

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-148

DIST. 6 REGION

W.P. No. 21-79-04

CONT. No. 83-39

W. O. No.

STR. SITE No. 24-145-471

HWY. No. 410

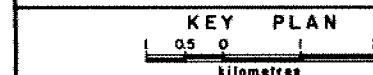
LOCATION Braughon Bypass
Clark Blvd. U/P

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



CLASS OF CONCRETE

DECK & PIERS -----	35	Mpa.
ABUTMENTS, WINGWALLS & BARRIER WALLS -----	30	Mpa.
REMAINDER -----	20	Mpa.

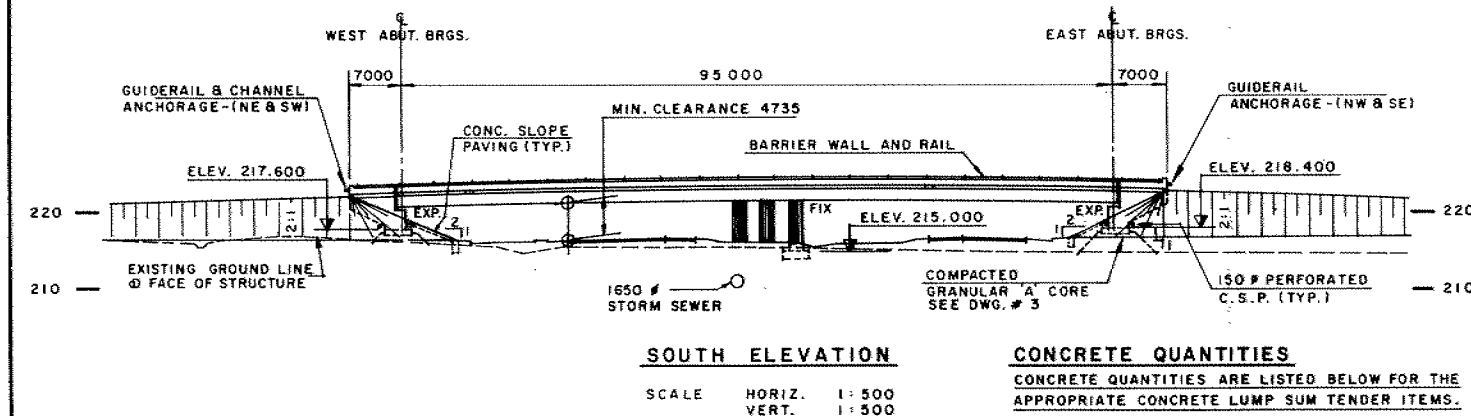
REINFORCING STEEL

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

FOOTINGS	-----	100'25
ABUTMENTS	-----FRONT FACE	80'20
	-----BACK FACE	70'20
PIERS	-----	80'20
DECK	TOP SLAB TOP	70'20
	BOTTOM	40'10
	BOTTOM SLAB & WEB SIDES	40'10
REMAINDER	-----	70'20
OR AS NOTED ON DRAWINGS.		

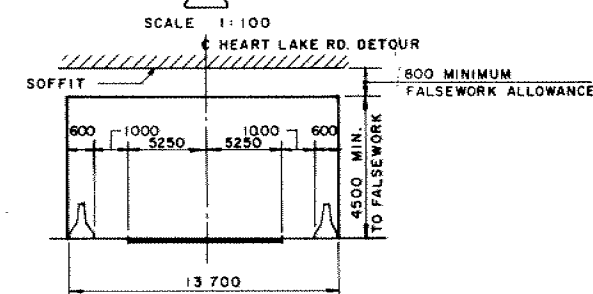
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 3\text{mm}$.
- THREE MONTHS AFTER STRESSING OPERATIONS HAVE BEEN COMPLETED THE DECK SHALL BE JACKED UP AT THE ABUTMENTS TO PERMIT THE BEARINGS TO RETURN TO THE VERTICAL POSITION.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

T/A DENOTES TOP OF ASPHALT PAVEMENT
P C DENOTES PROFILE CONTROL
W P DENOTES WORKING POINTS

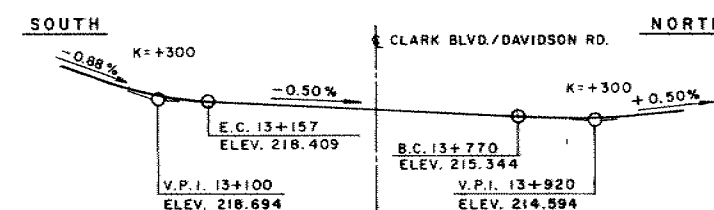


CONCRETE QUANTITIES ARE LISTED BELOW FOR THE
APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

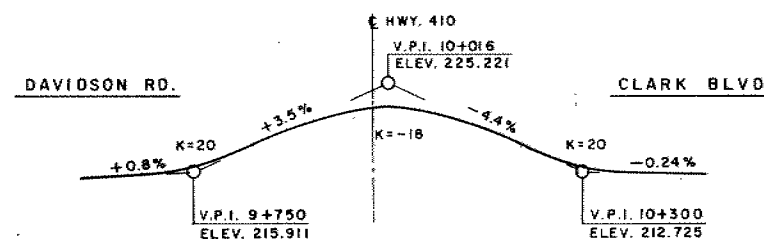
- | | | |
|---|----------|------------|
| 1 - CONCRETE IN PIERS, ABUTMENTS AND WINGWALLS- | | |
| | - 30 MPa | - 343 C.M. |
| | - 35 MPa | - 35 C.M. |
| 2 - PRESTRESSED CONCRETE BRIDGE DECK | - 2125 | C.M. |
| 3 - CONCRETE IN BARRIER WALLS | - 50 | C.M. |
| 4 - CONCRETE IN APPROACH SLABS | - 56 | C.M. |
| 5 - CONCRETE IN SLOPE PAVING | - 55 | C.M. |



N.T.S.



T/A AT PROFILE CONTROL
N.T.S.



T/A AT PROFILE CONTROL
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



REV	DATE	BY	DESCRIPTION	
			DATE	BY
DESIGN	Y.R.	CHECK	E.P.B.	LOADING OHSDCA-79
DRAWING	A.W.S.	CHECK	Y.R.	SITE 24-145-471
				DWS

CONT No
WP No 21-79-04



CLARK BOULEVARD UNDERPASS
FOOTING LAYOUT AND DETAILS

SHEET

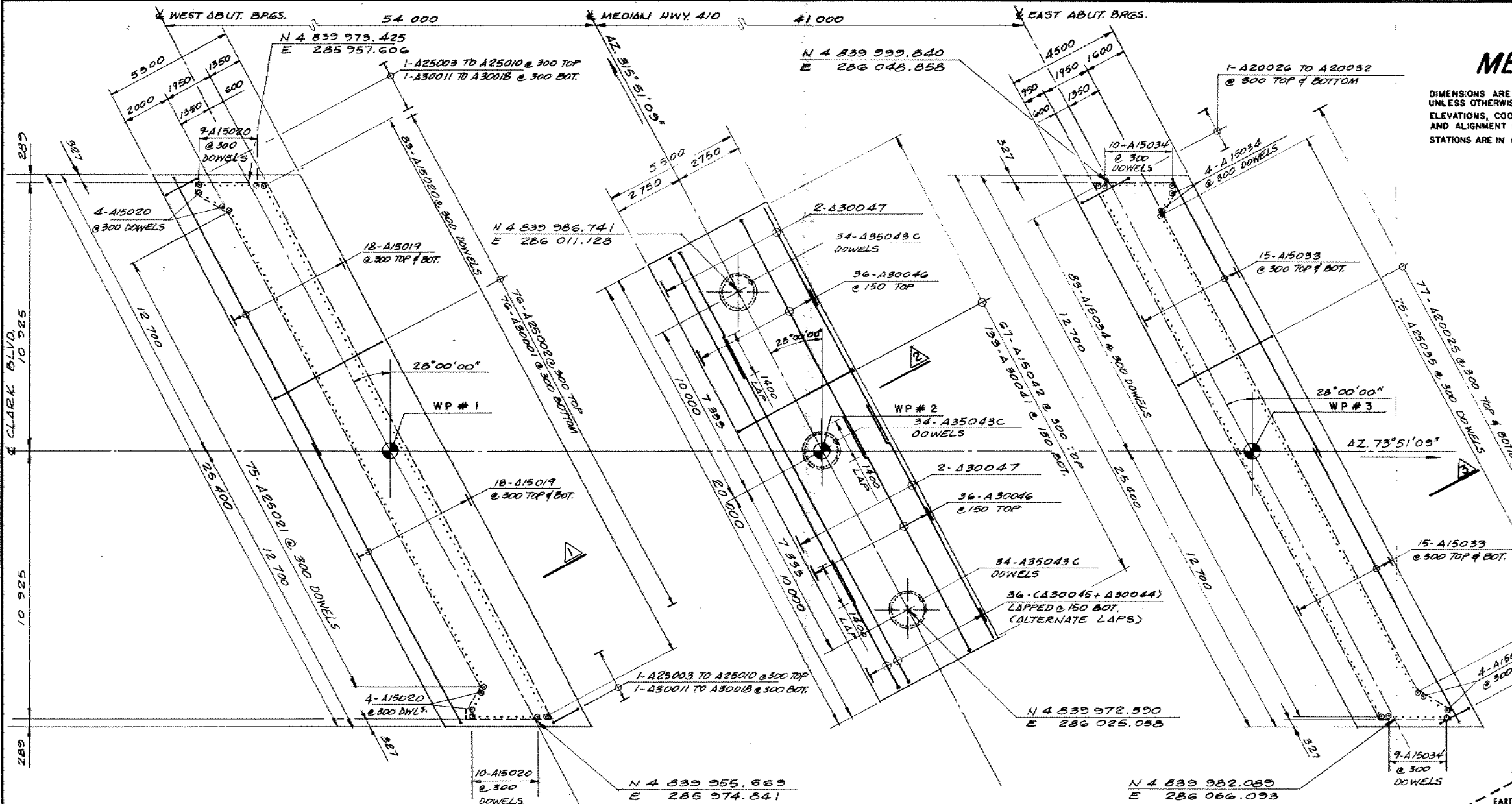
Giffels
Giffels Associates Limited
Consulting Engineers

METRIC

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

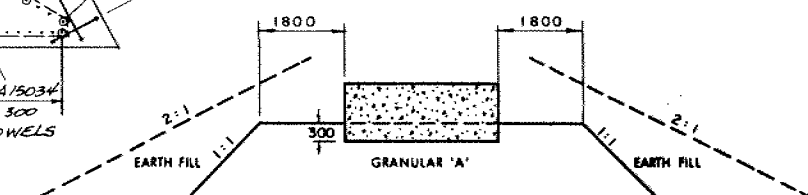
NOTES:

- FOR COLUMN LAYOUT SEE DWG. 112 G
- COMPACTED GRANULAR 'A' CORE
1- REMOVE TOPSOIL & / OR SOFT
SUBSOIL UNDER AREA OF COMPACTED
GRANULAR 'A' & EARTH FILL.
2- PLACE GRANULAR 'A' & EARTH FILL
TO ELEVATION SHOWN, COMPACTED
ACCORDING TO CURRENT M.T.C.
STANDARDS.
3- EXCAVATE COMPACTED GRANULAR 'A'
& EARTH FILL FOR FOOTING.

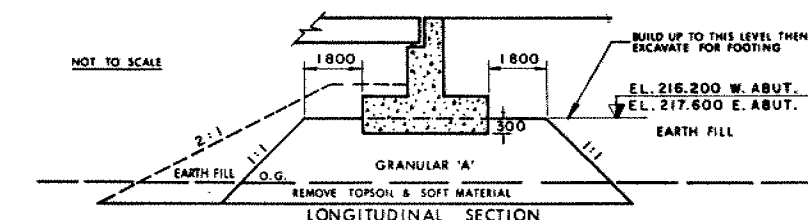


WORKING POINT DATA			
WP	STA. @ E CLARK BLVD.	PROVINCIAL COORDINATES	
		NORTH	EAST
1	9 + 946	4 839 964.547	285 966.223
2	10 + 000	4 839 979.565	286 018.093
3	10 + 041	4 839 990.968	286 057.476

FOUNDATION LAYOUT
SCALE 1:100

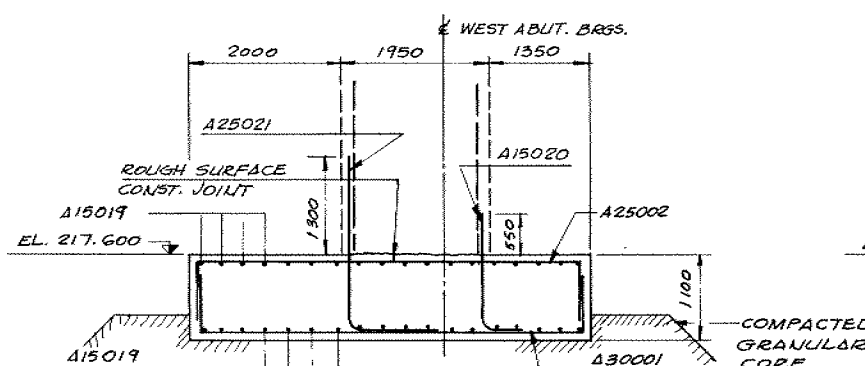


X SECTION

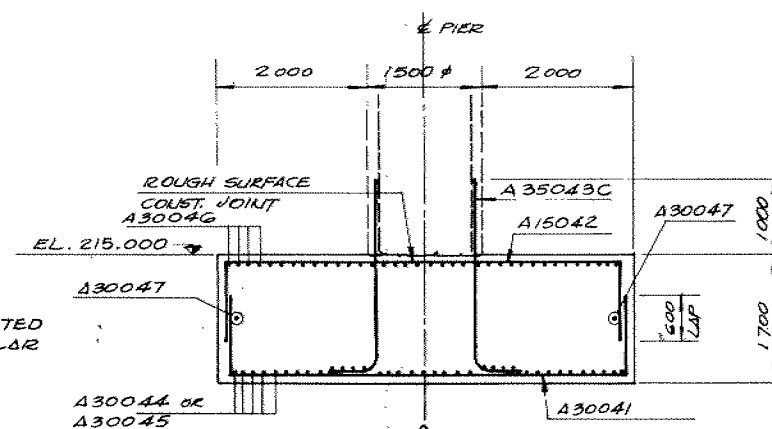


LONGITUDINAL SECTION

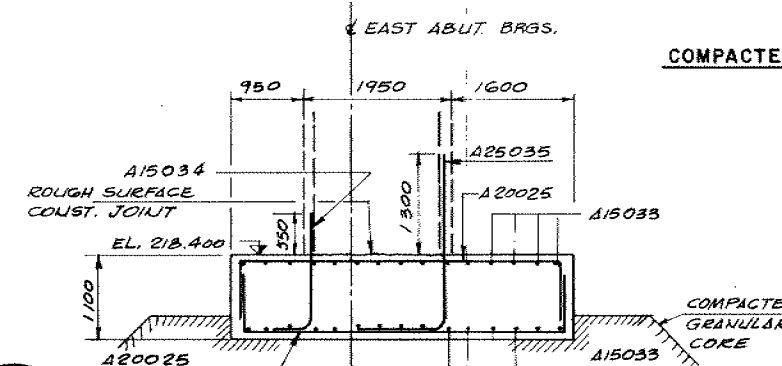
COMPACTED GRANULAR 'A' CORE FOR ABUTMENTS



SCALE 1:50



SCALE 1:50



SCALE 1:50

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN Y.R. CHECK E.P.B. LOADING OHBDC-A79 DATE JULY 82
DRAWING A.W.S. CHECK Y.R. SITE 24-145-471 DWG 3

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 39



Ministry of
Transportation and
Communications

INDEX

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NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

SS SPLIT SPOON	TP THINWALL PISTON
WS WASH SAMPLE	OS OSTERBERG SAMPLE
ST SLOTTED TUBE SAMPLE	RC ROCK CORE
BS BLOCK SAMPLE	PH T W ADVANCED HYDRAULICALLY
CS CHUNK SAMPLE	PM T W ADVANCED MANUALLY
TW THINWALL OPEN	FS FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_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^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT
For
Clark Boulevard Underpass
W. P. 21-79-04, Site 24-145-471
Highway 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 81 12 07 and 81 12 08 and consisted of advancing three sampled boreholes, one accompanied by a dynamic cone penetration test, for depths ranging from 4.2 to 8.4 metres.

SITE DESCRIPTION AND GEOLOGY

The site is located at the existing intersection of Heart Lake Road and Clark Boulevard/Davidson Road some 650 metres south of Highway 7, 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 composed of cohesive glacial till, whose thickness varies from 3 to 15 metres. The overburden is underlain by shale bedrock. This physiographic region is well drained by Credit, Oakville and Etobicoke Creeks, which have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog areas, although in many of the interstream areas drainage is still imperfect.

The shale bedrock is of the Meaford-Dundas formation, Ordovician Period.

SUBSURFACE CONDITIONS

Although variable in composition, generally competent subsurface conditions were encountered across the site. Surficial deposits varied from a sand and gravel at the west abutment location to a cohesive glacial till deposit at the pier and east abutment locations.

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 showing an estimated stratigraphical section based on borehole data, are shown on Drawing No. 2.

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

Sand and Gravel

Underlying the west abutment location and explored to a maximum depth of 4.2 metres is a surficial deposit of sand and gravel with traces of silt and clay. Typical grain size distribution curves for this granular deposit are shown on Figure 1. Based on augering operations, cobble and boulder sized fragments are well dispersed throughout this deposit and may account for refusal to augering at a depth of 4.2 metres.

Interpretation of standard penetration test 'N' values generally in excess of 100 blows per foot, suggests a denseness ranging from compact to very dense, but predominately very dense throughout.

Silty Clay, Sand and Gravel (Glacial Till)


Immediately underlying the pier and east abutment locations and explored for depths ranging from 6.7 to 8.4 metres is a cohesive till deposit consisting of silty clay with varying amounts of sand and gravel. Gradation of this till deposit became coarser (increased sand and gravel contents) at the east abutment location compared to the pier location, as shown by the two distinct sets of grain size distribution curves on Figure 2. Cobbles and boulders were also encountered towards the base of this deposit.

In addition to gradation, the plasticity of the fill decreased with increasing sand content. Results of Atterberg limit and water content testing are plotted on the Plasticity Chart, Figure 3. These results indicate the cohesive matrix of the till deposit to range from an inorganic silty clay of moderate plasticity (CL-CI) to slight plasticity (CL-ML).

Based on interpretation of 'N' values and augering operations, the consistency of this over-consolidated till deposit is assessed as being very stiff to hard, but generally hard below elevation 213.

Groundwater Conditions

Overnight stabilized water level readings taken in open boreholes were found to correspond to elevations of 215, 214, and 209.5. The higher water levels were recorded in boreholes close to existing roadway ditches and probably reflect a higher localized water table. However, due to the impermeable nature of the till at the pier location, the lowest water level may not reflect a true stabilized condition. Based on results of previous work carried out in the area, it is felt that groundwater will approximate elevation 213.5, with normal seasonal fluctuations occurring depending on the time of year.



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



M. Devata, P. Eng.,
Senior Foundations Engineer

A P P E N D I X



RECORD OF BOREHOLE No 1

METRIC 8

W P 21-79-04 LOCATION Co-ords. N 4 839 963.0; E 285 971.2 ORIGINATED BY H. S.
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY H. S.
DATUM Geodetic DATE 81 12 07 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
215.8	Ground Surface														
0.0	Brown Sand and Gravel Trace of silt and clay Cobbles and boulders throughout Compact to Very Dense		1	SS	28										
			2	SS	75/2	cm									47 39 11 3
			3	SS	93										
			4	SS	100/10	cm									66 21 8 5
211.6			5	SS	100/6	cm									
4.2	Refusal to Augering End of Borehole		6	SS	100/2	cm									52 41 5 2

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



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Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC 9

W P 21-79-04 LOCATION Co-ords. N 4 839 979.0; E 286 022.0 ORIGINATED BY H. S.
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY H. S.
DATUM Geodetic DATE 81 12 07 CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
215.0	Ground Surface																
0.0	(Glacial Till)		1	SS	20												
	Silty clay of low plasticity		2	SS	36												
	Brown Gray		3	SS	134												
	Trace of gravel and sand		4	SS	48												
	Very stiff to hard		5	SS	41												
	gravel and cobbles		6	SS	64												
			7	SS	171	18 cm											
208.3	cobbles & boulders		8	SS	125	15 cm											
6.7	Refusal to augering End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 $\frac{1}{5}$ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

METRIC 10

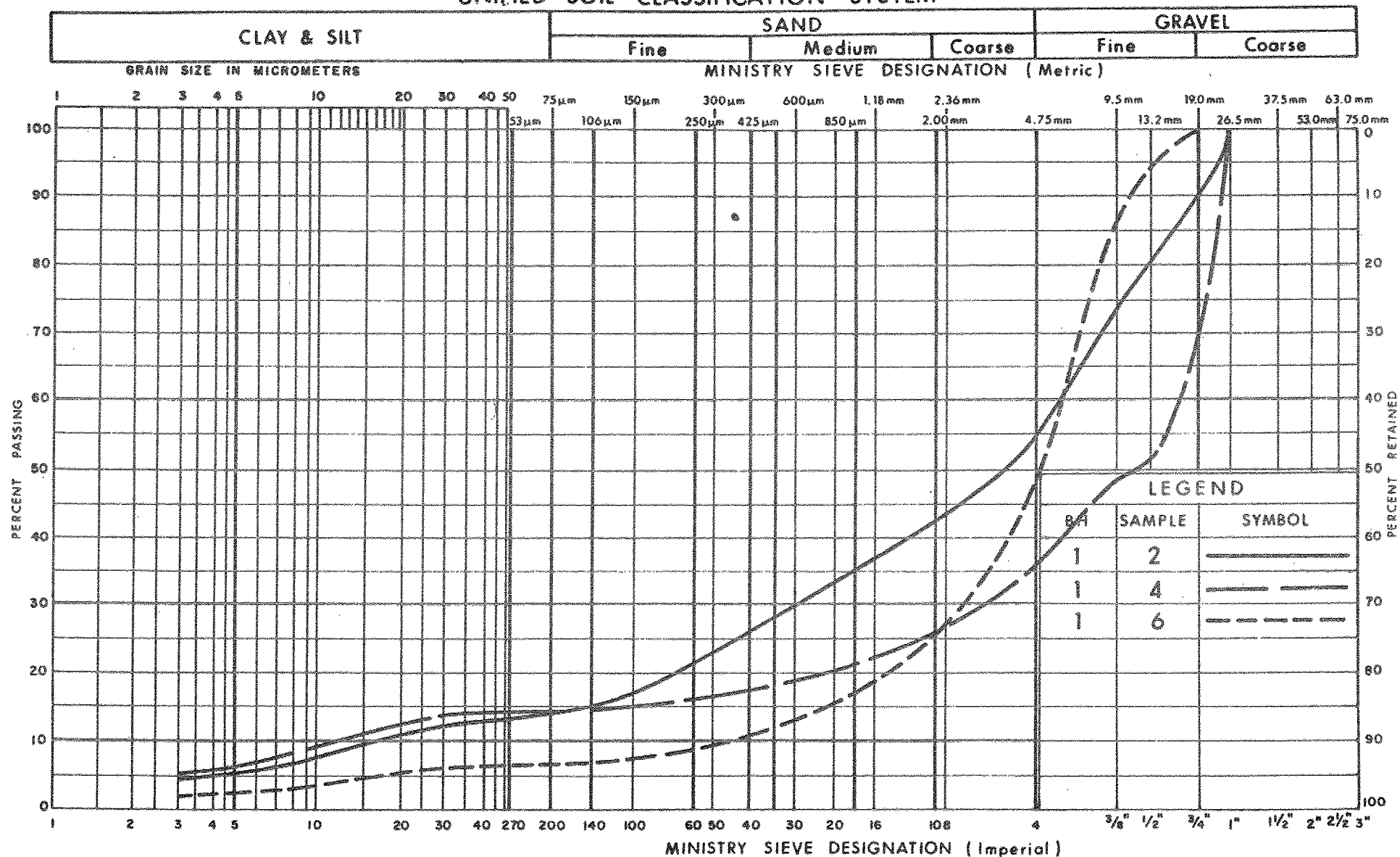
W P 21-79-04 LOCATION Co-ords N 4 839 986.0; E 286 056.5 ORIGINATED BY H. S.
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY H. S.
DATUM Geodetic DATE 81 12 07 - 08 CHECKED BY EP

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			SHEAR STRENGTH		WATER CONTENT (%)				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	10	20	30		
214.5	Ground Surface													GR SA SI CL
0.0	(Glacial Till)						214							9 43 39 9 18 35 39 8 22 36 35 7
	Silty clay of slight plasticity		1	SS	39		213							
	and		2	SS	54		212							
	Sand		3	SS	149		211							
			4	SS	153		210							
	Brown Grey		5	SS	111		209							
	- Varying amounts of gravel		6	SS	180		208							
	HARD		7	SS	95		207							
			8	SS	100/13 cm									
206.1		9	SS	100/2 cm										
8.4	Refusal to augering End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



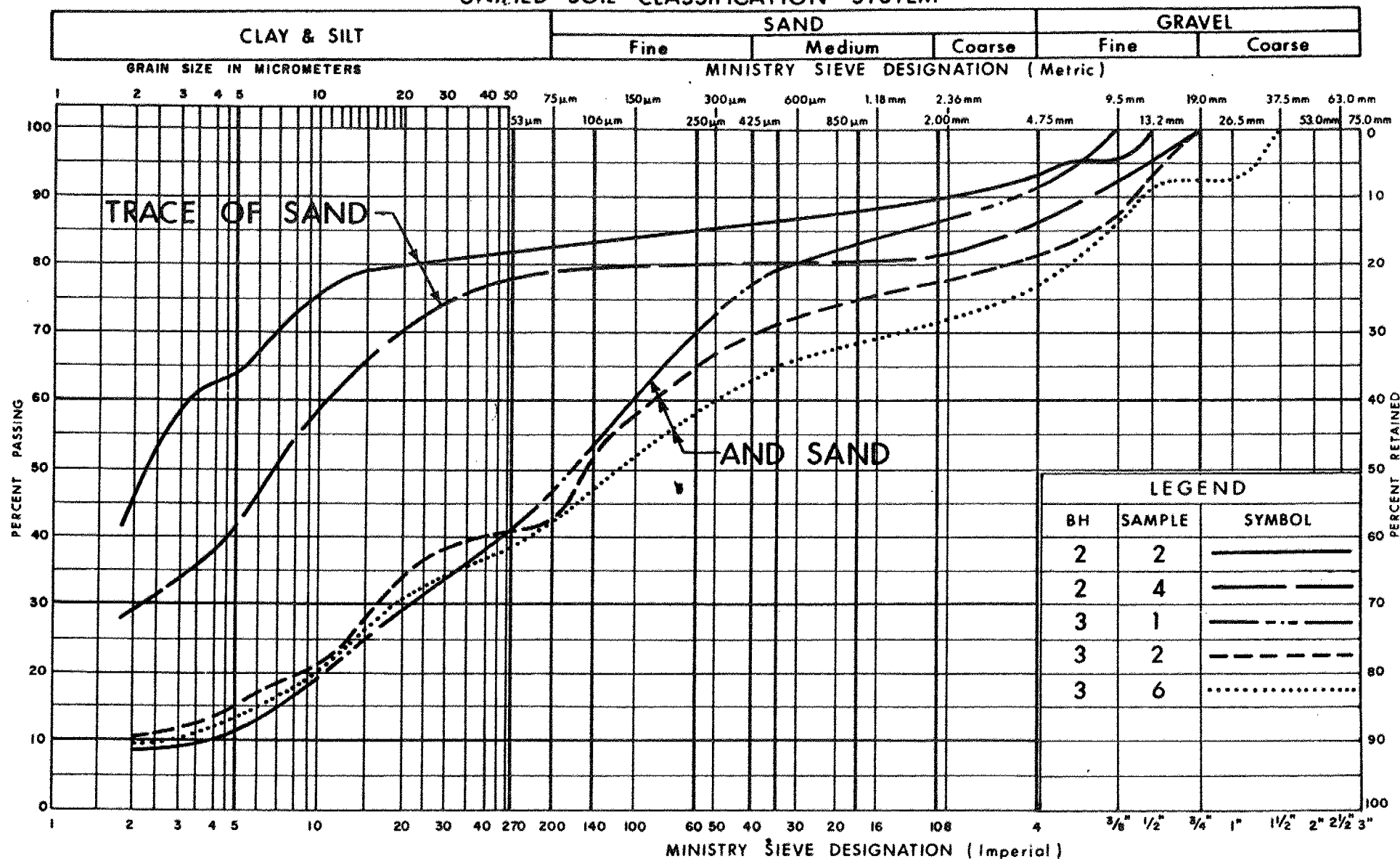
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Communications

GRAIN SIZE DISTRIBUTION SAND & GRAVEL, TRACE OF SILT & CLAY

FIG No 1

WP 21-79-04

UNIFIED SOIL CLASSIFICATION SYSTEM

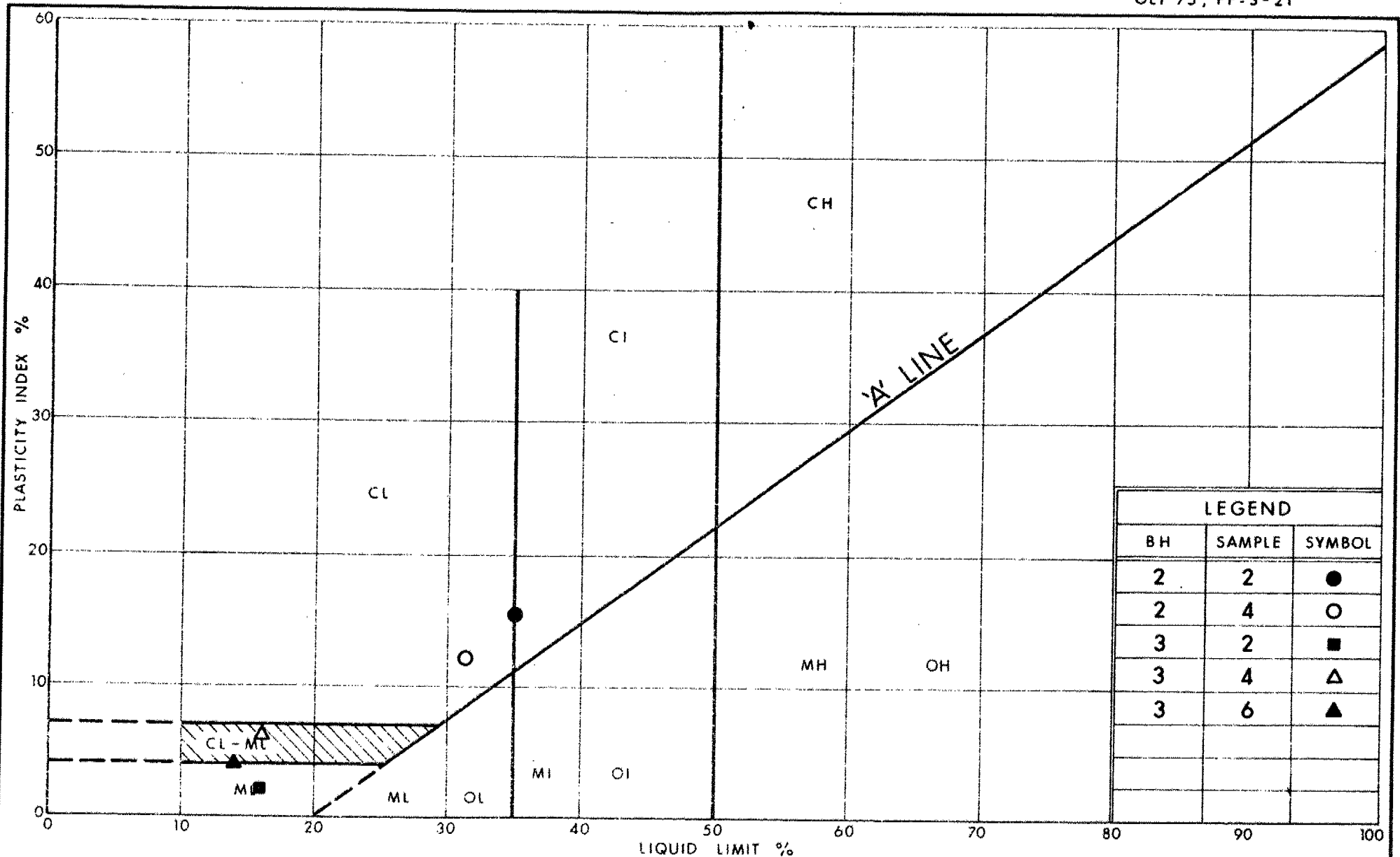


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GRAIN SIZE DISTRIBUTION
SILTY CLAY (Glacial Till)

FIG No 2

W P 21-79-04



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PLASTICITY CHART SILTY CLAY Matrix (Glacial Till)

FIG No 3

W P 21-79-04



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Communications

foundation investigation and design report

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

WP 21-79-04 DIST 6
HWY 410 STR SITE 24-145- 471
Clark Boulevard Underpass

CONT 83-39

DISTRIBUTION

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B. J. Giroux
R. Hore

R. Fitzbiggon (Cover only)
J. Anderson (Cover only)
T. J. Kovich (Cover only)

Files

FOUNDATION INVESTIGATION REPORT
For
Clark Boulevard Underpass
W. P. 21-79-04, Site 24-145-471
Highway 410, District 6, Toronto

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Sand and Gravel

Underlying the west abutment location and explored to a maximum depth of 4.2 metres is a surficial deposit of sand and gravel with traces of silt and clay. Typical grain size distribution curves for this granular deposit are shown on Figure 1. Based on augering operations, cobble and boulder sized fragments are well dispersed throughout this deposit and may account for refusal to augering at a depth of 4.2 metres.

Interpretation of standard penetration test 'N' values generally in excess of 100 blows per foot, suggests a denseness ranging from compact to very dense, but predominately very dense throughout.

Silty Clay, Sand and Gravel (Glacial Till)

Immediately underlying the pier and east abutment locations and explored for depths ranging from 6.7 to 8.4 metres is a cohesive till deposit consisting of silty clay with varying amounts of sand and gravel. Gradation of this till deposit became coarser (increased sand and gravel contents) at the east abutment location compared to the pier location, as shown by the two distinct sets of grain size distribution curves on Figure 2. Cobbles and boulders were also encountered towards the base of this deposit.

In addition to gradation, the plasticity of the fill decreased with increasing sand content. Results of Atterberg limit and water content testing are plotted on the Plasticity Chart, Figure 3. These results indicate the cohesive matrix of the till deposit to range from an inorganic silty clay of moderate plasticity (CL-CI) to slight plasticity (CL-ML).

Based on interpretation of 'N' values and augering operations, the consistency of this over-consolidated till deposit is assessed as being very stiff to hard, but generally hard below elevation 213.

Groundwater Conditions

Overnight stabilized water level readings taken in open boreholes were found to correspond to elevations of 215, 214, and 209.5. The higher water levels were recorded in boreholes close to existing roadway ditches and probably reflect a higher localized water table. However, due to the impermeable nature of the till at the pier location, the lowest water level may not reflect a true stabilized condition. Based on results of previous work carried out in the area, it is felt that groundwater will approximate elevation 213.5, with normal seasonal fluctuations occurring depending on the time of year.

DISCUSSION AND RECOMMENDATIONS

In order to carry Clark Boulevard over the proposed Highway 410, a two span 95 x 20 metre underpass structure is contemplated. Design requirements will necessitate realignment of Clark Boulevard to the south, shifting of Heart Lake Road at the crossing to the west, and construction of approach fill to a maximum height in the order of 9 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.

Foundations for perched abutments can be founded on spread footings located on a well compacted Granular 'A' core within the approaches as per current M. T. C. Standards. All surficial organic and/or softened material within the planned limits of the approaches must be subexcavated prior to placement of the well-compacted granular core. For spread footings founded on a Granular 'A' core and constructed to current M. T. C. standards, an allowable capacity at the S. L. S. Type II of 280 kPa and a factored capacity at the U. L. S. of 750 kPa may be used for design purposes.

Pier elements can be founded on spread footings located at or below elevation 213.5 for an allowable capacity at the S. L. S. Type II of 400 kPa and a factored capacity of the U. L. S. of 950 kPa.

Earth pressures against the abutment wall should be computed as per Subsection 6.6.1.2.2 of the O. H. B. D. C. Manual.

Resistance to sliding of the abutment footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and the Granular 'A' core.

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

No major dewatering difficulties are anticipated for pier footing excavations in consideration of the relatively low permeability of the glacial till deposit. Localized seepage into excavations can be controlled by perimeter ditches and pumping from corner sumps.

No stability problems are anticipated for permanent embankment slopes constructed to a 2:1 geometry.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. H. Sturm, Engineer-in-Training, utilizing equipment owned and operated by Atcost Soil Investigation, Toronto. This 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 'T. J. Kazmierowski'.

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

A handwritten signature in black ink, appearing to read 'M. Devata'.

M. Devata, P. Eng.,
Senior Foundations Engineer

A P P E N D I X



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-04 LOCATION Co-ords. N 4 839 963.0; E 285 971.2 ORIGINATED BY H. S.
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY H. S.
DATUM Geodetic DATE 81 12 07 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	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								
215.8	Ground Surface												
0.0	Brown Sand and Gravel		1	SS	28		215						
	Trace of silt and clay		2	SS	75/2	cm	214						47 39 11 3
	Cobbles and boulders throughout		3	SS	93		213						66 21 8 5
	Compact to Very Dense		4	SS	100/10	cm	212						52 41 5 2
211.6	Refusal to Augering End of Borehole		5	SS	100/6	cm							
4.2			6	SS	100/2	cm							

100/15 cm

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



RECORD OF BOREHOLE No 2

METRIC

W P 21-79-04 LOCATION Co-ords. N 4 839 979.0; E 286 022.0 ORIGINATED BY H. S.
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY H. S.
DATUM Geodetic DATE 81 12 07 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			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	○						—	—	
215.0	Ground Surface												10	20	30					
0.0	(Glacial Till)		1	SS	20	214														
	Silty clay of low plasticity		2	SS	36	213											10 10 (80)			
	Trace of gravel and sand		3	SS	134	212														
	Very stiff to hard		4	SS	48	211											13 10 48 29			
			5	SS	41	210														
			6	SS	64	209														
	gravel and cobbles		7	SS	171	18 cm														
			8	SS	125	15 cm														
208.3	cobbles & boulders																			
6.7	Refusal to augering End of Borehole																			

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

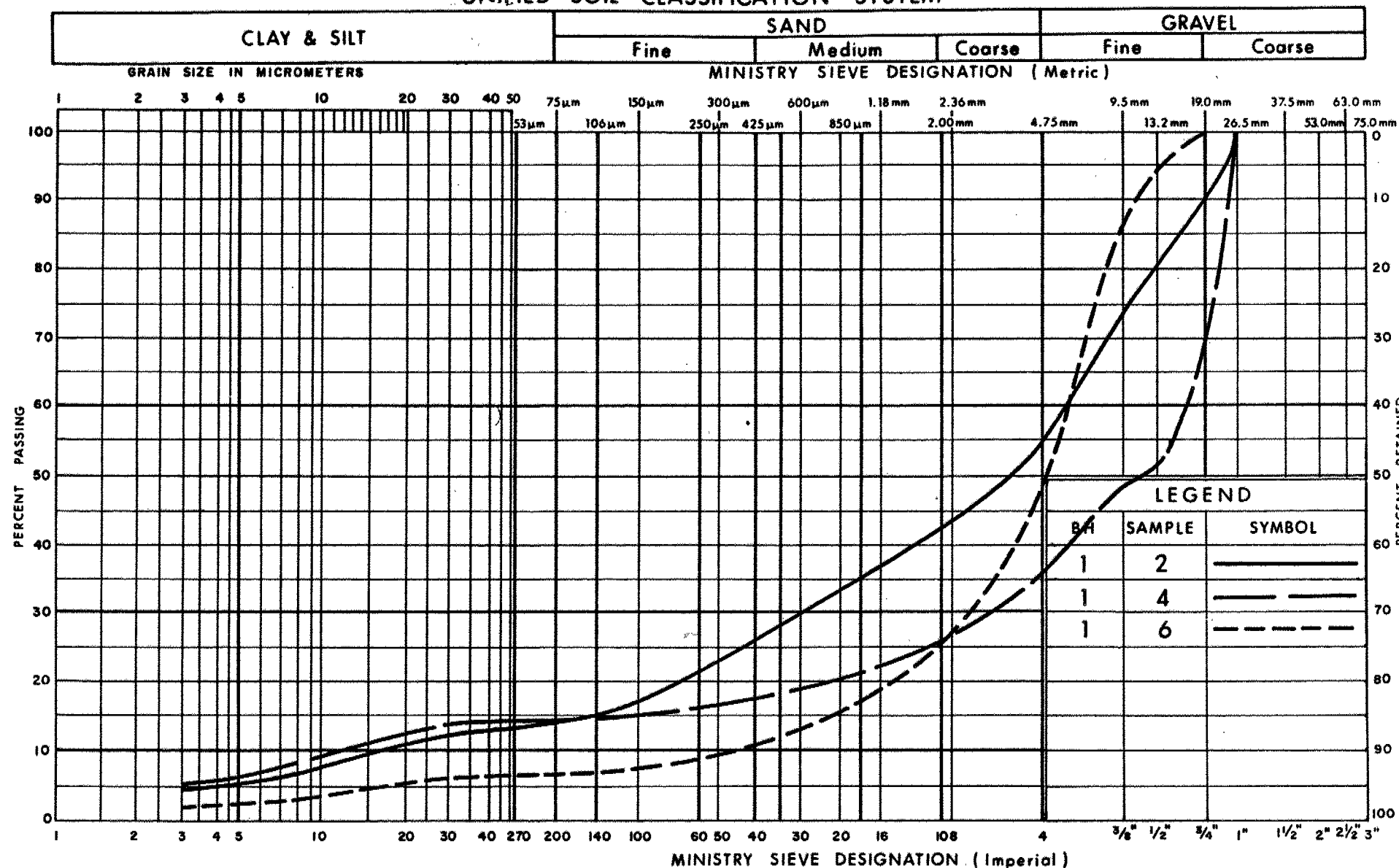
RECORD OF BOREHOLE No 3

METRIC

W P 21-79-04 LOCATION Co-ords N 4 839 986.0; E 286 056.5 ORIGINATED BY H. S.
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY H. S.
 DATUM Geodetic DATE 81 12 07 - 08 CHECKED BY EP.

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					
214.5	Ground Surface													
0.0	(Glacial Till)													
	Silty clay of slight plasticity		1	SS	39									9 43 39 9
	and													
	Sand		2	SS	54									18 35 39 8
			3	SS	149									
			4	SS	153									
	Brown Grey													
	- Varying amounts of gravel		5	SS	111									
	HARD		6	SS	180									22 36 35 7
			7	SS	95									
	Cobbles and Boulders													
			8	SS	100	13 cm								
206.1			9	SS	100	2 cm								
8.4	Refusal to augering End of Borehole													

UNIFIED SOIL CLASSIFICATION SYSTEM



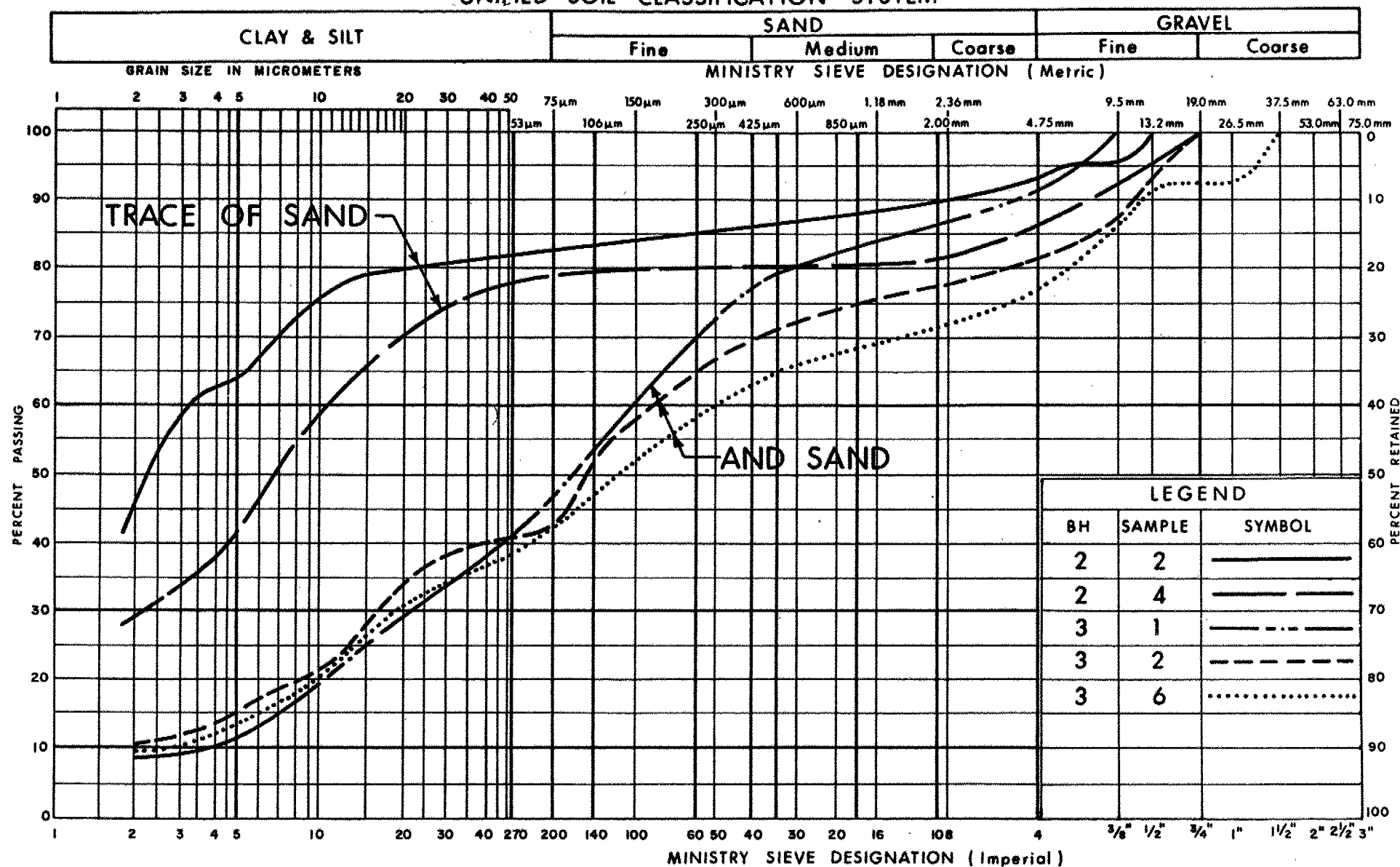
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GRAIN SIZE DISTRIBUTION
SAND & GRAVEL, TRACE OF SILT & CLAY

FIG No 1

WP 21-79-04

UNIFIED SOIL CLASSIFICATION SYSTEM

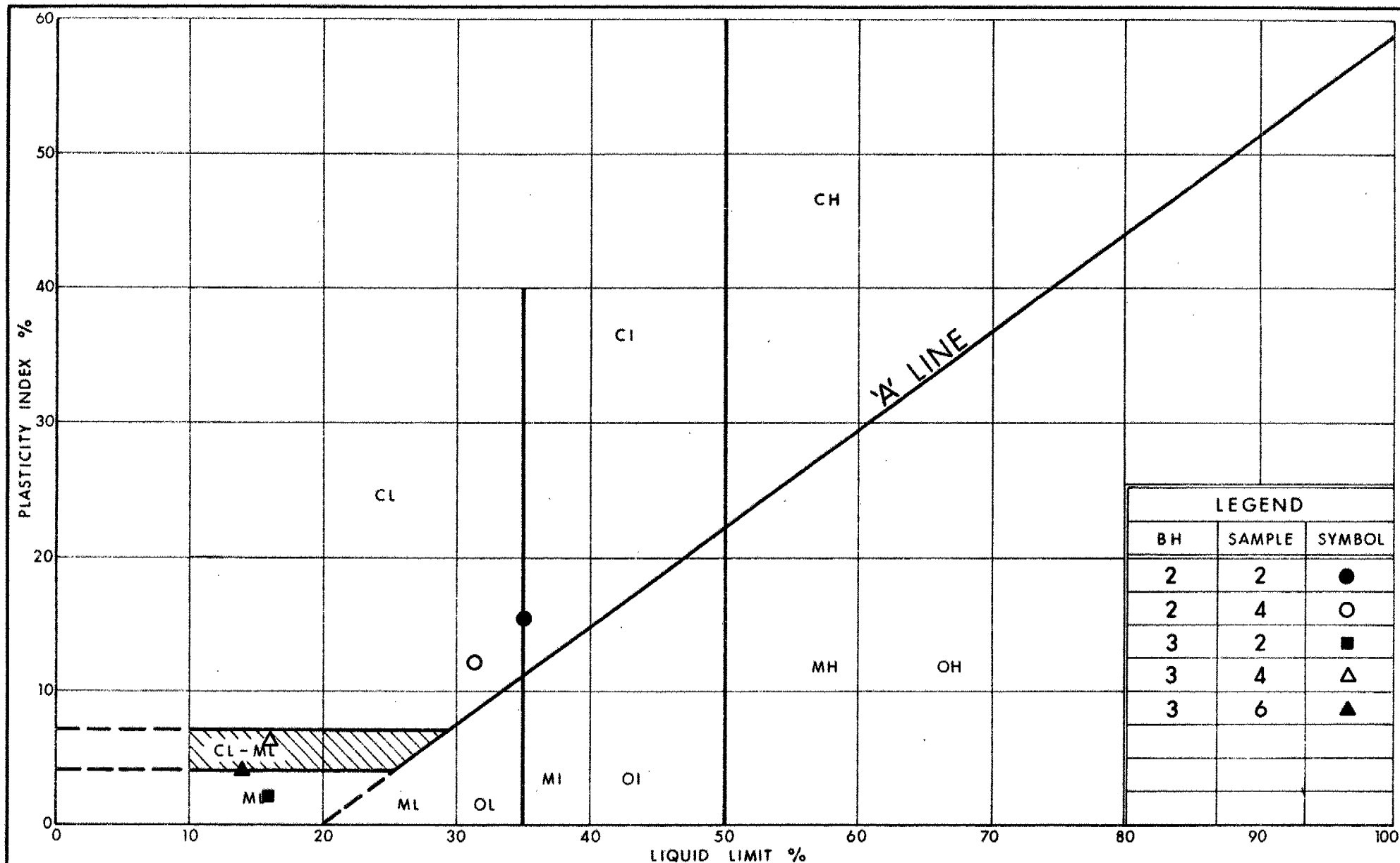


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GRAIN SIZE DISTRIBUTION
SILTY CLAY (Glacial Till)

FIG No 2

W P 21-79-04



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PLASTICITY CHART SILTY CLAY Matrix (Glacial Till)

FIG No 3

W P 21-79-04

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{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 = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

METRIC

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

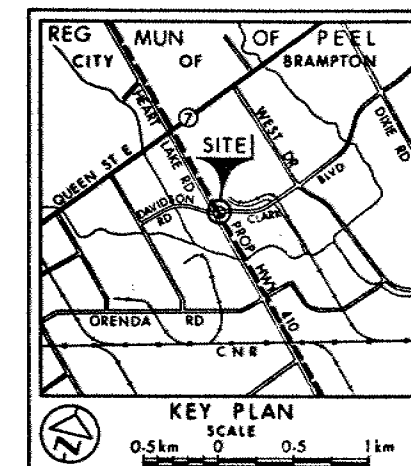
CONT No
WP No 21-79-04

CLARK BLVD

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



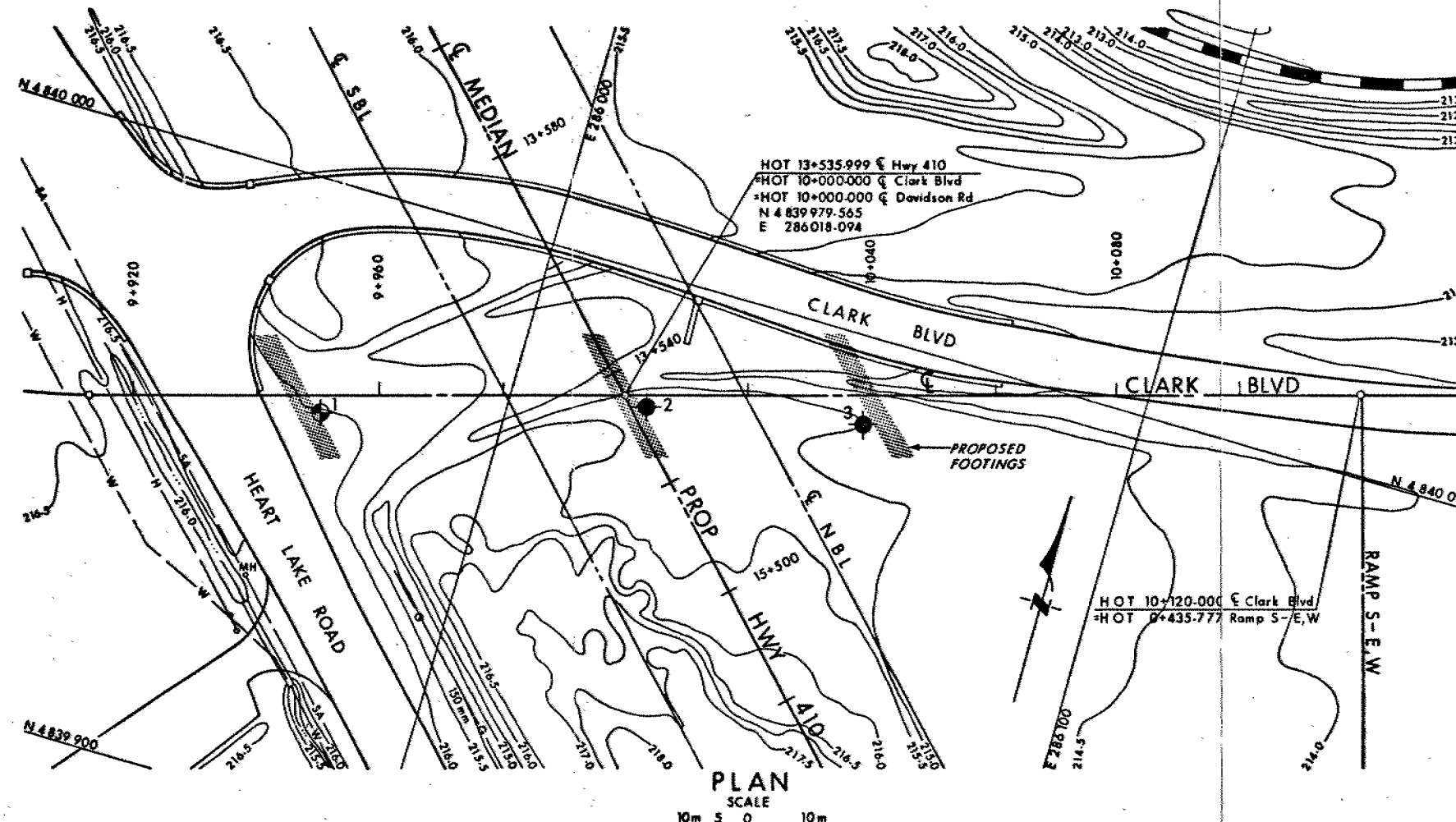
LEGEND

- ◆ 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 1981 12

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	215.8	4 839 963.0	285 971.2
2	215.0	4 839 979.0	286 022.0
3	214.5	4 839 986.0	286 056.5

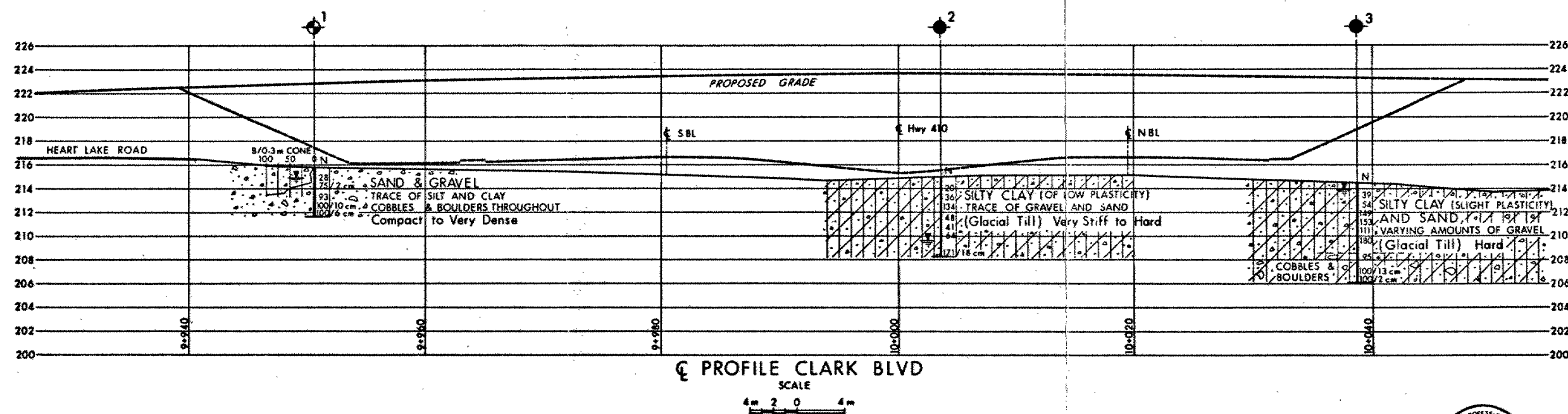
NOTE

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



NOTE:

Contour lines do not accurately represent existing ground surface due to recent grading operations.



REVISIONS	DATE	BY	DESCRIPTION

Geocres No 30M12-146

HWY No Prop 410 DIST 6

SUBMITTAL CHECKED DATE 1982 01 06 SITE 24-145-471

DRAWN BY CHECKED APPROVED DWG 217904-A

Sept. 19/88

Contract 83-39

Reinforced Embankment

Hwy 410

M. Devito & D. Demichio visited site in response to memo from Central Region Geotech.

He observed that although there were patches of no vegetation growth in which the Tensar 111 surface mat was visible, there were only 3 or 4 isolated erosion areas. In these areas the surface mat was absent (blown away?) and erosion has extended 1' to 2' into slope.

These areas were often associated with areas of uncontrolled run-off from the road, usually at catch basin locations.

However, we agreed that these were more cosmetic & superficial erosion concerns and that the stability of the embankment was not in jeopardy. In fact the 111 embankment was performing well and better than adjacent 2:1 embankments at the transitions.

M.D. recommended 1 contact maintenance to get advice of their seeding specialist. We agreed that the entire 1:1 site should be mapped and the areas of distress should be noted and identified.

- 1) suggested photography techniques
or 2) from helicopter preferably
or 3) from oblique airplane
or 3) from ground if necessary.
Morty suggested manual modelling.

The intent is to illustrate
% of slope that is distressed.

1) am to investigate costs and
make proposal.

As far as remedial measures
are concerned, we agreed that we
would contact the Maintenance Section re: seeding.
Also we would concentrate on severe erosion
areas and repair those by exposing the SR 2
grid, packing gravel to build up slope,
planting Topsoil and seeding and tying on
the surface mat.

D.H. Dunder

memorandum



To: Mr. W.L. Lin
Design Engineer (Central)
Operating Section
Structural Office
3501 Dufferin St., 4th Floor

Date: 82 11 01

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

Re: Clark Boulevard Underpass
Highway 410
W.P. 21-79-04, Site 24-145-471
District 6, Toronto

We have reviewed the final bridge plan drawings for the above-mentioned structure and have noted the incorporation of our comments as per the preliminary drawing. We have no further comments at the present time.

A handwritten signature in cursive script, appearing to read "Kenneth D. Chak".

K.D. Chak
Trainee Engineer

For: M. Devata, P. Eng.
Senior Foundations Engineer

KC:syc

memorandum



To: Mr. G. C. E. Burkhardt, Date: 81 11 20
Head,
Structural Section,
Central Region

From: Pavement & Foundation Design Section

Re: Foundation Request
Clark Boulevard Underpass and Culvert Sta. 13+120
Highway 410 - Brampton Bypass
W. P. 21-79-00, District 4, Hamilton

We have received the foundation request for the two above-mentioned structure sites on 81 11 17 and have noted the following discrepancies:

1. No mention has been made whether these jobs are recoverable or not.
2. No final 'E' plans for either of these structures has been submitted with the request. Due to the critical scheduling for the foundation reports (due 82 01-06) on these jobs and our present drafting and report preparation scheduling requirements, final 'E' plans with appropriate profile sections must be received no later than 81 12 02 to prevent any delay in issuance of the final report.

A handwritten signature in black ink, appearing to read "T. J. Kazmierowski".

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

TJK/bd

cc: R. Fitzgibbon

memorandum



To: Mr. W.L. Lin
Design Engineer (Central)
Operating Section
Structural Office

Date: 82 04 15

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

Re: Clark Boulevard Underpass
W.P. 21-79-04, Site 24-145-471
Hwy. 410, District 6, Toronto

We have reviewed the preliminary bridge plan drawing P-1 for the above-mentioned structure site. The only comment we have at the present time is that the well compacted granular 'A' cores for both abutments be shown dimensionally correct and labelled completely.

A handwritten signature in dark ink, appearing to read "Tom Kazmierowski".

T. Kazmierowski, P. Eng.
Foundations Engineer

TK/syc

FOUNDATIONS OFFICEREVIEW OF DESIGN DRAWINGS:

W.P.

21-79-04

W.O.

Foundation Report By:

Tom K.

Review of Design Drawings By:

Tom K.

Design Drawing No.'s:

P-1

1. Does footing design comply with our report or subsequent memos? *Yes*
- poor details of core
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? *N/A*
If not, make a new list.
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? *None.*
i.e., dewatering, stability of temporary slopes or excavations.
8. Summarize your comments; on separate sheet if necessary.

Drawings Received

Mar. 31 19.82

Reviewed

Apr. 14 19.82

Signed

JSK

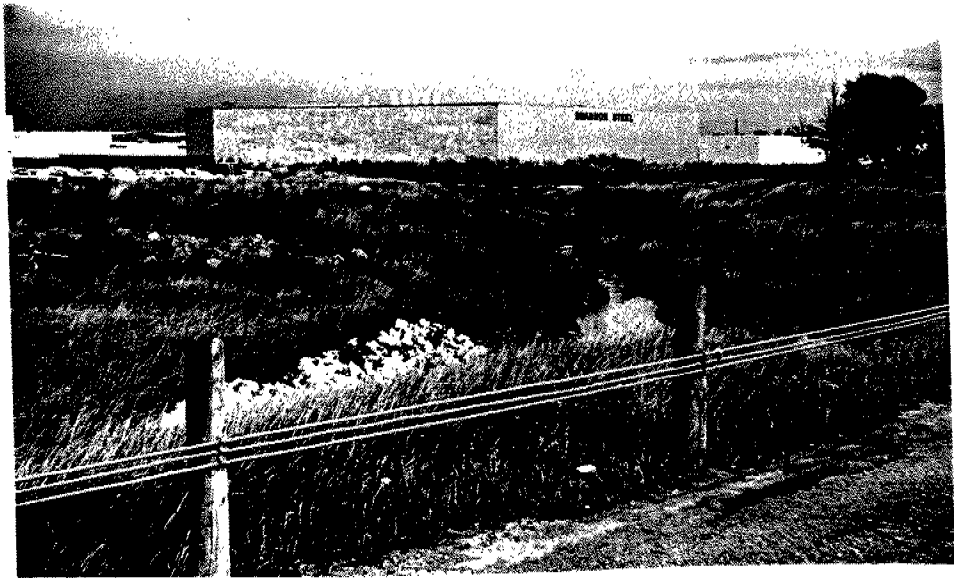
CLARK BLVD. U'PASS



LOOKING NORTH ALONG
410 ALIGNMENT PAST
CLARK BLVD.



LOOKING WEST ALONG
CLARK BLVD. PAST 410
ALIGNMENT



LOOKING EAST ALONG STREAM (FROM HEART LAKE RD.)
TOWARDS 410 ALIGNMENT



LOOKING NORTH ALONG 410 ALIGNMENT (STREAM BELOW
CAMERA VIEW) PAST STREAM



EXISTING STRUCTURE UNDER HEART LAKE RD. WEST OF
410 ALIGNMENT