

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 31-76-09 DIST 3

HWY 8N STR SITE nil

RETAINING WALL AT FREEPORT DR.

STA 10 + 145 to STA 10 + 260

*CONT 86-53*

DISTRIBUTION

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## FOUNDATION INVESTIGATION REPORT

For

Retaining Wall

Sta: 10 + 145 to Sta: 10 + 260

Hwy. #8N and Freeport Drive

W.P. 31-76-09

District #3 (Stratford)

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### INTRODUCTION

This report contains the results of a foundation investigation carried out at the aforementioned site on 83-02-23 and 83-02-24. The fieldwork consisted of three sampled boreholes and dynamic cone penetration tests adjacent to each boring. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped with 82 mm I.D. hollow stem augers.

### SITE DESCRIPTION

The site is located on the north side of the existing Hwy. #8, at the toe of an approx. 12 m high esker. Physiographically, this area is situated in the region known as the 'Waterloo Hills'.

### SUBSURFACE CONDITIONS

#### General

The subsoil at this location was found to consist of sand and gravel with trace (some) of silt and trace of clay. In borehole #2, this sand and gravel deposit is overlain by a relatively thin layer of sandy silt. The material in the esker is believed to consist of sand, gravel and cobbles, (as per our visual observation of a nearby exposed slope).

The boundaries between the different strata, together with the obtained field and laboratory tests results are shown on the record of borehole sheets contained in the appendix. The stratigraphical sections shown on drawing no. 317609-A is based on this information. The drawing also shows the locations and elevations of the borings. A detailed description of the encountered subsurface conditions is given below.

#### SANDY SILT, TRACES OF GRAVEL AND CLAY

This stratum was intersected in BH. #2 only and extends from immediately below the groundsurface for a depth of about 1.3 m. The material in the deposit consists mainly of silt (67%), sand (25%), with traces of gravel (6%) and clay (2%). The natural moisture content is in the order of 17%. The denseness is compact.

#### SAND AND GRAVEL TRACES OF SILT AND CLAY

Immediately below groundsurface of the above-described sandy silt zone, a granular type stratum was encountered. The lower boundary was not determined, since the borings were terminated within this zone, but was proven for a maximum depth of about 10.1 m. The material in the deposit consists of sand and gravel with traces of silt and clay. The results of the grain-size distribution tests are shown in an envelope form on Figure 1 of the appendix. In borehole #3, an approx. 1 m thick layer of silty sand was intersected within the main deposit. The natural moisture content ranges from 2% to 8%.

Standard penetration tests gave 'N' values from 37 to over 100 blows per 0.3 m. Based on these figures, the denseness of the overall deposit may be described as dense to very dense.

#### GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

BH. #1	EL. 300.5 (9.8 m below ground level)
BH. #2	No water in borehole (dry)
BH. #3	No water in borehole (dry)

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to construct a gravity-type (gabion) retaining wall between Sta. 10 + 145 and Sta. 10 + 260 at this location. The height of the wall varies from 1 m to 5 m. This wall will reduce the grading requirements of the existing esker and will limit the cut beyond the limits of the property owned by the Ministry. The esker is about 12 m high with an average slope of 2.6:1 at Sta. 10 + 206.

### WALL FOUNDATION

In view of the encountered subsoil conditions, it is recommended that the wall be founded within the original material at or below El.308.5. For the purpose of the Ontario Highway Bridge Design Code, the following design values are recommended:

#### Subsoil:

Net Safe Pressure: 400 kPa  
Factored Bearing Capacity at U.L.S.: 1100 kPa  
Bearing Capacity at S.L.S. Type II: 400 kPa  
Friction Coefficient Between Soil and Base: 0.50  
Frost Protection Requirement: 1.3 m  
Unit Weight of Subsoil: 21.2 kN/m<sup>3</sup>

#### Granular Backfill:

Angle of Internal Friction:  $\phi = 30^\circ$   
Unit Weight: 20 kN/m<sup>3</sup>  
Earth pressures should be computed (considering active state)  
as per Subsection 6.6.1.2.2. of the O.H.B.D.C.

In order to prevent the washout of the fines from the backfill and original soil, a filter medium should be installed between the backface of the wall and the granular backfill.

:  
Our calculations are based on a 3 m wide footing.

MISCELLANEOUS

The supervision of the field work was carried out by Mr. B. Ruck, Trainee Engineer. This report was written by Mr. P. Payer and reviewed by Mr. K.G. Selby. The equipment used was owned and operated by Atcost Soil Drilling Inc.



*P. Payer*  
P. Payer, P.Eng.  
Foundations Engineer

*K. G. Selby*

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

A P P E N D I X

# RECORD OF BOREHOLE No 1

METRIC

W P 31-76-09 LOCATION Co-ords. N 4 808 308.5; E 231 690.0 ORIGINATED BY BR  
 DIST 3 HWY 8N BOREHOLE TYPE Cont. Flight Auger (H.S.) COMPILED BY PP  
 DATUM Geodetic DATE 83 02 23 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES										
310.3	Ground Level														
0.0	Sand and Gravel Some Silt Trace of Clay V. Dense		1	SS	67		310							14 77 7 2	
			2	SS	77		308							50 34 14 2	
			3	SS	114									57 30 10 3	
			4	SS	96										
			5	SS	85		306								
			6	SS	86										
			7	SS	100/13 cm		304								50 34 12 3
			8	SS	130										
			9	SS	106										
			10	SS	90/15 cm		302								32 50 14 4
			11	SS	100/15 cm										
300.2					12	SS	78/15 cm								
10.1	End of Borehole														

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 2

METRIC

W P 31-76-09 LOCATION Co-ords. N 4 808 338.6; E 231 625.0 ORIGINATED BY BR  
 DIST 3 HWY 8N BOREHOLE TYPE Cont. Flight Auger (H.S.) COMPILED BY PP  
 DATUM Geodetic DATE 83 02 24 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
309.6	Ground Level										
0.0	Sandy Silt, Traces of Gravel and Clay		1	SS	23	Dry					6 25 67 2
308.3	Compact		2	SS	37						59 33 7 1
1.3	Sand and Gravel, Traces of Silt and Clay Dense to V. Dense		3	SS	110/	28cm					
			4	SS	43						
305.3			5	SS	98						81 16 2 1
4.3	End of Borehole										

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 3

METRIC

W P 31-76-09 LOCATION Co-ords. N 4 808 386.0; E 231 576.5 ORIGINATED BY BR  
 DIST 3 HWY 8N BOREHOLE TYPE Cont. Flight Auger (H.S.) COMPILED BY PP  
 DATUM Geodetic DATE 83 02 23 CHECKED BY EP

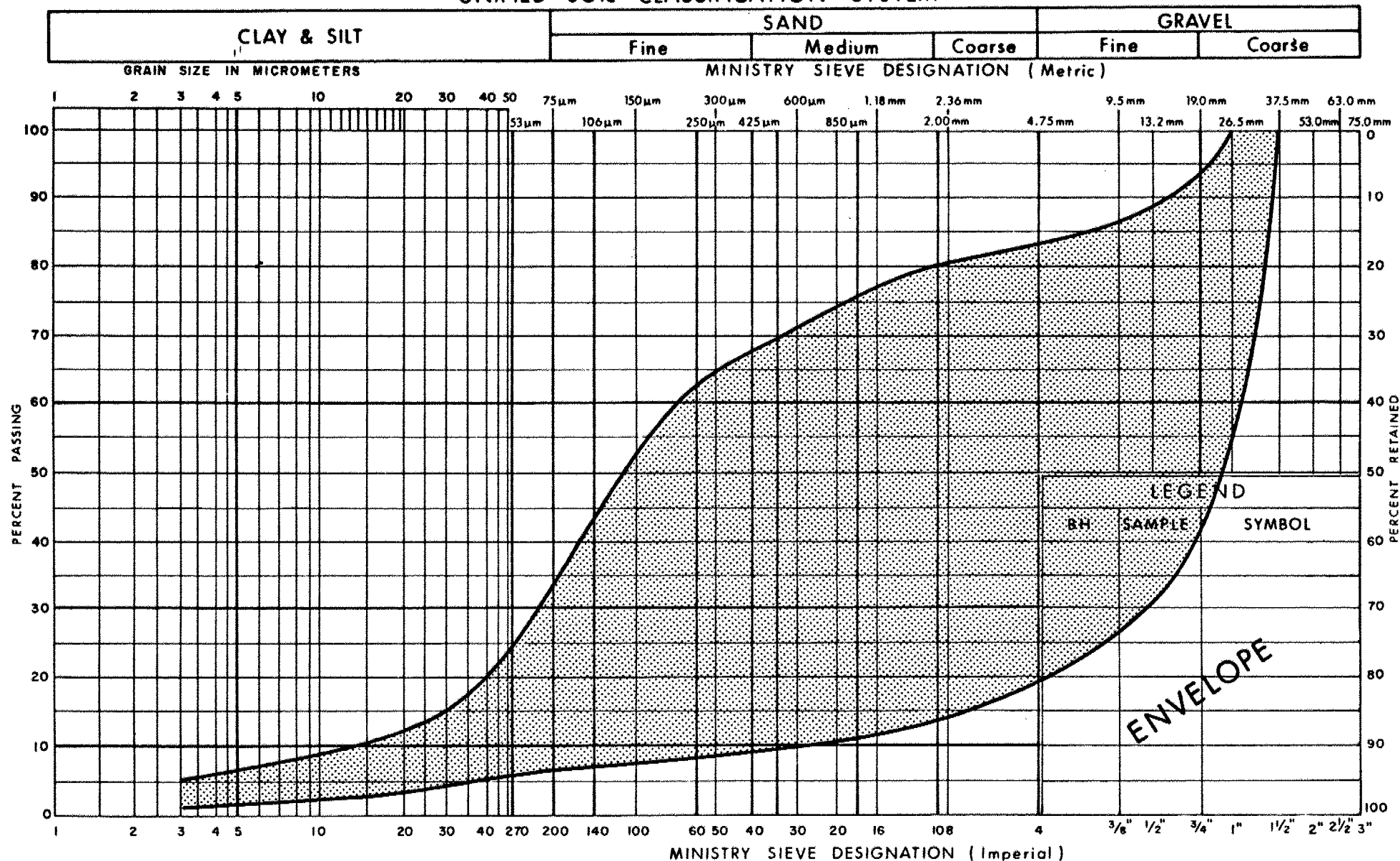
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
310.2	Ground Level										
0.0	Sand and Gravel Some Silt Trace of Clay V. Dense		1	SS	70	15cm					60 27 10 3
			2	SS	59						17 51 29 4
			3	SS	82	Dry					
			4	SS	109						
			5	SS	90						41 46 9 4
			6	SS	114						0 72 27 1
304.7	Silty Sand		7	SS	70	3 cm					42 42 14 2
5.5	End of Borehole										

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

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

FIG No 1

W P 31-76-09

## 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 (RQD), FOR MODIFIED RECOVERY, IS:

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$
$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### STRESS AND STRAIN

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w - w_p}$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

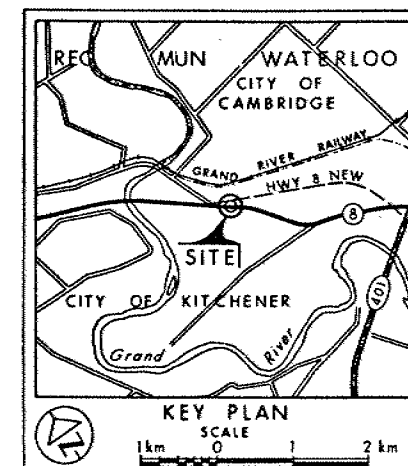
CONT No  
WP No 31-76-09



RET WALL Hwy 8N & Freeport Dr  
STA 10+145 TO STA 10+260  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

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



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 83 02 28
- Bore Hole 2 and 3 were Dry

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	310.3	4 808 308.5	231 690.0
2	309.6	4 808 338.6	231 625.0
3	310.2	4 808 386.0	231 576.5

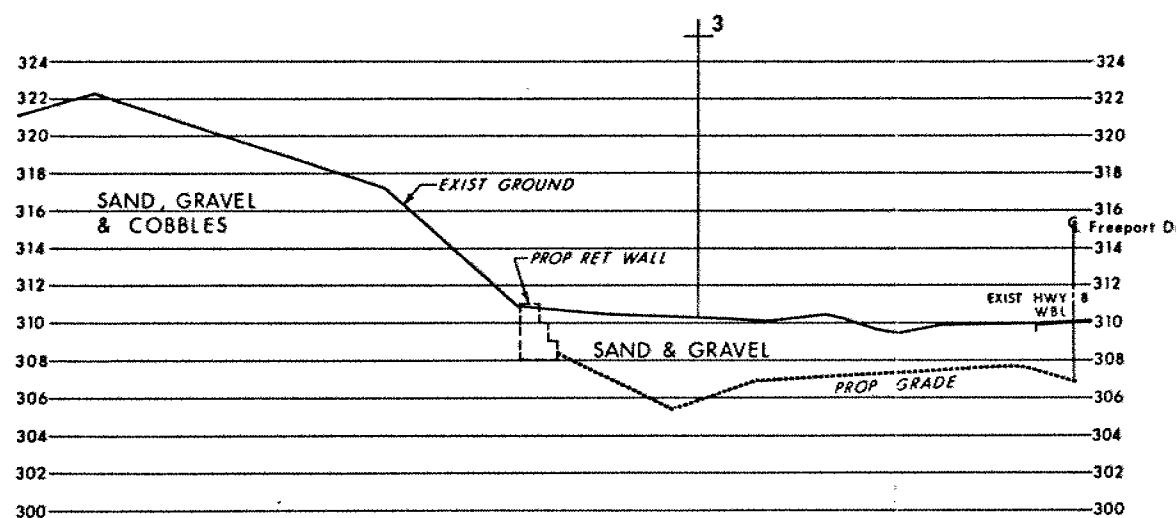
**NOTE**

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

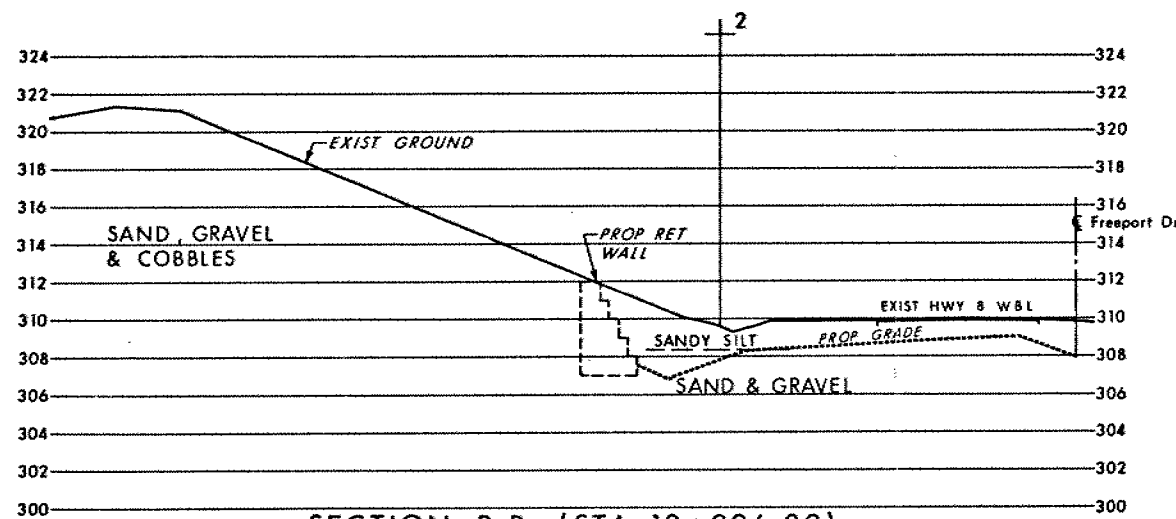
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

REV.	DATE	BY	DESCRIPTION
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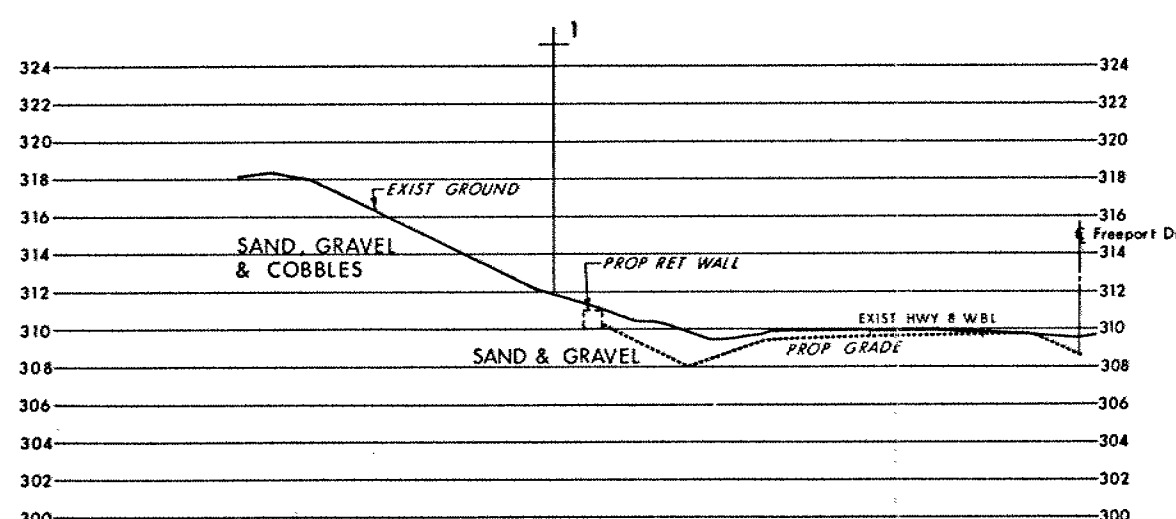
Geocres No 40P8-89  
HWY No 8N & FREEPORT DR DIST 3  
SUBM'D PP CHECKED DATE 1983 04 18 SITE  
DRAWN BY CHECKED APPROVED DWG 317609-A



SECTION A-A (STA 10+150.00)

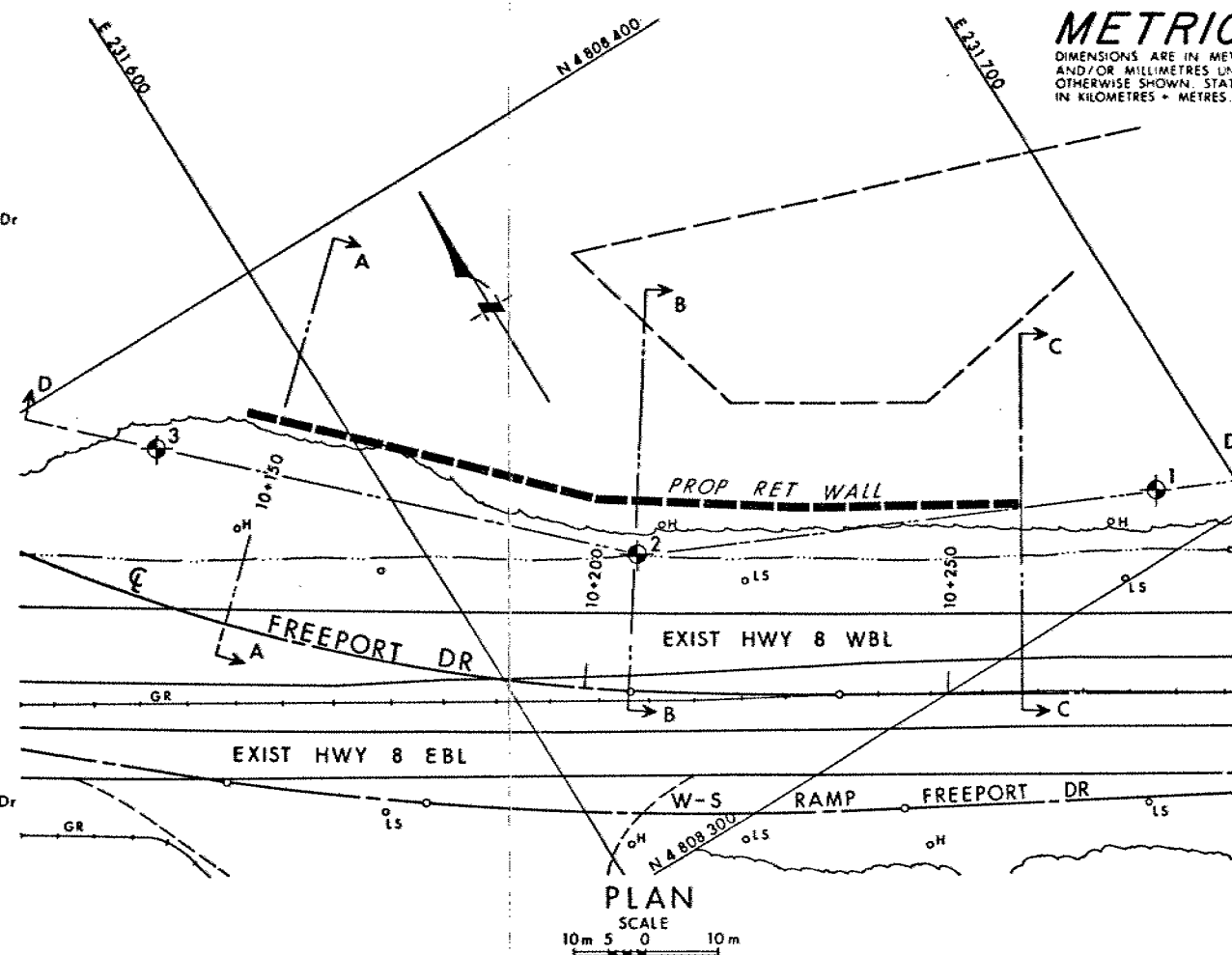


SECTION B-B (STA 10+206.00)



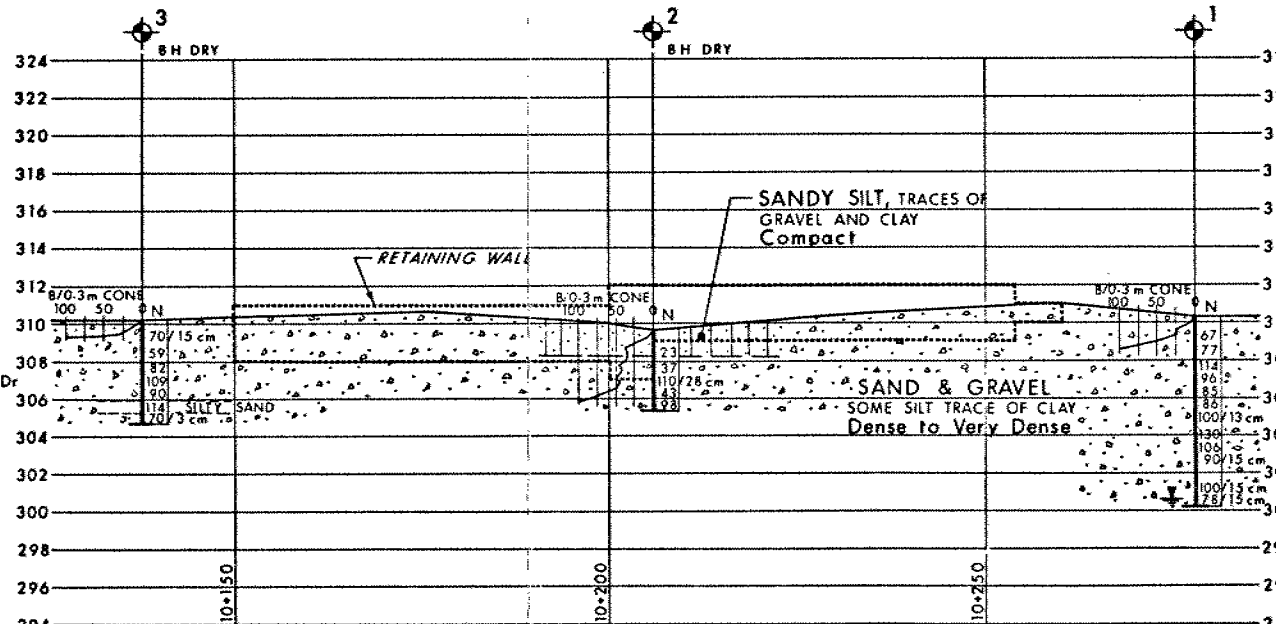
SECTION C-C (STA 10+260.00)

SCALE  
4m 2 0 4m



PLAN

SCALE  
10m 5 0 10m



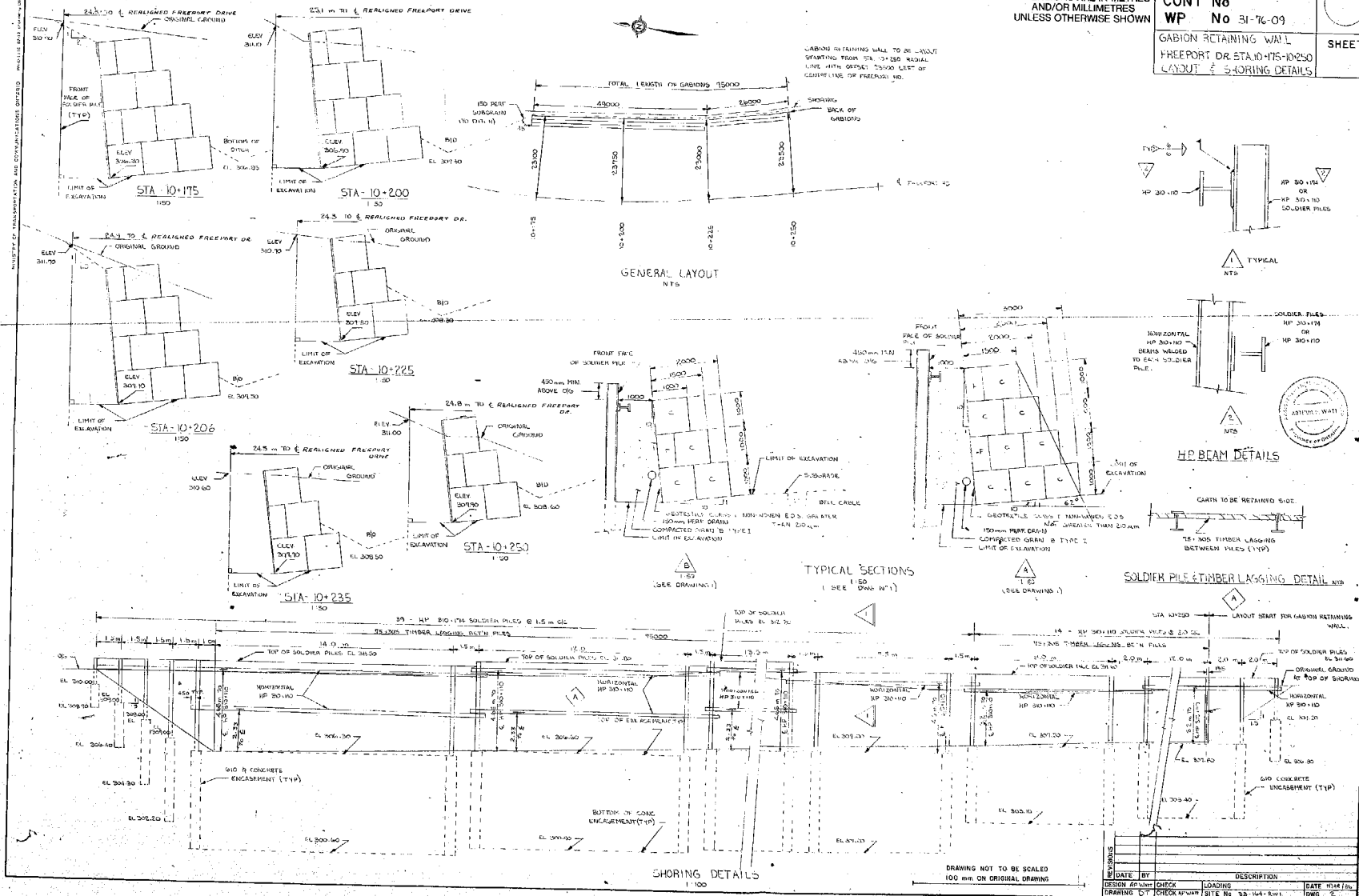
SECTION D-D (THROUGH BORE HOLES)

SCALE  
HOR 10m 5 0 10m  
VERT 4m 2 0 4m



DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

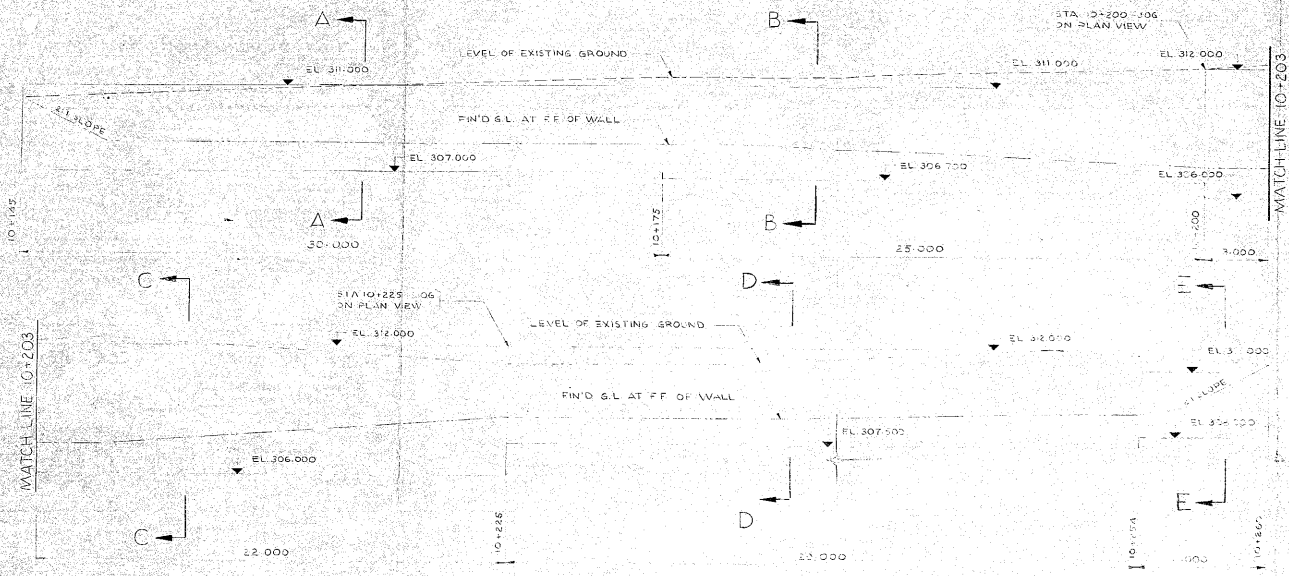
GABION RETAINING WALL  
FREEPORT DR. STA. 10+175-10+250  
LAYOUT & SHORING DETAILS



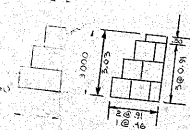
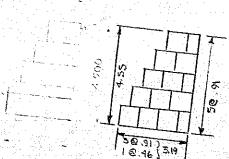
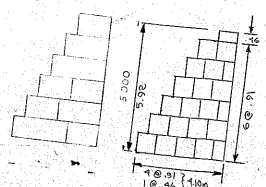
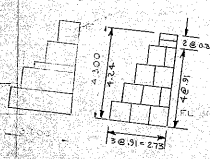
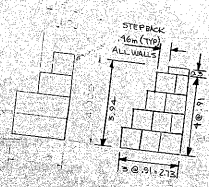
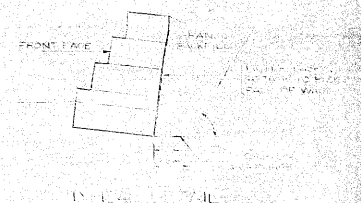
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

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

HWY 3N	DIST. 2	
<b>CONT No</b> <b>WP</b> No 31-76-09	<b>SHEET</b>	
FREEPORT GABION RETAINING WALL		



**ELEVATION OF FRONT FACE**  
 1110



**SECTIONS**  
 1110

DRAWINGS NOT TO BE SCALED  
 100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION	DATE
DESIGN	W.S.S.	CHECK & P.W. LOADING	
DRAWING	N.H.	CHECK & S.G. SITE No.	