

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40PI-74

DIST. 4 REGION

W.P. No. 66-67-09

CONT. No.

W. O. No.

STR. SITE No. 1-1E9

HWY. No. 403

LOCATION LYNDEN ROAD UNDERPASS

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 66-67-09

DIST 4

HWY 403

STR SITE 1-189

Lynden Road Interchange Underpass
10.6 km West of Hwy. 2, Ancaster

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ROCK CORES	79-04-25	PP

FOUNDATION INVESTIGATION REPORT

For

Lynden Road Interchange Underpass
10.6 km West of Hwy. 2, Ancaster
W.P. 66-67-09, Site 1-189
Hwy. 403, District 4, Hamilton

INTRODUCTION

This report contains the results of the foundation investigation carried out at the above mentioned site. The fieldwork consisted of four sampled boreholes and was carried out during the two periods of March 19 to 23, 1976 and January 10 to 24, 1979. The boreholes were advanced using hollow stem augers and rock coring techniques to depths ranging from 17.2 to 42.8 metres below the ground surface.

SITE DESCRIPTION

The site is located on the proposed new alignment of Hwy. 403 and proposed Lynden Road in the Township of Brantford, Brant County. The land is gentle to moderately rolling and used for agricultural purposes.

The site lies in the physiographic region known as the Haldimand Clay Plain. This extensive plain consists of stratified clay, silts and sands deposited by glacial lakes Whittlesey and Warren.

SUBSURFACE CONDITIONS

Generally, the subsurface conditions consist of up to 3.5 metres of clayey silt followed by an extensive layered deposit of clayey silt and silty clay. The stratified stratum is underlain by dolomite bedrock at elevation 177.2 or 41.8 metres below the ground surface.

For a detailed description of the various soil and rock types encountered in each borehole, refer to the Record of Borehole Sheets. The estimated stratigraphical profile shown on Drawing

No. 666709-A is based upon this information. The following paragraphs summarize the various soil and rock types encountered from ground level downwards.

Clayey Silt

Immediately below the ground surface a deposit of clayey silt containing occasional seams of silt and fine sand and traces of organics was encountered in B.H. #28, 29 and 30. The deposit ranges from 2.7 to 3.5 metres in thickness.

Standard Penetration Tests within this stratum ranged from 11 to 47 blows/0.3 metres. Therefore, the consistency can be described as varying from stiff to hard.

Layers of Clayey Silt and Silty Clay

Located below the clayey silt or the ground surface is a deep deposit consisting of layers of clayey silt and silty clay with occasional seams and layers of silt. The individual layers of clayey silt and silty clay ranged up to 210 mm in thickness. The overall thickness of the deposit was proven in B.H. #28 and found to be 39.1 metres.

Field vanes carried out within this deposit yielded an undrained shear strength ranging from 38 to over 107 kPa with a sensitivity of 2 to 5. These results, along with the laboratory quick triaxial and unconfined shear strength test results, are summarized on Figure 1.

The soil properties of the clayey silt and silty clay layers as determined by laboratory testing are listed below. The Atterberg Limit results are also plotted on the Plasticity Chart, Figure 2.

(i) Clayey Silt Layers		Range	Average
Natural Moisture Content (W)	%	23-31	26
Liquid Limit	(W _L) %	23-33	27
Plastic Limit	(W _p) %	17-22	18
Plasticity Index	(I _p) %	7-14	8

(ii) Silty Clay Layers		Range	Average
Natural Moisture Content	(W) %	26-35	30
Liquid Limit	(W _L) %	35-50	41
Plastic Limit	(W _P) %	19-27	22
Plasticity Index	(I _P) %	16-26	20

Consolidation tests were performed on representative samples obtained from this stratum. The results are plotted on the void ratio versus pressure curves, Figure 3 and 4. The tests generally indicate that the stratum is overconsolidated with a preconsolidation pressure ranging from 455 to 709 kPa.

Dolomite Bedrock

Sound dolomite bedrock was proven to exist at elevation 177.2 in B.H. #28 by obtaining 1.0 metre of BXL rock core. The rock is hard, light grey in colour and has a medium texture. See the Diamond Drill Record attached to the Appendix for a complete description.

Groundwater Level

The groundwater was observed by measuring in the open boreholes after completion of the investigation. The groundwater was observed to vary between 2.7 to 5.5 metres below the ground surface. This corresponds to between elevation 213.3 and 215.7. The groundwater levels are shown on the Record of Borehole Sheets and Drawing No. 666709-A.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct Hwy. 403 between Ancaster and Brantford. As part of this scheme Lynden Road is to be extended south to the existing Hwy. 2. This extension will cross Hwy. 403. A two span structure has been proposed at this intersection to carry Lynden Road over Hwy. 403. Hwy. 403 at this location is to be placed at approximately elevation 219.5 with Lynden Road at about 225.4. Approach fills of 5.0 and 7.5 metres will be required at the north and south abutments, respectively.

Structure Foundation

It is recommended that the proposed structure be founded on end bearing piles driven to the bedrock. The piles may be steel 'H', concrete filled closed end steel tube or reinforced concrete piles depending on economics. Properly seated piles on the bedrock may be designed to carry the full allowable structural capacity of the particular pile section chosen. The estimated tip elevation is 177+.

If steel 'H' piles are employed the pile tips should be fitted with flange plates to ensure proper seating in the bedrock and to prevent damage during driving when the bedrock is contacted. HP 310X110 steel piles so fitted may be designed for a load per pile of up to 1.1 MN.

Alternatively, closed end steel tubes may be employed if the wall thickness is 6.3 mm or greater. A 324 O.D X 6.3 mm closed end tube pile filled with concrete may be designed for a capacity of up to 1.1 MN per pile. During the driving operation there is the possibility of buckling the steel tube pile when contact is made with the bedrock if too high a driving energy is being utilized. To prevent pile damage the driving energy should be reduced to less than 40 kilojoules per blow for the final two metres of driving.

The structure may also be supported on end bearing reinforced concrete piles. The allowable load per pile will depend on the manufacturer's specifications for the particular pile section chosen.

Approach Embankment

Approach fills up to 7.5 metres above the existing ground surface will be required at the structure site. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no material larger than 75 mm is placed within the approach fills through which piles may have to be driven. The stability of the fill was checked using total stress analysis and found to be stable.

It is estimated that the approach fills could incur long-term settlements in the order of 200 to 250 mm due to consolidation of the layered clayey silt and silty clay stratum. The approach fill should be constructed to grade and allowed to settle over one winter season before final grading and paving. Settlement of the approaches will continue for several years. For this reason the proposed structure should be designed with approach slabs.

Other Considerations

For frost protection purposes the base of all pile caps should be provided with a minimum earth cover of ^{1.2}~~1.3~~ metres.


For estimating the earth pressure on the abutment walls due to a granular backfill having a unit weight of 21.2 kN/m^3 , a coefficient of active earth pressure (K_A) of 0.33 may be used for design purposes if some movement at the top is allowed. Otherwise, a coefficient of earth pressure at rest, K_0 , of 0.5 should be used in design.

In order to relieve the build-up of excess hydrostatic pressure behind the abutment walls, suitable drainage measures should be provided.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. R. Van Veen and Mr. C.T. Johnson. The rock core obtained was examined by Mr. B. Glassford, Geologist. This report was written by Mr. C.T. Johnson and reviewed by Mr. K.G. Selby.

The equipment used was owned and operated by Atcost Soil Drilling Inc., Concord and D.S.I.L. Drilling Inc., Scarborough.



C.T. Johnson, P. Eng.
Project Engineer



K.G. Selby, P. Eng.
Supervising Engineer

April, 1979

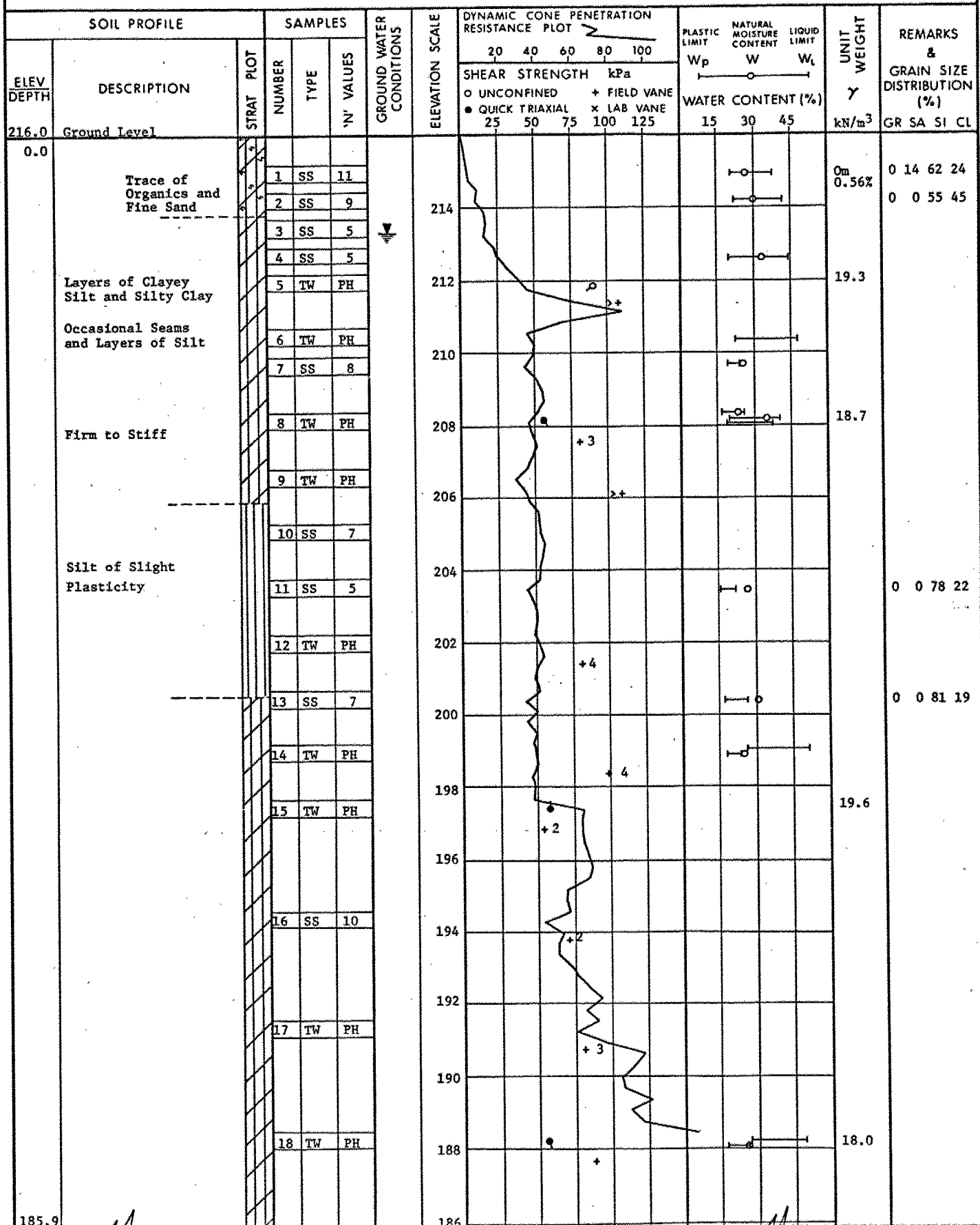
APPENDIX



RECORD OF BOREHOLE No 7

METRIC

W P 66-67-09 LOCATION Coords. N 4 782 399.5; E 253 613.5 ORIGINATED BY BVV
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY BVV
DATUM Geodetic DATE 1976 03 19 to 1976 03 23 CHECKED BY [Signature]



30.1

Continued

+3, x⁵: Numbers refer to Sensitivity

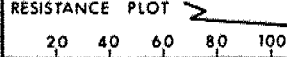
20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 7 Continued

METRIC

W P 66-67-09 LOCATION Coords. N 4 782 399.5; E 253 613.5 ORIGINATED BY BVV
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY BVV
DATUM Geodetic DATE 1976 03 19 to 1976 03 23 CHECKED BY *CP*

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					
185.9	cont'd																
30.1	Layers of Clayey Silt		19	TW	PH												
185.1	and Silty Clay																
31.9	End of Borehole																
							184										
							182										
							180										
179.8																	
36.2	End of Cone Test																



RECORD OF BOREHOLE No 28

METRIC

W.P. 66-67-09 LOCATION Coords. N 4 782 377.8; E 253 593.5 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers, BXL Rock Core and COMPILED BY CTJ
DATUM Geodetic DATE 79 01 10 and 79 01 19 Cone Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	15 30 45	W _p	W	W _L		
219.0	Ground Level													
218.5	Topsoil													
0.5	Clayey Silt		1	SS	11		218							0 1 84 15
	Brown		2	SS	26									
	Stiff to Hard		3	SS	32									
216.3			4	SS	10		216							
2.7	Layers of Clayey Silt and Silty Clay Up to 210 mm in Thickness													
	Occasional Seams and Layers of Silt		5	TW	PH		214						20.1	
	Brown and Grey		6	TW	PH		212						20.1	
	Firm to Very Stiff		7	SS	8		210							0 0 63 37
			8	TW	PH		208						19.8	
			9	TW	PH		206						19.1	
			10	TW	PH		204						20.1	
			11	SS	19		202							
	Silt of Slight Plasticity		12	SS	6		200						19.8	
			13	TW	PH		198							
			14	SS	sank		196							
			15	TW	PH		194							
			16	SS	11		192							
188.9							190							

30.1

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 28 Continued METRIC

W.P. 66-67-09 LOCATION Coords. N 4 782 377.8; E 253 593.5 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers, BXL Rock Core and Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 1979 01 10 to 1979 01 19 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
188.9	cont'd													
30.1														
	Layers of Clayey Silt and Silty Clay		17	SS	11		188							
	Occasional Seams and Layers of Silt						186							
	Stiff to Very Stiff						184							
			18	SS	25		182							
							180							
							178							
177.2														
41.8	Dolomite Bedrock		19	BXL RC	Rec. 100%									
176.2	Sound													RQD 100%
42.8	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 29

METRIC

W P 66-67-09 LOCATION Coords. N 4 782 409.0; E 253 587.7 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers & Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 79 01 22 and 79 01 23 CHECKED BY *CP*

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												
								○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL x LAB VANE											
								25 50 75 100 125				15 30 45							
217.6	Ground Level																		
0.0	Clayey Silt Traces of Organics Brown Stiff		1	SS	9		216						0 1 (99)						
			2	SS	15														
214.9			3	SS	12														
2.7	Layers of Clayey Silt and Silty Clay Up to 170 mm in Thickness, Occasional Seams and Layers of Silt		4	SS	7		214					19.5							
	Brown and Grey		5	TW	PH														
	Stiff to Very Stiff		6	SS	9		212					20.0							
			7	TW	PH														
			8	SS	10		210												
			9	TW	PH		208					19.6							
			10	SS	14		206												
			11	TW	PH		204					19.1							
			12	SS	8		202					20.0							
			13	TW	PH														
			14	SS	10		200												
198.4																			
19.2	End of Borehole																		



RECORD OF BOREHOLE No 30

METRIC

W.P. 66-67-09 LOCATION Coords. N 4 782 439.9; E 253 585.4 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem, Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 79 01 23 and 79 01 24 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			20 40 60 80 100	100					
220.3	Ground Level													
0.0	Trace of Organics Clayey Silt Seams of Silt and Fine Sand, Very Stiff to Hard Layers of Clayey Silt and Silty Clay Occasional Seams and Pockets of Silt Brown and Grey Stiff to Very Stiff		1	SS	18		220							
			2	SS	28		218							
216.8			3	SS	47									
3.5			4	SS	13		216							
			5	SS	18									
			6	TW	PH		214							19.7
			7	SS	10		212							
			8	TW	PH									20.2
			9	SS	9		210							
			10	TW	PH		208							19.3
			11	SS	8		206							
203.1			12	SS	8		204							
17.2	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



HOLE NO. _____ SHEET NO. _____

90°

TOTAL FOOTAGE _____

ELEV. COLLAR _____
 DATUM _____
 DATE STARTED _____
 DATE COMPLETED _____
 DRILLED BY _____
 LOGGED BY _____

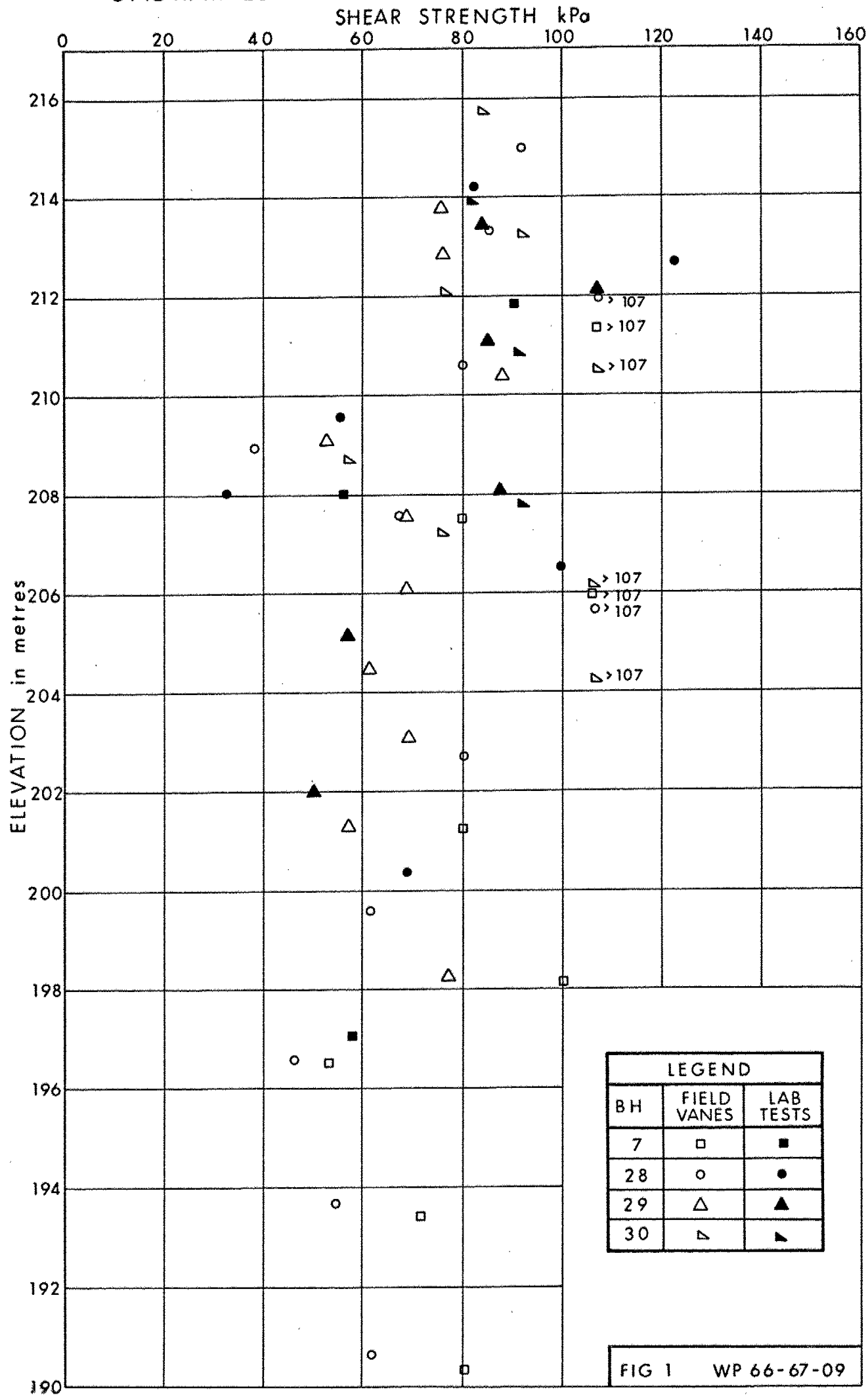
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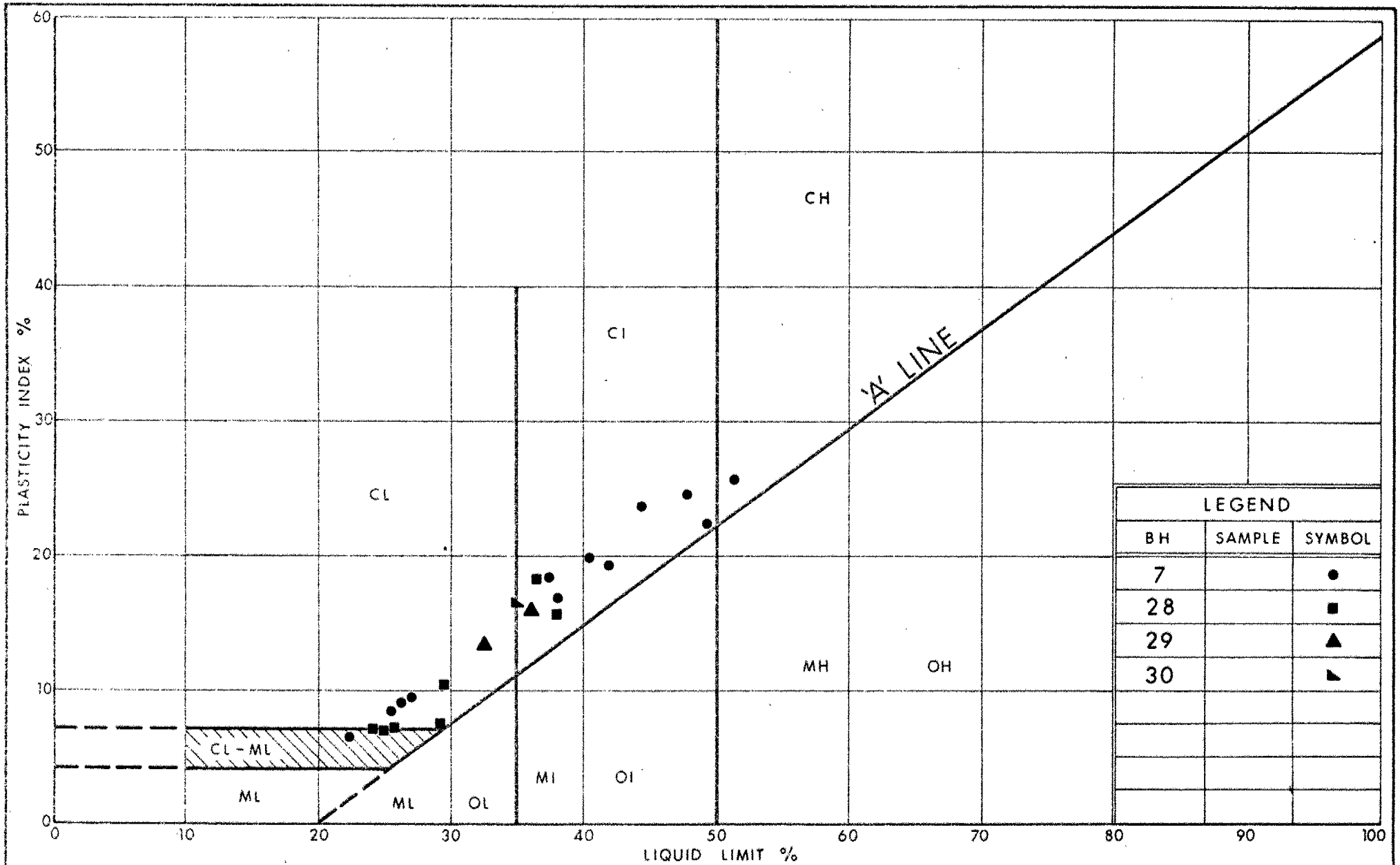
DATE OF EXAMINATION

Feb. 27/79

B.K.Glassford

UNDRAINED SHEAR STRENGTH Vs ELEVATION





Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART LAYERS OF CLAYEY SILT AND SILTY CLAY

FIG No 2

W P 66-67-09

VOID RATIO-PRESSURE CURVES

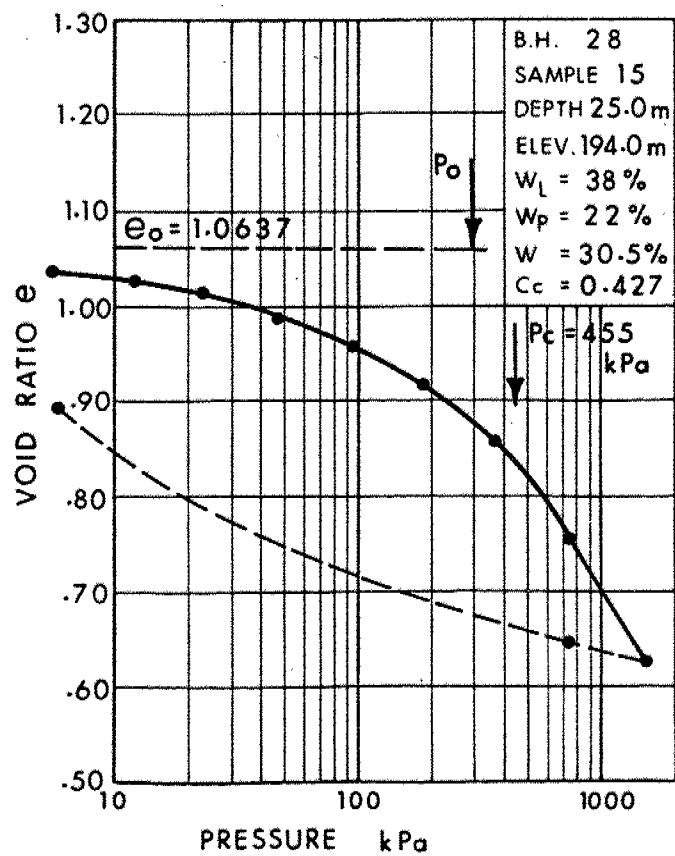
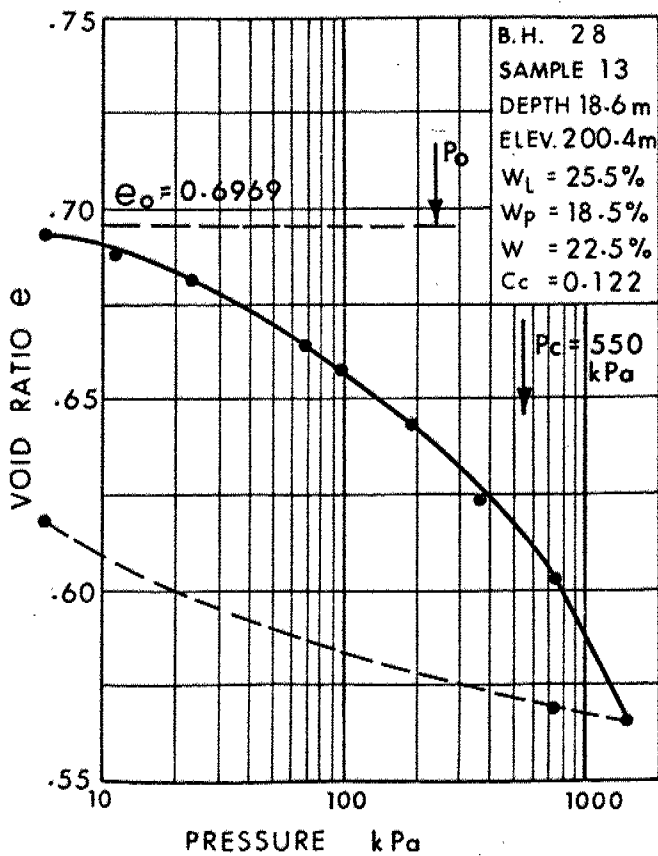
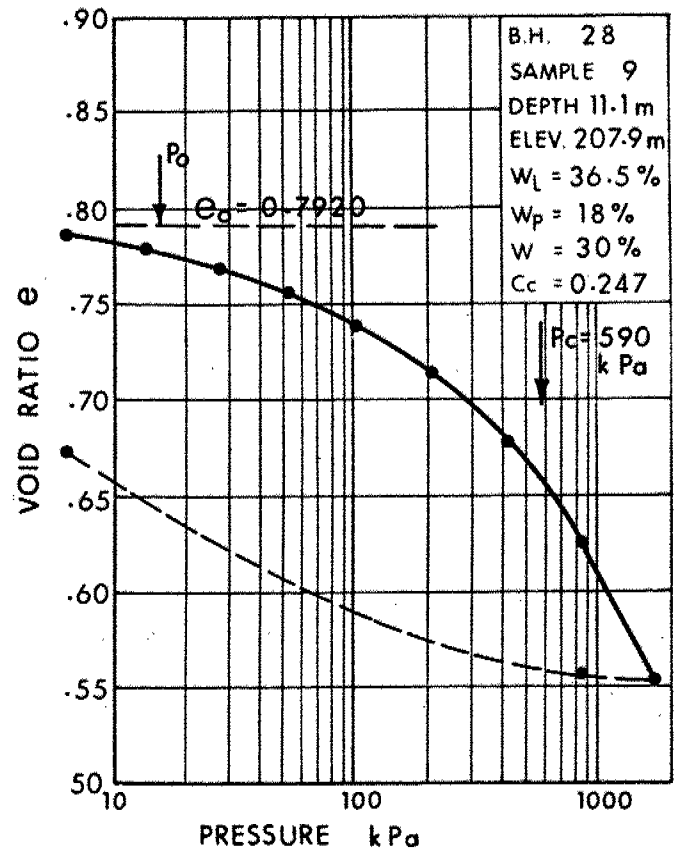
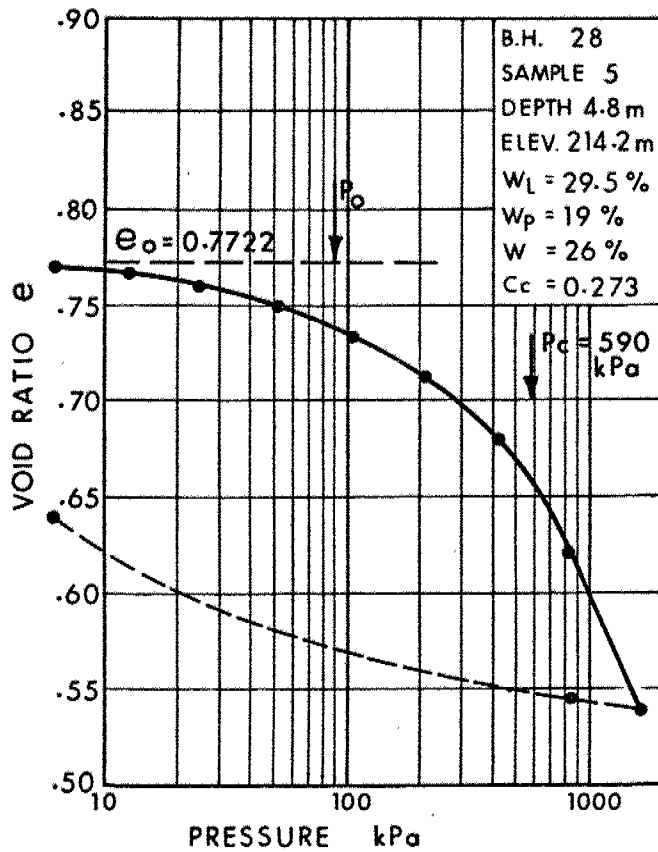


FIG. 3

WP 66-67-09

VOID RATIO - PRESSURE CURVES

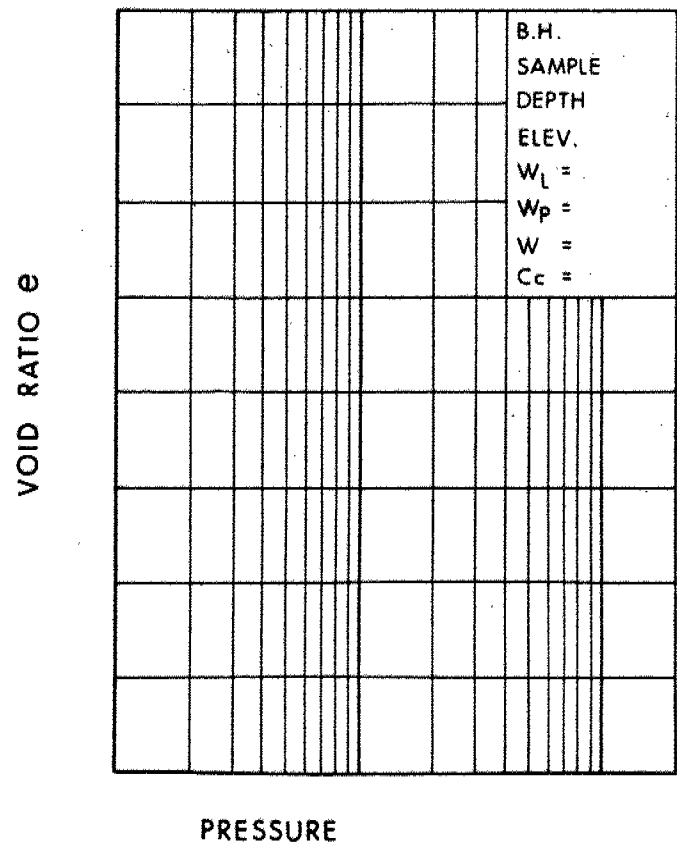
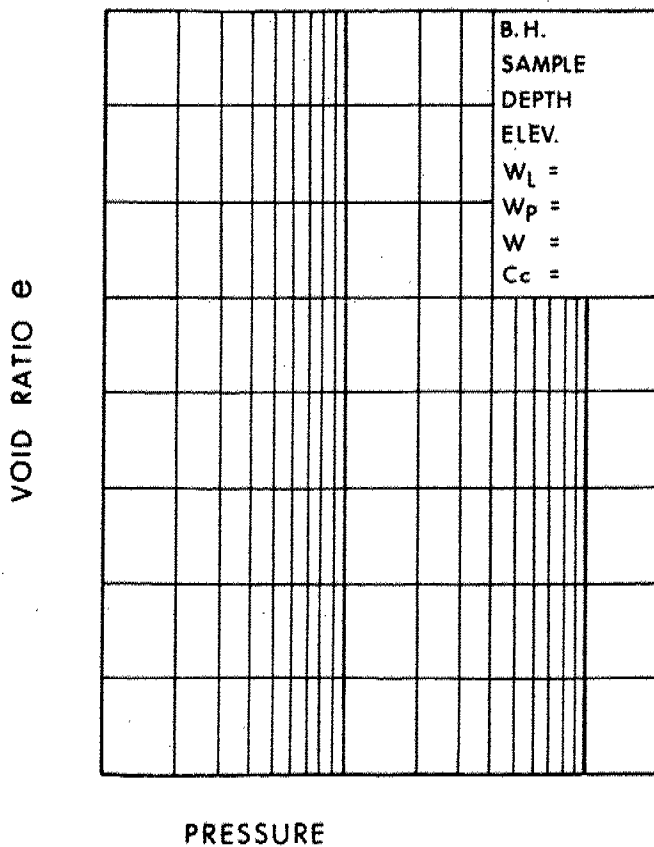
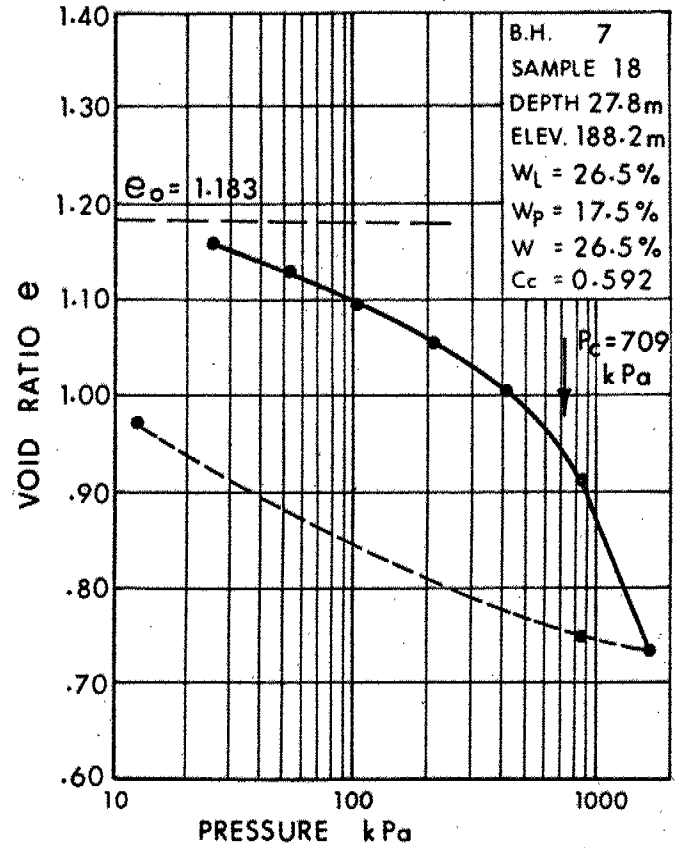
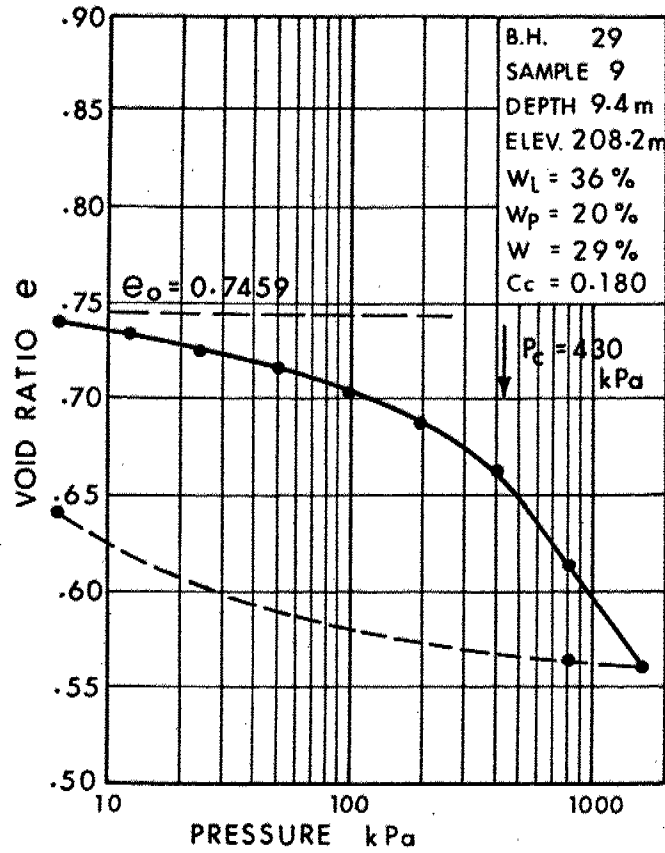


FIG. 4

WP 66-67-09

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

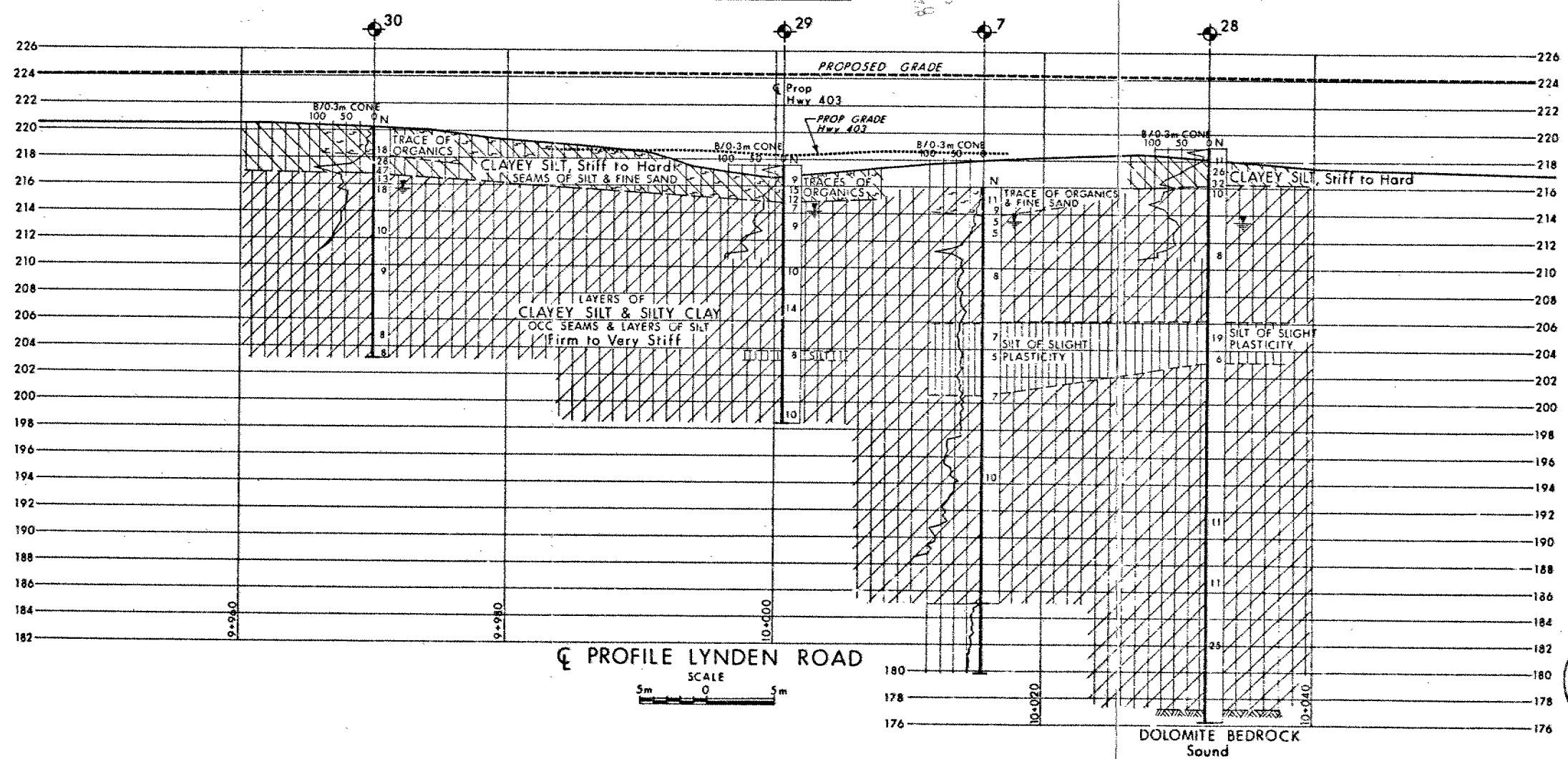
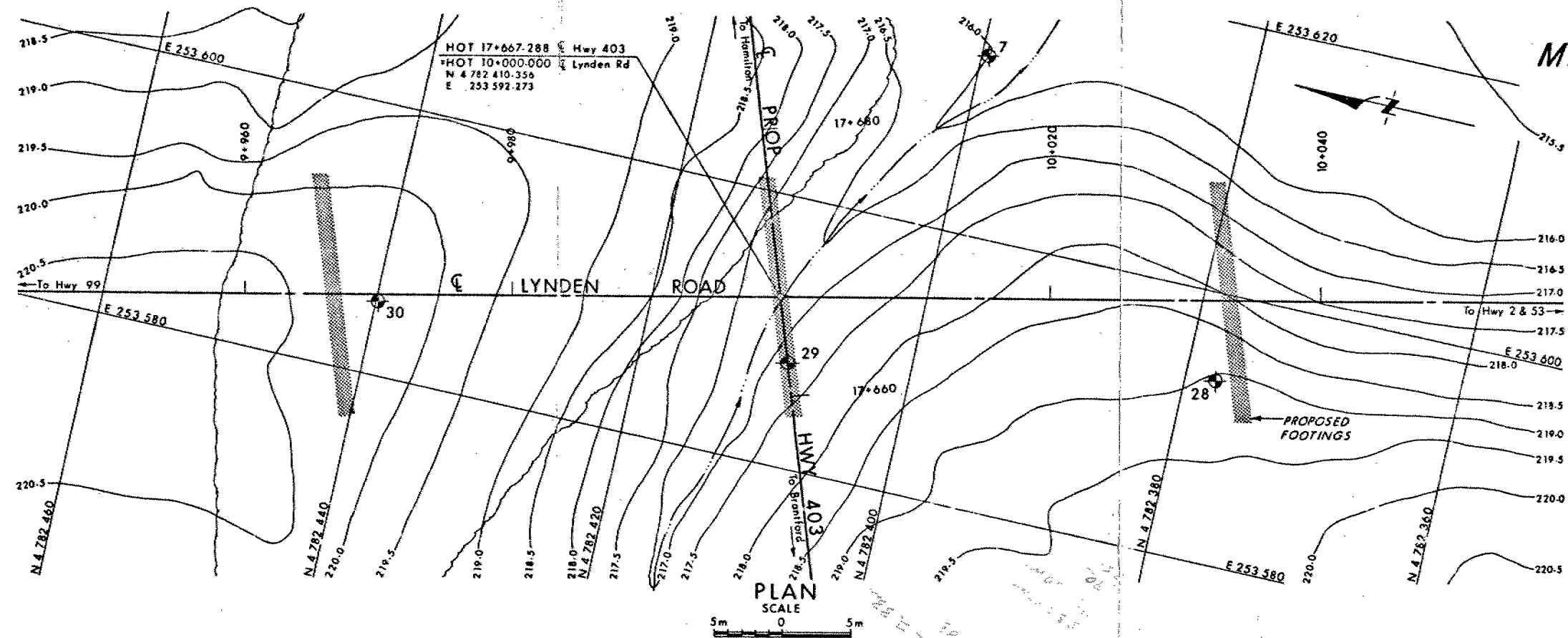
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_{α}	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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_f	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						



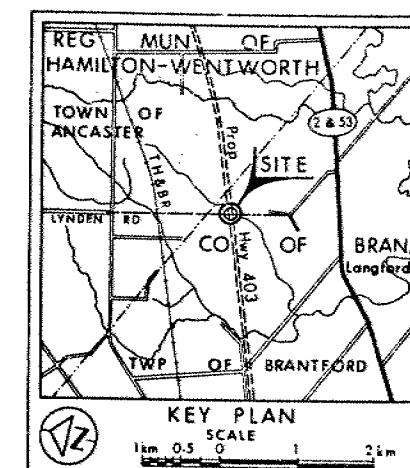
METRIC

CONT No
WP No 66-67-09







LYNDEN ROAD UNDERPASS
(10.6 km West of Hwy 2 Ancaster)
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 1979 01
- WL for BH#7, 1976 Q3 23

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
7	216.0	4 782 399.5	253 613.5
28	219.0	4 782 377.8	253 593.5
29	217.6	4 782 409.0	253 587.7
30	220.3	4 782 439.9	253 585.4

=NOTE=

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

[illegible]

Gaores No 40PI-74

HWY No Prop 403		DIST 4	
SUBMIT CT	CHECKED	DATE 1979 03 20	SITE 1-189
DRAWN	CHECKED	APPROVED	DWG 666709-

DIST. No 4
CONT No
WP No 66-67-09

LYNDEN ROAD UNDERPASS
HWY. 403
GENERAL ARRANGEMENT

SHEET

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

GENERAL NOTES

CLASS OF CONCRETE
DECK, MEDIAN & PIER COLUMNS 35 MPa
REMAINDER 30 MPa

CLEAR COVER TO REINF. STEEL

FOOTINGS	100 ± 25
ABUTMENTS & WINGWALLS	
FRONT FACE	80 ± 20
BACK FACE	70 ± 20
PIER COLUMNS	80 ± 20
DECK	
TOP	70 ± 20
BOTTOM	50 ± 10
BARRIER WALLS	70 ± 20
APPROACH SLABS	80 ± 20
AND AS NOTED	

REINFORCING STEEL

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

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE BEARING
SEATS LEVEL AND TO THE SPECIFIED ELEVATIONS

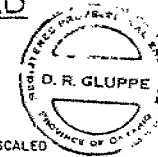
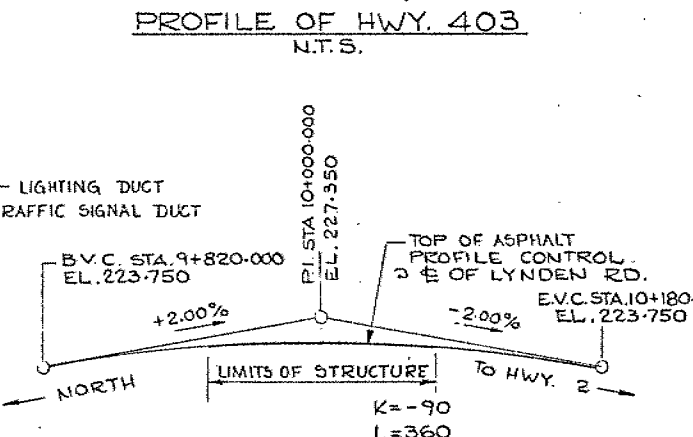
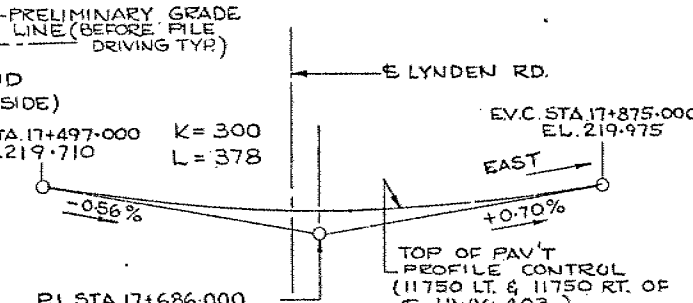
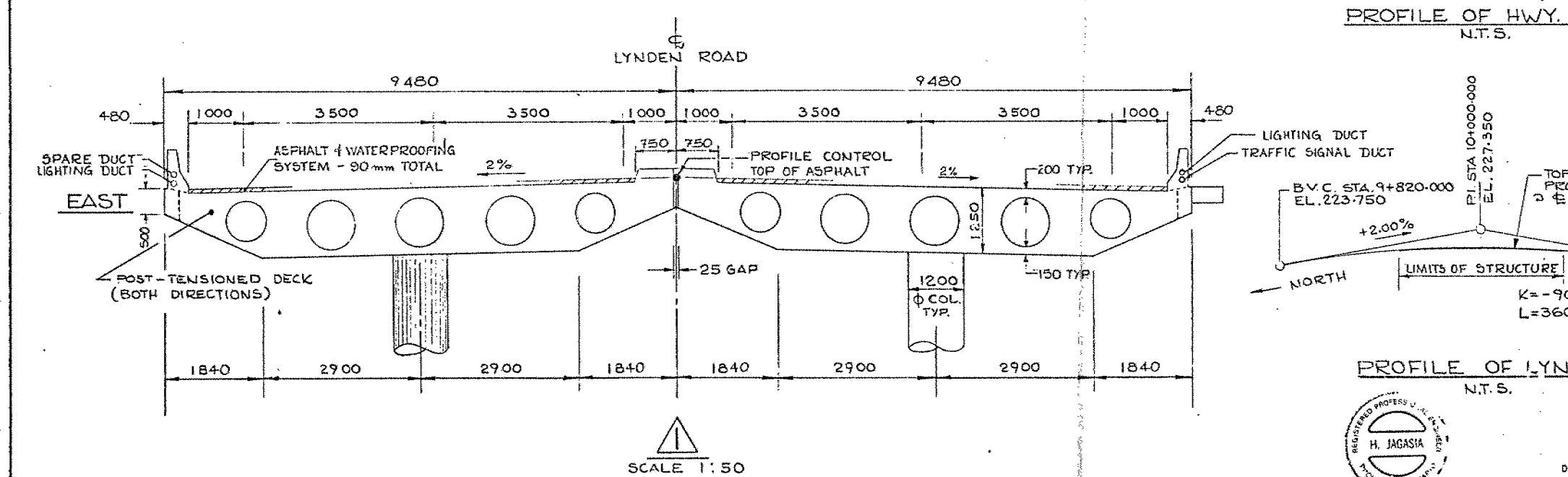
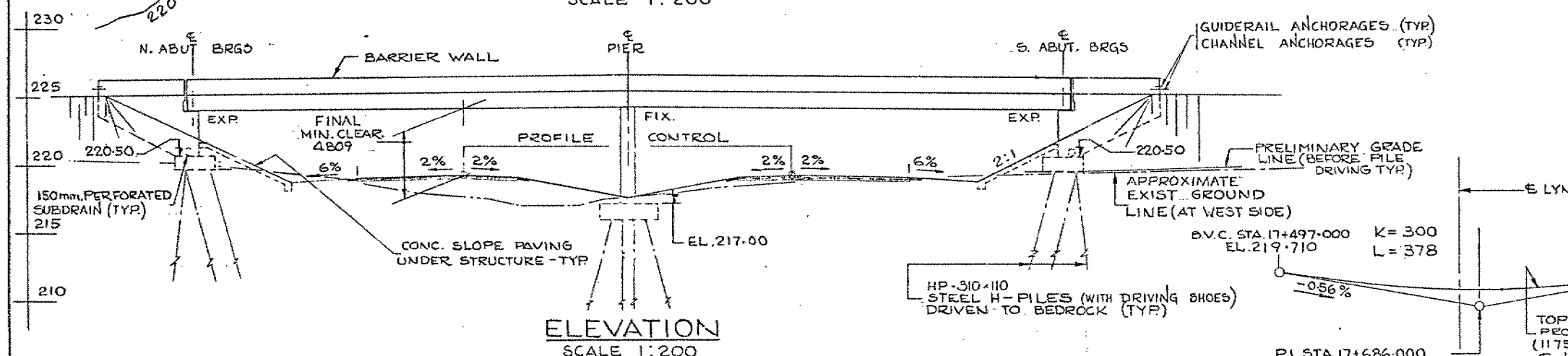
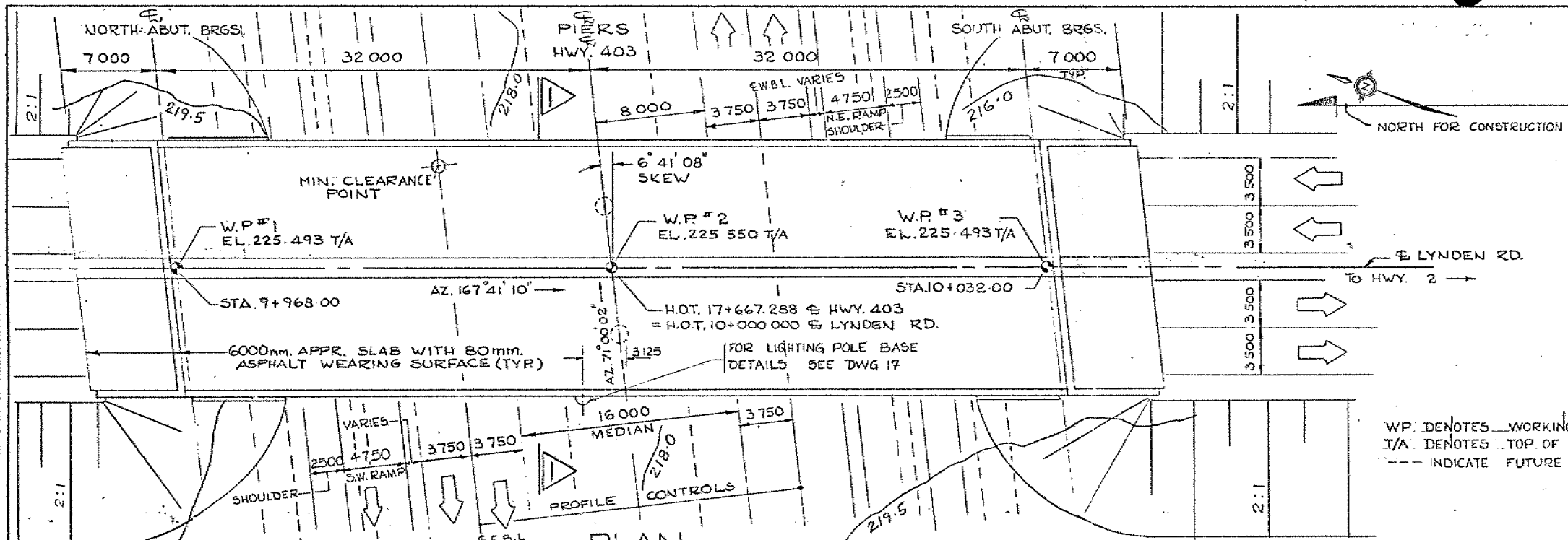
PRIOR TO PILE DRIVING - COMPACTED BOULDER FREE
FILL TO BE PLACED TO UNDERSIDE OF FOOTING
AND IN THE AREA OF THE PILES (MAXIMUM
PARTICLE SIZE 75 mm)

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BORE HOLE LOCATIONS & SOIL STRATA
3. FOOTING DETAILS
4. ABUTMENTS AND WINGWALLS
5. BEARING & PIER DETAILS
6. DECK DETAILS
7. DECK REINFORCING I
8. DECK REINFORCING II
9. TRANSV. CABLE DETAILS
10. LONG. CABLE DETAILS
11. JOINT ANCHORAGE AND ARMOURING
12. BARRIER WALL
13. 6000mm APPROACH SLAB
14. DETAILS OF CONCRETE SLOPE PAVING
15. BRIDGE DATE AND SITE NUMBER DATA
16. AS CONSTRUCTED ELEV. AND DIM.
17. STD DETAILS
18. QUANTITIES STRUCTURE I
19. QUANTITIES STRUCTURE II

APPLICABLE STANDARD DWGS

FOR ASPHALT & WATERPROOFING SYSTEM
REQUIREMENTS SEE OPSD-508.02



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN	D.R.G.	CHECK H.K.T.
DRAWING	J.T.C.	CHECK D.R.G.
LOADING	O.H.B.D.G.-A-8	DATE FEB 88
SITE No	1-189	DWG 1

OVERSIZE DRAWING

FOUNDATION DESIGN SECTION

REVIEW OF DESIGN DRAWINGS:

W.P. ... 66-67.09

W.O.

Foundation Report By: C.T. Johnson

Review of Design Drawings By: S. Holmes

Design Drawing No.'s: 1,2

1. Does footing design comply with our report or subsequent memos? *Yes*
2. If answer to 1. is No, is present design acceptable?
3. Has sufficient field work been done? *Yes*
4. Are estimated pile lengths shown on Drawings correct? If not, make a new list. *Approximately correct.*
5. If excavation of unsuitable soil is recommended, is this shown on Drawings? *N/A.*
6. Are approaches designed in accordance with our report? Check slopes and berm lengths. *Yes - See letter dated 88-06-16. The final grading on the approach fill will be delayed by 1 winter*
7. Do you anticipate any construction problems? i.e., dewatering, stability of temporary slopes or excavations. *No*
8. Summarize your comments: on separate sheet if necessary.

Drawings Received 19.....

Reviewed 19.....

Signed

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
M E M O R A N D U M

TO: Steve Holmes
Foundation Design Section
Central Building

DATE: 1988-06-14

FROM: Structural Section
Central Region

RE: Lynden Road Underpass
W.P. 66-67-07, Site 1-189
Highway 403, District 4

I have contacted McCormick Rankin and Structural Office with regard to the approach fill treatment for the above noted structure.

It is confirmed that the road design drawing will reflect the details of approach fill treatment as required by the Foundation Design Section. Therefore, the structural drawing will not repeat the details.

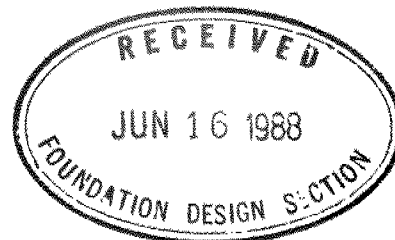
I trust that the above is to your satisfaction.

John Lam

J.R. Lam
Senior Structural Engineer
for:
G.C.E. Burkhardt
Head, Structural Section

JKL/jf

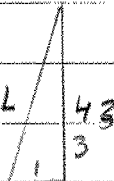
c.c. G. Al-Bazi
W. Kennedy
R. McCormick, McCormick Rankin




Pile Tip EL 177

NORTH ABUT. + SOUTH ABUT


$$220 - 177 = 43 \text{ m}$$



$$L = 43 \sqrt{\frac{10}{9}} = 45.3$$




$$L = 43 \sqrt{\frac{65}{8}} = 43.3$$




$$L = 43 \sqrt{\frac{17}{4}} = 44.3$$

CENTRE PIER

$$215.5 - 177 = 38.5$$



$$L = 38.5 \sqrt{\frac{17}{4}} = 39.7$$



$$L = 38.5 \sqrt{\frac{145}{12}} = 38.6$$

Summary:

Fill of 3m:

$$S_c = 182 \text{ mm}$$

$$t_{95} = 44 - 51 \text{ yrs}$$

Fill of 5m:

$$S_c = 270 \text{ mm}$$

$$t_{95} = 44 - 51 \text{ yrs}$$

Fill of 7m:

$$S_c = 342 \text{ mm}$$

$$t_{95} = 29 - 51 \text{ yrs}$$

Fills:Initial Effective Stresses: (Before Fill)

$$\sigma_{vo}' (0m) = 0 \text{ KPa}$$

$$\sigma_{vo}' (-18.6m) = (21.2 \text{ KN/m}^3 - 9.8 \text{ KN/m}^3) (18.6m) = 212.0 \text{ KPa}$$

Fill: (Surcharge)

$$\Delta\sigma_v (3m) = (19.6 \text{ KN/m}^3) (3m) = 58.8 \text{ KPa}$$

$$\Delta\sigma_v (5m) = (19.6 \text{ KN/m}^3) (5m) = 98.0 \text{ KPa}$$

$$\Delta\sigma_v (7m) = (19.6 \text{ KN/m}^3) (7m) = 137.2 \text{ KPa}$$

Final Effective Stresses: (After Fill)Fill of 3m

$$\sigma_{vo}' (+3m) = 0 \text{ KPa}$$

$$\sigma_{vo}' (0m) = 58.8 \text{ KPa}$$

$$\sigma_{vo}' (-18.6m) = 270.0 \text{ KPa}$$

Fill of 5m

$$\sigma_{vo}' (+5m) = 0 \text{ KPa}$$

$$\sigma_{vo}' (0m) = 98.0 \text{ KPa}$$

$$\sigma_{vo}' (-18.6m) = 310.0 \text{ KPa}$$

Fill of 7m

$$\sigma_{vo}' (+7m) = 0 \text{ KPa}$$

$$\sigma_{vo}' (0m) = 137.2 \text{ KPa}$$

$$\sigma_{vo}' (-18.6m) = 349.2 \text{ KPa}$$

Using Borehole 1:

Here $\sigma_p' = 69.9 \text{ KPa}$ & $\sigma_{vo}' = 106.0 \text{ KPa}$ @ middepth for each cases of fill, and

$$\text{OCR} = \frac{\sigma_p'}{\sigma_{vo}'} = \frac{69.9}{106.0} = 0.66 < 1 \Rightarrow \text{underconsolidated soil}$$

Therefore $S_c = \frac{C_c}{1+e_0} \frac{H_0}{\sigma_{vo}'} \log \left(\frac{\sigma_{vo}' + \Delta\sigma_v}{\sigma_{vo}'} \right)$ where $C_c = 0.09$
 $H_0 = 18.6m$
 $e_0 = 0.765$
 $\sigma_{vo}' = 106.0 \text{ KPa}$

and for:

Fill of 3m

$$\sigma_{vo}' + \Delta\sigma_v = 164.8 \text{ KPa}$$

$$S_c = \frac{0.09}{1+0.765} \left(\frac{18.6m}{110.765} \right) \log \left(\frac{164.8}{106.0} \right)$$

Fill of 5m

$$\sigma_{vo}' + \Delta\sigma_v = 204 \text{ KPa}$$

$$S_c = \frac{0.09}{1+0.765} \left(\frac{18.6m}{110.765} \right) \log \left(\frac{204.0}{106.0} \right)$$

Fill of 7m

$$\sigma_{vo}' + \Delta\sigma_v = 243.2 \text{ KPa}$$

$$S_c = \frac{0.09}{1+0.765} \left(\frac{18.6m}{110.765} \right) \log \left(\frac{243.2}{106.0} \right)$$

$$S_c = 0.182m = 182mm$$

$$S_c = 0.270m = 270mm$$

$$S_c = 0.342m = 342mm$$

Fills:

Load at depth of sample below the foundation is:

$$\text{Fill of 3m} \Rightarrow \text{Load} = (21.2 \text{ kN/m}^3 - 9.8 \text{ kN/m}^3)(5.75 \text{ m}) + 58.8 \text{ kPa} = 124.4 \text{ kPa}$$

$$\text{Fill of 5m} \Rightarrow \text{Load} = (21.2 \text{ kN/m}^3 - 9.8 \text{ kN/m}^3)(5.75 \text{ m}) + 98.0 \text{ kPa} = 163.6 \text{ kPa}$$

$$\text{Fill of 7m} \Rightarrow \text{Load} = (21.2 \text{ kN/m}^3 - 9.8 \text{ kN/m}^3)(5.75 \text{ m}) + 137.2 \text{ kPa} = 202.8 \text{ kPa}$$

Then from consolidation test let's use the following results:

$$\text{Fill of 3m} \Rightarrow \text{Load of } 94.34 \text{ \& } 188.29 \text{ kPa}$$

$$\text{Fill of 5m} \Rightarrow \text{Load of } 94.34 \text{ \& } 188.29 \text{ kPa}$$

$$\text{Fill of 7m} \Rightarrow \text{Load of } 188.29 \text{ \& } 377.55 \text{ kPa}$$

 $C_v = ?$

If the load = 94.34 kPa

$$\text{then } C_v = \frac{T_{90} (2H)^2}{4 t_{90}} \quad \text{where } T_{90} = 0.848$$

$$2H = \frac{(0.4757 \text{ m} + 0.4721 \text{ m})}{2} = 0.4739 \text{ m}$$

$$t_{90} = 1.77 \text{ min}$$

$$\therefore C_v = \frac{(0.848)(0.4739)^2(339.1)}{4(1.77)} \text{ m}^2/\text{yr}$$

$$\Rightarrow C_v = 9.12 \text{ m}^2/\text{yr}$$

If the load = 188.29 kPa

$$\text{then } C_v = \frac{T_{90} (2H)^2}{4 t_{90}} \quad \text{where } T_{90} = 0.848$$

$$2H = \frac{(0.4721 \text{ m} + 0.4673 \text{ m})}{2} = 0.4697 \text{ m}$$

$$t_{90} = 2.015 \text{ min}$$

$$\therefore C_v = \frac{(0.848)(0.4697)^2(339.1)}{4(2.015)} \text{ m}^2/\text{yr}$$

$$\Rightarrow C_v = 7.87 \text{ m}^2/\text{yr}$$

If the load = 377.55 kPa

$$\text{then } C_v = \frac{T_{90} (2H)^2}{4 t_{90}} \quad \text{where } T_{90} = 0.848$$

$$2H = \frac{(0.4673 \text{ m} + 0.4609 \text{ m})}{2} = 0.4641 \text{ m}$$

$$t_{90} = 1.102 \text{ min}$$

$$\therefore C_v = \frac{(0.848)(0.4641)^2(339.1)}{4(1.102)} \text{ m}^2/\text{yr}$$

$$\Rightarrow C_v = 14.05 \text{ m}^2/\text{yr}$$

Table: Time rate of settlement (Fill of 3m)

③

U_{AVE}	T	$S_c(H) = S_c U_{AVE}$ (m)	$t = THd^2/cv^*$ (yrs)	$t = THd^2/cv^{**}$ (yrs)
0.10	0.008	0.018	0.303	0.352
0.20	0.031	0.036	1.176	1.363
0.30	0.071	0.055	2.693	3.121
0.40	0.126	0.073	4.780	5.539
0.50	0.197	0.091	7.473	8.660
0.60	0.287	0.109	10.887	12.616
0.70	0.403	0.127	15.287	17.716
0.80	0.567	0.146	21.509	24.925
0.90	0.848	0.164	32.168	37.278
0.95	1.163	0.173	44.117	51.125
1.00	∞	0.182	∞	∞
		$S_c = 0.182m$	$*cv = 9.12m^2/yr$	$**cv = 7.87m^2/yr$

Graph: Time vs Settlement (Fill of 3m)

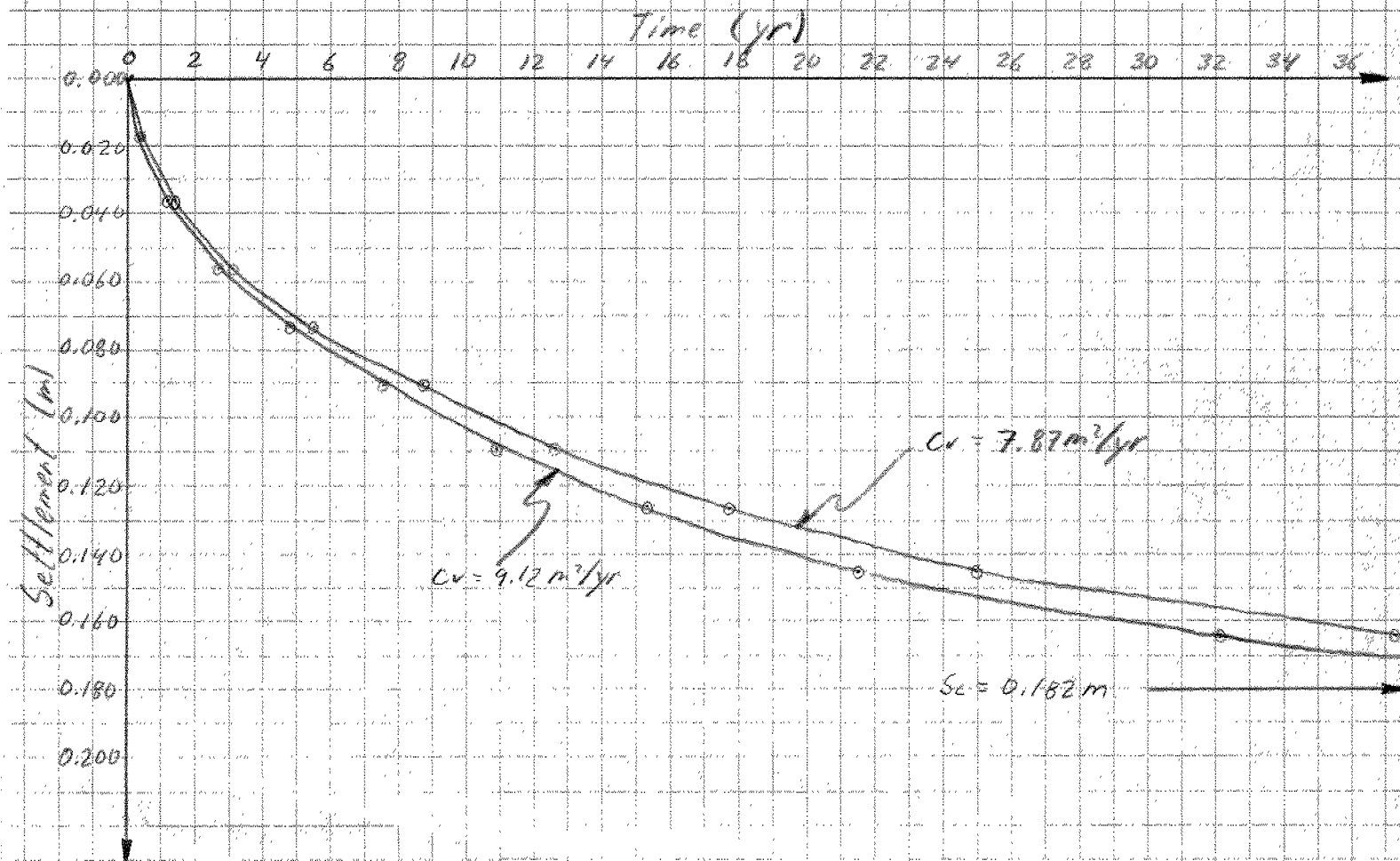


Table: Time rate of settlement (Fill of 5m)

(4)

U _{AVG}	T	$S_c(t) = S_c U_{AVG}$ (m)	$t = THd_r^2 / C_v^*$ (yrl)	$t = THd_r^2 / C_v^{**}$ (yrl)
0.10	0.008	0.027	0.303	0.352
0.20	0.031	0.054	1.176	1.363
0.30	0.071	0.081	2.693	3.121
0.40	0.126	0.108	4.780	5.539
0.50	0.197	0.135	7.473	8.660
0.60	0.287	0.162	10.887	12.616
0.70	0.403	0.189	15.287	17.716
0.80	0.567	0.216	21.509	24.925
0.90	0.848	0.243	32.168	37.278
0.95	1.163	0.257	44.117	51.125
1.00	∞	0.270	∞	∞
		$S_c = 0.270 \text{ m}$	$*C_v = 9.12 \text{ m}^2/\text{yr}$	$**C_v = 7.87 \text{ m}^2/\text{yr}$

Graph: Time vs Settlement (Fill of 5m)

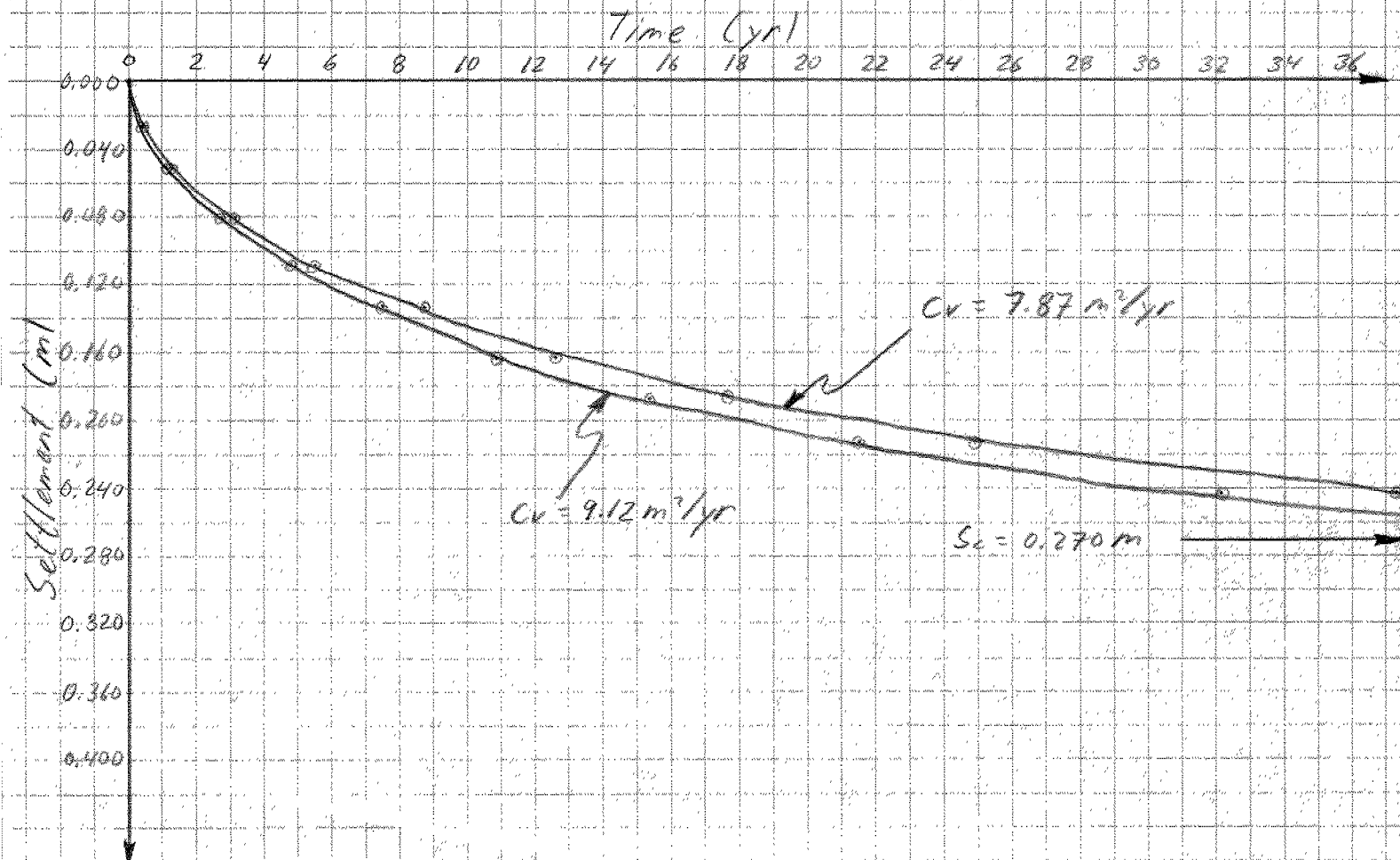
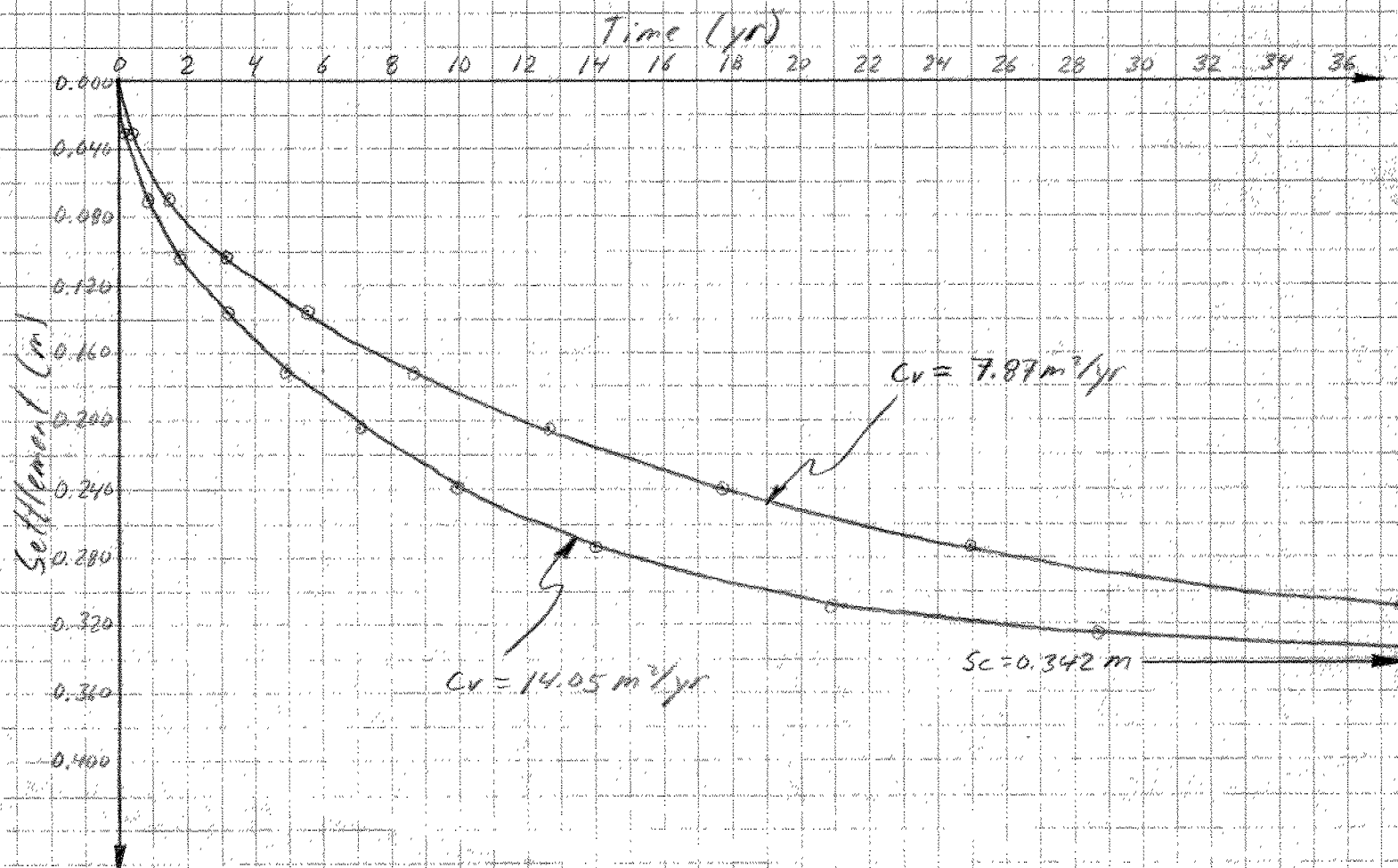


Table: Time rate of settlement (Fill of 7m)

⑥

U_{avg}	T	$S_{cd} = S_c U_{avg}$ (m)	$t = THd^2/C_v$ (yr)	$t = THd^2/C_v^{**}$ (yr)
0.10	0.008	0.034	0.352	0.197
0.20	0.031	0.068	1.363	0.763
0.30	0.071	0.103	3.121	1.748
0.40	0.126	0.137	5.539	3.103
0.50	0.197	0.171	8.660	4.851
0.60	0.287	0.205	12.616	7.067
0.70	0.403	0.239	17.716	9.923
0.80	0.567	0.274	24.925	13.962
0.90	0.848	0.308	37.278	20.881
0.95	1.163	0.325	51.125	28.637
1.00	∞	0.342	∞	∞
		$S_c = 0.342 \text{ m}$	$C_v = 7.87 \text{ m}^2/\text{yr}$	$C_v^{**} = 14.05 \text{ m}^2/\text{yr}$

Graph: Time vs Settlement (Fill of 7m)



memorandum

Tel: 3731



To: John Lam *87.09.11*
Sr. Structural Engineer
Structural Section
Central Region
5000 Yonge Street

Date: 1987 09 11

From: Foundation Design Section
Room 315, Central Building

RE: Lynden Road Interchange Underpass
Foundation Investigation & Design Report
Hwy. 403, Site No. 1-189, W.P. 66-67-09
District No. 4, Burlington



Further to your recent request we are providing foundation design recommendations for purposes of the O.H.B.D.C. which was not in use when the above-mentioned report was prepared in 1979.

Foundations

Steel H Piles driven to bedrock are considered to be the most suitable means of support for the structure at this site.

The following design values are recommended for HP 310 x 110:

Factored Capacity at U.L.S	1600 kN
Capacity at S.L.S. Type II	1150 kN

For different H piles, design values are proportional to their cross sectional areas and may be computed accordingly.

Backfill

For backfill to abutments and retaining walls earth pressures should be computed as per Subsection 6.6.1.2.2 of the Code. A yielding foundation condition may be assumed.

The Granular 'A' or 'B' backfill should be in accordance with Special Provision No. 121 (dated October, 1983). The following parameters are recommended for the granular backfill:

	<u>Gran. 'A'</u>	<u>Gran. 'B'</u>
Angle of Internal Friction	$\phi = 35^\circ$	30°
Unit Weight (kN/m^3)	$\gamma = 22.8$	21.2
K_A	.27	0.33

Please advise if further information is required. This memo should be attached to your copy of the original foundation report.

K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

KGS/mmj

c.c. - G. Al-Bazi

memorandum



To: Mr. K.G. Selby
Chief Foundation Engineer - West
Foundation Design Section
Central Building - Downsview

Date: 1987-09-08

RE: Lynden Road Underpass
W.P. 66-67-00, Site 1-189
Highway 403, District 4



Attached is a copy of the revised bridge site plan and profile for the above noted project.

A Foundation Investigation and Design Report was completed on April, 1979. Would you please up-date the report to comply with the O.H.B.D.C. requirements.

Current scheduling requires the Foundation Report by September 14, 1987.

If you have any queries regarding this matter, please do not hesitate to call.

John Lam

J.K. Lam
Senior Structural Engineer
for:
G.C.E. Burkhardt
Head, Structural Section

JKL/jf
attachment

Sept. 23, 1987
same alignment

same profile grade
span 100yds

appear similar.
Plan to be submitted

OVERSIZE DRAWING

memorandum

Tel: 3731



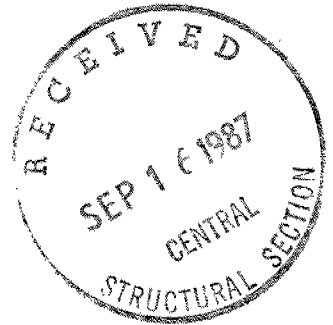
To:

John Lam *87.09.11*
Sr. Structural Engineer
Structural Section
Central Region
5000 Yonge Street

Date: 1987 09 11

From: Foundation Design Section
Room 315, Central Building

RE: Lynden Road Interchange Underpass
Foundation Investigation & Design Report
Hwy. 403, Site No. 1-189, W.P. 66-67-09
District No. 4, Burlington



Further to your recent request we are providing foundation design recommendations for purposes of the O.H.B.D.C. which was not in use when the above-mentioned report was prepared in 1979.

Foundations

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Backfill

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The Granular 'A' or 'B' backfill should be in accordance with Special Provision No. 121 (dated October, 1983). The following parameters are recommended for the granular backfill:

	<u>Gran. 'A'</u>	<u>Gran. 'B'</u>
Angle of Internal Friction	$\phi = 35^\circ$	30°
Unit Weight (kN/m^3)	$\gamma = 22.8$	21.2
K_A	.27	0.33

Please advise if further information is required. This memo should be attached to your copy of the original foundation report.

K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

KGS/mmj

c.c. - G. Al-Bazi

FOUNDATIONS OFFICE

REVIEW OF DESIGN DRAWINGS:

W.P. 66-67-09.....

W. O.

Foundation Report By :

C. T. Johnson

Review of Design Drawings By:

P.P. + T.K.

Design Drawing No.'s:

.....Final.....

1. Does footing design comply with our report or subsequent memos? Yes.
2. If answer to 1. is No, is present design acceptable? _____
3. Has sufficient field work been done? Yes
4. Are estimated pile lengths shown on Drawings correct? If not, make a new list. Close enough.
5. If excavation of unsuitable soil is recommended, is this shown on Drawings? N/A
6. Are approaches designed in accordance with our report? Check slopes and berm lengths. O.K.
7. Do you anticipate any construction problems? i.e., dewatering, stability of temporary slopes or excavations. No.
8. Summarize your comments; on separate sheet if necessary.

Drawings Received

Jan 29.....1980.....


Reviewed

March 21 1980

Received by Tom K.

March 18/80

Signed



memorandum

1201 WILSON AVENUE

DOWNSVIEW, ONT.



To: Mr. I. V. Oliver,
Head, Planning & Design Section,
Central Region, Toronto.

Date: 80 01 28,

SUBJECT: Lynden Road Underpass,
W.P. 66-67-09, Site 1-189,
Highway 403, District 4.

Please find enclosed two sets of the D4, Special Provisions along with two sets of half size prints for your use.

Copies of the D4, Special Provisions and half size prints are being forwarded to the following:

Regional Construction Office - Manager
Regional Structural Section - Head
Structural Office - Manager
Structural Office - Designer
Structural Office - Review Engineer
Estimating Office - Manager
Specifications & Standards Office - Manager
Pavement Design & Foundations Office - Head

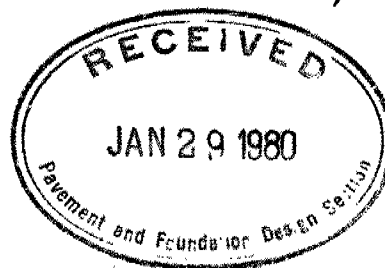
/cf
Enc.

Walton Lin

W. L. Lin,
Design Engineer,
Central Section.

c.c. D. Thrasher
G. Burkhardt
R. Dorton
W. McFarlane
W. Vielrose
B. Giroux
G. Martens
✓ G. Wrong
J. Anderson
R. Fitzgibbon

No comments on final
80-03-21
K.



337 N 4

CONT No

WP No 66-67-09

LYNDEN ROAD UNDERPASS

HWY 403

GENERAL PLAN

SHEET

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

GENERAL NOTES

CLASS OF CONCRETE
DECK & PIER COLUMNS 35 MP
PIER FOOTINGS, BARRIER WALLS, 30 MP
ABUTMENTS & WINGWALLS 20 MP
REMAINDER

REINFORCING STEEL

ALL REINFORCING STEEL SHALL BE IN
ACCORDANCE WITH C.S.A. G30.12 M GRADE 400
REINFORCING WITH BAR MARK SUFFIX "C" TO BE
EPOXY COATED.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS & ABUTMENTS 75 mm
PIER COLUMNS 80 mm
DECK TOP & BOTT. & APPROACH SLABS 50 mm
BARRIER WALLS (AS NOTED)

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING
THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED
ELEVATION TO A TOLERANCE OF ± 3 mm.
NO CONCRETE SHALL BE PLACED ABOVE THE
ABUTMENT BEARING SEATS UNTIL THE CONCRETE
IN THE DECK HAS BEEN PLACED, STRESSED &
GROUTED.

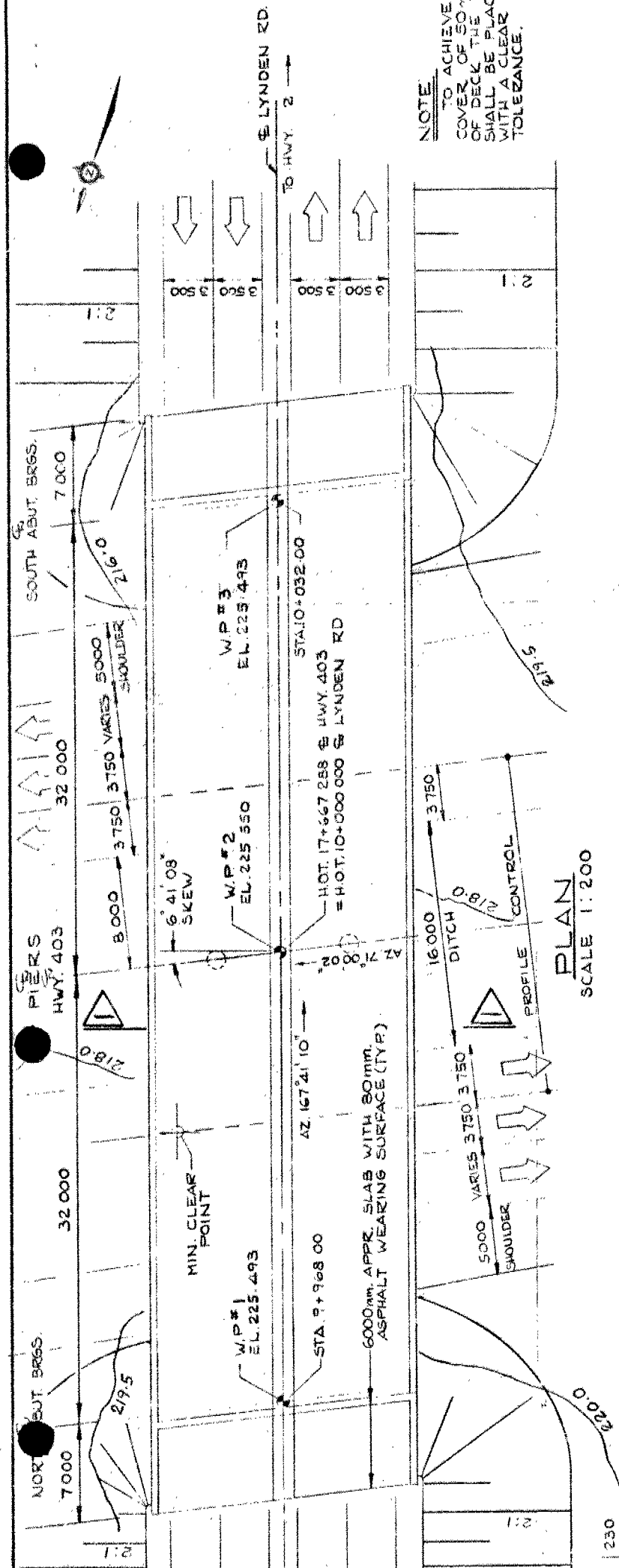
CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW
FOR THE APPROPRIATE CONCRETE
TENDER ITEMS:

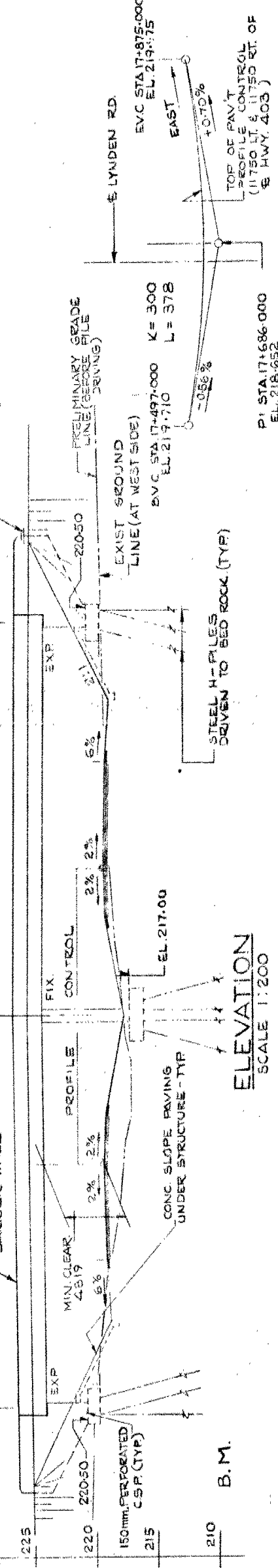
ITEM	CLASS	QTY (M ³)
1- CONCRETE IN PIERS COLUMNS	35	16
2- ABUTMENTS & WINGWALLS	30	220
3- PRESTRESSED CONCRETE BRIDGE DECK	35	1044
4- CONCRETE IN BARRIER WALL	30	37
5- CONCRETE IN APPROACH SLABS	30	57
6- CONCRETE IN ABUT. FTGS.	20	140
7- CONCRETE IN PIER FTGS.	35	85

LIST OF DRAWINGS

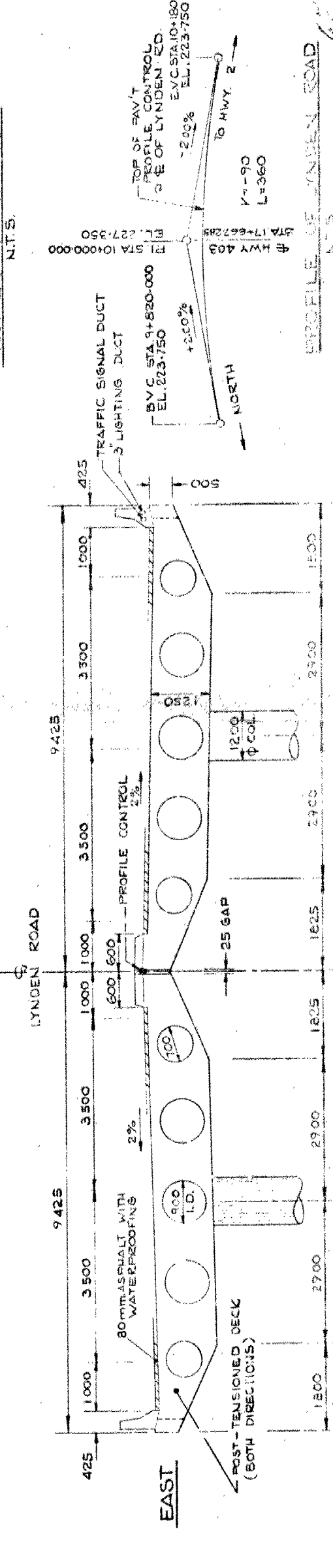
- 1- GENERAL PLAN
- 2- BORE HOLE LOCATIONS & SOIL STRATA
- 3- FOOTING DETAILS
- 4- ABUTMENTS AND WINGWALLS
- 5- PIER DETAILS
- 6- DECK DETAILS
- 7- DECK REINFORCING I
- 8- DECK REINFORCING II
- 9- TRANSV. CABLE DETAILS
- 10- LONG. CABLE DETAILS
- 11- EXPANS. JOINT
- 12- BARRIER WALL
- 13- APPROACH SLAB
- 14- DETAILS OF CONC SLOPE PAVING
- 15- AS CONSTRUCTED ELEV. & DIM.
- 16- STANDARD DETAILS I
- 17- STANDARD DETAILS II
- 18- STANDARD DETAILS III



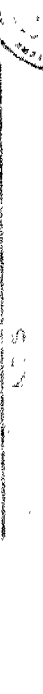
GUIDERAIL AND CHANNEL ANCHORAGES (NW & SE ONLY)



PROFILE OF HWY 403



PROFILE OF LYNDEN ROAD



SCALE 1:50

337 N 4

CONT No

WP No 66-67-09

LYNDEN ROAD UNDERPASS

HWY 403

GENERAL PLAN

SHEET

WP	STATION	NORTH	EAST
1	9+928.000	4782241.617	253585.446
2	10+000.000	4782410.353	253592.370
3	10+032.000	4782579.089	253599.095
4	9+999.226	4782411.900	253586.593
5	10+000.000	4782408.304	253587.772
6	9+966.901	4782444.890	253594.371
7	9+969.099	4782438.247	253576.521
8	10+030.901	4782382.162	253568.020
9	10+033.599	4782376.016	253559.170

LOCATION	NO.	BATTER	LENGTH	ELEV.
NORTH ABUT.	12	1:3	4.15 m	220.000
PIER	24	1:4	4.5 m	215.500
SOUTH ABUT.	6	1:3	4.5 m	220.000

PILE DATA (HP310 X110)

- NOTES:
- FILES TO BE GIVEN TO BEDROCK.
 - PILE TYPES SHALL BE REINFORCED.
 - ACCORDING TO THE STANDARD SPECIFICATIONS.
 - THEORETICAL DESIGN SHALL BE BASED ON THE FOLLOWING DATA:
 - PILE LAYOUT DIMENSIONS ARE TO BE MEASURED AT THE UNDERSIDE OF FOOTING.

METRIC

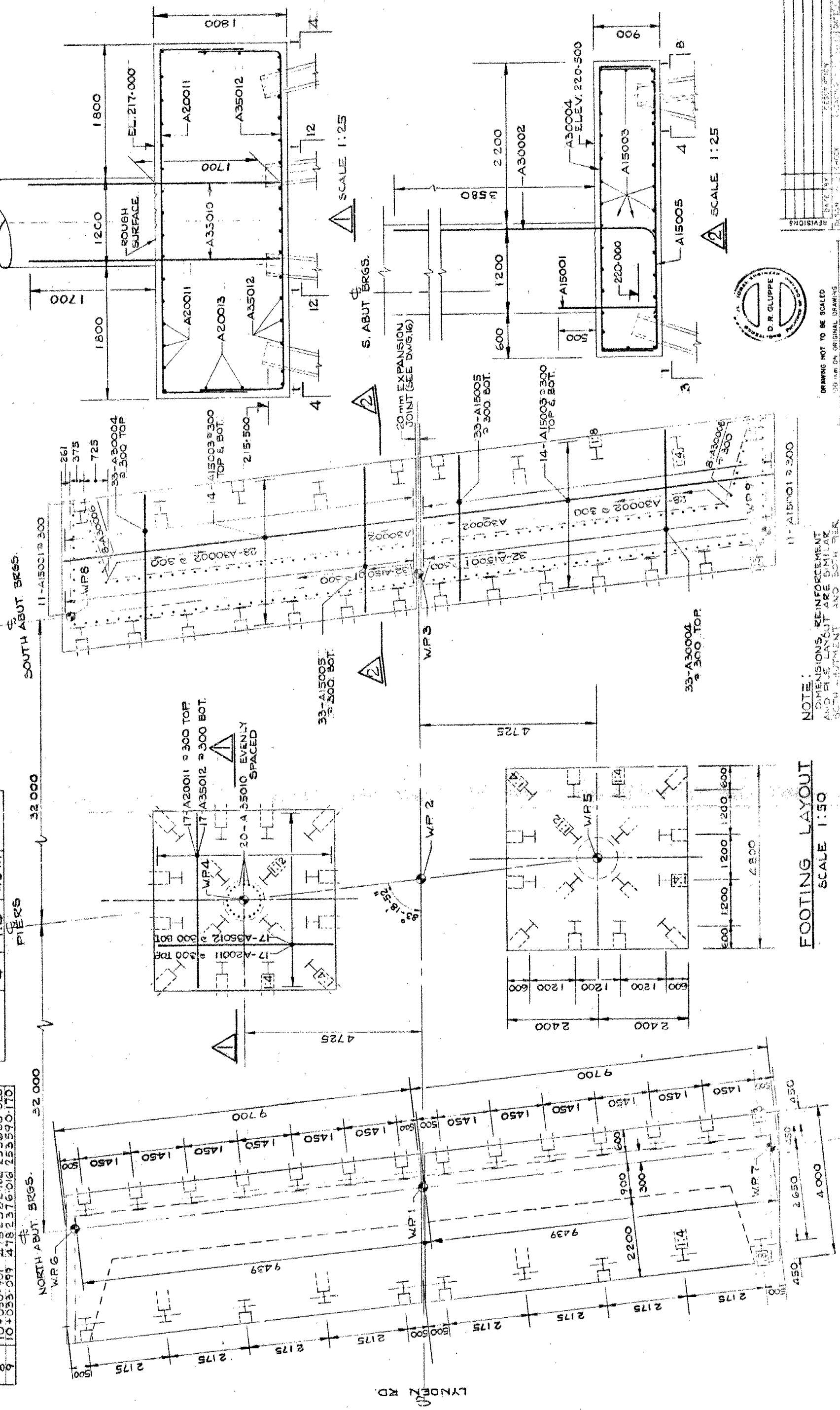
CONT No
WP No 85-67-09

LYNDEN ROAD UNDERPASS
HWY. 403

FOOTING DETAILS

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

PIER



NOTE:
DIMENSIONS, REINFORCEMENT
AND PILE LAYOUT ARE SIMILAR
BOTH ABUTMENT AND BOTH PIER
FOOTINGS.

FOOTING LAYOUT
SCALE 1:50

DRAWING NOT TO BE SCALED
USE DIMENSIONS ON ORIGINAL DRAWING

FOUNDATIONS OFFICE

REVIEW OF DESIGN DRAWINGS:

W.P. 66-67-09...

W.O.

Foundation Report By:

.....C.T. Johnson.....

Review of Design Drawings By:

.....PP.....

Design Drawing No.'s:

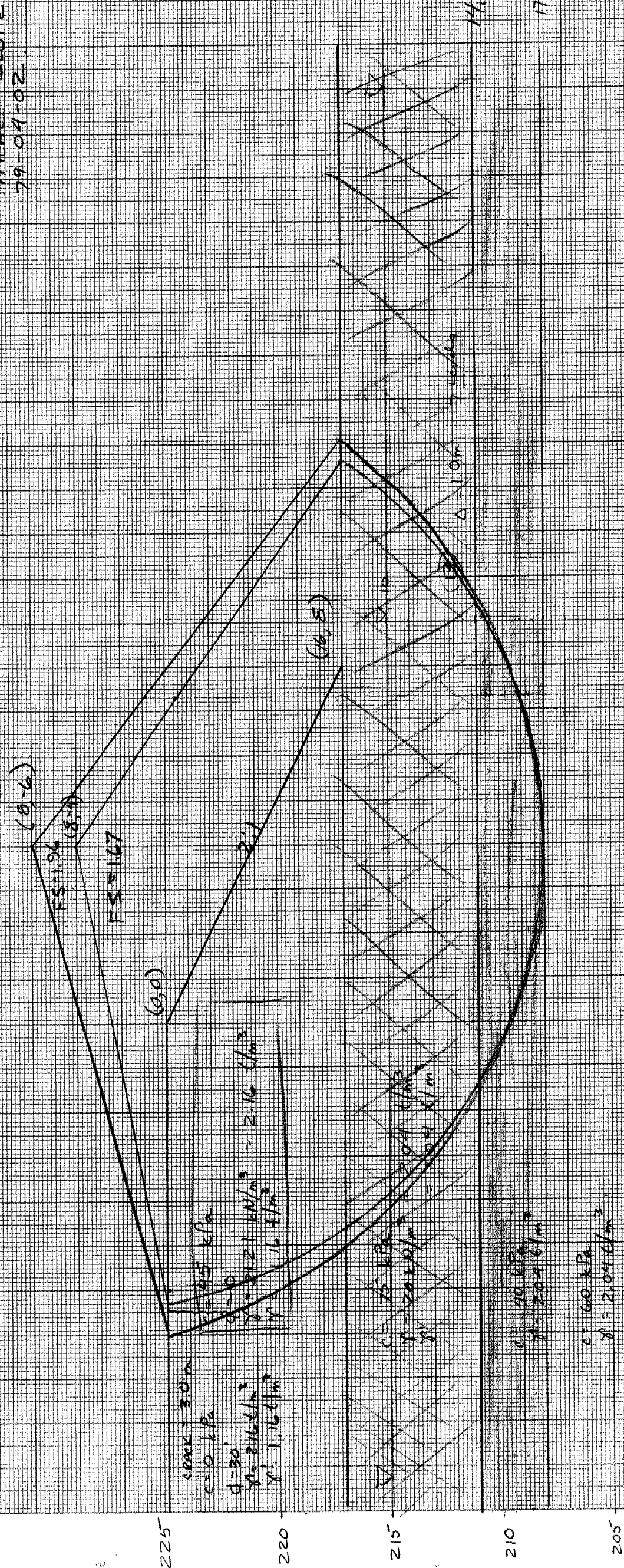
.....1-189-P1.....

1. Does footing design comply with our report or subsequent memos? YES
2. If answer to 1. is No, is present design acceptable? —
3. Has sufficient field work been done? YES
4. Are estimated pile lengths shown on Drawings correct? If not, make a new list. N/A
5. If excavation of unsuitable soil is recommended, is this shown on Drawings? N/A.
6. Are approaches designed in accordance with our report? Check slopes and berm lengths. YES
7. Do you anticipate any construction problems? i.e., dewatering, stability of temporary slopes or excavations. No
8. Summarize your comments; on separate sheet if necessary.

Drawings Received July 23 1979
Reviewed Aug. 16 1979

Signed P. Ray

WP 66-67-09
TYPICAL SLOPE
79-01-02



 * OUTPUT DATA *

===== FAILURE CIRCLE CENTERS WITH CORRESPONDING FACTORS OF SAFETY (COORDINATES IN M) =====

	0.0	2.00	4.00	6.00	8.00	10.00	12.00
-12.00	1.947	1.839	1.768	1.729	1.716	1.729	1.768
-10.00	1.997	1.874	1.796	1.751	1.737	1.751	1.795
-8.00	2.013	1.873	1.785	1.736	1.720	1.736	1.786
-6.00	1.999	1.841	1.743	1.689	1.672	1.689	1.742
-4.00	2.049	1.864	1.749	1.687	1.667	1.687	1.748
-2.00	2.141	1.908	1.779	1.696	1.672	1.697	1.769
0.0	2.323	1.991	1.816	1.725	1.696	1.726	1.816

===== CRITICAL CIRCLES =====

	RADIUS (M)	XC (M)	YC (M)	F. OF S.
1	21.00	8.00	-4.00	1.668
2	23.00	8.00	-6.00	1.672
3	19.00	8.00	-2.00	1.673
4	21.00	10.00	-4.00	1.687
5	21.00	6.00	-4.00	1.687
6	23.00	10.00	-6.00	1.689
7	23.00	6.00	-6.00	1.690
8	19.00	6.00	-2.00	1.697
9	17.00	8.00	0.0	1.697
10	19.00	10.00	-2.00	1.697

IS THE NEXT PROBLEM A MODIFICATION OF THE PREVIOUS ONE?

+ INPUT DATA +

Y COORD OF TENSION CRACK = 0.000 (M)

POINTS DEFINING CROSS-SECTION (COORDINATES IN M)

X COORDINATE	Y COORDINATE
-30.000	0.0
16.000	8.000
50.000	8.000

SECTIONAL DETAILS

SECTION	X COORD	SOIL TYPE	Y COORD	WATER TABLE
	(M)		(M)	(M)
1	-30.00	1	0.0	10.00
		2	8.00	
		3	14.00	
		4	17.00	
2	50.00	1	0.0	10.00
		2	8.00	
		3	14.00	
		4	17.00	

SOIL PROPERTIES

SOIL TYPE	ANGLE OF	BULK	SUBMERGED	
(NO.)	COHESION (KPA)	SHEAR (DEG)	DENSITY (TNE/M3)	DENSITY (TNE/M3)
1	95.00	0.0	2.16	1.16
2	75.00	0.0	2.04	1.04
3	40.00	0.0	2.04	1.04
4	60.00	0.0	2.04	1.04

+ OUTPUT DATA +

FAILURE CIRCLE CENTERS WITH CORRESPONDING FACTORS OF SAFETY (COORDINATES IN M)

	0.0	2.00	4.00	6.00	8.00	10.00	12.00
-12.00	2.293	2.166	2.083	2.036	2.028	2.036	2.088
-10.00	2.884	2.143	2.054	2.002	1.986	2.002	2.052
-8.00	2.323	2.163	2.061	2.004	1.985	2.004	2.061
-6.00	2.342	2.158	2.043	1.979	1.959	1.979	2.042
-4.00	2.439	2.218	2.082	2.007	1.984	2.007	2.081
-2.00	2.576	2.318	2.151	2.061	2.032	2.061	2.150
0.0	2.789	2.499	2.271	2.157	2.122	2.158	2.271

CRITICAL CIRCLES

	RADIUS	XC	YC	F. OF S.
	(M)	(M)	(M)	
1	23.00	8.00	-6.00	1.959
2	23.00	10.00	-6.00	1.980
3	23.00	6.00	-6.00	1.980
4	21.00	8.00	-4.00	1.985
5	25.00	8.00	-8.00	1.986
6	27.00	8.00	-10.00	1.987
7	27.00	6.00	-10.00	2.003
8	27.00	10.00	-10.00	2.003
9	25.00	10.00	-8.00	2.005
10	25.00	6.00	-8.00	2.005

IS THE NEXT PROBLEM A MODIFICATION OF THE PREVIOUS ONE?

SETTLEMENT ANALYSIS - SOUTH ABUTMENT

WP 66-67-09

79-04-03

C.T. JOHNSON

PAGE 1 OF 3

CONDITIONS: GROUND EL 218.0

FILL EL. 225.4

FILL HEIGHT = 7.5 m

$\gamma'(\text{FILL}) = 21.2 \text{ kN/m}^3$

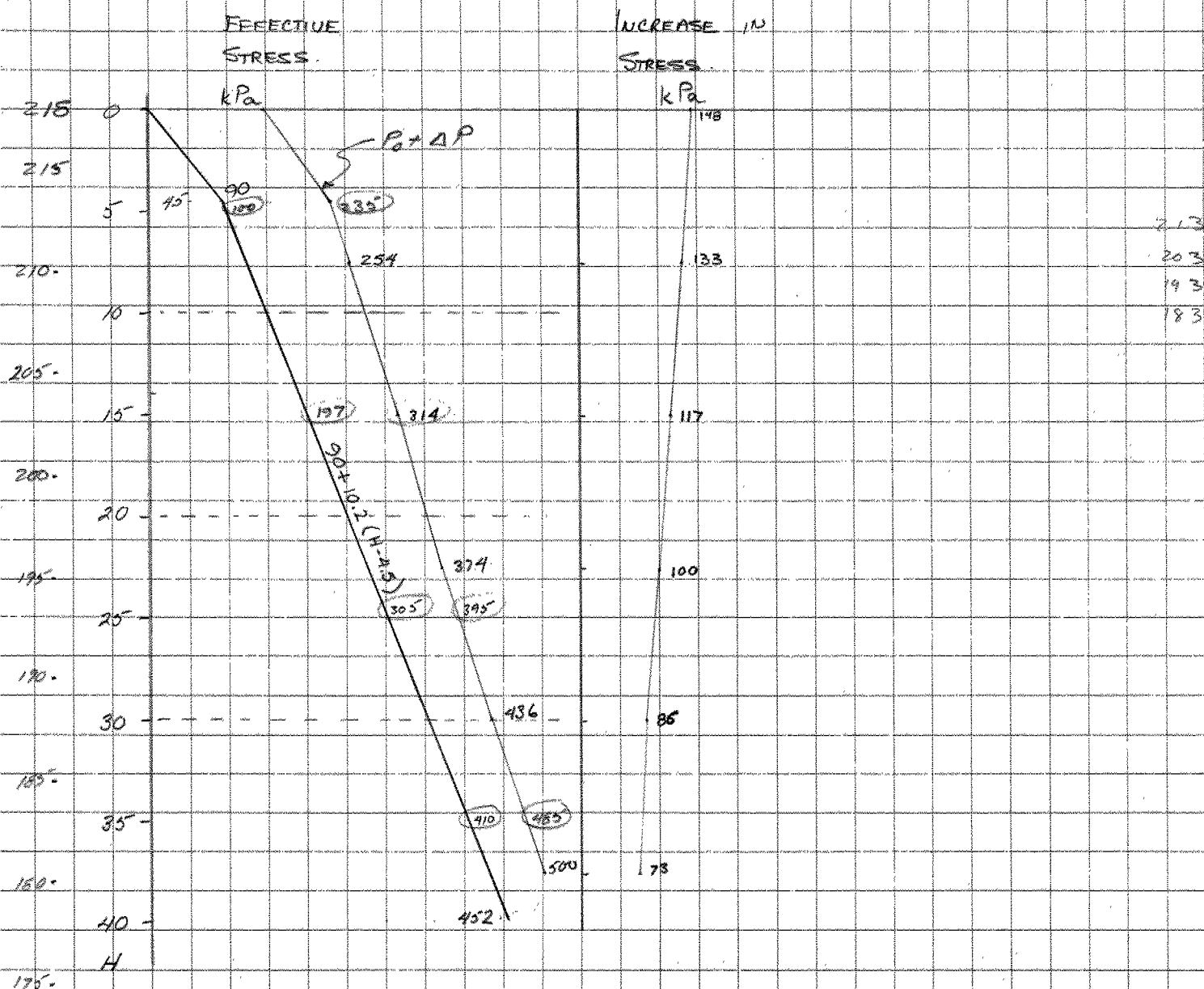
WIDTH OF FILL = 15 m @ 2:1 SLOPES

SETTLEMENT BASED ON B.H # 29

W/R @ 213.5 $\gamma = 20.0 \text{ kN/m}^3$ $\gamma' = 10.2 \text{ kN/m}^3$

B/R @ 177.2

PH-199



SETTLEMENT ANALYSIS - W.P. 66-67-090 TO 10 m $P_o = 100 \text{ kPa}$ $P_o + \Delta P = 235 \text{ kPa}$ EL. 213

BASED ON B.H. #28, S-5 EL. 214.2

$$e_o = 0.735 \quad AC + e_o = 0.706 \quad AC = 0.029$$

$$S = \frac{\Delta e}{1 + e_o} H = \frac{0.029}{1.735} 10,000 = 167 \text{ mm} \quad (CI) w = 28\%$$

BASED ON B.H. #7, S-5 EL. 212.6

$$e_o = .769 \quad AC + e_o = 0.749 \quad AC = 0.020$$

$$S = \frac{0.020}{1.769} 10,000 = 113 \text{ mm} \quad (CL) w = 29\%$$

BASED ON B.H. #7, S-6 EL. 210.5

$$e_o = 0.642 \quad AC + e_o = 0.630 \quad AC = 0.012$$

$$S = \frac{0.012}{1.642} 10,000 = 73 \text{ mm} \quad (CL) w = 24\%$$

BASED ON B.H. #29, S-8 EL. 209.7

$$e_o = 0.737 \quad C_o + AC = 0.727 \quad AC = 0.010$$

$$S = \frac{0.010}{1.737} 10,000 = 57 \text{ mm} \quad (CI) w = 27\%$$

BASED ON B.H. #7, S-8 EL. 208.3

$$e_o = 0.925 \quad C_o + \Delta e = 0.895 \quad AC = 0.030$$

$$S = \frac{0.030}{1.925} 10,000 = 156 \text{ mm} \quad (CL) w = 35\%$$

10-20 mm $P_o = 197 \text{ kPa}$ $\Delta P + P_o = 314 \text{ kPa}$ EL. 203

BASED ON B.H. #28, S-9 EL. 207.9

$$e_o = 0.775 \quad C_o + AC = 0.767 \quad AC = 0.008$$

$$S = \frac{0.008}{1.775} 10,000 = 45 \text{ mm} \quad (CL + CI) w = 28\%$$

BASED ON BH #26, S-13 EL. 200.4

$$e_0 = 0.642$$

$$\Delta C + e_0 = 0.632$$

$$\Delta C = 0.010$$

$$\delta = \frac{0.010}{1.642} 10,000 = 60 \text{ mm} \quad (\text{CL SOME CI}) w = 26\%$$

20-30 METRE DEPTH $P_0 = 305 \text{ kPa}$ $\Delta P + P_0 = 395 \text{ kPa}$ EL. 193.

BASED ON BH #7, S-15 EL. 197.3

$$e_0 = 0.6055$$

$$\Delta C + e_0 = 0.604$$

$$\Delta C = 0.0045$$

$$\delta = \frac{0.0045}{1.6055} 10,000 = 28 \text{ mm} \quad (\text{CL}) w = 29\%$$

BASED ON BH #26, S-15 EL. 194.0

$$e_0 = 0.580$$

$$\Delta C + e_0 = 0.547$$

$$\Delta C = 0.033$$

$$\delta = \frac{0.033}{1.580} 10,000 = 176 \text{ mm} \quad (\text{CI}) w = 38\%$$

30-40 METRE DEPTH $P_0 = 410$ $P_0 + \Delta P = 455 \text{ kPa}$ EL. 183

BASED ON BH #7, S-15 EL. 188.2

$$e_0 = 1.01$$

$$\Delta C + e_0 = 0.99$$

$$\Delta C = 0.02$$

$$\delta = \frac{0.02}{1.01} 10,000 = 198 \text{ mm} \quad (\text{CI-CH}) w = 42\%$$

SETTLEMENT SUMMARY

0-10 :	167 ; 113 ; 73 ; 57 ; 156	SAY	75 mm
10-20 :	45 ; 60	SAY	50 mm
20-30 :	25 ; 176	SAY	50 mm
30-40 :	198	SAY	25 mm
			200 mm

WP 66-67-09

79-04-02

SETTLEMENT - CONSOLIDATION TESTS

ELEV.	c_c	P_c (kPa)
207.9	0.7920	590
205.3	0.9650	≈ 340
209.7	0.7459	430
210.5	0.6600	364
212.6	0.7970	-
214.2	0.7722	530
197.3	0.6550	-
194.0	1.0637	455
188.2	1.183	709

SETTLEMENT ANALYSIS
WP 66-67-09

79-03-27
C.T. JOHNSON

BASED ON BH #25 CONSOLIDATION TESTS.

1)	219	TO	210	(9)	SAMPLE #	5	214.5	4.5
2)	210	TO	207	(3)	#	8	208.5	10.5
3)	207	TO	184	(23)	#	15	195.5	25.5

FILL \Rightarrow MAX. 8 METRES $AP = 21.2 \text{ kN/m}^3$

STRESS DISTRIBUTION - PURDUE METHOD. $L = 6.5 \text{ m}$, $H = 8$
 $\frac{L}{H} = \frac{6.5}{8} = 0.813$ 2:1 SIDE SLOPES

219 TO 210 1) $w/L @ 5.5 \text{ m}$

$$P_0 = (20 \times 4.5) = 90 \text{ kPa}$$

$$\frac{L}{H} = \frac{12.5}{8} = 1.6$$

$$\therefore \Delta \sigma_v = 0.77 (20 \times 8) = 123.2 \text{ kPa} \quad P_0 + \Delta \sigma_v = 213.2 \text{ kPa}$$

$$e_0 = 0.737 \quad e_0 + \Delta e = 0.710 \quad \Delta e = 0.027$$

$$\Delta H = \left(\frac{0.027}{1.737} \right) 9,000 = 140 \text{ mm}$$

10.2

$$2) \quad P_0 = (20 \times 5.5) + (20 - 9.8) 5 = 161 \text{ kPa}$$

$$\frac{L}{H} = \frac{18.5}{8} = 2.31$$

$$\therefore \Delta \sigma_v = 0.67 \times 160 = 107.2 \text{ kPa} \quad P_0 + \Delta \sigma_v = 268.2 \text{ kPa}$$

$$e_0 = 0.702 \quad e_0 + \Delta e = 0.679 \quad \Delta e = 0.023$$

$$\Delta H = \left(\frac{0.023}{1.702} \right) 3,000 = 40 \text{ mm}$$

$$3) \quad P_0 = \frac{161 + 10.2 (13.5)}{3.9} = 298.7 \text{ kPa}$$

$$\frac{L}{H} = \frac{31.5}{8} = 3.9$$

$$\therefore \Delta \sigma_v = 0.49 \times 160 = 78.4 \text{ kPa} \quad P_0 + \Delta \sigma_v = 298.7 + 78.4 = 377.1 \text{ kPa}$$

$$e_0 = 0.850 \quad e_0 + \Delta e = 0.830 \quad \Delta e = 0.020$$

$$\Delta H = \left(\frac{0.020}{1.850} \right) 23,000 = 245 \text{ mm}$$

$$\therefore \text{TOTAL SETTLEMENT} = 140 + 40 + 245 = 425 \text{ mm}$$

SETTLEMENT ANALYSIS

WP 66-67-09

REVISED ACCORDING TO

SCHMERTMANN

1) $\Delta \sigma_v = 123 \text{ kPa}$ $P_0 + \Delta \sigma_v = 90 + 123 = 213 \text{ kPa}$
 $e_0 = 0.772$ $e_0 + \Delta e = 0.757$ $\Delta e = .015$

$$\Delta H = \left(\frac{0.015}{1.772} \right) 9,000 = 76 \text{ mm}$$

2) SAMPLE 8

$P_0 = 161 \text{ kPa}$ $P_0 + \Delta \sigma_v = 267 \text{ kPa}$
 $e_0 = 0.746$ $e_0 + \Delta e = 0.737$ $\Delta e = .009$

$$\Delta H = \frac{0.009}{1.746} 3,000 = 15 \text{ mm}$$

SAMPLE 9

$P_0 = 161 \text{ kPa}$ $P_0 + \Delta \sigma_v = 267 \text{ kPa}$
 $e_0 = 0.792$ $e_0 + \Delta e = 0.78$ $\Delta e = 0.012$

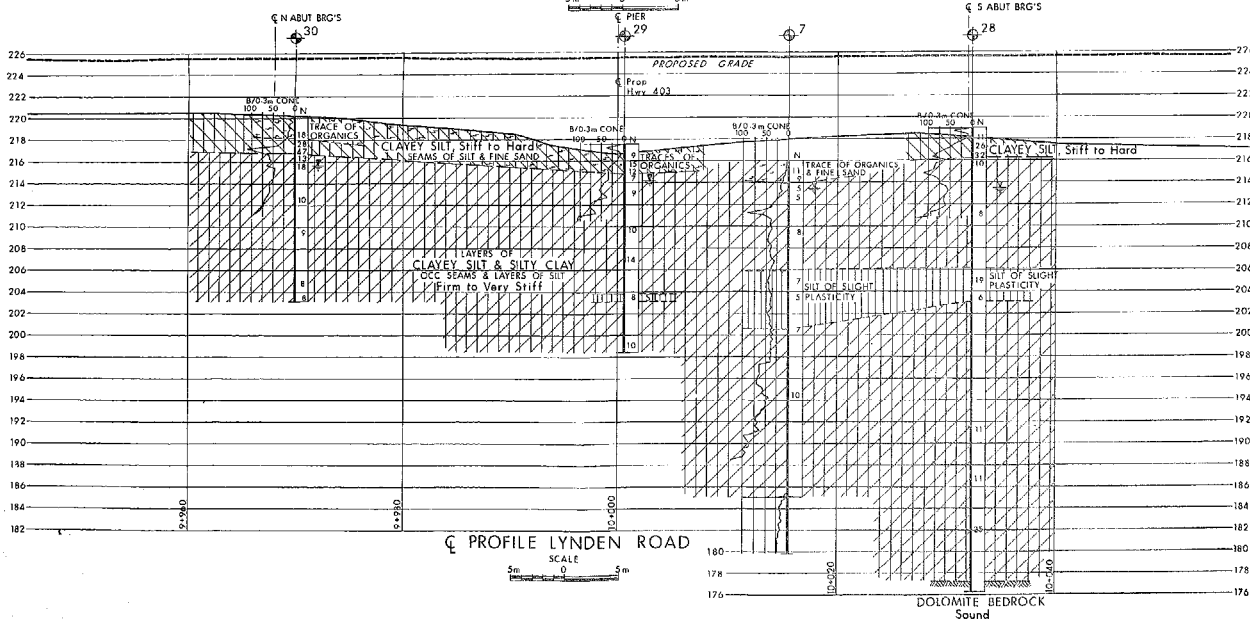
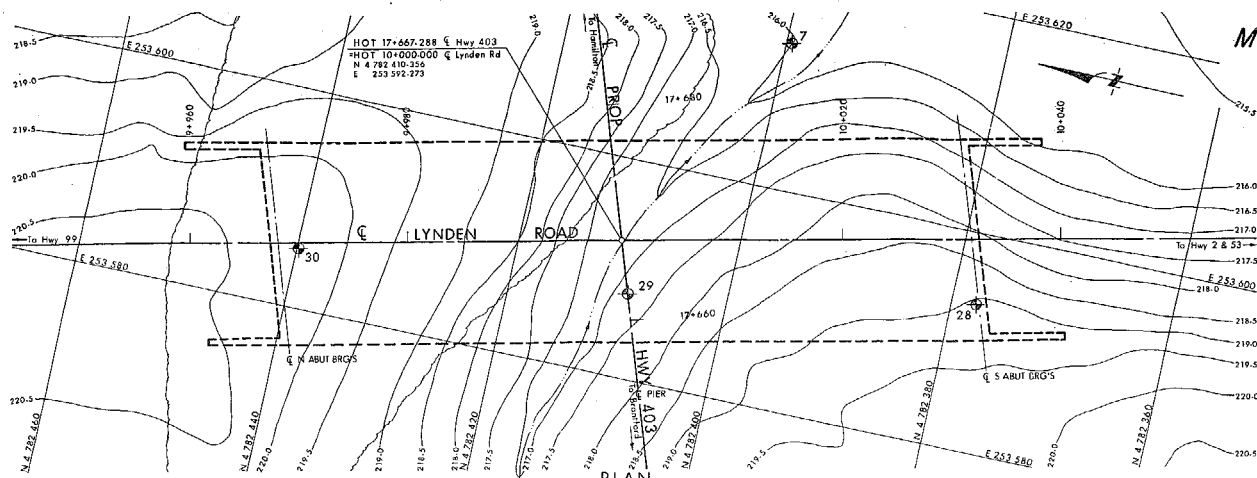
$$\Delta H = \frac{0.012}{1.792} 3,000 = 20 \text{ mm}$$

Ave = 17 mm

3) $P_0 = 299 \text{ kPa}$ $P_0 + \Delta \sigma_v = 377 \text{ kPa}$
 $e_0 = 1.0637$ $e_0 + \Delta e = 1.050$ $\Delta e = 0.0137$

$$\Delta H = \left(\frac{0.0137}{2.0637} \right) 23,000 = 152 \text{ mm}$$

8. TOTAL SETTLEMENT: $\Delta H = 76 + 17 + 152 = 245 \text{ mm}$
(REVISED)

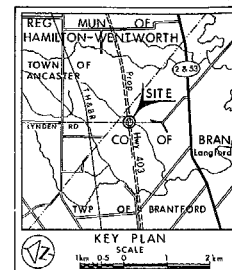


CONT No
 WP No 66-67-09

LYNDEN ROAD UNDERPASS
 (10.6 km West of Hwy 2 Ancaster)
 BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

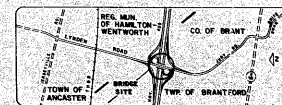
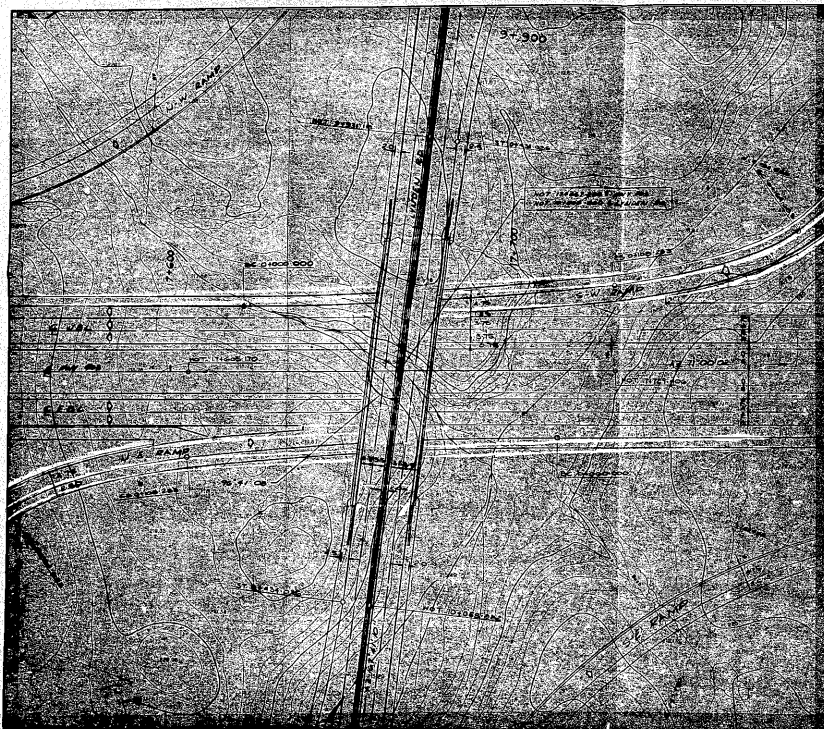
- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W/L at time of investigation 1979 01
- W/L for BH# 7, 1976 03 23

No	ELEVATION	CO-ORDINATES NORTH	EAST
7	216.0	4 782 399.5	253 613.5
28	219.0	4 782 377.8	253 593.5
29	217.5	4 782 409.0	253 587.7
30	220.3	4 782 439.9	253 585.4

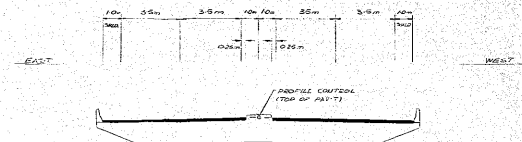
NOTE

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

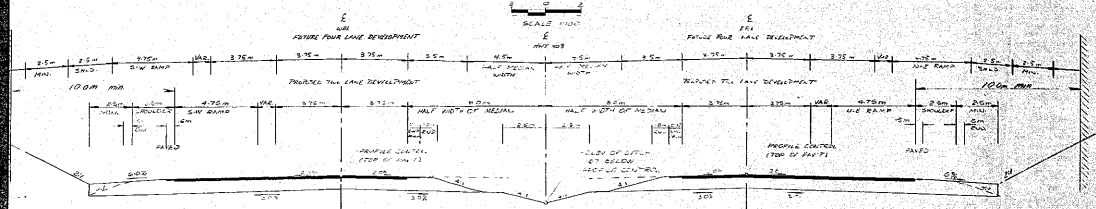
REVISIONS	
DATE	DESCRIPTION
Geocres No 40 P1-74	
Hwy No Prop 403	DIST 4
SUBMITTAL CHECKED	DATE 1979 03 20 SITE 1-182
DRAWN	CHECKED



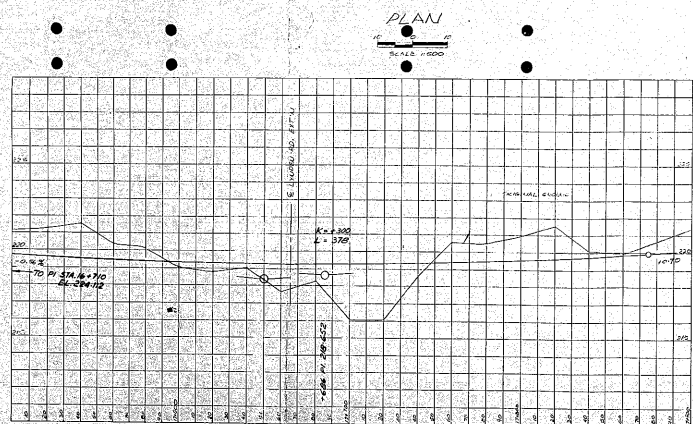
KEY PLAN



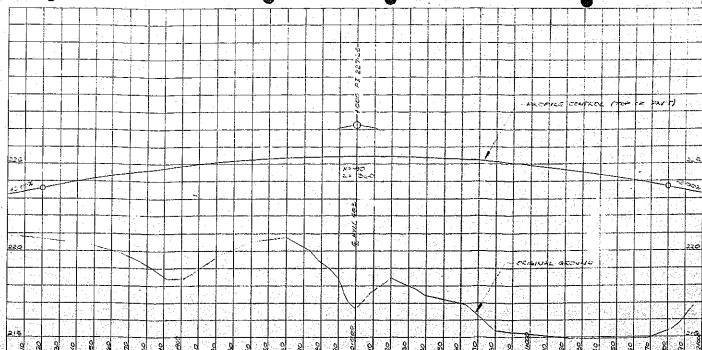
CROSS-SECTION THROUGH STRUCTURE



CROSS-SECTION THROUGH PROPOSED HIGHWAY NO 403



PROFILE - PROPOSED HIGHWAY 403



PROFILE - LYNDEN RD EXT N



NOTE: RAMP UP TO SW. BRIDGE 11.24.87

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

BRIDGE SITE

PROPOSED HWY 403

LYNDEN RD INT UNDERPASS

TOWN OF BRANTFORD BRANT COUNTY

SCALE: 1" = 100' DATE: 10/2/87

AS SHOWN: FEB 1979 10/2/87

DESIGNED: H. DEAN 10/2/87

BY: ELLIOT 7.4 6/2/87

MCCORMICK RANKIN
CONSULTING ENGINEERS

REVISION 1987-08-31 FUTURE FOUR LANE DEVELOPMENT
ADDED TO HWY 403 EBL 1.198

REVISION 1975-12-03 PROFILE OF HWY 403
(NO CHANGE TO ELEVATION AT STRUCTURE LOCATION) 3.04