

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40J8-40

DIST. 1 REGION

W.P. No. 91-67-01

CONT. No. 84-82

W. O. No.

STR. SITE No. 13-104-193

HWY. No. 2

LOCATION Baphiote Creek Bridge

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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

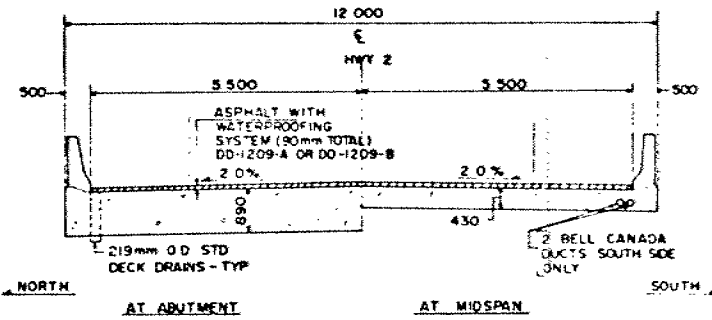
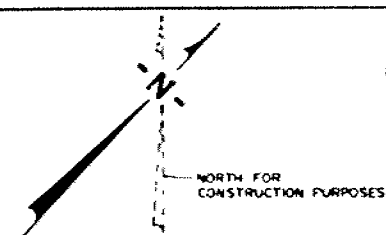
DIST. NO. 1 - HWY. NO. 2
CONT. No
WP No 91-67-01

BAPTISTE CREEK BRIDGE
0.48 km WEST OF EAST JCT.
HWY. NO. 401
GENERAL ARRANGEMENT

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

SHEET

BR-470



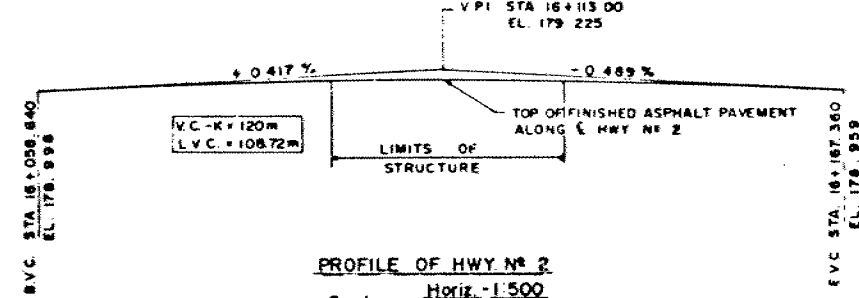
DECK SECTION
1:75

NOTES:

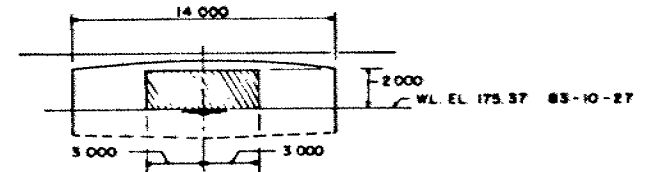
- CLASS OF CONCRETE**
FOOTINGS, MASS CONCRETE & APPROACH SLABS 20 MPa
REMAINDER 30 MPa
- CLEAR COVER TO REINFORCING STEEL**
FOOTINGS 100 mm 25 mm
ABUTMENTS & WINGWALLS (FRONT FACE) 80 mm 20 mm
ABUTMENTS (BACK FACE) 70 mm 20 mm
WINGWALLS (BACK FACE) 70 mm 20 mm
DECK (TOP) 70 mm 20 mm
DECK (BOTTOM & SIDES) 50 mm 10 mm
REMAINDER 70 mm 20 mm UNLESS OTHERWISE NOTED
- REINFORCING STEEL**
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED
BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS
- CONSTRUCTION NOTES**
BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS, KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 500 mm.
- FALSEWORK SUPPORTING THE DECK SHALL NOT BE REMOVED UNTIL AFTER THE BACKFILL HAS BEEN PLACED BEHIND THE ABUTMENTS TO AT LEAST ELEV. 178.400
- BARRIER WALL SHALL NOT BE POURED UNTIL AFTER DECK SUPPORTING FALSEWORK HAS BEEN REMOVED.

LIST OF DRAWINGS

- DWG 13-104-193-1. GENERAL ARRANGEMENT
- BORE HOLE LOCATION & SOIL STRATA
 - FOOTINGS
 - RIGID FRAME
 - WINGWALLS
 - BARRIER WALL
 - 6,000mm APPROACH SLAB
 - AS CONSTRUCTED ELEV. & DIM.
 - BRIDGE DATA & SITE NUMBER DATA
 - STANDARD DETAILS
 - BAILEY BRIDGE
 - BAILEY BRIDGE
 - QUANTITIES
 - QUANTITIES

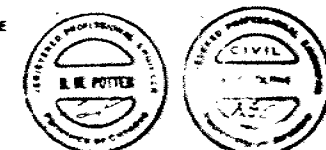


PROFILE OF HWY. NO. 2
Scales - Horiz. - 1:500
Vert. - 1:50



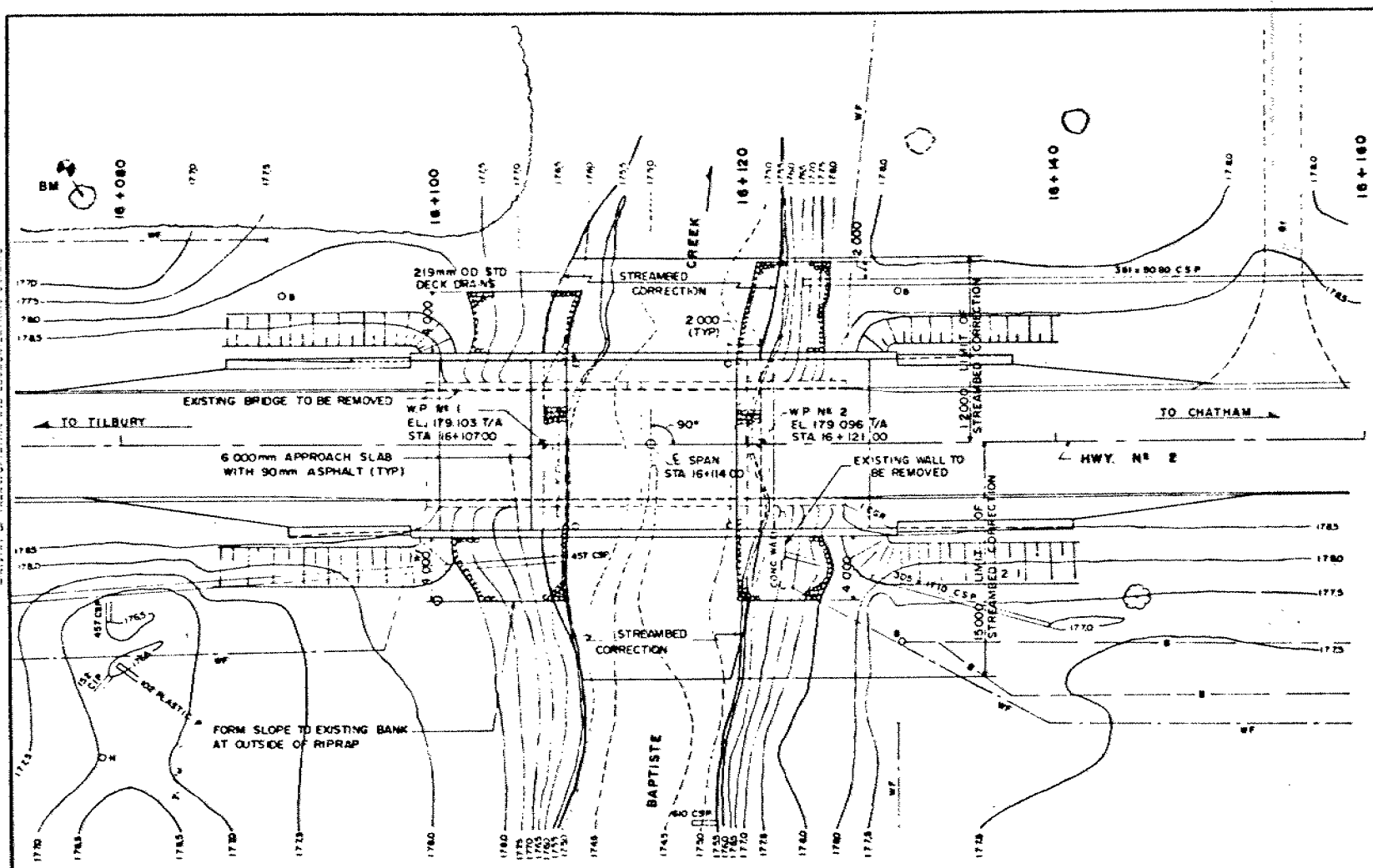
FINAL CLEARANCE FOR NAVIGATION
1:200

- BOAT TRAFFIC CAN BE TERMINATED DURING CONSTRUCTION
- PERMANENT NAVIGATION LIGHTS ARE NOT REQUIRED ON THE STRUCTURE



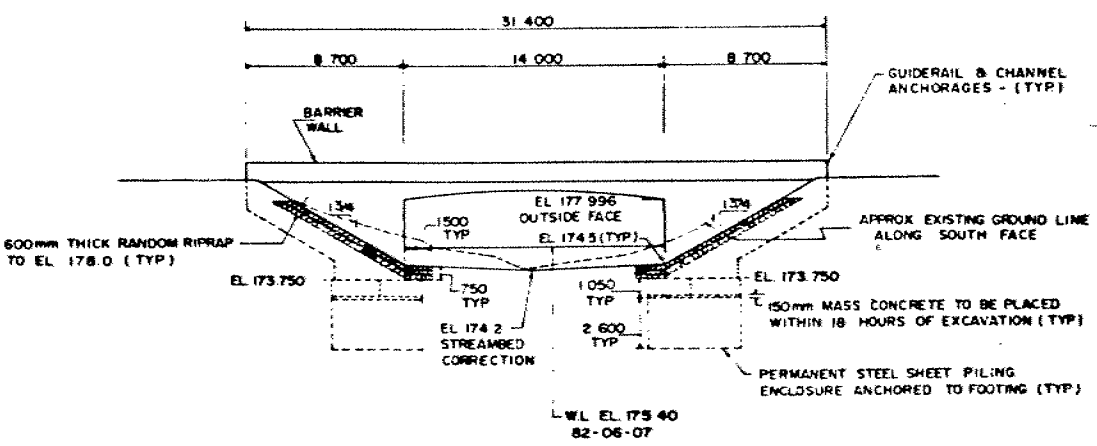
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
83-10-27	DESIGN	DESIGN
83-10-27	CHECK	CHECK
83-10-27	APPROVE	APPROVE



PLAN
1:200

WP = WORKING POINT
T/A = TOP OF ASPHALT



ELEVATION
1:200

BM 176.872
GEODETIC DATUM
N.B. W. IN S. ROOT 0.5 MAPLE
160 LT 16+077.6

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84 - 82



Ministry of
Transportation and
Communications

INDEX

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	W.P. 92-78-02, Site 6-105-46

Note: For purposes of the contract these reports supersede all other Foundation Reports prepared by or for the Ministry in connection with the above-mentioned projects.

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

For

W.P. 91-67-01; Site 13-104-193

Baptiste Creek Bridge, Tilbury

Hwy. #2, District 1, ChathamINTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed replacement structure at this site.

The fieldwork was conducted during the period from 83 02 15 to 83 02 16 utilizing a continuous-flight auger machine equipped with 82 mm I.D. hollow-stem augers.

This work consisted of 2 sampled boreholes/dynamic cone penetration tests.

SITE DESCRIPTION

The site is located near Tilbury at Baptiste Creek on Hwy. 2, approximately 0.5 km southwest of the Hwy. 401/Hwy.2 interchange. (Kent County, Conc. V & VI, Lot II, Tilbury East Twp.).

Physiographically the site lies in the St. Clair Clay Plains, an area of low relief in which a till plain is generally covered by a thin deposit of lacustrine clay.

SUBSURFACE CONDITIONSGeneral

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 2 of the contract documents.

At this site, approximately 34 m of silty clay of low to intermediate plasticity overlies the limestone bedrock.

Fill Material

The fill material at this site is silty clay of low plasticity containing variable amounts of sand, traces of gravel and occasional layers of silty sand. This predominantly cohesive material varies in consistency from soft to very stiff.

The fill at the abutments will extend from the surface to below the base of the existing footings (est. elev. 174.0± m). At the borehole locations the fill thickness ranges from 3.4 to 4.9 m.

The physical properties of the material, as determined from field test and one laboratory test, are summarized below:

Natural Moisture Content (W)	21.0%
Liquid Limit (W_L)	32.5%
Plastic Limit (W_P)	16.5%

Figure 1 illustrates a typical grain size distribution for this material.

Overburden

The native overburden at this site is silty clay of low plasticity containing some sand and traces of gravel. It extends to approximately elev. 144±m.

Above elevation 167±m the material occasionally did not fail during field vane shear testing indicating shear strengths in excess of 107 kPa. From the results of the field vane shear tests, the unconfined compression test and the standard penetration tests, it is estimated that the average shear strength of this portion of the deposit is in excess of 95 kPa. The consistency of the deposit ranges from stiff to very stiff. Occasional very small seams of silty sand were encountered within this layer.

Below elevation 167± the average shear strength is estimated to be in excess of 55 kPa while the consistency ranges from firm to stiff. Occasional silty sand layers were encountered near the bedrock boundary.

Physical properties of the material, as determined from field and laboratory tests, are summarized below:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (W)	16.0-25.0%	20.6%	20.3%
Liquid Limit (W_L)	17.5-32.5%	27.5%	31.0%
Plastic Limit (W_p)	14.5-18.0%	16.3%	16.8%
Unit Weight () (one test)	20.5 kN/m ³	N/A	N/A
Shear Strength			
- field vane (undisturbed)	40 - 107+ kPa	N/A	N/A
- field vane (remolded)	28 - 92 kPa	N/A	N/A
- unconfined compression	85 - 100 kPa	N/A	N/A

The shear strength tests indicate that the material has low sensitivity (1 to 2).

Figure 2 illustrates a typical grain size distribution for this material.

Bedrock

The bedrock in this area is soft calcareous shale with interbedded limestone. It is overlain by transitional zones grading from silty clay with shaly layers and occasional layers of silty sand to weathered shale. The bedrock elevation is approximately 144.0 m.

Groundwater

At the time of the field investigation, the groundwater elevation was 175.4 m, approximately the same level as Baptiste Creek.



D. H. Dundas

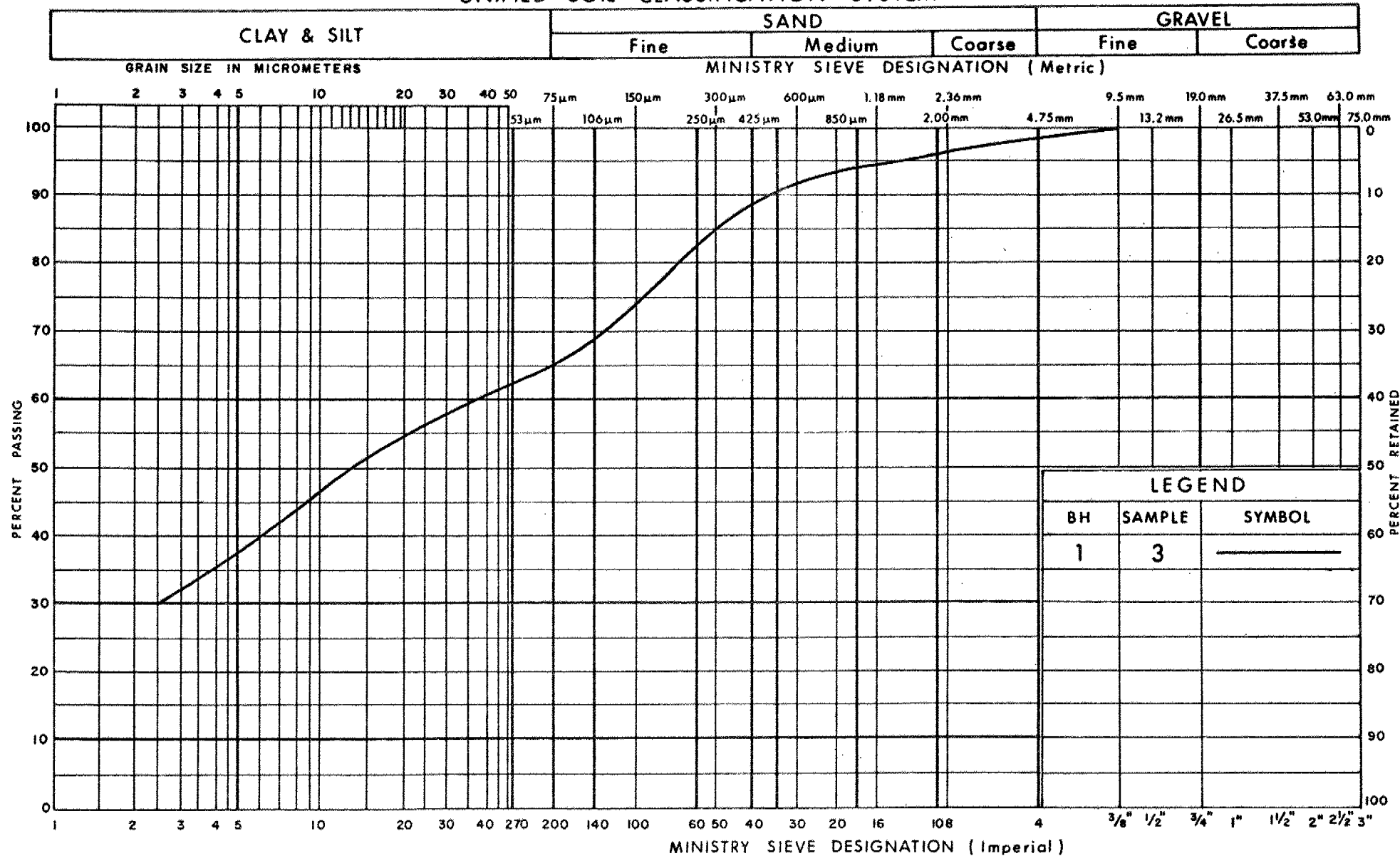
D. H. Dundas, P. Eng.
Foundations Engineer

K. G. Selby

K. G. Selby, P. Eng.
Chief Foundations Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



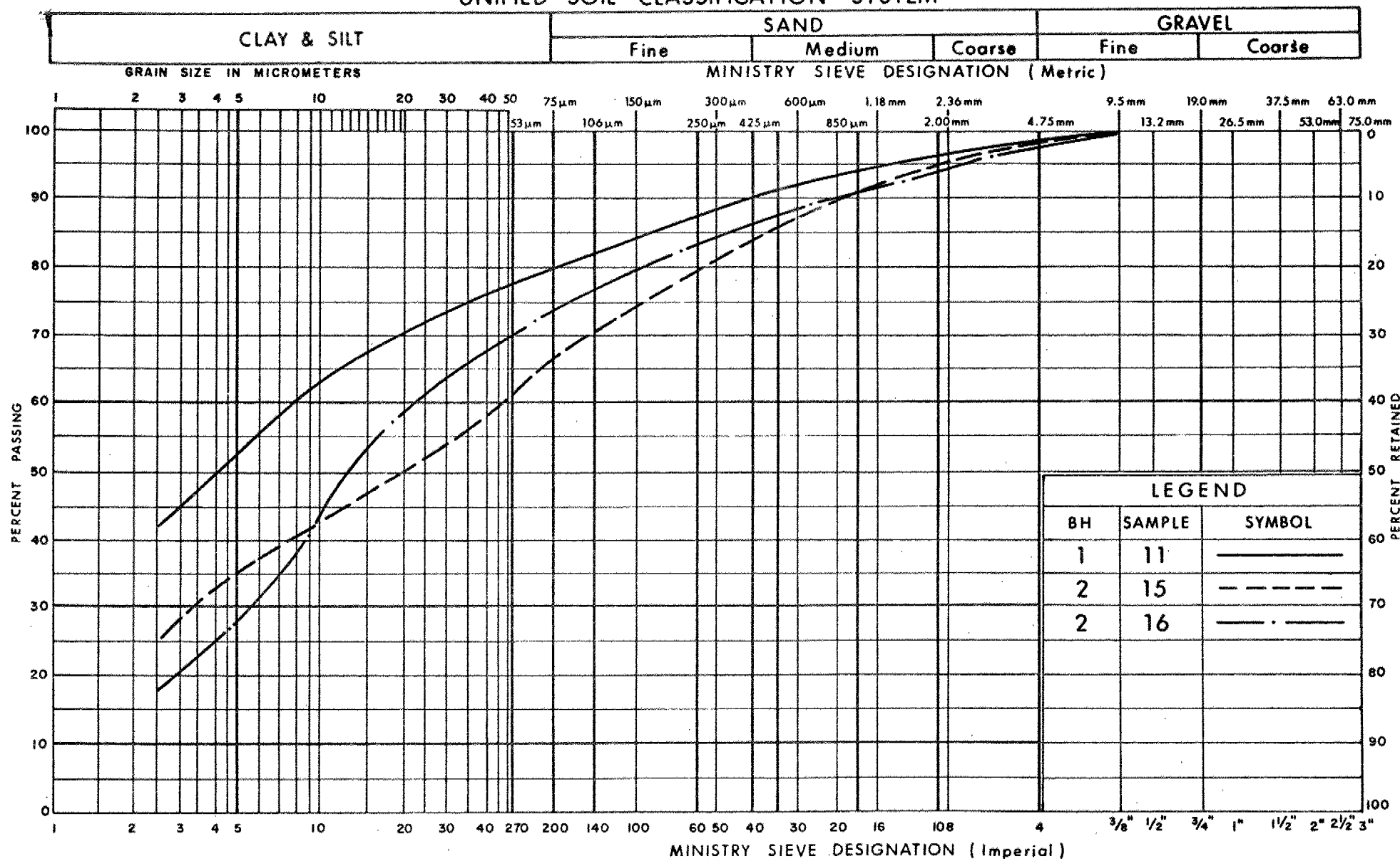
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GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Fill Material)

FIG No 1

W P 91-67-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Till)

FIG No 2

W P 91-67-01



RECORD OF BOREHOLE No 1

METRIC

9

W P 91-67-01 LOCATION Sta. 16 + 100, 5 m Lt. of Hwy. 2 ORIGINATED BY DD
DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
DATUM Geodetic DATE 83 02 15 CHECKED BY *so*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100 40 80 120 160 200										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE											
178.5	Ground Surface																	
0.0	Silty Clay (CL)		1	SS	8		178											
	Some/with Sand		2	SS	6													
	Trace Gravel		3	SS	7		176						2 33 38 27					
	occ. Layers of Silty		4	SS	13													
	Sand		5	SS	18													
	occ. brick fragments		6	SS	10		174											
173.6																		
4.9	Silty Clay (CL)		7	TW	PH		172						20.5	4 17 44 35				
	Some Sand		8	SS	12													
	Trace Gravel		9	SS	10		170							3 18 45 34				
	Stiff to Very Stiff		10	SS	10													
	(Till)		11	SS	7		168											
			12	SS	7		166							2 19 41 38				
	Firm to Stiff		13	SS	8		164											
162.2																		
16.3	End of Borehole													*Cu > 107kPa				

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC

10

W P 91-67-01 LOCATION Sta. 16 + 126, 7 m Rt. of Hwy. 2 ORIGINATED BY DD
 DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
 DATUM Geodetic DATE 83 02 16 CHECKED BY le

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	40 80 120 160 200					
178.0	Ground Surface													
0.0	Silty Clay (CL) Some/with Sand Trace Gravel occ. Layers of Silty Sand occ. brick fragments Soft to Very Stiff (Fill)		1	SS	9		176							
			2	SS	9									
			3	SS	2									
174.6			4	SS	40									
3.4			5	SS	24		174							
	Silty Clay (CL)		6	SS	21									
	Some Sand		7	SS	14		172							
	Trace Gravel		8	SS	11									
	Stiff to Very Stiff (Till)		9	SS	11		170							
			10	SS	10									
			11	SS	7		168							
	Firm to Stiff		12	SS	6									
			13	SS	6		166							
			14	SS	15		164							
			15	SS	20		162							
							160							
							158							
							156							
							154							
							152							
							150							
147.5							148							

30.5 CONT.

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

*C_u > 107kPa

RECORD OF BOREHOLE No 2 Cont

METRIC

11

W P 91-67-01 LOCATION Sta. 16 + 126, 7 m Rt. of Hwy. 2 ORIGINATED BY DD
 DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
 DATUM Geodetic DATE 83 02 16 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
147.5	CONT.		16	SS	14											2 24 63 11	
30.5	Silty Clay (CL) occ. Layers of Silty Sand occ. Shaly Layers																
144.0			17	SS	120											26 47 21 6	
34.0	Probable Bedrock End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

For

W.P. 93-78-02; Site 13-104-194

McDougall Drain Bridge, Chatham

Hwy. #2, District 1, ChathamINTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed replacement structure at this site.

The fieldwork was conducted during the period from 83 02 17-18 utilizing a continuous-flight auger machine equipped with 82 mm I.D. hollow-stem augers.

This work consisted of 2 sampled boreholes/dynamic cone penetration tests.

SITE DESCRIPTION

The site is located at McDougall Drain on Hwy. 2, approximately 4.5 km northeast of the Hwy. 401/Hwy. 2 interchange. (Kent County, Conc. VI, Lots 3 & 4, Tilbury East Twp.).

Physiographically the site lies in the St. Clair Clay Plains, an area of low relief in which a till plain is generally covered by a thin deposit of lacustrine clay.

SUBSURFACE CONDITIONSGeneral

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 2 of the contract documents.

At this site, approximately 34 m of silty clay of low to intermediate plasticity overlies the limestone bedrock.

Fill Material

The fill material at this site is silty clay of low to intermediate plasticity containing some sand, traces of gravel and occasional layers of silty sand. This predominantly cohesive material varies in consistency from stiff to very stiff.

The fill at the abutments will extend from the surface to below the base of the existing footings (est. elev. 173.5± m). At the borehole locations the fill thickness ranges from 3.0 to 3.4 m.

Physical properties of the material, as determined from field tests and one laboratory test, are summarized below:

Natural Moisture Content (W)	20.0%
Liquid Limit (W_L)	39.5%
Plastic Limit (W_p)	20.0%

Figure 1 illustrates a typical grain size distribution for this material.

Overburden

The native overburden at this site is silty clay of low plasticity containing some sand and traces of gravel. It extends to approximately elevation 144± m.

Above elevation 168± m the material did not fail during field vane shear testing indicating shear strengths in excess of 107 kPa. From the results of the field vane shear tests, the unconfined compression test and the standard penetration tests, it is estimated that the average shear strength of this portion of the deposit is in excess of 105 kPa. The consistency of the deposit ranges from stiff to very stiff. Occasional very small seams of silty sand were encountered within this layer.

Below elevation 168± the average shear strength is estimated to be in excess of 40 kPa while the consistency ranges from firm to stiff.

Physical properties of the material, as determined from field and laboratory tests, are summarized below:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (W)	17.5-23.5%	20.0%	19.5%
Liquid Limit (W_L)	29.0-32.0%	30.8%	31.0%
Plastic Limit (W_p)	16.5-18.0%	17.0%	16.8%
Unit Weight () (one test)	21.1 kN/m ³	N/A	N/A
Shear Strength			
- field vane (undisturbed)	44 - 107+ kPa	N/A	N/A
- field vane (remolded)	32 - 107+ kPa	N/A	N/A
- unconfined compression	151 - 267 kPa	N/A	N/A

The shear strength tests indicate that the material has low sensitivity (1 to 2).

Figure 2 illustrates a typical grain size distribution for this material.

Bedrock

The bedrock in this area is soft calcareous shale with interbedded limestone. It is overlain by transitional zones grading from silty clay with shaly layers and occasional layers of silty sand to weathered shale. The bedrock elevation is approximately 144.0 m.

Groundwater

At the time of the field investigation, the groundwater elevation was 175.4 m, approximately the same level as McDougall Drain.



D. H. Dundas

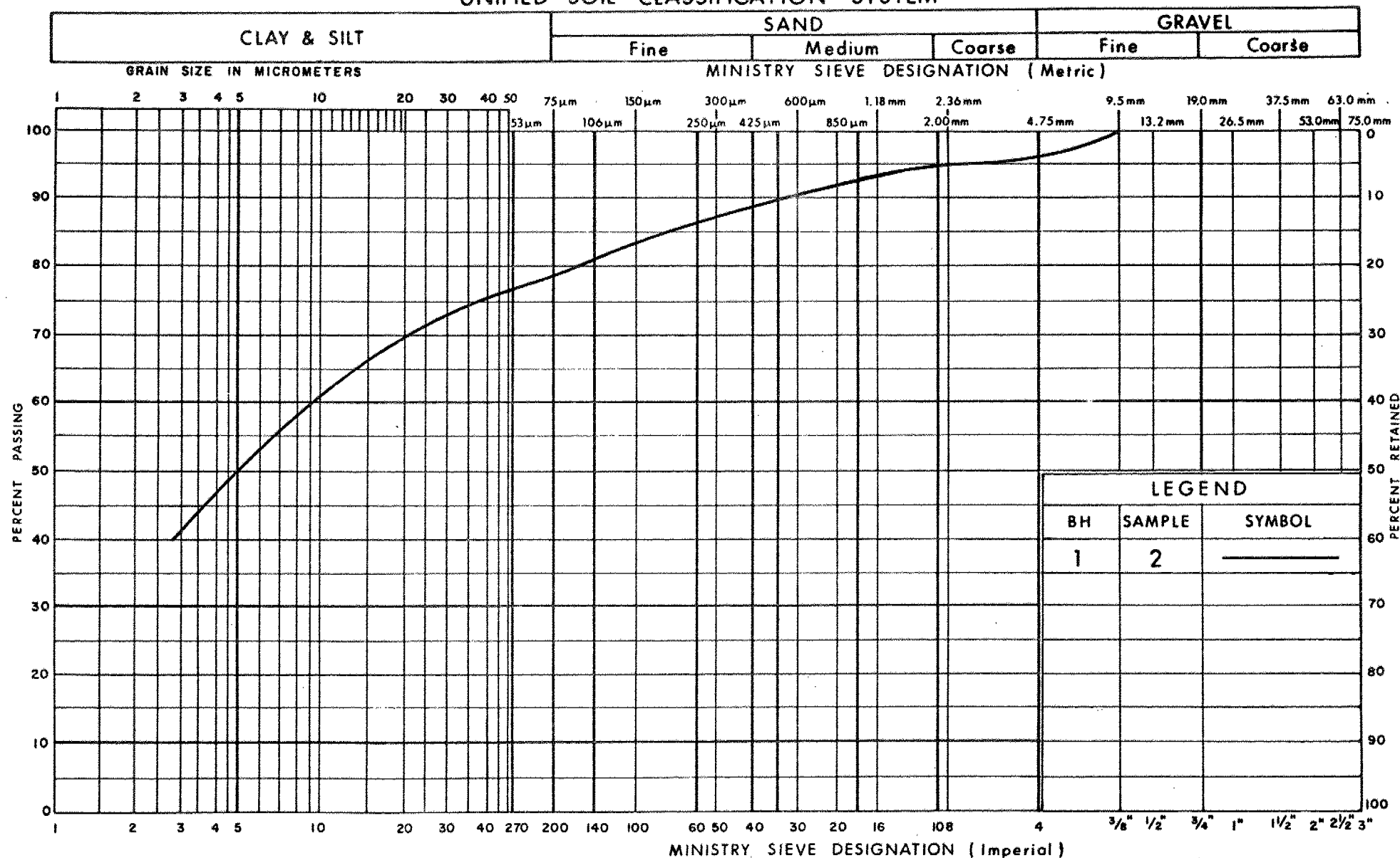
D. H. Dundas, P. Eng.
Project Foundation Engineer

K. G. Selby

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Senior Foundations Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



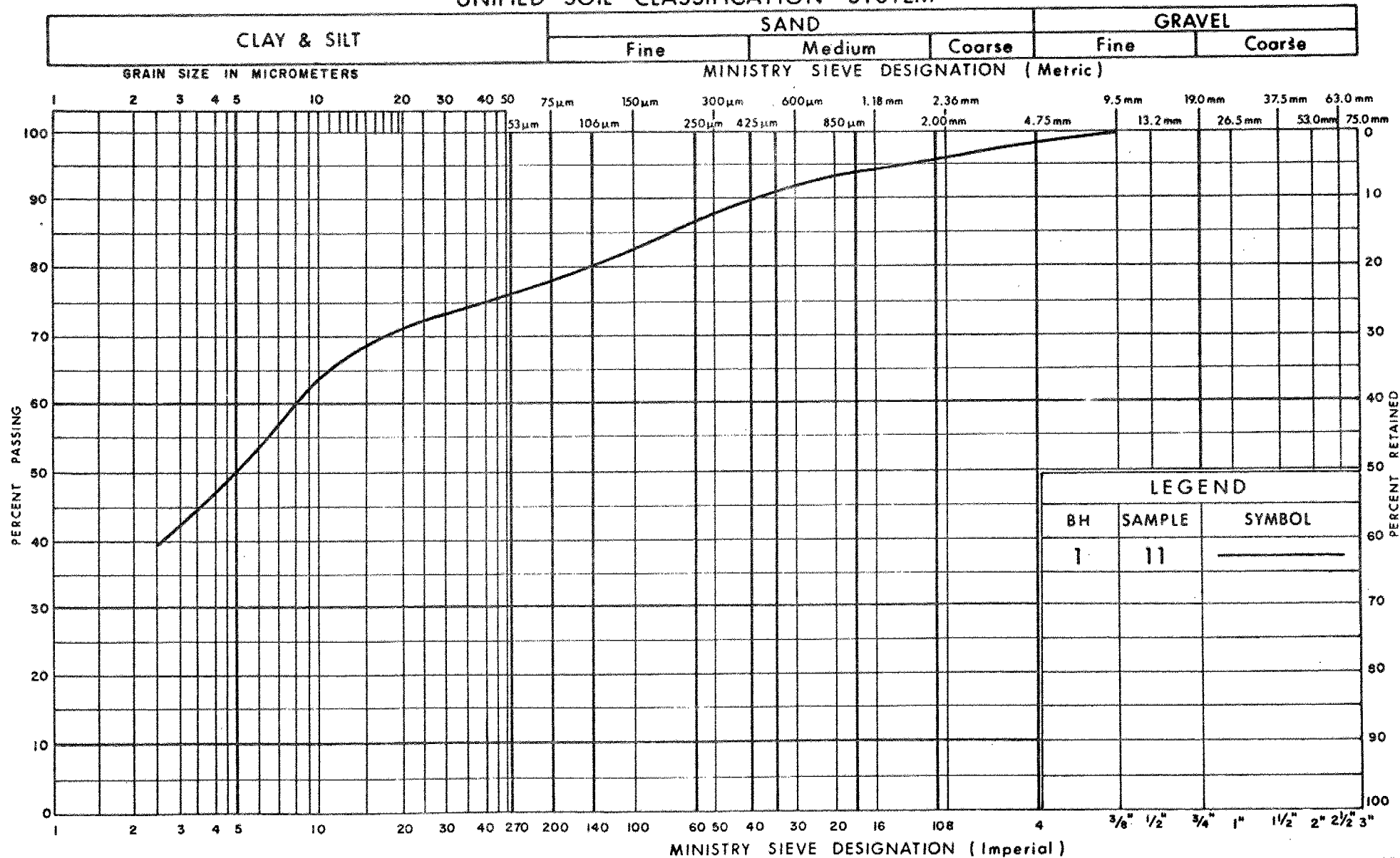
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Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Fill Material)

FIG No 1

W P 93-78-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Till)

FIG No 2

W P 93-78-02

RECORD OF BOREHOLE No 1

METRIC

18

W P 93-78-02 LOCATION STA 20+690 8m RT of HWY 2 ORIGINATED BY DD
 DIST 1 HWY 2 BOREHOLE TYPE HS AUGER & CONE TEST COMPILED BY DD
 DATUM GEODETIC DATE 83 02 17 CHECKED BY Se

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
177.2	GROUND SURFACE										
0.0	SILTY CLAY (CL to CI) SOME SAND TRACE GRAVEL OCC LAYERS OF SILTY SAND Stiff to Very Stiff (FILL)		1	SS	10		176				3 18 45 34
			2	SS	13						
			3	SS	12						
174.2			4	SS	24		174				
3.0			5	SS	18						
			6	SS	15						
			7	SS	13		172				
			8	SS	15						
			9	SS	14		170				
			10	SS	13						
			11	SS	14		168				1 20 44 35
			12	SS	13						3 18 45 34
			13	SS	12		166				
			14	SS	11						2 20 42 36
			15	SS	9		164				
			16	SS	9		162				
							160				
							158				
							156				
							154				
							152				
							150				
							148				
146.7											
30.5											

Cont

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1 Cont

METRIC

19

W P 93-78-02 LOCATION STA 20+690 8m RT @ HWY 2 ORIGINATED BY DD
DIST 1 HWY 2 BOREHOLE TYPE HS AUGER & CONE TEST COMPILED BY DD
DATUM GEODETIC DATE 83 02 17 CHECKED BY ide

[illegible]

³, ⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC 20

W P 93-78-02 LOCATION STA 20+704 6 m RT of HWY 2 ORIGINATED BY DD
DIST 1 HWY 2 BOREHOLE TYPE H S AUGER & CONE TEST COMPILED BY DD
DATUM GEODETIC DATE 83 02 17 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100 40 80 120 160 200										

178.0	GROUND SURFACE														
0.0	SILTY CLAY (CL to CI) SOME SAND TRACE GRAVEL OCC LAYERS OF SILTY SAND Stiff to Very Stiff (FILL)		1	SS	12										
			2	SS	11										
			3	SS	16										
174.6			4	SS	24										
3.4	SILTY CLAY (CL to CI) SOME SAND TRACE GRAVEL (TILL) Stiff to Very Stiff Firm to Stiff		5	SS	28										
			6	TW	PH										
			7	SS	13										
			8	SS	12										
			9	SS	12										
			10	SS	11										
			11	SS	9										
			12	SS	8										
			13	SS	10										
161.7															
16.3		END OF BOREHOLE													* C _u > 107 kPa

FOUNDATION INVESTIGATION REPORT

For

W.P. 92-78-02, Site 6-105-46

Little River (Tremblay Creek) Structure

Hwy. 2, District 1, ChathamINTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed replacement structure at this site.

The fieldwork was conducted during the period from 82 07 05 - 09, utilizing a continuous-flight auger machine equipped with 82 mm I.D. hollow-stem augers and a BX core barrel. This work consisted of 4 sampled boreholes/cone penetration tests. Bedrock was cored at 1 borehole.

SITE DESCRIPTION

The site is located at the Hwy. 2 crossing of Little River (Lot II, Con. 3 & 4, Twp. of Tilbury North, County of Essex).

Physiographically, the site lies in the St. Clair Clay Plains, an area of low relief in which a till plain is generally covered by a thin deposit of lacustrine clay.

SUBSURFACE CONDITIONSGeneral

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 2.

At this site, approximately 37 m of silty clay of low to intermediate plasticity overlies the limestone bedrock.

Silty Clay (CL to CI)

The overburden at this site consists of silty clay of low to intermediate plasticity containing some sand and some to traces of gravel.

The surface (2.1 m thickness) of the deposit contains some to traces of organics. The consistency of the deposit generally increases with depth, ranging from firm to hard.

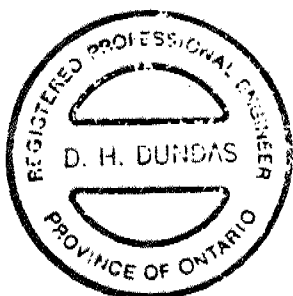
Figure 1 illustrates a typical grain size distribution for this deposit.

Bedrock

Refer to the Record of Borehole Sheets for bedrock elevations. The limestone bedrock is overlain by a transitional overburden zone (approximately 1.5 m in thickness) containing occasional limestone layers.

Groundwater

At the time of the field investigation, groundwater elevation was 176 m, approximately the same level as Little River (Tremblay Creek).



D. H. Dundas
D. H. Dundas, P.Eng.,
Project Foundations Engineer.

K. G. Selby
K. G. Selby, P.Eng.,
Senior Foundations Engineer.

A P P E N D I X

RECORD OF BOREHOLE No 1										METRIC			
W P 92-78-02		LOCATION Sta. 16 + 485, 6.0 m Rt. 2 Hwy. 2				ORIGINATED BY BY							
DIST 1 HWY 2		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY BY							
DATUM Geodetic		DATE 82 07 05-07				CHECKED BY DD							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
179.2	Ground Surface												
0.0	some/trace organics		1	TW	PH								
	-----		2	TW	PH								
	Silty Clay (CL to CI)												
	Some Sand												
	Trace Gravel												
	Firm to Hard		3	TW	PH								
			4	TW	PH								
			5	TW	PH								
			6	TW	PH								
			7	TW	PH								
148.7													

30.5

Cont

+3, x5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1 Cont										METRIC					
W P 92-78-02		LOCATION Sta. 16 + 485, 6.0 m Rt. of Hwy. 2				ORIGINATED BY BY									
DIST 1 HWY 2		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY BY									
DATUM Geodetic		DATE 82 07 05-07				CHECKED BY DD									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
148.7	Cont.														
30.5	Silty Clay (CL to CI)														
	Some Sand														
	Trace Gravel														
	Firm to Hard		8	TW	PH										
	occ. limestone layers		9	RC	8X										
140.5															
38.7	Bedrock		10	RC	100X										
	Limestone														
	Sound		11	RC	95X										
138.7															
40.5	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2										METRIC			
W P 92-78-02		LOCATION Sta. 16 + 483, 7.0 m Lt. of Hwy. 2				ORIGINATED BY FC							
DIST 1 HWY 2		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY FC							
DATUM Geodetic		DATE 82 07 07				CHECKED BY DD							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					
178.5	Ground Surface						20 40 60 80 100	20 40 60					
	some organics	1	SS		7								
		2	SS		11								
	Silty Clay (CL to CI)	3	SS		13								4 23 40 33
	Some Sand	4	SS		17								16 11 37 36
	Trace/some Gravel	5	SS		10								5 16 37 42
	Firm to Hard	6	SS		11								
		7	SS		12								
		8	SS		11								
168.4													*C > 107 kPa
10.1	End of Borehole												

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3										METRIC				
W P 92-78-02		LOCATION Sta. 16 + 460, 7.0 m Lt. of Hwy. 2				ORIGINATED BY FC								
DIST 1 HWY 2		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY FC								
DATUM Geodetic		DATE 82 07 08-09				CHECKED BY DD								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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					
178.7	Ground Surface													
0.0														
	some/trace organics		1	SS	10		178							
			2	SS	8									
	Silty Clay (CL to CI)		3	SS	20		176							
	Some Sand		4	SS	18									
	Trace Gravel		5	SS	8		174							
	Firm to Hard		6	SS	7									
			7	SS	6		172							
			8	SS	5									
			9	SS	5		168							
			10	SS	5									
			11	SS	5		166							
			12	SS	6									
			13	SS	6		164							
			14	SS	7									
							162							
							160							
							158							
							156							
							154							
							152							
							150							
148.2														
30.5														

Cont

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 Cont										METRIC				
W P 92-78-02		LOCATION Sta. 16 + 460, 7.0 m Lt. of Hwy. 2				ORIGINATED BY FC								
DIST 1 HWY 2		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY FC								
DATUM Geodetic		DATE 82 07 08-09				CHECKED BY DD								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40					
148.2	Cont.													
30.5	Silty Clay (CL to CI)													
	Some Sand													
	Trace Gravel													
	Firm to Hard													
	occ. limestone layers													
141.7	Hard		15	SS	67/	25 cm	142							*C _u > 107 kPa
37.0	Probable Bedrock													
	End of Borehole													

+3, x5: Numbers refer to Sensitivity

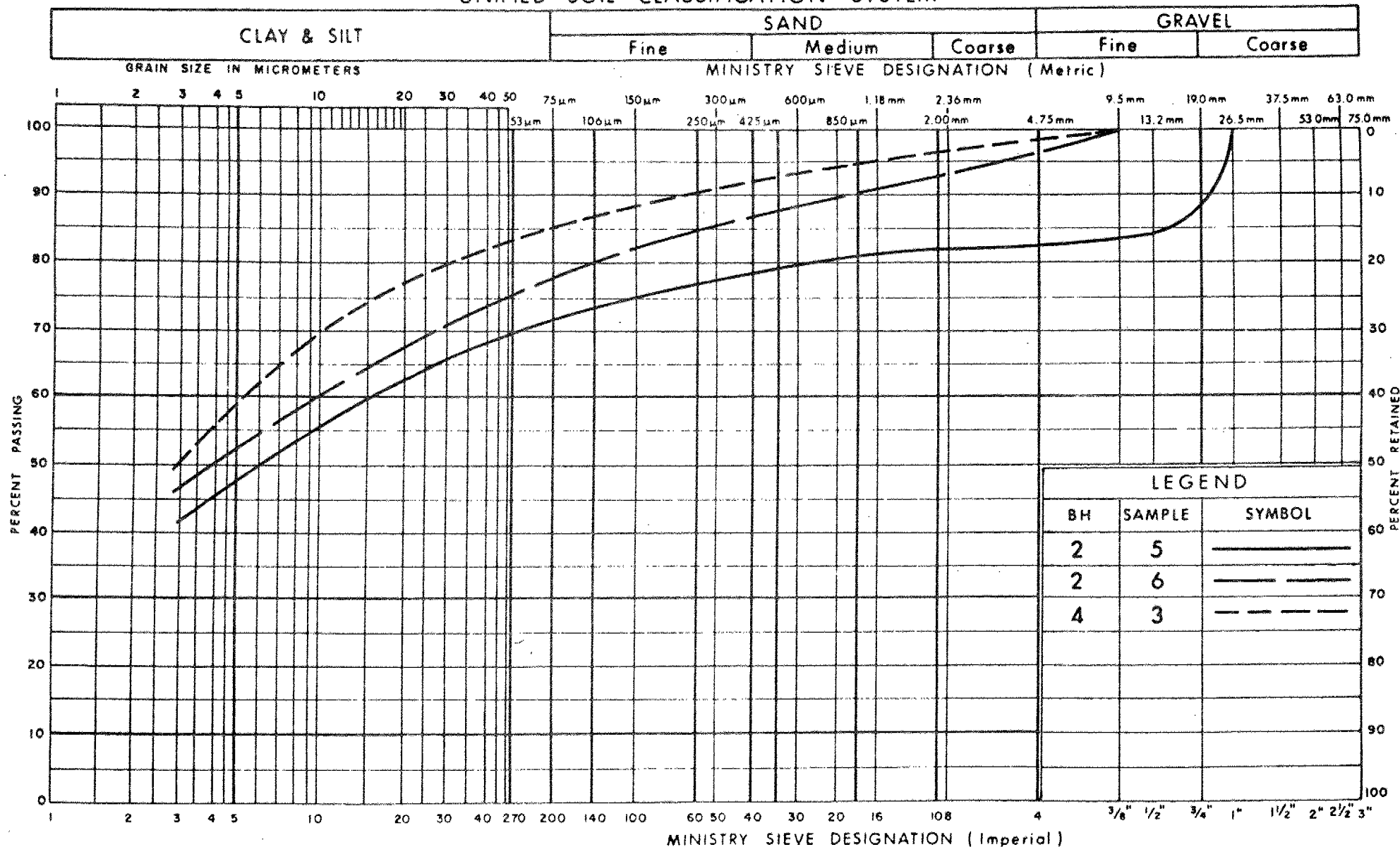
20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4										METRIC			
W P 92-78-02		LOCATION Sta. 16 + 460, 6.0 m Rt. of Hwy. 2					ORIGINATED BY BY						
DIST 1 HWY 2		BOREHOLE TYPE Solid Stem Auger					COMPILED BY BY						
DATUM Geodetic		DATE 82 07 08					CHECKED BY dd						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
179.3	Ground Surface												
0.0													
	some organics		1	SS	5								
			2	SS	5								
	Silty Clay (CL to CI)		3	SS	12								2 14 44 40
	Some Sand		4	SS	18								1 15 46 38
	Trace Gravel		5	SS	11								
	Firm to Hard		6	SS	11								
			7	SS	10								
			8	SS	5								
169.2													
10.1	End of Borehole												

+3, +5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
SOME SAND, TRACE / SOME GRAVEL

FIG No 1

W P 92 - 78 - 02

**ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION**

WP 91-67-01 DIST 1
HWY 2 STR SITE 13-104-193
Baptiste Creek Bridge, Tilbury

DISTRIBUTION

V.F. Boehnke (2)
J.R. Roy
R. Carney
D.A. Walker (2)
K. Bassi (2)
B.J. Giroux
R. Hore

A. Crowley (Cover Only)
T.J. Kovich (Cover Only)

Files

GEOCRES

40J8-40

DATE



FOUNDATION INVESTIGATION REPORT

For

W.P. 91-67-01; Site 13-104-193

Baptiste Creek Bridge, Tilbury

Hwy. #2, District 1, Chatham

INTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed replacement structure at this site.

The fieldwork was conducted during the period from 83 02 15 to 83 02 16 utilizing a continuous-flight auger machine equipped with 82 mm I.D. hollow-stem augers.

This work consisted of 2 sampled boreholes/dynamic cone penetration tests.

SITE DESCRIPTION

The site is located near Tilbury at Baptiste Creek on Hwy. 2, approximately 0.5 km southwest of the Hwy. 401/Hwy.2 interchange. (Kent County, Conc. V & VI, Lot II, Tilbury East Twp.).

Physiographically the site lies in the St. Clair Clay Plains, an area of low relief in which a till plain is generally covered by a thin deposit of lacustrine clay.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 916701-A.

At this site, approximately 34 m of silty clay of low to intermediate plasticity overlies the limestone bedrock.

Fill Material

The fill material at this site is silty clay of low plasticity containing variable amounts of sand, traces of gravel and occasional layers of silty sand. This predominantly cohesive material varies in consistency from soft to very stiff.

The fill at the abutments will extend from the surface to below the base of the existing footings (est. elev. 174.0± m). At the borehole locations the fill thickness ranges from 3.4 to 4.9 m.

The physical properties of the material, as determined from field test and one laboratory test, are summarized below:

Natural Moisture Content (W)	21.0%
Liquid Limit (W_L)	32.5%
Plastic Limit (W_p)	16.5%

Figure 1 illustrates a typical grain size distribution for this material.

Overburden

The native overburden at this site is silty clay of low plasticity containing some sand and traces of gravel. It extends to approximately elev. 144±m.

Above elevation 167±m the material occasionally did not fail during field vane shear testing indicating shear strengths in excess of 107 kPa. From the results of the field vane shear tests, the unconfined compression test and the standard penetration tests, it is estimated that the average shear strength of this portion of the deposit is in excess of 95 kPa. The consistency of the deposit ranges from stiff to very stiff. Occasional very small seams of silty sand were encountered within this layer.

Below elevation 167± the average shear strength is estimated to be in excess of 55 kPa while the consistency ranges from firm to stiff. Occasional silty sand layers were encountered near the bedrock boundary.

Physical properties of the material, as determined from field and laboratory tests, are summarized below:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (W)	16.0-25.0%	20.6%	20.3%
Liquid Limit (W_L)	17.5-32.5%	27.5%	31.0%
Plastic Limit (W_p)	14.5-18.0%	16.3%	16.8%
Unit Weight () (one test)	20.5 kN/m ³	N/A	N/A
Shear Strength			
- field vane (undisturbed)	40 - 107+ kPa	N/A	N/A
- field vane (remolded)	28 - 92 kPa	N/A	N/A
- unconfined compression	85 - 100 kPa	N/A	N/A

The shear strength tests indicate that the material has low sensitivity (1 to 2).

Figure 2 illustrates a typical grain size distribution for this material.

Bedrock

The bedrock in this area is soft calcareous shale with interbedded limestone. It is overlain by transitional zones grading from silty clay with shaly layers and occasional layers of silty sand to weathered shale. The bedrock elevation is approximately 144.0 m.

Groundwater

At the time of the field investigation, the groundwater elevation was 175.4 m, approximately the same level as Baptiste Creek.

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing two-span structure with a single-span bridge to carry Hwy. 2 over Baptiste Creek at the existing grade.

Two alternatives are proposed. The alternative which leads to the least expensive design should be adopted.

General Recommendations (Applicable to All Alternatives)

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a yielding foundation with $K_a = 0.33$ and $\gamma = 21.5 \text{ kN/m}^3$ for granular backfill.
- For frost protection, cover should be greater than 1.2 m.
- No stability problems are anticipated for embankments with slopes of 2:1 or flatter.
- The creek channel slopes should be protected from erosion by suitable rip rap or other protection.
- For all alternatives differential settlements should not exceed 25 mm.
- Dewatering is not anticipated to be a major problem because of the impermeable nature of the foundation soil.
- The minimum cover required for scour protection should be determined from hydrological data.

ALTERNATIVE 1 - Spread Footings on Glacial Till

The structure may be supported on spread footings founded on the silty clay till.

For this alternative remove the old footings, all fill material and any loose or soft material beneath the proposed footing locations, and cover (within 18 hours of exposure) the foundation soil with a 15 cm pad of mass concrete.

The elevation of the base of the existing footings is estimated at elev. 174.0±m.

The following design values are recommended for spread footings at or below the recommended footing level:

- net safe bearing pressure = 200 kPa

and for purposes of the O.H.B.D.C.:

- Factored Bearing Capacity at U.L.S. = 300 kPa
- Bearing Capacity at S.L.S. Type II = 200 kPa

ALTERNATIVE 2 - Steel H-Piles Driven to Bedrock

The structure may be supported on steel H-piles equipped with reinforced tips and driven to bedrock. The bedrock elevations is estimated at elev. 144.0±m.

The following design values are recommended:

<u>Pile Type</u>	<u>Safe Capacity</u>
310 HP 79	1150 kN per pile

and, for the purposes of the O.H.B.D.C.:

<u>Pile Type</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity at S.L.S. Type II</u>
310 HP 79	1600 kN per pile	1150 kN per pile

MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. D. H. Dundas, Project Foundation Engineer. The report was written by Mr. Dundas, and reviewed by Mr. K. G. Selby, Senior Foundations Engineer. The equipment used was owned and operated by Atcost Soil Drilling Inc.



D. H. Dundas

D. H. Dundas, P. Eng.
Project Foundation Engineer

K. G. Selby

K. G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 91-67-01 LOCATION Sta. 16 + 100, 5 m Lt. of Hwy. 2 ORIGINATED BY DD
DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
DATUM Geodetic DATE 83 02 15 CHECKED BY *Lo*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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178.5	Ground Surface							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
0.0	Silty Clay (CL)		1	SS	8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
	Some/with Sand		2	SS	6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

RECORD OF BOREHOLE No 2

METRIC

W P 91-67-01 LOCATION Sta. 16 + 126, 7 m Rt. of Hwy. 2 ORIGINATED BY DD
 DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
 DATUM Geodetic DATE 83 02 16 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	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					
178.0	Ground Surface													
0.0	Silty Clay (CL) Some with Sand Trace Gravel occ. Layers of Silty Sand occ. brick fragments Soft to Very Stiff (Fill)		1	SS	9		176							
			2	SS	9									
			3	SS	2									
174.6			4	SS	40									
3.4			5	SS	24		174							
	Silty Clay (CL)		6	SS	21									
	Some Sand		7	SS	14		172							
	Trace Gravel		8	SS	11									
	Stiff to Very Stiff (Till)		9	SS	11		170							
			10	SS	10									
			11	SS	7		168							
	Firm to Stiff		12	SS	6		166							
			13	SS	6		164							
			14	SS	15		162							
			15	SS	20		160							
							158							
							156							
							154							
							152							
							150							
147.5							148							

30.5 CONT.

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

*C_u > 107 kPa

RECORD OF BOREHOLE No 2 Cont

METRIC

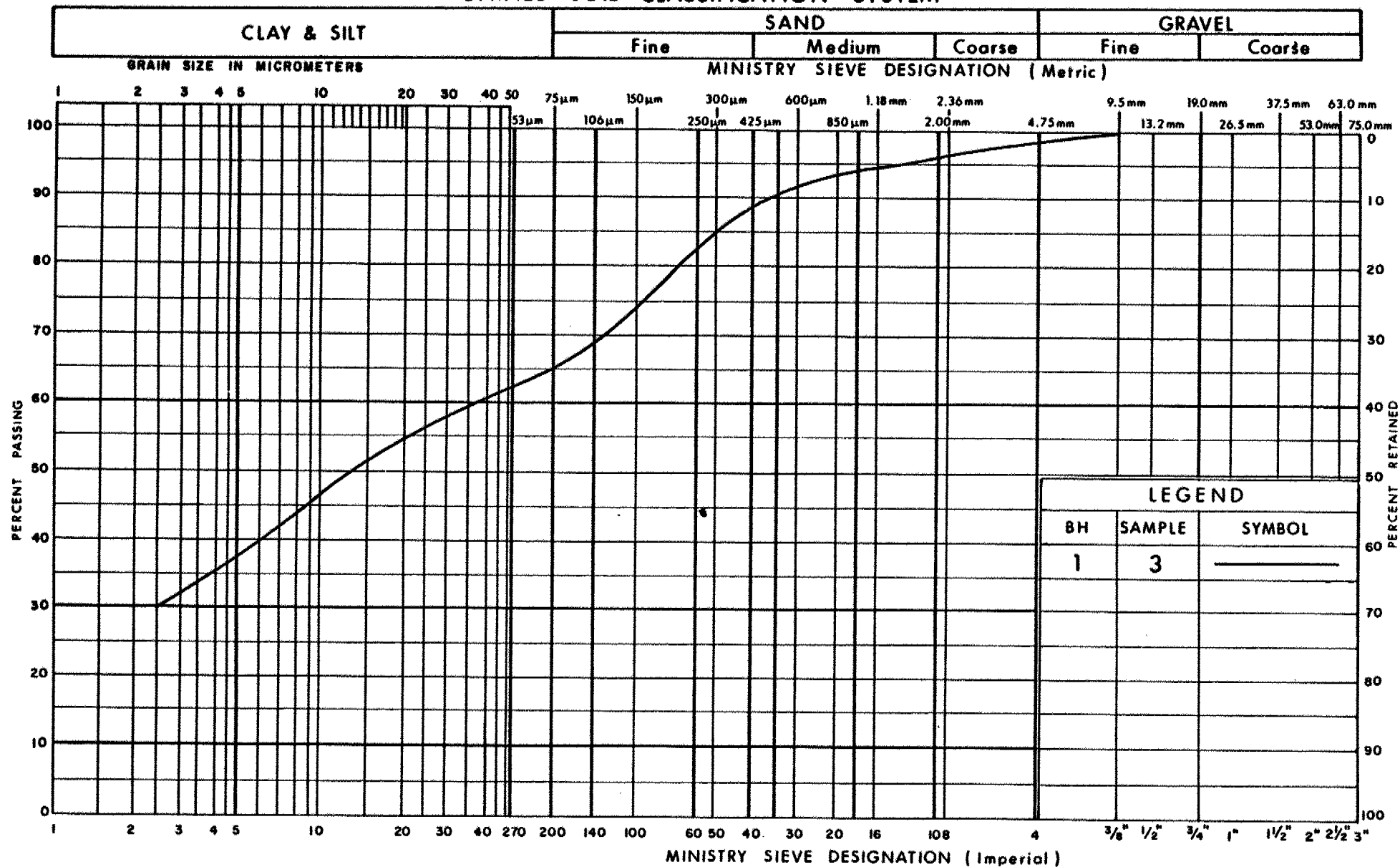
W P 91-67-01 LOCATION Sta. 16 + 126, 7 m Rt. of Hwy. 2 ORIGINATED BY DD
 DIST 1 HWY 2 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY DD
 DATUM Geodetic DATE 83 02 16 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
147.5	CONT.															
30.5	Silty Clay (CL)		16	SS	14											
	occ. Layers of Silty Sand					146										
	occ. Shaly Layers															
144.0			17	SS	120											
34.0	Probable Bedrock															
	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



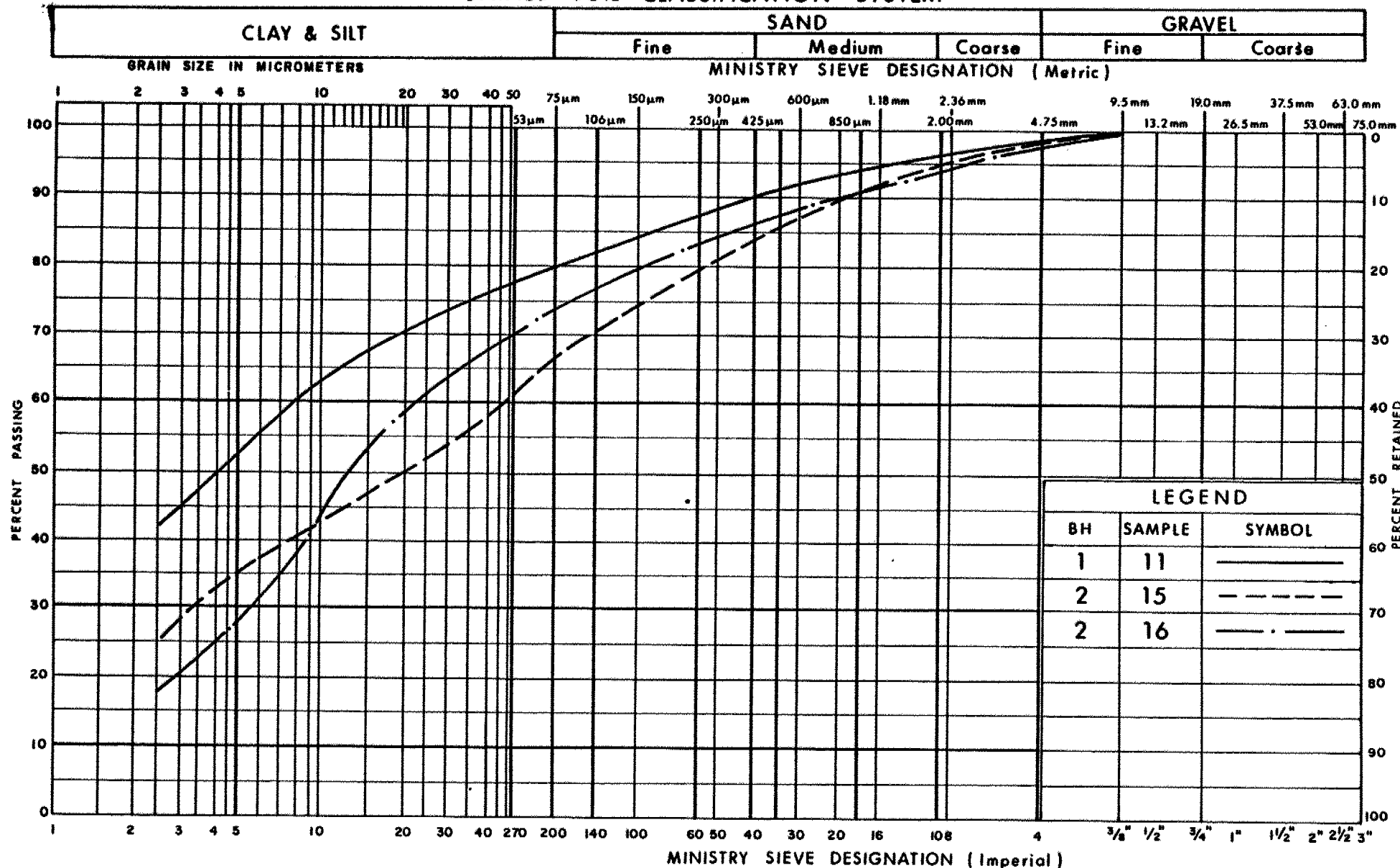
Ministry of
Transportation and
Communications

**GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Fill Material)**

FIG No 1

W P 91-67-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
(Till)

FIG No 2

W P 91-67-01

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

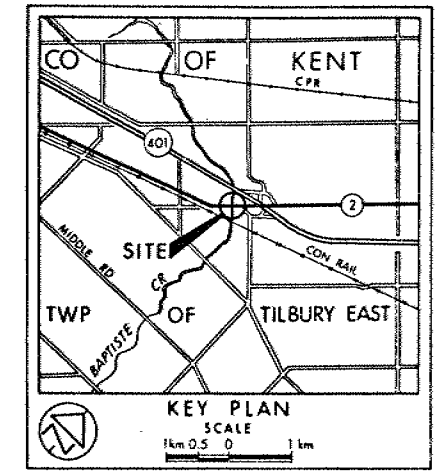
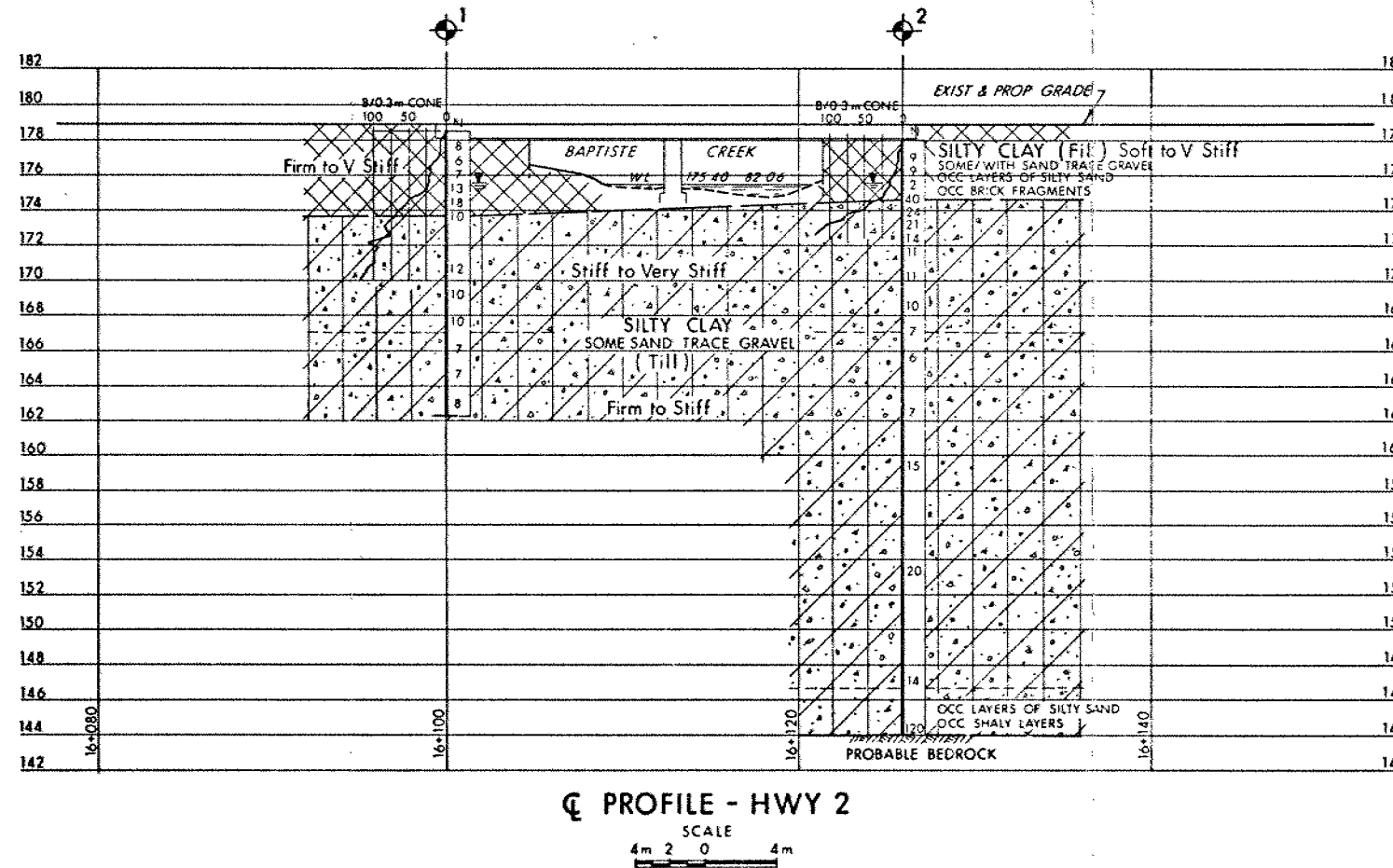
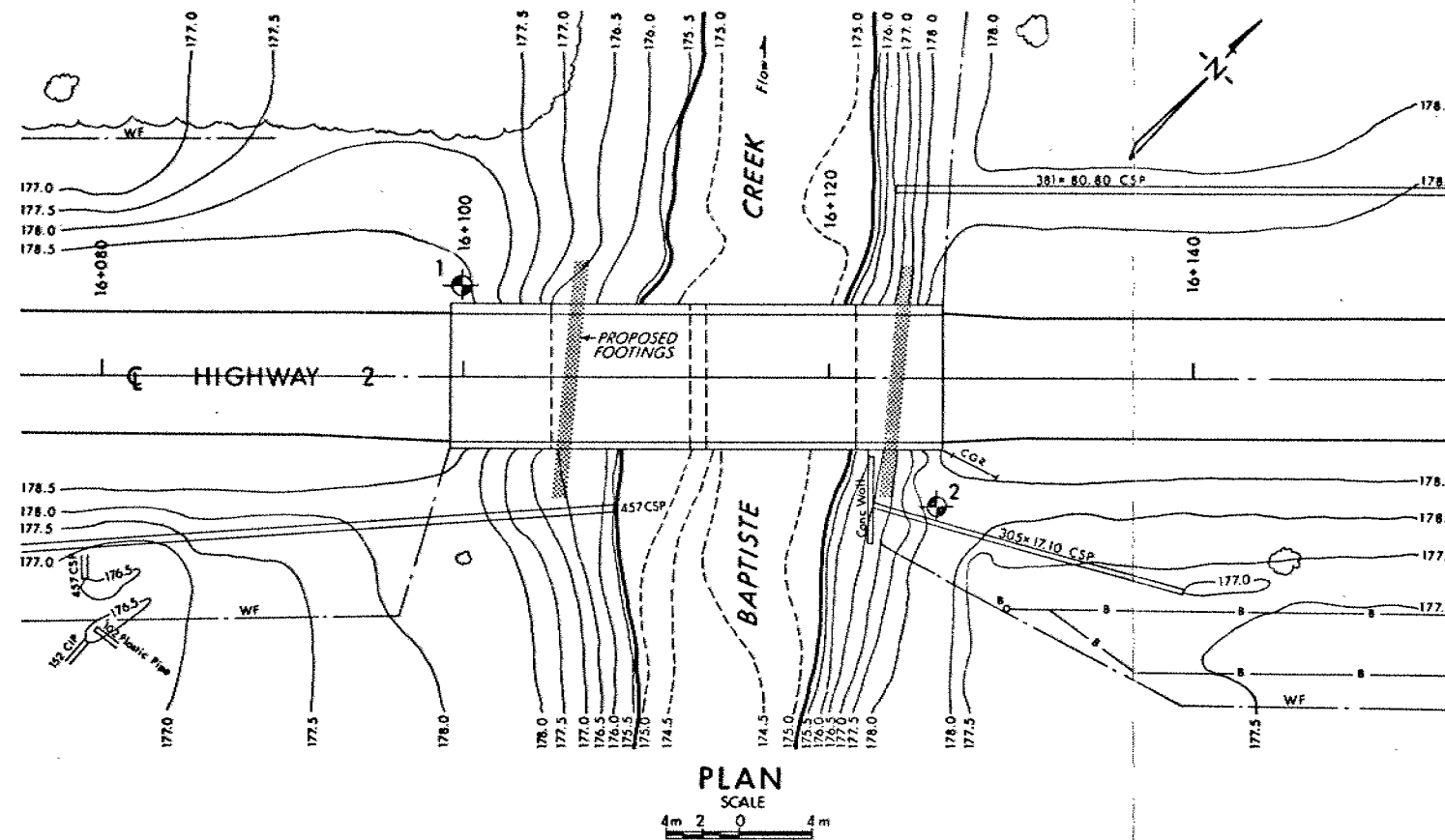
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 91-67-01

BAPTISTE CREEK
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



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)		
	WL at time of investigation 83 02		
No	ELEVATION	STATION	OFFSET
1	178.5	16+100	5 m LT
2	178.0	16+126	7 m RT

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

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

REV	DATE	BY	DESCRIPTION
Geocres No 4018-40			
HWY No 2		DIST 1	
SUBMD DD	CHECKED	DATE 83 03 21	SITE 13-104-193
DRAWN SO	CHECKED	APPROVED	DWG 916701-A

B. M. ROSS AND ASSOCIATES LIMITED

CONSULTING ENGINEERS



62 NORTH STREET
GODERICH, ONTARIO
TELEPHONE (519) 524-2641
N7A 2T4

B.M. ROSS, P.ENG., O.L.S.
K.G. DUNN, P.ENG.
S.D. BURNS, P.ENG.
B.W. POTTER P.ENG.

OUR FILE NO. BR-470

September 22, 1983

Mr. K. G. Selby, P. Eng.
Senior Foundations Engineer
Engineering Materials Office
Ministry of Transportation
and Communications
3501 Dufferin Street
DOWNSVIEW, Ontario
M3K 1N6



Dear Sir:

Re - Structural Design of Baptiste
Creek Bridge
-- W.P. 91-67-01

We wish to confirm our recent telephone conversation with you concerning the use of 1 3/4:1 in lieu of 2:1 embankment fill slopes along the face of the wing walls in the above proposed bridge design.

Your agreement with the use of the 1 3/4:1 slope along the face of the wing wall from the front face of the abutment to the end of the wing wall allows us to use a shorter wing wall length than that required by the 2:1 slope and within the range where the wing wall can be cantilevered from the abutment. With the use of the longer 2:1 slope wing wall, it is likely that a double system of cantilevered wing wall and footing supported retaining wall would be used, which could lead to future uneven settlement and misalignment of the barrier wall on top of the wing wall and retaining wall.

Our design will call for the protection of the 1 3/4:1 embankment fill slope with 600 mm thick random rip-rap and the fill slope will flatten to 2:1 upstream and downstream of the face of the bridge and within the limits of the random rip-rap.

We shall proceed with our design with the use of the 1 3/4:1 fill slope along the face of the wing wall.

Yours very truly,

B. M. ROSS AND ASSOCIATES LIMITED

KGD:jj

Per


K. G. Dunn, P. Eng.

c.c. V. F. Boehnke
Head Structural Section
M.T.C., London

memorandum



To: Mr. V.F. Boehnke
Head, Structural Section
Southwestern (London) Region

Date: 83 02 28

Attn: Mr. A.P. Watt

From: Pavement & Foundation Design Section
Room 315, Central Building
Downsview

Re: Foundation Investigations:

W.P. 91-67-01, Site 13-104-193
Baptiste Creek Bridge

and

W.P. 93-78-02, Site 13-104-194
McDougall Drain Bridge

Hwy. 2, District #1 (Chatham)

Fieldwork for the above-noted projects has been completed. This memo contains recommendations pertaining to the design and construction of the foundations for the proposed structures. These recommendations are intended to be sufficient to allow the design of the structures to proceed. Our complete foundation investigation and design report will be submitted in the near future.

Two alternatives are proposed. The alternative which leads to the least expensive design should be adopted.

General Recommendations (Applicable to All Alternatives)

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a yielding foundation with $K_a = 0.33$ and $\gamma = 21.5 \text{ kN/m}^3$ for granular backfill.
- For frost protection, cover should be greater than 1.2 m.
- No stability problems are anticipated for embankments with slopes of 2:1 or flatter.
- The creek channel slopes should be protected from erosion by suitable rip rap or other protection.

- For all alternatives differential settlements should not exceed 25 mm.
- Dewatering is not anticipated to be a major problem because of the impermeable nature of the foundation soil.
- The minimum cover required for scour protection should be determined from hydrological data.

ALTERNATIVE 1 - Spread Footings on Glacial Till

The structure may be supported on spread footings founded on the silty clay till.

For this alternative remove the old footings, all fill material and any loose or soft material beneath the proposed footing locations and cover (within 18 hours of exposure) the foundation soil with a 15 cm pad of mass concrete.

The elevation of the base of the existing footings is estimated at:

Location	Elevation
W.P. 91-67-01 Site 13-104-193 Baptiste Creek Bridge	174.0+ m
W.P. 93-78-02 Site 13-104-194 McDougall Drain Bridge	173.5+ m

The following design values are recommended for spread footings at or below the recommended footing level:

- net safe bearing pressure = 200 kPa
- and for purposes of the O.H.B.D.C.:
- Factored Bearing Capacity at U.L.S. = 300 kPa
- Bearing Capacity at S.L.S. Type II = 200 kPa

ALTERNATIVE 2 - Steel H-Piles Driven to Bedrock

The structure may be supported on steel H-piles equipped with reinforced tips and driven to bedrock. The bedrock elevation is estimated at elev. 144.0+ m.

The following design values are recommended:

<u>Pile Type</u>	<u>Safe Capacity</u>
310 HP 79	1150 kN per pile

and for the purposes of the O.H.B.D.C.:

<u>Pile Type</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity S.L.S. Type II</u>
310 HP 79	1600 kN per pile	1150 kN per pile

If there are any questions, please contact this Office.

D. H. Dundas

D.H. Dundas, P. Eng.
Project Foundations Engineer

DHD:syc

Baptiste Creek Bridge

Hwy. 2

Site No. ~~13-193~~

13-104-193



LOOKING WEST

