

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

W0 82-26025

DIST 4

HWY GO-ALRT

STR SITE

GO-ALRT, West Extension, Oakville Project  
- Bronte Creek GO-ALRT Bridge

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FOUNDATION INVESTIGATION REPORT  
FOR  
W.O. 82-26025  
District 4, Hamilton  
GO-ALRT, West Extension, Oakville Project  
- Bronte Creek Bridge

INTRODUCTION

This report summarizes the results of the foundation investigation for the proposed structure.

The fieldwork was conducted during the period from 83 10 31 to 83 11 11 utilizing continuous flight auger machines equipped with hollow-stem and solid-stem augers and BXL core barrels, and a modified diamond drill equipped with BX casing and a BXL core barrel.

This work consisted of:

- 6 dynamic cone penetration tests/sampled boreholes/rock cores,
- 1 dynamic cone penetration test/sampled borehole.

SITE DESCRIPTION

This site is located at Bronte Creek in the Town of Oakville, approximately 650 m south of the QEW. The GO-ALRT alignment is on the existing Ontario Hydro right-of-way, with the CNR to the south.

The area is described physiographically by Chapman and Putnam (1969) as the South Slope, which, in the vicinity of the site, consists generally of a shale plain overlain by a veneer of glacial drift. These soils have originated, to a large extent, from the underlying bedrock, although some imported glacial material is also present.

Topographically, this site consists of a flat plain, dissected by the valley of Bronte Creek. This valley is approximately 175 m wide and 20 m deep, with valley slopes in the order of 1.8 horizontal to 1 vertical.

The land use in the area is light industrial.

## SUBSURFACE CONDITIONS

### General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data, are shown on the Borehole Locations & Soil Strata Drawing for Bronte Creek.

Outside of the creek valley, the overburden generally consists of  $2\pm$  m of stiff to hard silty clay overlying the Queenston Formation shale bedrock. The elevation of the bedrock surface is estimated at  $102\pm$  m - the upper  $1\pm$  m being weathered. Below the weathered zone, the bedrock is generally sound and intact.

Within the creek valley the overburden at the pier locations consists of up to 2.4 m of soft to hard silty clay with gravel and occasional boulders. The elevation of the bedrock surface varies from 83.2 to 84.3 m - the upper  $1\pm$  m being weathered.

It was necessary to extrapolate the subsurface conditions for the west abutment footing location because of property and utility constraints. BH #36 and BH#37 are located in an area affected by the TransNorthern Pipeline trench.

### Overburden

#### SILTY CLAY

This soft to hard (typically stiff to hard) material is cohesive with low plasticity.

It contains occasional shaly layers, traces to with sand, traces to and gravel, and occasional boulders. The content of gravel and boulders is considerably higher within the creek valley, especially at the present and previous stream channels.

This material overlies the bedrock and ranges in thickness;

- from 1.2 to 4.1 m at the borehole locations outside the creek valley,
- from 0.9 to 2.4 m at the borehole locations within the creek valley.

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

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (w)	4.0 - 18.0 %	8.8 %	8.0 %
Liquid Limit ( $W_L$ )	18.0 - 31.5 %	24.2 %	25.0 %
Plastic Limit ( $W_p$ )	14.5 - 17.5 %	15.8 %	15.5 %

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

#### Bedrock

The site is underlain by shale of the Queenston Formation. The shale is predominantly red containing occasional (approximately 5%) green shale and siltstone layers. BH #40 and BH #41, drilled in the river valley, indicate the presence of stronger limestone layers (20-50%) from approximately 10 to 300 mm thick. The upper bedrock is weathered to varying degrees (see borehole logs), and becomes sound with depth. The sound bedrock is generally massive (i.e. it is not intersected by natural discontinuities) and is estimated to be of low unconfined compressive strength (i.e. 4 - 15 MPa). Refer to Table 1 (Appendix) for descriptions of the rock core that was recovered at this site.

#### Groundwater

Stabilized groundwater conditions were difficult to establish because of the impermeable nature of the overburden and the generally intact nature of the bedrock. At the time of the field investigation, the groundwater elevation was estimated at elevation 103.5±m at the east bank; at elevation 102.5± m at the west bank; and at the surface within the creek valley. Slight fluctuations in this level are expected to occur seasonally.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a 5-span bridge to carry the proposed GO-ALRT over Bronte Creek at a grade of 104± m.

### General Recommendations

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation with  $K_o = 0.43$  and  $\gamma = 22.0 \text{ kN/m}^3$  for Granular A backfill;  $K_o = 0.5$  and  $\gamma = 21.2 \text{ kN/m}^3$  for Granular C backfill.
- For frost protection, cover should be greater than 1.2 m.
- The minimum cover required for scour protection should be determined from hydrological data.
- No stability problems are anticipated for embankments or cuts with slopes of 2:1 or flatter. If steeper slopes are required please contact this section for recommended slope angles and erosion protection.
- The existing valley slopes are acceptable provided that any disturbance during construction is restored and erosion protection is provided.
- Differential settlements in the structures will be negligible.
- Dewatering is not anticipated to be a major problem because of the impermeable nature of the overburden and the generally intact nature of the bedrock. In most cases, it is believed that groundwater entering excavations can be controlled by conventional pumping techniques. However, due to the variable nature of the sediments in the creek valley a dewatering scheme will be required if piers are to be constructed in the dry.
- Excavations in bedrock may be accomplished without blasting techniques.

### Design Details

Two alternatives are recommended.

The piers may be founded on spread footings at or below the elevations indicated in Table A;

- i) within Zone 2 (weathered bedrock),
- or ii) within Zone 3 (sound bedrock).

Table A

Footing	Location (Sta.)	Elevation	
		Zone 2 (weathered bedrock)	Zone 3 (sound bedrock)
Pier 1	17 + 100 ±	84.2 m	82.9 m
Pier 2	17 + 152 ±	N/A	83.0 m
Pier 3	17 + 186 ±	83.5 m	82.2 m
Pier 4	17 + 220 ±	84.3 m	83.5 m

The abutments should be founded within the sound bedrock on spread footings with the entire footing base located within Zone 3 as shown on Figure A. Figure A also indicates estimated subsurface conditions at the valley slopes.

For all foundations, all soft or loose material at the proposed footing locations should be removed, and the foundation surface should be covered within 12 hours of exposure with a 15 cm pad of mass concrete.

The drainage course that has created the gully at the proposed west abutment location should be directed away from the structure in such a way as to control erosion of the valley slopes.

Where trenches (e.g. underground utilities) are encountered they should be excavated to sound bedrock and backfilled (within 12 hours of exposure) with mass concrete.

For resistance to lateral forces,

- a) key footing into bedrock a minimum of 0.5 m and use a friction coefficient of 0.25 between the bedrock and the footing,
- or b) dowel into bedrock a minimum of 1.5 m (as a design example a 5 cm diameter dowel installed as recommended will provide a safe shearing resistance of approximately 20 kN per dowel).

The following design values are recommended for footings within the indicated foundation zones:

- net safe bearing pressure
  - for Zone 2 = 670 kPa
  - for Zone 3 = 1000 kPa

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

- Factored Bearing Capacity at U.L.S.
  - for Zone 2 = 1000 kPa
  - for Zone 3 = 1500 kPa
- Bearing Capacity at S.L.S. Type II will not govern design.

#### MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. P. Dempsey, Student Specialist, and Mr. D. H. Dundas, Foundations Engineer. The description and evaluation of the bedrock was carried out by Mr. E. Magni, Geologist.

The report was written by Mr. Dundas, and reviewed by Mr. K. G. Selby, Senior Foundations Engineer.

The equipment used was owned and operated by Atcost Soil Drilling Inc.



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

*K. G. Selby*

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

## APPENDIX



# RECORD OF BOREHOLE No 36

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION Co-ords N 4 806 740.0, E 285 522.0

ORIGINATED BY DD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, H-S Auger, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE 83 10 31

CHECKED BY SO

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE								
103.5	Ground Surface										GR SA SI CL
0.0	Silty Clay (CL) occ. shaly layers some/with sand some gravel Very Stiff to Hard	1	SS	38							
	occ. boulders	2	SS	120/22 cm							24 38 27 11
		3	RC BXL	10%							
99.5											
4.0	weathered sound	4	RC BXL	67%							
	Bedrock Queenston Formation shale	5	RC BXL	100%							
97.4											
6.1	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 37

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION Co-ords. N 4 806 725.0, E 285 511.0

ORIGINATED BY PD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, H-S Auger

COMPILED BY DD

DATUM Geodetic

DATE 83 10 31

CHECKED BY SO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		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			20 40 60 80 100	SHEAR STRENGTH					
103.4	Ground Surface													
0.0	Silty Clay (CL) occ. shaly layers some/with sand trace/with gravel occ. lenses of silty sand Stiff to Hard		1	SS	20									
			2	SS	36									37 39 20 4
	occ. boulders		3	SS	58									
			4	SS	38									3 13 69 15
99.3			5	SS	54									
4.1	Bedrock Weathered Queenston Formation Shale		6	SS	60/15	cm								32 39 22 7
97.2			7	SS	60/5	cm								
6.2	End of Borehole  * water level not observed													

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 38

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION

Co-ords. N 4 806 752.0, E 285 549.0

ORIGINATED BY PD

DIST 4

HWY GO-ALRT

BOREHOLE TYPE

Cone Test, NX Casing, BXL Core

COMPILED BY DD

DATUM

Geodetic

DATE

83 11 08

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	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								
85.2	Ground Surface												
0.0	Silty Clay (CL) * occ. shaly layers Soft to Hard		1	SS	75	25 cm	85						15 7 64 14
84.3			2	RC BXL	97		84						
0.9	weathered sound		3	RC BXL	100		83						
	Bedrock Queenston Formation Shale						82						
80.9							81						
4.3	End of Borehole * trace/some sand trace/some gravel												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 39

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION

Co-ords. N 5 806 779.0, E 285 570.0

ORIGINATED BY PD

DIST 4

HWY GO-ALRT

BOREHOLE TYPE

Cone Test, NX Casing, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE

83 11 09

CHECKED BY SO

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						
85.2	Ground Surface										
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace/and gravel Soft to Hard		1	SS	37		85				54 18 22 6
83.5			2	SS	188/20	20 cm	84				2 10 68 20
1.7	<del>weathered</del> sound		3	RC BXL	95%		83				
	Bedrock Queenston Formation Shale		4	RC BXL	100%		82				
80.3							81				
4.9	End of Borehole										

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 40

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION Co-ords. N 4 806 807.0, E 285 591.0

ORIGINATED BY PD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, NX Casing, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE 83 11 14

CHECKED BY SO

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								
85.0 0.0	Ground Surface											
83.2 1.8	Silty Clay (CL) occ. shaly layers trace/some sand trace/with gravel Firm to Hard		1	SS	22							38 24 31 7
			2	SS	115/20 cm							31 14 43 12
	Bedrock Queenston Formation Shale		3	RC BXL	95%							
80.1 4.9	End of Borehole		4	RC BXL	98%							

OFFICE REPORT ON SOIL EXPLORATION

Bronte Creek Bridge										RECORD OF BOREHOLE No 41										METRIC									
WO 82-26025					LOCATION Co-ords. N 4 806 839.0, E 285 616.0					ORIGINATED BY PD																			
DIST 4 HWY GO-ALRT					BOREHOLE TYPE Cone Test, NX Casing, BXL Core					COMPILED BY DD																			
DATUM Geodetic					DATE 83 11 17					CHECKED BY SO																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)	10 20 30																
86.6	Ground Surface																												
0.0	Silty Clay (CL) occ. shaly layers trace/with sand trace/with gravel Firm to Hard		1	SS	36										25 27 37 11														
			2	SS	85																								
84.2	occ. boulders		3	SS	182										39 20 34 7														
2.4			4	RC BXL	100%																								
	weathered sound																												
	Bedrock Queenston Formation Shale		5	RC BXL	94%																								
81.0																													
5.6	End of Borehole																												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15  $\pm$  5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 42

METRIC

Bronte Creek Bridge

WO 82-26025

LOCATION Co-ords. N 4 806 873.0, E 285 642.0

ORIGINATED BY HI

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, NX Casing, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE 83 11 10-11

CHECKED BY SO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	Wp	W	WL		
104.2	Ground Surface												
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace/some gravel occ. boulders Soft to Hard		1	SS	60	15 cm							
103.0			2	SS	60	15 cm							
1.2			3	SS	60	8 cm							
	weathered sound		4	RC BXL	80%								
	Bedrock Queenston Formation Shale		5	RC BXL	93%								
99.4													
4.8	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

\*3, \*5: Numbers refer to  
Sensitivity

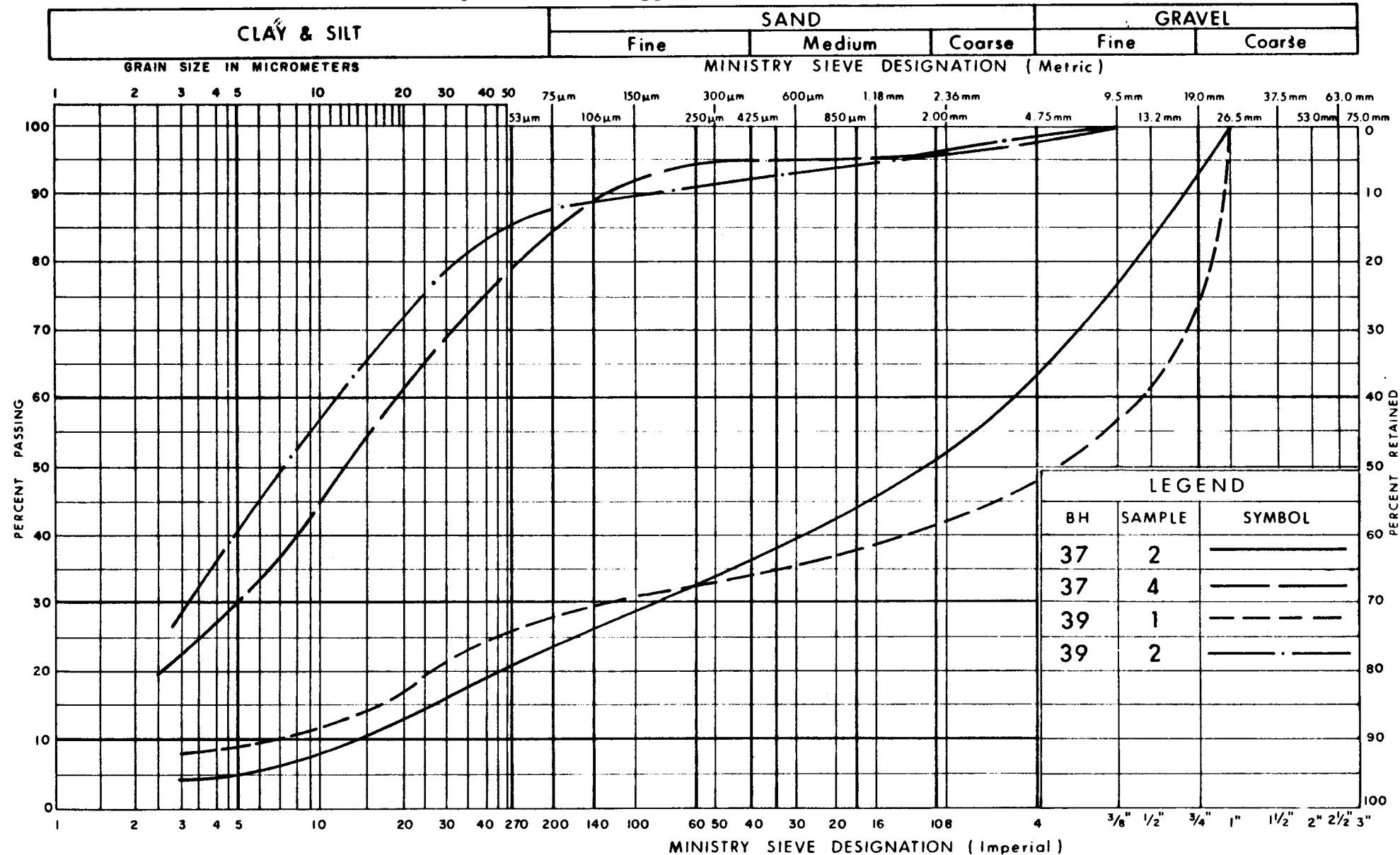
20  
15 5 (%) STRAIN AT FAILURE  
10

TABLE 1  
DESCRIPTION OF ROCK CORE - BRONTE CREEK

BOREHOLE NUMBER	CORE RECOVERY		CORE DESCRIPTION	
	DEPTH (m)	%	DEPTH (m)	DESCRIPTION
36	4.0 - 5.4	67	4.0 - 4.6	Shale, red (Queenston Fm), highly weathered
	- 6.1	100	4.6 - 6.1	Shale, red (Queenston Fm), sound
38	1.2 - 2.7	97	1.2 - 1.7	Shale, red (Queenston Fm), moderately weathered
	- 4.3	100	1.7 - 4.3	Shale, red (Queenston Fm), sound, containing approximately 5% green siltstone layers
39	1.8 - 3.4	95	1.8 - 2.3	Shale, red (Queenston Fm), highly weathered, occasional siltstone layers
	- 4.9	100	2.3 - 3.0	Shale, red (Queenston Fm), slightly weathered
			3.0 - 4.9	Shale, red and green (Queenston Fm), sound
40	1.9 - 3.4	95	1.9 - 2.0	Shale, red (Queenston Fm), highly weathered
	- 4.9	98	2.0 - 2.4	Shale, red (Queenston Fm), slightly weathered
			2.4 - 4.9	Shale, red and green (Queenston Fm), sound, containing approximately 50% limestone layers
41	2.4 - 4.0	100	2.4 - 2.6	Shale and limestone (Queenston Fm), highly weathered
	- 5.6	94	2.6 - 3.7	Shale, green and red (Queenston Fm), sound
			3.7 - 5.0	Shale, red (Queenston Fm), highly weathered
			5.0 - 5.6	Shale, red and green (Queenston Fm), sound
42	2.1 - 3.7	80	2.1 - 2.4	Shale, red (Queenston Fm), slightly weathered
	- 4.8	93	2.4 - 4.8	Shale, red and green (Queenston Fm), sound



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

# GRAIN SIZE DISTRIBUTION SILTY CLAY

OCC SHALY LAYERS, TRACE/WITH SAND, TRACE/ & GRAVEL, OCC BOULDERS

FIG No 1

GO - ALRT

BRONTE CREEK BRIDGE

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	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

### 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 = $\frac{c_u}{\tau_r}$

### 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 = $w_L - w_p$	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	$\text{kN}/\text{m}^3$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

# BRONTE CREEK

CONSTRUCTION EAST →

FIG A-1 - WEST ABUTMENT

FIG A-2 - EAST ABUTMENT

SCALE HOR 1:500  
VERT 1:100

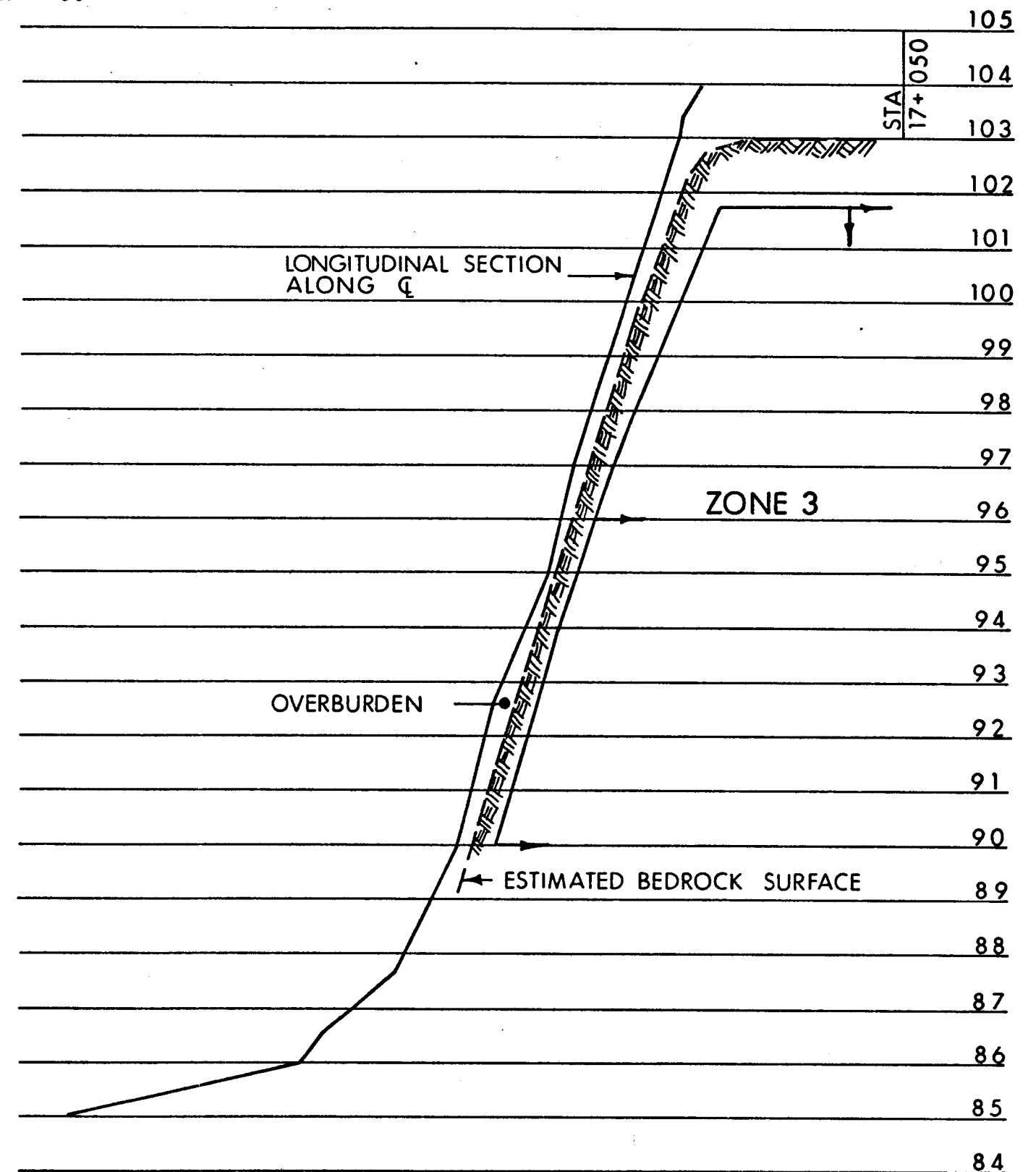
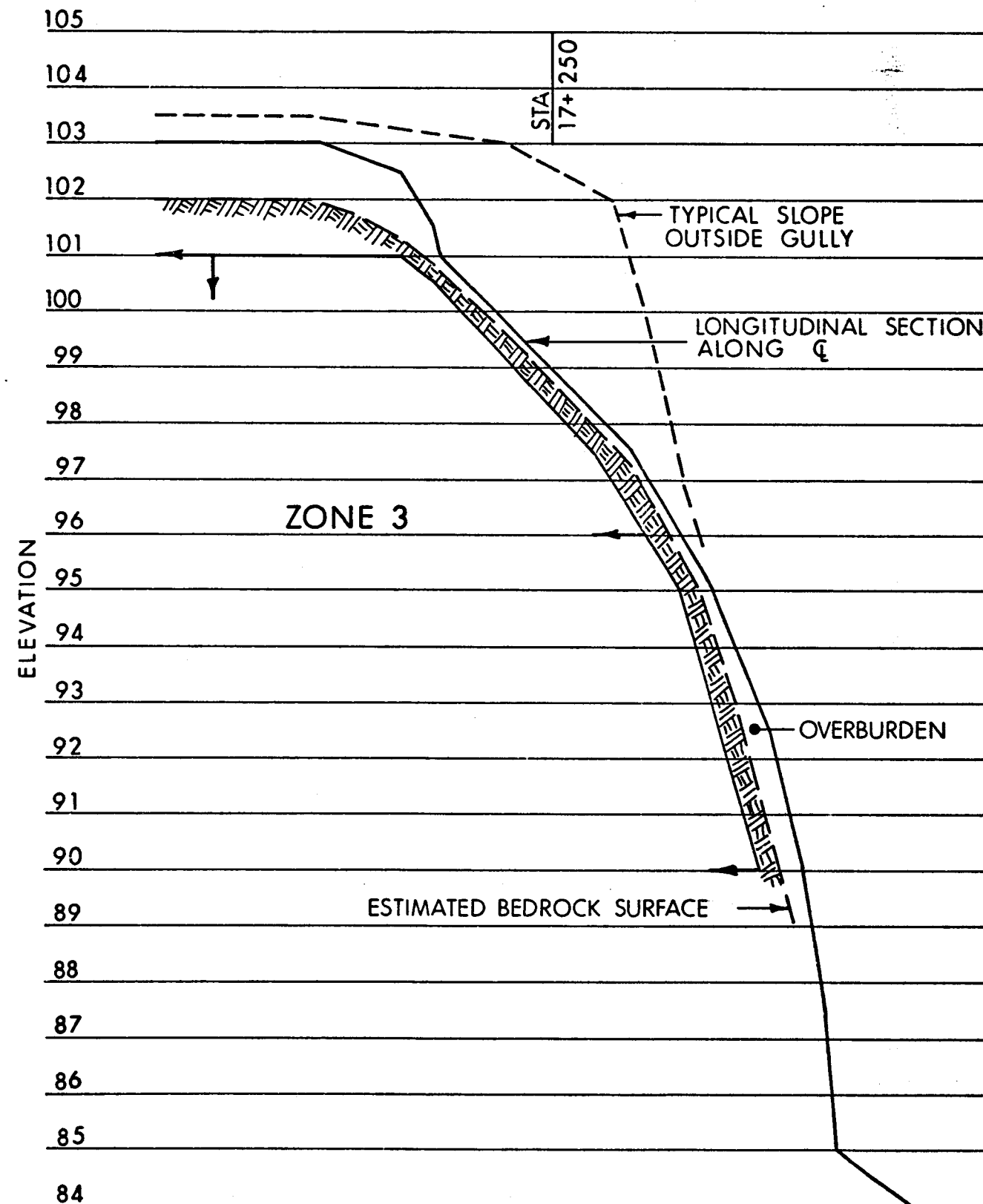
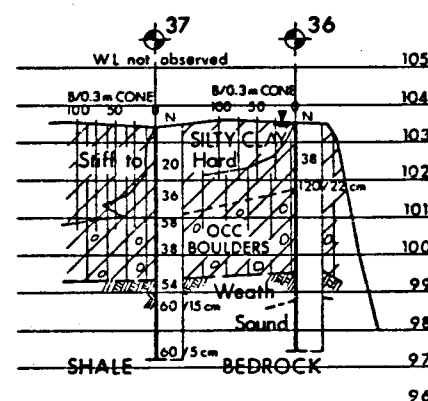
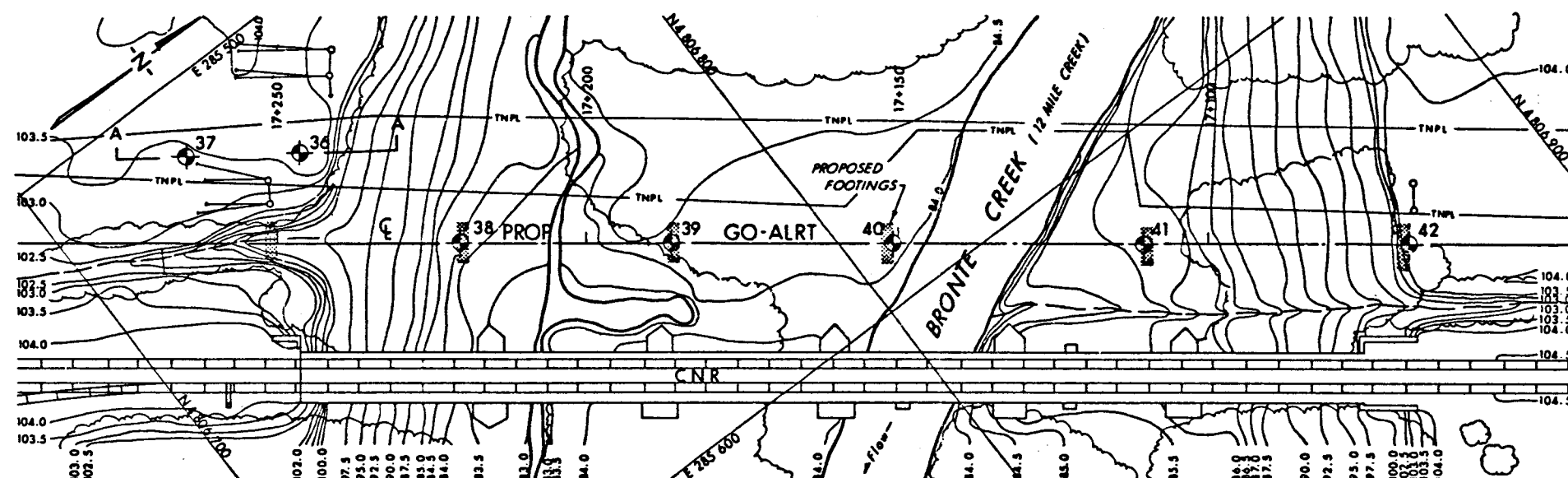
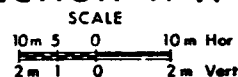


FIG A - ABUTMENT FOOTINGS  
GO-ALRT WEST EXTENSION-OAKVILLE PROJECT

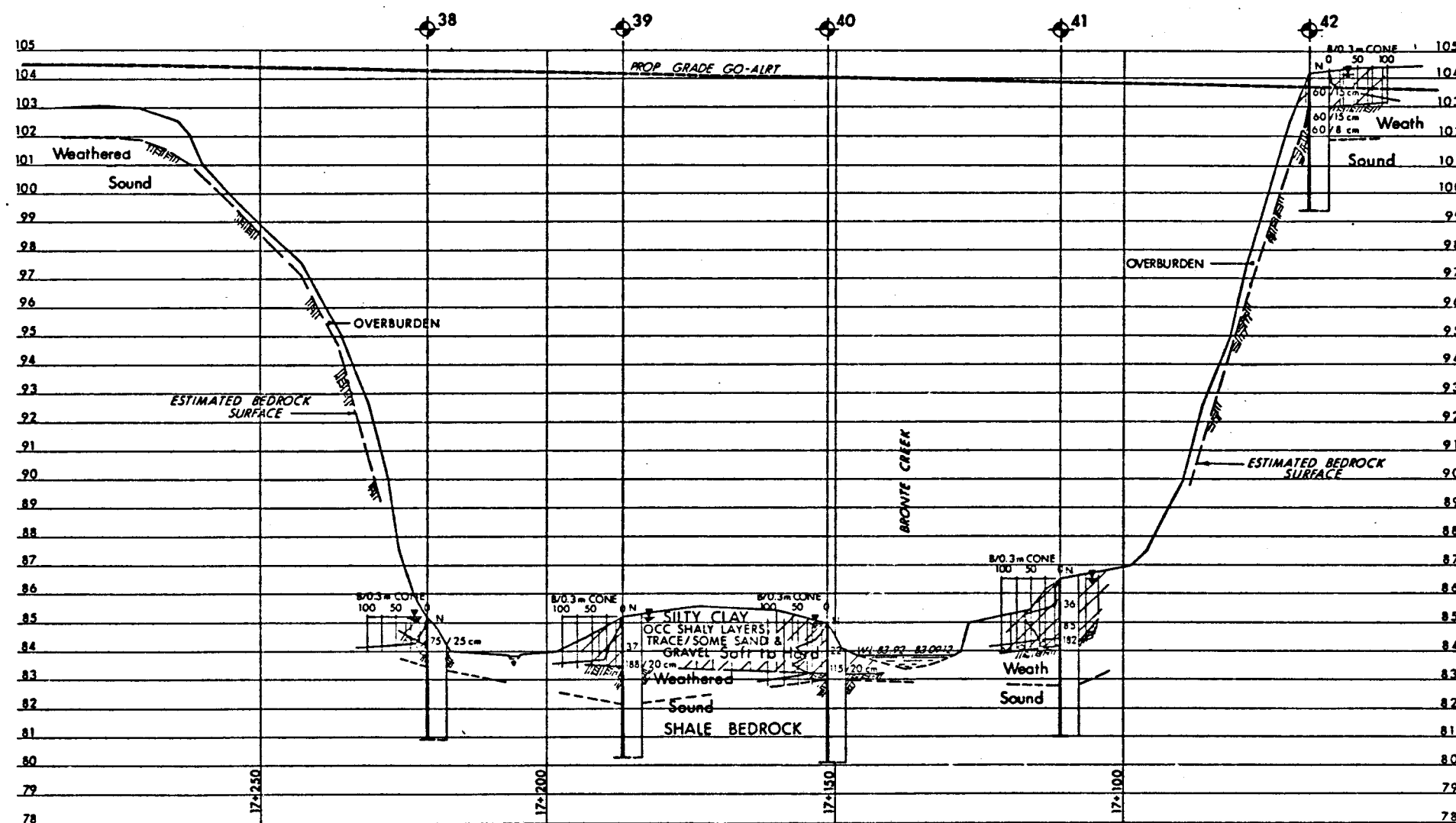
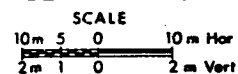
ALL DIMENSIONS SHOWN ARE  
IN METRES AND/OR MILLI-  
METRES UNLESS OTHERWISE  
NOTED.







**SECTION A-A**



Q PROFILE PROP GO-ALRT



### LEGEND

- |   |                                       |
|---|---------------------------------------|
|  | Bore Hole                             |
|  | Dynamic Cone Penetration Test (Cone)  |
|  | Bore Hole & Cone                      |
| N   | Blows/0.3m (Sid Pen Test, 475 J/blow) |
| CONE  | Blows/0.3m (60° Cone, 475 J/blow)     |
|  | WL at time of investigation 83 10&11  |

No	ELEVATION	CO - ORDINATES	
		NORTH	EAST
36	103.5	4 806 740.0	285 522.0
37	103.4	4 806 725.0	285 511.0
38	85.2	4 806 752.0	285 549.0
39	85.2	4 806 779.0	285 570.0
40	85.0	4 806 807.0	285 591.0
41	86.6	4 806 839.0	285 616.0
42	104.2	4 806 873.0	285 642.0



Geocres No 30MS-139

**==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.

60-ALRT REF PD2-300-

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: SO 1984 01 06		DESIGNED BY: LLO		ENGINEERING MATERIALS OFFICE FOUNDATION DESIGN SECTION		 Ministry of Transportation and Communications OAKVILLE PROJECT - WEST EXTENSION		HALTON REGION BRONTE CREEK BRIDGE BORE HOLE LOCATIONS & SOIL STRATA STA 17+152			
				CHK'D BY: 		APPROVED BY: K.L.S.						CONTRACT NO	DWG NO	REV	SHEET
				SCALE: FULL SIZE ONLY						PROJECT MANAGER					
				AS SHOWN											