

GEOCRES No. 417-56DIST. 18 REGION W.P. No. 185-90-00
formerly 7808-87-01CONT. No. W. O. No. STR. SITE No. 38S-350CHWY. No. 546LOCATION White River Farm
CulvertNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

FILE



Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 185-90-00 DIST 18
HWY 546 STR SITE 38S-350

White River Farm Culvert

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FOUNDATION INVESTIGATION REPORT

for

White River Farm Culvert, Highway 546

W.P.185-90-00, Site No. 38S-350

District 18, Sault Ste. Marie

INTRODUCTION

This report summarizes the results of the foundation investigation carried out at the above noted site in 1987 under W.P.7807-87-01 and a recent supplementary investigation under W.P.185-90-00. The investigations were carried out at the request of the Northern Region Structural Section for a proposed replacement of the existing two cell treated timber culvert. At the time of the investigation in 1987, it was proposed to replace the timber culvert at the same location. Thus the boreholes (BH 1-6) were advanced at the location of the existing culvert. The current design calls for a realignment of the existing highway and a new culvert location on an alignment approximately 19 m upstream and 10 m west of the centre of the existing crossing. From a review of the general topography of the area, it is envisaged that the subsurface soil conditions would be somewhat similar at the old and new culvert locations. Nevertheless, an additional borehole (BH 7) was advanced at approximately the centre of the new culvert alignment to confirm the subsoil conditions.

SITE DESCRIPTION

The site is located to the south of the existing Highway 546, approximately 25 km north of the intersection of Highways 554 and 546 in the Township of Kamichisitit, District of Algoma.

The immediate area is flat to moderately rolling. The site is heavily vegetated with trees on both sides of the river. Land use in the area is mainly a highway corridor. According to the Northern Ontario Engineering Geology Terrain Study published by the Ministry of Natural Resources, the dominant landform at the site is a Ground Moraine with till material. The subordinate landform is an Outwash Plain with sand and gravel material.

The existing Highway 546 embankment is approximately 2.5 m high at this location. The existing watercourse is accommodated by a two cell timber culvert.

INVESTIGATION PROCEDURES

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

Field

During the 1987 investigation, a total of four boreholes and two dynamic cone penetration tests were put down at the locations (BH 1-6) shown on Dwg. No. 1859000-A.

The supplementary foundation investigation was carried out on 93 07 05 and consisted of one (1) sampled borehole (BH 7) advanced to a depth of 7.6 m. The borehole was advanced using conventional hollow stem augering techniques with a track mounted continuous flight auger machine. The sampling program consisted of split spoon samples collected in the overburden. Disturbed subsoil samples were retrieved by split spoon sampler in accordance with Standard Penetration Test (ASTM D1586). Standard Penetration ('N') values were recorded for assessment of the denseness of the materials encountered. All subsoil samples were identified in the field and returned to the laboratory for further examination and appropriate testing.

Groundwater levels were measured in the borehole. All boreholes were backfilled upon completion of the field work.

Surveying required to ascertain borehole locations and elevations was carried out by the Northwestern Region Surveys and Plans Section.

Laboratory

The laboratory testing on selected soil samples consisted of the following:

- Grain Size Distribution
- Natural Moisture Content Determination
- Atterberg Limits
- Unit Weight Determination

Laboratory results are given in the following section of this report and are illustrated on Record of Borehole sheets included in the Appendix.

SUBSURFACE CONDITIONS

General

The major deposit encountered in the boreholes in this area consists of Silty Sand/Sandy Silt material with occasional gravelly layers. It was contacted in all boreholes to a maximum depth of 17.2 m. BH 1 to BH 6 were advanced from the existing embankment through a granular fill of 1.5 to 2.7 m thick. A silt layer was contacted in BH 1 and BH 3 underneath the granular fill. In BH 7, a topsoil layer was found at the surface to a depth of 0.8 m. The top 2 ± m, including the topsoil and part of the silty sand stratum, consists of numerous cobbles and boulders. Bedrock was not encountered in any of the boreholes at a maximum depth of 25.6 m (El.224.2 m).

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

Granular Fill

This is the highway embankment fill material. It was encountered in BH 1 to 6 with a thickness of 1.5 to 2.7 m. The Standard Penetration 'N' values ranged from 7 to 53/3cm. The material is generally in the loose to compact state of denseness.

Typical properties of the material, as determined by laboratory tests on representative samples may be summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Test</u>
Natural Moisture Content (w%)	3.5-8.0	2
Grain Size Distribution(%)		2
-Gravel	14-30	
-Sand	59-60	
-Silt	9-26	
-Clay	1	

Topsoil

This organic layer is only contacted in BH 7 at the ground surface. It is generally

described as sandy silt with organics and numerous boulders. The thickness of the stratum is about 0.8 m

Silt, trace clay with occasional clayey silt pockets

This deposit was encountered in BH 1 and BH 3 below the granular fill stratum. The thickness of the layer is 6.1 and 4.4 m in BH 1 and 3 respectively. The material is typically described as Silt, trace clay with occasional clayey silt pockets. Standard Penetration 'N' values range from 9 to 21 indicating a compact state of denseness.

Typical properties of the material, as determined by laboratory tests on representative samples may be summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Test</u>
Natural Moisture Content (w%)	23-30	3
Liquid Limit (w_L)	23-34	3
Plastic Limit (w_P)	20-23	3
Unit Weight Determination (kN/m^3)	20	1
Grain Size Distribution(%)		3
-Gravel	0-1	
-Sand	0-1	
-Silt	28-95	
-Clay	5-70	

A field vane shear test was carried out within the cohesive pockets of this deposit, resulting in an undrained shear strength of 48 kPa.

Silty Sand/Sandy silt

This is the major deposit in the area. It extends from the bottom of the granular fill or silt layer to a minimum depth of 25.6 m below ground surface. The material is generally described as silty sand to sandy silt with occasional gravel layers, and the proportion of silt to sand varies with depth and location. In BH 7, the top 1.2 m of the layer below the topsoil contains numerous boulders and cobbles. The Standard Penetration Resistance 'N' values recorded range from 6 to 54 blows/0.3 m, indicating loose to very dense state of denseness, but typically compact. The 'N' values generally increase with depth.

Typical properties of the material, as determined by laboratory tests on representative

samples may be summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Test</u>
Natural Moisture Content (w%)	11-34.5	11
Grain Size Distribution(%)		11
-Gravel	0-33	
-Sand	33-98	
-Silt	1-63	
-Clay	1-5	

Groundwater

The groundwater level measured in the boreholes was at approximately El. 245.5 to 248.5 m. The river water level was at El. 248.4 m. It is possible that the groundwater levels in some of the boreholes did not represent stabilized water levels

Groundwater levels are subject to seasonal fluctuations and hence may vary from the elevations given in this report.

DISCUSSION AND RECOMMENDATIONS

General

According to the Structural Design Report issued by your office on 93 07 06, the new structure will be a 4.04 m span x 2.34 m high horizontal elliptical culvert with a length of 27 m. The inlet invert elevation is 248.2 m. The proposed grade will result in a fill height of about $2 \pm$ m above the new structure and approach fill of up to about $3.5 \pm$ m high.

Foundation

The compact silty sand/sandy silt material, which will be encountered at the culvert invert level is considered suitable for the support of the culvert as well as the approach fill to final road grade. However, this material is susceptible to disturbance due to unbalanced hydrostatic force. An advance dewatering scheme should be incorporated to maintain the water level a minimum of 0.5 m below the base of the excavation, especially during the placement and compaction of granular bedding and granular backfills at the haunches. An oversized excavation together with pumping from perimeter ditches will be one approach for controlling the groundwater level.

Construction

The construction of the proposed culvert will involve excavations to a depth of about 1.5 to 2 m over most of its length. The topsoil layer should be removed prior to placement of the bedding material. Boulder obstructions are expected during the excavation process. Within the limits of the existing highway, the depth of excavation will be about 4 m. Temporary excavations to the above mentioned depths shall be carried out at 1.5H:1V slope provided an advanced dewatering system is installed as discussed above. At the north end, some temporary shoring will be required to protect the existing road during construction.

Backfill to the culvert should consist of granular material. Reference is made to OPSD 802.02 standards for details. Culvert inlet and outlet treatments should comply with MTO Standards. Beyond the limits of the culvert, suitable erosion protection shall be provided as per hydrological requirements. A filter fabric together with coarse granular fill or rock fill shall be used in this regard, from the base of the channel to about 0.5 m above the maximum water level.

Embankment Slopes

Approach embankment slopes may be safely constructed at a gradient of 2H:1V or flatter up to a maximum height of 5.0 m. Surficial organic material should be removed prior to filling. Only relatively free draining granular material should be used below the water level.

Closing Remarks

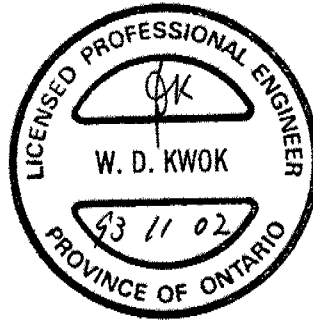
The successful performance of the proposed pipe arch culvert would require the provision of a compacted granular bedding at the base of the culvert. At this site, advance lowering of the water level has to be achieved before the fills could be properly placed and adequately compacted.

As indicated in our memorandum dated 93 03 23, to avoid difficulties associated with the construction described above, it is preferable to use a concrete culvert at this site as the requirements of placement and compaction of the granular fills are less severe for a relatively rigid concrete box culvert.

MISCELLANEOUS

The fieldwork for the foundation investigation was carried out in two phases. The initial investigation was carried out in 1987 under the supervision of Darren Protulipac, Student Engineer using the equipment owned and operated by Longyear Canada Inc. The supplementary investigation was carried out in 1993 under the supervision of D. Kwok, Project Foundation Engineer using the equipment owned and operated by Master Soil Investigation Ltd.

The project was carried out by D. Kwok under the general supervision of B. Iyer, Senior Foundation Engineer. The report was written by D. Kwok, reviewed by B. Iyer, and approved by M. Devata, Chief Foundation Engineer.



A handwritten signature in black ink, appearing to read "D. Kwok".

D. Kwok, P. Eng.
Project Foundation Engineer



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

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

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	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						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 7808-87-01 LOCATION Sta. 10+369 o/s 23.8m Lt of Hwy 546 CL (Line-B) ORIGINATED BY DP
 DIST 19 HWY 546 BOREHOLE TYPE HS Auger, Cone Penetration Test COMPILED BY DT/RV
 DATUM Geodetic DATE 1987 08 17-19 CHECKED BY DK/BI

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
249.8	Ground Surface													
0.0	Granular Fill Trace Organics		1	SS	12		249							14 59 26 1
248.3			2	SS	16									
1.5			3	SS	9									
			4	SS	14									1 1 28 70
			5	SS	12									
	Silt, Trace Clay Occasional Clayey Silt Packets Compact		6	SS	21									0 0 83 17
			7	TW	PH								20.0	0 0 95 5
			8	SS	13									
242.2			9	CS	-									
7.6			10	CS	-									0 33 82 5
			11	CS	-									
	Silty Sand to Sandy Silt Compact to Dense		12	CS	-									
			13	SS	30									0 35 83 2
			14	SS	29									
	Gravel Zones		15	WS	-									
232.6			16	SS	54									
17.2	End of Borehole													
224.2														
25.6	End of Cone Test													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 7808-87-01 LOCATION Sta 10+377.2 o/s 15.5m Lt of Hwy 546 CL (Line B) ORIGINATED BY DP
DIST 19 HWY 546 BOREHOLE TYPE HS Auger, Cone Penetration Test COMPILED BY DT/RV
DATUM Geodetic DATE 1987 08 19-20 CHECKED BY DK/BI

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%) 20 40 60
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE 20 40 60 80 100						
250.8	Ground Surface														
0.0	Granular Fill	X	1	SS	18		250							30 60 9 1	
			2	SS	16										
			3	SS	8										
248.1			4	SS	10										
2.7	Silty Sand to Sandy Silt Occasional Sand Layers Compact to Dense	.	5	SS	43			248						12 50 36 2	
			6	SS	10									0 52 47 1	
			7	SS	13			246						0 45 53 2	
			8	SS	12										
			9	SS	19									0 87 11 2	
			10	SS	25			244							
			11	WS	-									0 98 1 1	
			12	SS	25			242							
			13	SS	25			240							
238.2			14	SS	33										
12.6	End of Borehole														
226.5															
24.3	End of Cone Test														

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 7808-87-01 LOCATION Sta 10+393.2, o/s 17.1m Lt of Hwy 546 CL (Line B) ORIGINATED BY DP
 DIST 19 HWY 546 BOREHOLE TYPE Cone Penetration Test COMPILED BY DT/RV
 DATUM Geodetic DATE 1987 08 20 CHECKED BY DK/BI

SOIL PROFILE		SAMPLES			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 (%) 20 40 60	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									
250.4	Ground Surface												
0.0	Probably Granular Fill												
248.5													
1.9													
	Probably Sandy Silt to Silty Sand Occasional Gravel Layers												
241.3													
9.1	End of Borehole												

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 7808-87-01 LOCATION Sta 10+386 o/s 22.4m Lt of Hwy 546 CL (Line B) ORIGINATED BY DP
DIST 19 HWY 546 BOREHOLE TYPE HS Auger, Cone Penetration Test COMPILED BY DT/RV
DATUM Geodetic DATE 1987 08 21 CHECKED BY DK/BI

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
250.4	Ground Surface													
0.0	Granular Fill		1	SS	8		250							
			2	SS	11									
248.5			3	SS	7		248							
1.9	With Boulders		4	SS	6									
			5	SS	33									
			6	SS	7									
			7	SS	10									
			8	SS	17									
			9	SS	21									
			10	WS	-									
			11	SS	22									
			12	SS	19									
			13	SS	36									
			14	SS	48									
236.2	Sandy Silt to Silty Sand Occasional Gravel Layers Compact to Dense		15	SS	29									
14.2	End of Borehole													
233.0														
17.4	End of Cone Test													

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 7808-87-01 LOCATION Sta 10+378.2 a/s 20.6m Lt of Hwy 546 CL (Line B) ORIGINATED BY DP
 DIST 19 HWY 546 BOREHOLE TYPE Cone Penetration Test COMPILED BY DT/RV
 DATUM Geodetic DATE 1987 08 21 CHECKED BY DK/BI

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100					W _p	W		
250.8	Ground Surface															
0.0	Probably Granular Fill															
248.5																
2.1	Probably Sandy Silt to Silty Sand															
246.9																
3.7	End of Cone Test															

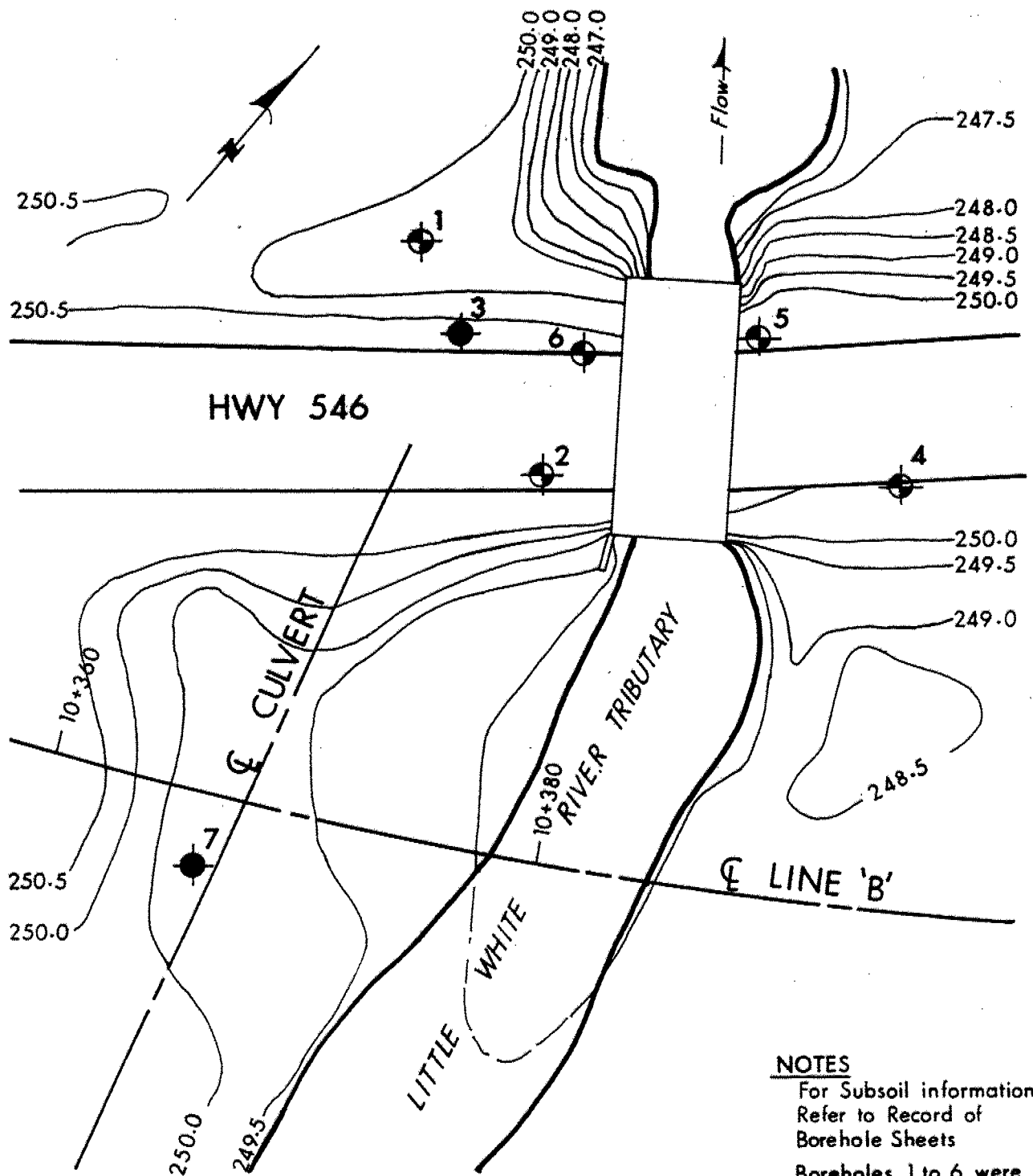
RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 185-90-00 LOCATION Sta 10+366.5 Rt 3.0 m Proposed Hwy 546 CL ORIGINATED BY DK
DIST 18 HWY 546 BOREHOLE TYPE H.S. Auger COMPILED BY DK
DATUM Geodetic DATE 93 07 05 CHECKED BY BI

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
249.2	Ground Surface																
0.0 248.4	Sandy Silt with Organics Numerous Boulders (Topsoil)		1	AS	-												
0.8	Numerous Cobbles and Boulders		2	SS	14		248										12 85 2 1
			3	SS	9		246										
	Silty Sand, Some Gravel		4	SS	6		244										
	Loose to Compact		5	SS	18												2 90 8 2
	Pinkish Brown		6	WS	**		242										
241.6																	
7.6	End of Borehole																
	* 93 07 05																
	** sand blow-back inside augers wash sample taken																



PLAN

SCALE



LEGEND

- Borehole
- ⊗ Borehole & Cone

NOTES

For Subsoil information
Refer to Record of
Borehole Sheets

Boreholes 1 to 6 were
put down in 1987 08
under WP 7808-87-01

Geocres No 41J-56

WP 185-90-00

Dist 18

Dwg No 1859000-A

memorandum



To: R.J. Krisciunas
Head, Structural Section
Northwestern Region

Date: 93 10 01

From: Foundation Design Section
Room 315, Central Building

Subject: Proposed Culvert Replacement
Hwy 546, Little White River Tributary
W.P. 185-90-00, Site 38S-350C
District 18, Sault Ste. Marie

Preliminary foundation recommendations for the above project were provided to you via our memorandum dated 93 03 23, copy of which is attached herein for your easy reference. The recommendations were made based on the results of a foundation investigation carried out in the vicinity of the existing culvert in 1987, under W.P. 7807-87-01. Subsequently, an additional borehole was sunk on 93 07 05 at the proposed culvert replacement location which is about 20 m away from the existing culvert.

Details of the subsurface conditions encountered together with the laboratory test results are summarized in the attached Record of Borehole sheet. Similar to the previous boreholes, non-cohesive material was encountered throughout the depth of the borehole. A topsoil layer was found at the surface to a depth of 0.8 m. Below the topsoil layer is a major deposit which predominantly comprises sand material with trace of silt and some gravel. Standard Penetration Test 'N' values range from 6 to 18 indicating loose to compact state of denseness. The top $2 \pm$ m, including the topsoil and part of the sand stratum, consists of numerous cobbles and boulders. The borehole was terminated at 7.8 m depth. Water level measured in the borehole upon completion of drilling was at El. 248.4 m which ties in well with the water level in the river.

According to the Structural Design Report issued by your office on 93 07 06, the new structure will be a 4.04 m span x 2.34 m high horizontal elliptical culvert with a length of 27 m. The inlet invert elevation is 248.2 m. The preliminary recommendations given in our previous memorandum have been reviewed taking into account the updated structural data and new borehole information. Previous recommendations regarding requirements on dewatering, excavation and backfilling and culvert protection are still valid. Reference is made to the attached memorandum for details. The topsoil layer should be removed prior to placement of the bedding material. Boulder obstructions are expected during the excavation process. As indicated in our previous memorandum, it is preferable to use a concrete culvert at

this site as the requirements of placement and compaction of the granular fills are less severe for a relatively rigid concrete box culvert.

Should there be any questions on the above or you need further input from our office, please contact us.

David Kwok, P. Eng.
Project Foundation Engineer
for
Balu Iyer, P. Eng.
Senior Foundation Engineer





memorandum



To: R.J. Krisciunas
Head, Structural Section
Northwestern Region

Attn: D.C. Dykstra
Structural Engineer

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

Re: White River Farm Culvert
Hwy. 546, Site 38S-350
W.P. 185-90-00
District 18, Sault Ste. Marie

Date: 1993 03 23

This memo report contains our recommendations regarding the design and construction of the proposed horizontal ellipse type steel culvert at the subject site.

Structural Details

The proposed culvert will have a 4.0 m span X 2.3 m rise and 25 m length. The new culvert will be located at the proposed alignment of Hwy. 546, about 20 m upstream of the existing timber culvert, as shown on Dwg. No. 1859000-A.

Subsurface Conditions

A foundation investigation was carried out in the vicinity of the existing culvert in 1987, under W.P. 7807²87-01. At that time, it was proposed to replace the timber culvert at the same location. Thus, the previous investigation was done about 20 m away from the present revised location of the culvert. However, from a review of the general topography of the area, it is considered that the subsurface soil conditions at the present culvert location would be somewhat similar to those encountered during the previous investigation.

During the 1987 investigation, a total of four boreholes and two dynamic cone penetration tests were put down at the locations shown on Dwg. No. 1859000-A. The generalized subsurface soil conditions were as follows. The ground level varied from 249.8 m to 250.8 m. Surficially, about 1.5 m to 2.7 m thick granular material, probably the old road fill, was encountered. This was underlain by a compact to dense sandy silt to silt stratum to the bottom of the boreholes, for a maximum thickness of about 16 m. This deposit encountered occasional sand and clay layers within a predominantly silt matrix. Groundwater level was encountered at El. 245.5 to 247.1, about 3.7 m to 4.3 m below grade. The river water level was at El. 248.4 m. It is possible that the groundwater levels in the boreholes did not represent stabilized water levels.

At the present culvert location, the ground surface elevation varies between 249m and 249.5m, except at the north end, within the limits of Hwy. 546, the ground rises to El. 250.5 m. The predominant soil stratum at the new culvert location would consist of compact to dense sandy silt to silt, with occasional layers of sand or clay. The groundwater level should be expected at or very close to the ground surface.

Discussion and Recommendations

The proposed culvert will be horizontal ellipse in shape with 4.0 m span X 2.3 m rise X 25 m length. The invert of the culvert will be at El. 247.7 m. The proposed final grade for Hwy. 546 in the vicinity of the culvert will be at about El. 252 m and will involve fills to about 3 m in height above grade.

The compact to dense sandy silt to silt stratum, which will be encountered at the invert level of the new culvert is considered suitable for the support of the culvert as well as the fill to final road grade. However, this material is susceptible to disturbance due to unbalanced hydrostatic force. An advance dewatering scheme should be incorporated to maintain the water level a minimum of 0.5 m below the base of the excavation, especially during the placement and compaction of granular bedding and granular backfills at the haunches. An oversized excavation together with pumping from perimeter ditches will be one approach for controlling the groundwater level.

The construction of the proposed culvert will involve excavations to a depth of about 1.5 m to 2 m over most of its length. Within the limits of the existing Hwy. 546, the depth of excavation will be about 4 m. Temporary excavations to the above mentioned depths shall be carried out at 1.5H to 1V slope provided an advance dewatering system is installed as discussed above. At the north end, some temporary shoring will be required to protect the existing road.

Beyond the limits of the culvert, suitable erosion protection shall be provided as per hydrological requirements. A filter fabric together with coarse granular fill or rockfill shall be used in this regard, from the base of the channel to about 0.5 m above the maximum water level.


Closing Remarks

The successful performance of the proposed pipe arch culvert would require the provision of a compacted granular bedding at the base of the culvert and compacted granular backfills at both haunches of the culvert. At this site, advance lowering of the water level has to be achieved before the fills could be properly placed and adequately compacted.

To avoid difficulties associated with the construction, as discussed above, consideration may be given to the use of a concrete box culvert at this site.

Even though the problems associated with the high water table would still exist, the requirements of compaction of the granular fills are less severe for a relatively rigid concrete box culvert. If this option is favoured, we would be pleased to provide additional comments.

We trust that the recommendations given above are sufficient for your present needs. Please call if you need further input on this project.

A handwritten signature in cursive script, appearing to read 'B. Iyer', with a horizontal line underneath.

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/jb

