

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31E-70

DIST. 11 REGION NORTHERN

W.P. No. 131-70-02

CONT. No. 75-61

W. O. No. 73-11043

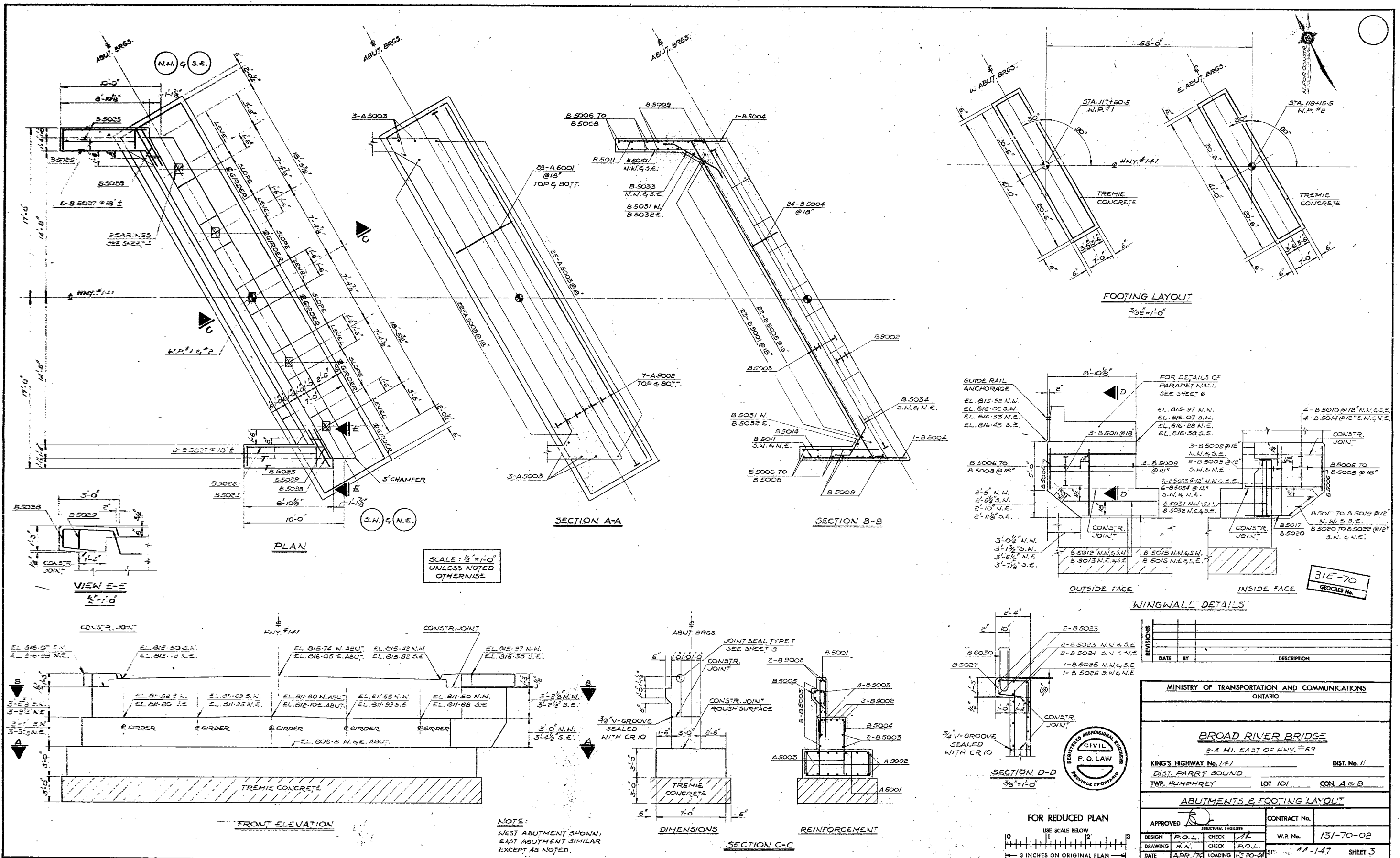
STR. SITE No. 44-147

HWY. No. 141

LOCATION KINGS HWY ⁵³² ~~531~~ & BROAD
RIVER

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 2

REMARKS: Documents to be unfolded before
microfilmed

[illegible]

REVISIONS <div style="border: 1px solid black; height: 100px; width: 100%;"></div>	
DATE	BY
DESCRIPTION	

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

BROAD RIVER BRIDGE

2.4 MI. EAST OF HWY. #69

KING'S HIGHWAY No. 141 DIST. No. 11

DIST. PARRY SOUND

TWP. HUMPHREY LOT 101 CON. A & B

ABUTMENTS & FOOTING LAYOUT

APPROVED <small>STRUCTURAL ENGINEER</small>	CONTRACT No. 												
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">DESIGN</td> <td style="width: 25%;">P.O.L.</td> <td style="width: 25%;">CHECK</td> <td style="width: 25%;">AL</td> </tr> <tr> <td>DRAWING</td> <td>H.N.</td> <td>CHECK</td> <td>P.O.L.</td> </tr> <tr> <td>DATE</td> <td>APR. 76</td> <td>LOADING</td> <td>15-20-24</td> </tr> </table>	DESIGN	P.O.L.	CHECK	AL	DRAWING	H.N.	CHECK	P.O.L.	DATE	APR. 76	LOADING	15-20-24	W.P. No. <u>131-70-02</u> SPT. <u>11-147</u> SHEET <u>3</u>
DESIGN	P.O.L.	CHECK	AL										
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DATE	APR. 76	LOADING	15-20-24										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

31E-70

TO: Mr. J. C. McAllister, (2)
Regional Structural Planning Supervisor,
Northern Region,
North Bay, Ontario.

FROM:

Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE:

November 8, 1973.

OUR FILE REF.

IN REPLY TO

NOV 14 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed New Crossing of
Hwy. 532 and Broad River
2.4 Miles East of Hwy. 69
District #11 (Huntsville, Ont.)
W.O. 73-11043 -- W.P. 131-70-01-02

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.



A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/ao
Attch.

c.c. E. J. Orr
B. R. Davis
A. Rutka
H. McArthur
R. S. Chapman
B. J. Giroux
J. E. Gruspier
S. McCombie
G. A. Wrong
B. A. Singh

Foundations Files
Documents

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FOUNDATION INVESTIGATION REPORT
For
Proposed New Crossing of
Hwy. 532 and Broad River
2.4 Miles East of Hwy. 69
District #11 (Huntsville, Ont.) 2
W.O. 73-11043 -- W.P. 131-70-01

1. INTRODUCTION:

In a memorandum dated September 18, 1973, the Foundations Office was requested by Mr. J. C. McAllister, Regional Structural Planning Supervisor, Northern Region, to carry out a foundation investigation for a proposed new crossing at Hwy. 532 and Broad River. Presently, a single span timber bridge carries Hwy. 532 across the Broad River.

Subsequently, this Office carried out a subsoil investigation to determine the subsoil and groundwater conditions prevailing at the site.

This report presents the results of our investigation together with our recommendations pertaining to the foundations for the new crossing structure.

2. DESCRIPTION OF THE SITE:

Hwy. 532 crosses the Broad River some 2.4 miles east of Hwy. 69. Broad River flows in a northerly direction from Little Whitefish Lake some quarter mile south of the crossing to Whitefish Lake which is situated immediately north of the crossing.

In general, Broad River is some 200 ft. wide but the approach fills to the existing bridge structure have narrowed the width of open water at the crossing to approximately 50 ft. The depth of the river at this place averages about 5 ft.

Topographically, the surrounding terrain consists of rugged rolling hills and is densely wooded. Bedrock outcrops appear in numerous places while in other places bedrock is covered by a thin surficial layer of topsoil.

3. FIELD AND LABORATORY INVESTIGATION PROCEDURES:

Two sampled boreholes were put down during the course of the field work; one at each probable footing location.

Boring was achieved by means of driving or drilling Nw or Bw casing to a given depth and washboring within the casing. Disturbed soil samples were obtained by means of using a standard 2 inch O.D. split-spoon sampler; the energy used in driving it conformed to the requirements of the Standard Penetration Test. Bedrock cores were obtained at the bottom of each borehole using AXT rock coring equipment.

Besides establishing the bedrock surface elevations at the boring location, a probe was pushed by hand to refusal near the centre of the river on either side of the existing structure, in an effort to establish the elevation of the bedrock surface beneath the river bed.

Boreholes were surveyed in the field by personnel from the Northern Region Engineering Surveys Office. The locations and elevations of the borings are shown on Drawing No. 73-11043A, in the Appendix to this report.

Borehole samples were carefully examined and classified in the field and subsequently in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine Atterberg Limits and Moisture Contents and Grain Size Distributions.

The results of field and laboratory tests are summarized

on the Record of Borehole sheets contained in the Appendix to this report.

4. SUBSOIL CONDITIONS:

4.1) General:

In general, the subsoil at the site consists of a 4 - 6 ft. deposit of fine to medium sand. Numerous boulders were encountered in this layer on the west side of the river, while seams and/or pockets of clayey silt were discovered within the layer on the east side of the river. The sand layer is underlain by a thin layer of silty clay which in turn is underlain by sound bedrock. At the location of Borehole #1 some 10 - 11 ft. of rock-fill was encountered above the sand layer. At the location of Borehole #2, a 4 ft. deposit of soft black organic silt and decayed organic material was encountered above the sand layer.

The boundaries between the various soil strata are shown on the Record of Borehole sheets contained in the Appendix. The estimated stratigraphical profile shown on Drawing No. 73-11043A is based on this information.

From ground level downward, the various strata are described with regard to soil types and soil properties as follows:

4.2) Rockfill - Boulders and Sand:

Borehole #1 was advanced through some 10 - 11 ft. of the west approach fill. The fill consists of boulders with medium sand filling the crevices between boulders.

4.3) Organic Silt - Muck:

This deposit was encountered at the location of Borehole #2 and extended from ground level down to a depth of approximately 4 ft. The material consists of organic silt with considerable amounts of decayed vegetable matter. It is black in colour and may be described as very soft.

4.4) Fine to Medium Sand:

This 4 - 5 ft. thick layer was encountered beneath the rockfill in Borehole #1 (elevation 798) and beneath the organic silt in Borehole #2 (elevation 799). It consists of fine to medium sand with varying amounts of silt and clay from one borehole to the other. In Borehole #1 numerous boulders were encountered within this stratum. The average water content of the material is 11%.

Based on a single standard penetration test 'N' value of 2 blows/foot, the deposit may be described as having a very loose relative density.

4.5) Silty Clay:

This 2-3 ft. thick layer was encountered beneath the sand layer. The material consists of silty clay with small amounts of gravel.

The water content averages 56% and the liquid and plastic limits are 49% and 21%, respectively.

Based on 'N' values obtained within this stratum, the material may be described as having a soft consistency.

4.6) Bedrock:

Bedrock was proven at both boring locations, beneath the silty clay layer. The bedrock surface was at elevation 790± and 793± at Boreholes #1 and 2, respectively. In addition, a probe was pushed by hand into the river bottom at approximately Station 117+80, to refusal at elevation 790±. Based on this information, it appears that the bedrock surface slopes upwards slightly from west to east across the river.

The bedrock samples were examined by M.T.C. Geologist, Mr. George Woda who described them as sound dioritic gneisses.

5. GROUNDWATER CONDITIONS:

Groundwater levels were determined in the field during the course of the subsoil investigation by recording the water

levels in the cased boreholes. At both borings the groundwater levels were at elevation 802.8 which was also the elevation of the river surface. Due to the permeable nature of the subsoil, the groundwater levels will undergo seasonal variations.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

The existing crossing at Broad River and Hwy. 532 consists of a single span (38.4' clear span) timber simple truss bridge. It is proposed to replace the timber bridge by either a small concrete structure with a span of 30 - 40 ft. or a structural steel plate pipe arch culvert some 19' x 12', placed on a 20° left skew to the centreline of Hwy. 532 at Sta. 117+90. Regardless of the scheme used, the existing road grade is to be raised to between elevations 816 and 818. This will necessitate raising the existing 8 - 9 ft. rockfill approaches by some 3 - 4 ft.

In general, the overburden at the site consists of 4 - 5 ft. of fine to medium sand with boulders underlain by 2 - 3 ft. of soft silty clay which in turn is underlain by sound gneiss bedrock.

6.2) Structure Foundations:

In view of the subsoil conditions at the site, if a small concrete structure is chosen for the crossing, the structure may be supported on spread footings placed on bedrock. Such footings should be adequately keyed into the rock. For this case, a design pressure of up to 50 t.s.f. may be assumed. Since the bedrock surface is some 10 - 14 ft. below the groundwater level, a dewatering scheme will be required in order to place the footings in the dry. To eliminate the need for dewatering, consideration should be given to forming the footings by tremie techniques.

As an alternative, the structure may be supported on

spread footings placed within the rockfill embankment with 1-1/4:1 or flatter forward and side slopes. A safe load of 2.5 t.s.f. may be assumed for design purposes.

The footing bottoms should be placed so as to have at least 6 feet of cover to provide for frost protection and should be a minimum of 10 feet from the forward slope of the rockfill. The loose sand and soft cohesive material beneath the existing approach embankments at the structure location should be excavated. The rockfill embankment should be rebuilt, initially to top of footing level with 1-1/4:1 or flatter forward and side slopes, then excavated for the structure foundation. Figure 1 below, shows the details of excavation, backfilling and embankment geometry.

Based on a finished grade of 817± the elevation of the base of the footing should be above the estimated high water level of 805± and therefore, no dewatering scheme will be required.

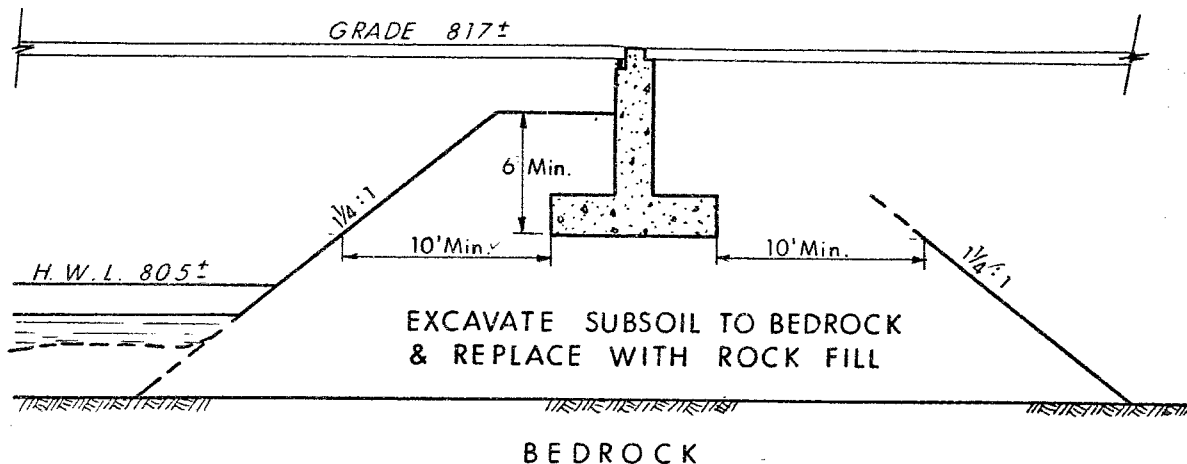


Fig. 1

6.3) Structural Steel Plate Pipe Arch Culvert:

If it is decided to replace the existing crossing with a flexible type culvert, the soft material below the river bed should be excavated to bedrock and replaced with a suitable free draining granular material. Bedding for the culvert should consist of a minimum 2 ft. thick layer of granular B. Granular B material should also be used for the backfill which should extend to a minimum height of 2 ft. above the pipe. Bedding and backfill should be compacted according to current M.T.C. standards. In order to place the culvert and bedding in the dry a major dewatering scheme will be required.

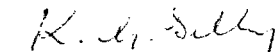
7. MISCELLANEOUS:

The field work was carried out during the period of October 10 - 15, 1973, under the supervision of Mr. L. J. Hodge, Project Foundations Engineer who also prepared this report.

Equipment used was owned and operated by Canadian Longyear Company Ltd., Rexdale.

This report was reviewed by Mr. K. G. Selby, Supervising Foundations Engineer.


L. J. Hodge



LJH/ao
November 5, 1973.

K. G. Selby, P. Eng.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 73-11043

LOCATION Sta. 117 + 55 16' Rt. 8

ORIGINATED BY LJH

W.P. 131-70-01

BORING DATE Oct. 11 - 12, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE NW/SE Casing & Washboring

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L	
809.4	Ground Level														
0.0	Rock Fill and Sand														
798.4			1	RC	42%	800									
11.0	Fine to medium sand and boulders.		2	RC	5%										
793.4															
16.0	Silty clay														
790.4	Soft Grey		3	SS	1/3"	790									
19.0	Bedrock														
	Paragneiss, Sound		4	RC	100%										
781.3	Hard		5	RC	100%										
28.1	End of Borehole					780									

OFFICE REPORT SOIL EXPLORATION

RECORD OF BOREHOLE NO 2

JOB 73-11043

LOCATION Sta. 118 + 32 34' Lt. C

ORIGINATED BY LJH

W.P. 131-70-01

BORING DATE Oct. 15, 1973

COMPILED BY LJH.

DATUM Geodetic

BOREHOLE TYPE NW/BW Casing and Washboring

CHECKED BY [Signature]

15 ϕ 5 % STRAIN AT FAILURE

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" " ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

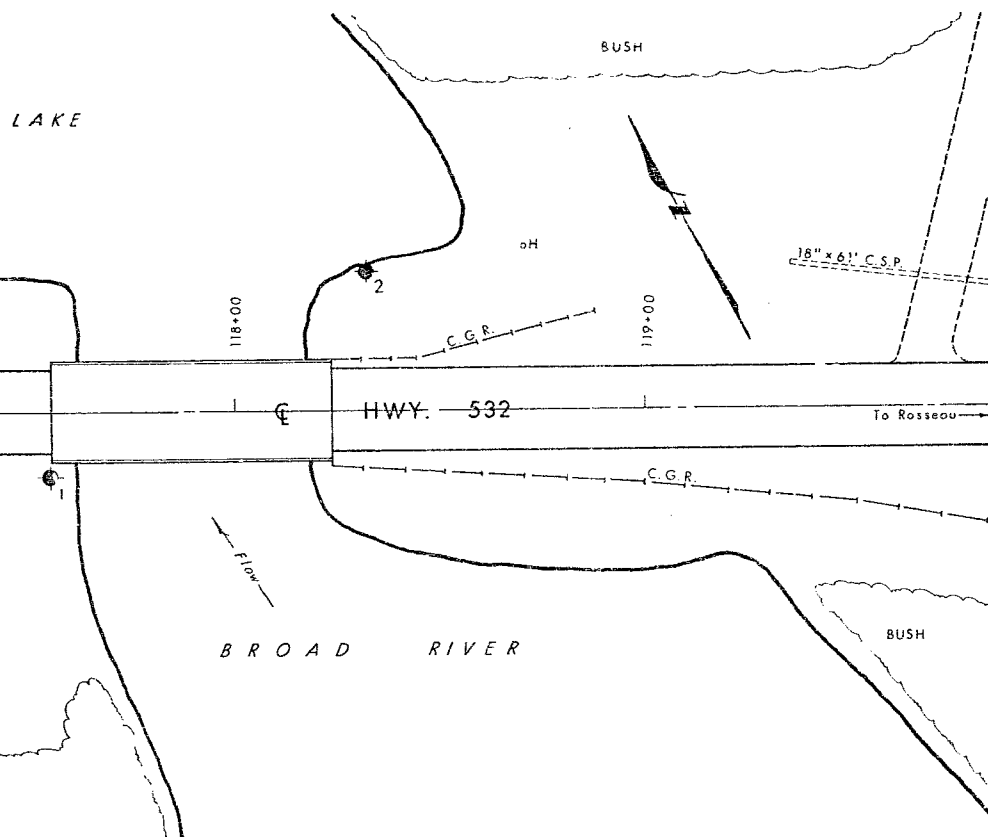
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

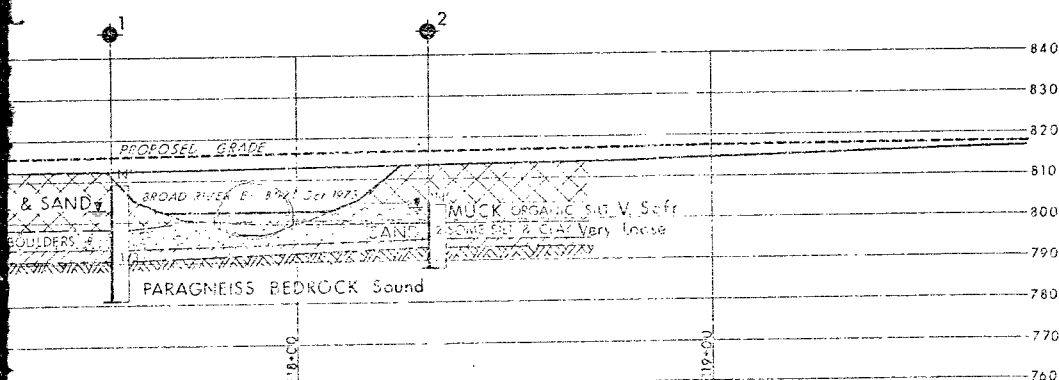
SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



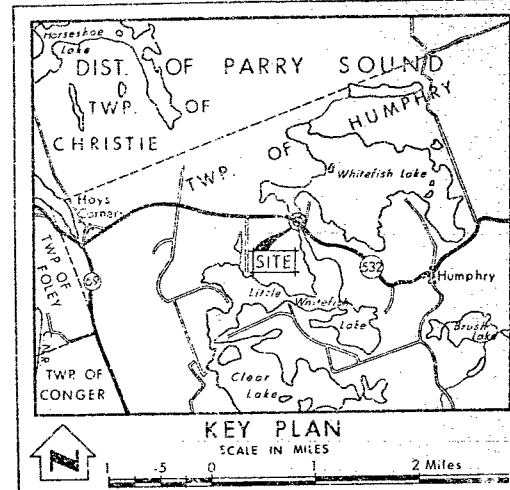
PLAN
SCALE

20 10 0 20 40 FT.



PROFILE
SCALE

20 10 0 20 40 FT.



LEGEND

- Bore Hole
- ⊕ Cone Penetration Test
- ⊕ Bore Hole & Cone Test
- ⊕ Water Levels established at time of field investigation, Oct. 1973

NO.	ELEVATION	STATION	OFFSET
1	809.4	117+55	16' RT.
2	803.2	118+32	34' LT.

NOTE: FOR CONTRACT DOCUMENT

The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HUNTSVILLE District Office.

— NOTE —

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

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS SECTION

BROAD RIVER

HIGHWAY NO. 532 DIST. NO. 11
Dist. of PARRY SOUND
TWP. HUMPHRY LOT 101 CON. A & B

BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT A.P.	CHECKED	AP NO. 131-70-01	DRAWING NO.
DRAWN BY	CHECKED	AP NO. 73-11043	73-11043A
DATE	20/10/72	DATE	BRIDGE DRAWING NO.
APPROVED	DATE	DATE	DATE

REF. NO. B-397-11

Mr. J. Wear,
Project Review Engineer,
East Bldg., Downsview.

Foundations Office,
Design Services Branch,
West Bldg., Downsview.

June 13, 1973.

Broad River Culvert, 2.2 Miles East of
the Jct. of Hwy. 69, Twp. of Humphry,
District of Parry Sound, Hwy. #532,
District #11 (Huntsville)
W.P. No. 131-70-01

W.O. 73-11043 ✓

We have reviewed the contract drawings for the above-mentioned project. Mr. R. P. Northwood, Soils Engineer, who wrote the Soils Report for this project, supplied us with the following soils information at this site:

0'	-	8'	Water
8'	-	9'	Med. Sand & Rock Fill
9'	-	11'	Silty Clay, Soft
11'	-	12'	Boulders, No Further Penetration

In his soils report Mr. Northwood had recommended the removal of soft silty clay.

Our comments regarding the construction of the culvert are as follows:

Because of the presence of boulders in the river, it is recommended that bedding for the culvert should consist of 2 ft. thick granular 'B' material at its minimum.

Backfill for the culvert should consist of granular 'B' material, and it should extend to at least 2 ft. above the top of the culvert.

A clay seal should be provided at the upstream end of the culvert to prevent seepage.

A 3-ft. thick filter of granular 'A' material should be provided at the downstream end of the culvert.

AP/ao

c.c. R. P. Northwood
H. McArthur

For:

APRakash

A. Prakash,
Senior Foundations Eng.,
K. G. Selby,
Supervising Foundations Eng.

Foundations Files
Documents

Jun 15/74

NOTE:

Further to our conversation on July 17, 1973, we understand that no dewatering will be done and the culvert will be constructed under 4 - 6 feet of water.

In this case we recommend that bedding and backfill should consist of granular 'A' material. Furthermore, we would like to point out that this type of construction cannot be guaranteed to perform satisfactorily.

A. Prakash

A. Prakash
Senior Foundation Engineer

July 18, 1973

MEMORANDUM

TO: Mr. J. Wear,
Project Review Engineer,
Systems Design Office,
Downsview.

FROM: Systems Design,
North Bay.

DATE: July 10, 1973.

OUR FILE REF. IN REPLY TO

SUBJECT: W.P. 131-70-01-02, Hwy. 532, Broad
River Culvert & Approaches,
District 11, Huntsville

Further to our telephone conversation re the above job, we have reviewed the project and are returning it herewith.

The use of cut off walls at the ends of culverts is intended to prevent water from flowing underneath. The water passing through the Broad River culvert could be accommodated by a 6' pipe so that the flow through a 19'-4" x 12'-2" pipe will be minimal under all conditions.

The method of preparing the bedding for the pipe and placing it in 4'-6" of water was discussed with the Structural Office, District and with Mr. J. Wilson of Armco. This method is carried out frequently and provided care is exercised, a satisfactory installation can be obtained. This then precludes the need to place the culvert in the dry.

The relatively low fill to be used over the culvert will produce low stresses in the pipe and, therefore, there appears to be no need to increase the gauge.

We have changed the backfill material from Granular "C" to Granular "B" on the recommendation of Mr. J. Wilson. This is the only change we have made from the original submission.

S. McCombie

S. McCOMBIE,
MANAGER, SYSTEMS DESIGN.

SMcC/db

c.c. -

R. S. Chapman
J. McAllister
W. Melinyshyn

NOTE:

Further to our conversation on July 17, 1973, we understand that no dewatering will be done and the culvert will be constructed under 4 - 6 feet of water.

In this case we recommend that bedding and backfill should consist of granular 'A' material. Furthermore, we would like to point out that this type of construction cannot be guaranteed to perform satisfactorily.

A. Prakash

A. Prakash
Senior Foundation Engineer

July 18, 1973

Ki Selby
73-11043(x)

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: File

FROM: J.R. Wear
Project Review Engineer
Project Review Section

ATTENTION:

DATE: July 23, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P 131-70-01, 02, Highway 532, Broad
River Culvert and Approaches, District 11,
Huntsville.

This memorandum is to acknowledge receipt as per letter attached of the above project resubmitted from the Region for further processing.

After further discussion with most affected parties, the concern for a satisfactory installation remains in view of recent failures of similar size pipes and the review within the industry for pipe arches.

I recommend that a meeting of interested parties be held to review the necessary requirements for this installation and for those in future.

The primary concern for this installation is the placing of such pipe without unwatering in a navigable channel with approximately 4 to 6 feet of water, and with a 2 foot excavation for bedding. All work of removing the existing timber structure and assembling and installing the 19' - 4" by 12' - 2" pipe is to be performed within a 2 week period during which time traffic will be rerouted.

The following points are expected to provide a basis for comments. In order to establish guidelines for the placing of pipes without unwatering the circumstances relating to this installation to be considered are as follows:

- 1) Current standards, specifications and procedures within MTC as used for this installation suggest placing culverts in the dry.
 - a) MTC Form 421-B specifies that for the contract price for earth excavation "the Contractor shall provide at his own expense, unless otherwise specifically provided, all excavation for diverting water, all shoring to protect the excavation, also all pumping, syphoning or bailing as may

be necessary to permit the satisfactory placing of the pipe."

- b) MTC Form 314.03.08 specifies 100% compaction max. dry density as determined by ASTM D 698.
- c) Standard DD-808-B specifies 95% compaction except for area beneath culvert.
- d) Standard DD-808-B specifies that "For culverts, the upstream end of the pipe must be bedded in clay and properly compacted to prevent seepage." For this installation such requirement is doubtful.
- e) MTC Form 421-B specifies that backfill with bedding implied, "shall be placed in layers not more than 6 inches in loose depth, and thoroughly compacted by tamping to the full width and depth of the excavation using water if necessary, particular care being taken to thoroughly consolidate the material under the haunches of the pipe or pipe arch."
- f) MTC Form 421-B specifies that "no payment will be made for the compaction of foundation materials, the unit price bid for the placing of such foundation materials being considered to fully cover the work of placing and compacting the material.
- g) MTC Form 421-B specifies that "in its final position and as a last assembly operation, all bolts shall be retightened with a torque measuring wrench to a minimum torque of 250 foot pounds for gauges heavier than #10."

2) Granular Bedding and Backfill

- a) Granular bedding and backfill material was originally to be Granular 'C'. Foundations Office in review recommended Granular 'B' presuming there would be unwatering and finally Granular 'A' when unwatering would not be undertaken. J. Wilson of Armco has recommended placing the best self-compactive material if placed in water. G. Wrong believes Granular 'B' in the area is difficult to obtain and also recommends Granular 'A'. The manner of shaping the bedding and obtaining compaction at the haunches where it is critical remains indeterminate.

- b) Standard DD-808-B specifies that for pipes with bottom radius up to 150 inches (approx. 12 ft. span) "Pipe-arch bed to be carefully shaped to receive the lowest segment of pipe formed by the bottom radius. The deflection referred to is 15 inches as per standard DD-812-E. However, for larger pipes "pipe-arch bed to be levelled and left uncompacted for the width of area under bottom radius of pipe-arch."

If the pipe were either assembled in place or placed in the dry, appropriate compaction could be introduced beneath the pipe and adjacent to the haunches. However, the term "levelled off" is not clearly understood nor the degree of compaction of bedding material spread under water.

- c) With possible uncertainty in the degree of compaction arising from 2(b) above, there may be possibility of an uplift stress develop at the pipe extremities under the influence of backfill over the roadbed vs none at the bevelled ends.

J. McAllister has advised that the waterway is unlikely to freeze to the bottom of the pipe and therefore differential heaving is not expected at pipe ends.

- d) The contract specifies that the bedding will be as per DD-808-B which specifies that granular beneath the pipe shall be 1 foot. However, the typical cross-section through the pipe on dwg. 10 regarding bedding specifies that "Depth of granular bedding as directed by the Engineer." The bedding width is the span of pipe plus 10 ft. (30 ft. approx.). The pipe length is 70 ft.

Foundations Office have advised that "because of the presence of boulders in the river, it is recommended that bedding for the culvert should consist of 2 ft. thick Granular 'B' material at its minimum." The question here is to what depth of excavation the Engineer will direct and the effect on a Contractor's bid price.

3) Granular Cover

Foundations Office have recommended at least 2 ft. of backfill material above the top of the culvert. The contract presently

specifies 1.5 ft.

4) Pipe Gauge

It is the recommendation of C. Grebski of the Structural Office and W. Porter of the Corrugated Metal Pipe Institute that the thickness of the pipe should be increased as is done in jurisdictions other than the Ministry. The gauge specified in this contract is the lightest i.e. #8. The gauge suggested is #5.

5) End Protection

For culvert end treatment, in locations of high differential volume of flow e.g. summer vs spring runoff, a clay seal at the upstream end head walls and cut-off walls would be necessary to protect against infiltration, scour and damage to the pipe. In the case of this contract, there is a constant minimal flow and the culvert simply acts as an equalizer to connect Whitefish and Clear Lakes.

The Foundations Office in reassessing that the flow condition through the culvert is minimal, rescends the recommendations for a clay seal on the upstream end and a 3 ft. thick Granular 'A' material on the downstream end.

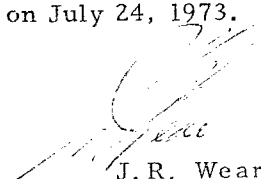
The contract specifies that rockfill is to be placed to widen existing embankments. However, the extent and depth of rockfill placed adjacent to the pipe within the area of the granular backfill is not specified. J. Harris indicates that 2 ft. of rockfill is satisfactory but recommends placing a filter blanket behind the rockfill of pit run gravel or a plastic woven fabric to 2 ft. above high water level to prevent loss of granular backfill from whatever wash may be expected from small boats.

Comments are expected from a meeting between the pipe industry representative and our drainage and standards Engineers on July 24, 1973.

JRW/rk
Attach.

c. c. :

J. Callaghan	W. Melinyshyn
R. Chapman	E. J. Orr
J. Ford	K. Selby ✓
C. Grebski	E. J. Willis
J. Harris	G. Wrong
S. McCombie	D. Zander
J. McAllister	


J. R. Wear
PROJECT REVIEW ENGINEER

for:
G. K. Hunter
SYSTEMS DESIGN ENGINEER

MEMORANDUM

TO: Mr. G.K. Hunter,
Systems Design Engineer,
East Building.

FROM: Structural Office,
West Building.

ATTENTION: Mr. J.R. Wear,
Project Review Engineer.

DATE: July 27th, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT:

RE: W.P. 131-70-01, 02 - Hwy. 532
- Broad River Culvert and Approaches
- District 11, Huntsville.

This refers to your memo of July 26th.

For several months we have had grave doubts concerning the predictability of corrugated steel structures. In particular it appears that the plate arches, with bottom plates having a large radius of curvature, are most suspect. These doubts have been raised within the Ministry, with other authorities and with representatives of the metal pipe industry.

Even when site conditions are favourable it must be recognized that such structures have a much higher probability of failure than alternative types. In this case it appears that the site conditions are anything but favourable. In addition it appears that a number of recommendations from such people as Mr. C.S. Grebski, Mr. J. Wilson of Armco, and our foundation engineers have not been acted upon.

It is my opinion that this structure should not be built in the form prepared.

If the award date can be set back to allow time, we would be happy to assist the Region in preparing contract documents for an alternative structure.

BSR/sm

cc. C.R. Wilmot,
E.J. Orr,
W. Melinyshyn,
E.J. Willis,
D.J. Zander,
J. Ford,
C. Grebski,
S. McCombie,
J. McAllister

B.S. Richardson

B.S. Richardson,
Product Process
Improvement Engineer,
FOR: B.R. Davis,
Structural Engineer.

73-11043 K. Selby

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: S. McCombie
Manager Systems Design
North Bay, Ontario

FROM: J.R. Wear
Project Review Engineer
Downsview, Ontario

ATTENTION:

DATE: July 30, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT:

W. P. 131-70-01, 02, Highway 532, Broad
River Culvert and Approaches, District 11,
Huntsville.

A more exhaustive review for the above project of the circumstances surrounding the placement of the large structural plate pipe arch reveals an inherent uncertainty of structural adequacy stemming from the present contract requirements.

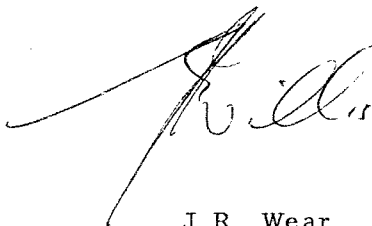
We do not feel confident in processing the documents for contract and would appreciate your reappraisal of the design in view of the memo (attached) from B. Richardson of the Structural Office dated July 27, 1973 advising of their concern and suggestion for selection of an alternate structure.

The advertising of the project was set at August 15, 1973 for construction to be finished this Fall.

In order to avoid delay in such installation please liaise with the Structural Office and Program Office to fulfill the above requirements.

I refer you to the memo to file dated July 23, 1973 a copy of which was previously provided.

If we may be of further assistance, please advise. For information concerning discussions with W. Porter and J. Wilson, please consult with D. J. Zander.



J.R. Wear
PROJECT REVIEW ENGINEER

JRW/rk

C. C. :

J. Callaghan
R. Chapman
B. Davis
J. Ford
C. Grebski
J. McAllister
W. Melinyshyn
E. J. Orr
K. Selby ✓
E. J. Willis
G. Wrong
D. J. Zander

for:

G. K. Hunter
SYSTEMS DESIGN ENGINEER

MEMORANDUM

TO: Mr. A. G. Stermac,
Principal Foundation Engineer,
Downsview.

FROM: Structural Planning,
Northern Region,
North Bay.

ATTENTION:

DATE: 18 September 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 131-70-02, Site 44-147,
Broad River Bridge,
Sec. Rd. #532, District #11.

It has been decided to redesign the proposed structure at Broad River. A foundation investigation will be required. As a structure had not been anticipated here, there is no site plan available. Copies of the 100 ft. scale plan and profile are attached.

It had originally been intended to place a $19'-3\frac{1}{2}"$ x $12'-2\frac{1}{2}"$ S.P.P.A. on a 20° left skew at Sta. 117+90. Because of the controls placed on this type of project, such as unwatering, compaction requirements, etc., it has been decided to submit the requirements to the Structural Office for design.

The span under consideration will be of the order 30' to 35' with minimum soffit el. 812.0. Grade will be approximately as shown. Your investigation should cover the possibility of a structure as described on the originally designed S.P.P.A.

Should you require any further assistance in this matter, please do not hesitate to call.



J. C. McALLISTER,
REG. STRUCTURAL PLANNING SUPVR.

JCMcA/les
Encl.

c.c. R. Murphy
J. Anderson

START FIELD WORK
FINISH FIELD WORK
REVIEW
MAILING

OCT 10, 1973
OCT 18, 1973
NOV. 15, 1973
NOV. 22, 1973

1100

1101.7/73

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. J. Hodge,
Foundation Section,
West Building.

FROM: B. K. Glassford

ATTENTION:

DATE: October 23, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 73-11073
W.P. 73-11043

Cores from these two projects were examined and logged
October 22, 1973.

W.P. 11073 - Hole #1
Jenkins Creek - Hwy. #120

25.0' - 31.0' (2' recovery)

Paragneiss with pegmatitic vein in the last 3" of core. Rock
is light grey in colour, hard, of medium texture and lineation
is inclined at approximately 45° to the horizontal surface.

Hole #5

6.5' - 7.5' (1' recovery)

Paragneiss rock, light grey colour, hard, medium texture
with lineation structure inclined at approximately 45° to
the horizontal surface.

W.P. 11043 - Hole #1
Broad Creek - Hwy. #532

8.5' - 11.5' (15" recovery)

Boulders of weathered paragneiss.

11.5' - 14.0' - Boulders of paragneiss.

19.0' - 21.0' - Paragneiss, friable and soft of medium
texture.

21.0' - 28.0' - Paragneiss, medium texture, hard, 3"
pegmatitic vein inclusion. Structural
lineation at approximately 30° to
horizontal surface.

BKG:mv

B.K. Glassford
B. K. Glassford,
Geologist.

Design Services Branch,
1201 Wilson Avenue,
Downsview, Ontario.
M3M 1J8

Telephone: 248-3282.
November 9, 1973.

Canadian Longyear Limited,
35 Brydon Drive,
Rexdale, Ontario.

Dear Sirs:

This letter confirms our request of October 9, 1973,
for the supply of a diamond drill together with all necessary
equipment, as specified under the terms of our Contract
Agreement, at Humphry on October 10, 1973.

Mobilization will be from North Bay, Ontario.

Our Project Number is W.O. 73-11043. ✓

Yours truly,

ORIGINAL SIGNED BY
A. G. STERMAC

KGE/ao

C.C. W. W. Fry
(Attn: Mrs. M. Porter)

A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

Foundations Files
Documents

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. K. Selby
Soil Mechanics Section
West Bldg.

FROM: Mr. A. Radkowski
Structural Office
West Bldg.

ATTENTION:

DATE: May 1st, 1974

OUR FILE REF.

IN REPLY TO

SUBJECT:

BROAD R. BR., 2.4 MI. EAST OF HWY #69
N.P. 131-70-02, SITE 44-147, HWY 532, DIST. 11

This will confirm that during our meeting this morning attended by Mr. C. Grebski and P. O. Law regarding the rock fill requirement under the abutment footings for the above structure, the following points were discussed and agreed upon:

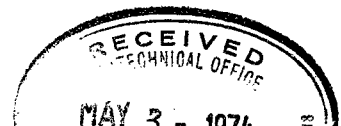
1. Additional borings will be required to determine if rock fill under abutment footings can be omitted.
2. To reduce the cost and construction time it was agreed to reduce the limits of subsoil excavation and rock fill requirement. The minimum distance from the face of tremie concrete to the edge of rock fill is to be 4 ft. instead of 8 ft. The rock fill slopes are increased to 1:2.
3. The rock fill excavated from the approaches may be used as a rock fill above the first stage construction.

A. Radkowski

A. Radkowski
Regional Structural Design Eng.

AF/ek

cc: J. McAllister
P. O. Law



Mr. J. McAllister
Regional Planning Supvr.
North Bay Regional Office

Mr. A. Radkowski
Structural Office
West Bldg., Downsview

May 2nd, 1974

BROAD R. BR., W.P. 131-70-02, SITE 44-147
SEC. HWY. 532, DISTRICT 11

Please refer to your memo of April 10th/74. As you will note from a copy of my memo of May 1/74 to K. Selby, Supervising Foundations Engineer, that an extent of subexcavation and as a result rock fill requirement for the above structure has been reduced considerably.

A number of boreholes would be required to ascertain the nature of the subsoil under proposed footings, and this will not exclude the possibility of rock fill requirement recommended at present.

I am of the opinion that this simple structure can easily be constructed in the period of 56 to 60 working days, and this would eliminate the need for on-site bailey and detour.

I trust you are in agreement with the proposed solution.

A. Radkowski
Regional Structural Design Eng.

AR/ek

cc: C. S. Grobski
K. Selby ✓



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. C. Mirza
Head
Soils Mechanics Office
West Bldg.

FROM: Structural Office
West Bldg.

ATTENTION:

DATE: May 8, 1974

OUR FILE REF.

IN REPLY TO

SUBJECT: BROAD RIVER BRIDGE - PARRY SOUND
W.P. #131-70-02, SITE #44-147
HWY. #532, DISTRICT #11

Attached herewith we are submitting the final
bridge drawings which show the foundation design for
this structure.

Kindly give us your comments at your earliest
convenience.



C. S. Grebski
Structural Design Engineer

CSG/ek
Attach.

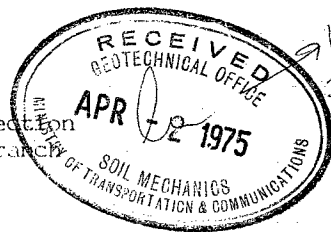
Handwritten notes:
Mr. Grebski
May 13 1974

Handwritten notes:
May 13 1974
MYLAR TO
STRUCTURAL
June 4/74





Memorandum



To: Distribution

From: Project Review Section
Systems Design Branch
East Building

MR. K. SELBY

Attention:

Date: April 1st, 1975

Our File Ref.

In Reply to

Subject: Contract 75-61, W.P. 131-70-01, Highway #141 - Broad River Bridge
and Approaches 2.2 Miles East of the Junction of Highway 69
District #11, Huntsville

The following are the minutes of a meeting held March 26th, 1975 in W-1, East Building.

Attending:	J. Wear - Chairman	R. Oliver
	D. Thrasher	D. Miehne
	A. Parnamagi	P. Hunt
	G. Wrong	K. Selby
	G. McClelland	

Purpose

To assess work requirements and determine outstanding issues prior to Head Office Contract Review meeting.

Detail

Agenda as per teletype dated March 24th, 1975 from Project Review Section to Regional Planning and Design.

1. Prestressed beams to be advanced ordered, as per decision at Head Office pre-review - March 21st, 1975.
2.
 - a) Staging Special Provision 150 to be deleted
 - b) Special Provision 192 for prevention of rotational and lateral deflection of beams to be retained.
3. Location of stockpiles for rock excavated from existing embankments will not be defined.
4. Resolutions from Township tabled by A. Parnamagi for the following:
 - a) Timber salvage - The Township desires salvage of timber from the existing structure. The degree of salvage is uncertain and to be further clarified by A. Parnamagi with the Township. This involves in addition, hardware and bolted beams. The contract will be processed assuming (i) salvage from above water line only, (ii) structure components to be carefully dismantled, (iii) salvaged material to be neatly stockpiled within the specified Township yard.

- b) Detour - The Township has agreed to the use of Clear Lake Road as a detour for the months of July, August and September. Confirmation is required for the latest date in which Highway 141 shall be reopened and the date included in the contract.
5. The Township objects to the school bus using the Clear Lake Road detour during the time for which the children must remain on the bus.
 6. Timber salvage - See Point 4 above.
 7. The existing bridge drawing shall be included in the contract to replace the schematic drawing prepared by Regional Planning and Design showing arrangement of timber.
 8. Granular backfill to structure - considering rock shall be placed as backfill to the new structure, and that three feet of rock above normal water level was deemed adequate, Granular C material shall be used for the remainder of backfill, above the rock, to the bottom of Granular A base course. The granular backfill material shall be measured by the cubic yard truck box measurement.
 9. Approach slabs were not deemed necessary and should any settlement be evident, padding could be included in a future grading contract the following year to the east of this contract.
 10. There is a shortage of excavated rock fill available on the west side of the structure and it was agreed that the Contract will probably require replacing the required rock fill from that made available through rock excavation at the east limit of the contract by use of a clam positioned on a rockfill platform on the east embankment. The breakdown quantities for earth and rock excavation, and fill are to be readjusted in the contract to separate and define the requirements for each side of the proposed structure.
 11. A review of grade point transitions is required for granular backfill to rockfill and to earth cut.
 12. Structure approach treatment as shown on Sheet 11 should be confirmed with the Standards Engineer.
 13. The Soils Mechanics Section advised that excavation to bed rock would be required and the resulting side slopes should be a minimum of one foot horizontal to two feet vertical. Through subsequent arrangement between Regional Planning and Design and the Soils Mechanics Section and due to dubious field application, the side slopes are to be defined as one to one. Very little material is expected to remain between the pedestals supporting the new structure foundations. The rock pedestals may consist of either the rock fill excavated from the existing embankment or the rock excavated from the east end of the project.

It was anticipated that the manner of excavating the existing embankment would be by backhoe for the rockfill and drag line for the silty material beneath the rockfill. Therefore, excavation of the rockfill will be considered as part of the item Earth Excavation (Grading) to the water line and the material excavated beneath by equipment rental. The silty material excavated by equipment rental shall be loaded onto trucks and hauled from the right-of-way. Payment for the hauling of silty material shall be by force account similar to the disposal as per muskeg excavation. The excavated rock shall be stockpiled on the adjacent road bed for reuse as rock backfill and payment for reuse made at the contract unit price for Earth Excavation (Grading).

14. Tremie Concrete - is required beneath structure foundations and is expected to be formed. No additional qualifications are required for the contract.
15. It was assessed that the timing for work of structure replacement may be critical and, therefore, the following action will be perused:
 - a) advance ordering of prestressed beams, as per point one,
 - b) the granular material requirements for the Clear Lake Road detour shall be reviewed by A. Parnamagi with the District to obtain such material from existing stockpile. Commercial sources are not readily available.
16. Navigable waters clearance is shown on the structure drawings as 15 feet horizontal and 7 feet vertical. There may be difficulty during excavation and backfilling operations to maintain a navigable waterway. However, the width of the river following total excavation should be sufficient to permit river traffic to be unimpeded. It is recommended that channel markers be established for river traffic during the progress of the work.
17. Standard DD-8-13-A for private entrances culverts shall be deleted.
18. Cross-hatching defining excavation areas is to be reviewed by Regional Planning and Design.
19. Revisions to Structure D-4 have been made.

Additional Points

<u>Utilities</u>	Utility adjustments to be reviewed by Regional Planning and Design and alterations shown on contract drawings.
<u>Paving</u>	Alterations are required on drawings to show paving. Estimating Office advise this will be expensive, but it is appropriate to be done in this contract.

Environmental

Excavation and backfill is a concern but the impact is not expected to present a problem for either cottage owners or fish habitat.

Soils Investigation

The Regional Materials and Testing Office are to supply additional soils borings to confirm the rock line, and the borings included in contract.

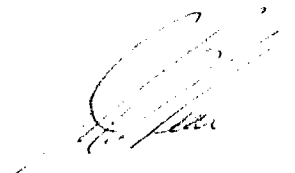
Timber Salvage

A. Radkowski to check with Structural Maintenance for the appropriate manner of disassembling the existing structure and advise Regional Planning and Design.

Conclusion

The Regional Planning and Design Office is to review each of the above and make the appropriate adjustments to the contract package.

Meeting adjourned at 4:30 p.m.



J.R. Wear
Project Review Engineer

JRW/kw

c.c. Those in Attendance
W. Birch
W. Ham
D.J. Zander



Memorandum

To: S. McCombie, Manager
Planning and Design Office
Northern Region - North Bay

From: Contract Review Section
Systems Design Branch
East Building, Downsview

Attention: A. Parnamagi

Date: April 7, 1975

Our File Ref.

In Reply to

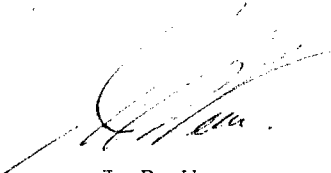
75-11-003
File
02
Subject: Contract 75-61, WP 131-70-01, Highway #141 - Broad River Bridge
and Approaches 2.2 Miles East of the Junction of Highway 69
District #11, Huntsville - re Advanced ordering of Prestressed Beams

Subsequent to the meeting of March 26th, we have been advised that their should be no difficulty for the Contractor to obtain prestressed beams for the above Contract.

Three sources were checked and indicated that the supply would be adequate for the number of beams considered. The production is expected to take approximately two days only.

The above amends the Minutes of Meeting and the Contract documents are to be adjusted accordingly. An item for the supply of beams is to be included in the Contract.

JRW/jc


J. R. Wear
Head, Contract Review Section

c.c. G. Wrong
G. McClelland
R. Oliver
D. Thrasher
D. Mieh
P. Hunt
K. Selby
W. Ham

