

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-166

DIST. 6 REGION

W.P. No. 21-79-05

CONT. No. 84-45

W. O. No.

STR. SITE No. 24-343

HWY. No. 410

LOCATION Hwy 7 (Queen St.)
Brampton

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

METRIC

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

HWY. 7 UNDERPASS
(QUEEN ST.)
GENERAL ARRANGEMENT

SHEET

Giffels Giffels Associates Limited
Consulting Engineers

GENERAL NOTES

CLASS OF CONCRETE	
DECK, PIERS & SIDEWALKS	35 MPa
ABUTMENTS, WINGWALLS &	
BARRIER WALLS	30 MPa
REMAINDER	20 MPa

REINFORCING STEEL
REINFORCING STEEL TO BE GRADE 400 EXCEPT AS NOTED.
BAR MARKED WITH SUFFIX 'C' SHALL BE COATED BAR.

CLEAR COVER TO REINF. STEEL

FOOTINGS	---	100 ± 25
ABUTMENTS	FRONT FACE	80 ± 20
	BACK FACE	70 ± 20
PIERS	---	80 ± 20
DECK	TOP	70 ± 20
	BOTTOM	50 ± 10
REMAINDER	---	70 ± 10
OR AS NOTED ON DRAWINGS.		

CONSTRUCTION NOTES

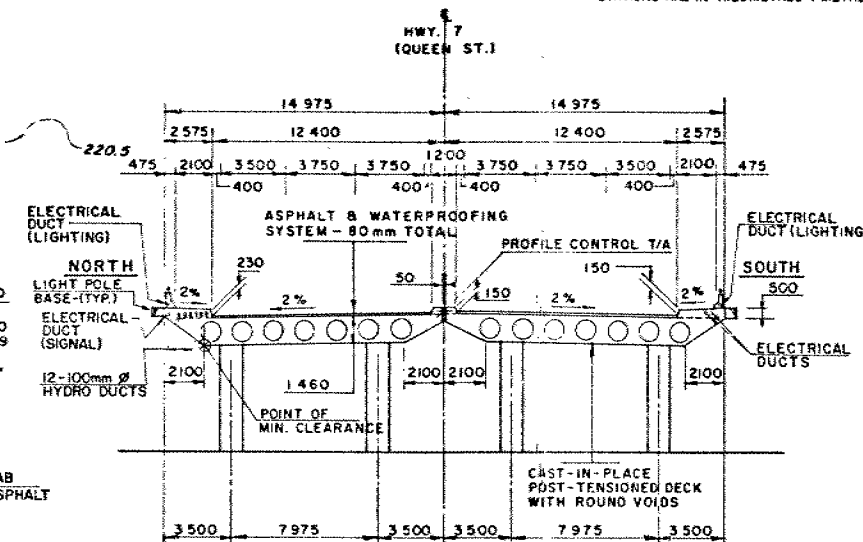
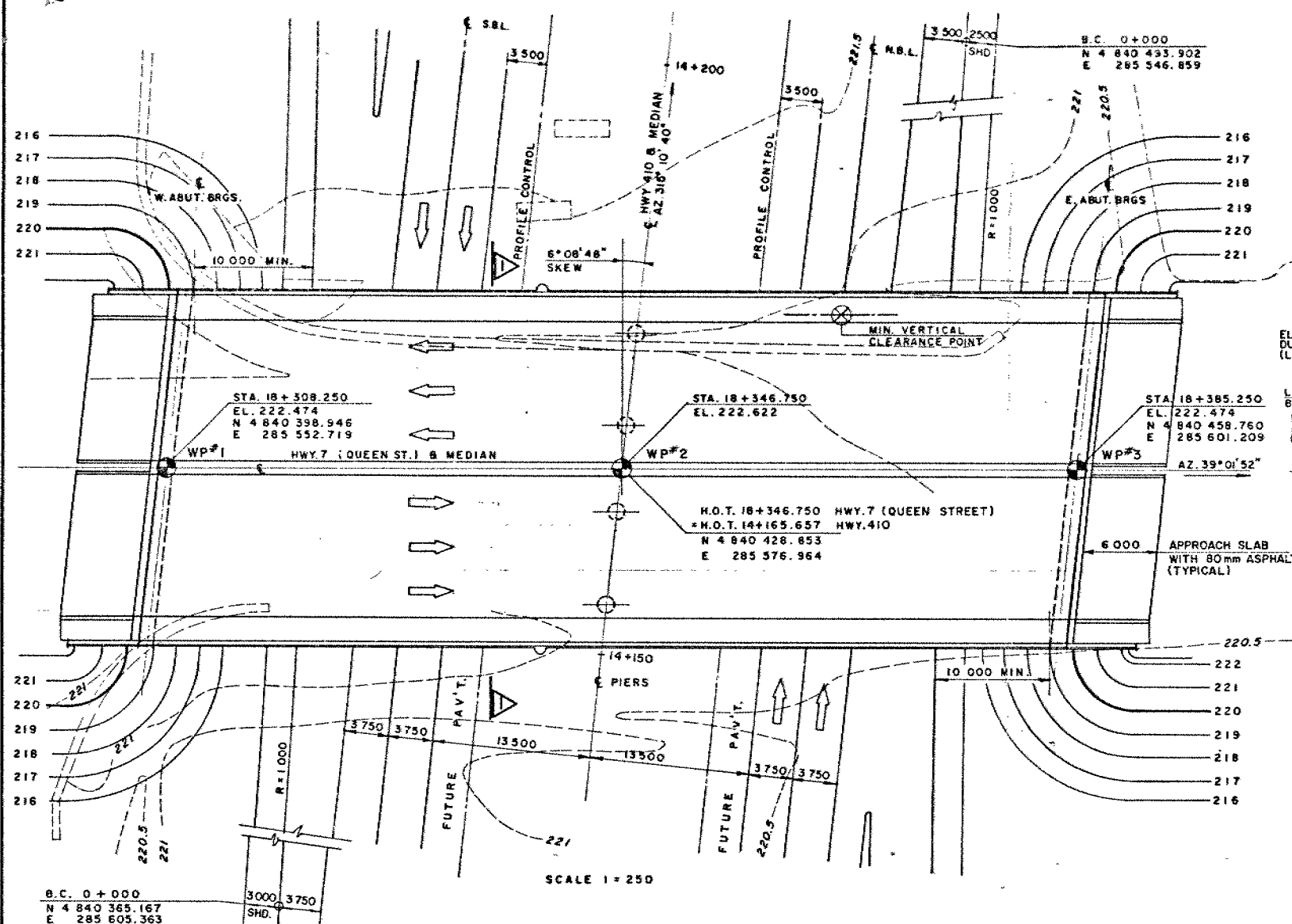
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 3\text{mm}$.
- THREE MONTHS AFTER STRESSING OPERATIONS HAVE BEEN COMPLETED THE DECK SHALL BE JACKED UP AT THE ABUTMENTS TO PERMIT THE BEARINGS TO RETURN TO THE VERTICAL POSITION. THE JACKING PROCEDURE SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO EXECUTION.

ABBREVIATIONS

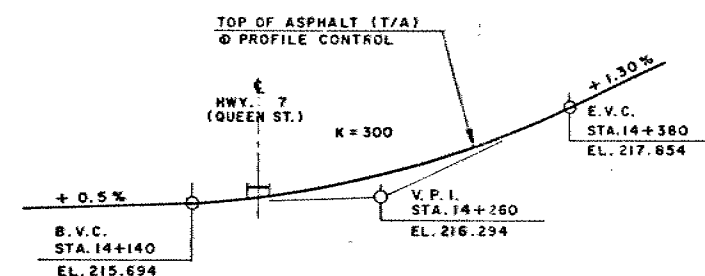
T/A DENOTES TOP OF ASPHALT PAVEMENT
E P DENOTES EDGE OF PAVEMENT.
WP DENOTES WORKING POINT

LIST OF DRAWINGS

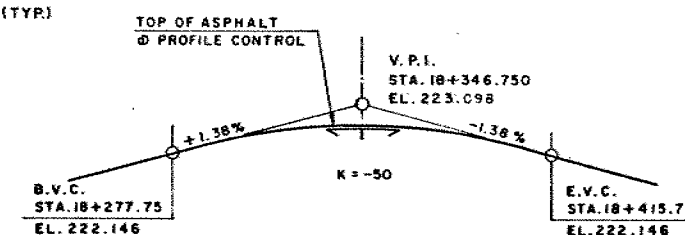
- 1 - GENERAL ARRANGEMENT
- 2 - BORE HOLE LOCATIONS & SOIL DATA
- 3 - FOUNDATION LAYOUT
- 4 - FOUNDATION DETAILS
- 5 - ABUTMENT DETAILS
- 6 - WING WALL DETAILS
- 7 - PIER DETAILS
- 8 - DECK LAYOUT
- 9 - LONGITUDINAL POST-TENSIONING
- 10 - TRANSVERSE POST-TENSIONING
- 11 - DECK REINFORCING I
- 12 - DECK REINFORCING II
- 13 - BARRIER WALL ON SIDEWALK
- 14 - RAILING FOR BARRIER WALL
- 15 - 6000 mm APPROACH SLAB
- 16 - EXPANSION JOINT
- 17 - DETAILS OF CONC. SLOPE PAVING
- 18 - AS CONSTRUCTED ELEV. & DIM.
- 19 - BRIDGE DATE & SITE NUMBER DATA
- 20 - EMBEDDED WORK (BRAMPTON H.E.C.)
- 21 - EMBEDDED WORK (LIGHTING)
- 22 - ELECTRICAL DETAILS
- 23 - QUANTITIES STRUCTURE
- 24 - QUANTITIES STRUCTURE



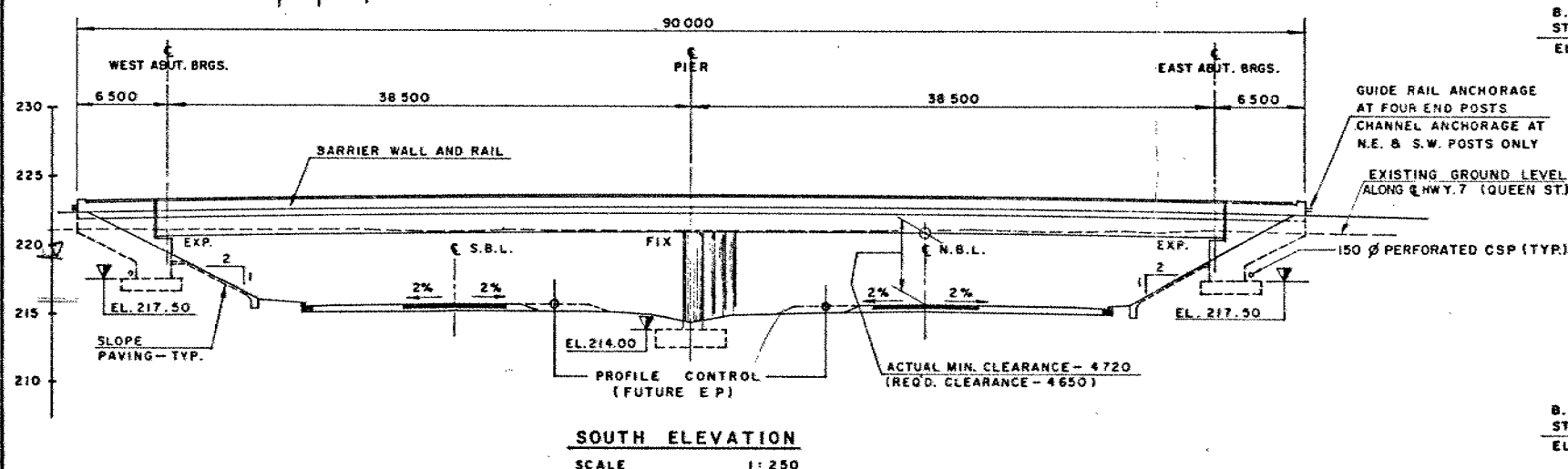
SCALE 1 : 200



PROFILE - HWY. 410
T/A AT PROFILE CONTROL
N.T.S.



PROFILE - HWY. 7 (QUEEN ST.)
T/A AT PROFILE CONTROL
N.T.S.



CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- | | | |
|--|----------|----------------------|
| 1 - CONCRETE IN PIERS, ABUTMENTS AND WINGWALLS | - 30 MPa | - 370 m ³ |
| | - 35 MPa | - 49 m ³ |
| 2 - PRESTRESSED CONCRETE BRIDGE DECK | - | 2 254 m ³ |
| 3 - CONCRETE IN BARRIER WALLS | - | 41 m ³ |
| 4 - CONCRETE IN APPROACH SLABS | - | 82 m ³ |
| 5 - CONCRETE IN SLOPE PAVING | - | 62 m ³ |

B.M. #1 ELEV. 222.742
N.S.W. IN N.W. ROOT OF 0.50 m
BLACK WALNUT - 150m RT. OF
STA. 14+306 HWY. 410

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REVISIONS	DATE		BY		DESCRIPTION
	DESIGN	Y R	CHECK	E P B	LOADING OHBDC-A79
	DRAWING	A W S	CHECK	Y R	SITE 24-145-143 DWG

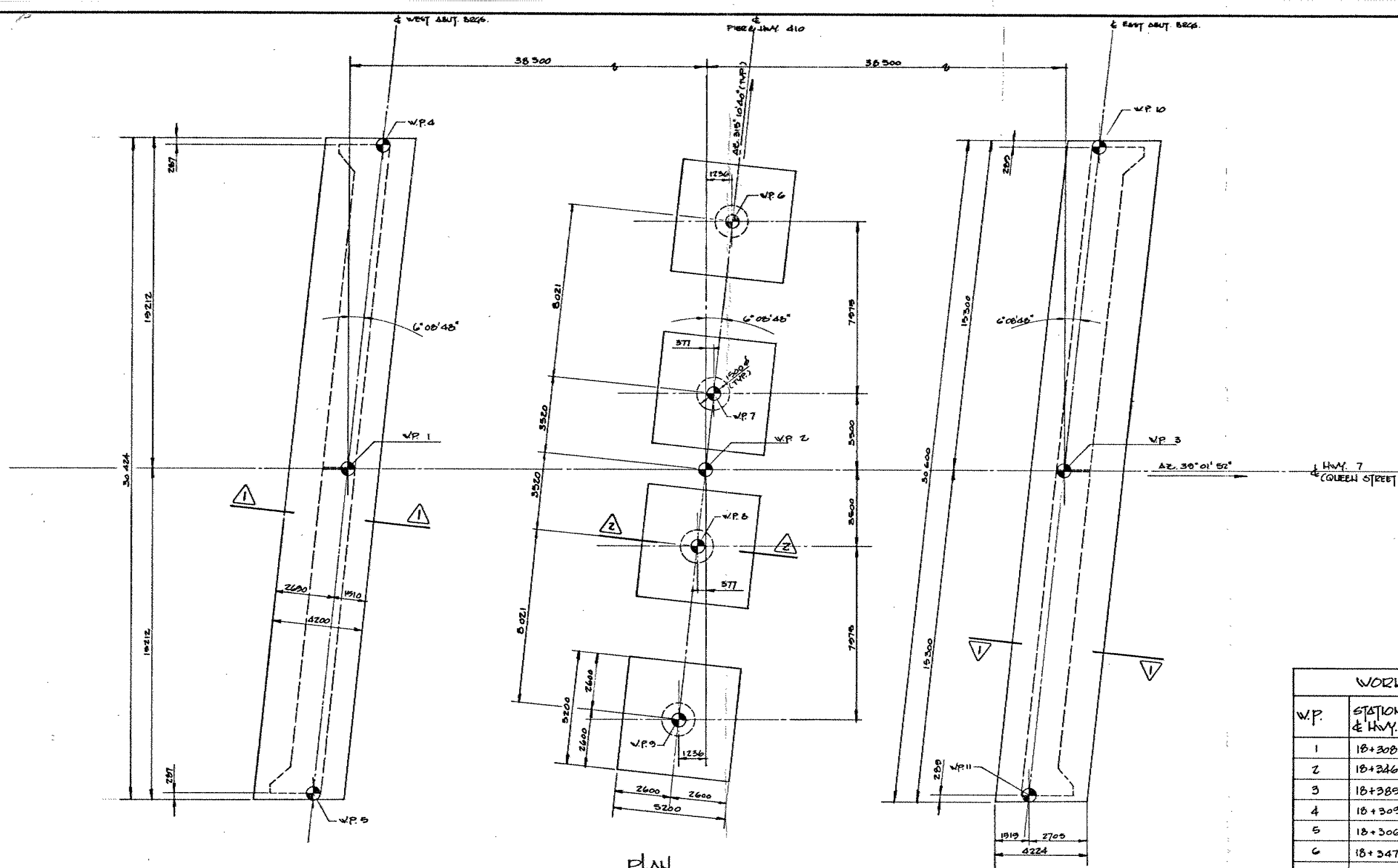
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Consulting Engineers

METRIC

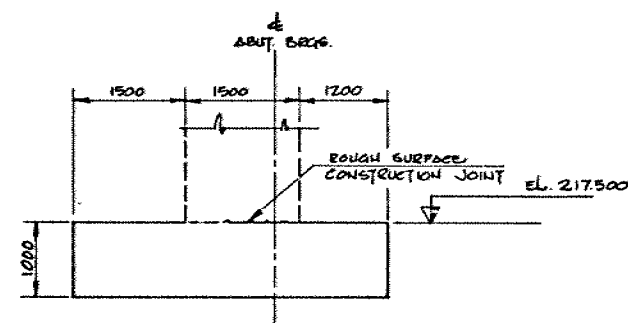
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STATIONS ARE IN KILOMETRES + METRES.

NOTES:

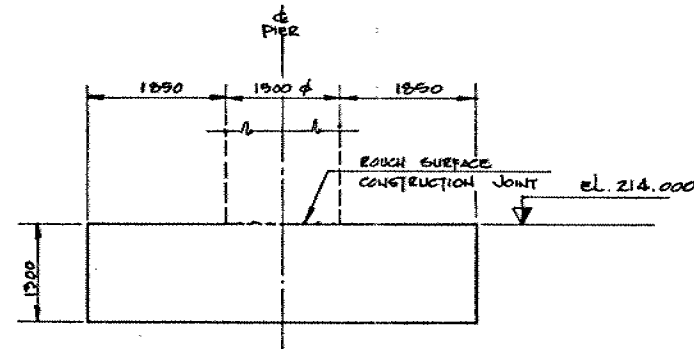
- FOR REINFORCING STEEL DETAILS SEE DWG. 13.4



PLAN
SCALE 1:100



SCALE 1:50




 SCALE 1:50

WORKING POINT DATA			
W.P.	STATION ST & HWY. 7	PROVINCIAL CO-ORDINATES	
		NORTH	EAST
1	18+308.250	4 840 338.946	285 552.719
2	18+346.750	4 840 428.853	285 576.964
3	18+383.250	4 840 458.760	285 601.209
4	18+309.857	4 840 409.593	285 542.133
5	18+306.642	4 840 388.299	285 563.300
6	18+347.986	4840 437.039	285 568.829
7	18+347.127	4840 431.350	285 574.483
8	18+346.373	4 840 426.356	285 579.445
9	18+345.514	4 840 420.667	285 585.099
10	18+386.857	4 840 469.407	285 590.628
11	18+383.643	4 840 448.113	285 611.790



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS						
	DATE	BY	DESCRIPTION			
DESIGN	Y.R.	CHECK	E.P.B	LOADING	DHBOC-479	DATE DEC. 62
DRAWING	A.W.S.	CHECK	Y.R.	SITE	24-145-343	DWG 3

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METRIC

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

NOTES:

- FOR FOUNDATION LAYOUT SEE DWG. NO. 3
- FOR COLUMN DETAILS SEE DWG. NO. 6.
- FOR WORKING POINT DATA SEE DWG. NO. 3

NOTE:

- * FOOTING REINFORCEMENT FOR BOTH ABUTMENTS SIMILAR, UNLESS OTHERWISE NOTED.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REV	REVISIONS		DESCRIPTION			
	DATE	BY	CHECK E.P.B.	LOADING	DATE	
1	DESIGN	Y.R.	CHECK E.P.B.	LOADING	08BDC-A-79	DEC. 8
	DRAWING	A.W.S.	CHECK Y.R.	SITE	24-145-343	DWG. 4



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 21-79-05

DIST 6

HWY 410

STR SITE 24-343

Queen Street (Hwy. 7) Underpass

DISTRIBUTION

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FOUNDATION INVESTIGATION REPORT

For

Queen Street (Hwy. 7) Underpass

W.P. 21-79-05 Site: 24-343

Hwy. 410, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks. The fieldwork was carried out between 74 01 29 and 74 02 14 under W.P. 134-73-02 and a subsequent Foundation Investigation Report issued on 74-04-08.

Six boreholes, four of which accompanied by a dynamic cone penetration test, were put down during the course of the field investigation. The borings and the penetration tests were advanced by means of a continuous flight auger machine adapted for soil sampling purposes for depths ranging from 15.7 to 16.6 metres. Bedrock was cored in all boreholes for a maximum depth of 2 metres.

Site Description and Geology

The site is located immediately east of the existing intersection of Queen St. (Hwy. 7) and Heart Lake Road, in the City of Brampton, Municipality of Peel.

Land use in the area has recently changed from predominately farming to industrial subdivision development. Topography across the site is generally flat with ground surface sloping gently towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is a ground moraine composed of cohesive glacial till, laid down during the Wisconsinian glacial age. Deposits of silt and sand are often found interbedded within the till.

Subsurface Conditions

Although variable in composition, generally competent subsurface conditions were encountered across the site.

The predominant stratum encountered at the site is a cohesive deposit of stiff to hard silty clay with sand and gravel. At three boring locations, this stratum is overlain by fill material of up to 1.5 m thick. The surficial cohesive deposit is followed by a granular deposit ranging from silt to silty sand, which is in turn underlain by a heterogeneous mixture of silty clay, sand and gravel of glacial origin. The overburden is followed by limestone bedrock.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile and three estimated soil stratigraphical sections based on borehole data, are shown on Drawing No. 217905-A.

The various soil types encountered are briefly described in the following paragraphs.

Fill Material

Roadway fill material was encountered at three boring locations (B.H.'s 2, 3 and 4). The fill material was composed of silty clay of low plasticity with sand and gravel at two boreholes. At B.H. #3, it is a silty sand with traces of gravel. The thickness of the fill material was found to be 1.5 m at all three boreholes. Standard Penetration Testing carried out within this stratum gave 'N' values ranging from 9 to 18 blows per 0.3 metres. Based on these values, it is estimated that the fill material has been moderately compacted.

Silty Clay, with Sand and Gravel

This is the predominant stratum which was encountered immediately below the ground surface or directly under the fill material where it

exists. The thickness of this deposit ranges from 2.2 m at B.H.#3 to 9.8 m at B.H.#4. Random thin seams of silt and sand are present within this deposit. At B.H.#4, the upper 2.1 m of this deposit consists of alternate layers of silty sand and silty clay.

Grain-size distribution tests were performed on the samples obtained from the cohesive portion of this deposit. The results are summarized on Fig. #2 in envelope form.

Atterberg Limit tests were carried out on the cohesive portion of the samples obtained. The results, which are plotted on the Record of Borehole Sheets and the Plasticity Chart (Fig.#1), are summarized in tabulated form as below.

			Range
Liquid Limit	(W _L)	%	16-34
Plastic Limit	(W _p)	%	12-20
Natural Moisture Content	(W)	%	8-18

Based on these values, it may be estimated that the cohesive deposit is an inorganic silty clay of low plasticity (CL).

Standard Penetration testing carried out within this deposit gave 'N' values ranging from 14 to in excess of 100 blows per 0.3 metres. It is estimated that the consistency of this deposit varies between stiff to hard.

Granular Deposits - Silts and Sands:

Directly underlying the silty clay deposit is a granular deposit, whose composition ranges from silt with some sand to sand with some silt and a trace to some gravel. The thickness of this granular deposit varies between 3.3 m (B.H.#1) and 8.2 m (B.H.#2). The results of the grain-size distribution testing carried out on samples recovered from this deposit are presented on Fig.#3. Standard Penetration Testing was carried out within this stratum. This testing gave 'N' values ranging from 37 to in excess of 100 blows per 0.3 metres. The relative density of this deposit is therefore estimated to be varying from dense to very dense.

Silty Clay, Sand, and Gravel (Glacial Till)

This deposit of glacial origin was encountered at all boring locations except at B.H. #2. It is composed of a heterogeneous mixture of silty clay, sand and gravel. Its thickness ranges from 0.9 m (B.H.#3) to 5.9 m (B.H.#1). Typical grain-size distribution curves are shown on Fig.#4. From a limited number of Atterberg limit tests, it is estimated that the glacial till has a matrix which is an inorganic silty clay of low plasticity (CL). Standard Penetration testing gave 'N' values of in excess of 100 blows per 0.3 metres. Based on these values, it is estimated that the consistency of the glacial till is hard.

Bedrock

Bedrock was proven at all boring locations by obtaining 1.1 to 2.0 metres of BXL size rock core. Rock surface elevations varied from 205.6 to 206.9 corresponding to depths of 14.6 to 13.9 metres respectively. Rock is described as a good quality limestone showing signs of minor fracturing.

Groundwater Conditions

Groundwater conditions were observed by recording the water levels in the open boreholes during the course of the field investigation. The observations indicated that the groundwater table within the overburden varied between elevations 218.7 and 220.5 corresponding to levels from 1.5 to 0.5 m below the ground surface at the time of investigation.

DISCUSSION AND RECOMMENDATION

In order to carry Queen Street (Hwy.7) over the proposed Highway 410, a two span 38 m - 38 metre underpass structure some 30 metres wide is contemplated. Design requires a depressed grade for Hwy.410, with a top of pavement elevation of approximately 215.5 at the proposed crossing, necessitating cuts in the order 6 metres and approach fills of 2 metres.

In consideration of the variable but competent subsoil conditions across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as follows.

Perched Abutments

Foundations for perched abutments can be supported on spread footings founded within the stiff to hard silty clay deposit at or below elevation 219.0. The front face of the footings should be at least 3 metres behind the forward slope surface. Perched footings so founded may be designed using a factored capacity at the U.L.S. of 750 kPa and a capacity at the S.L.S. Type II of 400 kPa. In determining the sliding resistance between the base of the concrete footing and the underlying silty clay, an adhesion value of 100 kPa is recommended.

The excavation for the footings will be carried out within the cohesive silty clay. No major dewatering problems are anticipated since this deposit is relatively impervious. Any minor inflow into the excavation from sources such as water bearing granular seams within the silty clay deposit, can be handled using techniques such as pumping from sumps.

Earth pressures against the abutment walls should be computed as per Subsection 6.6.1.2.2 of the O. H. B. D. C. Manual with provisions made for adequate drainage behind the abutment.

Provided backfill to the abutments consists of free draining granular material and adequate provisions are made for an appropriate drainage scheme, the following equivalent fluid pressures may be assumed for computation of earth pressures.

- a) At ultimate limit state
 - active condition 8.0 kPa/m
 - at rest condition 10.0 kPa/m
- b) At serviceability limit state
 - active condition 6.5 kPa/m
 - at rest condition 8.5 kPa/m

The underside of all footing elements should be provided with a minimum 1.3 metres of earth cover for frost protection purposes.

A constraint on the use of heavy vibratory equipment within a restricted distance to the back of the abutment wall should be included as per current MTC directives.

Pier Foundations

Pier elements can be supported on shallow spread footings founded within the competent overburden. In consideration of the cut grade elevation for Hwy.410, spread footings should be located at or below elevation 214.0 for a factored capacity at the U.L.S. of 850 kPa and a capacity at the S.L.S. Type II of 450 kPa. At this founding elevation, subsoils consist of very dense silts and sands at the southern portion of the pier and hard silty clays with sand and gravel at the northern portion.

The base of the pier footing will be located well below the groundwater level recorded during the time of the investigation. In this regard it is recommended that the foundation elements be constructed only after the Hwy.410 cut has been advanced and the permanent drainage system installed. This provision would lower the prevailing groundwater level at this location. The excavation will then be some 1.3 metres below the ground surface. Any surficial runoff and in flow emanating from the granular subsoil could be controlled using techniques such as pumping from sumps.

The settlement of the footing will be negligible in magnitude provided the foundation subsoil is not loosened or softened by the construction operations or uncontrolled surface runoff. In this regard it would be advantageous to cover the foundation subsoil with a working mat of lean concrete as soon as the footing level is reached.

Earthwork Considerations

As mentioned previously, the maximum depth of the Hwy. 410 cut section, in the vicinity of the proposed structure, will be of the order of 6 metres. The excavation will be carried out within the cohesive silty clay stratum. At certain locations, however, it would extend into the underlying granular deposit of silts and sands. The base of the cut will extend well below the groundwater level as recorded during the field investigation. To ensure the stability of the base of the excavation and the future performance of the pavement section, it will be necessary to lower the groundwater level permanently. This may be accomplished by installing at the toes of the cut slopes, a drainage system consisting of a perforated subdrain of adequate capacity. This subdrain should be located at least 1.3 metres below the finished grade and be connected to the nearby storm sewer, so that continuous flow can be maintained. In addition, the size of the subdrain should be such that it can handle the surficial runoff as well.

A cut of the depth contemplated will be inherently stable with respect to a deep seated failure within the subsoil, provided 2:1 slopes are employed. The cut slopes will have to be protected against erosion caused by uncontrolled surficial runoff. This may be accomplished by sodding the slopes.

Temporary cut slopes within the silty clay will stand at a 1:1 geometry, however, these slopes will weather rapidly and show signs of surficial distress if not protected in a reasonable length of time.

Up to 2.0 metres of fill will be required along the approaches to the structure (along Hwy.#7). The approaches will be inherently stable both in the longitudinal and transverse directions provided that

- i) 2:1 slopes are employed
- ii) the fill is properly compacted.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. V. Korlu, Project Engineer, utilizing equipment owned and operated by P.V.K. and Sons Drilling Co. Ltd., Burford.

The original foundation investigation report issued under W.P. 134-73-02 was prepared by Mr. C. S. Poon, Project Engineer.

This revised report was written by Mr. T. J. Kazmierowski, Foundations Engineer and reviewed by Mr. M. Devata, Senior Foundations Engineer.



A handwritten signature in black ink, appearing to read 'Tom Kazmierowski', written over the printed name and title.

T. J. Kazmierowski, P. Eng.
Foundation Engineer

A handwritten signature in black ink, appearing to read 'M. Devata', written over the printed name and title.

M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X



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Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 385.5; E 285 567.7 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74 01 29 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100
								SHEAR STRENGTH							WATER CONTENT (%)		
							○ UNCONFINED + FIELD VANE										
							● QUICK TRIAXIAL x LAB VANE										
221.1	Ground Surface													GR SA SI CL			
0.0	Silty Clay of low plasticity with Sand and Gravel Very Stiff to Hard		1	SS	17		220							22 25 41 12			
			2	SS	47												
			3	SS	128												
			4	SS	146/		28 cm								0 31 55 14		
			5	SS	100/		13 cm										
215.9			6	SS	100/		20 cm										
5.2	Grey Silt Some Sand Very Dense		7	SS	100/	13 cm	216							0 23 76 1			
212.6	Grey (Glacial Till) Silty Clay, Sand and Varying amounts of Gravel Hard		8	SS	106		214										
8.5			9	SS	100/	8 cm	212										
			10	SS	108/	15 cm	210										
			11	SS	100/	5 cm								14 35 41 10			
206.6			12	SS	100/	5 cm	208										
14.5	Limestone Bedrock		13	RC BXL	92% REC		206										
204.6																	
16.5	End of Borehole																

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

OFFICE REPORT ON SOIL EXPLORATION



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RECORD OF BOREHOLE No 2

METRIC

W P 21-79-C5 LOCATION Co-ords. N 4 840 413.9; E 285 540.3 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Ceodetic DATE 74 02 11 CHECKED BY *[Signature]*

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						
221.4	Ground Level													
0.0	Silty Clay-low plasticity with Sand & Gravel & Trace of Organics (Fill) Stiff		1	SS	14		220							19 24 47 10
219.9	Brown Silty Clay of low Plasticity with Sand Hard		2	SS	46									0 38 52 10
1.5			3	SS	82									0 28 54 18
			4	SS	105									0 81 (19)
			5	SS	150	25 cm	218							17 59 (24)
			6	SS	128	28 cm	216							
215.0	Grey Silty Sand with some Gravel Very Dense		7	SS	124		214							
6.4			8	SS	163		212							
			9	SS	125	20 cm	210							
			10	SS	191	23 cm	208							
206.6	Limestone Bedrock Partly Fractured		11	BXL RC	75% REC		206							
14.6			12	BXL RC	76% REC									
204.8	End of Borehole													
16.6														

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



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RECORD OF BOREHOLE No 3

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 411.8 E 285 599.1 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74 02 07 CHECKED BY [Signature]

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			WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								W _p W W _L					
220.8	Ground Level																				
0.0	Silty Sand with Trace of Gravel		1	SS	18		220														
219.3	(Fill) Compact		2	SS	14										16 31 38 15						
1.5	Silty Clay of Low Plasticity		3	SS	44																
	Some Sand and Gravel		4	SS	93		218								0 22 53 25						
217.1	Stiff to Hard Brown		5	SS	57																
3.7	Grey		6	SS	98		216								0 5 95 0						
	Silty Sand with occasional layers of silt		7	SS	119										0 64 (36)						
			8	SS	142/28 cm		214														
			9	SS	46		212														
211.0	Very Dense		10	SS	100/13 cm		210														
9.8	Grey (Glacial Till)		11	SS	100/10 cm										47 36 (17)						
	Silty Clay, Sand varying am'ts of Gravel						208														
206.9	Hard																				
13.9	Limestone		12	BXL RC	70% REC		206														
205.1	Bedrock		13	BXL RC	100%																
15.7	End of Borehole																				

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



Ministry of
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RECORD OF BOREHOLE No 4

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 441.0 E 285 570.8 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74-02-13 CHECKED BY *[Signature]*

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					
221.0	Ground Level																GR SA SI CL
0.0	Silty Clay with Seams of Sand and Gravel																
219.5	(Fill) Stiff		1	SS	9		220										0 57 (43)
1.5	with alter- nating layers of Silty Sand		2	SS	43												0 42 45 13
			3	SS	77		218										
	Brown Grey		4	SS	124												
			5	SS	145	23 cm											
	Silty Clay of Low Plasticity with Sand varying am'ts of Gravel		6	SS	88		216										
			7	SS	172	20 cm	214										37 18 29 16
			8	SS	100	15 cm											
	Hard		9	SS	100	15 cm	212										14 30 42 14
209.7							210										
11.3	Silty Sand, Trace to Some Gravel		10	SS	172	25 cm											
	Very Dense		11	SS	100	15 cm	208										0 52 42 6
206.7																	
14.3	(Glacial Till) Silty		12	SS	100	10 cm	206										
205.8	Clay, Sand and Gravel																
15.2	Hard		13	BXL	70%												
204.2	Limestone Bedrock Partly Fractured		14	BXL RC	80%												
16.8	End of Borehole																

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



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 447.1; E 285 617.1 ORIGINATED BY V.K.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74 01 29 CHECKED BY *ep*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100/28 cm	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
220.2	Ground Level												
0.0	Brown		1	SS	45		220						
	Silty Clay of Low Plasticity With Sand and Gravel		2	SS	117		218		100/28 cm				0 41 46 13
			3	SS	100	15 cm							
216.4	Hard		4	SS	135	25 cm							0 23 65 12
3.8			5	SS	118	25 cm	216						3 27 54 16
	Silty Sand With Occ. Layers of Silt		6	SS	159	25 cm							
	Dense to Very Dense		7	SS	37		214						0 85 (15)
	Brown		8	SS	113		212						
	Grey												
	Some Gravel		9	SS	166		210						22 54 (24)
			10	SS	100	15 cm							
208.3							208						
11.9	Grey (Glacial Till)		11	SS	100	8 cm							
	Silty Clay, Sand, Vary- ing Amt's of Gravel						206						
205.6	Hard												
14.6	Limestone Bedrock		12	BXL RC	67% REC		204						
203.7	Partly Fractured		13	BXL RC	67% REC								
16.5	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications

RECORD OF BOREHOLE No 6

METRIC

W P 21-79-05 LOCATION Co-ords. N 4 840 472.7 E 285 592.4 ORIGINATED BY V.R.
DIST 6 HWY 410 BOREHOLE TYPE Continuous Flight Auger - BXL Core COMPILED BY R.Z.
DATUM Geodetic DATE 74-02-14 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
220.7	Ground Level													GR SA SI CL
0.0	Silty Clay of Low Plasticity with varying am'ts of Sand and Gravel		1	SS	47		220							0 5 85 10
			2	SS	47									20 36 36 8
			3	SS	62		218	100/25 cm						
			4	SS	142									
	Brown Grey		5	SS	190									
	Hard						216							0 16 52 32
214.6			6	SS	172									
6.1	Grey						214							
	Silty Sand		7	SS	150									
	Trace of Gravel													
	Very Dense		8	SS	163	25 cm	212							0 75 (25)
			9	SS	173		210							
			10	SS	160	23 cm								
207.9							208							45 36 (19)
12.8	Grey (Glacial Till)		11	SS	100	13 cm								
	Silty Clay, Sand and Gravel													
206.1	Hard						206							
14.6	Limestone Bedrock		12	BXL	60%									
205.0	Partly Fractured			RC										
15.7	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
0 (%) STRAIN AT FAILURE



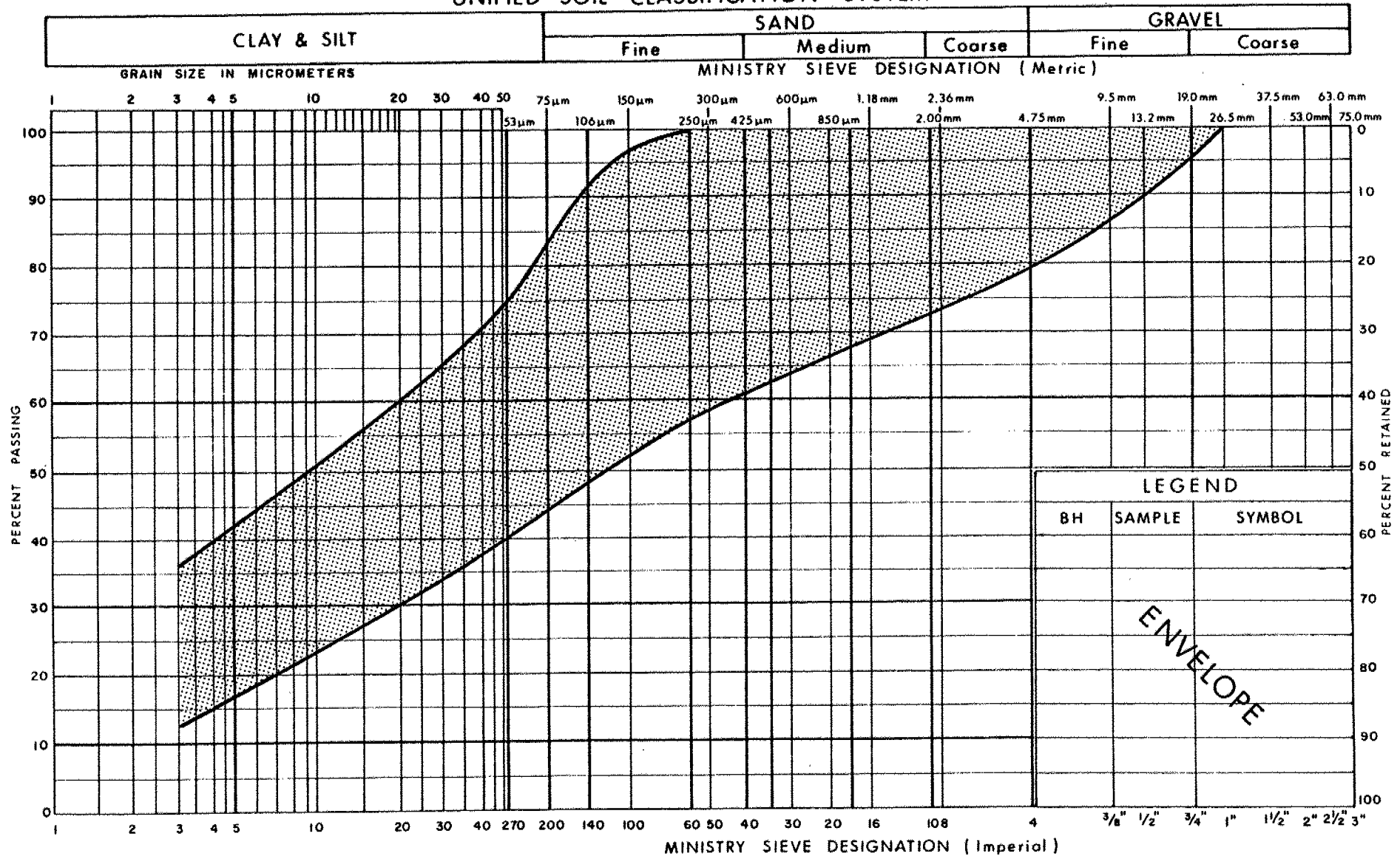
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PLASTICITY CHART

SILTY CLAY, WITH SAND & GRAVEL

W P 21-79-05

UNIFIED SOIL CLASSIFICATION SYSTEM



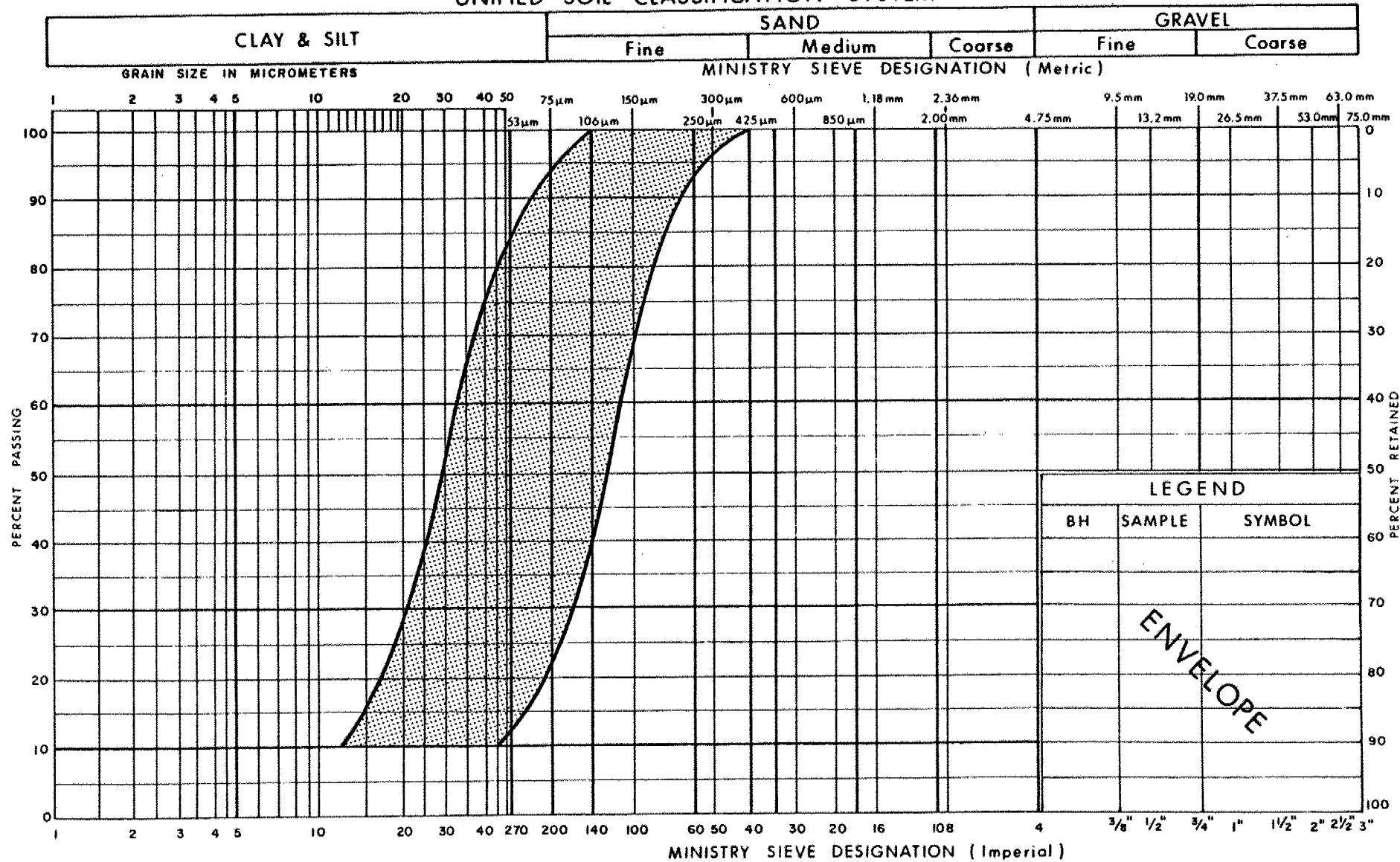
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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY (OF LOW PLASTICITY)
WITH SAND & GRAVEL

FIG No 2

W P 21-79-05

UNIFIED SOIL CLASSIFICATION SYSTEM



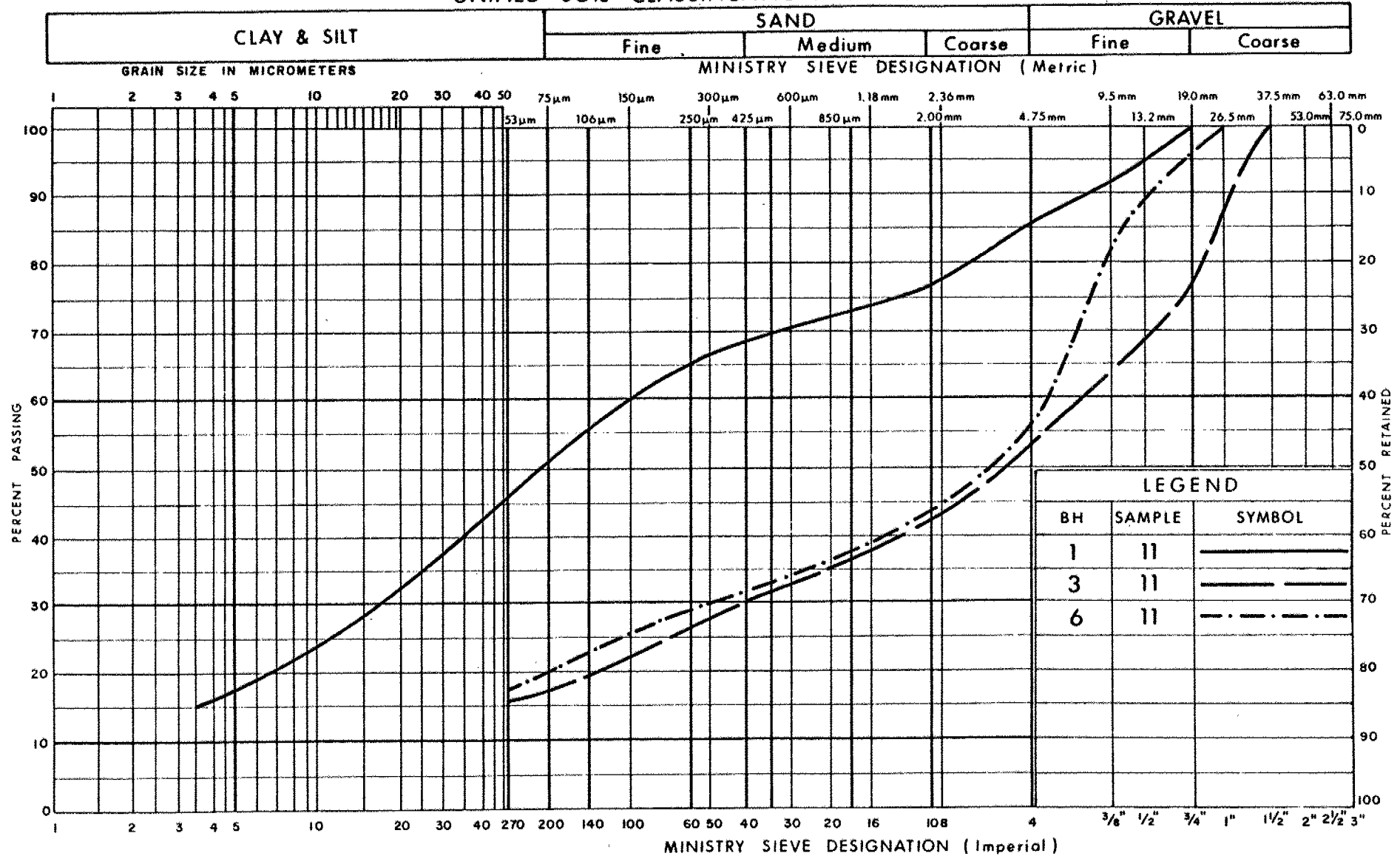
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GRAIN SIZE DISTRIBUTION
SILTY SAND

FIG No 3

W P 21-79-05

UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 4

WP 21-79-05

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

STRESS AND STRAIN

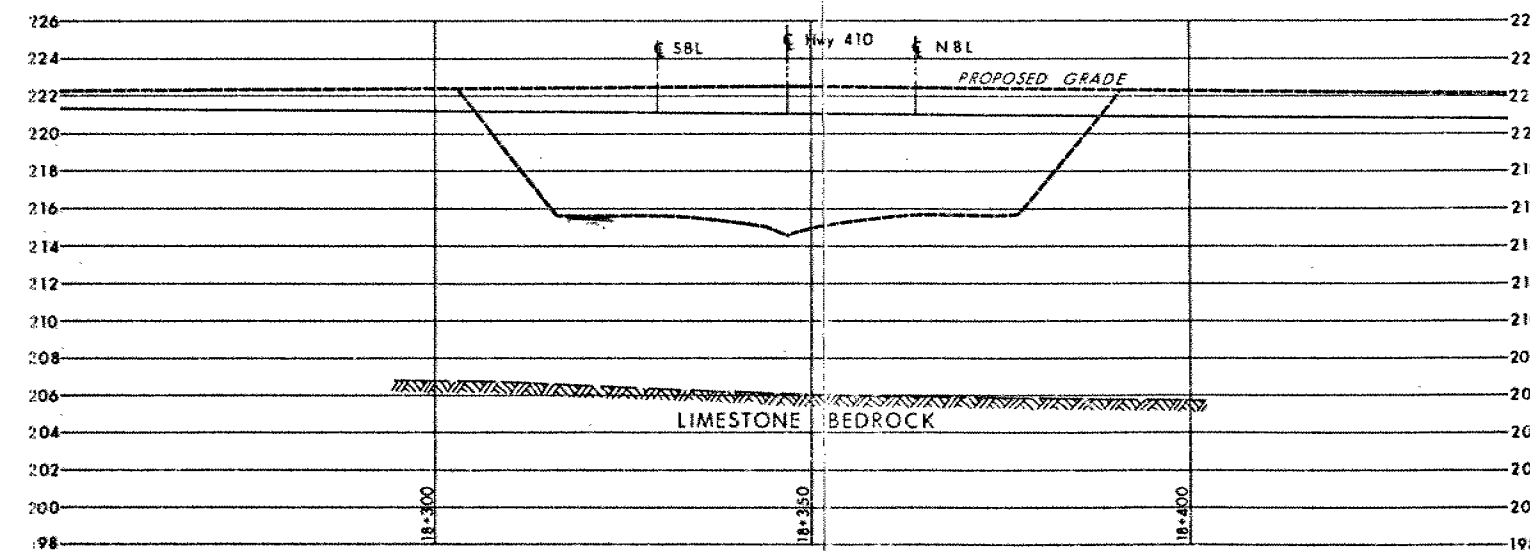
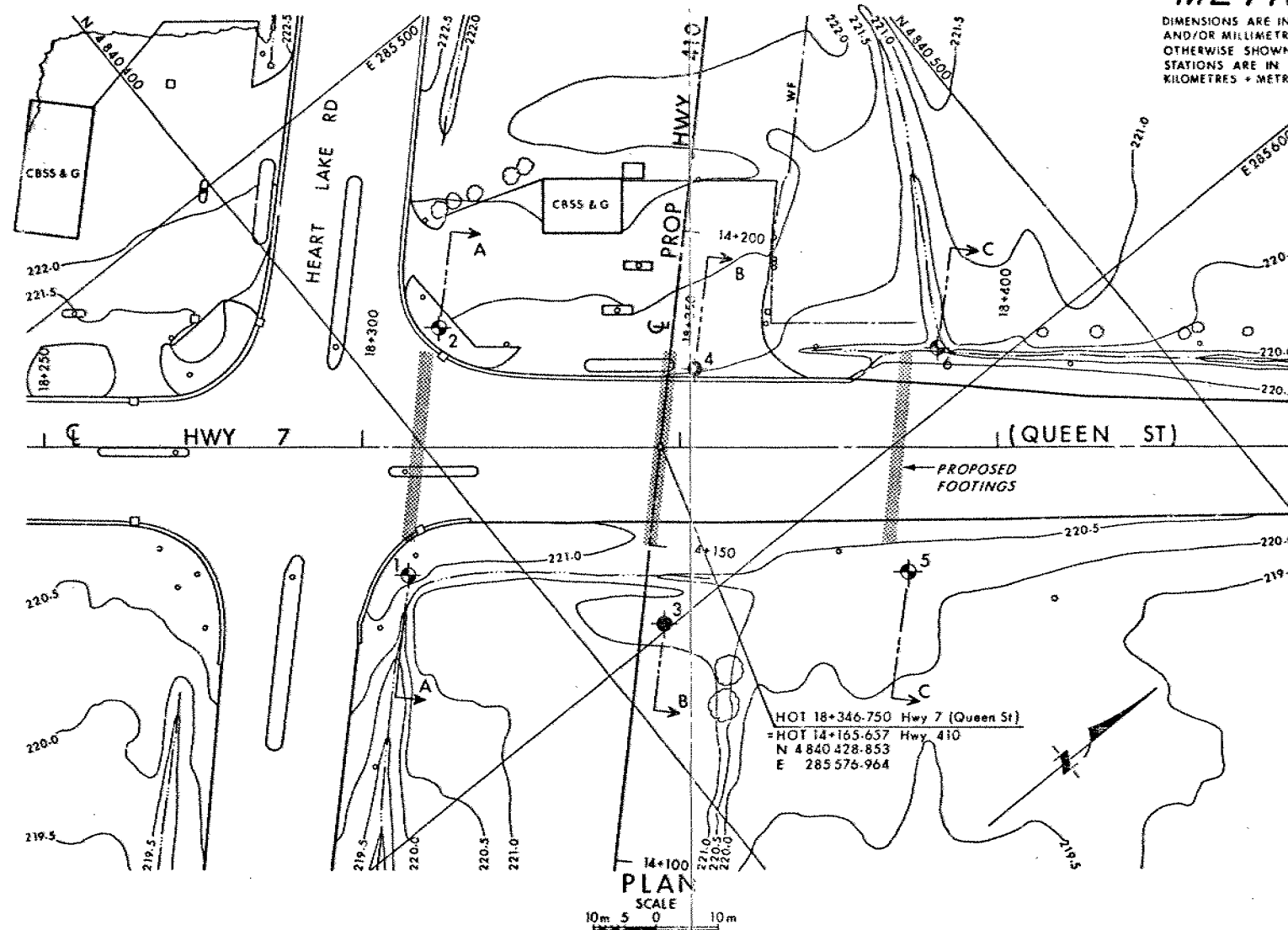
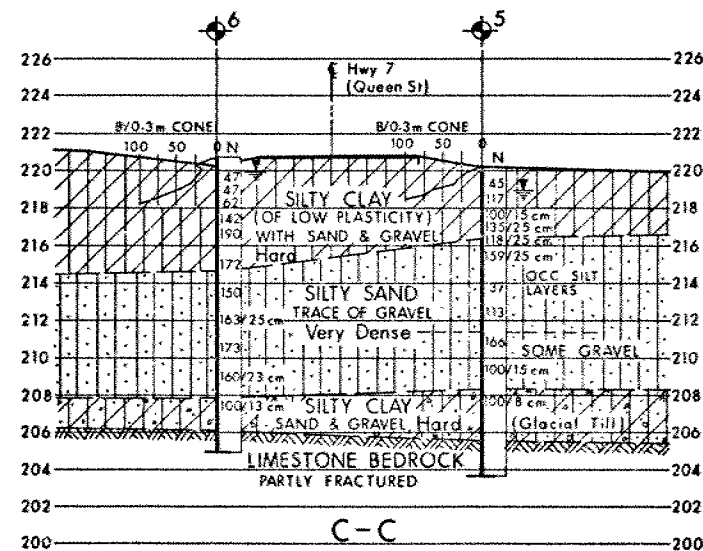
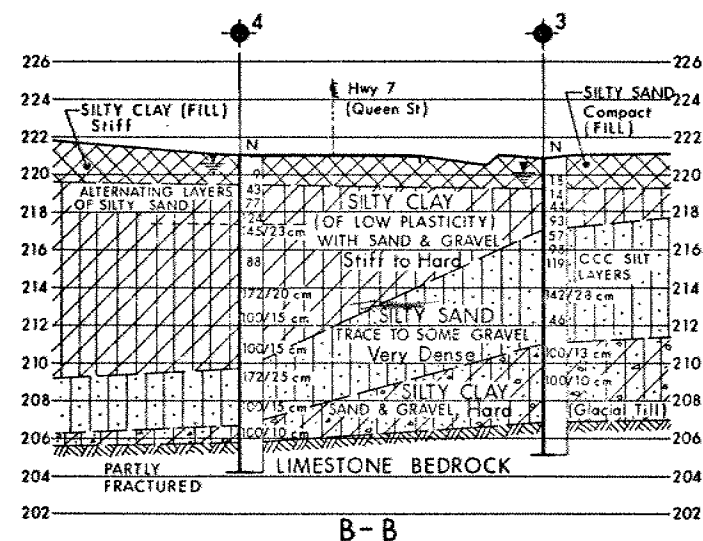
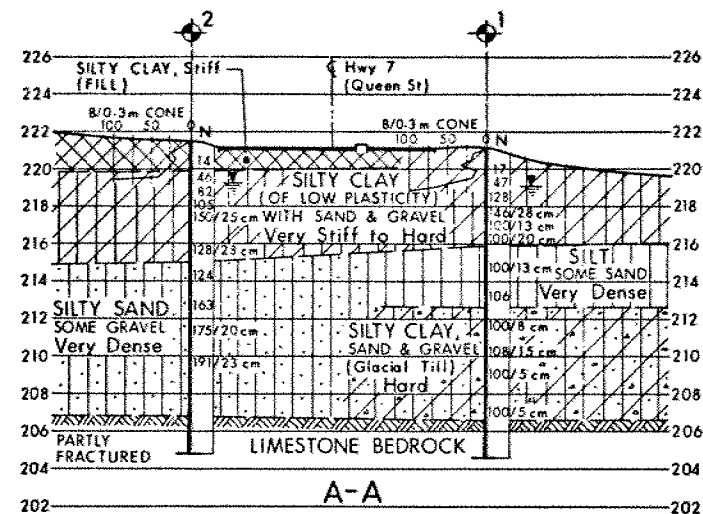
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	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
P	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 ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



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

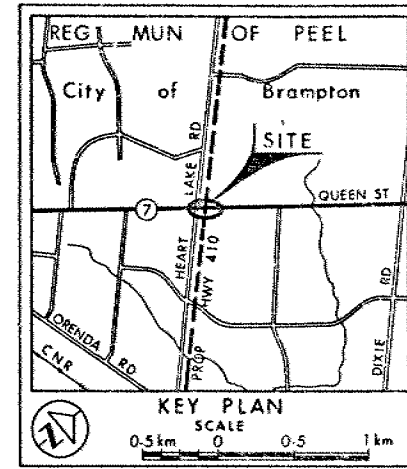
CONT No
WP No 21-79-05

HWY 7 (QUEEN ST) UNDERPASS

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)
- Wt at time of investigation
1974 01 and 1974 02

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	221.1	4 840 385.5	285 567.7
2	221.4	4 840 413.9	285 540.3
3	220.8	4 840 411.8	285 599.1
4	221.0	4 840 441.0	285 570.8
5	220.2	4 840 447.1	285 617.1
6	220.7	4 840 472.7	285 592.4

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	BY	DESCRIPTION

Geocres No 30M12-166

HWY No 410
SUBMITTAL CHECKED DATE 1982 05 25 SITE 24-343
DRAWN BY CHECKED APPROVED DWG 217905-A