

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 42D-20

DIST. 19 REGION

W.P. No. 682-93-01

CONT. No. 93-227

W. O. No.

STR. SITE No. 48E-54C

HWY. No. 17

LOCATION Lamont Creek Culvert

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

Longyear Paul Captain 905-832-7979
Dominion Soil Mike Tabias 807-683-8935
(807) 623-2929 Robin Crowley 473-6841

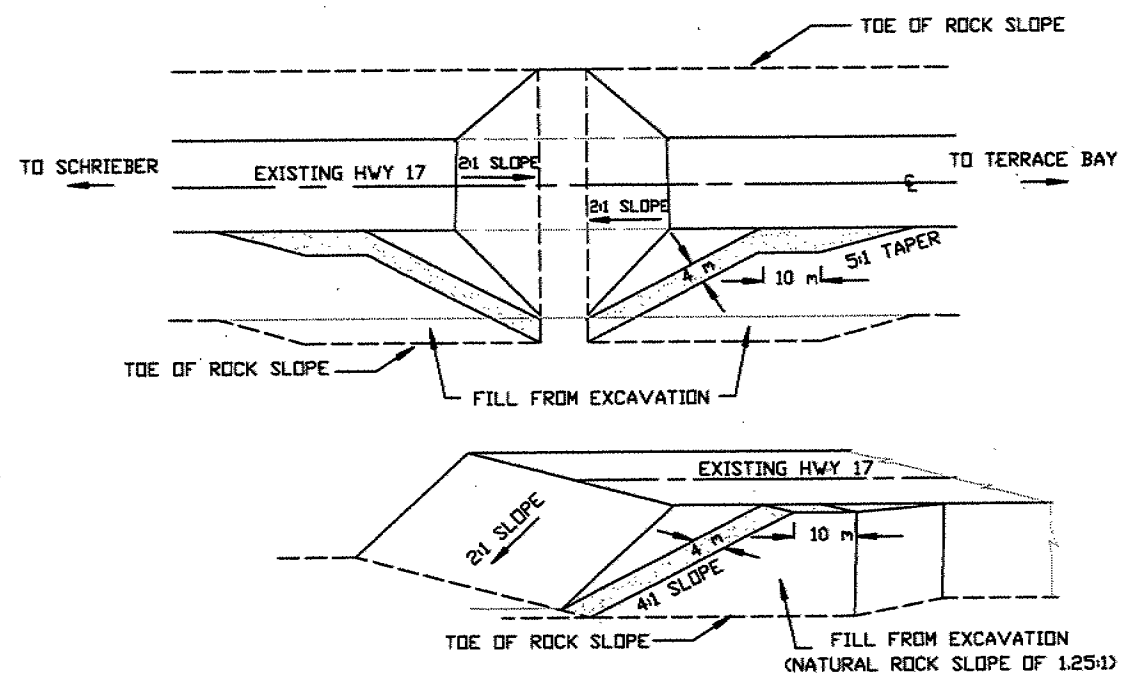
Tempo Station, left, 2 storey gray block
Cosiana Inn.

FILE No. _____ DATE _____

Dennis Giczkar Area Engineer 3/F.
Dowdak

REMARKS

(807) 473-2180 West
Shipping & Receiving — Alan Cava / Judy 801 Walsh At Mountdale Ave.
Thunder Bay, Ontario. P 7C 4X9
Peter Bound (807) 473-2132, Ray / Kriszmas (807) 473-2000
District Engineer — C.E. Pitchard (807) 473-2043 815 South James St.
Assistant District Engineer — Richard Bruneau
Maintenance Supervisor (Frank Mauro / George Ward) (807) 473-2141
Mice Chamberlain (Survey) (807) 473-2000
Environmental Unit (Harold Makela, Wes Mound) (807) 473-2078
Patrol Yard in Rossport David & Debbie Iddison (807) 824-2224
Filane's Motel (807) 824-2782 \$52
Red Dog Inn (807) 825-3288 \$58. Mauro
Bala Iyer (905) 819-0437
Airplane Motor Hotel (Thunder Bay) (807) 577-1181
Amex Janine 443-8405 CP 801 8:45 10:25 Oct 12 Lumina
Best Western Nor-Wester Resort Hotel (807) 473-9123 CP 814 11:30 13:00 Oct 18 #299 + 1050 km
204 / km



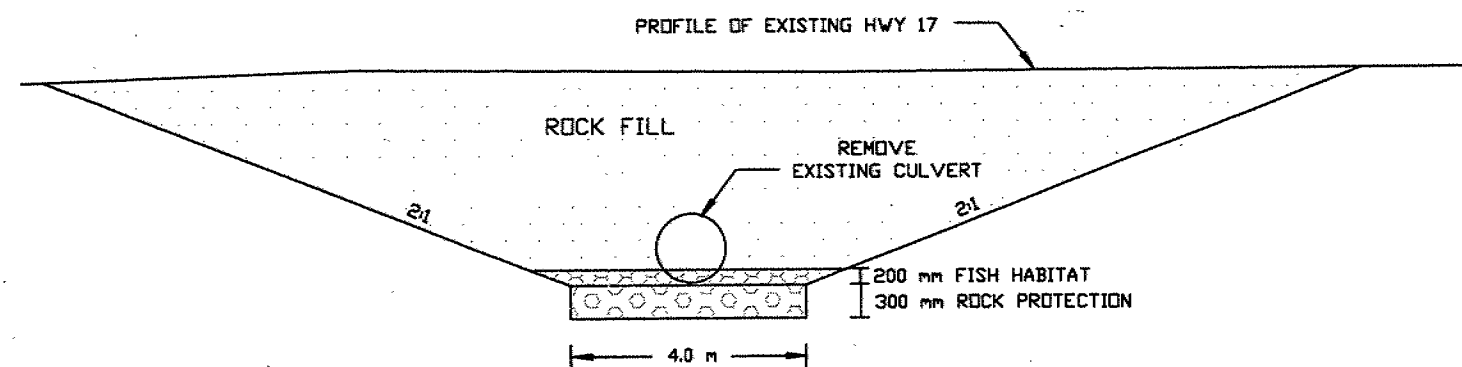
PLAN AND VIEW OF TYPICAL CULVERT REMOVAL AND STREAM REHABILITATION

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

CONT No 93-227
WP No 682-93-01

TYPICAL SECTIONS

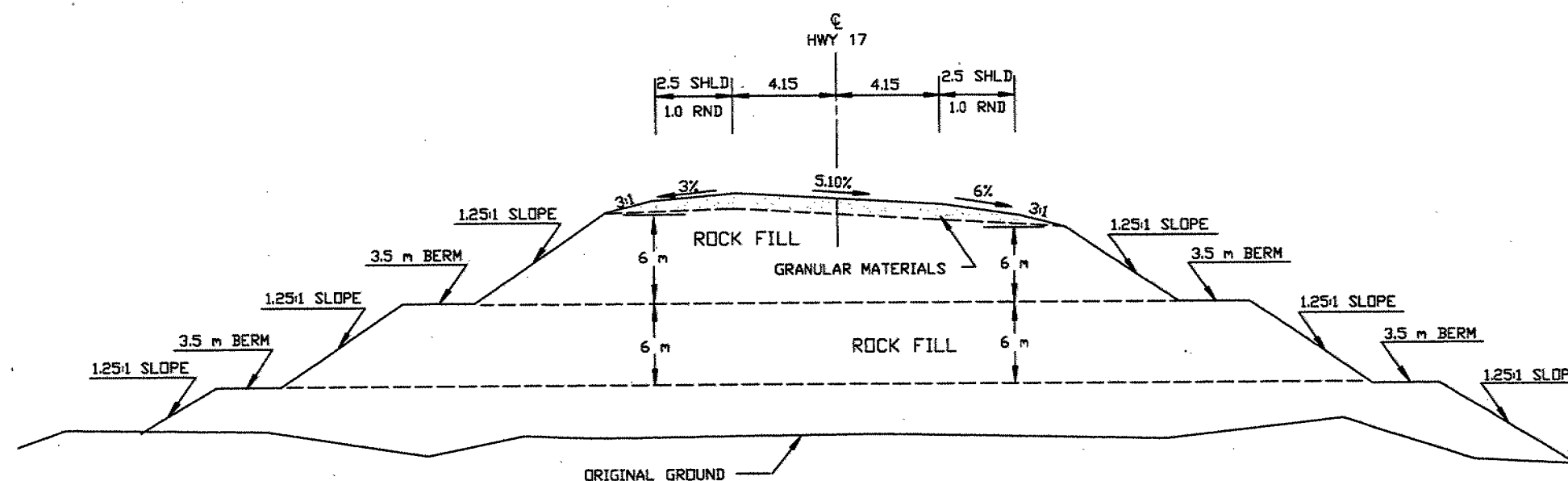
SHEET
00-1



TYPICAL X-SECTION OF CULVERT REMOVAL AND STREAM REHABILITATION

**at locations 15+682.0
and 16+526.1**

NOT TO SCALE



TYPICAL ROCK FILL SECTION

from Sta.16+075 to Sta.16+175 RT.
from Sta.16+025 to Sta.16+125 LT.

NOT TO SCALE

MINISTRY OF TRANSPORTATION, ONTARIO PR-D-708 98-00

METRIC

PLATE No 389-17/98-0
CONT No 93-227
WP No 107-87-00



NEW CONSTRUCTION
STA 12+950 TO STA 13+300
Survey _____ Revised _____

SHEET
18 A

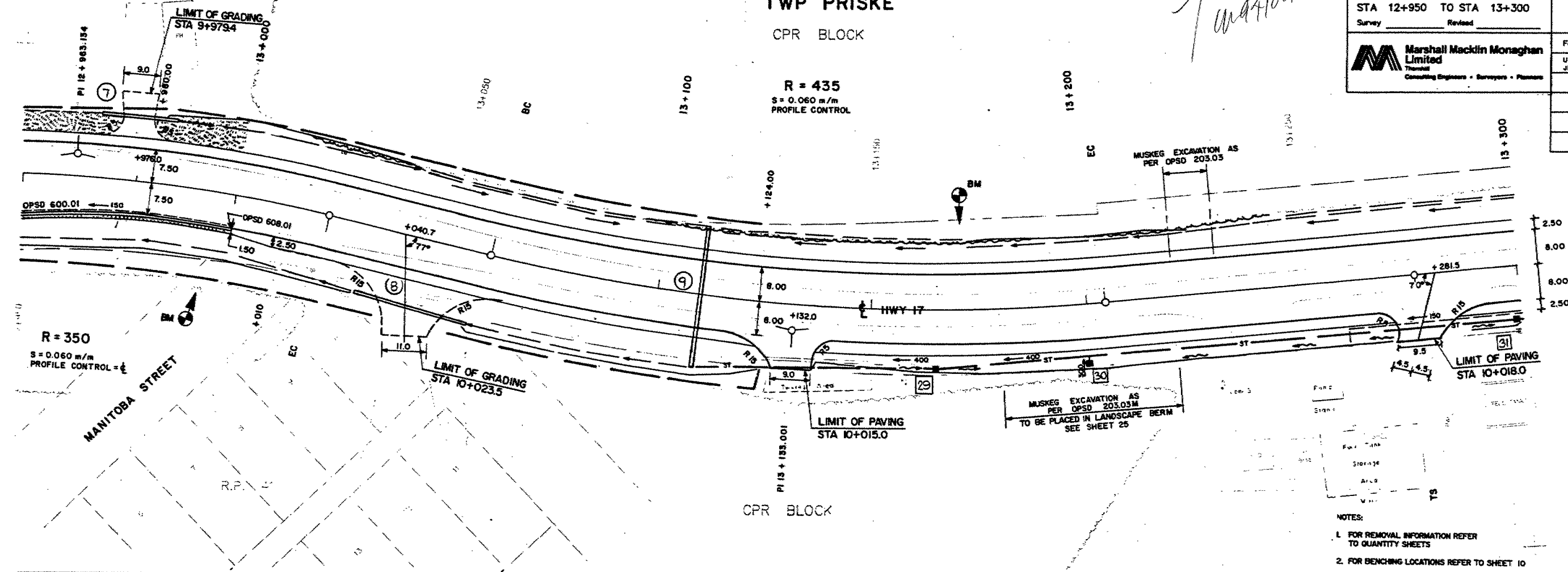
Marshall Mecklin Monaghan Limited
Thermal
Consulting Engineers - Surveyors - Planners

February 1992
UPDATED
JUNE 1990

TWP PRISKE

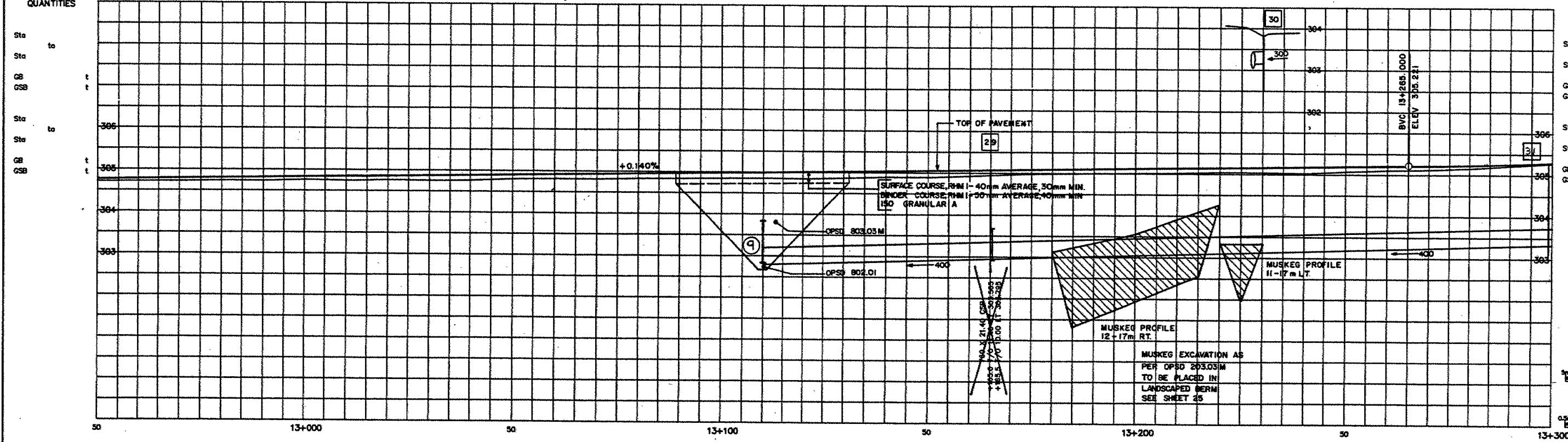
CPR BLOCK

R = 435
S = 0.060 m/m
PROFILE CONTROL



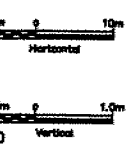
- NOTES:
- 1. FOR REMOVAL INFORMATION REFER TO QUANTITY SHEETS
 - 2. FOR BENCHING LOCATIONS REFER TO SHEET 10

QUANTITIES



QUANTITIES

SCALES



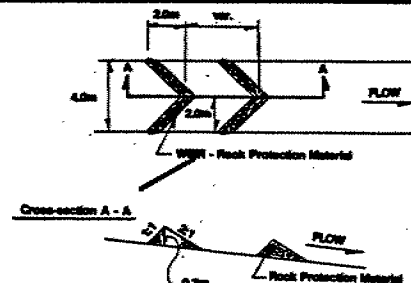
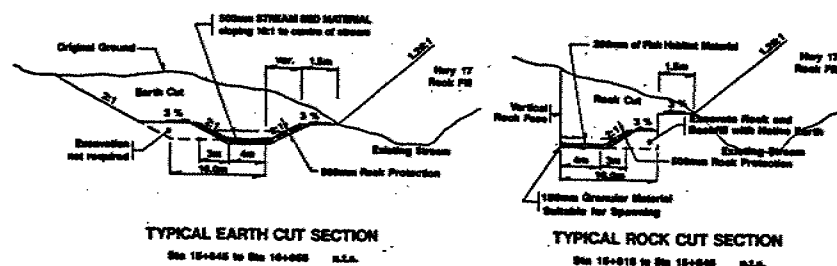
METRIC

PLATE No
CONT No 93-227
WP No 107-87-00

NEW CONSTRUCTION
STA 15+400 TO STA 16+100
Survey _____ Revised _____

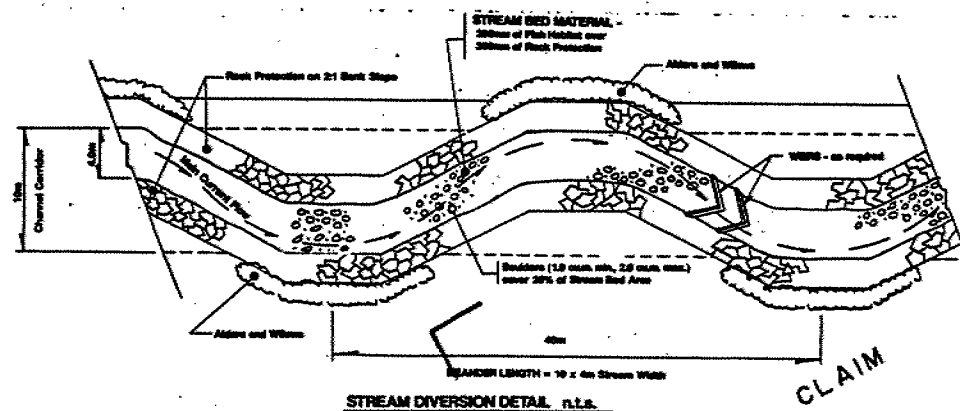
Marshall Macklin Monaghan Limited
Township
Consulting Engineers - Surveyors - Planners

SHEET 23A
AUGUST 1991
UPDATED JUNE 1992



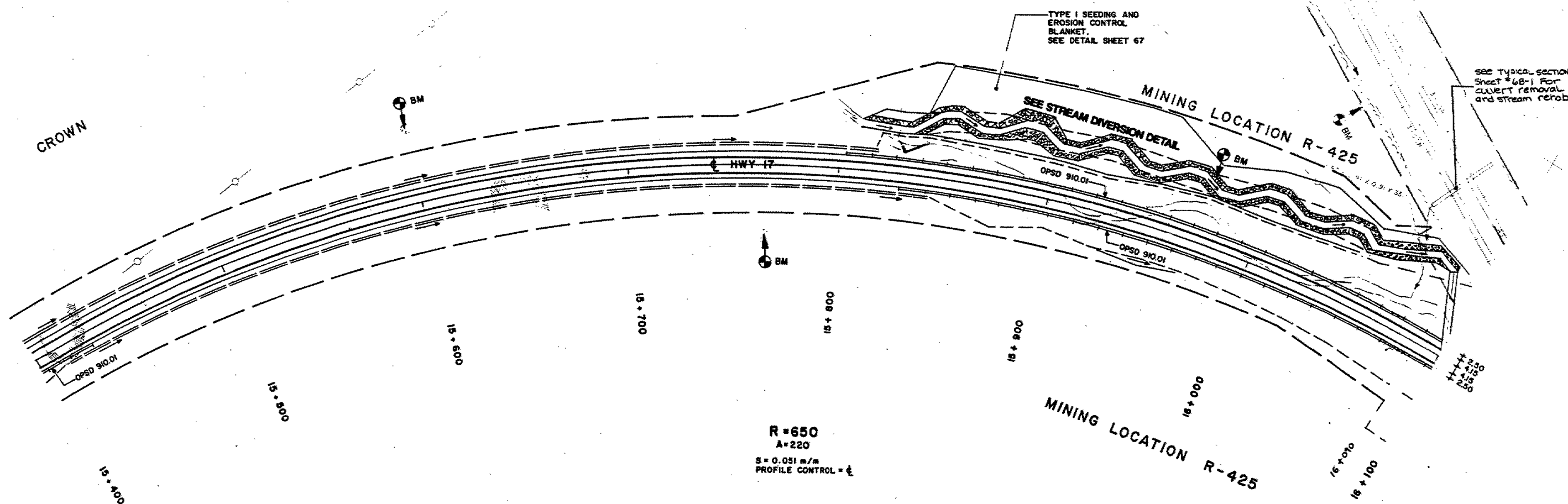
WEIR LOCATIONS FOR STREAM DIVERSION: - Township of Prince

STATIONS:	15+812	15+832	15+852	15+872	15+892	15+912
	15+814	15+834	15+854	15+874	15+894	15+914
	15+816	15+836	15+856	15+876	15+896	15+916
	15+818	15+838	15+858	15+878	15+898	15+918



MINING CLAIM TB 6172

MINING CLAIM TB 6173



R=650
A=220
S=0.051 m/m
PROFILE CONTROL = 6

SCALE
10m 20m

- NOTES:
1. FOR REMOVAL INFORMATION REFER TO QUANTITY SHEETS
 2. FOR BENCHING LOCATIONS REFER TO SHEET 10
 3. FOR CLOSE CUT CLEARING SEE QUANTITY SHEETS

METRIC

PLATE No

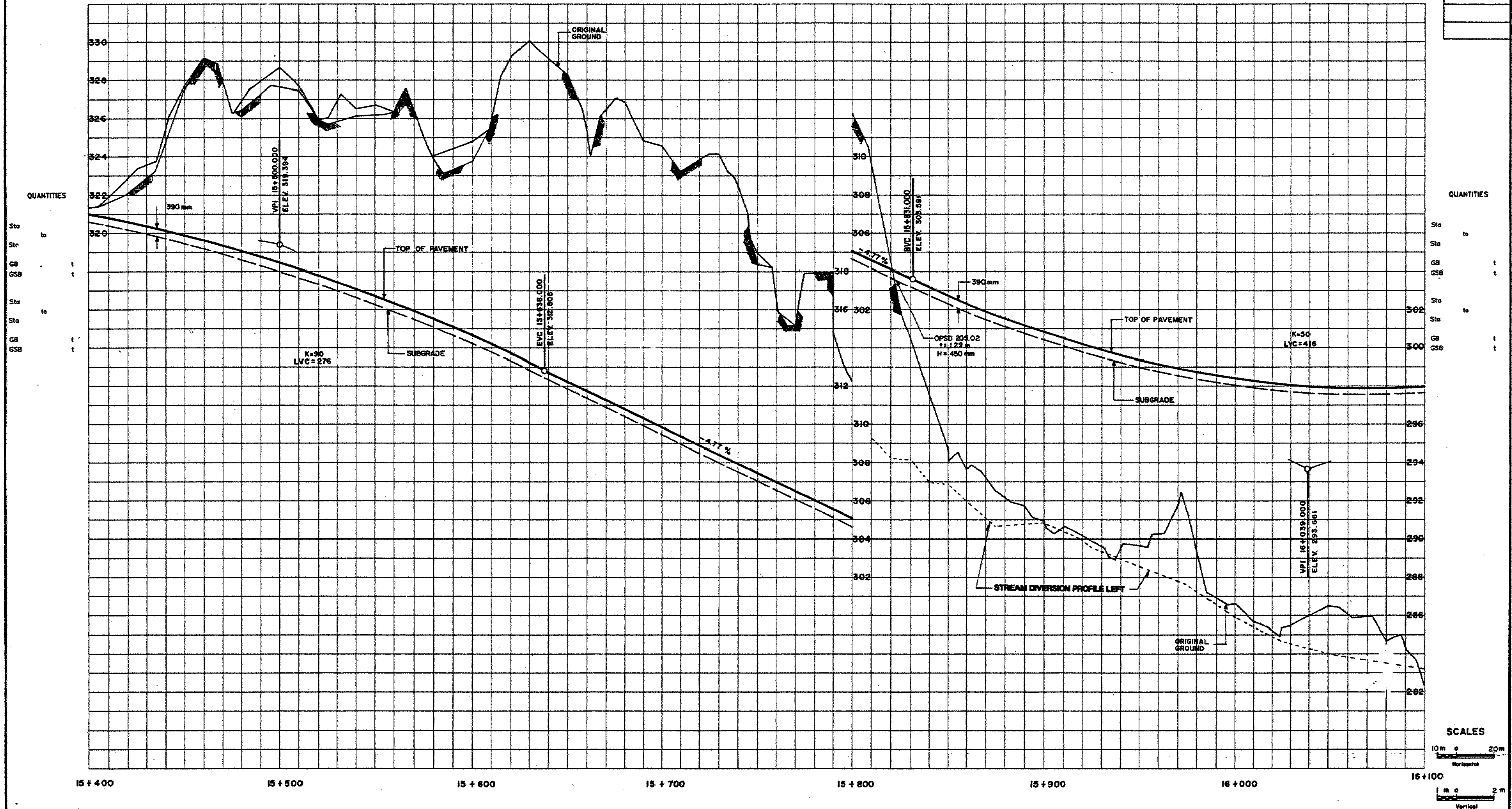
CONT No 93-227
WP No 107-87-00

NEW CONSTRUCTION
STA 15 + 400 TO STA 16 + 100
Survey Revised

SHEET
24A

**Marshall Macklin Monaghan
Limited**
Consulting Engineers - Surveyors - Planners

AUGUST 1991



METRIC

PLATE No
CONT No 93-227
WP No 107-87-00

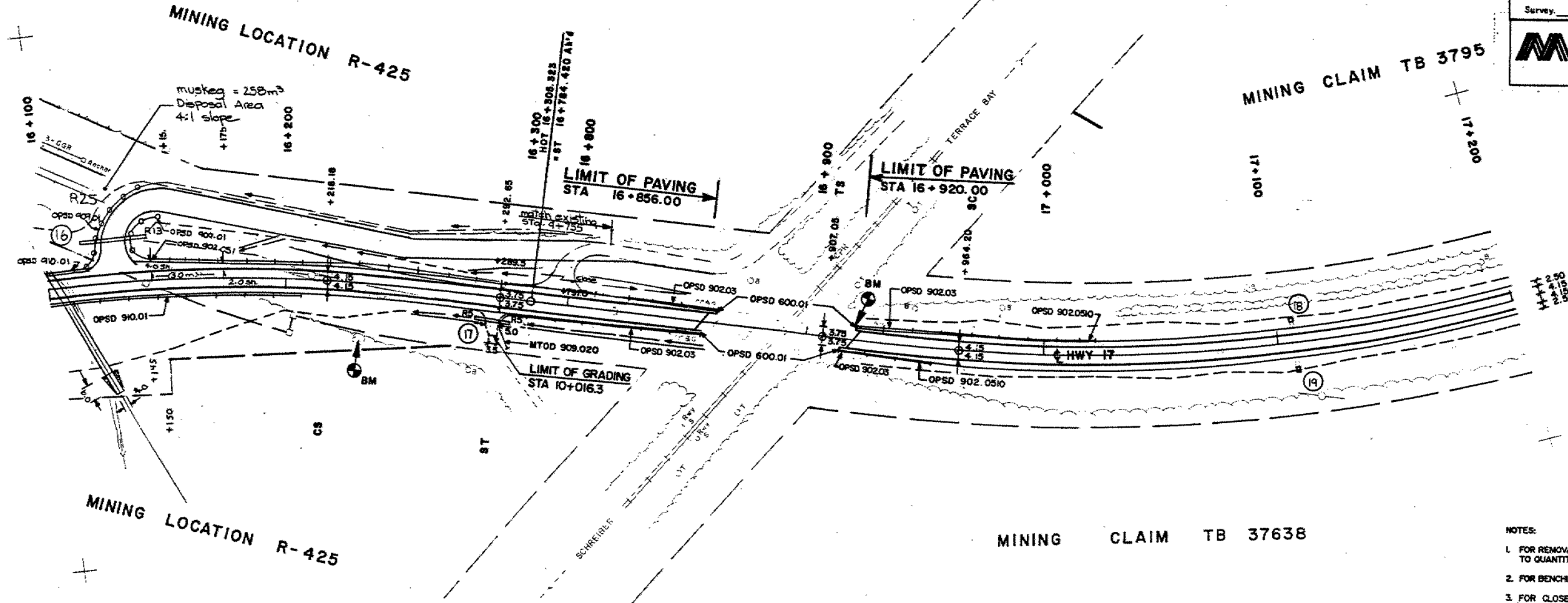
NEW CONSTRUCTION
STA 16+100 TO STA 17+200
Survey: Revised:

Marshall Macklin Monaghan
Limited
Consulting Engineers - Surveyors - Planners

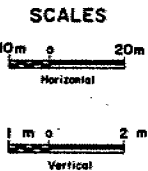
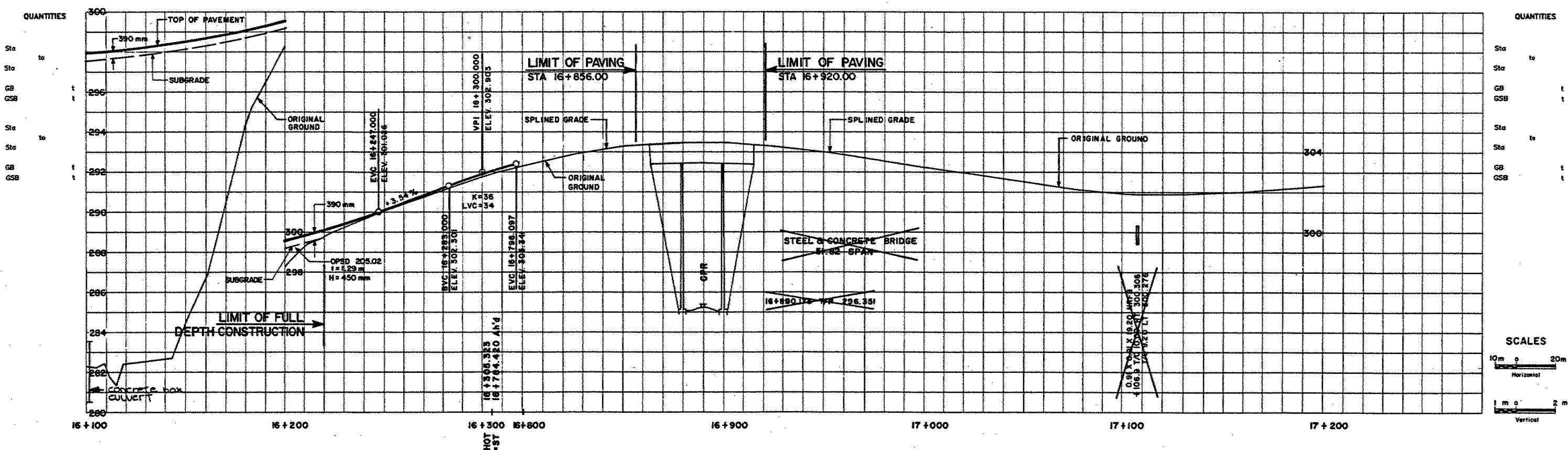


SHEET
25A

AUGUST 1991



- NOTES:
1. FOR REMOVAL INFORMATION REFER TO QUANTITY SHEETS
 2. FOR BENCHING LOCATIONS REFER TO SHEET 10
 3. FOR CLOSE CUT CLEARING SEE QUANTITY SHEETS



ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 682-93-01 DIST 19
HWY 17 STR SITE 48E-54C
Proposed Lamont Creek Culvert
Hwy 17 Realignment

DISTRIBUTION

R.J. Krisciunas (3)
P. Bound
O.E. Ramakko
F.A. Adams (2)
B. Farago
G.E. Greene
E.A. Joseph
G. Norman (Cover Only)
F. Bacchus (Cover Only)
File

memorandum



To: Ray Krisciunas
Head, Structural Section
Northwestern Region

Attn: C.L. Brown

From: Foundation Design Section
Room 315, Central Building

Subject: Proposed Lamont Creek Culvert
Hwy 17 Realignment
W.P. 682-93-01, Site 48E-54C
District 19, Thunder Bay

Date: 93 10 25

The foundation investigation for the above noted project has recently been complete. This report summarizes the findings of the investigation and foundation recommendations for the proposed structure. Due to the urgent nature of the job and the ministerial commitments, a memo type report is produced herein to provide a quick response to the request. Borehole locations are shown on a copy of the contract drawing. It is attached herein together with the Record of Borehole sheets.

Due to the high occurrence of traffic accidents on Hwy 17 around the area of the site, it is proposed to straighten the curve of the existing highway by realigning the highway south of the existing. A new culvert is therefore necessary to carry water across the highway from Lamont Creek. The culvert will be a 3.0 m x 3.25 m concrete box of about 80 m long. There will be about 14 \pm m of fill on top of the new culvert.

The existing Lamont Creek meanders across the site with a number of tributaries. The area of the flood plain is heavily vegetated with tall trees. The creek bed is generally granular and bouldery with some organics. The existing highway embankment at the culvert location is about 11 to 14 m high and composed of rock fill. It stands at an angle of about 2H:1V to 1.25H:1V.

A total of five(5) boreholes and one(1) cone penetration test were carried out between 93 10 13 and 93 10 16 to a depth of 12.6-15.7 m and 12.8 m respectively. Cone penetration tests were also performed at BH 1 location from the ground surface to 12.3 m depth and at BH 2 and BH 3 from the bottom of the borehole to a depth of 21.1 m. The boreholes were advanced using conventional hollow stem augering techniques with a continuous flight auger machine mounted on a muskeg vehicle. 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. Surveying required to ascertain borehole locations and elevations was carried out by the Northwestern Region Surveys and Plans Section.

The Record of Borehole sheets attached illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes are shown in Figure 1.

The subsurface stratigraphy in the area comprises of a major deposit of silt with occasional sand layers. The silt stratum is typically in a compact state of denseness. It is overlain by a silty sand/sandy silt layer ($1.5-2.0 \pm$ m) at the surface with occasional cobbles and boulders in BH 1 and 4 to 6. Organic material and woodchips are typically found at the surface in all boreholes to a depth of 0.8 to 2.0 m. Bedrock was not encountered in any of the boreholes. Groundwater level was monitored in all boreholes during and after completion of drilling. The stabilized groundwater table varies from 0.5 to 2.6 m depth, and typically ties in well with the water level of the creek in the vicinity of the borehole. The level of the creek bed varies and drops in a number of steps across the site. The water level in the creek was at about EL 280.67 m near BH 3. Seasonal fluctuations in water levels are expected.

DISCUSSION AND RECOMMENDATIONS

Based on the results of the investigation, we provide the following foundation recommendations for the design and construction of the structure:

Foundation -

The length of the proposed concrete culvert is about 80 m. The proposed invert elevation at the inlet and outlet is El 283.98 m and El 280.4 m respectively. Assuming a slab thickness of 0.5 m, the founding elevation for the box culvert at the inlet and outlet is El 283.48 m and El 279.9 m respectively. According to the investigation results, the box culvert will be founded on the native compact silt stratum. The founding material is considered competent enough to support the box culvert and conventional shallow foundation is recommended. The following design capacities as per O.H.B.D.C. are recommended:

Factored Capacity at U.L.S.= 550 kPa
Bearing Capacity for Serviceability requirements = 300 kPa
(this corresponds to a settlement of about 50-75 mm)

Due to the height of fill involved and possible variation of founding subsoils along the length of the culvert, it is recommended to provide a camber of 150 mm at the centre of the culvert to account for the differential compression settlement.

A 2.2 m earth cover should be provided for frost protection unless the culvert is structurally designed to resist the frost action.

Construction-

The construction of the culvert will involve excavation of up to $2 \pm$ m below the existing ground surface. The water bearing silt material is susceptible to disturbance under unbalanced hydrostatic head and prior dewatering should be carried out before excavation takes place. Dewatering can be in the form of an oversized excavation which can allow sump pumping in perimeter ditches to maintain the ground water a minimum of 0.5 m below the culvert bottom. Some provision is required to divert the creek around the work area.

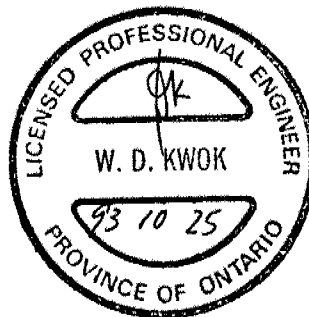
All organic material should be removed prior to placement of fill for the embankment. Below the water level, only relatively free draining granular material should be used. Culvert inlet and outlet treatments should comply with MTO standards. If rock fill is used, the sizes of the rock fill within a 1 m buffer zone around the culvert should be well graded and kept to a maximum of 300 mm.

Temporary excavations up to $2 \pm$ m will be required. Cut slopes should be formed to 2H:1V gradient or flatter.

Embankment slope -

According to the design profile, the approach fill slopes will be up to $16.0 \pm$ m high. For a rock fill embankment, slopes should be constructed at 1.25H:1V to a maximum height of 6 m with a 2 m wide berm every 6 m up to a maximum height of 18 m, so that no uninterrupted slope is higher than 6 m.

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer using the equipment owned and operated by Dominion Soil (Thunder Bay) Inc. The project was carried out 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", written over a horizontal line.

David Kwok, P. Eng.
Project Foundation Engineer



A handwritten signature in black ink, appearing to read "M. Devata", written over a horizontal line.

Murty Devata, P. Eng.
Chief Foundation Engineer

- c.c. P. Bound
O.E. Ramakko
F.A. Adams
B. Farago
G.E. Greene
E.A. Joseph
G. Norman (cover only)
F. Bacchus (cover only)

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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	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_i	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 1										1 OF 1		METRIC					
W.P. 682-93-01			LOCATION Sta. 16+055, a/s 28m Lt of Hwy 17 CL			ORIGINATED BY DK											
DIST 19 HWY 17			BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DT											
DATUM Geodetic			DATE 93 10 13			CHECKED BY BJ											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT 7 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	W _p	W	W _L		
285.1	Ground Surface		1	AS	-												
0.0	Silty Sand with Organics Some Cobbles		2	SS	34												
			3	SS	27												
			4	SS	18												
			5	SS	13												
	Silt Occasional sand seams Light Grey Compact		6	SS	10												
			7	SS	7												
	Silty Fine Sand		8	SS	29												
			9	SS	0												
	Sand Layers		10	SS	6												
	Sandy Silt		11	SS	18												
272.5																	
12.6	End of Borehole																
	* 93 10 14																

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta.16+085, Hwy 17 CL ORIGINATED BY DK
 DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT
 DATUM Geodetic DATE 93 10 14 CHECKED BY BJ

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									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	* LAB VANE						
285.0	Ground Surface						20	40	60	80	100						
0.0	Trace Organics		1	AS	—												
			2	SS	10		284										
			3	SS	10												
			4	SS	18		282										
	Silt Occasional Sand Seams Light Grey Compact		5	SS	17												
			6	SS	18		280										
	Silty Fine Sand		7	SS	15												
			8	SS	26		278										
			9	SS	12												
	Sand, Trace Silt		10	SS	4		276										
			11	SS	10												
			12	SS	23		274										
269.5																	
15.5	End of Borehole																
	Probable Sandy Silt Compact to Dense																
264.0																	
21.0	End of Cone Test																
	* 93 10 15																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+111, o/s 21m Rt of Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger, Cone test COMPILED BY DT
DATUM Geodetic DATE 93 10 15 CHECKED BY 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			20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60					
282.0	Ground Surface		1	AS	-												
0.0	With Organics and Woodchips		2	SS	13												
			3	SS	13												
			4	SS	14												
	Silt		5	SS	13												
	Occasional Sand Layers																
	Light Grey		6	SS	14												
	Compact																
			7	SS	3												
	Sand Layers		8	SS	7												
			9	SS	7												
			10	SS	26												
			11	SS	14												
	Silty Sand																
			12	SS	13												
266.3																	
15.7	End of Borehole																
	Probable Sandy Silt																
	Compact to Dense																
261.0																	
21.0	End of Cone Test																
	* 93 10 18																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+052, Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger COMPILED BY DT
DATUM Geodetic DATE 93 10 14 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					
286.5	Ground Surface		1	AS	1									
0.0	Silty Sand with Cobbles, Some Organics		2	SS	16									
			3	SS	14									
			4	SS	11									
			5	SS	19									
			6	SS	16									
			7	SS	13									
	Silt Occasional Sand Seams Light Grey Compact		8	SS	6									
			9	SS	19									
			10	SS	11									
272.3			11	SS	22									
14.2	End of Borehole													
	• 93 10 16													

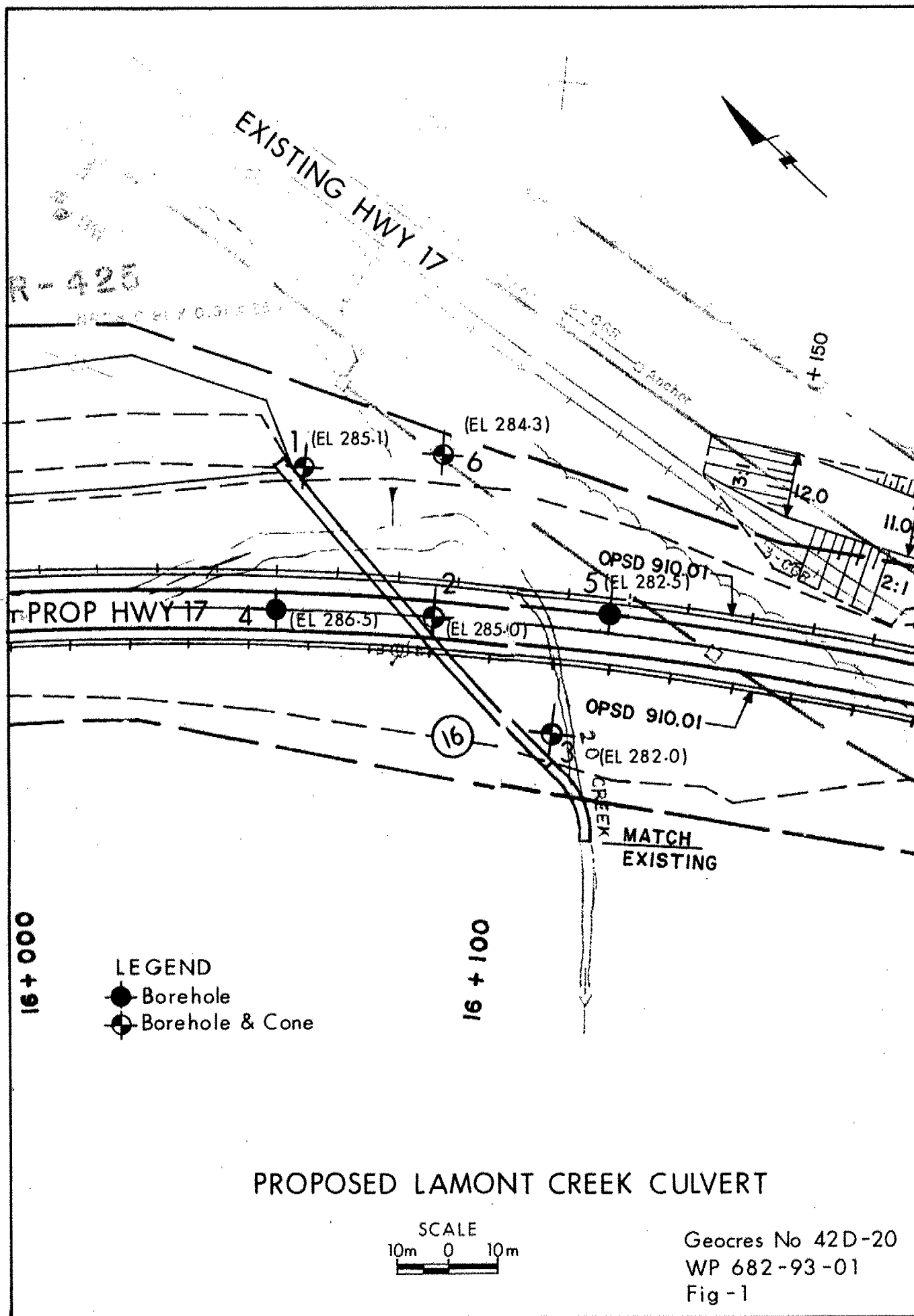
RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+120, a/s 4m Lt of Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger COMPILED BY DT
DATUM Geodetic DATE 93 10 15 CHECKED BY 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _P	W		
282.5	Ground Surface															
0.0	Organic		1	AS	-											
	Silty Sand With Gravel		2	SS	17											
			3	SS	16											
			4	SS	11											
			5	SS	7											
	Silt Occasional Sand Layers Light Gray Compact		6	SS	17											
			7	SS	12											
	Sand Trace Silt		8	SS	10											
			9	SS	9											
			10	SS	17											
			11	SS	18											
266.8	Becoming Dense		12	SS	34											
15.7	End of Borehole															
	* 93 10 18															



GEOCREST No. 42D-20DIST. 19 REGION W.P. No. 682-93-01CONT. No. W. O. No. STR. SITE No. 48E-54CHWY. No. 17LOCATION Loumont Creek CulvertNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 682-93-01

DIST 19

HWY 17

STR SITE 48E-54C

Proposed Lamont Creek Culvert
Hwy 17 Realignment

DISTRIBUTION

R.J. Krisciunas (3)
P. Bound
O.E. Ramakko
F.A. Adams (2)
B. Farago
G.E. Greene
E.A. Joseph
G. Norman (Cover Only)
F. Bacchus (Cover Only)
File

memorandum



To: Ray Krisciunas
Head, Structural Section
Northwestern Region

Attn: C.L. Brown

From: Foundation Design Section
Room 315, Central Building

Subject: Proposed Lamont Creek Culvert
Hwy 17 Realignment
W.P. 682-93-01, Site 48E-54C
District 19, Thunder Bay

Date: 93 10 25

The foundation investigation for the above noted project has recently been complete. This report summarizes the findings of the investigation and foundation recommendations for the proposed structure. Due to the urgent nature of the job and the ministerial commitments, a memo type report is produced herein to provide a quick response to the request. Borehole locations are shown on a copy of the contract drawing. It is attached herein together with the Record of Borehole sheets.

Due to the high occurrence of traffic accidents on Hwy 17 around the area of the site, it is proposed to straighten the curve of the existing highway by realigning the highway south of the existing. A new culvert is therefore necessary to carry water across the highway from Lamont Creek. The culvert will be a 3.0 m x 3.25 m concrete box of about 80 m long. There will be about $14 \pm$ m of fill on top of the new culvert.

The existing Lamont Creek meanders across the site with a number of tributaries. The area of the flood plain is heavily vegetated with tall trees. The creek bed is generally granular and bouldery with some organics. The existing highway embankment at the culvert location is about 11 to 14 m high and composed of rock fill. It stands at an angle of about 2H:1V to 1.25H:1V.

A total of five(5) boreholes and one(1) cone penetration test were carried out between 93 10 13 and 93 10 16 to a depth of 12.6-15.7 m and 12.8 m respectively. Cone penetration tests were also performed at BH 1 location from the ground surface to 12.3 m depth and at BH 2 and BH 3 from the bottom of the borehole to a depth of 21.1 m. The boreholes were advanced using conventional hollow stem augering techniques with a continuous flight auger machine mounted on a muskeg vehicle. 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. Surveying required to ascertain borehole locations and elevations was carried out by the Northwestern Region Surveys and Plans Section.

The Record of Borehole sheets attached illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes are shown in Figure 1.

The subsurface stratigraphy in the area comprises of a major deposit of silt with occasional sand layers. The silt stratum is typically in a compact state of denseness. It is overlain by a silty sand/sandy silt layer (1.5-2.0 \pm m) at the surface with occasional cobbles and boulders in BH 1 and 4 to 6. Organic material and woodchips are typically found at the surface in all boreholes to a depth of 0.8 to 2.0 m. Bedrock was not encountered in any of the boreholes. Groundwater level was monitored in all boreholes during and after completion of drilling. The stabilized groundwater table varies from 0.5 to 2.6 m depth, and typically ties in well with the water level of the creek in the vicinity of the borehole. The level of the creek bed varies and drops in a number of steps across the site. The water level in the creek was at about EL 280.67 m near BH 3. Seasonal fluctuations in water levels are expected.

DISCUSSION AND RECOMMENDATIONS

Based on the results of the investigation, we provide the following foundation recommendations for the design and construction of the structure:

Foundation -

The length of the proposed concrete culvert is about 80 m. The proposed invert elevation at the inlet and outlet is El 283.98 m and El 280.4 m respectively. Assuming a slab thickness of 0.5 m, the founding elevation for the box culvert at the inlet and outlet is El 283.48 m and El 279.9 m respectively. According to the investigation results, the box culvert will be founded on the native compact silt stratum. The founding material is considered competent enough to support the box culvert and conventional shallow foundation is recommended. The following design capacities as per O.H.B.D.C. are recommended:

Factored Capacity at U.L.S. = 550 kPa

Bearing Capacity for Serviceability requirements = 300 kPa

(this corresponds to a settlement of about 50-75 mm)

Due to the height of fill involved and possible variation of founding subsoils along the length of the culvert, it is recommended to provide a camber of 150 mm at the centre of the culvert to account for the differential compression settlement.

A 2.2 m earth cover should be provided for frost protection unless the culvert is structurally designed to resist the frost action.

Construction-

The construction of the culvert will involve excavation of up to 2 ± m below the existing ground surface. The water bearing silt material is susceptible to disturbance under unbalanced hydrostatic head and prior dewatering should be carried out before excavation takes place. Dewatering can be in the form of an oversized excavation which can allow sump pumping in perimeter ditches to maintain the ground water a minimum of 0.5 m below the culvert bottom. Some provision is required to divert the creek around the work area.

All organic material should be removed prior to placement of fill for the embankment. Below the water level, only relatively free draining granular material should be used. Culvert inlet and outlet treatments should comply with MTO standards. If rock fill is used, the sizes of the rock fill within a 1 m buffer zone around the culvert should be well graded and kept to a maximum of 300 mm.

Temporary excavations up to $2 \pm$ m will be required. Cut slopes should be formed to 2H:1V gradient or flatter.

Embankment slope -

According to the design profile, the approach fill slopes will be up to $16.0 \pm$ m high. For a rock fill embankment, slopes should be constructed at 1.25H:1V to a maximum height of 6 m with a 2 m wide berm every 6 m up to a maximum height of 18 m, so that no uninterrupted slope is higher than 6 m.

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer using the equipment owned and operated by Dominion Soil (Thunder Bay) Inc. The project was carried out 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.



David Kwok, P. Eng.
Project Foundation Engineer



Murty Devata, P. Eng.
Chief Foundation Engineer

c.c. P. Bound
O.E. Ramakko
F.A. Adams
B. Farago
G.E. Greene
E.A. Joseph
G. Norman (cover only)
F. Bacchus (cover only)

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

SS SPLIT SPOON	TP THINWALL PISTON
WS WASH SAMPLE	OS OSTERBERG SAMPLE
ST SLOTTED TUBE SAMPLE	RC ROCK CORE
BS BLOCK SAMPLE	PH TW ADVANCED HYDRAULICALLY
CS CHUNK SAMPLE	PM TW ADVANCED MANUALLY
TW THINWALL OPEN	FS 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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+055, o/s 28m Lt of Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DT
DATUM Geodetic DATE 93 10 13 CHECKED BY 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	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
285.1	Ground Surface												
0.0	Silty Sand with Organics Some Cobbles		1	AS									
			2	SS	34								
			3	SS	27								
			4	SS	16								
			5	SS	13								
	Silt Occasional sand seams Light Grey Compact		6	SS	10								
	Silty Fine Sand		7	SS	7								
			8	SS	29								
	Sand Layers		9	SS	0								
	Sandy Silt		10	SS	6								
272.5			11	SS	18								
12.6	End of Borehole												
	* 93 10 14												

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta.16+085, Hwy 17 CL
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger, Cone Test
DATUM Geodetic DATE 93 10 14
ORIGINATED BY DK
COMPILED BY DT
CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 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	W _p W W _L	20 40 60			
285.0	Ground Surface													
0.0	Trace Organics		1	AS										
			2	SS	10									
			3	SS	10									
			4	SS	18									
			5	SS	17									
	Silt Occasional Sand Seams Light Grey Compact		6	SS	18									
			7	SS	15									
	Silty Fine Sand		8	SS	26									
			9	SS	12									
			10	SS	4									
	Sand, Trace Silt		11	SS	10									
			12	SS	23									
269.5	End of Borehole													
15.5	Probable Sandy Silt Compact to Dense													
264.0														
21.0	End of Cone Test													
	* 93 10 15													

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+111, o/s 21m Rt of Hwy 17 CL
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger, Cone test
DATUM Geodetic DATE 93 10 15

ORIGINATED BY DK

COMPILED BY DT

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					
282.0	Ground Surface													
0.0	With Organics and Woodchips		1	AS										
			2	SS	13									
			3	SS	13									
			4	SS	14									
			5	SS	13									
	Silt Occasional Sand Layers Light Grey Compact		6	SS	14									
			7	SS	3									
	Sand Layers		8	SS	7									
			9	SS	7									
			10	SS	26									
			11	SS	14									
	Silty Sand													
266.3			12	SS	13									
15.7	End of Borehole													
	Probable Sandy Silt Compact to Dense													
261.0														
21.0	End of Cone Test													
	* 93 10 16													

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 682-93-01 LOCATION Sta. 16+052, Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger COMPILED BY DT
DATUM Geodetic DATE 93 10 14 CHECKED BY 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			20	40	60	80	100	W _P	W	W _L		
286.5	Ground Surface		1	AS													
0.0	Silty Sand with Cobbles, Some Organics		2	SS	16												
			3	SS	14												
			4	SS	11												
			5	SS	19												
			6	SS	16												
			7	SS	13												
	Silt Occasional Sand Seams Light Grey Compact		8	SS	6												
			9	SS	19												
			10	SS	11												
272.3			11	SS	22												
14.2	End of Borehole																
	+ 93 10 16																

1 OF 1 METRIC

W.P. 682-93-01 LOCATION Sta. 16+084, o/s 32m Lt Hwy 17 CL ORIGINATED BY DK
DIST 19 HWY 17 BOREHOLE TYPE H.S. Auger/Cone Test COMPILED BY DT
DATUM Geodetic DATE 93 10 16 CHECKED BY BI

[illegible]

