THURBER ENGINEERING LTD.

MEMORANDUM

To: Christopher Schueler, P.Eng.
AECOM

Date: January 5, 2016

From: Alastair Gorman, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 19-4406-20

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN
MADOC / DEER CREEK CULVERT (SITE 11-067/C)

1 INTRODUCTION

This memo presents a brief summary of the factual findings from a foundation review carried out for the existing Madoc / Deer Creek Culvert on Highway 62 in the geographic township of Madoc – Municipality of Hastings, Ontario. It also presents preliminary geotechnical recommendations for use in assessment of the existing foundations at the site. It is noted that the proposed structural alternatives are not yet defined.

The recommendations provided in this memorandum are for planning, structure evaluation and preliminary design purposes only. Additional investigation and analysis may be required in any subsequent detail design phase of the project.

The following reference numbers apply to this site:

- Current W.P. 4015-13-01
- Site No. 11-067/C
- GEOCRES No. 31C-091
- Historic W.P. 125-61

2 SITE DESCRIPTION

The site is located on Highway 62 immediately south of Highway 7 in the Geographic Township of Madoc – Municipality of Hastings, at the north end of the community of Madoc. Based on information shown on the archive Bridge Site drawing for the adjacent Highway 7 culvert (Proposed Crossing at Madoc Creek and The King's Highway No. 7), the existing concrete culvert has a span of 7.3 m and a height of 1.8 m. It accommodates 2 lanes of traffic on Highway 62. The road grade on the culvert is approximately 2.5 m above the adjacent ground level.

The natural terrain in the vicinity of the culvert is generally flat and marshy. The archive drawings indicates that the original grade in the vicinity of the culvert ranged from elevation 169.5 to 170.5 m. Highway 62 was originally constructed to approximately elevation 171.7.

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3 SUBSURFACE CONDITIONS

The site is located within the physiographic region known as the Dummer Moraines, an area of rough stoney land bordering the Canadian Shield. The moraines are characterized by angular fragments and blocks of limestone as well as some Precambrian rocks. Geologic maps indicate that the underlying bedrock generally consists of carbonate metasedimentary rocks (marble) of the Grenville Supergroup, locally overlain by limestones and intrusive igneous rocks.

A site investigation was completed by the Ontario Department of Highways between June 26 and July 4, 1962 for the proposed extension of the existing culvert under Highway 62, a new crossing for the Madoc By-Pass (current Highway 7) and the Madoc Creek diversion. Six boreholes and five dynamic cone penetration tests (DCPTs) were advanced during the investigation. Of these, one borehole (Borehole No. 1) and one DCPT (Borehole No. 6) were situated at the east end of the Highway 62 culvert.

The soil conditions encountered in the borehole consisted of a 600 mm thick topsoil layer overlying native silty clay, underlain by bedrock. The silty clay was grey and very stiff, with Standard Penetration Test (SPT) N-values of 20 to 27 blows/0.3 m penetration. Moisture contents of about 20% to 26% were measured. The clay layer was 2.6 m thick.

Bedrock was encountered in the borehole at 3.2 m depth (Elev. 166.4) and proven by recovering a 3.0 m length of rock core. The bedrock was described as very hard, dark grey diabase (traprock). The DCPT encountered refusal on probable bedrock at approximate Elev. 165.2 m.

The groundwater level observed in the borehole was at approximately 0.8 m below the ground surface (Elev. 168.9 m), at about the same level as the creek water.

The available GEOCRES files are attached in Appendix A. GEOCRES data was not available for the original Highway 62 culvert constructed prior to 1964.

4 SITE OBSERVATIONS

Foundations engineering staff from Thurber visited the site to observe conditions related to the geotechnical performance.

No obvious signs of settlement or distress of the existing culvert was observed. Some leaching through possible cracks was noted near the east end of the north face, and concrete deterioration was observed on the west end of the north wall. Minor outward movement of all wingwalls was apparent.

The approach embankments appeared to be stable, with no obvious signs of instability, bulging or creek channel erosion. Some uneven grading and minor erosion was observed in areas of poor vegetation cover, particularly on the southeast approach embankment. Wet ground was noted below a CSP outlet on the west side of the embankment south of the culvert, and an area of crushed rock was present further to the south for an unknown reason.

Photographs of the structure and the approaches are attached in Appendix B.

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5 EXISTING FOUNDATIONS

The RFP information indicates that the existing culvert was constructed in 1964 and consists of a cast-in-place, rigid frame, open-footing culvert, with a span of 7.3 m and length of 16 m. Archive drawings of the culvert were not available, and it is unclear whether a pre-existing culvert was extended or completely replaced at this location in 1964.

The archive GEOCRES report from July 1962 indicates that the pre-existing culvert under Highway 62 was to be extended to the east as part of the Highway 7 – Madoc By-Pass project (current Highway 7). In addition to the culvert extension, a culvert was to be constructed at the new Highway 7 crossing to the northeast, and Madoc Creek was to be realigned between the two culverts.

The GEOCRES report addressing the culvert extension recommends that the extension footings be placed on sound bedrock at approximate Elev. 166.4 m, and the "net safe bearing capacity of the bedrock" be taken as 10 T/sq.ft. (equivalent to 958 kPa).

It was noted in the 1964 report that the founding level of the existing culvert footings could not be determined at the time of investigation. It was therefore recommended that the existing founding level be determined during construction, and either a rigid connection be provided between the existing culvert and extension if the existing footings extended to bedrock, or a vertical expansion joint be provided if the existing footings were founded on clay. No construction joint is currently evident inside the culvert.

Later correspondence from August 1963 questioned the feasibility of using a box culvert at this location, and may indicate that complete replacement of the pre-existing culvert was subsequently planned. The box culvert concept was rejected, and it was again recommended that spread footings be taken down to bedrock.

Based on this information, the existing culvert is believed to be supported on spread footings founded on bedrock. No information regarding the footing dimensions is available.

6 ASSESSMENT OF EXISTING FOUNDATIONS

The archive information suggests that the existing culvert is founded on spread footings extended to bedrock. The foundations appear to be performing satisfactorily, and it can be assumed that the foundations will continue to perform satisfactorily in the future.

The RFP document suggests that the required rehabilitation work will consist of concrete repair to the culvert barrel and ends, as well as footing repair. In this case, there will be no appreciable increase in the loading.

If a significant (greater than 10%) increase in loading or replacement of the culvert is subsequently planned, further assessment of the foundations will be required and the need for site investigation and field testing to support the preparation of foundation design recommendations and/or confirm the existing foundation design should be evaluated.

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The observed movement of the wingwalls suggests that the wall foundations cannot fully resist the applied earth pressures. Inspection should be continued to assess whether the movement is ongoing and determine if remedial measures will eventually be required to stabilize the walls.

7 EXCAVATION AND ROADWAY PROTECTION

If the selected rehabilitation strategy requires excavation in the approach fills adjacent to the cuvert, it is recommended that site investigation and field testing be carried out in each approach fill in order to characterize the fill and to select parameters for the design of roadway protection. One borehole within each approach fill and within the probable extent of excavation is considered to be appropriate. The boreholes should extend for the full depth of fill or to twice the depth of excavation, whichever is the greater.

8 CLOSURE

The factual subsurface information used in the preparation of this memorandum was taken from the report by The Ontario Department of Highways titled “Proposed Madoc Creek Culvert Extension at Hwy. #62, and Proposed New Culvert at Madoc Creek and Hwy. #7, Madoc By-Pass, District #8, Kingston, Ontario”, WP 917-61 and 125-61, dated July 24, 1962.

The memorandum was prepared by Mr. Murray Anderson, P.Eng., Senior Foundations Engineer and was reviewed by Mr. Alastair Gorman, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Jan 5/16

Murray Anderson, P.Eng.
Associate, Senior Foundation Engineer

JAN 5/16

Alastair Gorman, P.Eng.
Associate, Senior Foundation Engineer

Jan 5/16

P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

Attachments

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Appendix A

GEOCRES Report, Correspondence, and Archive Drawings

BA 1482

ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Bridge Engineer. *Date* July 24, 1962.

Subject D.H.O. FOUNDATION INVESTIGATION REPORT

From Materials & Research Division, (Foundation Section) W.J.62-F-70 & 71 - W.P. 917-61 & 125-61.

Attention: Mr. S. McCombie.

Re: Proposed Madoc Creek Culvert Extension at Hwy. #62, and Proposed New Culvert at Madoc Creek and Hwy. #7, Madoc By-Pass, District #8, Kingston, Ontario.

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

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

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
J. Ford
E. A. Cash
J. E. Gruspier
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E. R. Saint
F. Norman
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Foundations Office
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TABLE OF CONTENTS

FOUNDATION INVESTIGATION

For

Proposed Madoc Creek Culvert Extension at Hwy. #62, and Proposed New Culvert at Madoc Creek and Hwy. #7, Madoc By-Pass, District #8, Kingston, Ontario.
W.J. 62-F-70 & 71 -- W.P. 917-61 & 125-61

1. INTRODUCTION:

A memo from the Bridge Location Section, dated January 31, 1962, was received, requesting a foundation investigation at the site of the proposed culvert extension at the crossing of Hwy. #62 and Madoc Creek. The same memo requested a foundation and soils investigation at the site of the proposed new crossing at Madoc By-Pass (Hwy. #7) and Madoc Creek diversion. A field investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the afore-mentioned locations.

Presented in this report are the results of this investigation, together with recommendations pertaining to the design of the proposed foundations and approach embankments.

2. DESCRIPTION OF THE SITE:

The site is located on the north side of the Village of Madoc, east of Hwy. #62. The area adjacent to Madoc Creek is flat, partly grass and weed covered and partly swampy. Exposed bedrock on the surface is visible about 100' south of the site. Madoc Creek is some 10 - 15' wide, 0.5 - 1.0' deep and has a meandering course. The elevation of the prevailing water level of the creek was established at El. 554.5.

cont'd. /2 ...

2. DESCRIPTION OF THE SITE: (cont'd.) ...

The present structure at the crossing of Hwy. #62 and Madoc Creek is a 24' x 6' concrete culvert, in slightly poor condition. Attempts to locate the base of the footings of the culvert were not successful.

Physiographically, the site is situated on the border between the Canadian Shield and Dummer Moraines geological region. The moraines of this area are characterized by angular fragments and blocks of limestone with many Precambrian rocks also present. The underlying bedrocks are sedimentary limestones, mostly of the Black River group although including some of the overlying Trenton.

3. FIELD INVESTIGATION PROCEDURE:

A total of 5 boreholes and 6 dynamic cone penetration tests was carried out during the course of the fieldinvestigation. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. Undisturbed soil samples were obtained by means of 2-inch I.D. Shelby tubes, which were either pushed into the soil by hand, or hammered by means of a 140-lb. hammer. Disturbed samples were recovered by means of a standard split-spoon sampler. The dimensions of the split-spoon sampler and the energy used in driving it, conform to the requirements of the "Standard Penetration Test". AXT core barrels were used for acquiring rock core samples. Driving energy of the dynamic cone penetration tests was 350 ft. lbs. per blow.

cont'd. /3 ...

3. FIELD INVESTIGATION PROCEDURE:

Ground water level observations were carried out during the field work.

The locations and elevations of all boreholes are shown on Drawing #62-F-70 - 71A, which is attached to this report.

4. LABORATORY TESTS:

Samples were visually examined and identified in the field prior to being transported to the laboratory. Upon receipt in the laboratory, tests were carried out on various representative samples to determine the natural moisture content, Atterberg limits and the content of organic impurities of the deposits. Additional tests on undisturbed cohesive samples were performed to define the unconfined shear strength, density and sensitivity of the samples.

Laboratory and field test results are included under Appendix I of this report.

5. SOIL TYPES AND SOIL CONDITIONS:

5.1) General:

Subsoil at the site, indicated by the boreholes, consists of 10.0 - 14.0' of overburden, under which bedrock was encountered. The boundaries of the various strata of the overburden, together with the bedrock, are shown on the attached borelog sheets. The estimated stratigraphical profiles shown on Drawing #62-F-70 - 71A, are based upon this information.

A description of the various layers encountered, is as follows:

cont'd. /4 ...

5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.2) Topsoil:

The upper 2.0 - 3.5' of each borehole was found to be topsoil. This material is either silt or sand, highly contaminated with organic and vegetable matter, soft, and without any engineering value. The layer is dark brown or black in colour when wet.

5.3) Silty Clay to Clay:

Underlying the topsoil in B.H. #1 and #2, a silty clay deposit was observed down to elevation 546.0 - 547.0. The same material was separated from the topsoil by a 1.5' thick sand layer in B.H. #3. The consistency of the stratum in B.H. #1 was "very stiff", and in B.H. #2 and #3, "stiff", corresponding to average standard penetration 'N' values of 23 and 10, respectively.

The shear strength of undisturbed samples taken in B.H. #1, based on laboratory unconfined compression tests, was found to be approximately 3000 p.s.f. The sensitivity of the deposit was calculated by performing the laboratory unconfined compression tests on undisturbed and remolded soil samples, and was found to be 2.5. The natural moisture content of the stratum varied between 20% and 30%. The average plastic and liquid limits, 20% and 42%, respectively. The value of the bulk density can be taken as 125.0 p.c.f.

5.4) Sand with Organic Matter:

Underlying the topsoil in B.H. #3 and #4, a 1.5' thick layer of organic contaminated sand deposit was encountered, extending from El. 553.0 down to El. 551.5. In B.H. #3 it was found

cont'd. /5 ...

5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.4) Sand with Organic Matter: (cont'd.) ...

to have "compact" relative density, while in B.H. #4 its relative density was "very loose". The dark colour and the slightly plastic nature of the deposit was indicative of the presence of organic matter.

5.5) Peat (Muck):

This material was observed in B.H. #4 at elevation 551.5 extending to El. 545.0 and in B.H. #5 from El. 553.5 down to El. 546.5. The stratum is highly organic and black in colour with a natural moisture content above 100%. The very low penetration 'N' values (1 blow per foot) indicate a "very soft" consistency of the deposit. The layer has high plasticity, the values of liquid limit being near or above 100%, and those of the plastic limit between 70 and 80%. The average content of organic impurities, determined by laboratory tests, was found to be about 10% by weight.

5.6) Gravelly Sand and Boulders:

Overlying the bedrock in B.H. 2, 3, 4, & 5, a coarse grained deposit was found, its thickness varying from 1.0' to 5.0'. The predominant constituent materials of the layer are gravel and sand with occasional boulders.

5.7) Bedrock:

At approximate elevations varying from 546.5 - 542.0, bedrock was observed in each borehole. In B.H. #1, 2, 3 and 4, the bedrock was found to be Diabase (Traprock). It is a very fine

cont'd. /6 ...

5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.7) Bedrock: (cont'd.) ...

grained intrusive igneous rock, having a very hard nature; its colour is dark grey. In some places, it was intersected with very thin seams of pyrite. In B.H. #5 limestone bedrock was encountered at El. 545.5. From El. 538.0 downward, the limestone appeared to change to metamorphic limestone (marble). It is a fine grained stone, dark grey in colour and belongs to the Black River formation.

6. GROUND WATER CONDITIONS:

Ground water level observations were carried out during the field investigation. The ground water level in every borehole was found to be 2.0 - 2.5' below the ground level at El. 554.0, which is the approximate elevation of the creek water level.

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a 10' - 20' culvert extension on the east side of the existing one, at the crossing of Hwy. #62 and Madoc Creek. It is also proposed to build a new culvert at the crossing of Hwy. #7, Madoc By-Pass and Madoc Creek diversion. The length of the proposed creek diversion is about 220'.

Subsoil at the site of the culvert extension consists of a very stiff silty clay deposit underlain by hard Diabase bedrock.

The overburden at the site of the proposed new culvert consists of layers of organic topsoil, sand with organic matter, organic clay and peat (muck). The above very soft deposits are

cont'd. /7 ...

7. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

underlain by Diabase and Limestone bedrock. The bedrock was proved by drilling 10 ft. core samples. Recommendations as to the foundation of the proposed structures are given below:

7.1) Culvert Extension on Hwy. #62:

Spread footings are recommended for the culvert extension. The base of the footings should be placed on sound bedrock, at approximate elevation 546.0. As mentioned above, it was not possible to locate the base of the existing culvert. This should be done prior to the construction of the extension. If the existing culvert is founded on the bedrock, the extension may be connected to the existing structure by means of a rigid joint. However, if the present footings of the culvert are founded in the clay deposit, the extension should be built as an independent unit, with a vertical expansion joint between them, to minimize the effect of possible differential settlement. The estimated net safe bearing capacity of the bedrock may be taken to be 10 T/sq.ft.

7.2) New Culvert at the Crossing of Hwy. #7, Madoc By-Pass and Madoc Creek:

A spread footing type foundation is recommended for the new culvert. The base of the footings should be placed on sound bedrock. At this site, the elevation of the upper surface of the bedrock varies between 542.0 and 545.5. The exact elevation of the proposed base of footings cannot be decided therefore, but it should be on the sound rock along the entire length of the structure.

cont'd. /8 ...

7. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

7.2) New Culvert at the Crossing of Hwy. #7, Madoc By-Pass and Madoc Creek: (Cont'd.) ...

The net safe bearing pressure can be taken as 10 T/sq.ft.

No major dewatering problems are anticipated during the excavations. Any seepage into the excavations should be controlled by open pumping.

All organic material should be excavated under the approach fills and be replaced with acceptable fill material. The embankments then should be constructed with side slopes of 2 horizontal to 1 vertical to eliminate any stability problems.

8. SUMMARY:

It is proposed to construct a 10' - 20' extension on the east side of the existing culvert at the crossing of Hwy. #62 and Madoc Creek. It is also proposed to build a new culvert at the crossing of Hwy. #7, Madoc By-Pass and Madoc Creek.

Subsoil at the site consists of 10' - 14' of mostly organic overburden followed by Diabase and Limestone bedrock.

Recommendations pertaining to the foundation of the proposed structures are as follows:-

(1) Spread footing type foundations are recommended for both structures.

(2) The base of the footings should be placed on sound bedrock.

(3) The safe net bearing capacity of the bedrock is estimated to be 10 T/sq.ft.

cont'd. /9 ...

8. SUMMARY: (cont'd.) ...

(4) All organic material should be excavated under the approach fills and replaced with suitable fill material. The embankments should be constructed with side slopes of 2 horizontal to 1 vertical, to eliminate stability problems.

(5) No dewatering problems are anticipated. Any seepage into the excavations should be controlled by open pumping.

9. MISCELLANEOUS:

The field work, performed during the period from June 25th to July 4th, 1962, together with the preparation of this report, was undertaken by Mr. A. K. Barsvary. The investigation was carried out under the general supervision of Mr. K. G. Selby, who also reviewed this report.

Equipment used was owned and operated by the Canadian Longyear Co., Ltd. of North Bay.

July 1962.

APPENDIX I.

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- 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 :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.
VERY SOFT	0 - 2	0 - 250
SOFT	2 - 4	250 - 500
FIRM	4 - 8	500 - 1000
STIFF	8 - 15	1000 - 2000
VERY STIFF	15 - 30	2000 - 4000
HARD	> 30	> 4000

DENSENESS	'N' BLOWS / FT.
VERY LOOSE	0 - 4
LOOSE	4 - 10
COMPACT	10 - 30
DENSE	30 - 50
VERY DENSE	> 50

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS 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
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 INTERCEPT — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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_o	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

cc: Gen. Files

23-65-114

K.S: proposed Madoc Creek Extensions. Hwy 62.

Mr. S. McCombie,
Bridge Planning Engr.,
Bridge Division.

Attention: Mr. A. Watt

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

August 6, 1963

Proposed Madoc Creek Extension at Hwy. #62,
Madoc By-Pass, District #8, Kingston, Ont.
W.P. ~~917-61~~ 125-61 -- W.J. 62-F-70

Further to our discussion by phone on August 6, 1963, this is to advise you that the above culvert extension, if constructed as a box section, may be founded at or about el. 552.0 using a safe net pressure of 2 t.s.f.

K. G. Selby

KGS/MdeF

cc: Foundations Office
Gen. Files

K. G. Selby
SENIOR FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

cc: Foundations Office (Rm. 110)

Mr. S. McCombie,
Bridge Planning Engr.,
Bridge Division.

Attention: Mr. A. Watt

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

August 6, 1963

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SENIOR FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

August 19. 1963
Bill Hashimura.
Q: Can a box type culvert be used at Hwy 7 crossing? If so, at what elevation should be the sole? What is the allowable bearing capacity at this elevation?

A: Box culverts should not be used because of the very bad and soft ground it is recommended that spread footings should be taken down to bedrock.

A Stermac

FORM OB-ML-126 REV 1961 OFFICE REPORT ON SOIL EXPLORATION

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 62-F-70 & 71 LOCATION Hwy. #62 Sta. 27+75 35' Rt. of ℄ ORIGINATED BY A.B.

W.P 917-61 & 125-61 BORING DATE June 26, 1962. COMPILED BY A.B.

DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY A.B.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 10 20 30 40 50 / SHEAR STRENGTH P.S.F. Undisturbed • Remoulded 1000 2000 3000	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
556.5	Groundlevel									
0.0	Silty topsoil									
554.5										
2.0	Silty clay very stiff grey coloured		1	SS	20					WL IN BH. 554.0
			2	TW	27	550			126.0	
			3	TW	23				125.0	
546.0										
10.5	Diabase Bedrock (Traprock)		4	RC		540				
536.0										
20.5	End of borehole.									

FORM OB-ML-126 REV (1961)

61-4391

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 62-F-70 & 71 LOCATION Madoc Bypass Line 'A' Sta. 229+00 100' Rt. of ℄ ORIGINATED BY A.B.

W.P 917-61 & 125-61 BORING DATE June 29, 1962. COMPILED BY A.B.

DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY A.B.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 10 20 30 40 50 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
556.5	Groundlevel									
0.0	Silty topsoil.									
554.0										▽ W.L. in B.H. 554.0
2.5	Silty clay stiff grey coloured.		1	SS	13					
			2	SS	9	550				
547.5										
9.0	Gravelly sand.		3	SS	43					
546.5								Refusal @ 10'-3"		
10.0	Bedrock									
	End of borehole.					540				

FORM OB - ML - 126 REV - 961

61-4391

REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 62-F-70 & 71 LOCATION Madoc Bypass Line 'A' Sta. 229+80 45' Rt. of ℄ ORIGINATED BY A.B.

W P. 917-61 & 125-61 BORING DATE June 29, 1962. COMPILED BY A.B.

DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY A.B.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 10 20 30 40 50 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F	REMARKS
556.5	Groundlevel									
0.0	Sandy silt Topsoil									W.L. in BH. 554.0
553.0										
3.5	Sand with organic matter. Compact.		1	SS	14					
551.5										
5.0	Clay Stiff (Slightly Organic) Grey coloured.		2	SS	10	550				
547.0										
9.5	Gravelly coarse to fine sand. Dense.		3	TW	15					
			4	SS	24					
542.0										
14.5	Diabase Bedrock (Traprock)		5	RC		540				
532.0										
24.5	End of borehole.									

FORM 08 - MI. 126 REV. 1961 — REPORT ON SOIL EXPLORATION

81-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 62-F-70 & 71 — LOCATION Madoc Bypass Line 'A' Sta. 230/25 ℄ — DESIGNATED BY A.B.

W.P 917-61 & 125-61 — BORING DATE June 27, 1962. — COMPILED BY A.B.

DATUM G.S.C. — BOREHOLE TYPE Washboring NX & BX Casing. — CHECKED BY A.B.

ELEV. / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 10 20 30 40 50 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT — WL; PLASTIC LIMIT — WP; WATER CONTENT — W; WATER CONTENT % 20 40 60 80 100	BULK DENSITY P.C.F.	REMARKS
556.5 / 0.0	Groundlevel									
	Silty Topsoil									W.L. in BH. 554.0
553.0 / 3.5	Sand with organic matter. Very loose.		1	SS	1					
551.5 / 5.0	Peat (Muck) Very soft black coloured.		2	SS	1	550				
			3	SS	1/2					
545.0 / 11.5	Boulders or weathered bedrock.									
542.5 / 14.0	Diabase Bedrock with thin seams of pyrite (Traprock)		4	RC		540				
534.0 / 22.5	End of borehole.									

FORM OB - ML - 126 REV 1961

61-4391

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 62-F-70 & 71 LOCATION Madoc Bypass Line 'A' Sta. 230+15 50' Lt. of ℄ ORIGINATED BY A.B.

W.P. 917-61 & 125-61 BORING DATE July 3, 1962. COMPILED BY A.B.

DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY A.B.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 10 20 30 40 50 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60 80 100	BULK DENSITY P.C.F.	REMARKS
556.5	Groundlevel									
0.0	Silty Topsoil									W.L. in BH. ▽ 554.0
553.5										
3.0	Peat (Muck) Very soft Black coloured		1	SS	1					
			2	SS	1	550				
546.5			3	SS	10					
10.0	Gravelly sand									
545.5	Firm									
11.0	Limestone Bedrock		4	RC		540				
538.0										
18.5	Metamorphic limestone (Marble)									
535.5										
21.0	End of borehole.									

FORM 08 - ML 6 REV - 961

OFFICE REPORT SOIL EXPLORATION

81-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

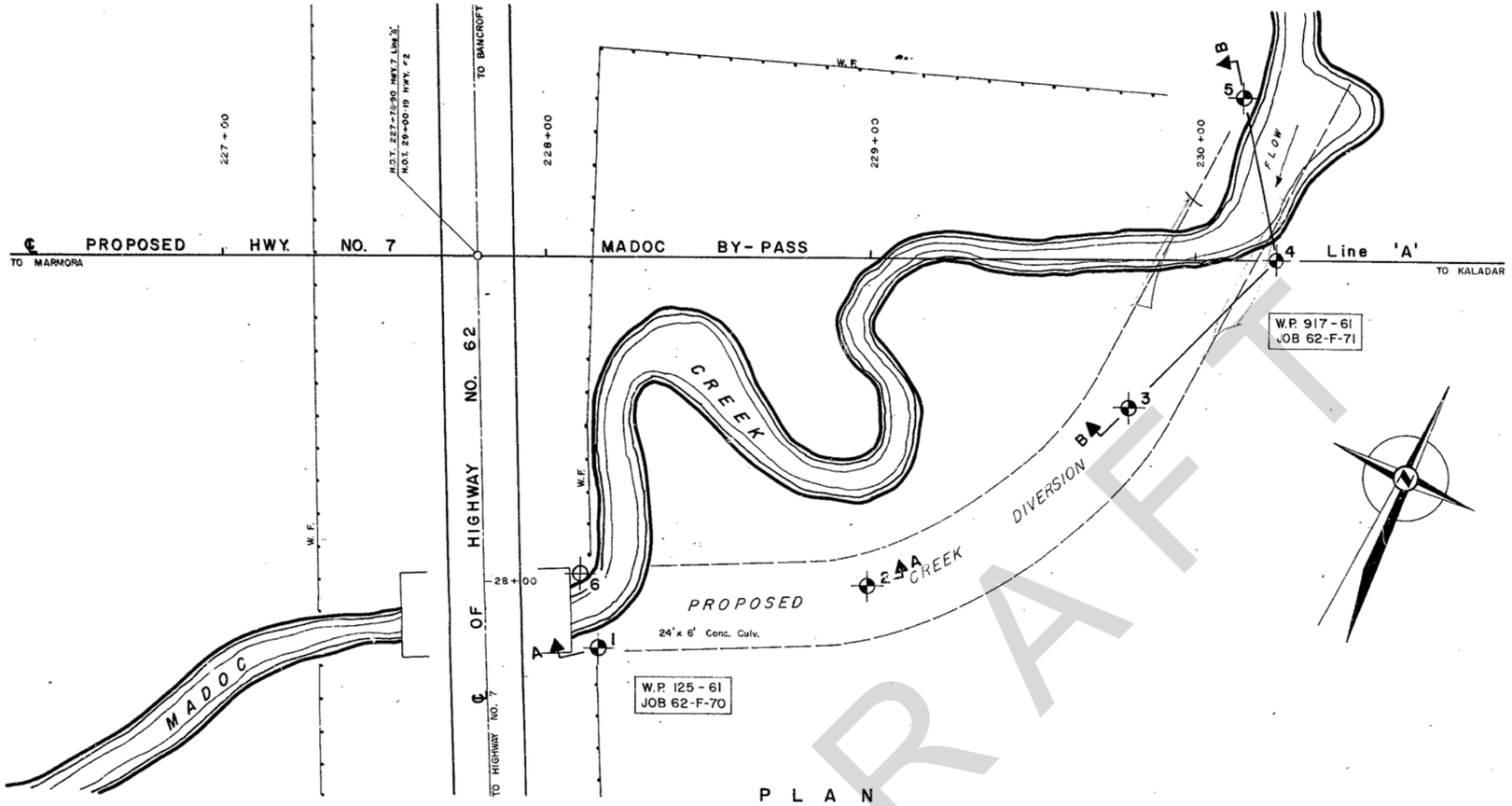
JOB 62-F-70 & 71 LOCATION Hwy. #62 Sta. 28+00 30' Rt. of ℄ ORIGINATED BY A.B.

W.P 917-61 & 125-61 BORING DATE July 4, 1962. COMPILED BY A.B.

DATUM G.S.C. BOREHOLE TYPE Dynamic Penetration Only. CHECKED BY A.B.

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 10 20 30 40 50 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE				
555.0 / 0.0	Groundlevel									
						550				
						540				

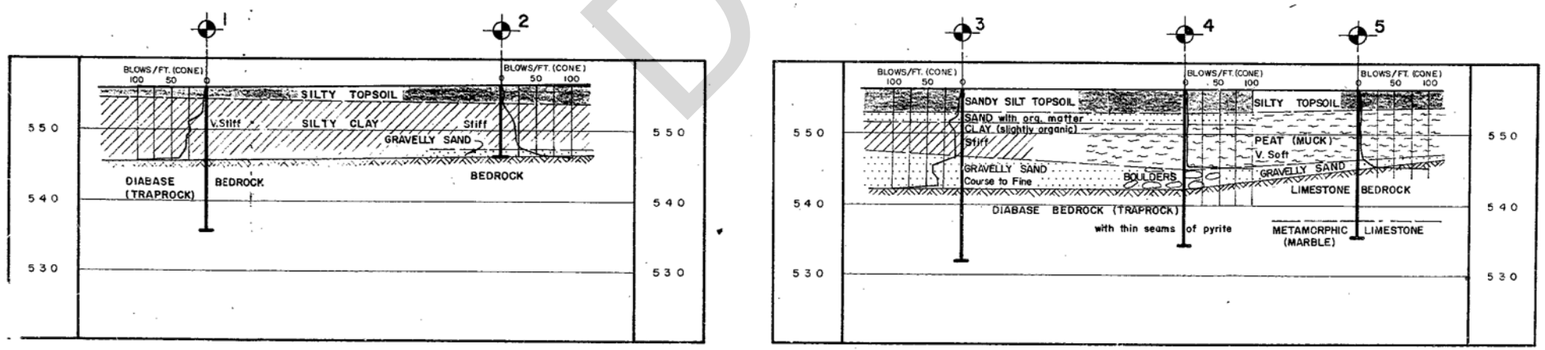
62-F-70
62-F-71
W.P. # 917-61
W.P. # 125-61 (NEW)
Hwy # 62 & Hwy # 7
AT
MADOC CREEK



PLAN

SCALE IN FEET

20 10 0 20 40



A – A

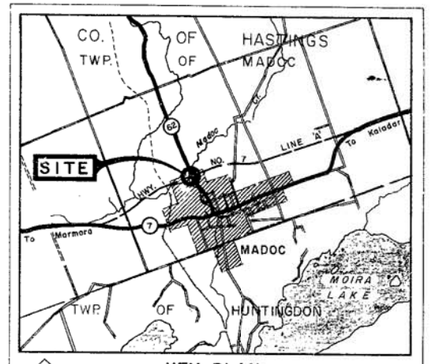
B – B

SECTIONS

SCALE IN FEET

10 5 0 10 20 VERTICAL

20 10 0 20 40 HORIZONTAL



KEY PLAN

SCALE IN MILES

1 1/2 0 1

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. (June 1962)

NO.	ELEVATION	STATION	OFFSET
1	556·2	228+17	120' RT.
2	556·5	229+00	100' RT.
3	556·5	229+80	45' RT.
4	556·5	230+25	℄
5	556·5	230+15	50' LT.
6	555·0	228+12	97' RT.

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISION

Work Project Numbers corrected on plan. (August 9, 1961)

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH SECTION

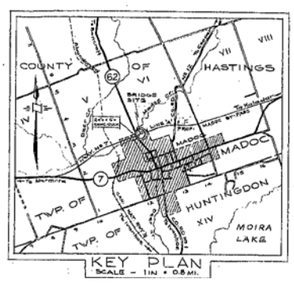
MADOC CREEK DIVERSION AT HIGHWAY NO. 62 & HIGHWAY NO. 7 LINE 'A'

(MADOC BY-PASS)

ORIGINATED A. BARSVARY	DISTRICT NO. 8	DATE 2 AUGUST 1962
DRAWN D. MUMFORD	W.P. NO. 917-61 & 125-61	JOB NO. 62-F-70 & 71
CHECKED	CONTRACT NO.	DRAWING NO.
APPROVED		62-F-70 & 71A

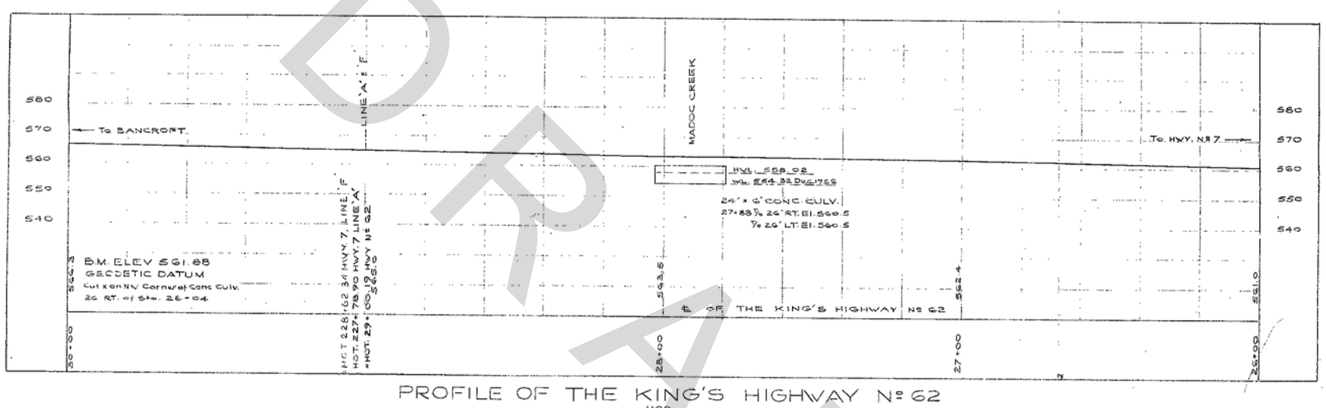
E-4008-1

E4008-1



To KALADAR

SEE PLAN Nº 3622-1
PROFILE Nº F-8082-E
Nº C-232-23



PROFILE OF THE KING'S HIGHWAY Nº 62
SCALE - HOR. - 1 IN = 20 FT.
VER. -

G.B.M. Nº 179-G, ELEV. 587.144
IVANHOE: C.P.R. Bridge, over C.N.R. Madoc tramway, 1 mile east of station. South face of concrete capping at easterly wall on east abutment. Bolt set horizontally.

E4008-1

VP 917-61

ADDITIONS	DATE	REMARKS	BY
	JAN 1962	Line 'B' Transfer to Line 'A' Added	H. Beaumont
	JAN 9/62	Location of Stream Diversion Changed.	J. Curtis
	[illegible]	This Plan Supersedes E 2733-1	V. Nikodim

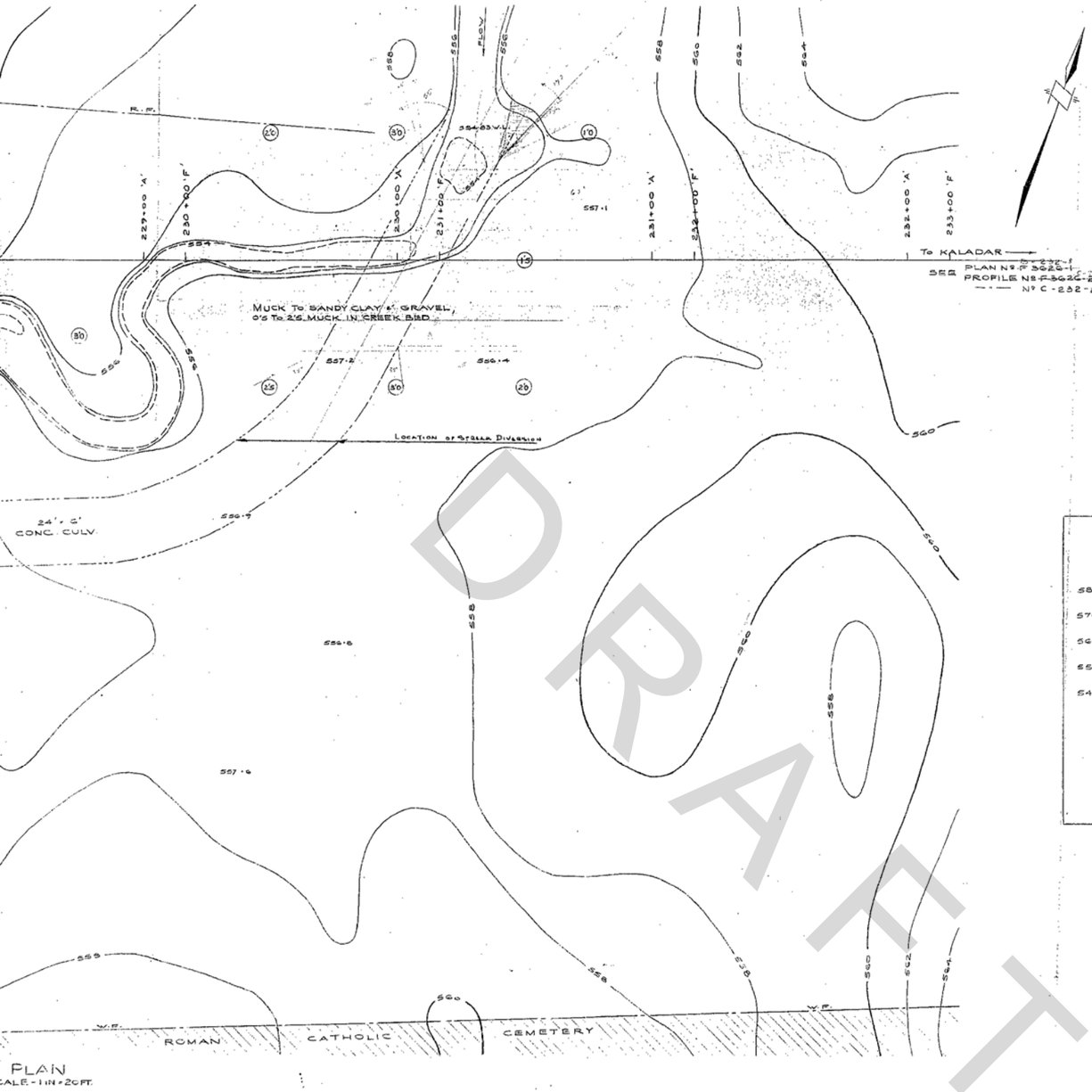
DEPARTMENT OF HIGHWAYS - ONTARIO
PLANNING & DESIGN BRANCH
DISTRICT Nº 8

PROPOSED CROSSING
AT
MADOC CREEK
AND
THE KING'S HIGHWAY Nº 7
PROPOSED MADOC BY-PASS, LINE 'A'
IN THE VILLAGE OF MADOC
TOWNSHIP OF MADOC COUNTY OF HASTINGS

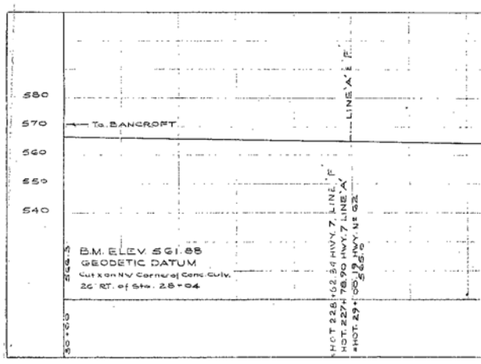
BRIDGE SITE

SURVEY BY CHIEF OF PARTY - A. KORCHUK SUPERVISOR - A. BOUCHER	APPROVED Director of Planning & Design
DRAWN BY DRAFTSMAN - V. NIKODIM SUPERVISOR - G. BROWN	SCALE - AS SHOWN DATE OF SURVEY - NOV 1960 DATE OF PLAN - JULY 1961
CHECKED BY DRAFTSMAN - V. NIKODIM SUPERVISOR - G. BROWN	W.O. N 34-61-64 X-ING Nº 8 PLAN E-4008-1

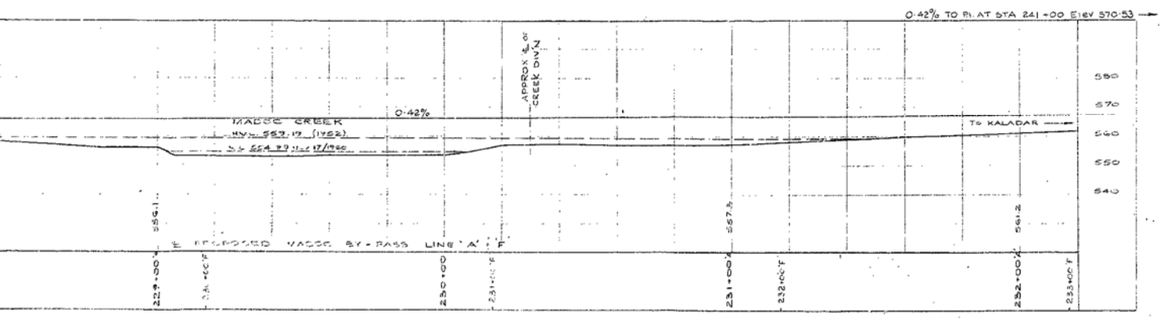
OF HASTINGS
HIP OF MADOC
GE OF MADOC



PLAN
CALE - 1 IN = 20 FT.



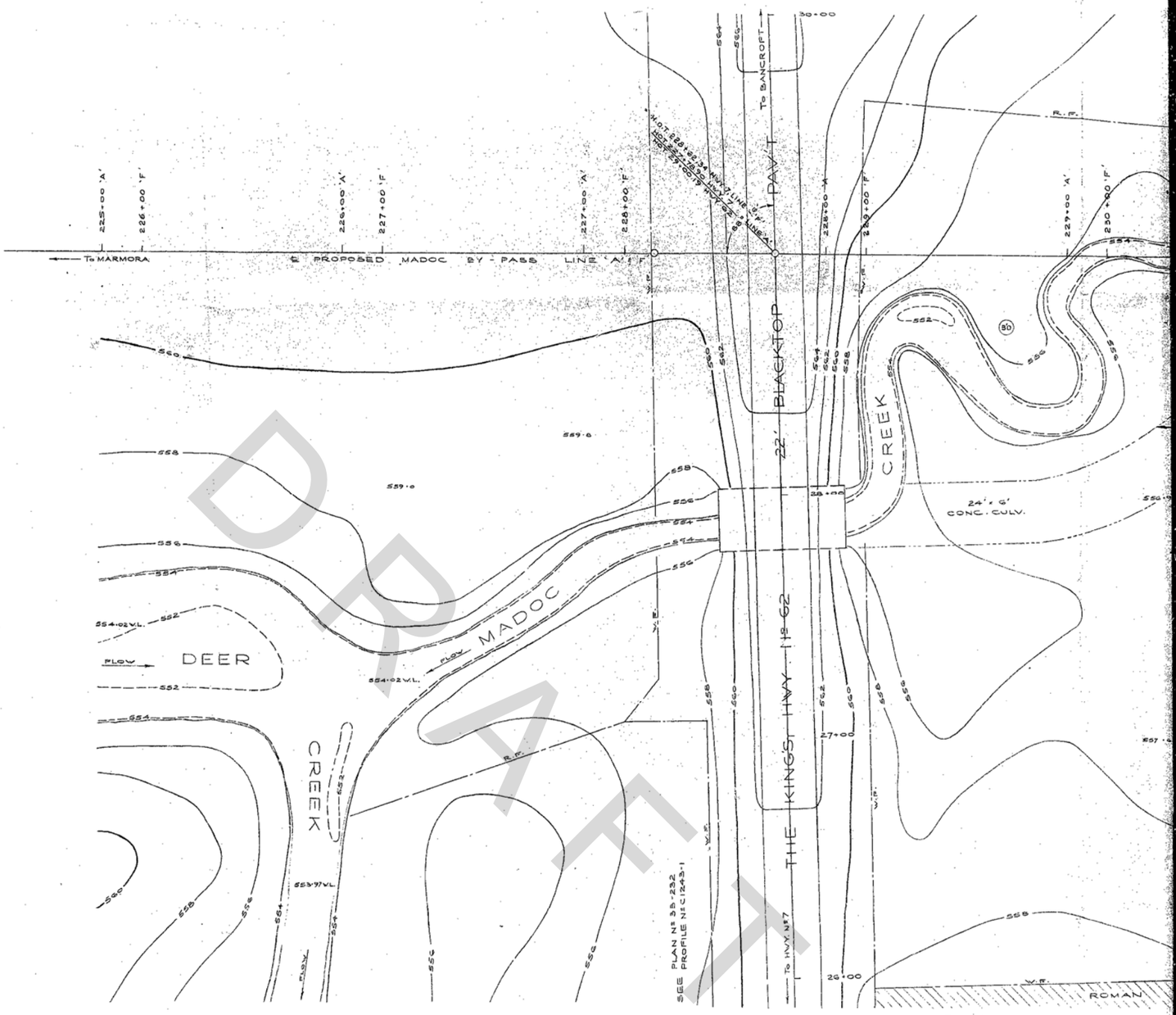
PROFILE



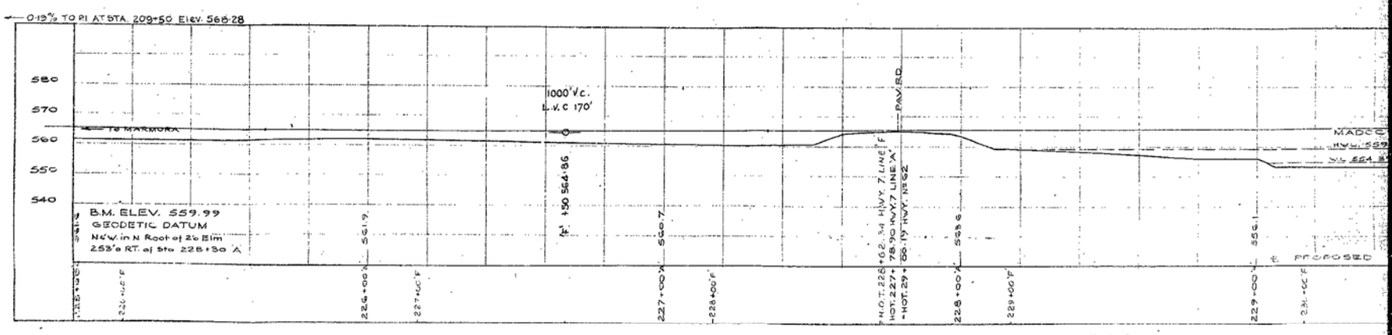
PROFILE
LE - HOR.
VER. - 1 IN = 2 FT.

E 4008-1

COUNTY OF HASTINGS
TOWNSHIP OF MADOC
VILLAGE OF MADOC



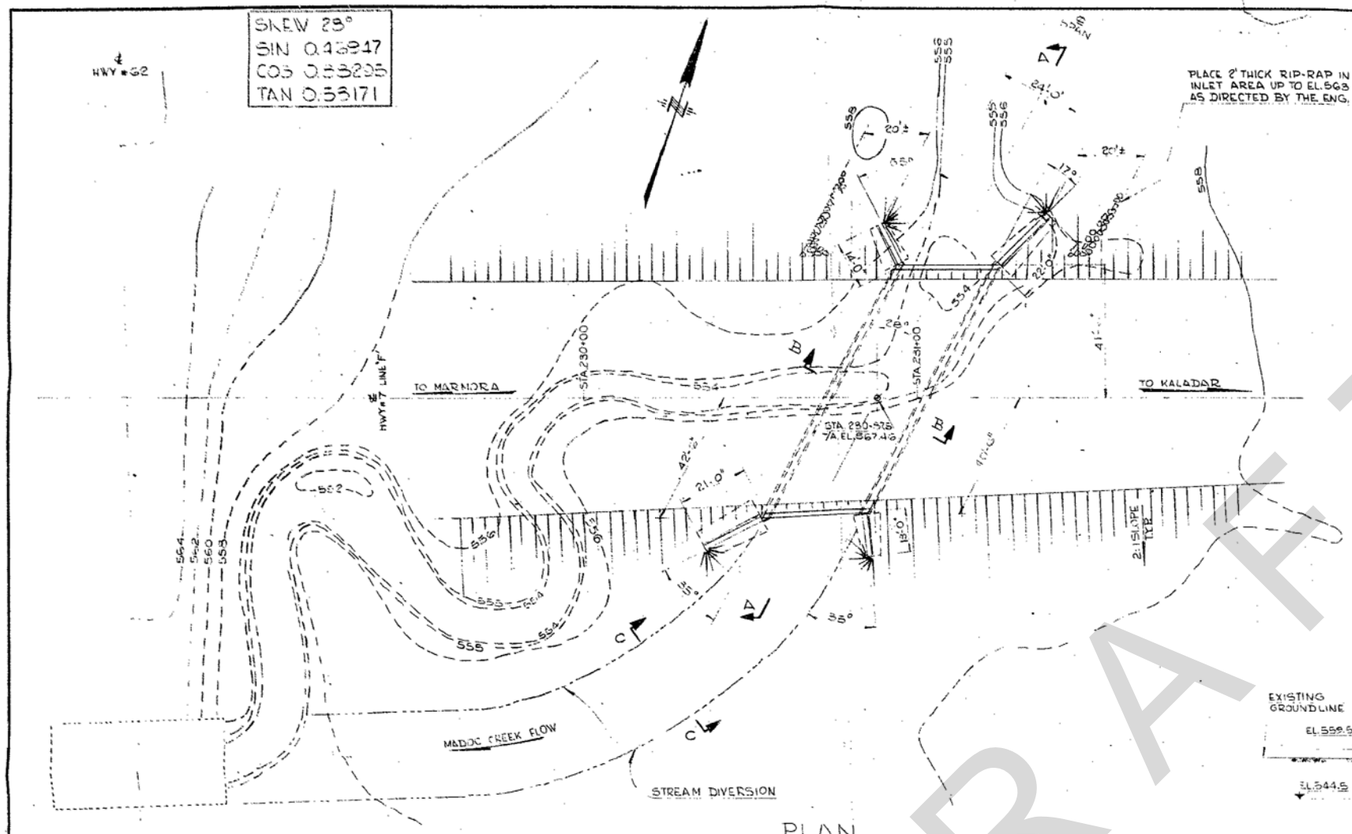
PLAN
SCALE - 1 IN = 20 FT.



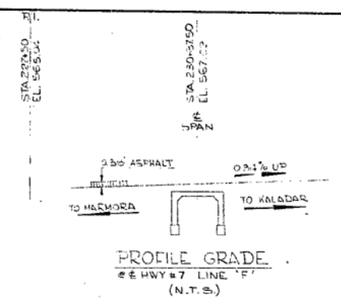
PROFILE
SCALE - HOR. - 1 IN = 20 FT.
VER.

E 4008-1

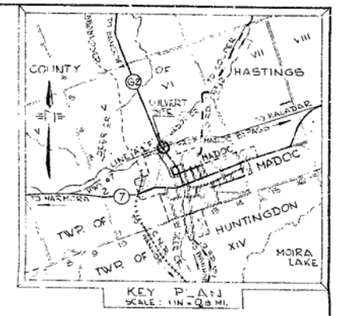
SKEW 28°
SIN 0.46947
COS 0.88295
TAN 0.53171



PLAN
SCALE: 1" = 20'

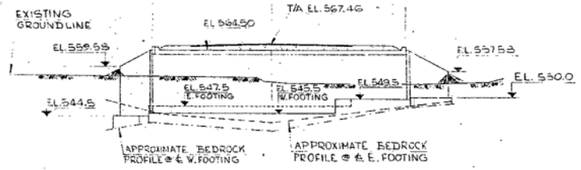


PROFILE GRADE
℄ HWY #7 LINE 'F'
(N.T.S.)

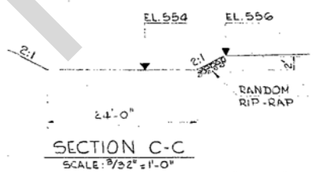


G.B.M. Nº 179-G, ELEV. 587.144
IVANHOE: C.P.R. BRIDGE OVER C.N.R. MADOC BRANCH 1 MILE EAST OF STATION. SOUTH FACE OF CONCRETE COPING OF BALLAST WALL ON EAST ABUTMENT. BOLT SET HORIZONTALLY.

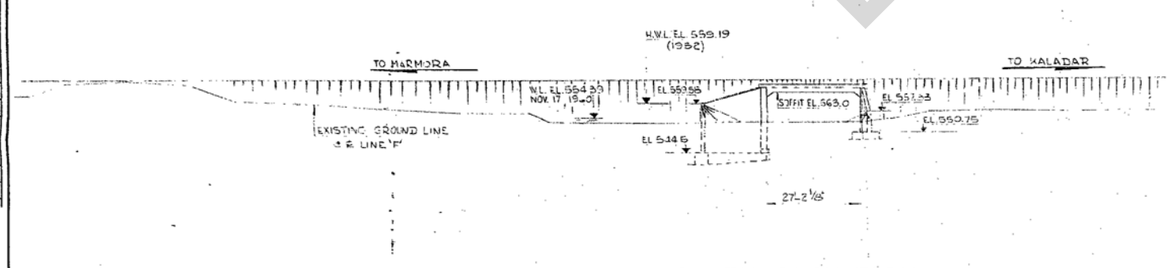
NOTES
TO ENGINEER:
CONCRETE WORK ON THIS STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE ENGINEER.
TO CONTRACTOR:
STRUCTURE TO BE BUILT IN ACCORDANCE WITH FORM Nº9 AND THE SPECIAL PROVISIONS. EXTRA COPIES OF WHICH MAY BE OBTAINED FROM THE ENGINEER.
CONCRETE MIX:
MIN. STRENGTH OF CONCRETE @ 28 DAYS: 3000 P.S.I. APPROVED ADMIXTURES SUPPLIED BY THE CONTRACTOR WILL BE ADDED TO ALL CONCRETE AS SPECIFIED BY THE ENGINEER.
BORING DATA:
THE COMPLETE SOIL INVESTIGATION REPORT FOR THIS STRUCTURE MAY BE EXAMINED AT THE BRIDGE OFFICE AND FOUNDATION OFFICE, DOWNSVIEW AND AT THE KINGSTON DISTRICT OFFICE.
CLEAR COVER ON REINFORCING STEEL:
3" UNLESS OTHERWISE NOTED.
CONSTRUCTION NOTES:
ALL EXPOSED EDGES TO BE CHAMFERED 1"x1" EXCEPT AS NOTED. ALL CONSTRUCTION JOINTS MUST BE APPROVED BY THE ENGINEER.



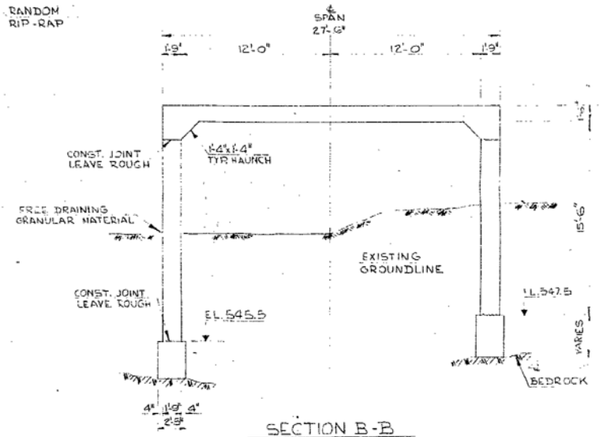
SECTION A-A
SCALE: 1" = 20"



SECTION C-C
SCALE: 3/32" = 1'-0"



SOUTH ELEVATION
SCALE: 1" = 20'



SECTION B-B
SCALE: 3/16" = 1'-0"

PRINT RECORD

No.	FOR	DATE

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

MADOC CREEK STRUCTURE
MADOC BY PASS @ HWY. Nº 62

KING'S HIGHWAY No. T.C.H. 7 — DIST. No. 8
CO. OF HASTINGS — VILLAGE OF MADOC
TWP. OF MADOC — LOT — CON.

PRELIMINARY PLAN

APPROVED — BRIDGE ENGINEER				SITE No. 12-249	W.P. No. 917-61
DESIGN	G.P.	CHECK		CONTRACT Nos.	
DRAWING	G.P.	CHECK			
DATE	DEC. 1963	LOADING	H20-S16	DRAWING No.	D-5353-P2

THURBER

Appendix B

Site Photographs

Highway 62 Pavement over Madoc / Deer Creek Culvert looking North

West End of Madoc / Deer Creek Culvert under Highway 62

Northwest Corner of Madoc / Deer Creek Culvert

West End of Madoc / Deer Creek Culvert looking South at South Approach

East End of Madoc / Deer Creek Culvert looking South

Northeast Corner of Madoc / Deer Creek Culvert