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STR. SITE No. 47-24

HWY. No. 11

LOCATION Hwy 11 & Aidie Creek

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

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foundation investigation and design report

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WP	130-88-01	DIST	53
HWY	11	STR SITE	47-24

Aidie Creek Bridge at Hwy. 11

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GEOCRES 31M-56

DATE MAY 29 1995

FOUNDATION INVESTIGATION REPORT
For
Aidie Creek Bridge at Hwy. 11
W.P. 130-88-01, Site 47-24
District 53, New Liskeard

INTRODUCTION

This report summarizes the results of the foundation investigation conducted at Aidie Creek Bridge, Hwy. 11. The investigation was carried out upon the request of the Northern Region Structural Section for the proposed widening or replacement of the existing crossing at Aidie Creek. The field work for the investigation was carried out between 94 11 18 and 94 11 21 and consisted of six (6) sampled boreholes.

SITE DESCRIPTION

The site is located on Hwy 11 at Aidie Creek about 12 km north of Englehart, in the Twp of Chamberlain, District of Timiskaming.

According to the Northern Ontario Engineering Geology Terrain Study published by the Ministry of Natural Resources, the site is located in a glaciolacustrine plain with a mixture of clay, sand and silt materials. It is generally of low relief, but has somewhat higher elevations and is characterized by more rugged topography with numerous bedrock outcrops and extensive sand plains.

The existing crossing is a rigid frame structure with a span length of 12 ±m. It was constructed in 1939 and has badly deteriorated over the years. At many locations of the structure, surface concrete has spalled off and underlying longitudinal bars and stirrups are exposed. The abutment slopes are standing at an angle of 1.25H:1V approximately and consists of rock fill with rock sizes up to 300 ±mm. The embankment slopes are generally flat and grassed. No obvious sign of distress was noted on the pavement or the slopes around the structure location.

Apart from the highway corridor, the area to the south west of the site is used as a picnic area with a small scenic falls in the vicinity.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing.The procedures employed are discussed below.

Field

The field work for the investigation was carried out between 94 11 18 and 94 11 21 and consisted of six (6) sampled boreholes which were advanced to depths of 2.8 to 7.3 m. Rock coring was carried out in all the boreholes to verify bedrock.

The boreholes were advanced using conventional hollow stem augering techniques. Boreholes were sunk by a track mounted continuous flight auger drill rig. The sampling program consisted of split spoon samples collected in the overburden. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). They provided Standard Penetration Resistance ('N') values for assessment of the denseness of the non-cohesive material. Bedrock was cored at all the hole locations. Wire line rock coring techniques were applied in retrieving rock core samples for rock quality determination and classification purposes. Standard NW core barrels and casings were used.

All subsoil samples and rock cores were identified in the field and returned to the laboratory for further examination and appropriate testing.

The groundwater was monitored in all open boreholes. All the boreholes were backfilled upon completion of the fieldwork.

Survey information related to the location and elevation of the boreholes was provided by Northern Region Survey and Plans Section.

Laboratory

The laboratory testing program for selected soil samples consisted of:
- Atterburg Limit Test
- Grain Size Distribution
- Unit Weight Determinations
- Natural Moisture Content Determinations

Unconfined compression test was also carried out on some rock cores. Laboratory test results are given in the following section of this report and are also illustrated on Record of Borehole sheets included in the Appendix.

SUBSURFACE CONDITIONS

General

The Record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes are shown on Drawing No. 1308801-A.

The subsurface stratigraphy typically consists of fill material overlying native clayey silt and/or sandy silt material. Fill material was not encountered in BH 2 where drilling was advanced at the toe of the abutment slope. Bedrock was generally contacted at shallow depths (0.7-4.4 m).

Following are the specific descriptions of the material encountered in the investigation:

Fill

Fill material is encountered in all boreholes except BH 2 with thickness ranging from 0.7 to 3.7 m. The fill was probably placed during construction of the existing structure. The composition of the material various from cohesive clayey silt to non-cohesive silty sand. A bouldery layer was encountered in BH 1. No laboratory testing was carried out on samples from this strata.

The Standard Penetration Resistance 'N' values obtained range widely from 4 to 100 blows/0.15 m, which reflect the erratic nature of the fill material.

Clayey Silt

This cohesive layer was contacted in all the boreholes except BH 5. The thickness of this stratum varies from 0.5 to 2.1 m. The material contains organics at BH 2 location near the bank of the creek. At BHs 1,3 and 4, it consists of some sand. Typical properties of the material, as determined by laboratory tests on representative samples are summarized as follows:

Property	Range	No. of Tests
Natural Moisture Content (w)	15.5-37.5	6
Liquid Limit (w_L)	23-30	6
Plastic Limit (w_P)	13.5-20	6
Grain Size Distribution (%)		3
- Gravel	0-4	
- Sand	13-35	
- Silt & Clay	65-83	

Based on Standard Penetration Resistance 'N' values, the consistency of this layer varies from very soft to stiff.

Sandy Silt

This non-cohesive layer is only encountered in BHs 2 and 3. with 0.3 and 0.8 m thickness respectively. Laboratory testing carried out on the sample retrieved from BH 3 indicates a moisture content of 15% and grain size distribution of 0% gravel, 36% sand and 64% silt and clay.

Based on Standard Penetration Resistance 'N' values, the material is generally compact.

Bedrock

Bedrock was cored at all the hole locations. It is a strong slightly weathered to unweathered gneissic Granite of the Superior Province. Core recoveries obtained range from 67 to 100% and Rock Quality Designations range from 0 to 100%.

Rock cores from the field were examined and classified by MTO petrographer. Detailed descriptions of the rock are attached in the Appendix. Unconfined compression test was carried out on three rock samples, namely BH 1-RC 5, BH 2-RC 4 and BH 3-RC 4. The unconfined compressive strengths obtained are 39.0 MPa, 68.6 MPa and 86.9 MPa.

Groundwater

Groundwater measured in the open boreholes during the investigation was generally within 1 m depth. During the time of the investigation, the water level in the creek was at El. 249 m approximately. the water was about 0.6 m deep.

Seasonal fluctuations in water levels are expected.

DISCUSSION AND RECOMMENDATION

General

The existing structure at Aidie Creek on Hwy 11 has badly deteriorated. It is also of substandard width and work is required to bring this crossing up to current standards. Three options are being considered by the Region, as follows:

1. Rehabilitate and widen the existing bridge on both sides by connecting independent frames to the existing rigid frame.

2. Replace the existing structure with a new concrete rigid frame. A detour Bailey bridge is required to maintain the traffic flow during construction. Centerline of the detour is about 12 m offset to the east of the existing bridge. The grade will generally remain the same as existing.

3. Replace the existing structure with a concrete culvert with wingwalls. A detour Bailey bridge is also required in this case to maintain the traffic flow during construction. Centerline of the detour is about 15 m offset to the east of the existing bridge. There will be a minor grade raise of about 500 mm.

Drawing 1308801-A illustrates the details for the above options.

Discussion

In general, the subsurface stratigraphy consists of existing fill and native clayey/sandy silt material overlying bedrock. Bedrock is relatively shallow and dips gently from El. 251.2 m at BH 5 location in a northwesterly direction to El. 247.3 m at BH 2 location. No suitable founding material can be found above bedrock and since bedrock is shallow, it is advisable to construct the footing elements on bedrock to acquire the high bearing capacity. Based on the information provided by the Structural Section, the existing structure is founded on bedrock.

Bedrock is a strong slightly weathered to unweathered granite. It was however noticed during the foundation investigation that the bedrock was quite closely jointed near the top, probably due to blasting activities during construction of the existing bridge. In view of this, unconfined compression test was carried out on selected rock samples, and based on the results and the joint spacings, the bearing capacity of bedrock was determined.

Foundation

It is recommended to support the structure on conventional footings founded on bedrock. For footings founded on bedrock, the following design capacities are recommended as per O.H.B.D.C.:

Factored Bearing Capacity at U.L.S. = 6000 kPa
Bearing Capacity at S.L.S. does not govern

For footings founded on bedrock, frost cover is not required.

Option 1 (widening of existing structure) -

According to the information provided by Structural Section, the existing footings are founded on bedrock. Rock benches were formed to cater for the gradient of the rock line. The new footings can be constructed in the same manner. Stepped footings should be constructed at a slope no steeper than 10H:7V. In rock excavation, care should be taken to avoid affecting the integrity of the existing foundation. As an alternative to excavating to form rock benches, mass concrete filling can be used to form a flat surface for the footing. The sliding resistance between concrete and rock may be calculated using an unfactored value of 35°, provided the rock surface is relatively rough. The sliding resistance can be increased by embedding dowels into bedrock. Based on interpolations from the investigation results, the estimated bedrock surface at the footing widening locations are as follows:

Northeast	El. 248.5 ±m
Northwest	El. 247.5 ±m
Southeast	El. 249.0 ±m
Southwest	El. 247.5 ±m

The above values are for preliminary estimating purposes. Actual founding elevations have to be verified during construction. The rock surface at the footing base should be inspected and all loosened or highly fractured rock should be removed prior to placement of concrete.

Option 2 (Replacement Rigid Frame) -

The existing structure will be removed and replaced by a new structure. The existing foundation should be carefully inspected and depending on the conditions of it, it may be reused for the new structure. In that case, new foundation is only required for the widened portion of the bridge and the recommendations given above for option 1 are also valid here.

The detour Bailey bridge can also be supported by shallow footings founded on bedrock with the same bearing capacities as given above. The estimated rock surface elevations are as follows:

Northeast	El. 249.8 ±m
Northwest	El. 249.2 ±m
Southeast	El. 251.2 ±m
Southwest	El. 249.8 ±m

Alternatively, the existing overburden can be removed down to bedrock and the excavation backfilled with rock fill. The top of the rock fill should be properly chinked with small rock fragments and compacted. For foundation constructed in this manner, the bearing capacities as per O.H.B.D.C. are as follows:

Factored Bearing Capacity at U.L.S. = 700 kPa
Bearing Capacity at S.L.S. = 250 kPa

For footings constructed in this manner, frost action is negligible. In view of the temporary and flexible nature of the Bailey bridge, differential movements due to the frost action, if any, can be handled by adjusting the bridge in the field.

Option 3 (Replace with a concrete culvert) -

The proposed culvert is in a skew as shown in Figure 2. The footings elements of the culvert together with the wingwalls can also be founded on bedrock with the above design capacities. Considering three strip footings for the culvert, the estimated bedrock surface elevations based on available information are as follows:

North Strip -	From El. 249.3 ±m east to 247.3 ±m west
South Strip -	From El. 249.5 ±m east to 247.8 ±m west
Central Strip -	From El. 247.5 ±m east to 247.0 ±m west

The above values are for preliminary estimating purposes. Actual founding elevations have to be verified during construction. The rock surface at the footing base should be inspected and all loosened or highly fractured rock should be removed prior to placement of concrete.

The detour Bailey bridge can be designed with the same recommended values given in Option 2. The locations of the footing elements are slightly different from the previous option and the estimated bedrock elevations in this case are as follows:

Northeast	El. 250.0 ±m
Northwest	El. 249.5 ±m
Southeast	El. 251.5 ±m
Southwest	El. 250.5 ±m

Backfill

Granular materials such as Granular 'A' or 'B' or Rockfill are recommended for backfill to abutment walls or culvert wingwalls.

Lateral pressures should be computed as per Section 6-7.4 of the O.H.B.D.C. For the backfill, the following parameters are recommended:

Material	ϕ	γ
Granular 'A'	35°	22.8 kN/m^3
Granular 'B'	30°	21.2 kN/m^3
Rock Fill	35°	19.0 kN/m^3

The rock backfill requirements should adhere to OPSD 3505.00.

Abutment Slopes

The maximum fill height at the approaches is about 5 ±m. For earth slopes, 2H:1V are recommended. Rock fill slopes can be built with 1.5H:1V. Only free draining fill material should be used under water. The abutment slopes should be protected with rip-raps to at least 1 m above the High Water Level. If new fill is placed over an existing slope, the existing slope should be properly benched in accordance with OPSD 208.01 prior to receiving the new fill.

Construction Considerations

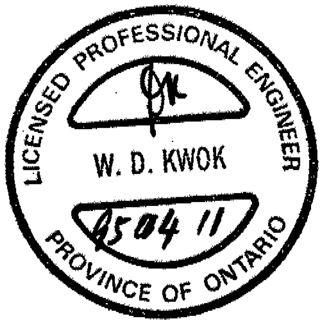
Temporary excavation slopes in the overburden can be formed at 1H:1V up to 5 ±m. For the part submerged in water, the slope has to be flattened to 1.5H:1V.

During construction of the footings, temporary dams have to be built to keep water from flowing into the excavation. Alternatively, a steel box can be used to contain the area for dewatering. If excessive seepage of water occurs in the excavation, tremie concrete can be used for the footings.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer. The equipment was owned and operated by Dominion Soil Investigations Inc. Rock cores were examined by MTO petrographer, D. Williams.

The report was written by D. Kwok, reviewed and approved by T. Kim , Senior Foundation Engineer.



D. Kwok, P.Eng.
Project Foundation Engineer

T. Kim, P. Eng.
Senior Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W.P. 130-88-01 LOCATION Sta 17+523.7 o/s 7.45 m Lt of CL Hwy 11 ORIGINATED BY DK

DIST 53 HWY 11 BOREHOLE TYPE S.S. Auger, NW Core Barrel COMPILED BY DK

DATUM Geodetic DATE 94 11 19 CHECKED BY TK

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%) (w_P, w, w_L)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
252.4	Ground Surface								
0.0	Clayey Silt with Gravel Some Sand and Organics Brown (Fill) Hard				*	252			
		1	SS	35		251			
		2	SS	28					
		3	SS	100	/15cm	250			
	Boulders					249			
248.7 / 3.7	Clayey Silt, Some Sand Seams Grey, Soft	4	SS	4			plotted		4 13 (83)
248.0 / 4.4	Bedrock	5	RC	REC	100%	248			RQD 78%
		6	RC	REC	100%	247			RQD 46%
		7	RC	REC	94%	246			RQD 50%
245.1 / 7.3	End of Borehole								

* Hole caved in at 1.5 m depth
Water level not established

Dynamic Cone Penetration Resistance Plot: 20 40 60 80 100. Shear Strength kPa: o Unconfined, + Field Vane, ● Quick Triaxial, × Lab Vane; 20 40 60 80 100. Water Content (%): 10 20 30.

$+^3$, $\times^5$: Numbers refer to Sensitivity

15-◇-5 (20 above, 10 below) (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC

W.P. 130-88-01 LOCATION Sta 17+548.0 o/s 10.85 m Lt CL Hwy 11 ORIGINATED BY DK
DIST 53 HWY 11 BOREHOLE TYPE S.S. Auger, NW Core Barrel COMPILED BY DK
DATUM Geodetic DATE 94 11 18 - 94 11 19 CHECKED BY TK

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%) (wP – w – wL)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
249.7	Ground Surface								
0.0	Clayey Silt Grey Very Soft to Soft — — — with organics					▼*	249		
			1	SS	3				
			2	SS	2		248		
247.6									
247.3	Sandy Silt with Gravel, Grey		3	SS	100	/5cm **			
2.4	Bedrock		4	RC	REC	100%	247		RQD 81%
			5	RC	REC	97%	246		RQD 84%
			6	RC	REC	100%	245		RQD 65%
244.0			7	RC	REC	100%			RQD 96%
5.7	End of Borehole * 94 11 19 ** bouncing on rock								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 ◇ 5 (20 above, 10 below) (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC

W.P. 130-88-01 LOCATION Sta 17+527.8 o/s 8.35 Rt CL Hwy 11 ORIGINATED BY DK

DIST 53 HWY 11 BOREHOLE TYPE S.S. Auger, NW Core Barrel COMPILED BY DK

DATUM Geodetic DATE 94 11 21 CHECKED BY TK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	NATURAL MOISTURE CONTENT / WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
252.4	Ground Surface								
0.0	Silty Sand, Trace Gravel and Organics, Brown, Very Loose (Fill)		1	SS	4	▼*	252		
250.9 / 1.5	Sandy Silt, Scattered Rootlets, Brown, Compact		2	SS	17		251	o (approx. 15)	0 36 (64)
250.1 / 2.3	Clayey Silt with Sand, Grey, Firm		3	SS	100 /23cm	**	250	wP–wL plotted (approx. 14–20)	4 30 (66)
249.6 / 2.8	Bedrock		4	RC	REC 78%		249		RQD 65%
			5	RC	REC 75%				RQD 0%
			6	RC	REC 96%		248		RQD 36%
			7	RC	REC 100%				RQD 100%
			8	RC	REC 100%		247		RQD 100%
246.3 / 6.1	End of Borehole								

* 94 11 21

** bouncing on rock

Legend: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m^3

$+^3$, $\times^5$: Numbers refer to Sensitivity   20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

Foundation Design

RECORD OF BOREHOLE No 4

METRIC

W.P. 130-88-01 LOCATION Sta 17+552.9 o/s 7.25 Rt CL Hwy 11 ORIGINATED BY DK

DIST 53 HWY 11 BOREHOLE TYPE S.S. Auger, NW Core Barrel COMPILED BY DK

DATUM Geodetic DATE 94 11 18 CHECKED BY TK

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
252.2	Ground Surface					252		
0.0 / 250.8	Clayey Silt, Some Sand Trace Gravel and Organics Brown, Firm (Fill)	1	SS	5	▼*	251		
1.4 / 249.2	Clayey Silt with Sand Scattered Organic Fibres Grey, Firm	2	SS	6		250		
		3	SS	5			o (wp–w plotted)	0 35 (65)
3.0 / 246.2	Bedrock	4	RC	REC	100%	249		RQD 64%
		5	RC	REC	100%	248		RQD 15%
		6	RC	REC	100%			RQD 0%
		7	RC	REC	100%	247		RQD 67%
6.0	End of Borehole * 94 11 19							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15◇5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W.P. 130-88-01
LOCATION Sta 17+526.7 o/s 14.6 m Rt CL Hwy 11
ORIGINATED BY DK

DIST 53 HWY 11
BOREHOLE TYPE S.S. Auger, NW Core Barrel
COMPILED BY DK

DATUM Geodetic
DATE 94 11 21
CHECKED BY TK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.9	Ground Surface										
0.0 / 251.2	Silty Sand with Gravel (Fill)					▼*					
0.7	Bedrock		1	RC	REC	100%	251				RQD 45%
			2	RC	REC	100%	250				RQD 86%
249.1 / 2.8	End of Borehole										

* 94 11 21

$+^3, \times^5$: Numbers refer to Sensitivity

15-◇-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

Foundation Design

RECORD OF BOREHOLE No 6

 METRIC

W.P. 130-88-01 LOCATION Sta 17+554.2 o/s 18.0 m Rt CL Hwy 11 ORIGINATED BY DK

DIST 53 HWY 11 BOREHOLE TYPE S.S. Auger, NW Core Barrel COMPILED BY DK

DATUM Geodetic DATE 94 11 18 CHECKED BY TK

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.6	Ground Surface										
0.0	Clayey Silt with Organics and Rootlets Dark Brown (Fill) Firm					▽*	251				
250.4			1	SS	8						
1.2	Clayey Silt Greenish Grey and Brown, Stiff					**					
249.9			2	SS	100	/15cm	250		plotted		
1.7	Bedrock						249				
248.0											
3.6	End of Borehole										

* 94 11 19

** bouncing on rock

$+^3$, $\times^5$: Numbers refer to Sensitivity

15◇5 (20 above, 10 below) (%) STRAIN AT FAILURE

ROCK CORE DESCRIPTION
WP 130-88-01

	CORE RECOVERY				CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	5	4.44-4.90	100	78	4.44-7.32	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to dark grey; coarse to fine grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, dipping to near vertical, planar to undulating, smooth to rough.
	6	4.90-6.12	100	46		
	7	6.12-7.32	94	50		
2	4	2.41-3.33	100	81	2.41-5.72	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, near vertical to flat, planar to undulating, smooth to rough.
	5	3.33-4.29	97	84		
	6	4.29-4.80	100	65		
	7	4.80-5.72	100	96		
3	4	2.82-3.40	78	65	2.82-6.07	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, near vertical to flat, planar to undulating, smooth to rough.
	5	3.40-3.91	75	0		
	6	3.91-4.55	96	36		
	7	4.55-4.90	100	100		
	8	4.90-6.07	100	100		

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION
WP 130-88-01

	CORE RECOVERY				CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
4	4	3.00-3.35	100	64	3.00-6.04	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, near vertical to flat, planar to undulating, smooth to rough.
	5	3.35-4.27	100	15		
	6	4.27-4.80	100	0		
	7	4.80-6.04	100	67		
5	1	0.71-1.55	100	45	0.71-2.80	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, near vertical to dipping, planar to undulating, smooth to rough.
	2	1.55-2.80	100	86		
6	3	1.68-1.78	100	0	1.68-3.56	**GRANITE** (gneissic), moderate reddish orange to moderate orange pink to greyish orange pink; coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, dipping to near vertical, planar to undulating, smooth to rough.
	4	1.78-2.01	67	0		
	5	2.01-3.56	100	95		

*CR = CORE RECOVERY
*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
Logged by: DAW, Soils and Aggregates Section

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/0.3 m)	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

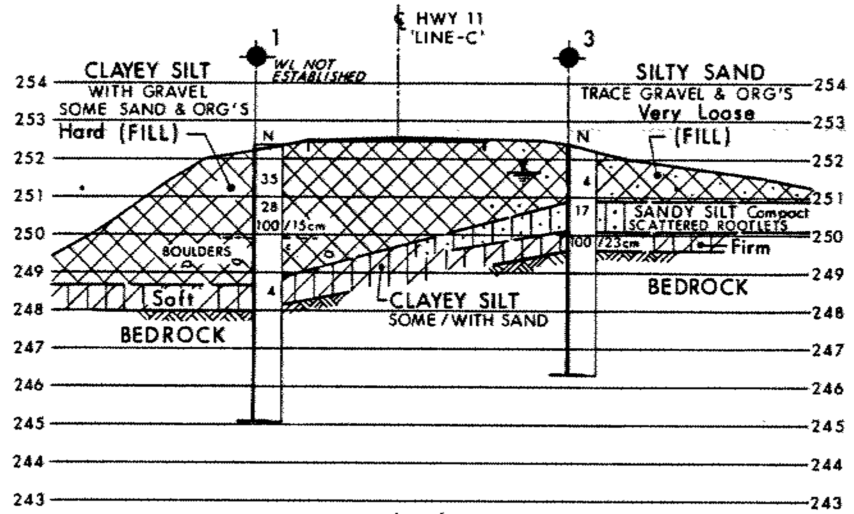
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

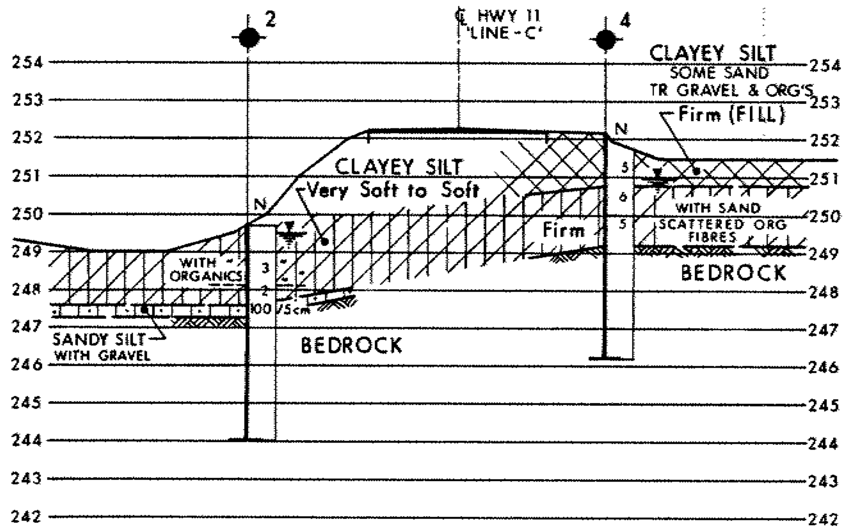
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE



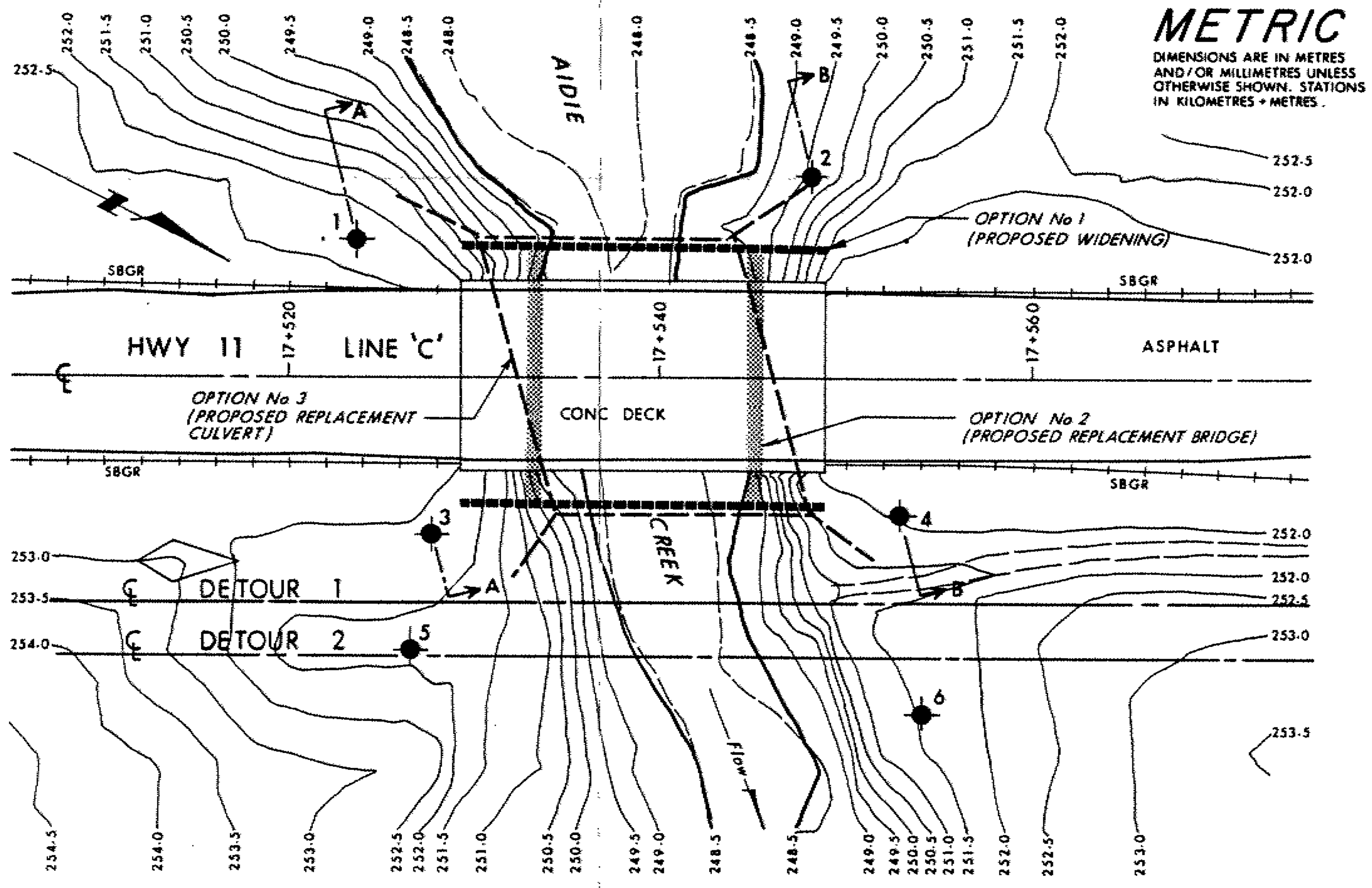
A - A



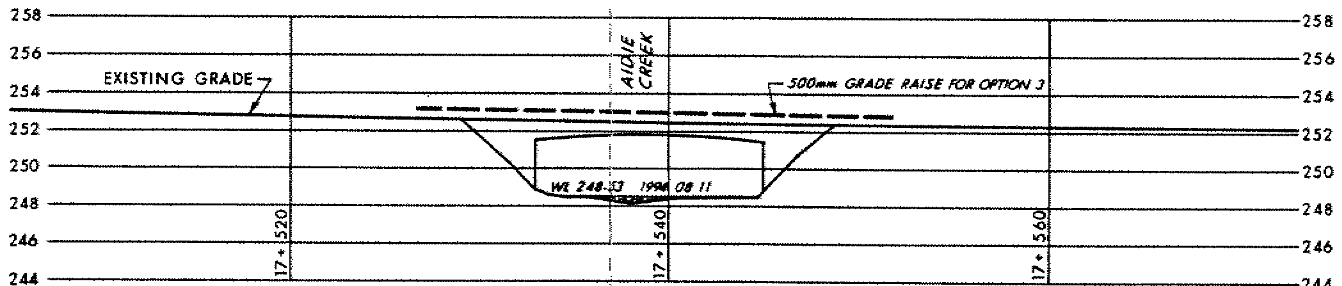
B - B

SECTIONS

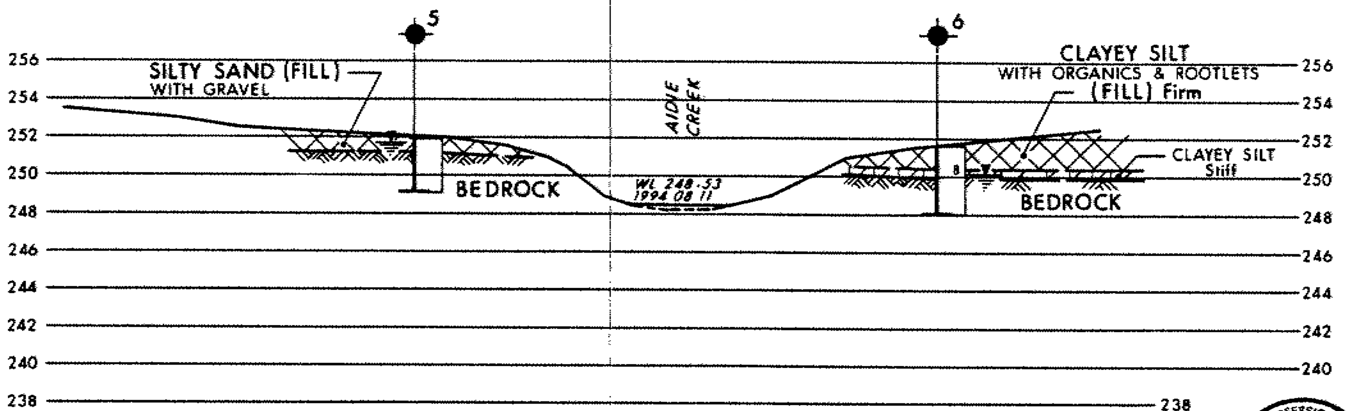
SCALE
4m 0 4m Hor
2m 0 2m Vert



PLAN
SCALE
4m 0 4m



℄ PROFILE OF HWY 11 LINE 'C'
SCALE
4m 0 4m



℄ DETOUR 1
SCALE
4m 0 4m

REF PLAN E-346-11-1, 1994 09

METRIC

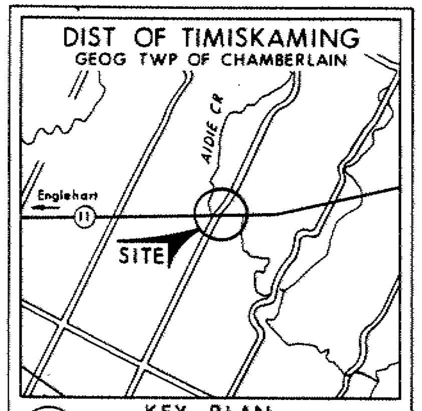
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 130-88-01

AIDIE CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN
SCALE
1km 0 1km

LEGEND

- ● Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1994 11

No	ELEVATION	STATION	OFFSET
1	252.4	17+523.7	7.5 m LT
2	249.7	17+548.0	10.9 m LT
3	252.4	17+527.8	8.4 m RT
4	252.2	17+552.9	7.3 m RT
5	251.9	17+526.7	14.6 m RT
6	251.6	17+554.2	18.0 m RT

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 GC 2.01 of OPS Gen Cond

LICENSED PROFESSIONAL ENGINEER
W. D. KWOK
PROVINCE OF ONTARIO

REV.	DATE	BY	DESCRIPTION

Geocres No 31M-56

HWY No 11 (LINE-'C')			DIST 53
SUBM'D DK	CHECKED DK	DATE 1995 05 09	SITE 47-24
DRAWN DT	CHECKED KS	APPROVED	DWG 1308801-A

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10