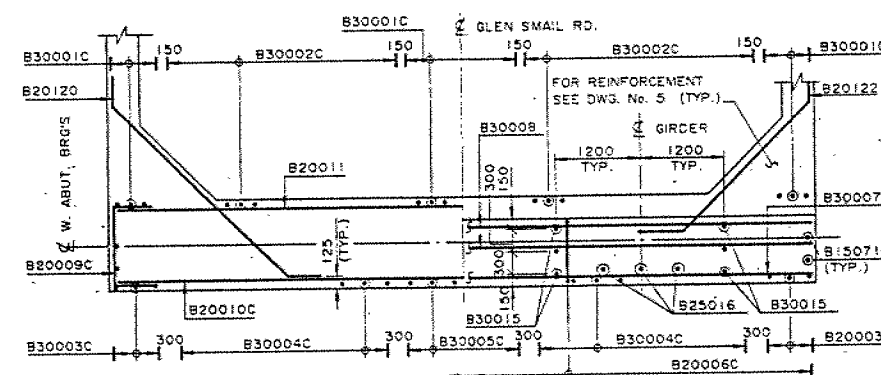
SCALE 1:20



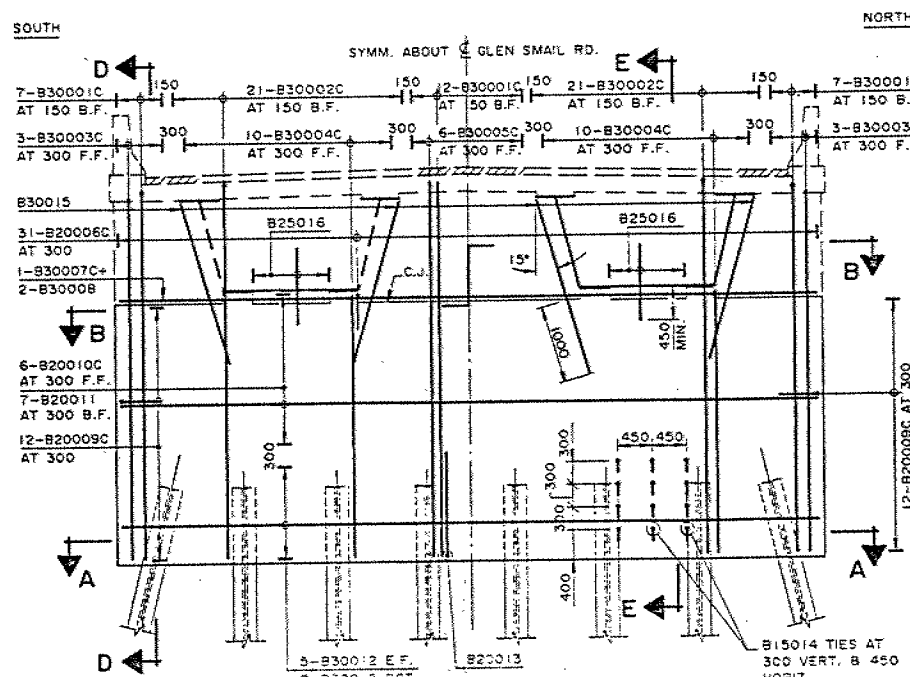
DETAIL 'A'  
SCALE 1:40



SECTION A-A  
SCALE 1:50

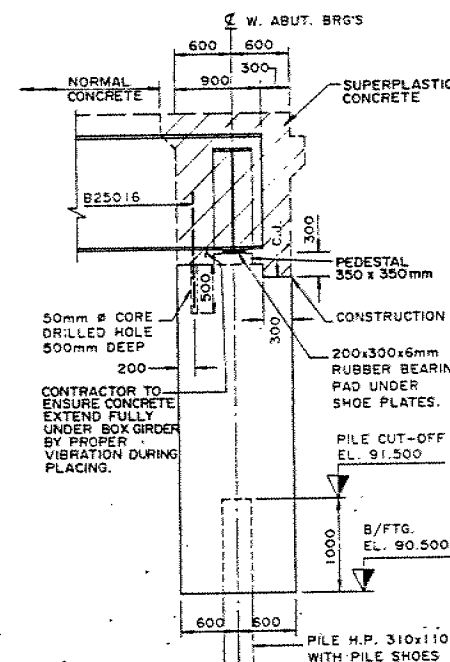


SECTION B-B  
SCALE 1:50

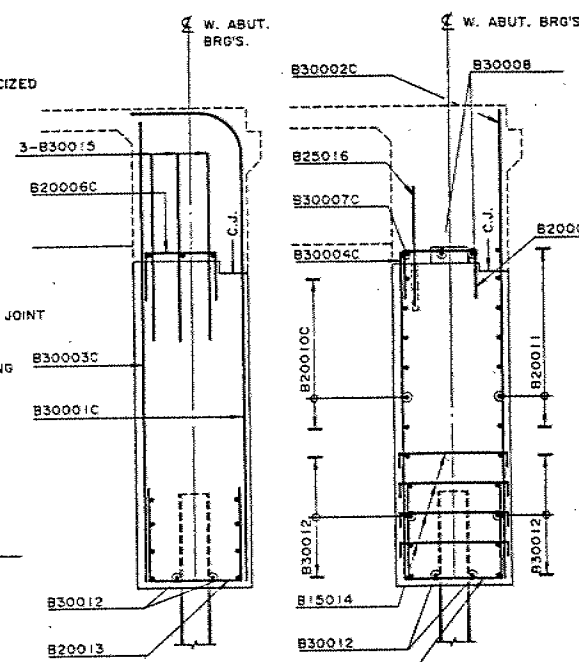


ELEVATION

REINFORCEMENT



SECTION C-C  
SCALE 1:40



SECTION D-D  
N.T.S.

SECTION E-E  
N.T.S.

#### CONSTRUCTION SEQUENCE:

- CONSTRUCT THE ABUTMENTS INCLUDING WINGWALLS TO THE BEARING SEAT ELEVATION. TO PROVIDE STABILITY DURING CONSTRUCTION, CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS & WINGWALLS. FORMWORK & LATERAL BRACING SHALL NOT BE REMOVED UNTIL DECK CONCRETE HAS REACHED 75% OF ITS SPECIFIED STRENGTH.
- ERECT THE STEEL BOX GIRDERS IN PLACE.
- CORE DRILL HOLES, PLACE & GROUT ANCHOR RODS.
- CAST THE DECK & TOP PORTION OF THE ABUTMENTS INTEGRALLY WITH THE STEEL BOX GIRDERS IN ONE POUR.

- CONCRETE IN THE DECK SLAB SHALL BE RETARDED USING A TYPE R<sub>1</sub> RETARDER FOR THE DURATION OF THE POUR.

#### LIST OF PILES

LOCATION	ROW	No.	LENGTH(m)	BATTER
W. ABUT.	CENTRE	6	19.6	-
	SIDES	2	20.5	1:4
E. ABUT.	CENTRE	6	19.0	-
	SIDES	2	19.5	1:4

#### NOTES

- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
- PILES TO BE DRIVEN IN ACCORDANCE WITH STD. SS 103-10 OR SS103-11 USING AN ULTIMATE CAPACITY OF 3450KN.
- PILE DESIGN DATA  
MAX. COMBINED FACTORED LOADS:  
SLS TYPE II = 1150KN  
ULS = 1600KN
- GIRDER BEARING SEAT TO BE FINISHED LEVEL TO RECEIVE SHOE PLATE.
- PROVIDE 6mm RUBBER PAD UNDER EACH SHOE PLATE.

#### NOTES:

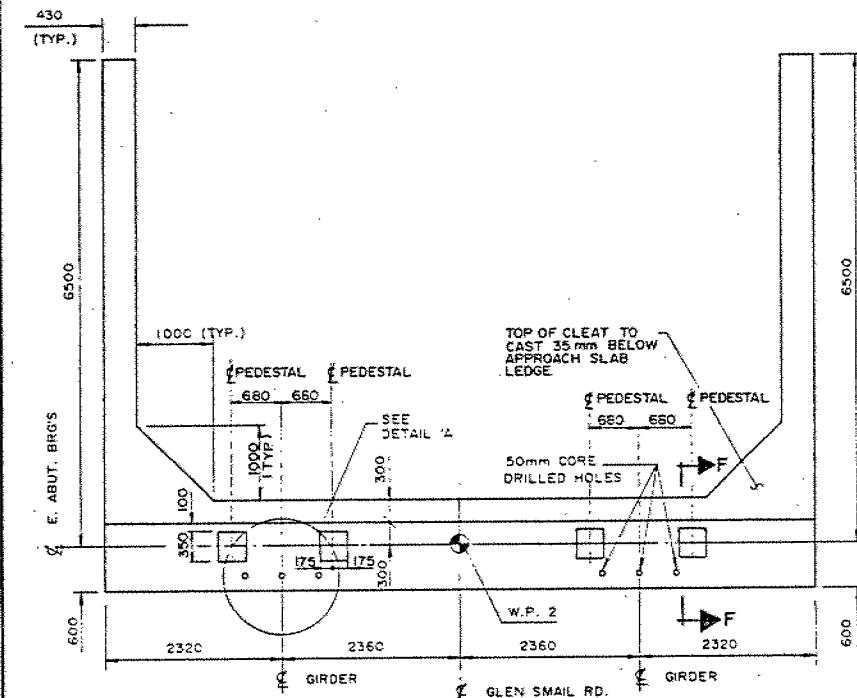
- F.F. DENOTES FRONT FACE
- B.F. DENOTES BACK FACE
- E.F. DENOTES EACH FACE

#### APPLICABLE STANDARD DRAWINGS

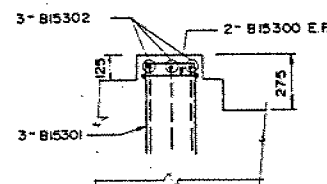
OPSD 3301.00 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'W' PILES.

REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

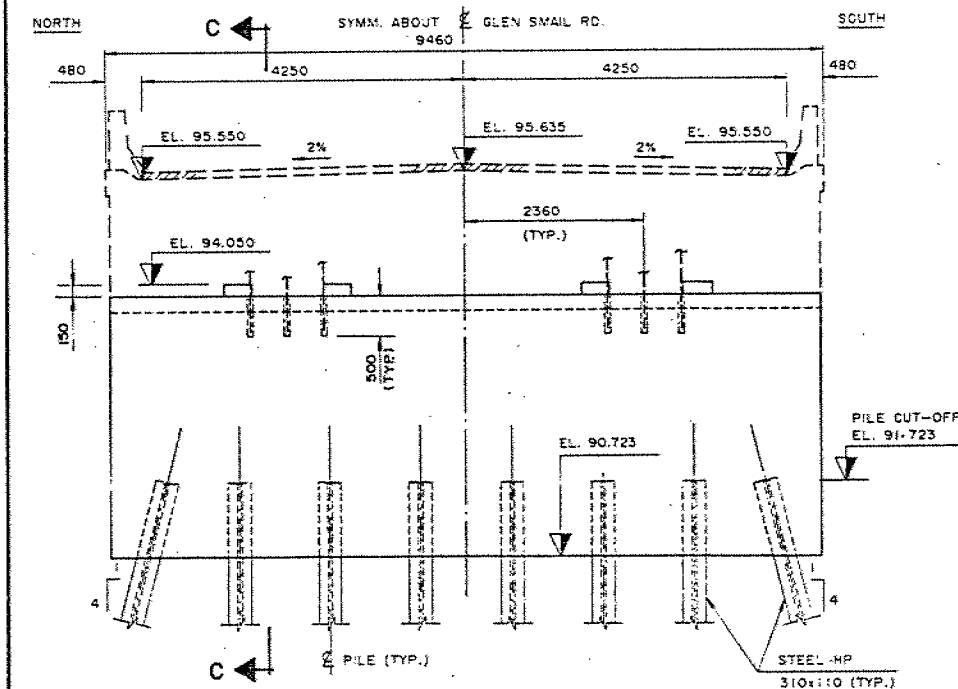
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING



PLAN  
SCALE 1:50

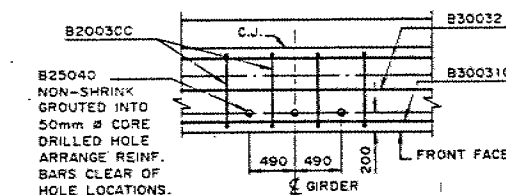


SECTION F-F  
SCALE 1:20

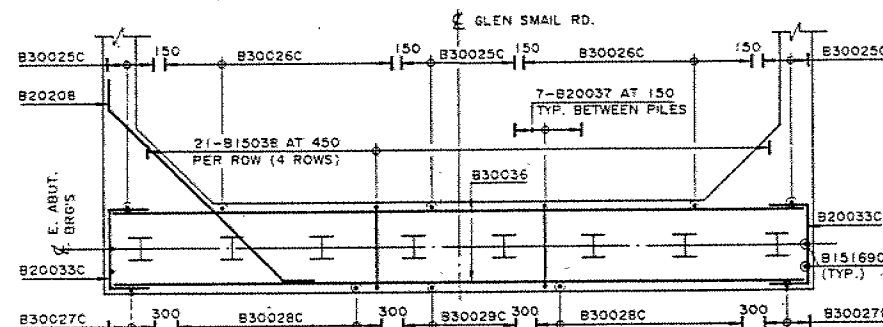


DIMENSIONS

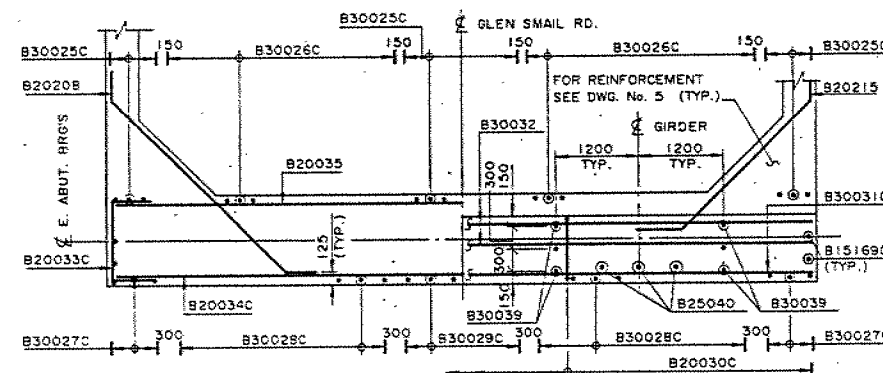
ELEVATION  
SCALE 1:50



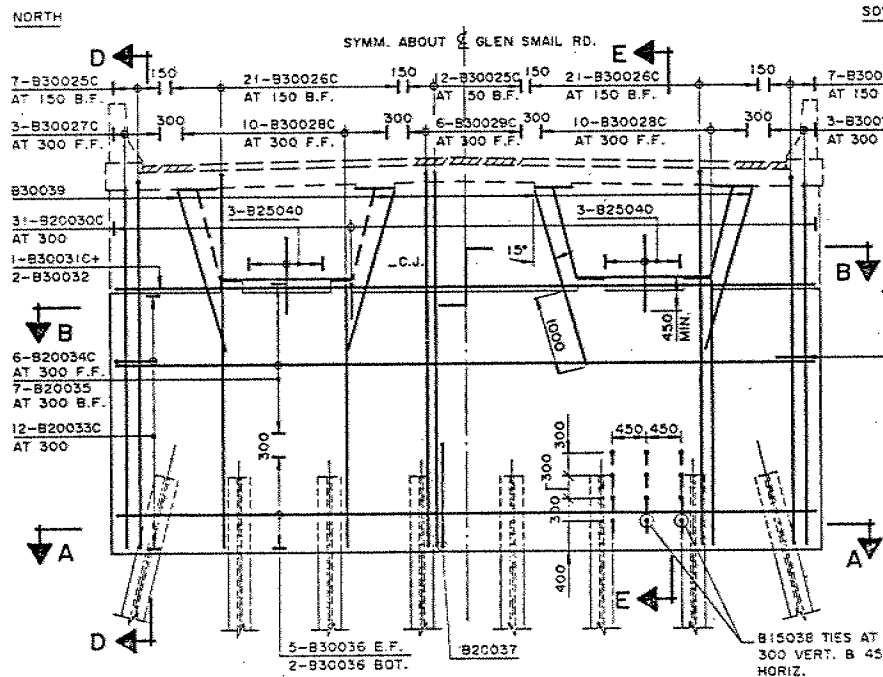
DETAIL 'A'  
SCALE 1:40



SECTION A-A  
SCALE 1:50



SECTION B-B  
SCALE 1:50



REINFORCEMENT

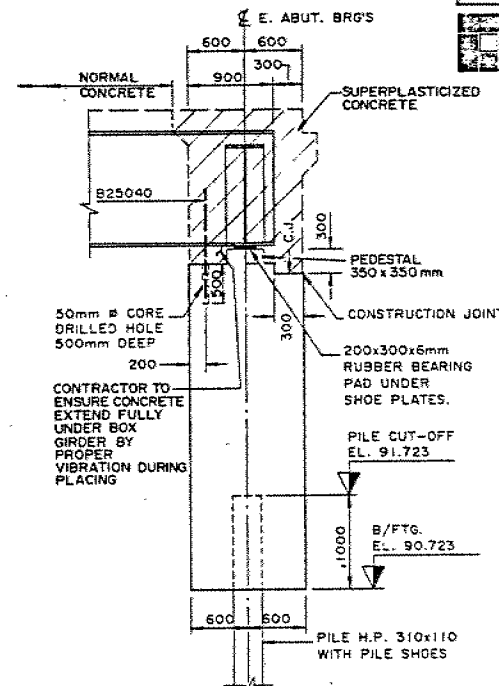
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No 94-28  
WP No 177-89-03

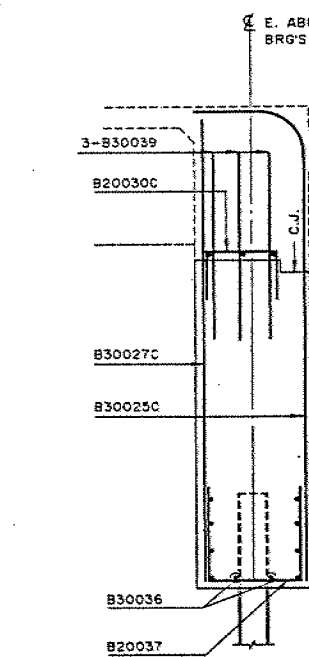
GLEN SMAIL ROAD UNDERPASS  
BRIDGE 1A(N.B.L.)  
HWY. 416  
EAST ABUTMENT

SHEET  
211

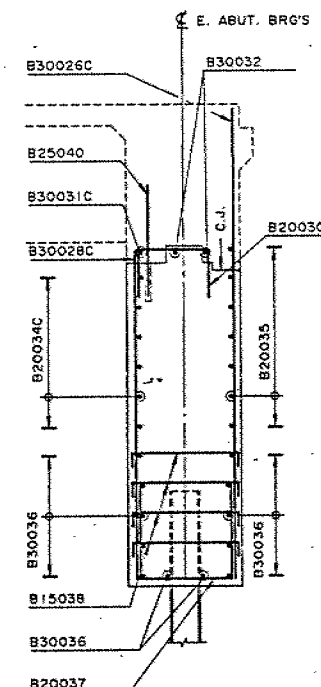
totten sims hubicki associates  
ENGINEERS ARCHITECTS AND PLANNERS



SECTION C-C  
SCALE 1:40



SECTION D-D  
N.T.S.



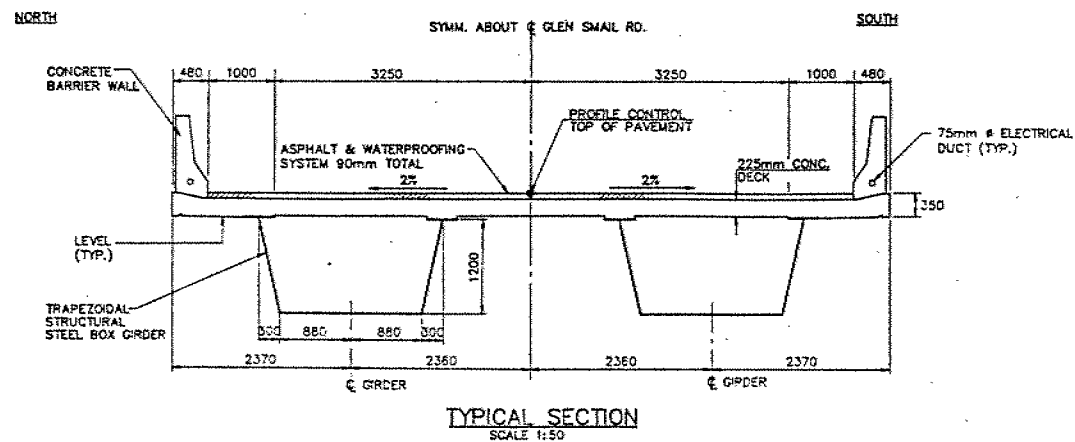
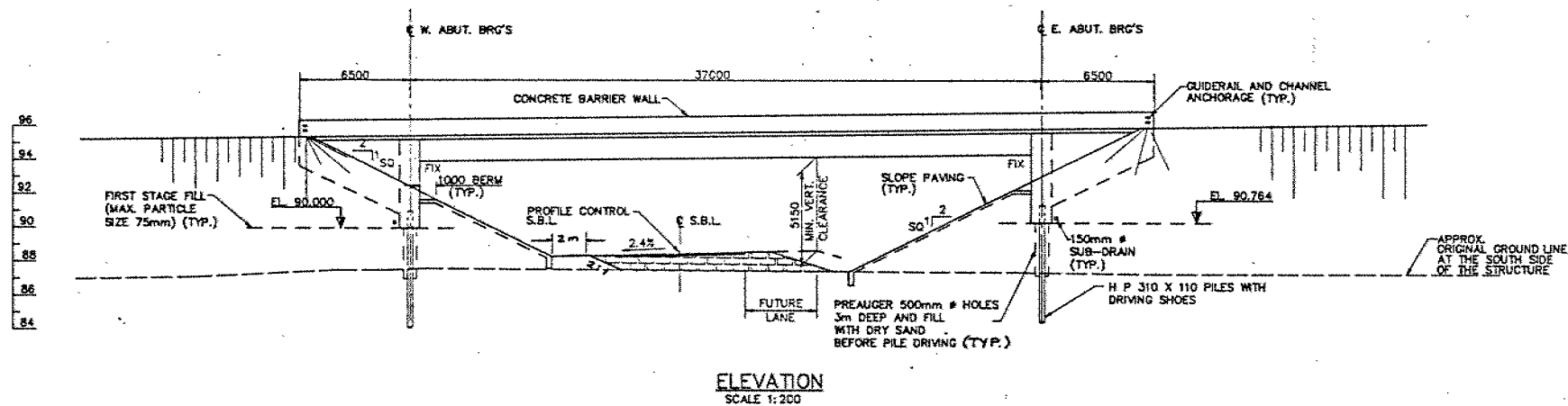
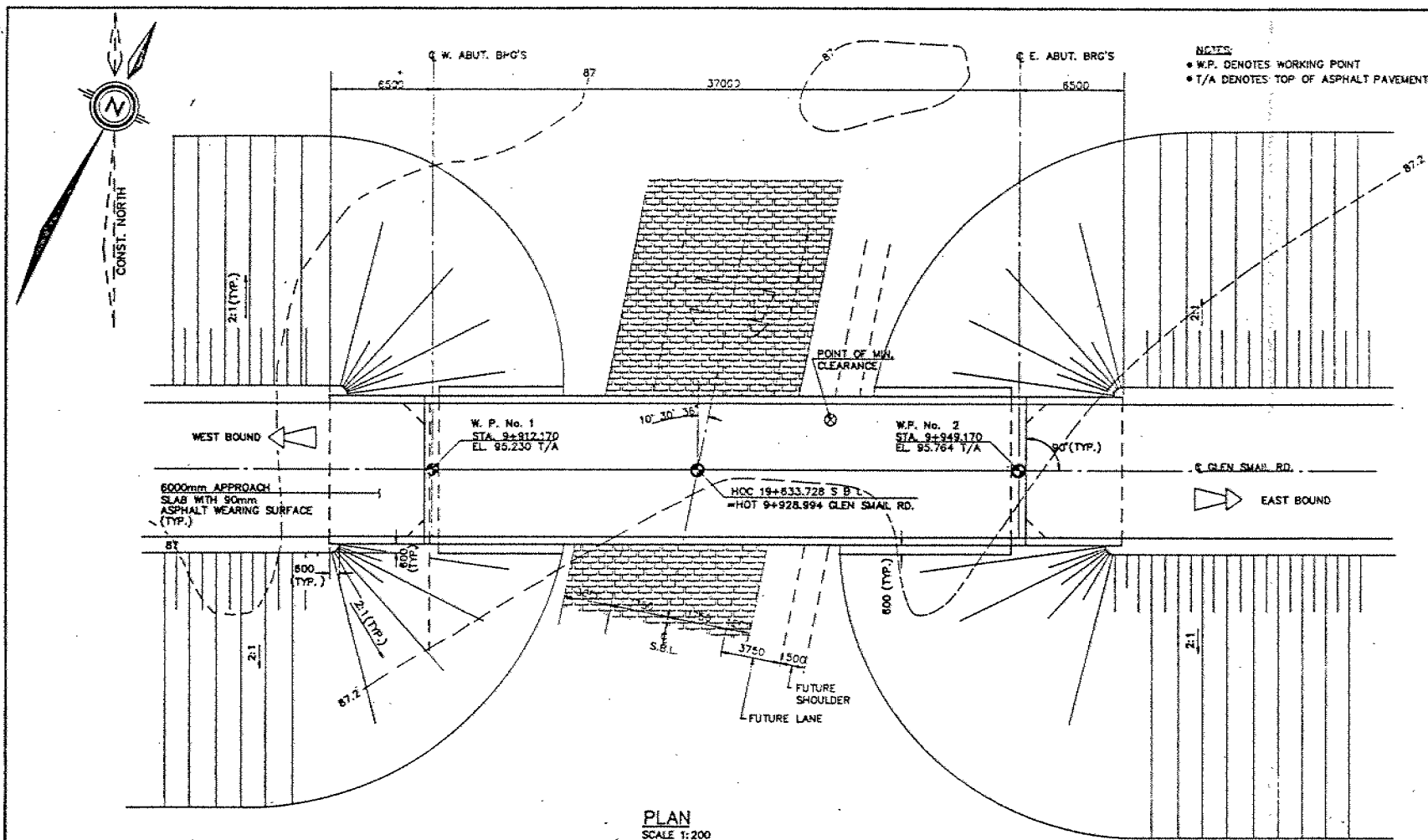
SECTION E-E  
N.T.S.

NOTES:  
F.F. DENOTES FRONT FACE  
B.F. DENOTES BACK FACE  
E.F. DENOTES EACH FACE

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN W.L. [CHK S.W.L.] CODE 048DC 63 1 LOAD CLASS A/DATE MAR., 91



**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



**DISTRICT No. 9**  
**CONT No 94-28**  
**WP No 177-89-06**

**GLEN SMAIL ROAD UNDERPASS**  
**BRIDGE 1B (S.B.L.)**  
**HWY 416**  
**GENERAL ARRANGEMENT**

**SHEET**  
**226**

**totten sims hubicki associates**  
ENGINEERS ARCHITECTS AND PLANNERS

### GENERAL NOTES

#### CLASS OF CONCRETE

- ALL CONCRETE 30MPa

#### REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

#### CLEAR COVER TO REINFORCING STEEL

- ABUTMENTS & WINGWALLS  
FRONT FACE 80 ±20mm  
BACK FACE 70 ±20mm
- DECK:  
TOP 70 ±20mm  
BOTTOM 40 ±10mm
- APPROACH SLABS 80 ±20mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 ±20mm

### CONSTRUCTION NOTES

- BEARING SEATS SHALL BE FINISHED LEVEL TO THE SPECIFIED ELEVATIONS.
- NO BACKFILL SHALL BE PLACED UNTIL DECK CONCRETE HAS REACHED 75 % OF ITS SPECIFIED STRENGTH.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 0.5m.

### LIST OF DRAWINGS:

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- WEST ABUTMENT AND PILE DETAILS
- EAST ABUTMENT
- WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- DECK DETAILS
- BARRIER WALLS
- 6000mm APPROACH SLAB
- DETAILS OF CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING - STEAM AND DIESEL HAMMERS
- AS CONSTRUCTED ELEV. AND DIM.
- ELECTRICAL EMBEDDED WORKS
- QUANTITIES - STRUCTURAL I
- QUANTITIES - STRUCTURAL II

### LEGEND

DENOTES WORK TO BE DONE BY OTHERS.

### APPLICABLE STANDARD DRAWINGS

OPSD 3501.00 GRANULAR BACKFILL REQUIREMENTS

MTC B.M. 848005  
ELEV. 87.820  
TABLET SET VERTICALLY ON N.E. CORNER OF  
CONC. CULVERT 12.8 RT STA. 19+707.6

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

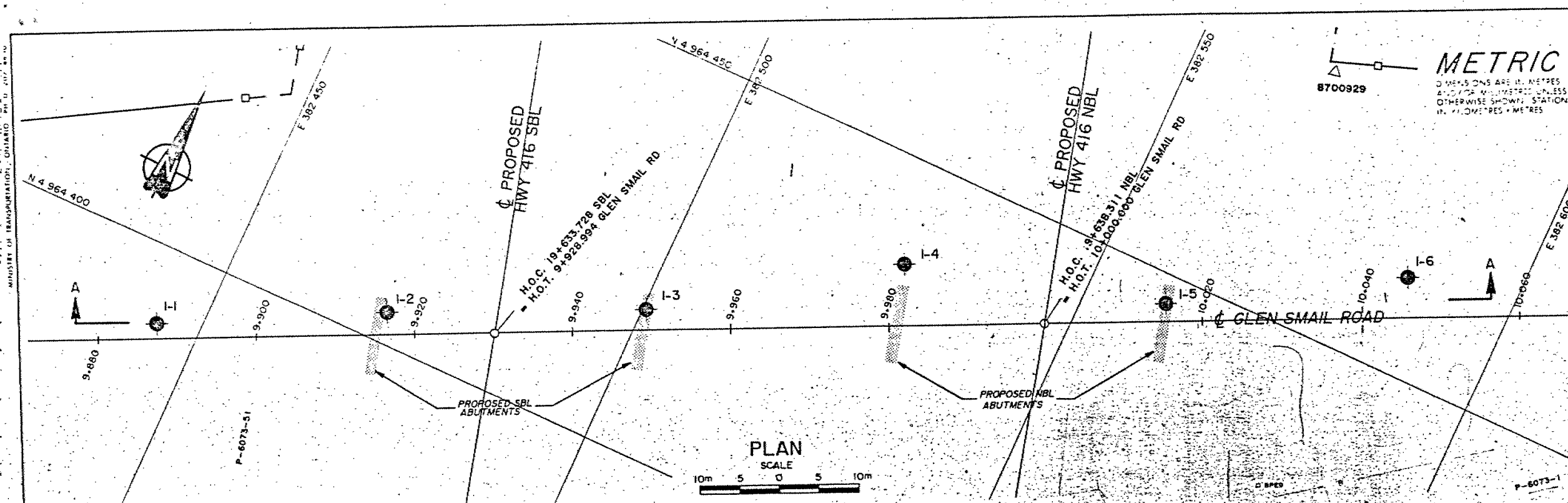
REVISIONS	DATE	BY	DESCRIPTION

DESIGN: W.L. CHK: S.W.L. CODE: 6-HCC 63 LOAD CLASS: 'A' DATE: MAR. 91  
DRAWING: A.R. CHK: G.L.A. SITE: 16-309 STRUCT: SCHEME: DWG: 1

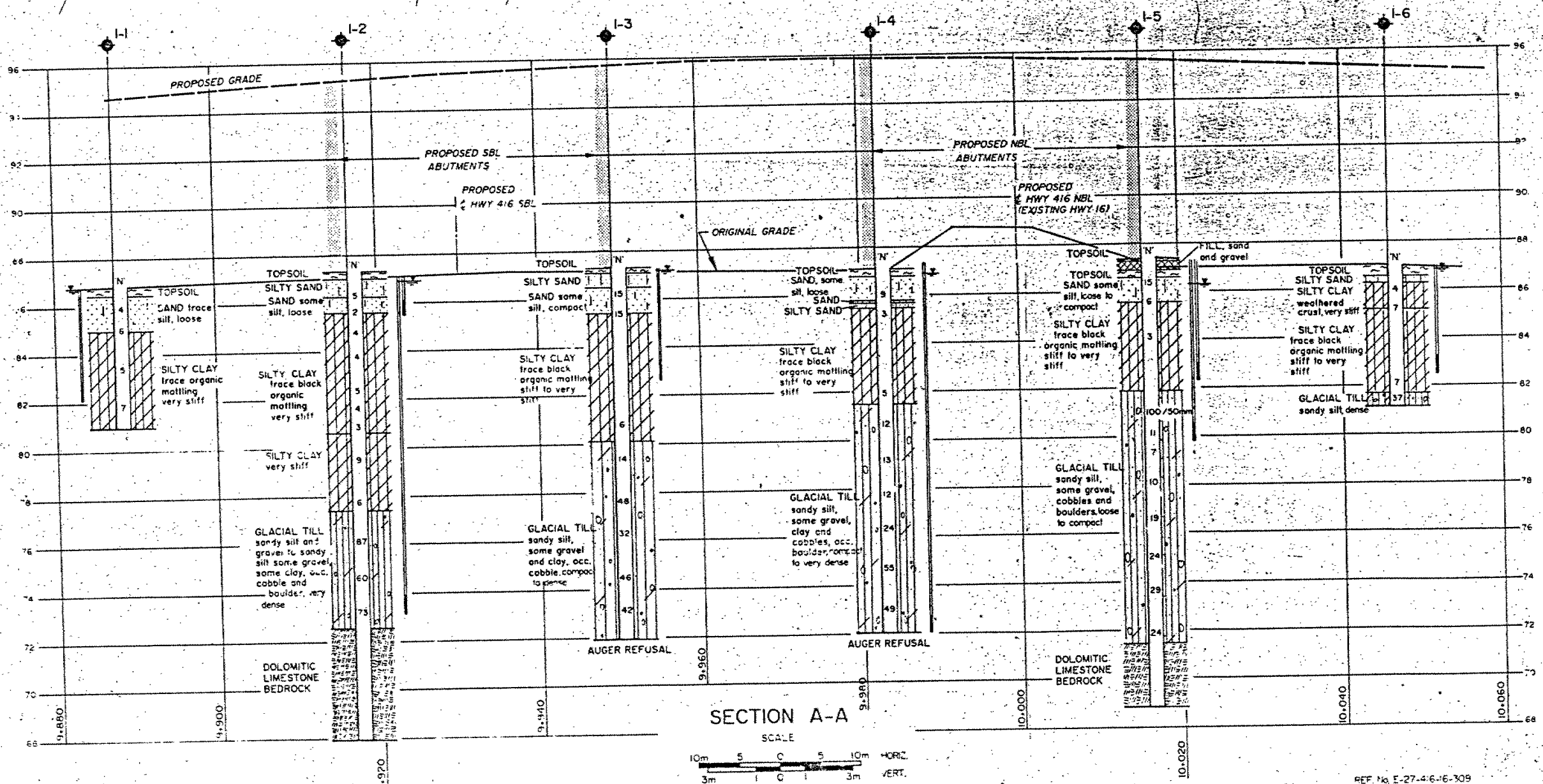
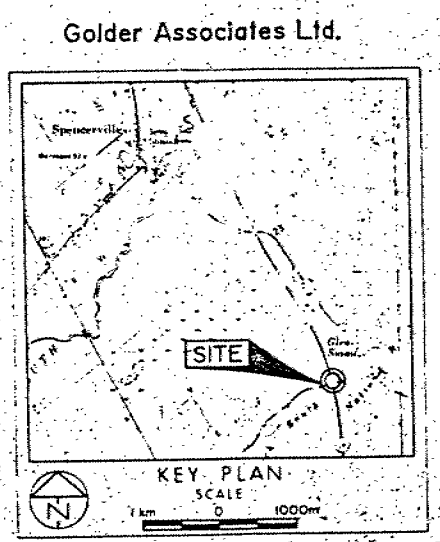
42-03-37373



MINISTRY OF TRANSPORTATION, ONTARIO



8700929  
METRIC  
DIMENSIONS ARE IN METRES  
UNLESS OTHERWISE SHOWN  
OTHERWISE SHOWN IN STATIONS  
IN KILOMETRES + METRES



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 (MAY 1990)
- Standpipe

No.	ELEVATION	STATION	OFFSET
I-1	86.8	9+887.3	2.0m LI
I-2	87.3	9+916.4	2.9m LI
I-3	87.3	9+949.5	2.7m LI
I-4	87.1	9+982.1	7.9m LI
I-5	87.4	10+015.5	2.4m LI
I-6	87.0	10+046.2	5.1m LI

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 to this project and other related documents may be examined at the Engineering Materials Office. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

DATE	BY	DESCRIPTION

Geocres No 318-60

HWY No 416  
SUBM'D AC CHECKED AC DATE 90/08/01 SITE 16-309  
DRAWN JC CHECKED DATE 90/08/01 DWS 1778903-4





# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No 94-28  
WP No 177-89-06

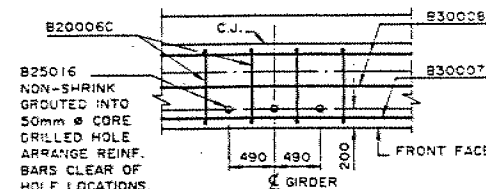
GLEN SMAIL ROAD UNDERPASS  
BRIDGE 18(S.B.L.)  
HWY. 416  
WEST ABUTMENT & PILE DETAILS



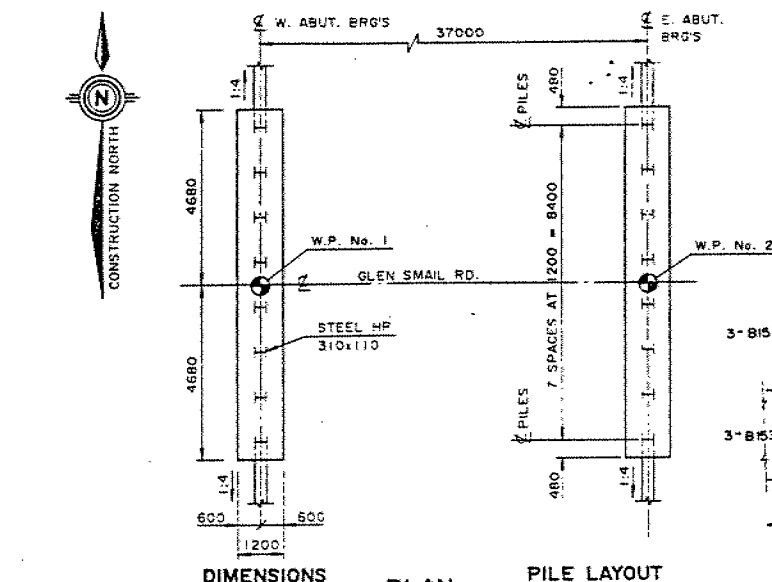
SHEET  
228

totten sims hubicki associates  
ENGINEERS ARCHITECTS AND PLANNERS

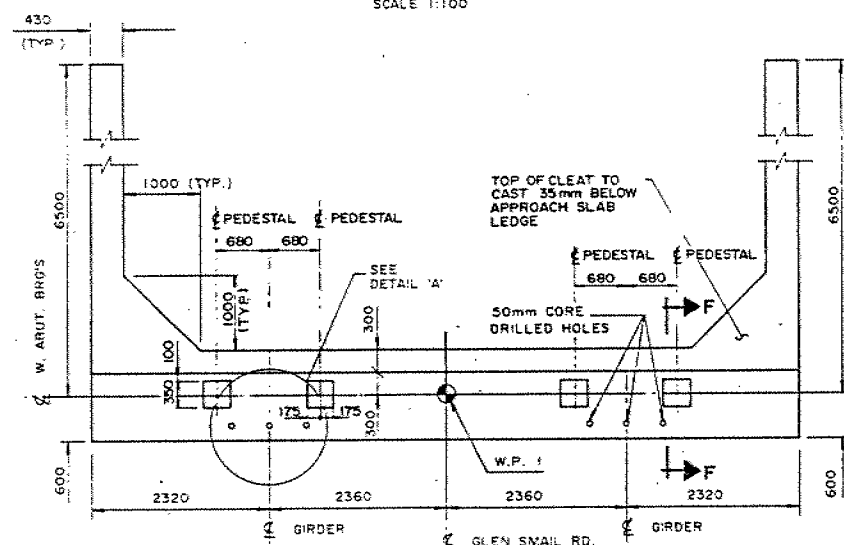
W.P. COORDINATES			
W.P. No.	STA.	NORTH	EAST
1	9+92.170	4964399.481	382467.924
2	9+949.170	4964415.548	382501.254



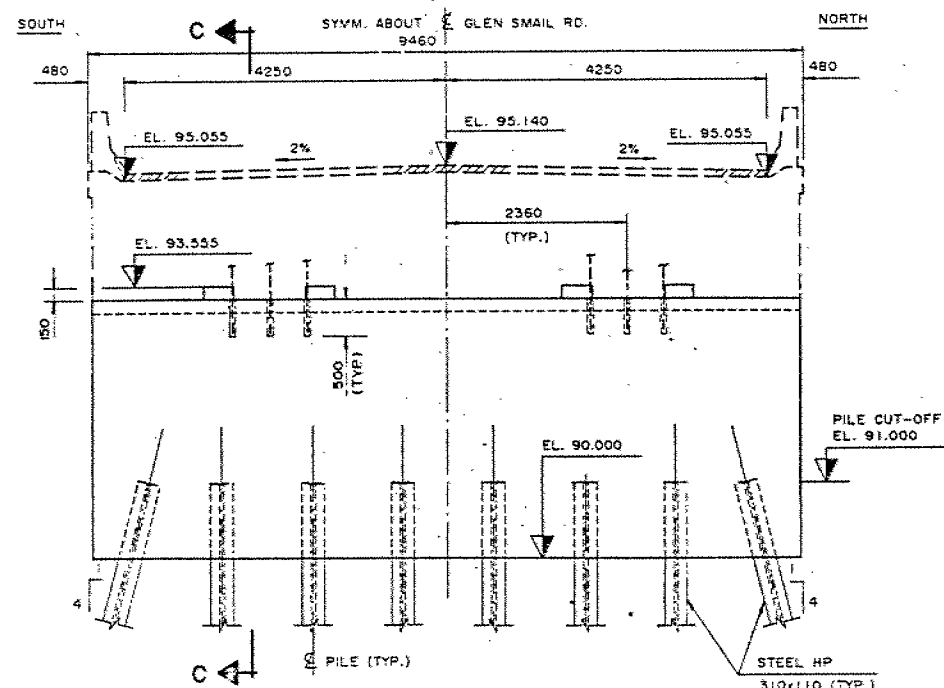
DETAIL 'A'  
SCALE 1:40



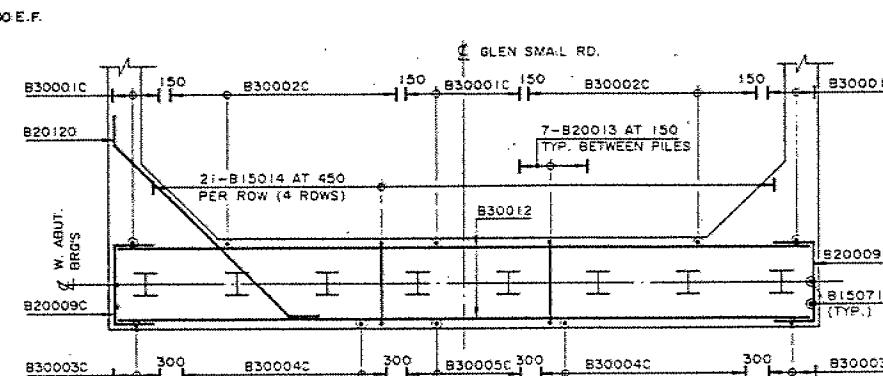
PLAN  
SCALE 1:100



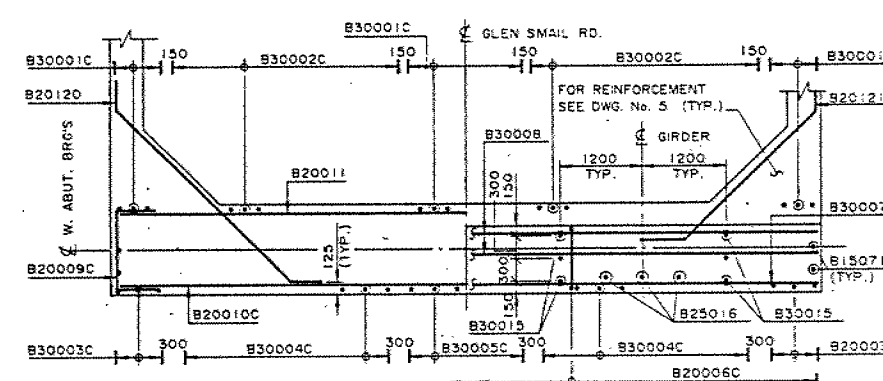
PLAN  
SCALE 1:50



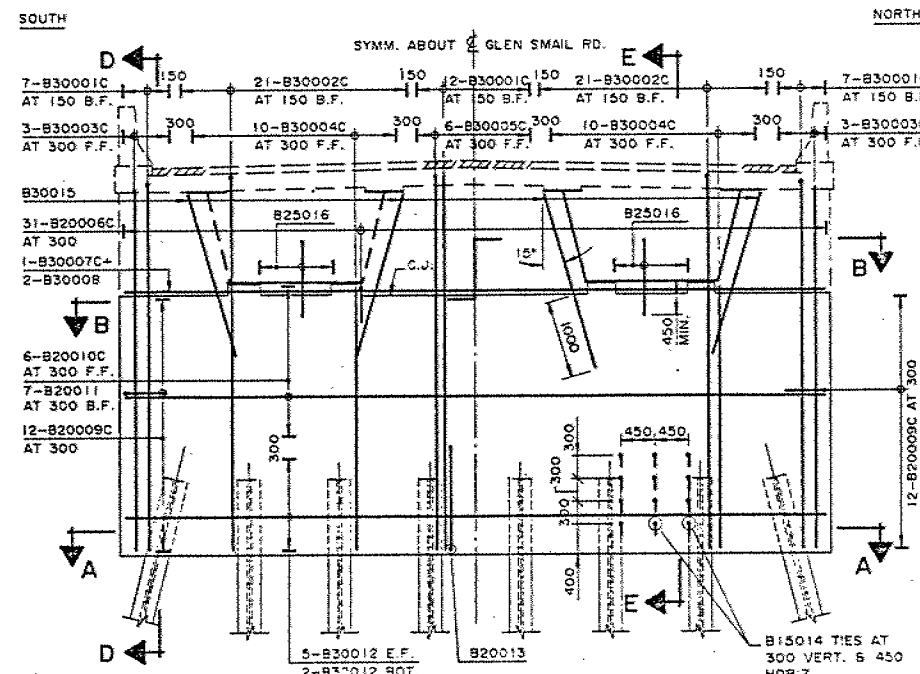
DIMENSIONS



SECTION A-A  
SCALE 1:50

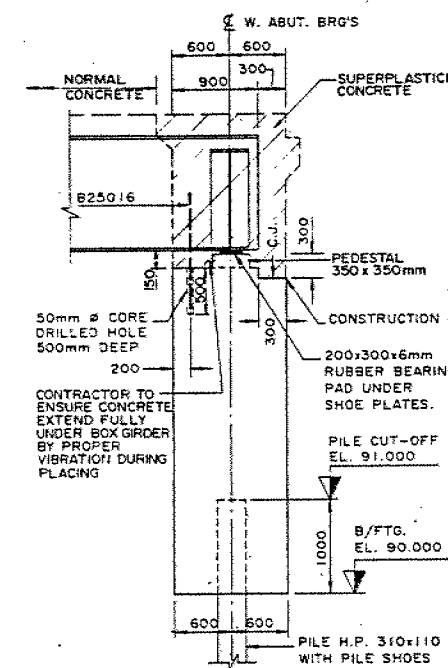


SECTION B-B  
SCALE 1:50

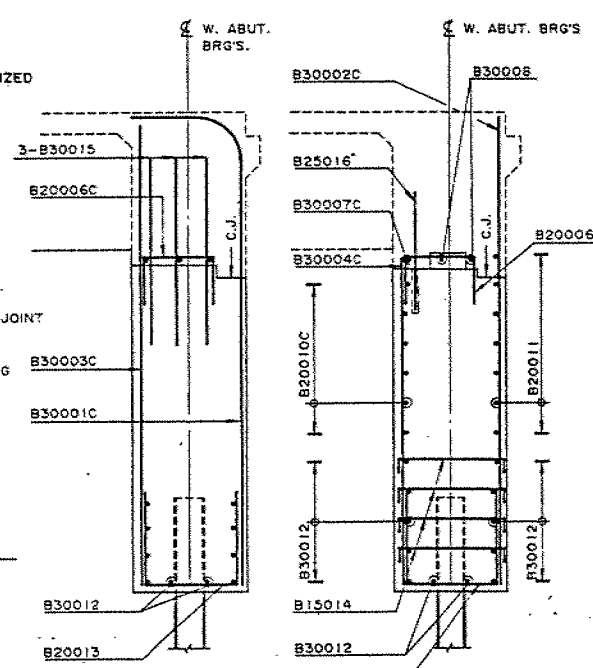


ELEVATION  
SCALE 1:50

REINFORCEMENT



SECTION C-C  
SCALE 1:40



SECTION D-D  
N.T.S.

SECTION E-E  
N.T.S.

## CONSTRUCTION SEQUENCE:

1. a) CONSTRUCT THE ABUTMENTS INCLUDING WINGWALLS TO THE BEARING SEAT ELEVATION. TO PROVIDE STABILITY DURING CONSTRUCTION, CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS & WINGWALLS. FORMWORK & LATERAL BRACING SHALL NOT BE REMOVED UNTIL DECK CONCRETE HAS REACHED 75% OF ITS SPECIFIED STRENGTH.  
b) ERECT THE STEEL BOX GIRDERS IN PLACE.  
c) CORE DRILL HOLES, PLACE & GROUT ANCHOR RODS.  
d) CAST THE DECK & TOP PORTION OF THE ABUTMENTS INTEGRALLY WITH THE STEEL BOX GIRDERS IN ONE POUR.
2. CONCRETE IN THE DECK SLAB SHALL BE RETARDED USING A TYPE R<sub>x</sub> RETARDER FOR THE DURATION OF THE POUR.

## LIST OF PILES

LOCATION	ROW	No.	LENGTH(m)	BATTER
W. ABUT.	CENTRE	6	19.0	-
	SIDES	2	19.7	1:4
E. ABUT.	CENTRE	6	20.0	-
	SIDES	2	20.5	1:4

## NOTES

- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
- PILES TO BE DRIVEN IN ACCORDANCE WITH STD. SS 103-10 OR SS103-11 USING AN ULTIMATE CAPACITY OF 3450KN.
- PILE DESIGN DATA  
MAX. COMBINED FACTORED LOADS:  
ULS TYPE II = 1150KN  
ULS = 1600KN
- GIRDER BEARING SEAT TO BE FINISHED LEVEL TO RECEIVE SHOE PLATE.
- PROVIDE 6mm RUBBER PAD UNDER EACH SHOE PLATE.

## APPLICABLE STANDARD DRAWINGS

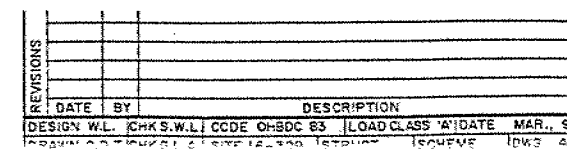
OPSD 3301.00 SPICE AND DRIVING SHOE DETAIL FOR STEEL 'H' PILES.

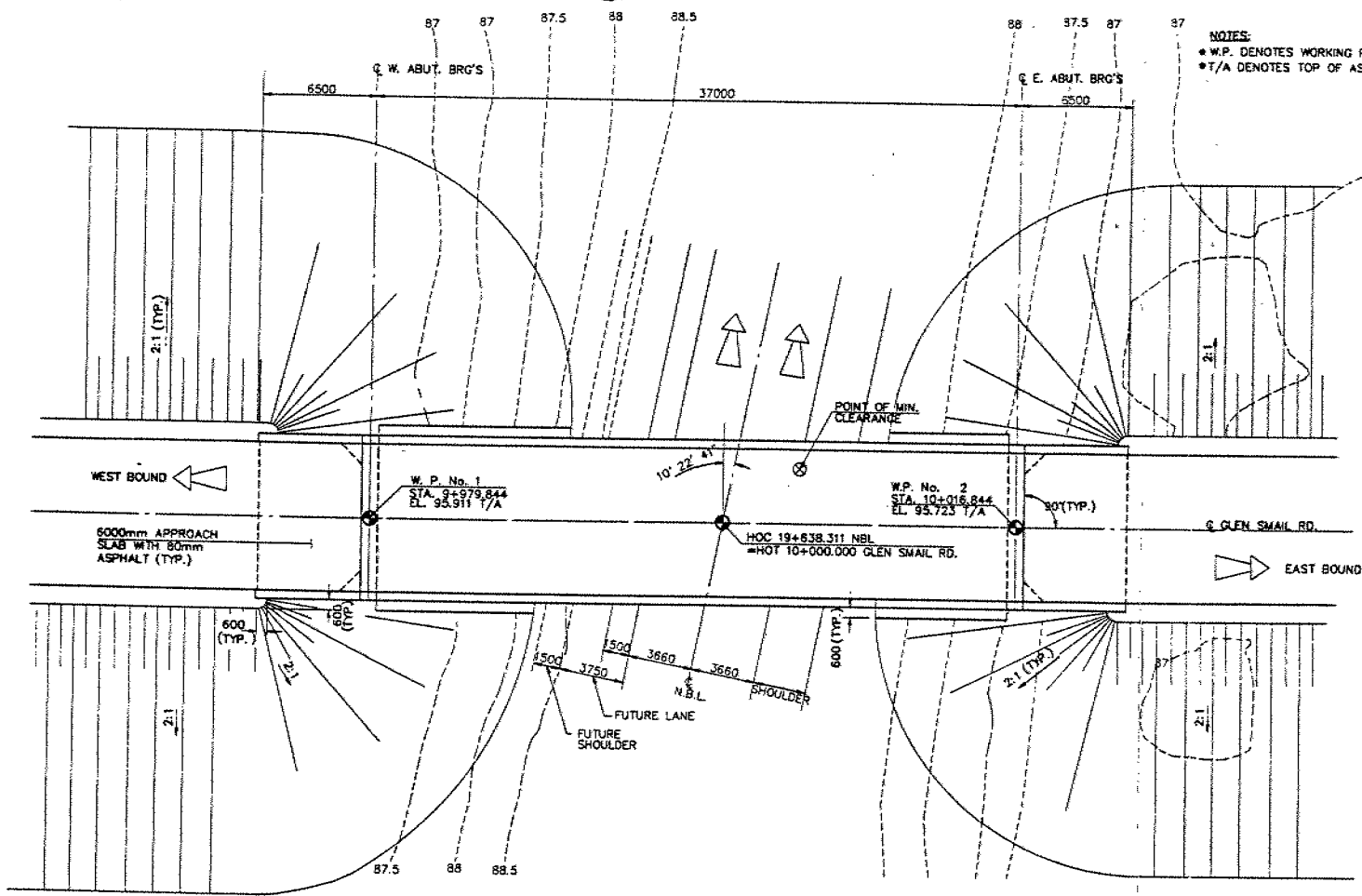
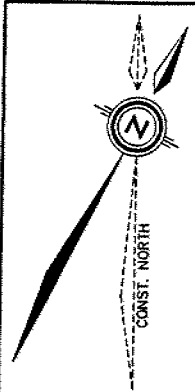
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## NOTES:

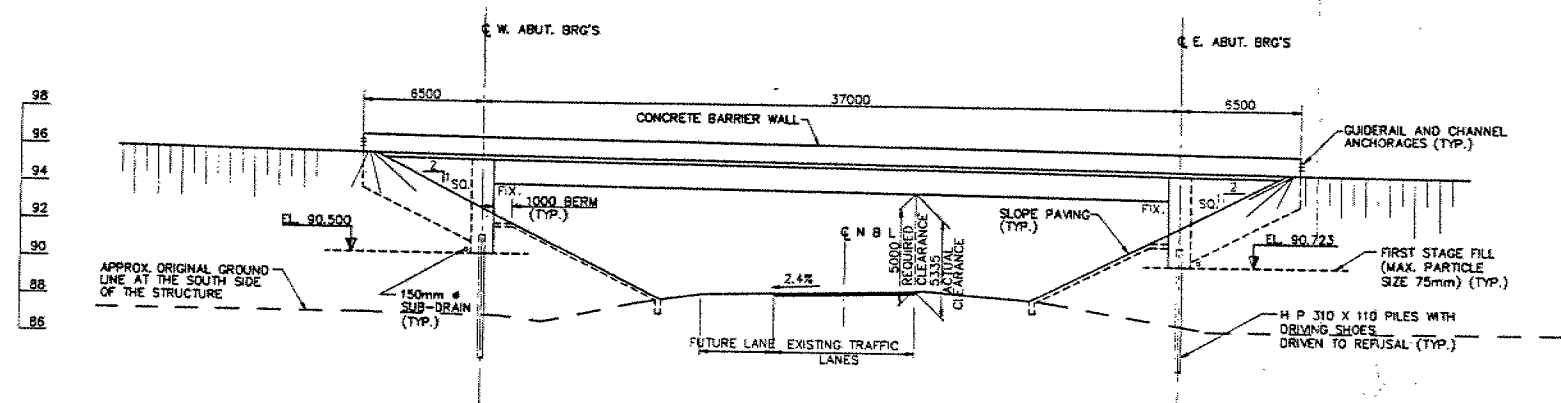
- F.F. DENOTES FRONT FACE
- B.F. DENOTES BACK FACE
- E.F. DENOTES EACH FACE

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

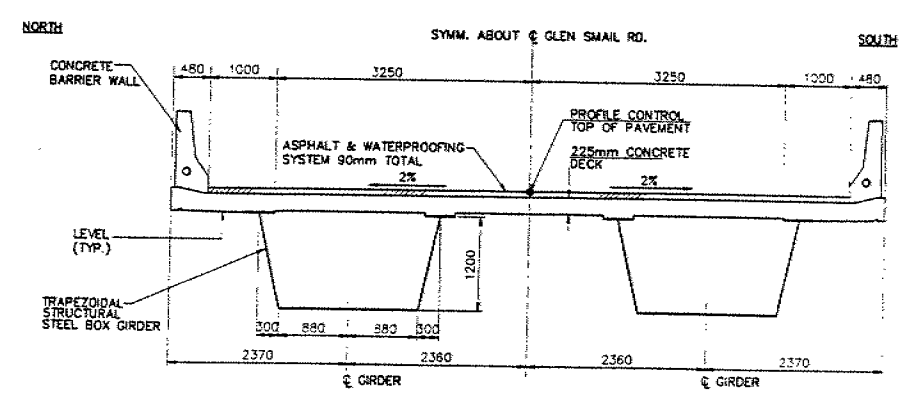




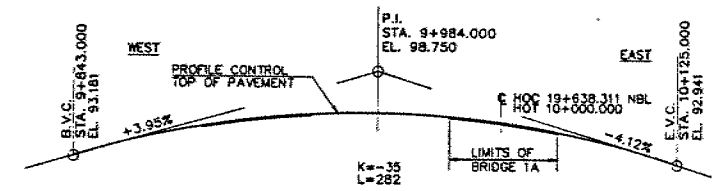
PLAN  
SCALE 1:200



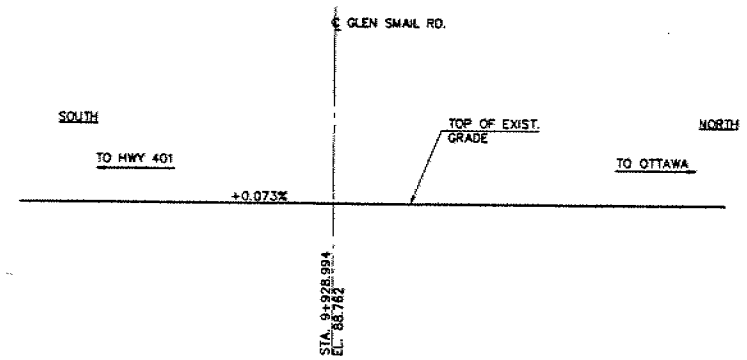
ELEVATION  
SCALE 1:200



TYPICAL SECTION  
SCALE 1:50



PROFILE ALONG C GLEN SMAIL ROAD  
N.T.S.



PROFILE ALONG C N.B.L. HWY 416  
N.T.S.

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DISTRICT No. 9  
CONT No  
WP No 177-89-03

GLEN SMAIL ROAD UNDERPASS  
BRIDGE 1A N. B. L.  
HWY 416  
GENERAL ARRANGEMENT

SHEET

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ENGINEERS ARCHITECTS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE

- ALL CONCRETE 30MPa

REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

- ABUTMENTS & WINGWALLS  
FRONT FACE 80 ±20mm  
BACK FACE 70 ±20mm
- DECK:  
TOP 70 ±20mm  
BOTTOM 40 ±10mm
- APPROACH SLABS 80 ±20mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 ±20mm

CONSTRUCTION NOTES

- BEARING SEATS SHALL BE FINISHED LEVEL TO THE SPECIFIED ELEVATIONS.
- NO BACKFILL SHALL BE PLACED UNTIL DECK CONCRETE HAS REACHED 75 % OF ITS SPECIFIED STRENGTH.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 0.5m.

LIST OF DRAWINGS:

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- ABUTMENT AND PILE DETAILS
- WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- DECK DETAILS
- BARRIER WALL
- 6000mm APPROACH SLAB
- DETAILS OF CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING
- AS CONSTRUCTED ELEV. AND DIM.
- QUANTITIES - STRUCTURAL

APPLICABLE STANDARD DRAWINGS

- DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
- DD-4602 CONSTRUCTION CLEARANCE

MTC B.M. 848005  
ELEV. 87.820  
TABLET SET VERTICALLY ON N.E. CORNER OF  
CONC. CULVERT 12.8 RT STA. 19+707.6

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

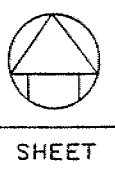
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	W.L.	CHK S.W.L.	CODE OHBDC 83
DRAWING	A.R.A.	CHK G.L.A.	SITE 16-309
			STRUCT
			SCHEME
			DWG 1
			DATE OCT., 90

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

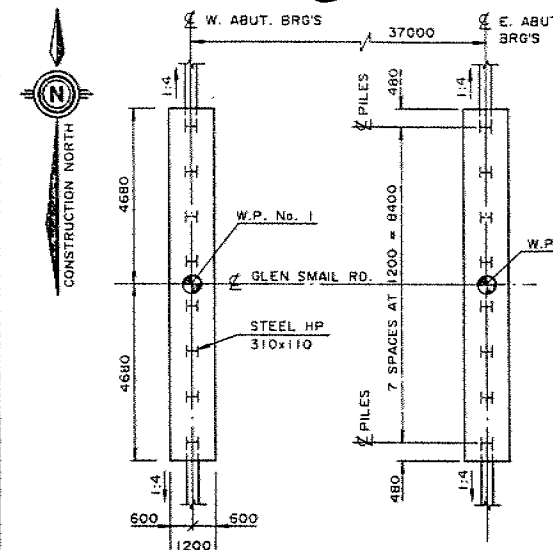
CONT No  
WP No177-89-03

GLEN SMAIL ROAD UNDERPASS  
BRIDGE 1A N.B.L.  
HWY. 416  
ABUTMENT & PILE DETAILS

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ENGINEERS ARCHITECTS AND PLANNERS

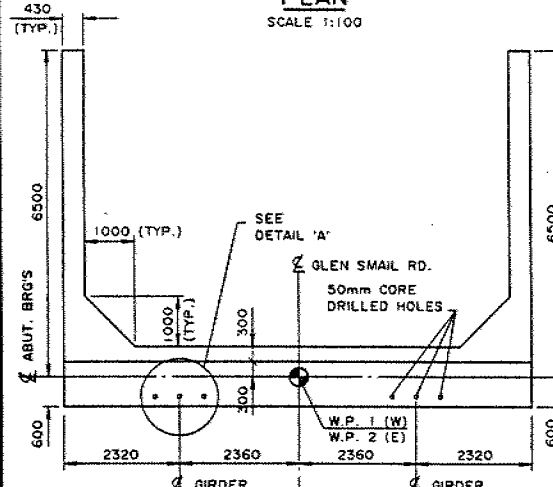


SHEET



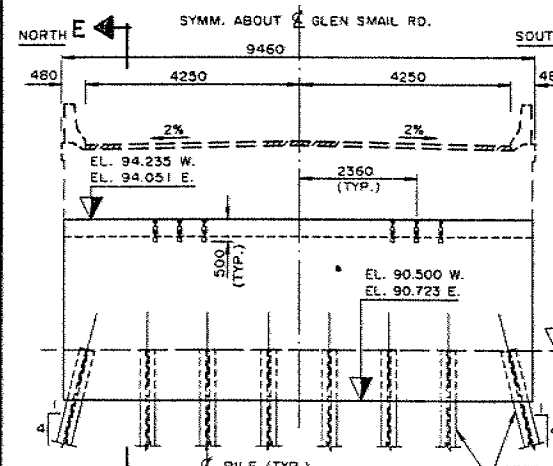
DIMENSIONS PLAN PILE LAYOUT

SCALE 1:100



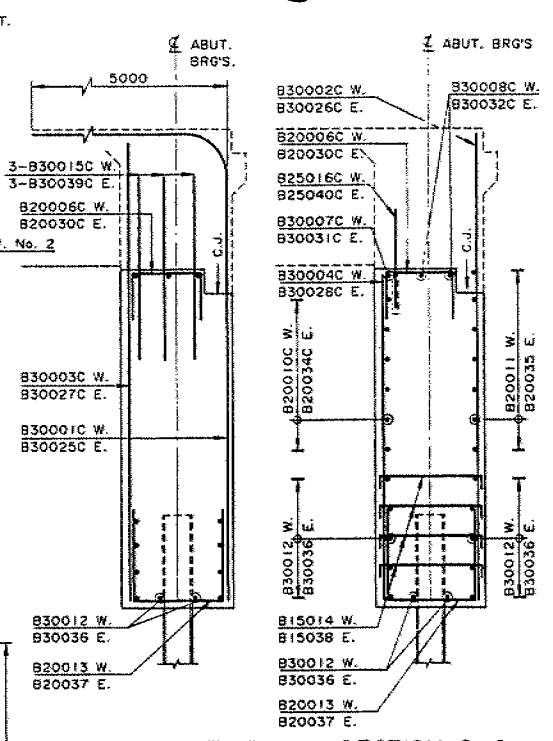
PLAN

SCALE 1:75



ABUTMENT ELEVATION

SCALE 1:75

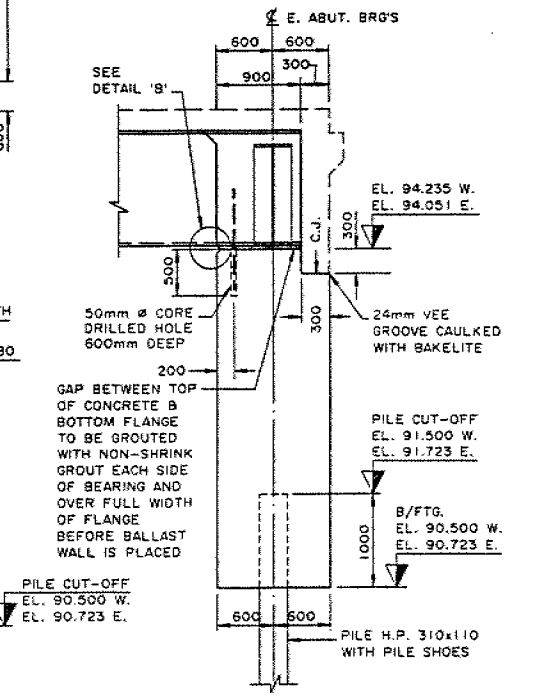


SECTION F-F

N.T.S.

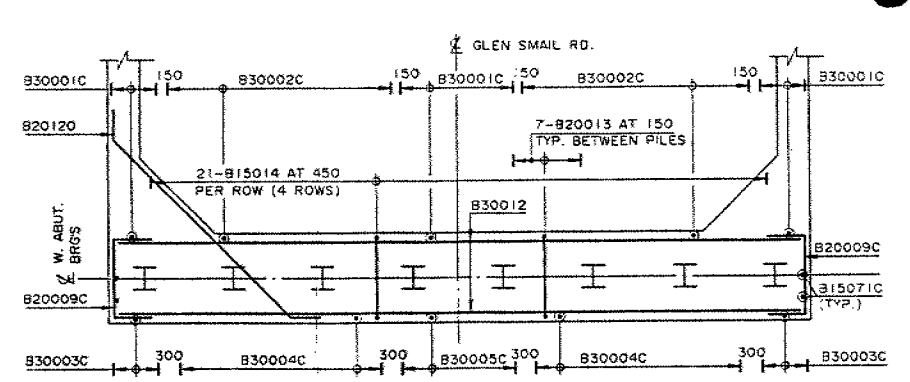
SECTION G-G

N.T.S.



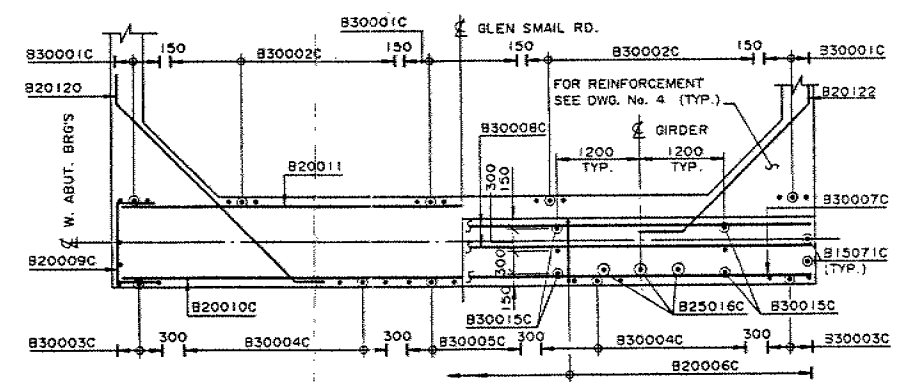
SECTION E-E

SCALE 1:40



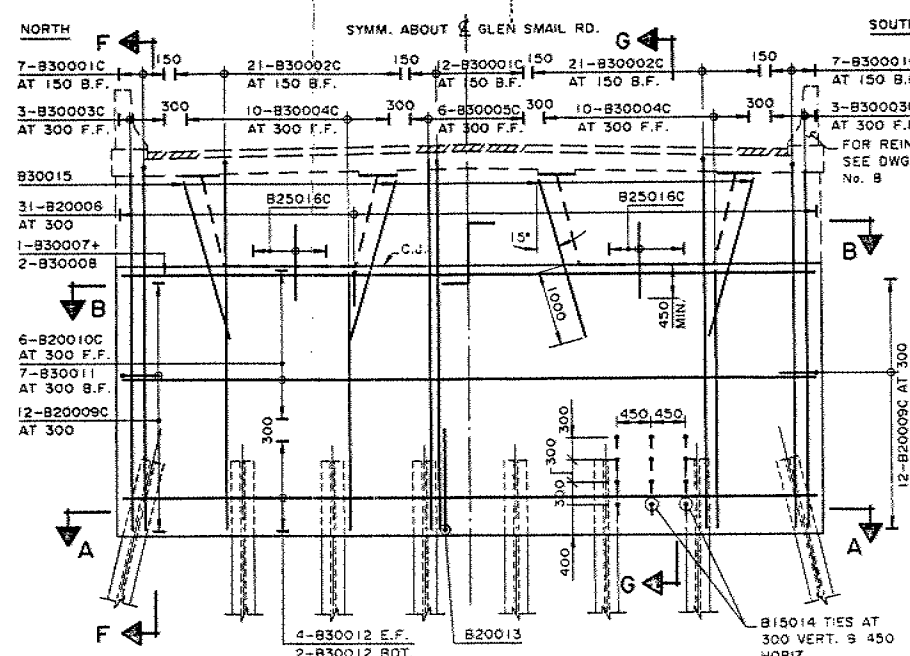
SECTION A-A

SCALE 1:50



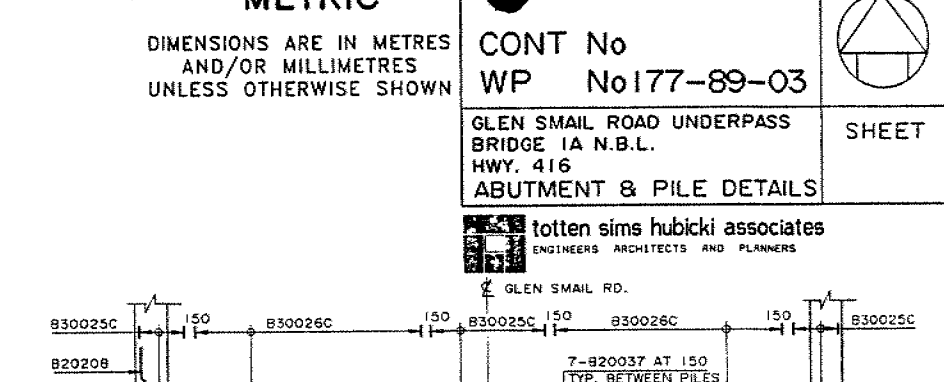
SECTION B-B

SCALE 1:50



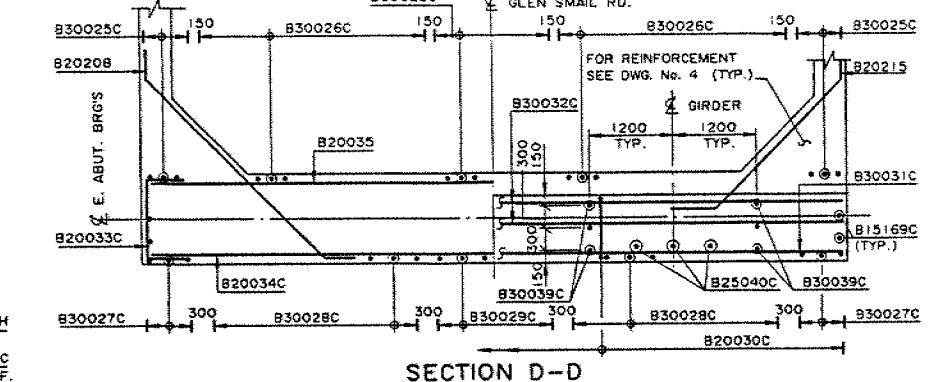
WEST ABUTMENT REINFORCEMENT

SCALE 1:50



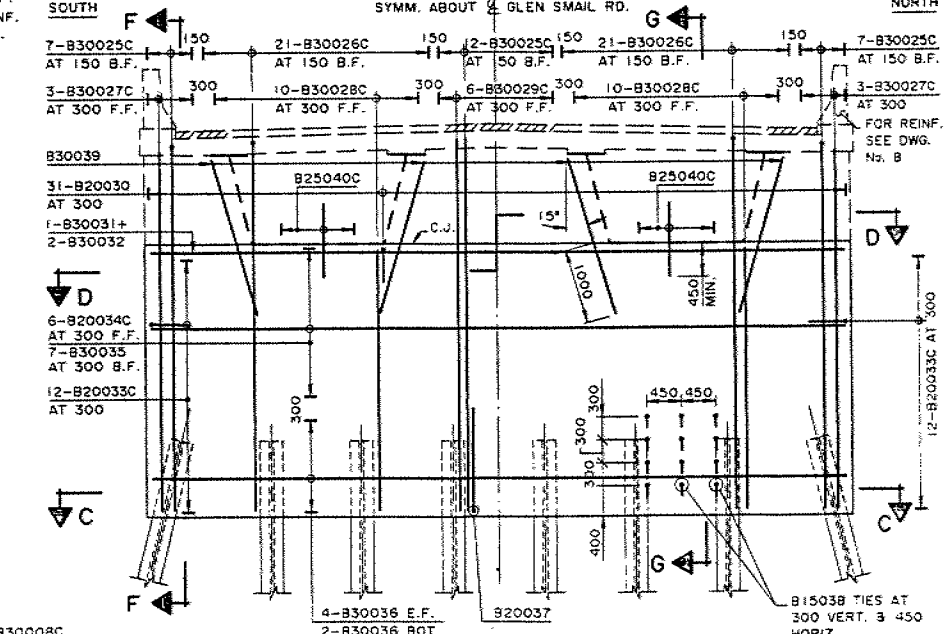
SECTION C-C

SCALE 1:50



SECTION D-D

SCALE 1:50



EAST ABUTMENT REINFORCEMENT

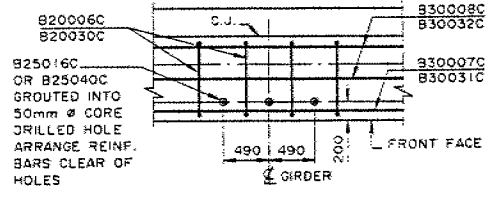
SCALE 1:50

LIST OF PILES					
LOCATION	No.	LENGTH	TYPE	PILE DESIGN DATA	
				LOAD AT SLT TYPE II	FACTORED CAPACITY AT ULS
W. ABUT.	B	20.20	HP310x110	1150 KN	1600 KN
E. ABUT.	B	20.43	HP310x110	1150 KN	1600 KN

- NOTES
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
  - PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
  - PILES TO BE DRIVEN TO REFUSAL IN ACCORDANCE WITH DRAWING 13.
  - GIRDER BEARING SEAT TO BE FINISHED LEVEL TO RECEIVE BEARING PLATE.

CONSTRUCTION SEQUENCE:

- THE ABUTMENTS INCLUDING WINGWALLS ARE CONSTRUCTED TO THE BEARING SEAT ELEVATION. TO PROVIDE STABILITY DURING CONSTRUCTION, CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS & WINGWALLS. FORMWORK & LATERAL BRACING SHALL NOT BE REMOVED UNTIL DECK CONCRETE HAS REACHED 75% OF ITS SPECIFIED STRENGTH.
- THE STEEL BOX GIRDERS ARE ERECTED AND PUT IN PLACE.
- THE DECK & TOP PORTION OF THE ABUTMENTS ARE CAST INTEGRALLY WITH THE STEEL BOX GIRDERS IN ONE POUR.
- CONCRETE IN THE DECK SLAB SHALL BE RETARDED USING A TYPE R<sub>1</sub> RETARDER FOR THE DURATION OF THE POUR. THE DOSAGE OF RETARDER AS DIRECTED BY THE ENGINEER.



DETAIL 'A'

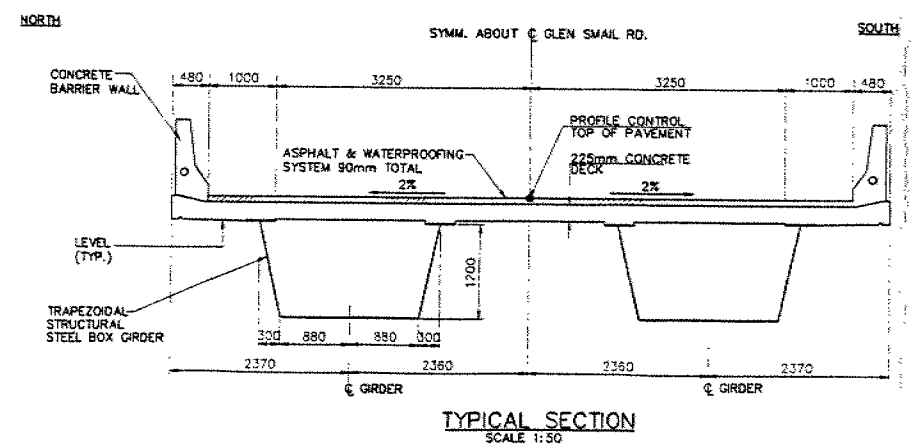
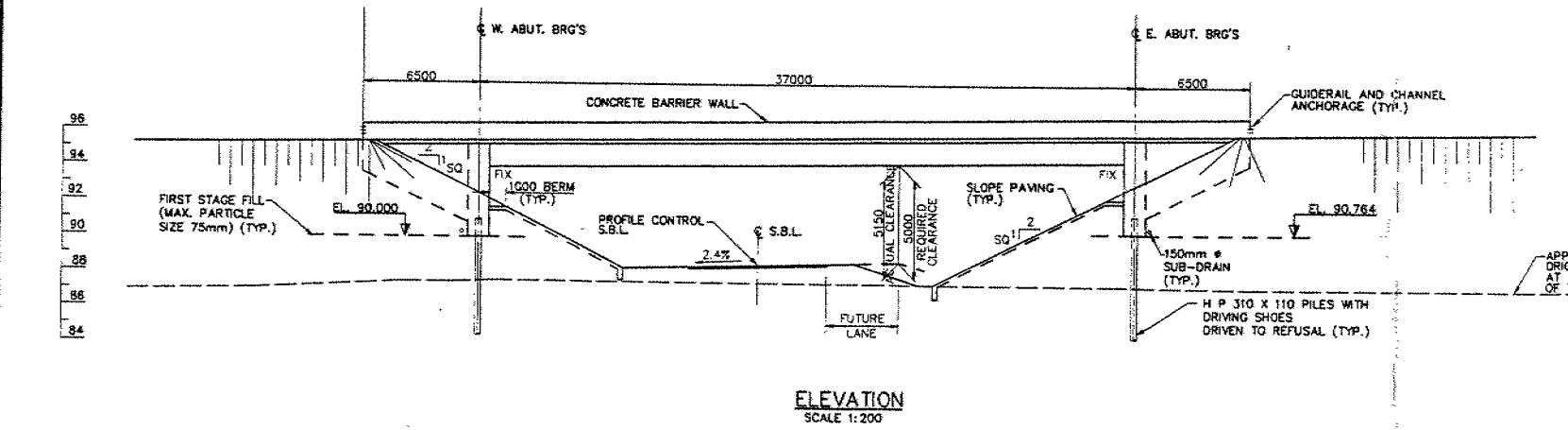
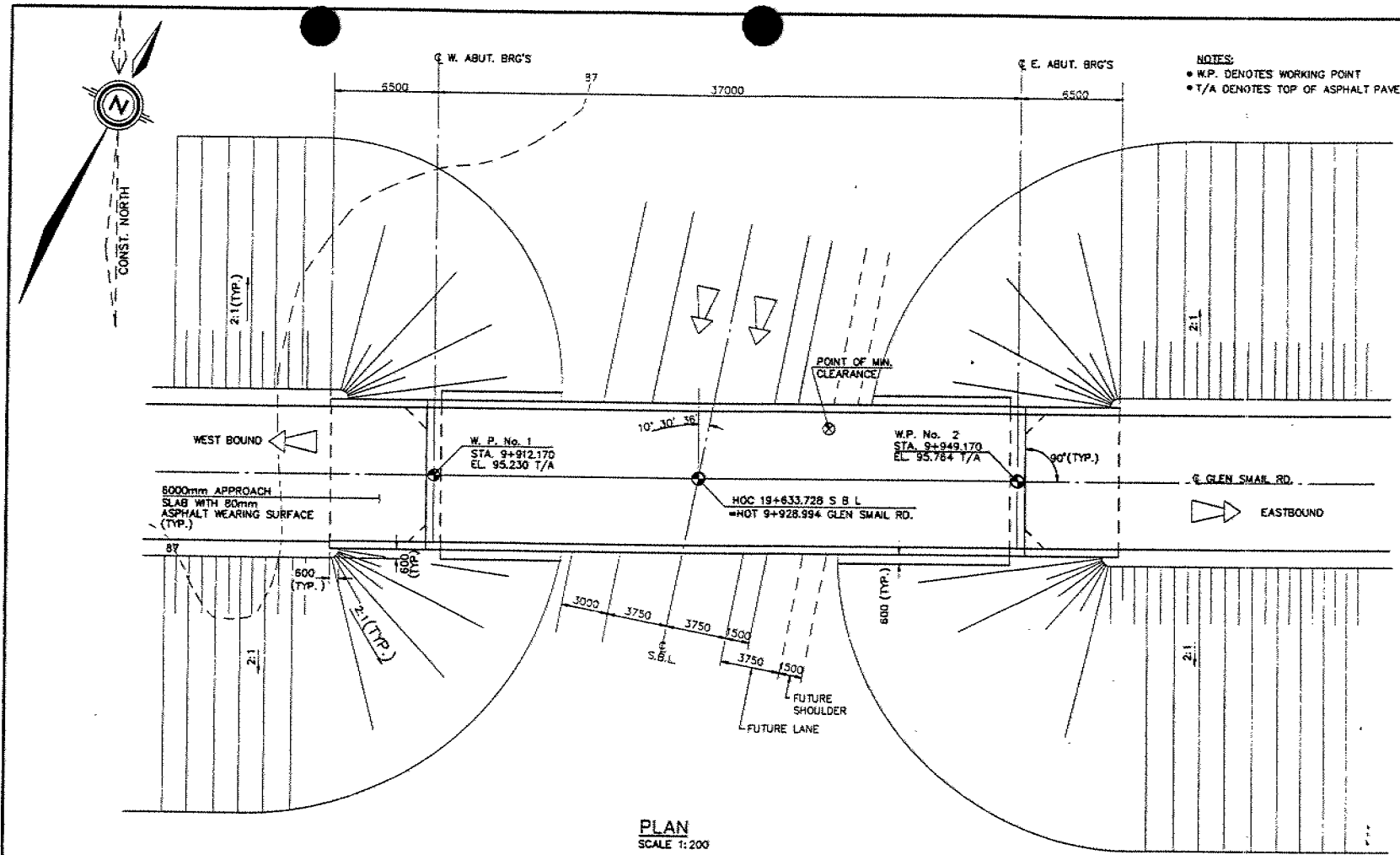
SCALE 1:40

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

APPLICABLE STANDARD DRAWINGS

DD-3301 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'H' PILES.

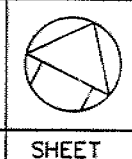
REVISIONS	DATE	BY	DESCRIPTION
DESIGN W.L.	CHK'S W.L.	CODE	OHBC 83
DRAWN C.D.T.	CHK'G L.A.	SITE 16-309	STRUCT
		SCHEME	DWG 3



MTC B.M. 848005  
ELEV. 87.820  
TABLET SET VERTICALLY ON N.E. CORNER OF  
CONC. CULVERT 12.8 RT STA. 19+707.6

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DISTRICT No. 9  
CONT No  
WP No 177-89-06  
GLEN SMAIL ROAD UNDERPASS  
BRIDGE 1B S B L  
HWY 416  
GENERAL ARRANGEMENT



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ENGINEERS ARCHITECTS AND PLANNERS

### GENERAL NOTES

- CLASS OF CONCRETE**
- ALL CONCRETE 30MPa
- REINFORCING STEEL**
- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.
- CLEAR COVER TO REINFORCING STEEL**
- ABUTMENTS & WINGWALLS  
FRONT FACE 80 ±20mm  
BACK FACE 70 ±20mm
  - DECK:  
TOP 70 ±20mm  
BOTTOM 40 ±10mm
  - APPROACH SLABS 80 ±20mm
  - REMAINDER (UNLESS OTHERWISE NOTED) 70 ±20mm

### CONSTRUCTION NOTES

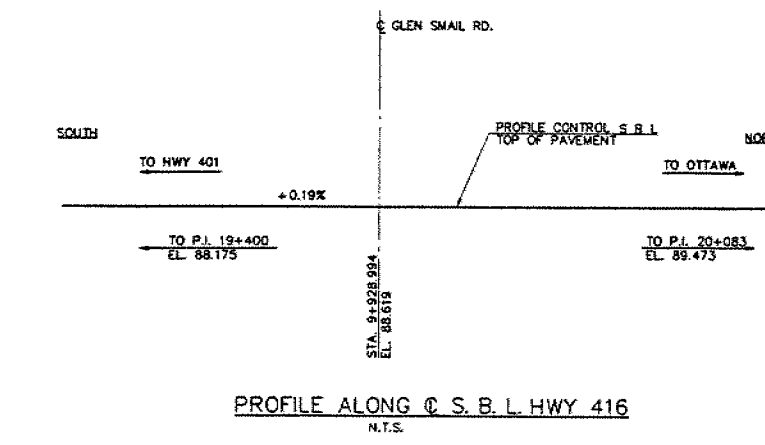
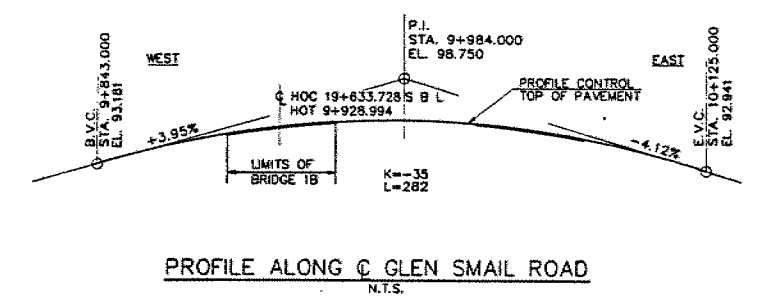
- BEARING SEATS SHALL BE FINISHED LEVEL TO THE SPECIFIED ELEVATIONS.
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- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 0.5m.

### LIST OF DRAWINGS:

- GENERAL ARRANGEMENT
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- DECK DETAILS
- BARRIER WALL
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- DETAILS OF CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING
- AS CONSTRUCTED ELEV. AND DIM.
- QUANTITIES - STRUCTURAL

### APPLICABLE STANDARD DRAWINGS

- DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
- DD-4602 CONSTRUCTION CLEARANCE



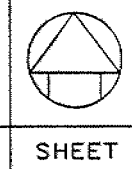
DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	W.L.	CHK S.W.L.	CODE OHBDC 83 LOAD CLASS 'A' DATE OCT. 90
DRAWING	A.R.A.	CHK G.L.A.	SITE 18-309 STRUCT SCHEME DWG 1

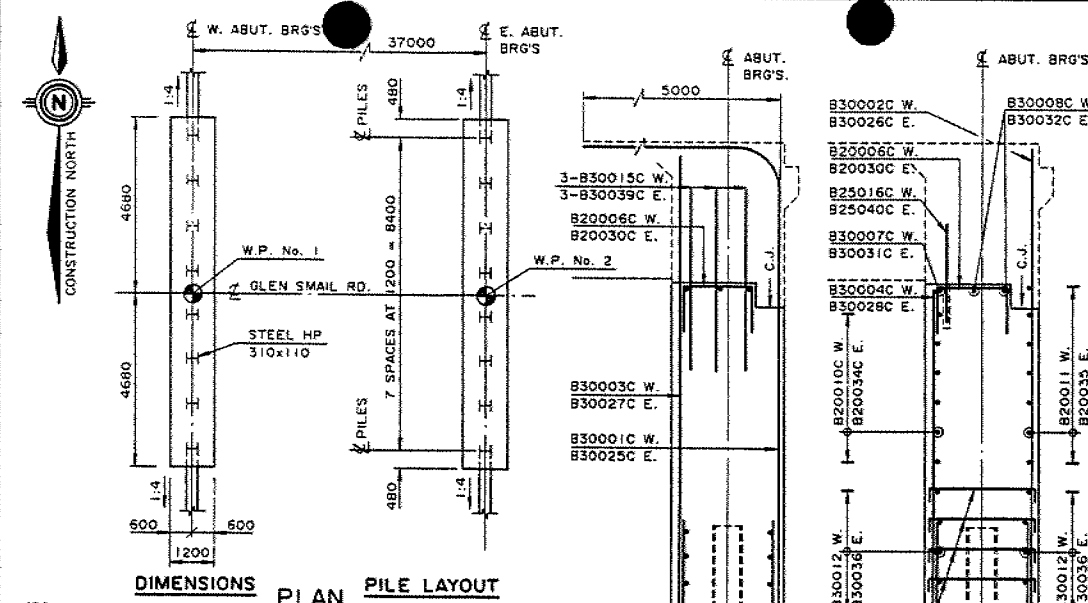


METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

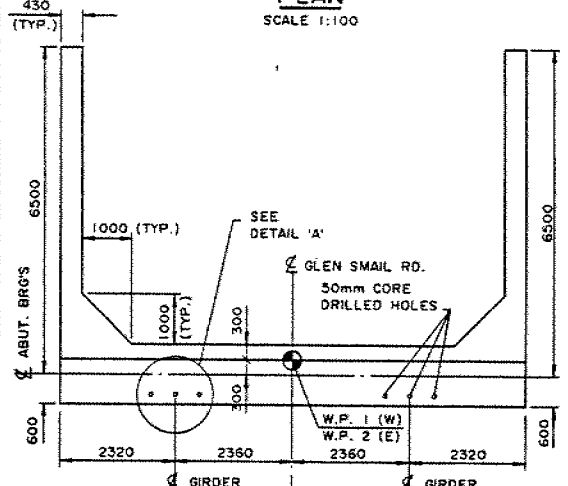
CONT No  
WP No 177-89-06  
GLEN SMAIL ROAD UNDERPASS  
BRIDGE 18 S.B.L.  
HWY. 416  
ABUTMENT & PILE DETAILS



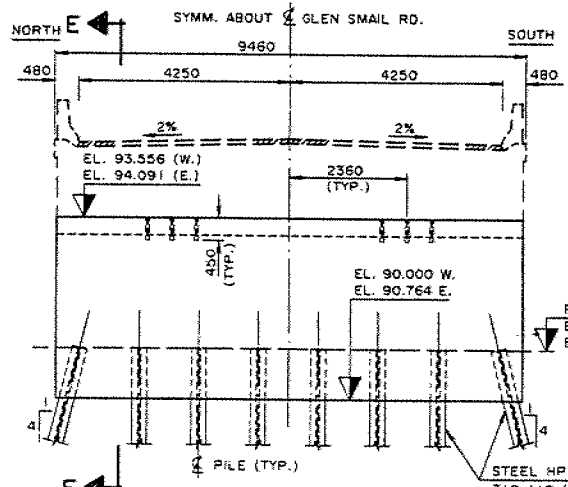
totten sims hubicki associates  
ENGINEERS ARCHITECTS AND PLANNERS



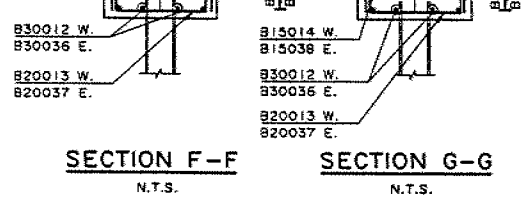
DIMENSIONS PLAN PILE LAYOUT  
SCALE 1:100



PLAN  
SCALE 1:75

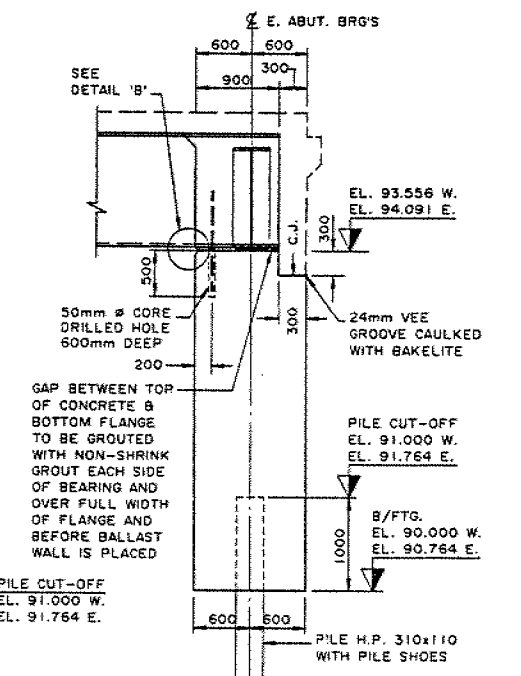


ABUTMENT ELEVATION  
SCALE 1:75

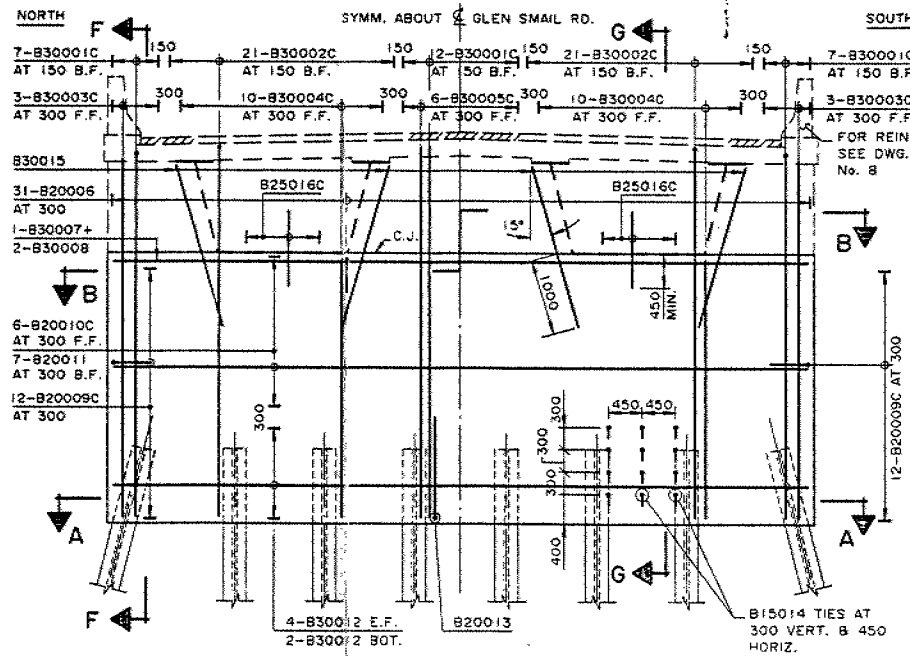


SECTION F-F  
N.T.S.

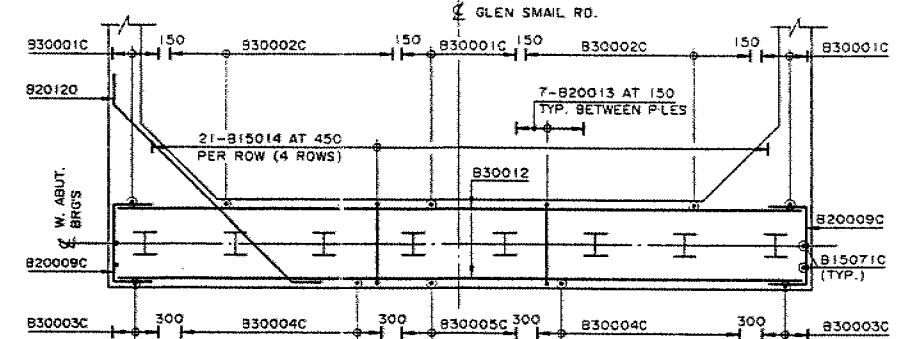
SECTION G-G  
N.T.S.



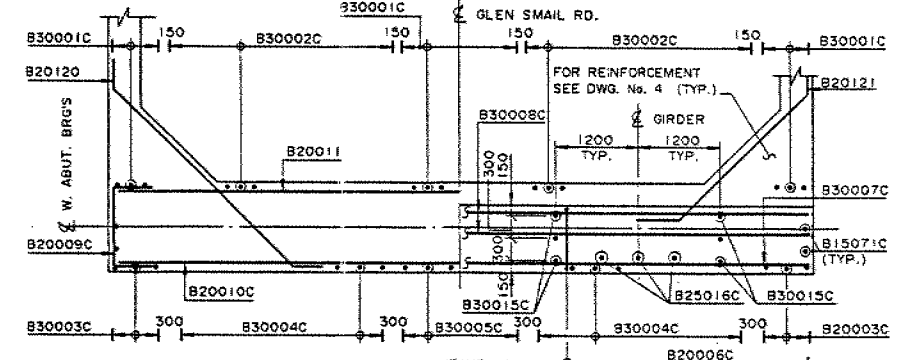
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SCALE 1:40



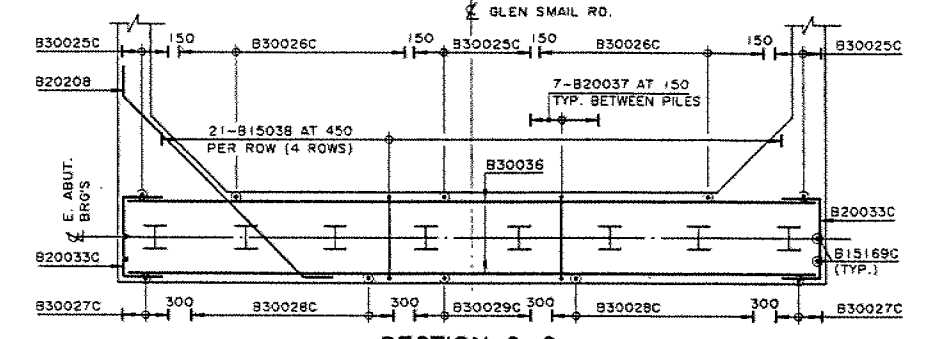
WEST ABUTMENT REINFORCEMENT  
SCALE 1:50



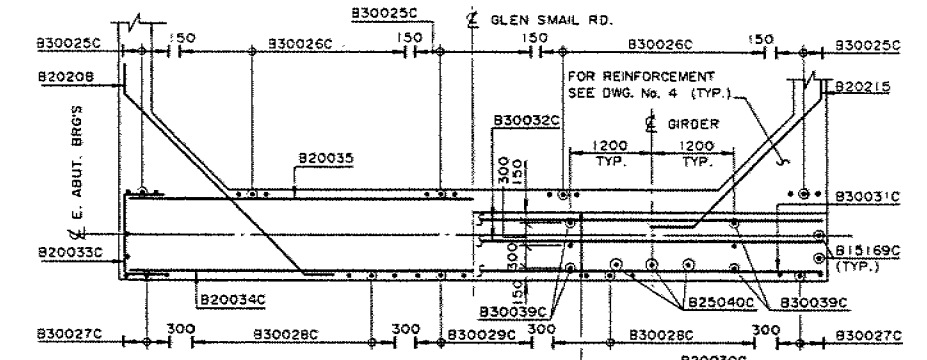
SECTION A-A  
SCALE 1:50



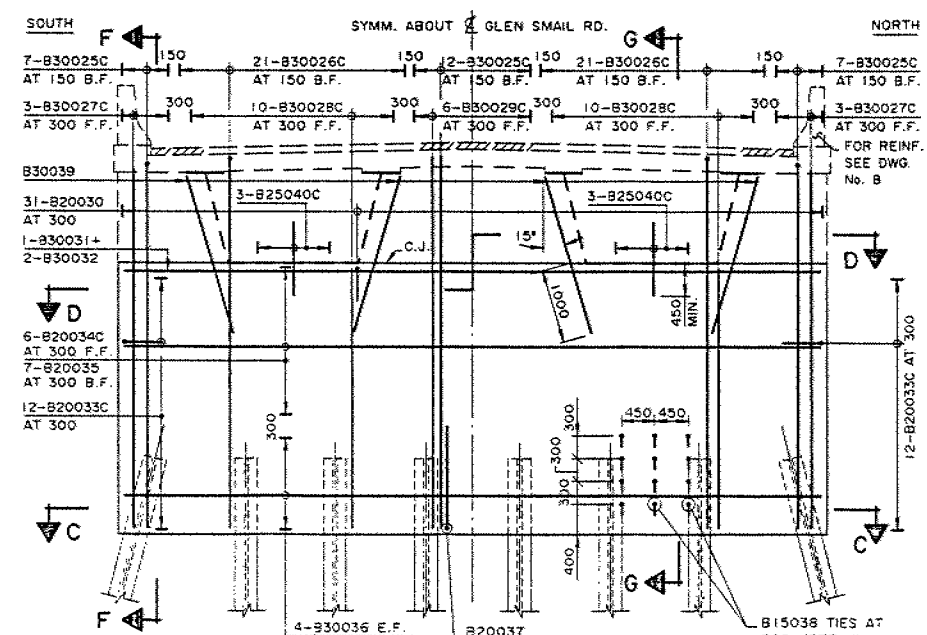
SECTION B-B  
SCALE 1:50



SECTION C-C  
SCALE 1:50



SECTION D-D  
SCALE 1:50

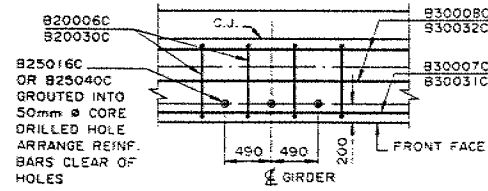


EAST ABUTMENT REINFORCEMENT  
SCALE 1:50

LIST OF PILES					
LOCATION	No.	LENGTH	TYPE	PILE DESIGN DATA	
				LOAD AT SLS TYPE II	FACTORED CAPACITY AT ULS
W. ABUT.	B	20.0m	HP310x110	1150 KN	1600 KN
E. ABUT.	B	20.5m	HP310x110	1150 KN	1600 KN

- NOTES
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
  - PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
  - PILES TO BE DRIVEN TO REFUSAL IN ACCORDANCE WITH DRAWING 13.
  - GIRDER BEARING SEAT TO BE FINISHED LEVEL TO RECEIVE BEARING PLATE.

- CONSTRUCTION SEQUENCE:
- THE ABUTMENTS INCLUDING WINGWALLS ARE CONSTRUCTED TO THE BEARING SEAT ELEVATION. TO PROVIDE STABILITY DURING CONSTRUCTION, CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS & WINGWALLS. FORMWORK & LATERAL BRACING SHALL NOT BE REMOVED UNTIL DECK CONCRETE HAS REACHED 75% OF ITS SPECIFIED STRENGTH.
  - THE STEEL BOX GIRDERS ARE ERECTED AND PUT IN PLACE.
  - THE DECK & TOP PORTION OF THE ABUTMENTS ARE CAST INTEGRALLY WITH THE STEEL BOX GIRDERS IN ONE POUR.
- CONCRETE IN THE DECK SLAB SHALL BE RETARDED USING A TYPE R<sub>1</sub> RETARDER FOR THE DURATION OF THE POUR. THE DOSAGE OF RETARDER AS DIRECTED BY THE ENGINEER.



DETAIL 'A'  
SCALE 1:40

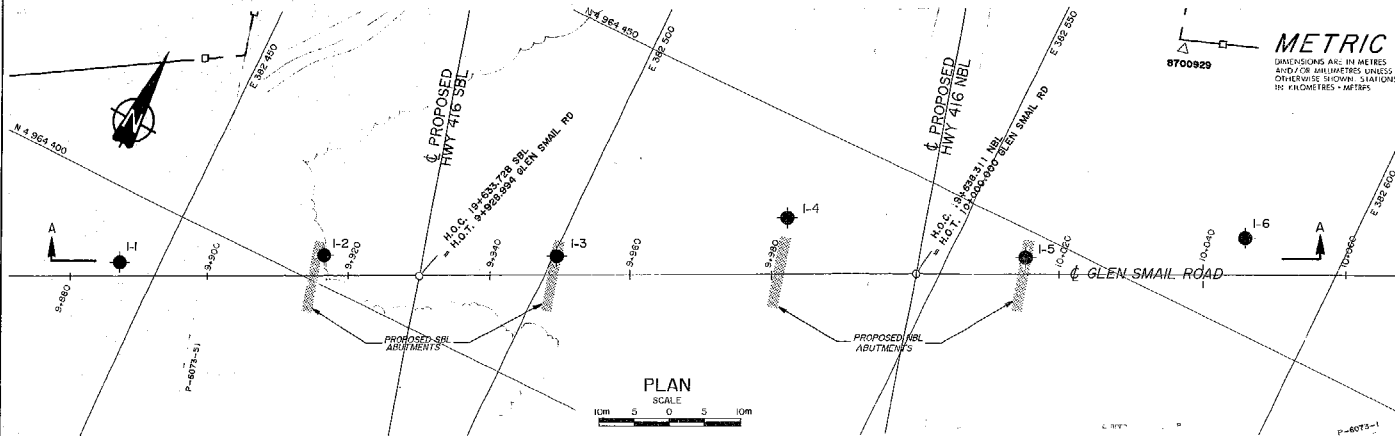
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

APPLICABLE STANDARD DRAWINGS

DD-3922 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'H' PILES.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN W.L. CHK'S.W.L. CODE OHBC 93	LOAD CLASS 'A'	DATE	OCT. 90
DRAWN C.D.T. CHK G.L.A. SITE 16-309	STRUCT	SCHEME	DWG 3

- 1) Page 5: Vane Shear Shear Strength ranging from 68 kpa to 144 kpa is reported.  
How Shear Strength in excess of 100 kpa was measured using 6"x3" Vane.  
For sensitive clays,  $W_u$  usually close to  $W_L$ .
- 2) Page 9: Except for at two location (depth), the  $C_u \geq 100$  kpa.  
Why such a low Bearing Capacity Values are reported.
- 3) Page 11: Pile Capacity is based on end bearing.  
Should there be a pile load test.  
Why Pipe pile is favoured over H-pile.  
  
Recommendation for Earth pressure Calculations based on wall movement equivalent to 0.05%  $H$ .  
Who decides this movement & the recommendation should be based on soil condition & Soil Structure interaction.
- 4) Page 12: Embankment Fill height in the range of 8.5m to 9.0m  
Will exert about 190 kpa  
 $N$ -Values are  $< 7$ , However  $C_u \geq 68$  kpa to 144 kpa  
Based on this data, no stability problems anticipated.  
No berms provided: Should the overall slope be 2.5H to 1V.  
Recommended allowable bearing pressure S.L.S Type II is 160 kpa  $< 190$  kpa.
- 5) Page 13: As indicated above S.L.S Type II for 25 mm Settlement is 160 kpa; Whereas load from fill is about 190 kpa  
How the total Settlement be within 25 mm.



**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES - METRES.

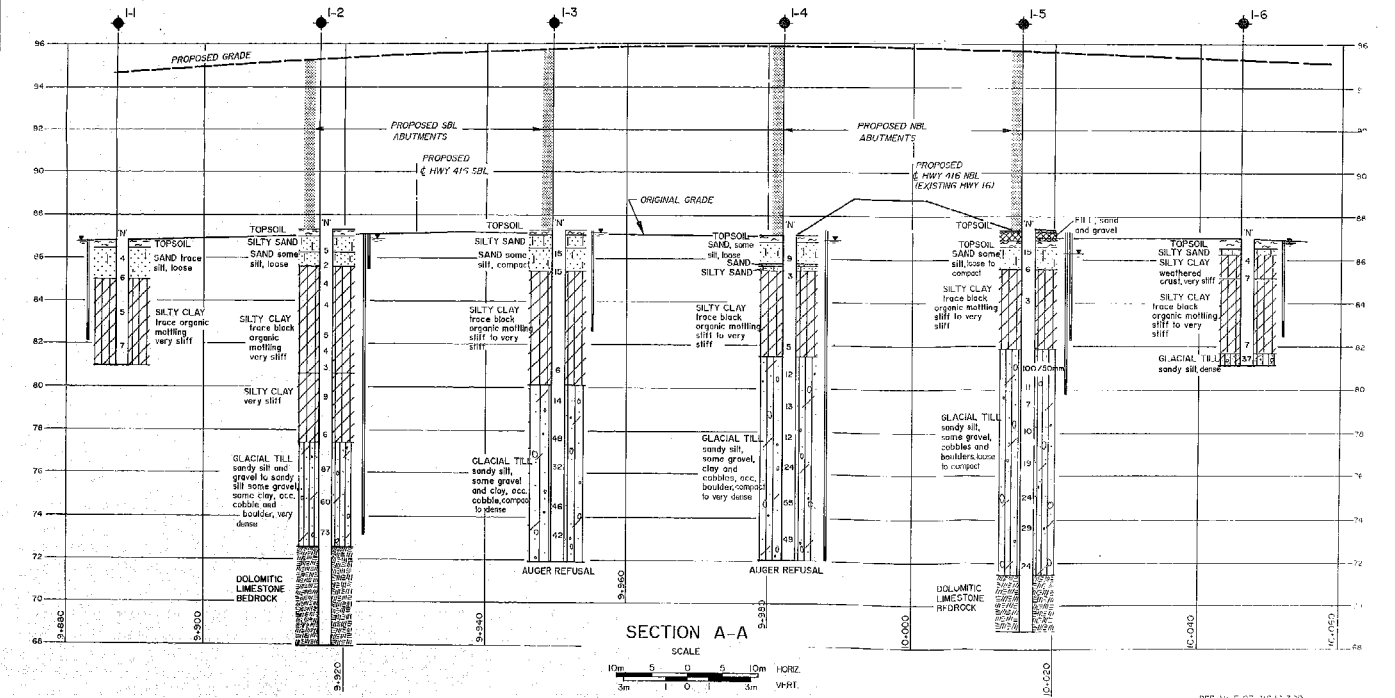
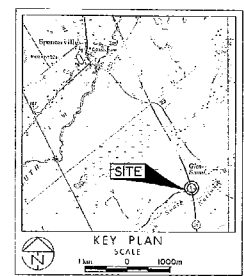
CONT No  
WP No 177-89-03

GLEN SMAIL ROAD  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

Golder Associates Ltd.



- LEGEND**
- Bore hole
  - ⊕ Dynamic Cone Penetration Test (Cone)
  - ⊕ Bore Hole & Cone
  - N Blow/0.3m (Std Pen Test, 475 1/blow)
  - CONE Blow/0.3m (Std Pen Test, 475 1/blow)
  - W.I. at time of investigation (MAY 1990)
  - Standpipe

No	ELEVATION	STATION	OFFSET
I-1	86.8	9+867.3	2.0m LI
I-2	87.3	9+916.4	2.5m LI
I-3	87.3	9+949.5	2.7m LI
I-4	87.3	9+982.1	7.9m LI
I-5	87.4	10+015.5	2.4m LI
I-6	87.0	10+046.2	5.1m LI

**-NOTES-**

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

NOTE: The complete foundation investigation and design report  
for project and other related documents may be examined at the  
Frederick and Atholville Library, Downsview. Information contained in  
this report and related documents is specific to the conditions  
described in the conditions of Section 137-2 of Form 100.

Geotechnical No. 78-100  
Date: May 1990  
Drawn by: J. A. C. (JAC) Date: 08/08/01  
Checked by: J. A. C. (JAC) Date: 14/10/00  
Scale: 1:1000

When N.E.B.  
How Silty Clay  
can be classified as  
very stiff.