

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30m14-53

DIST. 6 REGION CENTRAL

W.P. No. 290-61 *

CONT. No. N.A. * Superseded by new W.P.

W. O. No. 70-F-102

STR. SITE No. _____

HWY. No. 404

LOCATION HWY. 404 & BEAVER
CX.

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

70-F-102

290-61

HWY. 404 & BEAVER CR.

30M14-53

W.O.

W.P.

LOCATION

GEOCRES NO.

● DATA ON FILE IN SOIL MECHANICS SECTION

REFER TO: W.O. FILE

Superseded by WP 57-73-01

REMARKS

GEOCRES

INDEXING CARD FOR REPORTS NOT MICROFILMED

GI-20

AUG. 74

MEMORANDUM

30M14-53

TO: Mr. E. R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: February 9, 1971

OUR FILE REF.

IN REPLY TO

FEB 15 1971

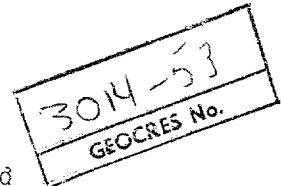
SUBJECT:

FOUNDATION INVESTIGATION REPORT
For

Proposed Crossing
At the New Hwy. #404 (Line 'A') and
Beaver Creek Diversion
Township of Markham, County of York
District No. 6 (Toronto)

W.O. 70-11102 -- W.P. 290-61

Superseded by W.P. 57-73-01



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

ACS/MseF

Attach:

cc: Messrs. B. R. Davis

H. A. Tregaskes

D. W. Farren

G. K. Hunter (2)

H. Greenland

G. C. E. Burkhardt (2)

T. J. Kovich

B. J. Giroux

B. A. Singh

McCormick & Rankin, Ltd. - J. Tuck

Foundations Files ✓

Gen. Files

A. G. Stermac
A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing
At the New Hwy. #404 (Line 'A') and
Beaver Creek Diversion
Township of Markham, County of York
District No. 6 (Toronto)
W.O. 70-11102 -- W.P. -

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the proposed crossing of Beaver Creek and Hwy. #404, in Markham Township, County of York. The request was contained in a memo from the Bridge Office - (Mr. G. C. E. Burkhardt, Regional Bridge Planning Engineer), dated November 2, 1970. Subsequently, an investigation was carried out by this Section to determine the subsoil and groundwater conditions at the site.

The results of this investigation are presented in this report, together with our recommendations for the design of the structure foundations as well as the stability and settlement considerations associated with the approach fills.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located some 2 miles west of the Village of Buttonville; Beaver Creek is located in this area. Beaver Creek is very winding, with a number of oxbows visible to the north, the ground surface undulating between elevation 615 and 626, and is developed for farming purposes. The river channel is approximately 30 feet wide with an average depth of 7 feet. The water in the channel was about 3 feet deep at the time of the investigation.

The general area is situated in the 'Peel Plain' physiographic region. The underlying geological material of

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

the plain is a till or boulder clay containing large amounts of Palaeozoic shale and limestone. In much of the Peel Plain this has been modified by a veneer of clay, which when deep enough, is clearly seen to be varved. In various places, however, the stream valleys are bordered by trains of sandy alluvium.

3. FIELD AND LABORATORY WORK:

A total of five sampled boreholes, all of which were accompanied by a dynamic cone penetration test, was carried out at the site during the course of the field investigation. The boreholes and the cone penetration tests were advanced by means of diamond drill rigs adapted for soil sampling purposes.

Samples were obtained at required depths in a 2-inch O.D. split-spoon sampler which was hammered into the soil. The method of driving the split-spoon sampler conformed to the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests.

Artesian conditions were encountered in 3 of the borings. The emission of water was properly sealed, at appropriate elevations, by conventional methods. During sampling and drilling operations, detailed logs of the borings were made; these logs contain a record of the drilling and sampling techniques used, together with the soil types encountered.

The locations and elevations of all the boreholes are shown on Drawing #70-11102A, together with the estimated stratigraphical profile across the site. Surveying at the site was carried out by the personnel from McCormick, Rankin and Associates, Consulting Engineers, Port Credit. The elevations given in this report are referenced to a Geodetic datum.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following

3. FIELD AND LABORATORY WORK: (cont'd.) ...

this examination, laboratory testing was carried out on selected representative samples to determine the following physical properties of the overburden:

Natural Moisture Content
Atterberg Limits
Grain-size Distribution
Organic Content

The results of these tests are plotted on the Record of Borelog sheets as well as on Figures No. 1, 2 and 3, all of which are contained in the Appendix of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The surficial deposit at this site consists of an organic silt extending 2.5 to 6 feet below the ground surface. Underlying this deposit is a stratum of sandy silt to silty sand, having a thickness ranging between 2 and 9 feet. This deposit is followed by a 10.5 to 15.5 feet thick deposit of firm to hard cohesive glacial till. Underlying the glacial till is a deposit of sand to silty sand and gravel, extending at least 22 feet below the glacial till deposit.

The boundaries of the various deposits are shown on the accompanying borelog sheets. The inferred stratigraphical profile, along the centre-line of the proposed structure, is plotted on Drawing No. 70-11102A.

From ground surface downward, the various soil types encountered are as follows:

4.2) Organic Silt:

Over the entire site a surficial deposit composed of brown to black, very soft to firm ('N' values 1 - 5 blows/ft.) organic silt was encountered. The thickness of the deposit

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) Organic Silt: (cont'd.) ...

ranges from 2.5 feet at B.H. #4 to 6 feet at B.H. #1.

Laboratory testing carried out in this material showed that the organic content varied from 8 to 21 percent (by weight). The natural moisture content ranges from 96 to 189 percent.

4.3) Sandy Silt to Silty Sand (Upper Granular Deposit):

Underlying the organic material is a stratum of brown to grey sandy silt to silty sand with a trace of clay and gravel, the thickness of which ranged from 2 feet at B.H. #5 to 9 feet at B.H. #4. Occasional clayey silt seams up to 4 inches thick were encountered within this deposit. Grain-size distribution curves, obtained on samples of the granular subsoil, are plotted in envelope form on Fig. #1 in Appendix I.

Standard penetration resistance tests were carried out within the deposit; the results are plotted on the Record of Borelog sheets. This testing gave 'N' values which range from 2 blows/ft. to 30 blows/ft. Based on these results, it is estimated that the relative density of the granular deposit varies from very loose to compact.

4.4) Heterogeneous Mixture of Clayey Silt, Sand and Gravel - (Glacial Till):

Underlying the granular deposit of sandy silt to silty sand, is a glacial deposit, composed of a heterogeneous mixture of clayey silt, sand and gravel. This deposit was penetrated fully in two boreholes; the depths varied from 10.5 feet at B.H. #3 to 15.5 feet at B.H. #5. Random pockets or layers of sand and gravel were encountered within this deposit.

Grain-size distribution testing was carried out on typical samples obtained from this deposit. The results are shown in envelope form on Figure #2.

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.4) Heterogeneous Mixture of Clayey Silt, Sand and Gravel - (Glacial Till): (cont'd.) ...

Atterberg limit tests were carried out on samples from this deposit; the results, which are shown on the Record of Borelog sheets, are also plotted on the Plasticity Chart, Figure #3. The results are summarized in the following table:

<u>Tests</u>		<u>Range</u>
Liquid Limit	(W _L) %	14 - 22
Plastic Limit	(W _P) %	10 - 13
Natural Moisture Content	(W) %	10 - 14
Plasticity Index (I _L)		0.1 - 0.7

Based on these values, it is estimated that the glacial till has a matrix which is inorganic and of low plasticity.

Standard penetration testing carried out within this deposit, gave 'N' values which ranged from 5 blows/ft. to 80 blows for 5 inches. Based on these values, it is estimated that the consistency of the deposit is firm to hard.

4.5) Sand to Silty Sand, trace of Gravel (Lower Granular Deposit):

Underlying the glacial till is a deposit of very dense ('N' values 60 blows/ft. to 66 blows for 4 inches) sand to silty sand, with a trace of some gravel. This deposit was only proven at B.H. #3; at this location the boring operations were terminated within this subsoil, and proven to extend for a depth in excess of 28 feet.

Grain-size distribution testing was carried out on representative samples from this deposit. The results are plotted on Figure #1.

5. GROUNDWATER CONDITIONS:

In order to establish the groundwater level conditions across the site, water level observations were carried out in the open boreholes during the time of the field investigation. The readings obtained are plotted on the Record of Borelog sheets and on Drawing No. 70-11102A. The observations indicate that the groundwater level varies from elevation 604 to 609, which corresponds to depths of between 1.5 and 6 feet below existing ground surface. The water level in Beaver Creek, at the time of investigation, was estimated to be at elev. 603.

Artesian water conditions were encountered in three boreholes (B.H.'s #3, 4 and 5). The artesian heads encountered, with respect to ground surface, were of the order of 15 feet.

Detailed information is shown in the table below:

TABLE 1

Borehole No.	Artesian Water Encountered at Elev.	Artesian Head Above Ground Surface
3	589	10 feet
4	593	4 feet
5	591	15 feet

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to relocate the Beaver Creek at the crossing of Hwy. #404, 2 miles west of the Village of Buttonville, in Markham Township, County of York. The present proposal calls for either a multiplate pipe arch culvert or rigid frame box type culvert, having a total length of 400 feet and a width of 20 feet.

The profile grade of the new Hwy. #404 in the vicinity of the crossing will be about 625. The relocated channel will have the same invert elev. (604) as that of the existing channel.

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

6.1) General: (cont'd.) ...

At this grade the maximum height of the approach fills will be of the order of 21 feet.

The stratigraphy across the site consists of a very soft to firm, surficial layer of organic silt, underlain by a stratum of very loose to compact sandy silt to silty sand, which, in turn, is followed by a firm to hard deposit of glacial till (heterogeneous mixture of clayey silt, sand and gravel). The glacial till overlies a stratum of very dense sand to sand and gravel.

As mentioned elsewhere, two possible schemes may be considered at the crossing of new Hwy. #404 and Beaver Creek relocation, namely:

- 1) Multiplate Corrugated Steel Pipe Arch Culvert
- 2) Rigid Frame Box Type Culvert

6.2) Multiplate Corrugated Steel Pipe Arch:

The exact cross-sectional dimension of the pipe arch culvert are not available at the present time; however, they will have to comply with hydrological requirements.

The presence of very soft to firm organic silt requires certain measures at the location of the proposed pipe arch culvert. In order to ensure adequate foundation support for the pipe arch culvert, it is recommended that the organic silt deposit should be subexcavated for the full depth as shown in Figure #4.

With regard to bedding requirements, excavation for the pipe should be taken down to at least 1 ft. below the invert level and should have a minimum width at this depth extending 5 feet either side of the pipe. Bedding should consist of G.B.C. Class 'A' material and should be placed as follows, as per D.H.O. Standard DD-803A.

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

6.2) Multiplate Corrugated Steel Pipe Arch: (cont'd.) ...

1. For the width of area under the bottom radius of the pipe arch, the bed should be levelled and left uncompacted.

2. The area adjacent to the haunches of the pipe and under the portion of sloping invert should be compacted by means of hand-tamping.

3. Apart from the areas mentioned above, the bedding material should be machine-compacted on both sides of the pipe simultaneously in equal lifts.

It should be noted that the quantities for the sub-excavation of organic silt and backfilling with acceptable material may overlap with the bedding requirements for the placement of the pipe.

6.3) Rigid Frame Box Type Culvert:

The proposed invert elevation of the Beaver Creek at this crossing will be at approximate elevation 604. In order to provide adequate cover for frost protection requirements, the footings should be located at or below elev. 600. At this site artesian water conditions were encountered at elevation 597 or lower. In view of the close proximity of the artesian zone to the footing foundation level, in our opinion, this type of structure should not be considered at this crossing.

6.4) Approach Embankments:

The fills will have a maximum height of about 21 feet above the creek bed. Fills of this height, with standard 2:1 slopes, will be inherently stable with respect to a deep-seated failure within the foundation subsoil, provided any surficial organic deposit is subexcavated for its entire depth. The width

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

6.4) Approach Embankments: (cont'd.) ...

of the subexcavation should be the base width of the future roadway. The extent of the subexcavation of organic silt was not determined at the time of this investigation and this should be investigated by the Regional Materials Section.

The settlement, induced in the foundation subsoil, will be elastic in nature and negligible in magnitude.

The approach fills, in the vicinity of the structure, should be protected against the scour action of the river. Rip-rap, meeting the hydrological requirements at this site, could be used for this purpose.

7. MISCELLANEOUS:

The field work, performed during the period of January 13 - 19, 1970, was carried out under the immediate supervision of Mr. S. Ahmad, Project Foundation Engineer, who also prepared this report.

The equipment was owned and operated by Master Soil Investigation Ltd., Toronto, and Dominion Soil Investigation, Ltd., Toronto.

This project was carried out under the general supervision of Mr. B. T. Darch, Senior Foundation Engineer. This report was reviewed by Mr. M. Devata, Supervising Foundation Engineer.

February, 1971.

APPENDIX I

FOUNDATION SECTION

JOB	70-11102	LOCATION	Co-ords. 15,934,407 N; 1,033,672 E.	ORIGINATED BY	SAA
W.P.		BORING DATE	January 18, 1971	COMPILED BY	SAA
DATUM	Geodetic	BOREHOLE TYPE	Diamond Drill - Washboring	CHECKED BY	<i>ML</i>

[illegible]

FOUNDATION SECTION

CHECKED BY

[illegible]

FOUNDATION SECTION

SAA

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w	BULK DENSITY	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT				SHEAR STRENGTH P.S.F.
611.0	Ground Level										
0.0	Organic Silt		1	SS	1	610					
608.5	Very Soft Black		2	SS	4						
2.5	Sandy silt, trace of clay & gravel, occ. clayey silt seams up to 4" thick		3	SS	12						
	Loose to Compact		4	SS	21						
600.5	Brown - Grey		5	SS	17						
10.5	Het. mix. of clayey silt sand & gray (Glac. Till)		6	SS	14						
597.5	Stiff to Hard		7	SS	15						
			8	SS	11						
13.5	End of Borehole		9	SS	57						

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

108 70-11102

LOCATION Co-ords. 15,934,536 N; 1,033,476 E.

ORIGINATED BY SAA

W.P. BORING DATE January 13-14, 1971

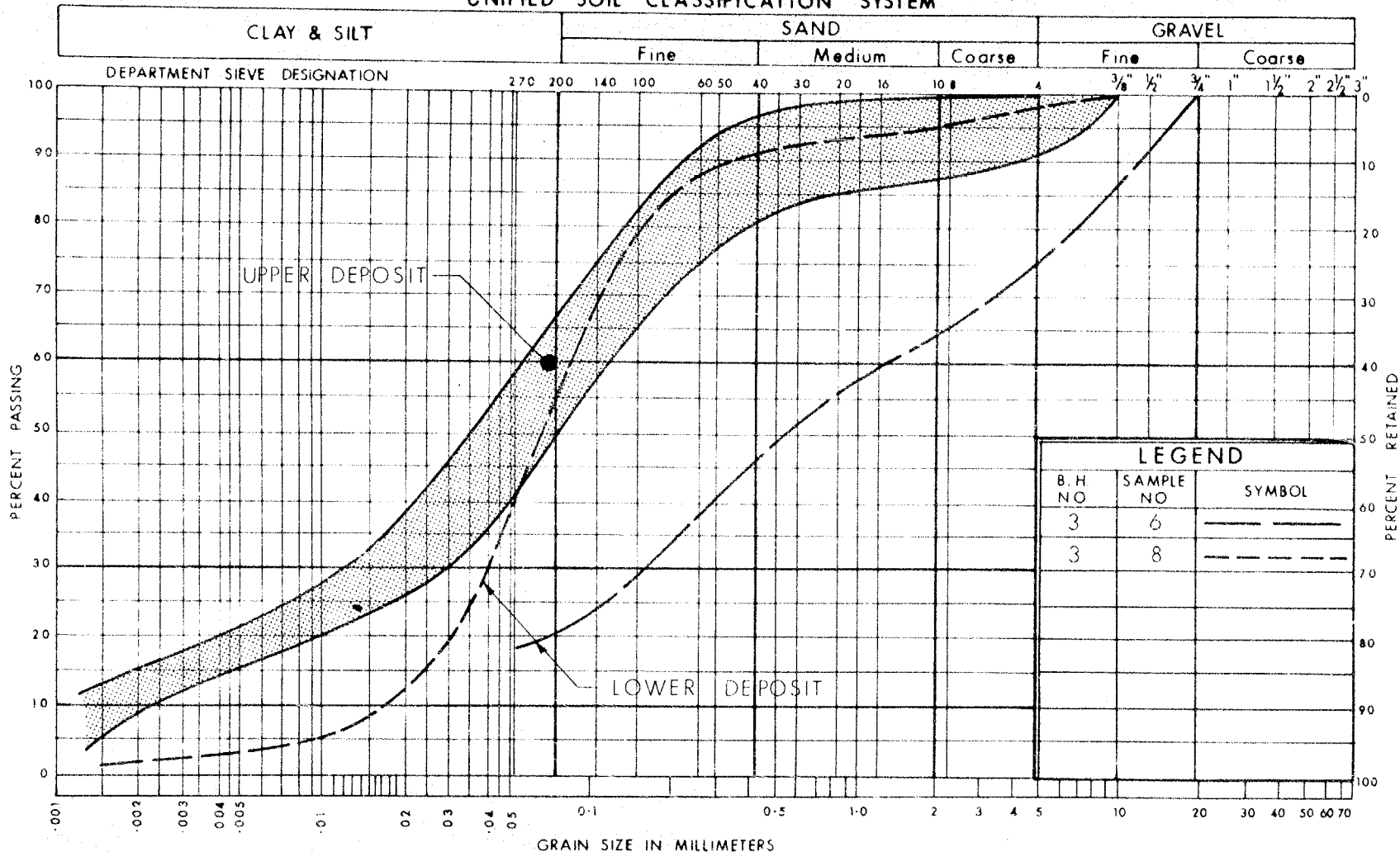
COMPILED BY SAA

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring

CHECKED BY *[Signature]* 17628.

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		SHEAR STRENGTH P.S.F.	WATER CONTENT % 10 20 30		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	w_p ——— w ——— w_L		
613.0	Ground Surface									
608.5	Organic Silt									
4.5	Very Soft - Black		1	SS	2	610				
606.5	Sandy silt, trace of clay & gravel. Loose		2	SS	8					
6.5	Het. mix. of clayey silt, sand and gravel		3	SS	23					
	Glacial Till		4	SS	123	600				
	Very Stiff - Hard Grey		5	SS	135					
501.0			6	SS	80/5"					
22.0	End of Borehole					590				

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND

W.P. No.

JOB No: 70-11102

FIG. NO. 1

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

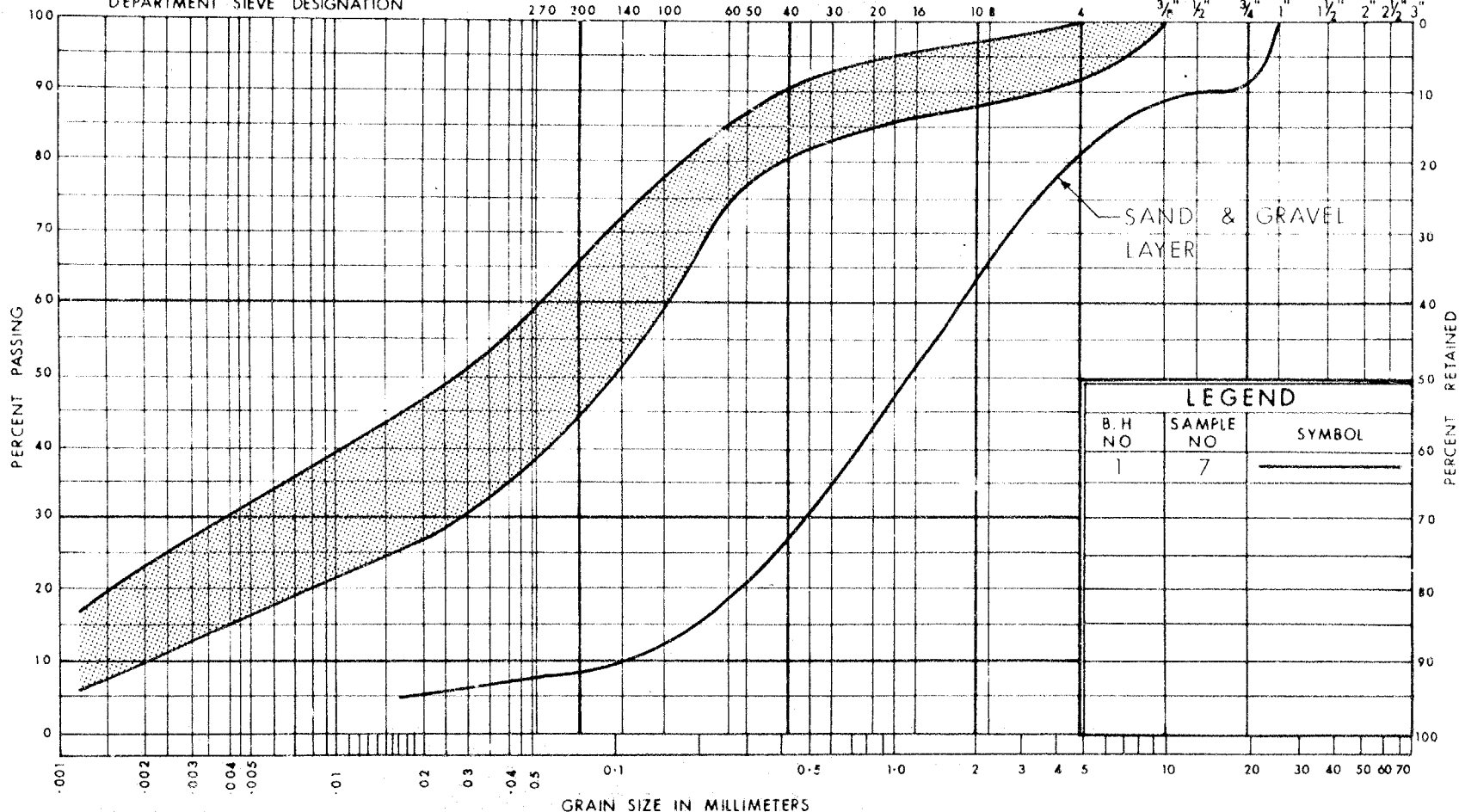
Medium

Coarse

Fine

Coarse

DEPARTMENT SIEVE DESIGNATION



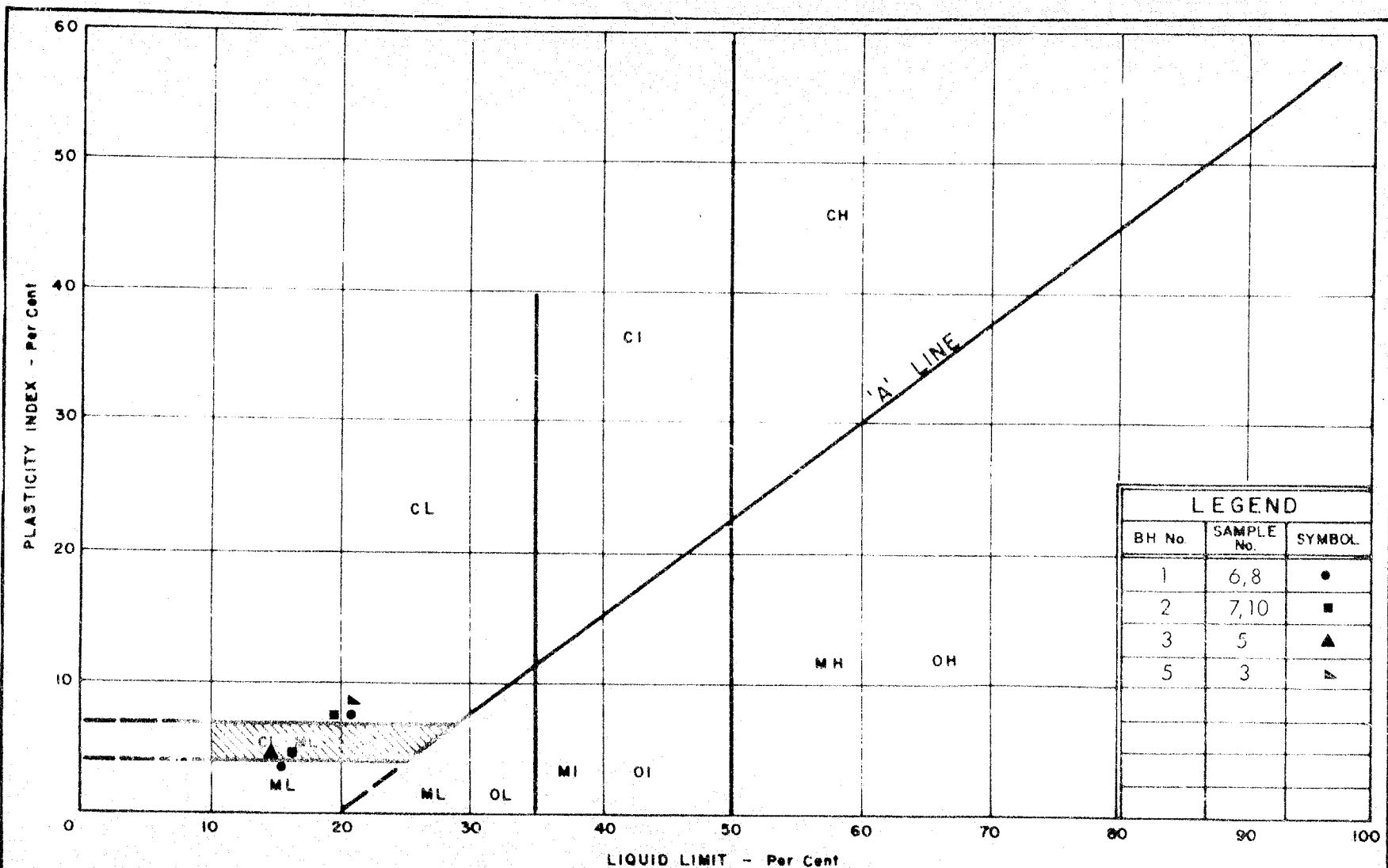
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TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
GLACIAL TILL (Cohesive)

W.P. No.

JOB No: 70-11102

FIG. NO. 2



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART

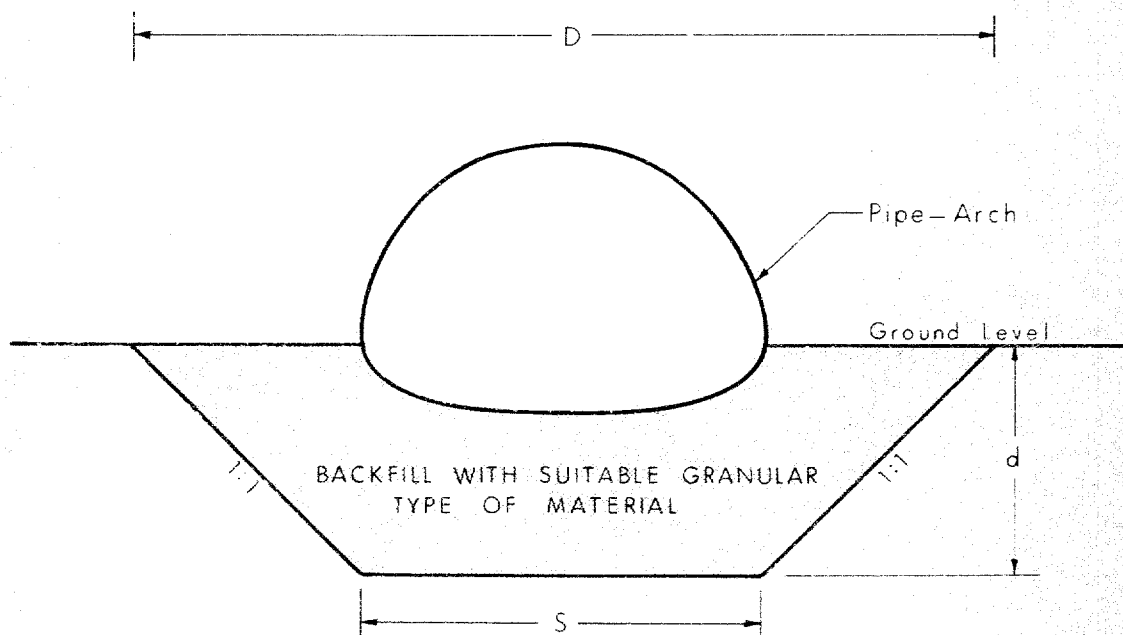
GLACIAL TILL

WP No.

JOB No. 70-11102

FIG. NO. 3

DETAILS OF ORGANIC SILT SUB-EXCAVATION



S — Span of Pipe Arch

D — Total width of Sub-Excavation
at ground level

d — Depth of Sub-Excavation

FIG. 4

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 :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

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.	AUER 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
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

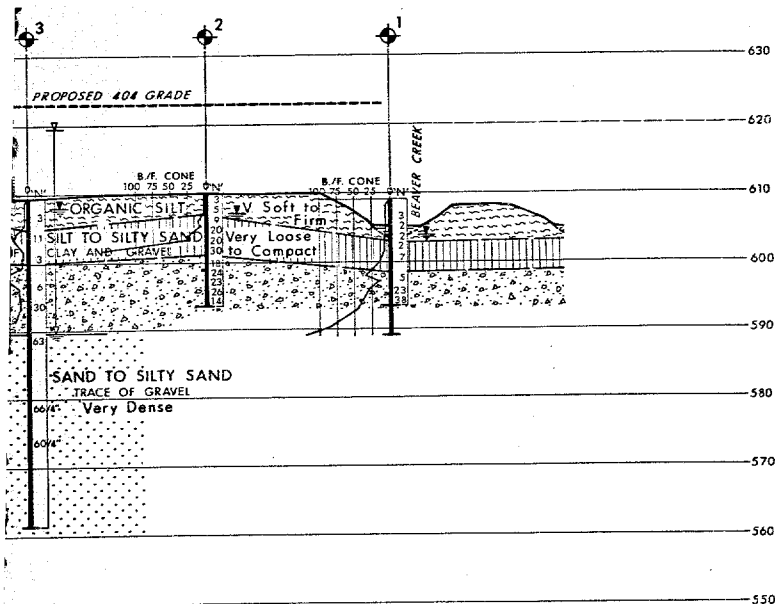
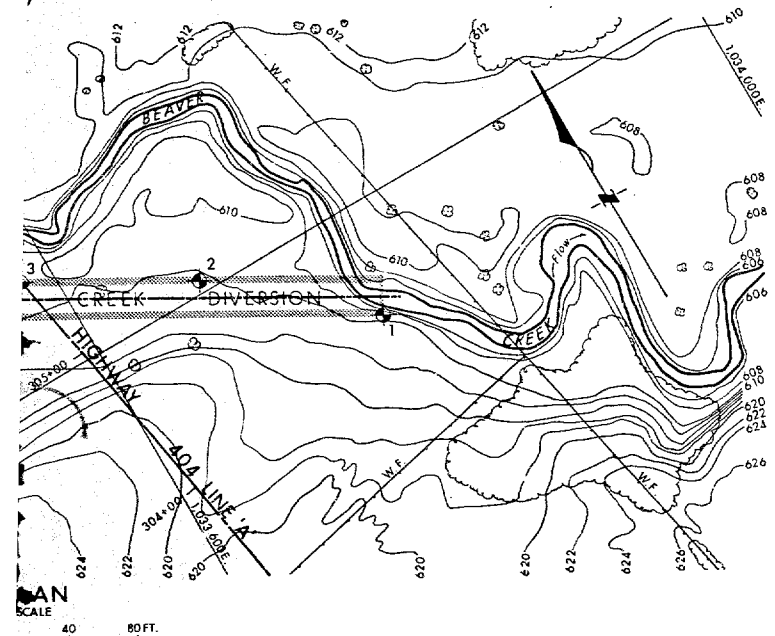
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

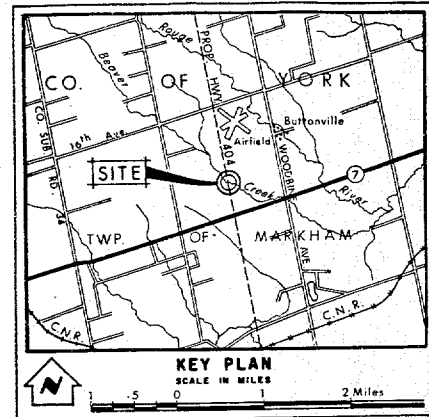
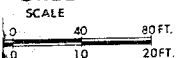
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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



CREEK DIVERSION



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, Jan. 1971		
	HEAD Artesian Water ENCOUNTERED		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	609.0	15,934,336	1,033,754
2	610.0	15,934,407	1,033,672
3	609.4	15,934,458	1,033,582
4	611.0	15,934,469	1,033,512
5	613.0	15,934,536	1,033,406

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.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & TESTING OFFICE - FOUNDATION SECTION			
BEAVER CREEK DIVERSION			
KING'S HIGHWAY NO. Prop. 404 (LINE'A)		DIST. NO. 6	
CO. YORK			
TWP. MARKHAM		LOT 12	CON. III
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D. S.A.	CHECKED <input checked="" type="checkbox"/>	W.F. NO.	M.B.T. DRAWING NO.
DRAWN <input checked="" type="checkbox"/>	CHECKED <input checked="" type="checkbox"/>	JOB NO. 70-11102	70-11102 A
DATE Feb. 8, 1971	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 160-74-24

DIST 6

HWY 404

STR SITE 37-277

Beaver Creek Bridge
0.5 Miles North of Hwy. 7

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	77 04 27	M.D.
TUBES	—	—
ROCK CORES	—	—

FOUNDATION INVESTIGATION REPORT
For

Beaver Creek Bridge
0.5 Miles North of Hwy. 7
Hwy. 404, District 6, Toronto
W.P. 160-74-24, Site 37-277

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. The fieldwork was carried out during the period of February 7, 1977 to February 10, 1977. It consisted of a total of 3 boreholes advanced by either augering or wash boring techniques to depths ranging from 25 to 41 feet below the ground surface.

SITE DESCRIPTION

The site is located some 2 miles west of the Village of Buttonville and approximately 0.5 miles north of Hwy. 7. Beaver Creek is meandering, with a number of oxbows visible to the north. The ground surface undulates between elevation 615 and 626 and is developed for farming purposes. The river is approximately 10 feet wide with an average depth of 3 feet at the time of the investigation.

The general area is situated in the 'Peel Plain' physiographic region. The underlying geological material of the plain is a till or boulder clay containing large amounts of Paleozoic shale and limestone. In various places the stream valleys are bordered by trains of sandy alluvium.

SUBSURFACE CONDITIONS

General

On the east side of Beaver Creek, the subsoil consists of a compact silty fine sand to silt deposit about 24 feet thick underlain by very stiff to hard cohesive glacial till. Whereas, on the west side of Beaver Creek the overburden consists of 4 to 6 feet of silty sand with some clay and organic inclusions followed by 2 to 7 feet of loose to compact silt with

traces of fine sand and gravel. This granular stratum is underlain by a very stiff to hard cohesive glacial till. Detailed descriptions of the various soil types encountered in each borehole are given on the Record of Borehole Sheets. The estimated stratigraphical profile of Drawing No. 1607424-A is based upon information from the Record of Borehole Sheets. From ground level downwards, the various soil types encountered are as follows.

Silty Sand, Some Clay and Organic Inclusions

On the flood plain west of Beaver Creek under about 2 feet of topsoil a 4 to 6 foot layer of silty sand with some clay and organic inclusions was encountered. This deposit is underlain by approximately a 1 foot layer of gravel.

The Standard Penetration Test results gave 'N' values ranging from less than 1 blow per foot to 3 blows per foot. Based on these values the relative density of the silty sand deposit is estimated to be very loose.

Silt With Traces of Sand and Gravel

Immediately below the thin gravel deposit a 2 to 7 foot deposit of grey silt with traces of sand and gravel was encountered. Based on 'N' values which ranged from 4 to 13 blows per foot the relative density is estimated to be loose to compact.

Two typical grain size distribution curves for this non-cohesive deposit are shown in Fig. 1.

Silty Fine Sand to Silt

In borehole 3 which is located on the east bank beyond the limits of the Beaver Creek flood plain, a 24 foot deposit of silty fine sand to silt was encountered under a 1 foot layer of topsoil. The upper 10 feet of this granular deposit is brown in colour and the lower portion is grey.

The 'N' values ranged from 10 to 24 blows per foot which indicates that the relative density of the granular deposit is compact.

Two typical grain size distribution curves obtained on samples of this granular stratum are shown in Fig. 2.

Heterogenous Mixture of Clayey Silt and Sand, Trace of Gravel

Beneath the granular deposit of silty fine sand to silt or beneath the deposit of silt is a glacial till composed of a heterogeneous mixture of clayey silt and sand with traces of gravel. The deposit was explored to a depth of 16 feet. In B.H's #1 and #2 a 2 foot seam of very dense silt with a trace of sand was encountered within the glacial till stratum, whereas, in B.H #3 a clayey silt seam approximately 4 feet in thickness is present within the glacial till stratum.

Grain-size distribution testing was carried out on typical samples obtained from this deposit. The results are shown in envelope form on Fig. 3.

Atteberg Limit tests were carried out on samples from this deposit; the results, which are shown on the Record of Borelog Sheets, are also plotted on the Plasticity Chart, Fig. 4. The results are summarized in the following table:

<u>Tests</u>		<u>Range</u>	<u>Average</u>
Liquid Limit	(w_L) %	14 - 22	17
Plastic Limit	(w_p) %	10 - 12	10
Natural Moisture Content	(w) %	7 - 18	11
Liquidity Index	(I_L)	-1.0 - 0.5	

Based on these values, it is estimated that the glacial till has a matrix which is inorganic and of low plasticity.

Standard penetration testing carried out within this deposit, gave 'N' values which ranged from 15 blows/ft. to over 100 blows/ft. Based on these values, it is estimated that the consistency of the deposit is stiff to hard.

Groundwater Conditions

In order to establish the groundwater level conditions across the site, water level observations were carried out in the open boreholes during the time of the field investigation. The groundwater level was observed to vary between elevation 606.5 and 609.0 or 3 to 10 feet below existing ground level. The water level in Beaver Creek was found to be at elevation 606.0 at the time of the field investigation.

DISCUSSIONS AND RECOMMENDATIONS

General

Beaver Creek is being realigned under present Contract 76-107. The realigned creek will cross Hwy. 404 at Sta. 309+00. This is some 350 feet north of the previously investigated site as per the original foundation report W.P. 37-277, dated February 9, 1971.

The proposed profile grade of Hwy. 404 at this location will be approximately at elevation 626, i.e. a maximum fill height of about 15 feet.

Three alternative schemes may be considered for this crossing:

- 1) Rigid frame structure
- 2) Multi-plate pipe arch culvert
- 3) Single span structure.

Rigid Frame Structure

Rigid frame open structure can be supported on spread footings within the granular deposit at or below elevation 603.0. Spread footings so founded may be designed using an allowable bearing pressure of up to 2.0 t.s.f. In any event, a minimum of 4 feet of earth cover should be provided to the underside of the footings for frost protection purposes.

The footing excavations will extend below the groundwater level. Due to the granular nature of the immediate subsoil a dewatering scheme will be necessary to control the seepage and/or the hazard of "boiling" of the base due to the unbalanced hydrostatic water pressure head. In order to prevent the "boiling" at the base of the excavation, it is recommended that the sheeting be driven to a depth below the base equal to the unbalanced hydrostatic head existing above this level.

If the structure is designed as a rigid frame, then a coefficient of earth pressure at rest (K_0) of 0.5 should be assumed for the granular material placed behind the wall when designing the wall structure. The design should incorporate the full effect of the surcharge located above the walls. In order to relieve the buildup of excess hydrostatic pressure behind the walls, suitable drainage measures should be provided. One way would be by placing weep holes at the base of the walls.

The foundation soil, in the immediate vicinity of the footings, should be protected against the scour action of the Beaver Creek diversion. A properly designed and placed rip-rap cover could be used for this purpose.

Multi-Plate Pipe Arch Culvert

Multi-plate pipe arch culvert is a second alternative.

With regard to bedding requirements, excavation for the pipe should be taken down to one foot below the invert level and should have a minimum width at this depth extending 5 feet on either side of the pipe. The bedding should be placed as follows:

- a) For the width of the area under the bottom radius of the pipe arch the bed should be levelled and left uncompacted.
- b) The area adjacent to the haunches of the pipe and under the portion of the sloping invert should be compacted by means of hand tamping.
- c) Apart from the areas mentioned above the bedding material should be machine compacted on both sides of the pipe simultaneously in equal lifts.

To prevent piping around the culverts, a 3 foot thick blanket of approved impermeable material (clay) should be placed at the culvert inlet as a sealer behind a 2 foot layer of rip-rap. This blanket should extend to the high water level. Around the culvert outlet, a 3 foot thick blanket of granular 'A' material should be placed as a filter behind a 2 foot layer of rip-rap.

Single Span Structure

Alternatively, Beaver Creek could be spanned with a single span structure on abutments perched within the fill material. This type of structure could be supported on end bearing piles driven into the glacial till stratum. The maximum allowable load per pile will depend on the type of pile section chosen. For example, a 12 BP 74 steel 'H' pile driven to approximately elevation 580 would provide a safe load of 95 tons/pile. Also, #14 timber piles driven to approximately elevation 590 would provide a safe load of 25 tons/pile. Alternatively, 1' X 1' precast square concrete piles driven to approximately elevation 585 would provide a safe load of 100 tons/pile. However, pile driving during construction

should be controlled by means of the Hiley Formula as per current MTC standards.

For estimating the earth pressure on the abutment walls due to the backfilled granular material, a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted. If no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest $K_o = 0.5$ may be used for design purposes.

Approach Fills

The fills along either approach to the structure will have a maximum height of about 15 feet. Fills of this height will be inherently stable with respect to a deep seated failure within the foundation subsoil, provided that the upper organic subsoil is subexcavated to its full depth and replaced with properly compacted material and constructed with 2:1 slopes.

The approach fills in the vicinity of the structure should be protected against the scour action of the river. Rip-rap, meeting the hydrological requirements at this site, could be used for this purpose.

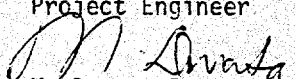
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. C.T. Johnson, Project Engineer. The equipment used was owned and operated by Geocon Ltd., Toronto, Ontario.

This report was written by Mr. C.T. Johnson and reviewed by Mr. M. Devata, Supervising Engineer.



C.T. Johnson
Project Engineer



M. Devata P. Eng.
Supervising Engineer

MD/CTJ/1f
April, 1977



FOUNDATION REQUEST

In a memorandum dated December 23rd, 1976, Mr. C.F. Farrell of the Structural Planning Office requested the Soil Mechanics Section to review our previous foundation report (W.P. 37-277, dated February 9, 1971) taking into account the new location of the Beaver Creek Crossing and reduced median width of Hwy. 404.

FIELD AND LABORATORY INVESTIGATION PROCEDURES

The field investigation was carried out between February 7, 1977 and February 10, 1977. A total of three sampled boreholes, each accompanied by a dynamic cone penetration test were put down. All boreholes were advanced using a muskeg mounted CME 55 equipped with 3¼" hollow stem augers and solid stem augers.

The locations and elevations of the boreholes were surveyed by personnel from the Toronto District Construction Section.

Disturbed soil samples were recovered by means of a 2 inch O.D. split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Samples were visually examined and identified in the field and again in the laboratory.

To determine the physical properties of the various soil types encountered the following laboratory tests were performed on representative samples:

- Atterberg Limit Tests
- Natural Moisture Content
- Grain size Distribution
- Organic Content

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 160-74-24 LOCATION Co-ords. N 15 934 778; E 1 033 423 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 7 & 8, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE 3 1/2" H.S.A. and Wash Boring with Penetration Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ P.C.F	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
611.4	Ground Level															
0.0	Topsoil					610										
2.0	Silty Sand some clay and organic inclusions		1	SS	3											Organic
603.5	Gravel		2	SS	2/18											6.1%
7.9	Silt traces of sand and gravel Loose		3	SS	13											3 10 77 10
601.4	Glacial Till		4	SS	9											6 35 46 13
10.0	Heterogeneous Mixture of Clayey Silt and Sand, traces of Gravel Stiff to Hard		5	SS	15	600										
			6	SS	36											
			7	SS	28											
	Silt trace of sand		8	SS	21											4 34 36 26
			9	SS	46	590										
586.2	Grey		10	SS	76											
25.2	End of Borehole		11	SS	100	8 1/2"										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 160-74-24 LOCATION Co-ords N 15 934 794; E 1 033 510 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 8 and 9, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger & Boring with Penetration CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
611.0	Ground Level															
0.0	Topsoil	11.1	1	SS	2	610										
2.0	Silty sand some Clay & organic inclusions	11.1	2	SS	10											
605.1	Gravel	11.1	3	SS	4											
5.9	Silt trace of sand and gravel	11.1	4	SS	10											
598.5	Loose Grey	11.1	5	SS	28	600										1 0 94 5
12.5	Glacial Till	11.1	6	SS	32											
	Heterogenous Mixture of Clayey Silt and sand. Traces of Gravel	11.1	7	SS	59											3 37 31 29
	Very stiff to hard Silt, trace of Sand	11.1	8	SS	150/11.1"	590										1 8 81 10
585.4	Grey	11.1														
25.6	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

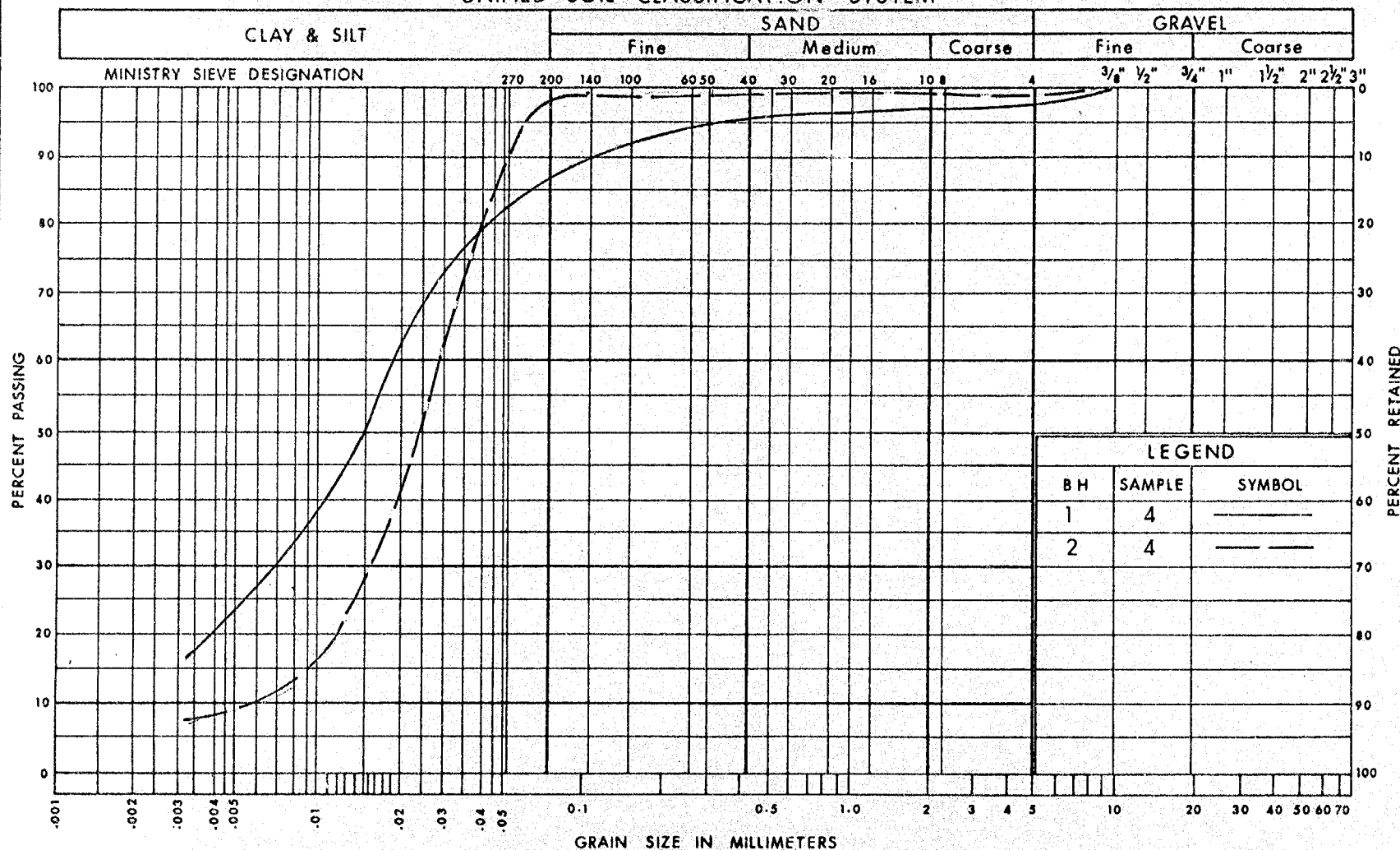
WP 160-74-24 LOCATION Co-ords N 15 934 815; E 1 033 620 ORIGINATED BY C.T.J.
 DIST 6 HWY 404 BORING DATE February 9 & 10, 1977 COMPILED BY C.T.J.
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem Auger with Dynamic Penetration CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					Test LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
619.2	Ground Level															
0.0	Topsoil	xx														
1.0	Traces of Clay		1	SS	10											
			2	SS	18											
			3	SS	24											
	Brown		4	SS	24											
	Grey		5	SS	21											
	Silty fine Sand		6	SS	10											
	to Silt		7	SS	13											
	Compact		8	SS	11											
594.7			9	SS	61	8"										
24.5			10	SS	24											
	Glacial Clayey Silt		11	SS	115											
	Till very stiff															
	Grey															
	Heterogeneous Mix.															
	of Clayey Silt and															
	Sand, traces of Gravel															
	Hard															
577.9	Grey		12	SS	142	9"										
41.3	End of Borehole															

20
15 0.5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of
Transportation and
Communications

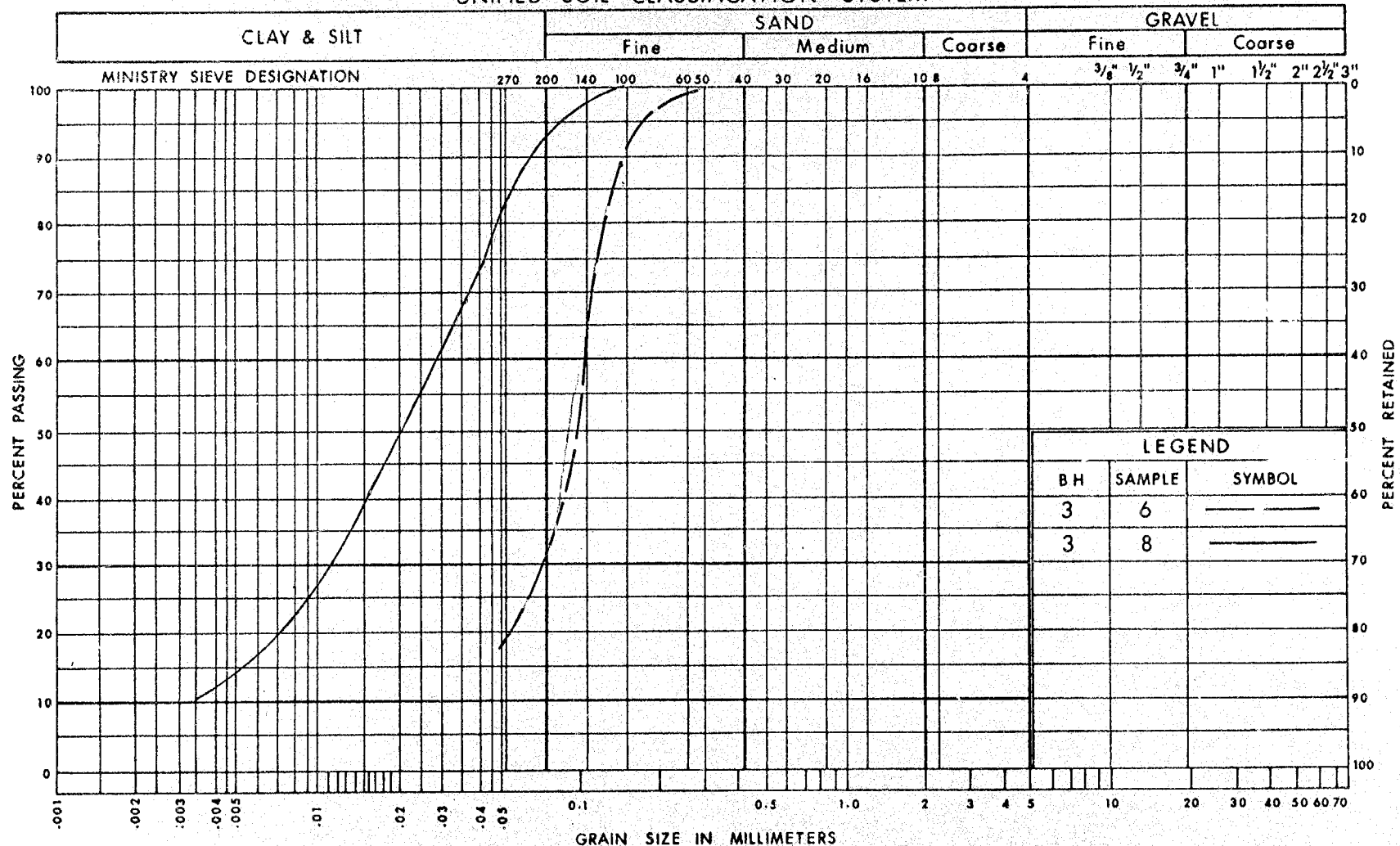
ENGINEERING SERVICES BRANCH

 GRAIN SIZE DISTRIBUTION
SILT
TRACES OF SAND & GRAVEL

FIG No 1

W P 160-74-24

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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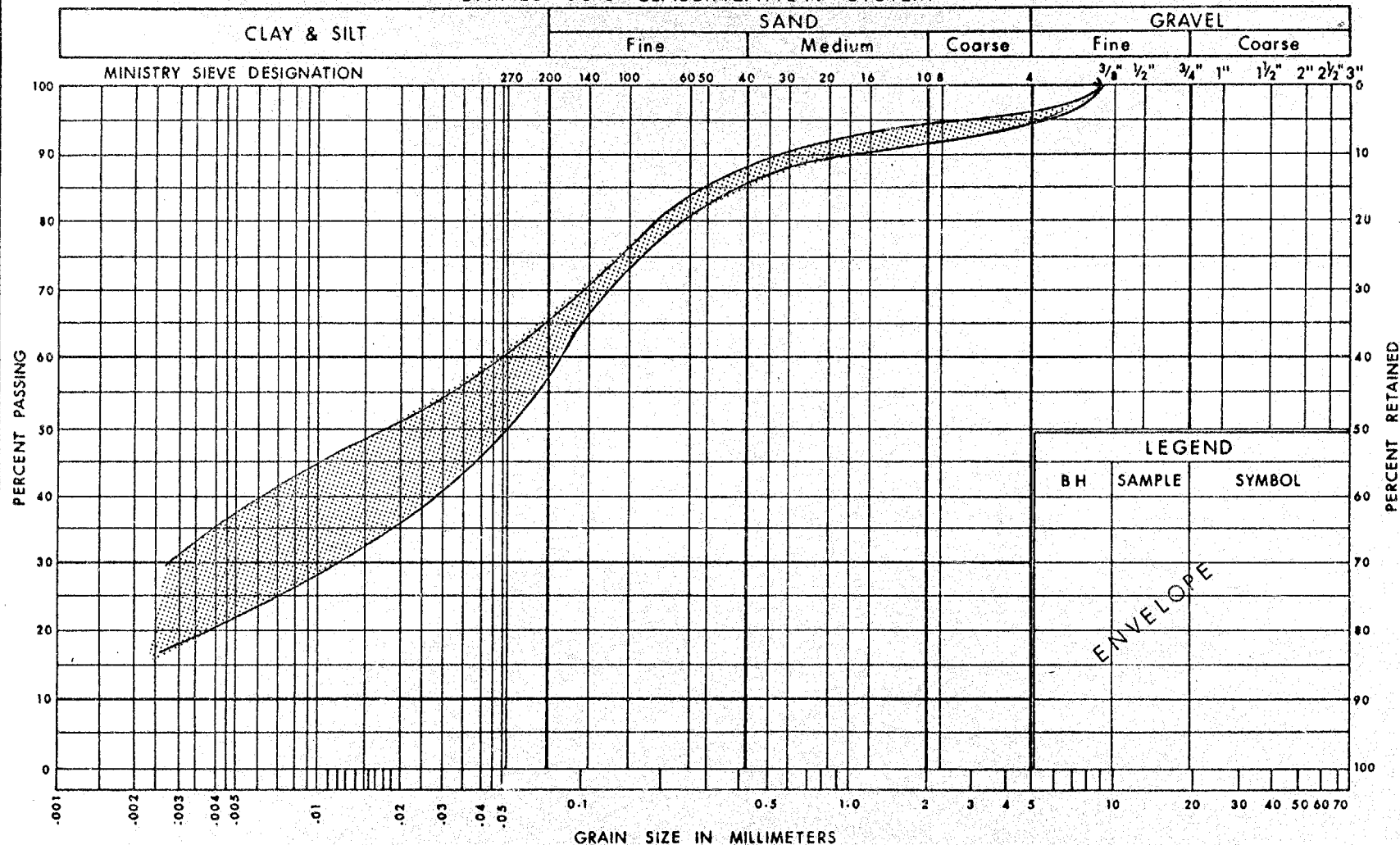
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GRAIN SIZE DISTRIBUTION
SILTY SAND TO SILT

FIG No 2

W P 160-74-24

UNIFIED SOIL CLASSIFICATION SYSTEM



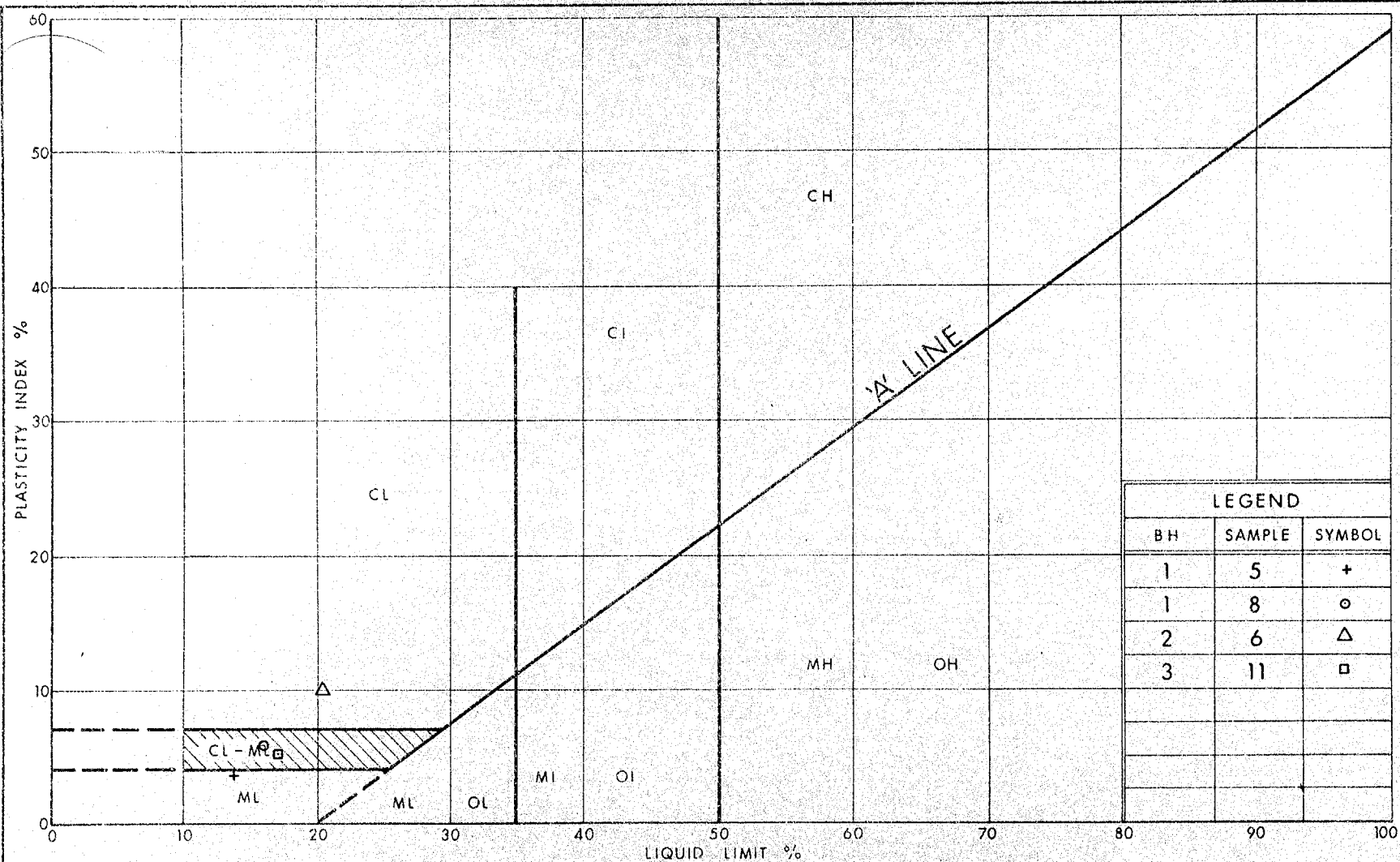
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GRAIN SIZE DISTRIBUTION
GLACIAL TILL
HET MIX OF CLAYEY SILT & SAND TR OF GRAVEL

FIG No 3

W P 160-74-24



Ontario

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Communications

PLASTICITY CHART GLACIAL TILL HET MIX OF CLAYEY SILT & SAND TR OF GRAVEL

FIG No 4

W P 160-74-24

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION 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
CIU	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_r	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
$\bar{\sigma}$	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

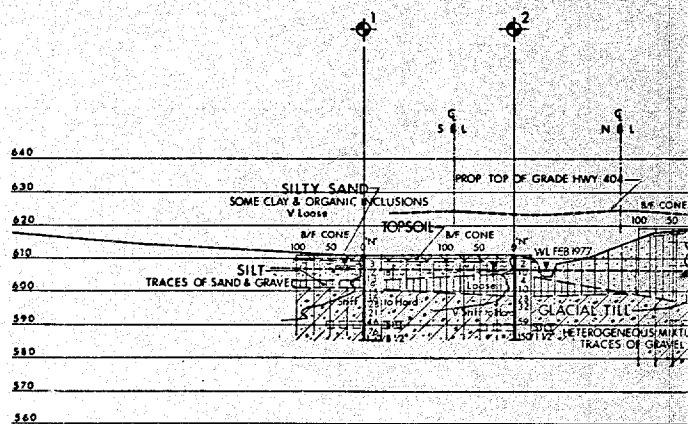
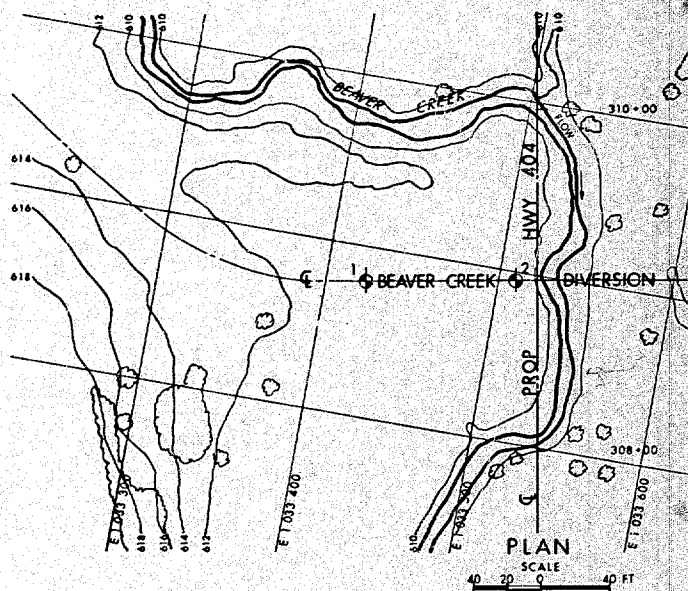
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

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



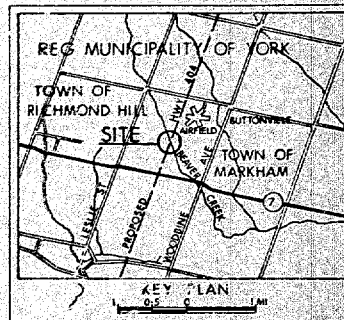
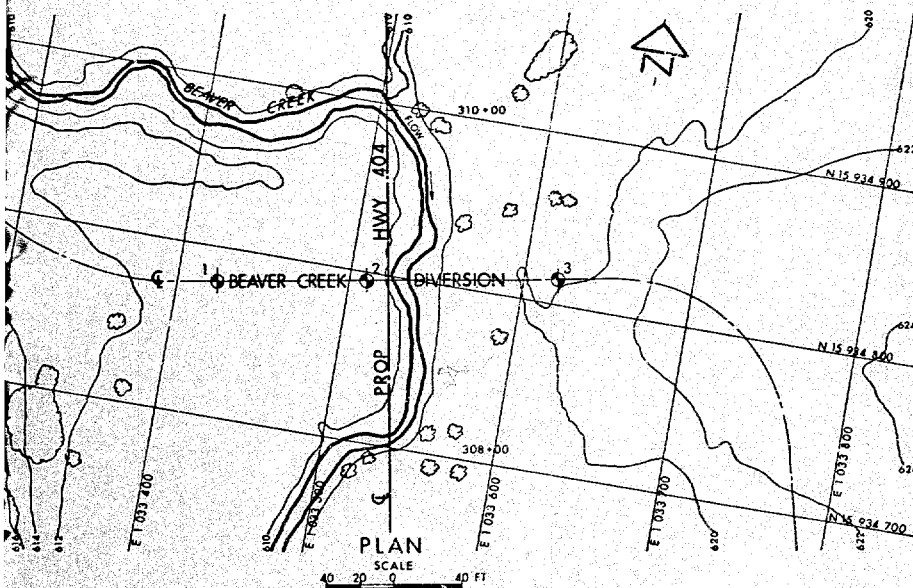
CONT No
WP No 160-74-24



BEAVER CREEK BRIDGE

SHEET

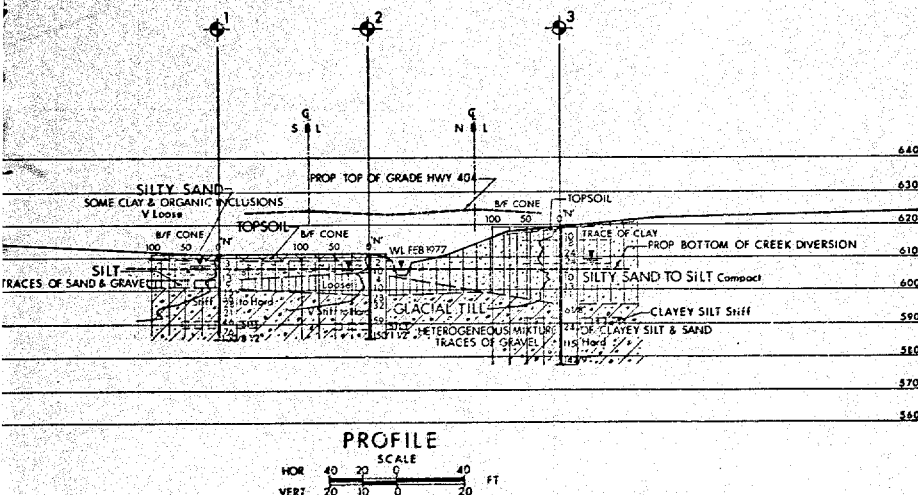
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- "N" Blows/ft (Std Pen Test 350ft lbs energy)
- CONE Blows/ft (60" Cone 350ft lbs energy)
- W.L. at time of investigation FEB 1977

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	611.4	15 934 778	1 033 423
2	611.0	15 934 794	1 033 510
3	619.2	15 934 815	1 033 620



-NOTE-

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

DATE	BY	DESCRIPTION

GEOGRES No 30M14-53

REF McCORMICK RANKIN & ASSOC M-404-BC

HWY No 404
DATE APR 7 1977
DRAWN BY J. CHECKED BY J. APPROVED BY J.
SHEET 37-297
DWG 1607424-A

STRUCTURAL PLANNING AND
DESIGN DATA REPORTS FOR
HWY. 404 CROSSING AT BEAVER CK.
SITE 37-277, DISTRICT 6

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

CENTRAL REGION

MARCH, 1977

CONTENTS :

MEMORANDUM OF TRANSMITTAL

STRUCTURAL PLANNING REPORT

HYDROLOGY REPORT

BW-2313A
(revised March 10, 1977)

PRELIMINARY FOUNDATION RECOMMENDATIONS

CROSS-SECTION SHEET

ATTACHMENTS :

BRIDGE SITE DRAWING

M-404-BC
(dated February, 1977)

REVISIONS AND ADDENDA:



Memorandum

To: Mr. C.S. Grebski
Structural Design Engineer
West Building

From: G.C.E. Burkhardt
Structural Section
3501 Dufferin St.

Attention: Mr. W. Lin
Reg. Structural Design Engineer

Date: March 16, 1977

Our File Ref.

In Reply to

Subject:

Hwy. 404 Crossing at Beaver Creek
(approximately 0.5 mi. North of Hwy. 7)
W.P. 160-74-24 Site 37-277
District 6, Toronto

Within the section of Hwy. 404 comprised between Hwy. 7 and Gormley Side Road two major waterways will cross the proposed C.A.H. 404-Rouge River and Beaver Creek.

The Beaver Creek structural design, completed during 1972, needs now to be revised in view of a reduction in the ultimate Hwy. 404 median width from 82' to 50' and also due to the fact that the Beaver Creek is being realigned under present contract 76-107. This relocation became necessary to construct a temporary haul road that will permit the placement and rough grading, north of subject location, of a substantial amount of material available from the area of the Hwy. 404/Hwy. 7 interchange.

To enable your office to carry out the updated design attached please find the following information:

Bridge Site Drawing

M-404-BC
(dated February, 1977)

Hydrology Report

BW-2313A
(revised March 10, 1977)

Preliminary Foundation Recommendations

Structural Planning Report and
Cross-Section Sheet

The road design work associated with this water crossing is being handled by McCormick, Rankin and Associates Ltd., Consulting Engineers, under W.P. 160-74-04.

Please note that, according to present scheduling, the following dates must be met:

Preliminary Structural drawing by:	April 20, 1977
Completion date by:	July 13, 1977
Complete D4 by:	July 27, 1977

Drawing number 37-277 is to be used for the structural design.



MB:sg

M.D. Bendayan,
Structural Planning Engineer
for:
G. C. E. Burkhardt,
Head, Structural Section

c.c. F. G. Allen
R. S. Pillar
R. A. Dorton
M. R. Ernesaks
H. Greenland
R. Fitzgibbon
J. Anderson
R.C. McCormick (McCormick, Rankin)

STRUCTURAL PLANNING REPORT
CENTRAL REGION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS,
ONTARIO

HWY. 404 CROSSING AT BEAVER CREEK
(APPROX. 0.5 MI. NORTH OF HWY. 7)

KING'S HIGHWAY No. 404

DIST. No. 6

Regional Municipality of York

Town of Markham and

LOT. 12 CON. 3

Town of Richmond Hill

SITE No.

37-277

W.P. No.

160-74-24

DRAWING

No.

37-277

REGIONAL STRUCTURAL PLANNING ENG. G.C.E. Burkhardt

STRUCTURAL PLANNING ENG. M. D. Bendayan

STRUCTURAL PLANNING SUPERVISOR _____

DATE March 16, 1977

C.A.H. 404 KEY MAP
in the
REGIONAL MUNICIPALITY OF YORK
and
METROPOLITAN TORONTO

SCALE: 1 in. = 1 mile

TOWNSHIP OF
EAST
GAVILLIMBURY
(EAST GAVILLIMBURY)



STRUCTURAL PLANNING REPORT

HIGHWAY 404 CROSSING AT BEAVER CREEK
(APPROXIMATELY 0.5 MI. NORTH OF HWY. 7)

W.P. 160-74-24, SITE 37-277

DISTRICT 6, TORONTO

1. BACKGROUND AND PROPOSED WORK:

The structure under consideration was designed in 1972 as a double corrugated steel pipe-arch culvert whose length was suitable for the then proposed ultimate Hwy. 404 cross-section at above site: four basic lanes per direction divided by an 82' wide median. The Beaver Creek was assumed to cross Hwy. 404 at Sta. 307 +05.

Since it has been recently decided to construct Hwy. 404 in this area for an ultimate narrower median (50' wide) and, in addition, the original Beaver Creek realignment has been modified (it now crosses Hwy. 404 at Sta. 309+00), a new structural design is required for subject crossing. The Creek relocation, which is presently being carried out as part of Contract 76-107 (Hwy. 404 from Steeles Ave. to north of Hwy. 7) became required in order to provide for a haulage road that would permit to carry, across subject waterway, the large amount of fill material available from the Hwy. 404/Hwy. 7 excavation site.

The mentioned creek realignment has been approved by the Metropolitan Toronto and Region Conservation Authority who requires now, in view of expected urban local development, to design the structure hydrologic parameters based on the "Regional Storm".

The present report is intended to provide the information necessary to carry out the "new design" at the Beaver Creek crossing.

2. HORIZONTAL AND VERTICAL GEOMETRY:

a) Horizontal:

The Hwy. 404 is on tangent across the structure, having an azimuth equal to $349^{\circ} 52' 54''$. The centreline of the

relocated Beaver Creek is, within the structure limits, perpendicular to the Highway 404 alignment. Co-ordinated points along the Highway have been shown on drawing M-404-BC.

The chainage equation reads H.O.T. 309+00 Centreline Hwy. 404 = H.O.T. 100+00 Centreline Beaver Creek.

b.) Vertical:

Hwy. 404 is on a 2,400' V.C. (L.V.C. = 2656') defined by grades of -0.83% from the south and +0.83% towards north with the associated V.P.I. located at Sta 318+00 (El. 616.85).

The Hwy. 404 profile controls have been located at the initial median edges of pavement (top of pavement) i.e., 49' east and west of Highway centreline.

3. CROSS-SECTIONS:

The Highway 404 in this area will be built initially with only two 12' lanes per direction separated by a 98' wide median. Provision has been made on the overall design to expand the highway to four lanes each way, the future widening to be done towards the "inside".

Based on preliminary cost estimates, and bearing in mind the wide gap that will exist in the Hwy. median for an unpredictable number of years, it is the Reg. Structural Section recommendation to construct initially two separate bridges (each one able to accommodate two lanes plus 8' right and 4' left shoulders), as opposed to 220'+ long twin culverts which Centre Section will not be completely justified before the C.A.H. is widened to the full planned cross-section.

This proposal has been discussed with the Structural Office who agreed with such a concept. Should, however, the results of a more in depth study (to be done during the preliminary design stage) indicate that a culvert scheme results more economical than the twin bridge arrangement, such finding shall be communicated to the Reg. Structural Section, without delay, so that the Reg. Design Section becomes aware of the proposed revision and adjust the affected road design work accordingly.

For a bridge solution, the effective opening (measured perpendicularly to the waterway) is to be 40 ft. at elevation 609.7 (the soffit elevation is to be 617.7 or higher). Two structure alternates could be considered:

- 1) Rigid frame with a 40 ft. wide channel. In this case, as the abutments spread footings have to be constructed within the granular deposit at or below elev. 605., a dewatering scheme is required.

2) Single span structure founded on perched abutments. In such a case the channel can be reduced to a 22' width with side slopes of 2:1; the abutments can be supported on end bearing piles.

As alternate 1 would require the construction of an expensive permanent sheet pile protection scheme (to protect the bridge footings from the scourable bed material), it has been decided upon (in consultation with the Structural Office) to opt for a perched type of abutments' bridge.

More details re. foundation and hydrological requirements are given in paragraphs # 4 & #5.

Highway 404 Cross-Sections for the culvert and bridge alternatives have been shown on the attached sketch.

4. FOUNDATION SOILS:

Foundation Report W.O. 70-11102 was prepared in February, 1971 to cover the then proposed culvert crossing at Sta 307 + 05 of Hwy. 404. Recently, as mentioned before, the Beaver Creek has been realigned so as to cross Hwy. 404 some 200 ft. north of the original location.

For this reason, the Soil Mechanics Section had to conduct supplementary field work being the resultant, preliminary foundation recommendations contained in the enclosed memo dated February 14, 1977. In addition, the said Section was approached to establish the conditions under which perched type of abutments could be constructed. The following summarizes the final Soil Mechanics recommendations to be included in the pertinent foundation report due by April 27, 1977:

1. A rigid frame type of structure can be supported on spread footings, within the granular deposit, at or below elevation 605., using an allowable bearing pressure of 3 t.s.f.

As the footing excavations will extend below the ground water level, a dewatering scheme will be necessary to control the seepage and/or the hazard of "boiling" of the base. To achieve this, it is recommended to drive the sheeting to a depth below the base equal to the unbalanced hydrostatic head above this level.

2. As the piles required for the above-mentioned dewatering work must be left in place, because permanent footing protection against the scourable bed material becomes then required, it is recommended to avoid this extra expense and work by constructing twin bridges on "perched abutments". For these type of structures, footings could be constructed using the following alternatives:

- a) Timber piles #14 driven to approximately elev. 590.
(assuming an allowable load of 25 ton/pile).
 - b) 12BP74 Steel H piles driven to approximately elev. 580.
(a load of 95 ton/pile can be used in the design).
 - c) Precast square (1'x1') concrete piles driven to elev. 585+
(assuming a load of 100 ton/pile).
3. Although twin corrugated steel pipes could provide an alternate to the bridges solution, their construction (as mentioned in paragraph #3) has been found to be more expensive and less functional than the twin bridge scheme. Foundation requirements for such type of pipes are given in the enclosed memo from the Soil Mechanics Section.

Attention is called to the fact that, if circular pipes are chosen and to take full hydrological advantage of same, their invert elevation should be located 3' below creek bed.

- 4. The proposed roadway approaches will be inherently stable provided 2:1 slopes are used and the upper organic subsoil in subexcavated and replaced with properly compacted material.

5. HYDROLOGY:

Hydrology Report BW 2313 was prepared back on December 16, 1971 based on a 50 year design storm crossing the then assumed Hwy. 404 cross-section (4 lanes each way divided by a 82' wide median).

As a result of the now contemplated reduction in median width and to comply to the Metropolitan Region and Conservation Authority's request to design the crossing for a Regional Flood frequency (the catchment area under discussion is expected to become urbanized in the near future), it was required to update such a report. The revised study also considers the realignment of the creek, presently under construction.

The following summarizes the Hydrology Report BW-2313A issued on March 10, 1977, a copy of which is attached herewith.

1. Culvert type of structures to be considered include:

- a) Twin concrete box culverts - 14'x12' with headwall or flared wingwalls and 16' x 12' without headwall or wingwalls; in both cases the inlet edges should be bevelled at 45° and the centre wall should present a cutwater protection.

The invert elevation is to be located one foot below creek bed (604+ at Highway Centreline) and the gradient is to be equal to 0.0025.

NOTE: The value of 0.00188 mentioned for the gradient on the Hydrology Report was based on the elevations given on sheet 36 of the drawings prepared for Contract 76-107. Very recently, however, it was learned that the elevation given for the creek bed at Sta 97+50 should have read 605.95 instead of the value shown of 605.70. This is the reason for such a difference in the gradient value.

Details re. cutoff walls at the upstream and downstream ends channel width random rip-rap at the inlet and outlet, etc. are specified in the Hydrology Report.

- b) Twin elliptical corrugated metal pipes 22.8' x 11.7' each, with mitered ends.

Crown elevation at 615.7+ with remaining details as per a).

- c) Twin circular corrugated metal pipes, 16' diameter each. For this case, to take full advantage of the pipe capacity, place the invert 3' below creek bed (elev. 602+ at Highway Centreline). Crown elevation becomes 618+. Remaining details as per a).

2. Twin Bridges (one to serve N.B. and the other to accommodate S.B. lanes) can be designed either with closed (full depth) or perched type of abutments.

The opening required is 40' at elevation 609.7 and the invert elevation should not be less than 617.7.

Erosion protection, foundation and channel diversion are specified in the Hydrology Report. In particular, it is preferred to have the footings on piles (perched type of abutments) to avoid problems with scourable bed material.

The channel base for bridges with perched type of abutments is to be 22' wide with side slopes of 2:1

6. APPROVALS:

- As this crossing is not considered navigable, Navigable Waters Protection Act approval is not required.
- Preliminary approval for the proposed work has been obtained from the Metropolitan Toronto and Region Conservation Authority. This agency will be approached for his final approval and possible comments when the Preliminary Bridge Drawing becomes available.

7. MISCELLANEOUS:

6.

1. The road design work associated with subject water crossing is being performed by McCormick, Rankin and Associates Limited under W.P. 160-74-04.
2. The above noted Consulting Engineers also prepared the submitted Bridge Site Drawing M-404-BC, dated February 1977.
3. A roadway detour will not be necessary as Highway 404 is non existent in this area.
4. If bridges are to be constructed, 20'-0" approach slabs will be constructed at the ends of same. In addition, 3" of asphalt wearing surface should protect the structure decks.
5. In the case of constructing twin structures, single beam guide rail with channel will be installed at the Hwy. 404 "approaching situations" to both bridges. It is therefore required to provide proper anchorages at the respective four ends of the structures concrete barrier walls.
6. In addition to normal distribution within M.T.C. Preliminary Structural Drawings will be sent to the Town of Markham and Town of Richmond Hill for their information.
7. Number 37-277 should be used for the necessary structure Drawings.
8. The Regional Design Office has indicated that the Design Criteria for this project is being finalized and will be issued soon.
9. It is assumed that any utilities to be located at subject site will not interfere with the construction of the proposed structure.

PREPARED BY:

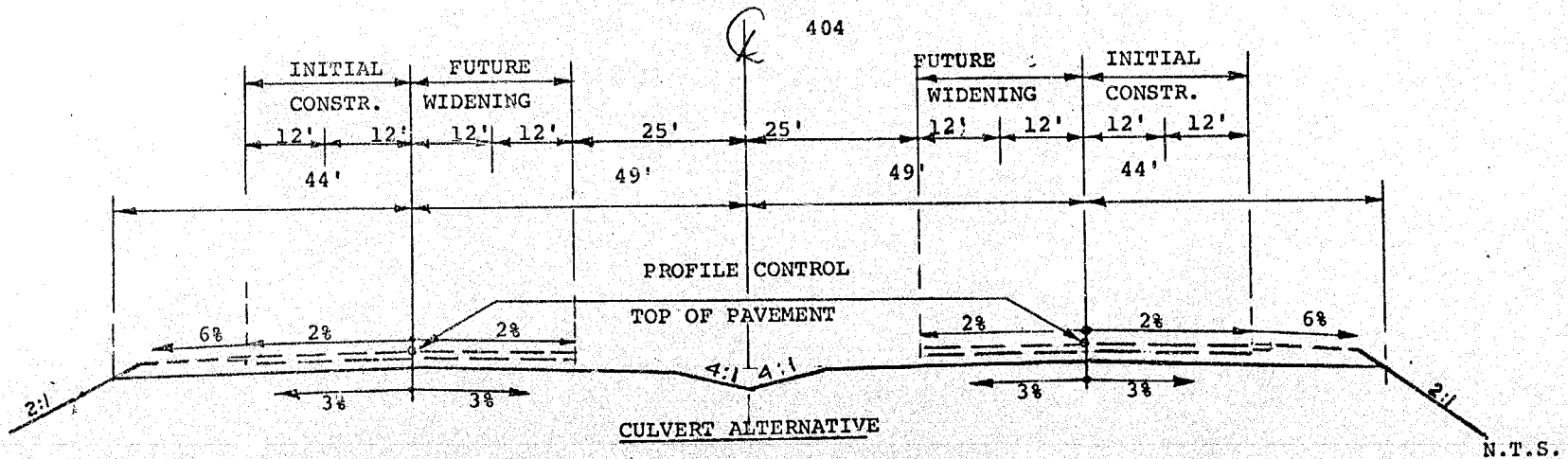
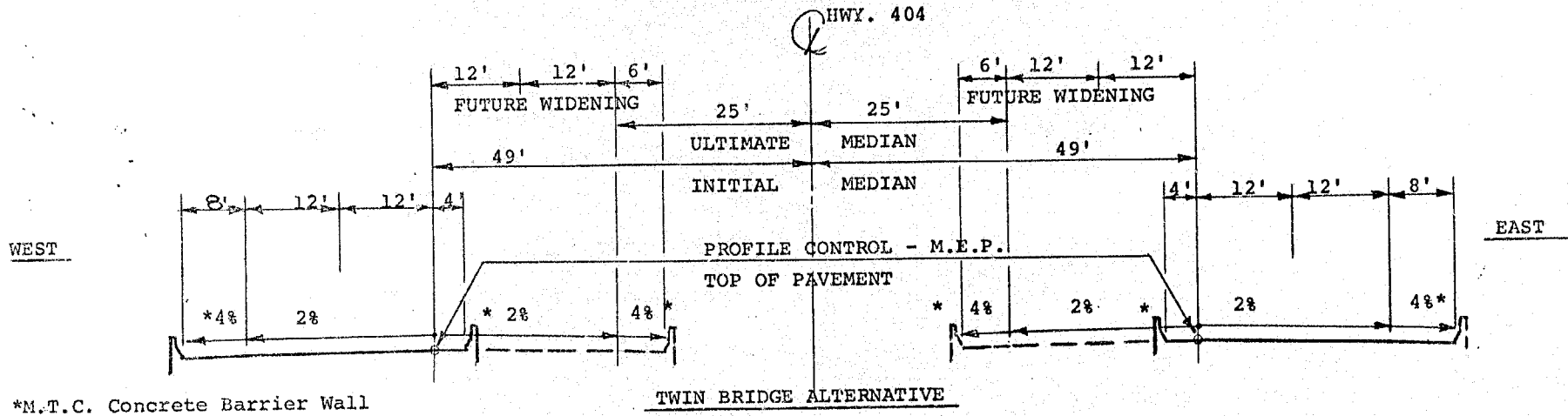
M. Boudreau
STRUCTURAL PLANNING ENGINEER

APPROVED BY:

J. J. Farrell
SENIOR STRUCTURAL PLANNING ENGINEER

HWY 404 CROSSING AT BEAVER CREEK
 WP 160-74-24, SITE 37-277
 DISTRICT NO. 6 TORONTO

STRUCTURAL SECTION
 MARCH 1977





Memorandum

To: Mr. G.C.E. Burkhardt,
Head, Structural Planning
Section, Central Region.

From: Hydrology Section

Attention: Mr. M.D. Bendayan

Date: 77 03 10

Our File Ref.

In Reply to

Subject: Re: Hwy. 404 Crossing at Beaver Creek
Site 37-277, W.P. 160-74-24
District 6, Toronto.

Revised Final Hydrology Report - BW 2313A

The final hydrology report for the above crossing was written by this Section on 1971-12-16 under BW 2313. Since then, there have been a few changes as per memorandum from your office dated 1976-12-21. The revisions include a different concept for the roadway type, realignment of the Beaver Creek diversion, re-design to Hazel centred criteria, and consideration of other alternative types of structures.

The highest known HWL is estimated to be elevation 613.3 (Hurricane Hazel, 1954) and the H.W.L. that would occur if the Regional storm were centred on Beaver Creek is estimated to be elevation 614.4. The revised recommendations which incorporate the above information are as follows.

Alternative Structure Types

A. Twin Concrete Box Culverts (strongly preferred).

Size:

- (a) Twin 14' x 12' with headwall or 30° to 60° flared wing walls, with bevelled inlet as follows.
 - (i) Top bevel: 45° with 6" sides.
 - (ii) Side bevel: 45° with 12" sides.
 - (iii) Centre wall: 45° cutwater.
- (b) Twin 16' x 12' with projecting ends (no headwall or wingwalls) but with bevelled inlet edges as specified above.

Location:

Station 309+00

Road Sag Elevation:

As shown on Contract Drawings 76-107
(no relief flow)

Invert Elevation:

One foot below creek bed on centre line,
elevation 604±.

Gradient:

.00188 ft./ft. - similar to the
proposed grade for the creek bed.

Soffit Elevation: 616±

Skew Angle: Zero

Cutoff Wall: 4' deep concrete cutoff walls, upstream and downstream; alternatively steel sheeting cutoff walls well anchored to the culvert.

Erosion Protection: Random rip-rap to elevation 616.5 minimum at the inlet and 615.5 at the outlet, on fill faces adjacent to the culverts.

B. Twin Horizontal elliptical corrugated metal pipes

Size: 22.8' x 11.7' each (mitered ends).

Crown Elevation: 615.7±

Location, Road Sag
elevation, Invert
elevation, Gradient,
Skew angle, cutoff
wall and erosion
protection: As above.

C. Twin Corrugated Metal Pipes

Size: 16' diameter each.

Invert: 3' below creek bed on centre line,
elevation 602±.

Crown Elevation: 618±

Location, Road Sag
elevation, Gradient,
Skew angle, cutoff
wall and Erosion
Protection: As above.

D. Bridges for N.B.L. and S.B.L.

Size: Clear opening 40' measured at right
angles to flow at elevation 609.7.

Soffit Elevation: 617.7 or higher.

Location, Road Sag
elevation and Skew
angle: As above.

Erosion Protection: Random rip-rap to elevation 616 on
fill faces and channel banks adjacent
to bridge, with a toe 6 feet wide and
2 feet thick.

Foundation:

Footings should be on piles, due to scourable bed material, unless sheet piles required for dewatering are left in place as permanent scour protection.

Channel Diversion:

1. The diversion should have a base width of 30 ft. for the straight portion parallel to and east of the highway, tapering to the widths specified below at the structures, and to the width of the natural channel at each end of the diversion.

Channel base width at structures:

A. Twin Box	30 ft. approximately.
B. Twin Ellipse	50 ft. "
C. Twin Pipe	35 ft. "
D.1 Bridge - closed abutment	40 ft. "
D.2 Bridge - spillthrough	22 ft. "

2. Bank protection should be provided on the outside of bends.
3. The alignment shown on sheet 36 of contract 76-107 is reasonable, although we suggest easing the bend near station 107 (channel chainage as per sheet 36).
4. The old channel should be filled to the level of the adjacent ground.

H. Shah

H. Shah,
Intermediate Hydrology Engineer.
for
J.D. Harris,
Head, Hydrology Section.

HS/rh



Memorandum

To: Mr. G.C.E. Burkhardt
Regional Structural Planning Engineer
Central Region
3501 Dufferin Street, Downsview

From: Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

Attention:

Date: February 14, 1977

Our File Ref.

In Reply to

Subject: Hwy. 404 and Beaver Creek Crossing
W.P. 160-74-24, Site 37-277
District 6, Toronto

A meeting was held in the Region on December 17, 1976 with regard to Hwy. 404 new concept from Hwy. 7 northerly to Regional Road No. 14. At this meeting it was agreed that this Section will provide preliminary foundation recommendations for the above mentioned structure by not later than February 15, 1977, taking into account the new design concepts developed since the submission of original foundation report (W.P. 37-277, dated February 9, 1971).

Based on the recent field investigations carried out by this Section, our preliminary recommendations for the new concept of the above mentioned structure are as follows:

At this site Hwy. 404 will cross the realigned Beaver Creek by means of a culvert structure.

The culvert structure for the new concept will have a total length of about 220 feet. The proposed grade of Hwy. 404 at this location will be approximately at elevation 626.0, i.e. a maximum fill height of about 15 feet. The recent subsurface investigation carried out at the new site revealed that the sub-soil consists of, on the east side, under a thin topsoil, a compact silty fine sand deposit about 24.0 feet thick underlain by very stiff to hard cohesive glacial till which was proven to extend to a depth in excess of 17.0 feet. On the west side, under about 2 feet of topsoil, a layer of loose sand or soft to firm organic clayey silt, 4.0 to 5.0 feet thick is underlain by loose to compact silty fine sand of 3.0 to 6.6 feet thick. This granular stratum is underlain by very stiff to hard cohesive glacial till which was proven to extend to a depth in excess of 15.0 feet.

The groundwater level was observed to vary between elevation 606.5 and 610.0 or 3 to 10 feet below existing ground level. The creek water level was found to be at elevation 606.0.

Two alternatives are considered for this crossing:

1. Rigid frame open structure can be supported on spread footings within the granular deposit at or below elevation 605.0. Spread footings so founded may be designed using an allowable bearing pressure of up to 3 t.s.f. In any event, a minimum of 4 feet of earth cover should be provided to the underside of the footings for frost protection purposes.

cont'd.....

The footing excavations will extend below the groundwater level. Due to the granular nature of the immediate subsoil a dewatering scheme will be necessary to control the seepage and/or the hazard of "boiling" of the base due to the unbalanced hydrostatic water pressure head. In order to prevent the "boiling" at the base of the excavation, it is recommended that the sheeting be driven to a depth below the base equal to the unbalanced hydrostatic head existing above this level.

If a structure is designed as a rigid frame, then a coefficient of earth pressure at rest (K_o) of 0.5 should be assumed for the granular material placed behind the wall when designing the wall structure. However, if some movement of the top of the wall is allowed, then a coefficient of active earth pressure (K_a) of 0.33 can be used. In all cases the design should incorporate the full effect of the surcharge located above the walls. In order to relieve the buildup of excess hydrostatic pressure behind the walls, suitable drainage measure should be provided. One way would be by placing weep holes at the base of the walls.

The foundation soil, in the immediate vicinity of the footings, should be protected against the scour action of the Beaver Creek diversion. A properly designed and placed rip-rap cover could be used for this purpose.

2. Multi-plate pile arch culvert is the second alternative.

With regard to bedding requirements, excavation for the pipe should be taken down to one foot below the invert level and should have a minimum width at this depth extending 5 feet on either side of the pipe. The bedding should be placed as follows:

- a) For the width of the area under the bottom radius of the pipe arch the bed should be levelled and left uncompacted.
- b) The area adjacent to the haunches of the pipe and under the portion of the sloping invert should be compacted by means of hand tamping.
- c) Apart from the areas mentioned above the bedding material should be machine compacted on both sides of the pipe simultaneously in equal lifts.

The fills along either approach to the structure will have a maximum height of about 15 feet. Fills of this height will be inherently stable with respect to a deep seated failure within the foundation subsoil, provided that the upper organic subsoil should be subexcavated and replaced with properly compacted material and constructed with 2:1 slopes.

cont'd.....

This Section will submit the final foundation report for the new concept by April 18, 1977.

V. Korlu
V. Korlu
Project Engineer

For: M. Devata
Supervising Engineer

VK/gs

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

Files
Record Services

XXXXXXXXXXXXXXXXXXXX

MEMORANDUM

30M14-113

Mr. G. C. E. Burkhardt, (2)
Regional Bridge Planning Engineer,
Central Region,
90 Floral Pkwy., Downsview.

FROM:

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

ATTENTION:

DATE:

October 22, 1971.

OUR FILE REF.

IN REPLY TO

NOV 1 1971

SUBJECT:

SOIL INVESTIGATION REPORT

For

A Study of the Artesian Conditions
At the Crossing of
Regional Road #14 (Gormley Rd.)
And Proposed CAH #404
District #6 (Toronto)
W.O. 71-11089 -- W.P. ~~290-61~~

SEE also 72-11-032
70-11-107

~~760-74-30~~

160-74-04

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

AGS/ao
Attach.

cc: Messrs. B. R. Davis
A. Rutka
D. W. Farren
G. K. Hunter
H. Greenland
B. J. Giroux
T. J. Kovich
G. A. Wrong
B. A. Singh

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER.

Foundations Files
Documents

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 5. DISCUSSION AND CONCLUSIONS.
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 - 5.2) Structure Over Proposed CAH #404.
 - 5.3) Section No. 1, Sewer Along Ramp S-14-W.
 - 5.4) Sections #2 and #3, North-South Sewers Discharging at Sta. 631+15 and West-east Culvert at Sta. 631+15.
 - 5.5) Sections #4 & #7, Sewers Discharging Into Box Culvert at Sta. 616+40.
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 - 5.7) Section #8, Culvert at Sta. 616+40.
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 6. MISCELLANEOUS.
-

SOIL INVESTIGATION REPORT
For
A Study of the Artesian Conditions
At the Crossing of
Regional Road #14 (Gormley Rd.)
And Proposed CAH #404, Dist. #6 (Toronto)
W.O. 71-11089 --- W.P. 290-61

1. INTRODUCTION:

A foundation investigation report for the proposed new structure at Gormley Road and future Hwy. #404 was issued by the Foundation Office in January 1971. Due to the presence of artesian water bearing strata certain restrictions on depth of excavations were recommended in the report. A proposal for the new structure was reviewed by us on July 14, 1971, which did not comply with these recommendations and this fact was pointed out to the Bridge Office and to the Consultant, McCormick, Rankin & Associates. During subsequent discussions with the latter it became evident that in order to comply with the foundation report it would be necessary to raise the grade of Hwy. 404 some 8 feet at an estimated additional cost of some \$500,000. An additional complication had also arisen due to the fact that McCormick, Rankin & Associates had been retained by the Regional Municipality of York to prepare a report on the feasibility of realigning Gormley Road. It was therefore decided to obtain additional field information in order that all aspects of the problem could be studied more precisely.

The additional field and laboratory investigation have now been completed, the results of which are compiled in this report, together with detailed discussions of the artesian conditions and conclusions as to the feasibility of construction of the bridge, culverts and sewers.

2. FIELD AND LABORATORY INVESTIGATIONS:

The field investigation consisted of some 17 sampled boreholes, and the installation of 10 piezometers. Borings were carried out by a continuous flight auger and a conventional diamond rig, adapted for soil sampling purposes. Split spoon samples were taken at regular intervals and the penetration "N" values recorded. Porous brass type (geonor) piezometers were installed at those locations where artesian waters were noted. The polyflow tubings of such piezometers were cased in E and A size drill rods and BOURDON pressure gauges installed above ground level. Upon arrival in the laboratory, soil samples were visually examined and identified. For further classifications of the soils some laboratory tests of moisture contents, Atterberg limits and grain size analyses were performed on representative samples. All the laboratory and field test results are marked on the attached borelogs as well as the observed hydrostatic conditions at the borehole locations. The equilibrium water levels were established either by piezometers or by open borings.

The locations and elevations of the boreholes are plotted on Drawing #71-11089A in the Appendix.

3. SUBSOIL CONDITIONS:

Two main deposits from the upper approx. 30-40 ft. portion of the overburden, namely, a clayey silt to silt with traces of sand and gravel and a layer of sands, silty sands and sandy silts.

The clayey silt to silt stratum appears to be a glacial deposit, having a heterogeneous grain size distribution. The material has very slight plasticity, with an average plastic limit of 13%, and liquid limit of 17%. The natural moisture contents usually lie below the plastic limits, averaging some 10%. Grain size analyses resulted in 2-14% gravel, 20-38% sand, 31-51% silt and 11-24% clay size particles within the samples tested. Penetration "N" values ranged from 22 blows per foot to much above 100 blows per ft. corresponding to very stiff to hard consistencies.

3. SUBSOIL CONDITIONS: (cont'd) ...

The sands, silty sands and sandy silts usually underlie the glacial tills and they act as aquifers, containing waters under uplift pressures. In certain locations sand and silt seams were also observed within the main body of the cohesive layer in random order. These seams appear to be connected with the underlying sands, thus artesian pressures were also noted within these seams. The relative density of the granular deposit is usually very dense, having penetration "N" values over 50 blows per foot. A few unreasonably low "N" values were attributed to the loosening effect of the artesian waters.

4. GROUNDWATER CONDITIONS:

In order to measure hydrostatic pressures, piezometers were installed in three groups at various elevations. One additional piezometer was installed in Borehole #3. Highest artesian pressure was observed in the piezometer, placed north of Regional Road #14, adjacent to Borehole #7 at elevation 835 ft. At this location and depth the pressure measured was equivalent to a head of water up to elevation 872.5, some 4.5 ft. above ground level. South of the road the highest artesian water noted was some 14 ft. above ground, at elevation 869.3 ft. This piezometer was installed in Borehole #12 at elevation 829 ft., some 24 ft. below ground level. The depth of the piezometers and the measured hydrostatic heads are plotted on the corresponding borelogs, also on the sections through the various sewers and culverts (see Drawing #71-11089A & 71-11089B). Detailed groundwater conditions are given for each proposed sewer and culvert under the following sections.

5. DISCUSSION AND CONCLUSIONS:

5.1) General:

Several sewers and culverts are proposed to be constructed in this area in conjunction with the interchange of CAH #404 and Regional Rd. #14. A new location of the underpass structure along the possible realignment of Reg. Rd. #14 is also considered.

5. DISCUSSION AND CONCLUSIONS: (cont'd) ...

W.O. 280-61

5.1) General: (cont'd) ...

Oct/71

Some discussion and comments pertaining to soil and hydrostatic conditions along a good portion of these structures were already given in our memo, dated Sept. 14, 1971. These comments will be repeated here with additional information if any. For easier reference main sewers and culverts are numbered as shown on Drawing #71-11089A and also on the soil profiles.

5.2) Structure Over Proposed CAH #404:

In this area subsoil consists of glacial and glacio-fluvial deposits. The material in these deposits consists mainly of hard clayey silt with layers and seams of silt and of sand. The sand layers are aquifers containing artesian water with a maximum pressure head to El. 870 \pm . The existing ground level in the area ranges from El. 868 to El. 858. Generally speaking the surface deposits in the vicinity of the proposed structure at both the existing and possible realigned Gormley Rd. sites consists of hard impervious clayey silt which overlies the above-mentioned aquifers. With regard to excavations, therefore, the distance of the excavation base above the aquifer determines whether or not blowouts or 'boiling' is likely to occur.

Eight borings have been carried out in this area and in six of these the water bearing strata were intersected and artesian pressures observed. The highest elevation and lowest elevations at which aquifers were first encountered in borings were El. 857 and El. 828. Here the ground levels were El. 868 and El. 860 respectively.

It can be concluded from the foregoing that the original recommendation for the structure foundations as contained in Report W.O. 70-11107 are still valid if a serious dewatering problem is to be avoided. The median ditch at El. 855 will possibly intersect an aquifer under head if constructed as shown on Drawing M 404-14 (April 13, 1971).

5. DISCUSSION AND CONCLUSIONS: (cont'd) ...

5.2) Structure Over Proposed CAH #404: (cont'd) ...

At the approximate location of the bridge along the proposed realignment of Gormley Rd. two boreholes were carried out, numbered 7 and 8. Piezometers placed near Borehole #7 registered high artesian pressures. Piezometer #10 at elevation 835.5 ft. recorded a pressure equal to a column of water up to elevation 872.5 ft. Piezometer #11 placed in a sand seam at elevation 855.5 ft. developed a hydrostatic head reaching elevation 869.5 ft. In Borehole #8 at the approximate location of the proposed east abutment the clayey silt was noticed to extend down to the end of the hole at elevation 839.2 ft. Water first appeared in the boring at elevation 841 ft. and rose to elevation 855 ft., some 5.7 ft. below ground level (see soil profile).

Tentatively, it may be concluded that footings at the west abutment should not be placed lower than elevation 859 ft. 856 and at the east abutment not lower than 855 ft., lest a "blow out" or "boiling" occur at the bottom of the excavations. For the foundation design of the bridge it will be necessary to carry out boreholes at the exact footing locations.

5.3) Section No. 1, Sewer Along Ramp S-14-W:

This sewer is proposed to run along ramp S-14-W, and as such the invert will be well above existing ground level, except along the south 100 ft. length or so. Two boreholes, numbered 9 and 11, were carried out at the proposed line. Borehole #11 at the north section revealed clayey silts down to elevation 835 ft. with a static water level at 841.5 ft. Piezometers at Borehole #9 indicated high artesian pressures from approximately 2 ft. below ground downward. The head of water was measured to reach approx. elevation 854 ft. Since subsoils at this location consisted of sandy silts and silts, vigorous boiling is anticipated in the excavations. This sewer will be discharging into the culvert at Sta. 616+40, consequently the problem can be mitigated by raising the proposed culvert to the level of the existing natural drainage.

5. DISCUSSION AND CONCLUSIONS: (cont'd) ...

5.4) Sections #2 and #3, North-south Sewers Discharging at Sta. 631+15 and West-east Culvert at Sta. 631+15.

The invert levels of the sewers running from north to south range from elevation 864 ft. to elevation 857 ft. Soil conditions as observed in Boreholes #6 and 16 revealed that the proposed sewers will be just at, or immediately above the silty sand aquifer. Groundwater in Borehole #16 was first hit at elevation 856 ft. and it rose to elevation 867 ft. The invert of the west-east sewer at Sta. 631+15 will be well within the cohesive stratum, except at the west end portion. Unstable conditions might be expected to develop at the locations, where the invert level encroaching the aquifer, consequently it is desirable to raise the inverts of these sewers at least 5 ft. from the present proposal (Drawing #71-11089 B).

5.5) Sections #4 & #7, Sewers Discharging Into Box Culvert at Sta. 616+40:

These sewers are proposed to run along CAH #404, discharging into the 8' x 6' box culvert around Sta. 616+40, from the north as well as from the south directions. The invert levels range from elevation 855 ft. to approx. elevation 840 ft. A total of six boreholes were placed along the proposed lines, and in two locations adjacent to Boreholes #7 and 12 hydrostatic conditions were measured by groups of piezometers. In both locations high uplift pressures were recorded within the water bearing layers. Artesian water was also registered by the piezometers placed within the cohesive stratum as shown on Drawing #71-11089 B. Since substantial portions of the proposed sewers will be below the level where water under pressure exists serious dewatering problems would occur during construction. An approx. 8 ft. lift of the invert elevations of these sewers will eliminate most of the problems, and will minimize the problems probably remaining near the outlets.

5. DISCUSSION AND CONCLUSIONS: (cont'd) ...

5.6) Section #5, Sewer Discharging Into North-south
Sewer at Sta. 625+00:

The invert of this sewer will range from approx. elevation 860 ft. to elevation 848 ft. and will discharge into the north-south sewer at approx. Sta. 625+00. Soil conditions, as defined by Boreholes #7 and 17 indicate that here again grave dewatering problems would occur, on account of the artesian pressures. The proposed invert elevation coincides with the boundary between the cohesive and granular layers along a large portion of the sewer. Quick conditions in the excavations could be eliminated by raising the invert some 5 ft.

5.7) Section #8, Culvert at Sta. 616+40:

The invert level of this culvert is 837.5 to 836.5. At the west end subsoil is sand from ground level downwards and no artesian pressures were encountered. The groundwater level is at ground surface. At the east end subsoil is clayey silt underlain by sand. The sand contains water under artesian pressure with a head to El. 854 (10 ft. above ground level).

A serious dewatering problem exists here and the culvert should be raised to the same level as the existing natural drainage to avoid problems.

5.8) Sections #6 & 9, Sewer Between 599+00 and 610+10
and Culvert Around Elevation 599+00:

No invert elevations were given for the proposed culvert at the existing creek near Sta. 599+00. In the two boreholes, put near the creek groundwater was encountered at 2.3 ft. below ground, rising up to approx. ground level. In order to avoid any dewatering problem it is suggested that the culvert be placed at the approx. elevation of the creek bed.

Soil stratigraphy along the long sewer, west of the proposed CAH #404 consists of a 10-15 ft. deep deposit of clayey silt (glacial till) followed by sandy silts and silty sands. The northerly half of the sewer - if it is built as proposed - will be some 10-15 ft. below the water level, and due to the susceptible nature of the sands and silts, quick conditions in the excavations will certainly occur, unless a dewatering scheme is provided for.

5. DISCUSSION AND CONCLUSIONS: (cont'd) ...

5.8) Sections #6 & 9, Sewer Between 599+00 and 610+10
and Culvert Around Elevation 599+00: (cont'd)...

Raising the invert elevation preferably above the observed equilibrium water levels (see Drawing #71-11089) will eliminate or reduce the problems.

6. MISCELLANEOUS:

The field work was carried out during the period of August 24 to Sept. 13, 1971, under the supervision of Messrs. K. Williams and W. Alcock, Student Technicians. Equipment used was owned and operated by Dominion Soil Investigation Ltd. and Master Soil Investigation.

This report was prepared by Mr. A. K. Barsvary, Senior Foundation Engineer and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

October 1971.

APPENDIX I

RECORD OF BOREHOLE No. 1

FOUNDATION SECTIC

LOCATION

Co-ords. 15,962,558 N; 1,028,760 E.

ORIGINATED BY CK

W.P. 290-61

BORING DATE

Sert. 1, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE

Washboring BX Casing

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB71-11089

W.P.290-61

DATUMGeodetic

LOCATION

Co-ords. 15,963,500 N; 1,028,839 E.

BORING DATE

Sept. 2 - 3, 1971

BOREHOLE TYPE

Washboring, NX Casing


ORIGINATED BY

CK

COMPILED BY

AKB

CHECKED BY



SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				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		SHEAR STRENGTH P.S.F.				w _p — w — w _L 10 20 30				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE							
840.5	Ground Level					840									
0.0	Clayey silt to silt, traces of gravel.		1	SS	55	830									
	Hard		2	SS	82										
827.5			3	SS	100	820									
13.0	Sandy silt becoming silty sand and sand.	4	WS												
			5	SS	130										
			6	SS	100										
			7	SS	130										
	Very Dense		8	WS											8 54 31 7
805.1			9	SS	100										
35.1	End of Borehole														

FOUNDATION SECTION

CHECKED BY

[illegible]

FOUNDATION SECTION

CHECKED BY 

[illegible]

FOUNDATION SECTION

CHECKED BY

[illegible]

FOUNDATION SECTION

JOB 71-11089

LOCATION Co-ords. 15,967,438 N; 1,028,622 E.

ORIGINATED BY CK

W.P. 290-61

BORING DATE Sept. 13, 1971

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Augering

CHECKED BY

[illegible]

FOUNDATION SECTION

ORIGINATED BY CK

COMPILED BY AKB

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 71-11089

LOCATION Co-ords. 15,966,194 N; 1,029,144 E.

ORIGINATED BY CK

W.P. 290-61

BORING DATE Sept. 9-10, 1971

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		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		SHEAR STRENGTH P.S.F.		WATER CONTENT % w_p — w — w_L				
860.7	Ground Level					860							
0.0	Silt to clayey silt with some sand and trace of gravel.		1	SS	38	▽							2 29 58 11
			2	SS	32								
			3	SS	34								
			4	SS	38								
	Hard		5	SS	36								
839.2			6	SS	67	▽							
21.5	End of Borehole					840							

FOUNDATION SECTION

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 71-11089

LOCATION Co-ords. 15,965,077 N; 1,028,853 E.

ORIGINATED BY KW

W.P. 290-61

BORING DATE August 25-26, 1971

COMPILED BY _____ AKB

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

[illegible]

FOUNDATION SECTION

ORIGINATED BY KW

COMPILED BY AKB

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 13

FOUNDATION SECTION

JOB 71. 289

LOCATION Co-ords. 15,964,892 N; 1,029,187 E.

ORIGINATED BY WA & CK

W.P. 290-61

BORING DATE Aug. 26 - Sept. 1, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Auger & Washboring BX Casing

CHECKED BY

[illegible]

ORIGINATED BY KW

COMPILED BY LAKE

CHECKED BY

[illegible]

FOUNDATION SECTION

CHECKED BY

[illegible]

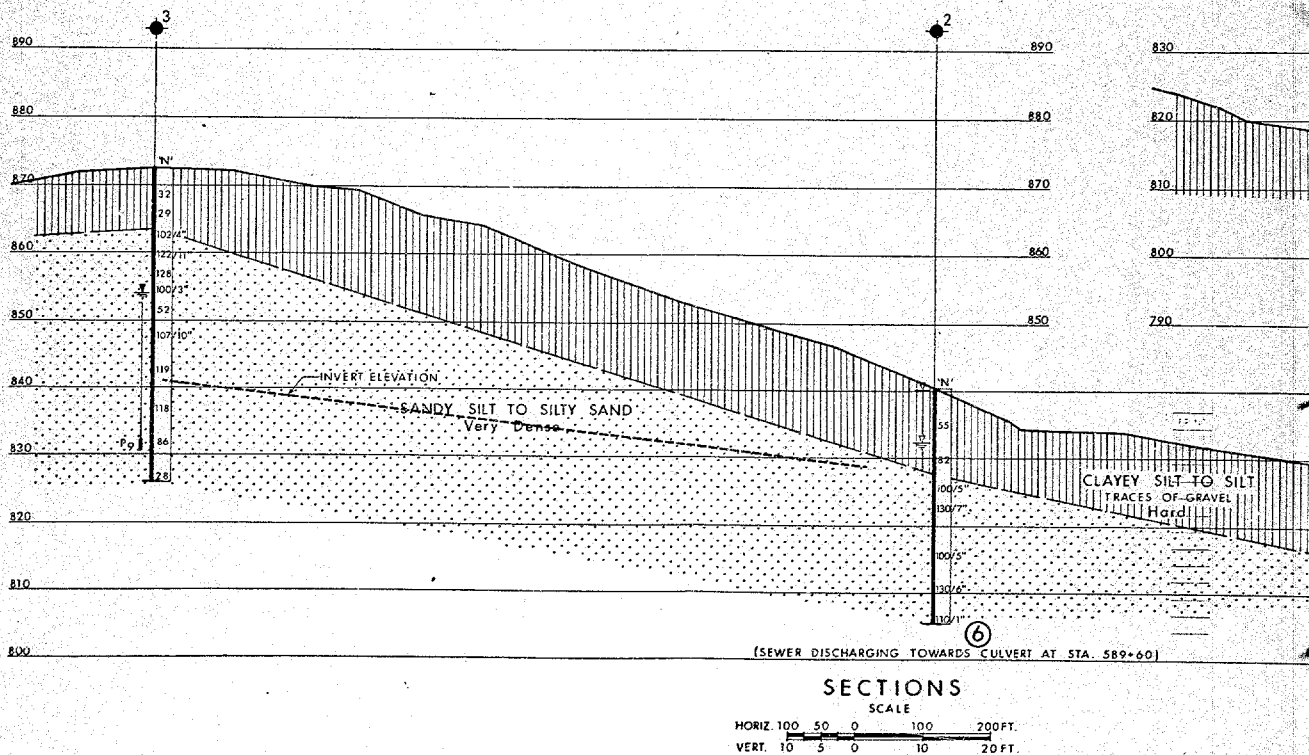
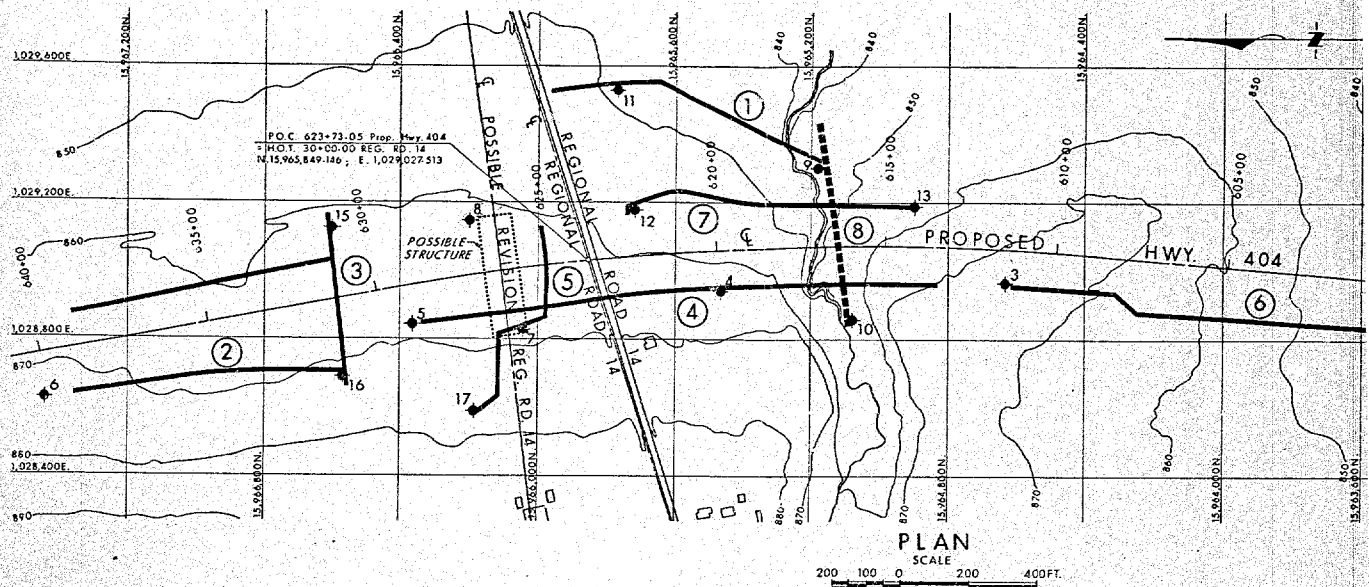
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ORIGINATED BY CK

COMPILED BY PK

CHECKED BY

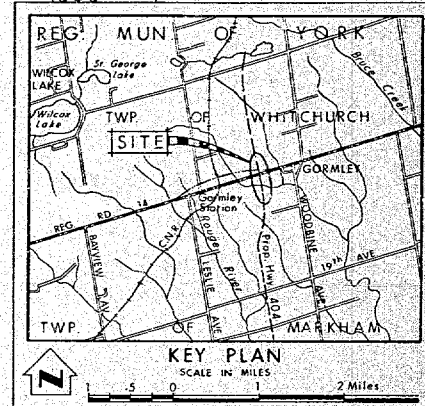
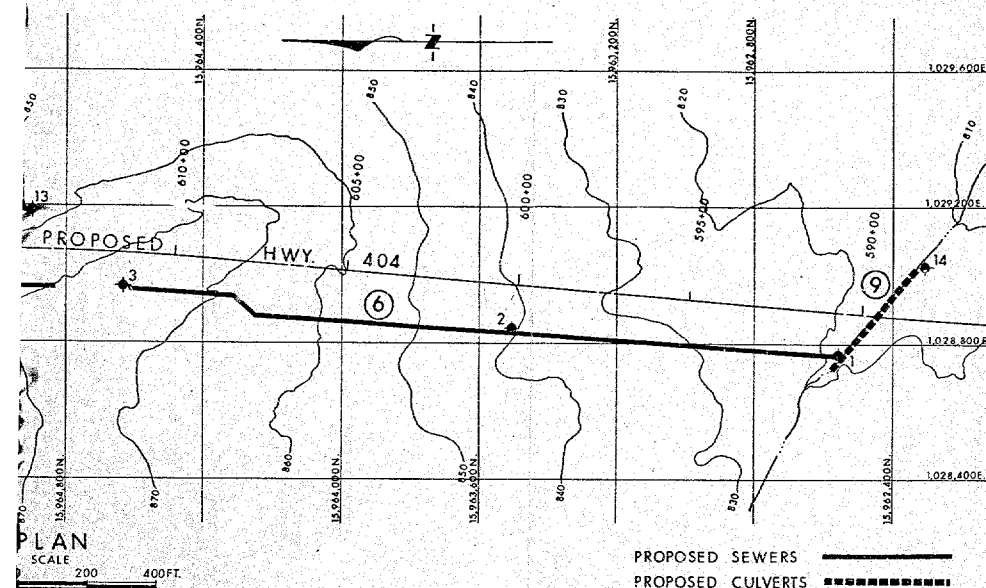
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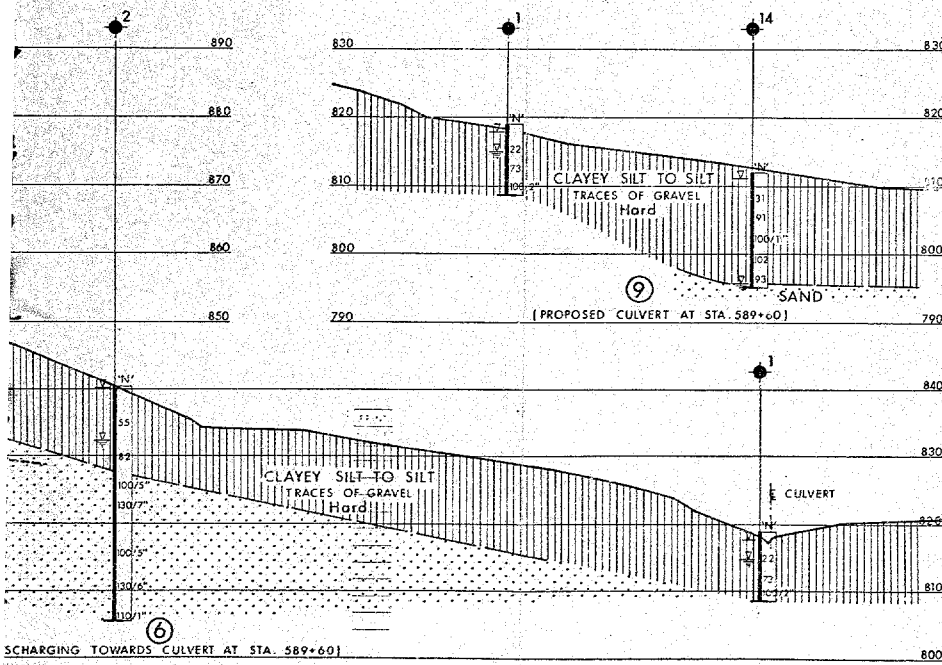
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17

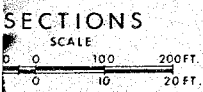
30M14



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, Aug. & Sept. 71		
	Piezometer		
	Head Encountered		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	819.0	962,558	28,760
2	840.5	963,500	28,839
3	872.5	964,628	28,961
4	863.0	965,465	28,938
5	868.5	966,362	28,842
6	873.6	967,438	28,622
7	867.9	966,042	28,824
8	860.7	966,194	29,144
9	843.8	965,175	29,301
10	853.4	965,077	28,853
11	848.4	965,767	29,532
12	855.3	965,716	29,175
13	857.2	964,892	29,187
14	812.2	962,303	29,015
15	861.1	966,595	29,125
16	871.0	966,565	28,687
17	876.0	966,182	28,585



SCARGING TOWARDS CULVERT AT STA. 589+60



SECTIONS

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

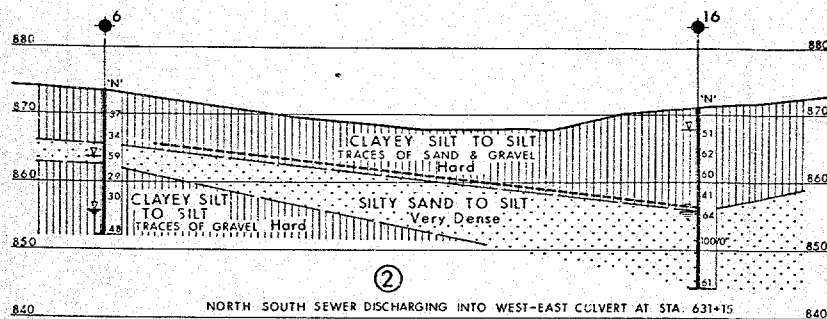
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REGIONAL ROAD 14 (GORMLEY ROAD)

HIGHWAY NO. Prop. 404 DIST. NO. 6
Regional Municipality of YORK
TWP. MARKHAM & WHITCHURCH

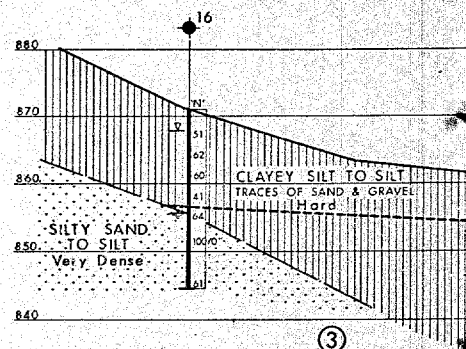
BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. A. B. CHECKED <i>g</i> W.P. NO. 290-61	DRAWING NO.
DRAWN <i>g</i> CHECKED <i>g</i> JOB NO. 71-11089	71-11089A
DATE Oct. 21, 1971 SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>g</i> CONT. NO.	

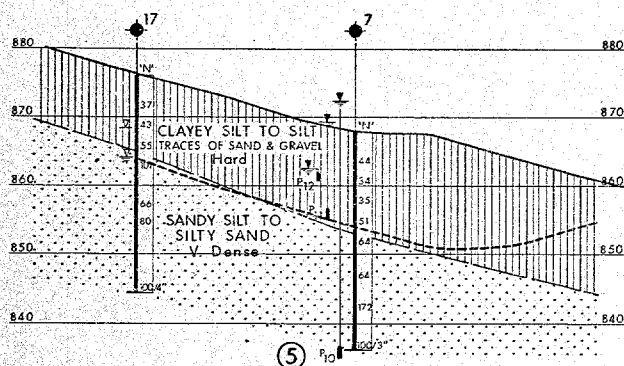
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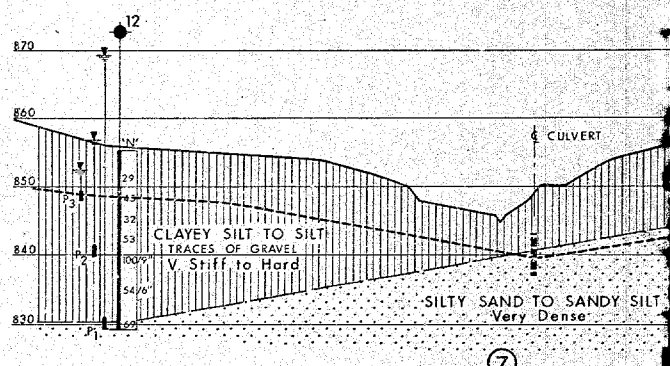
NORTH SOUTH SEWER DISCHARGING INTO WEST-EAST CULVERT AT STA. 631+15



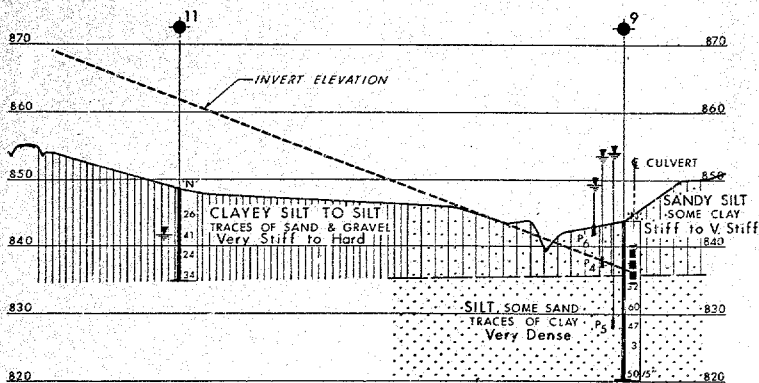
WEST EAST CULVERT DISCHARGING CREEK AT STA. 631+15



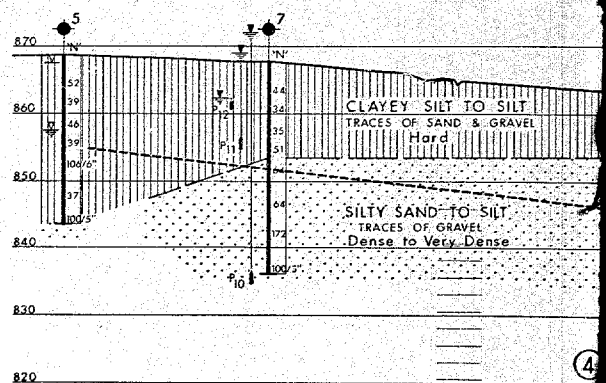
SEWER DISCHARGING INTO NORTH SOUTH SEWER AT STA. 625+00



SEWER DISCHARGING INTO CULVERT AT STA. 616+40



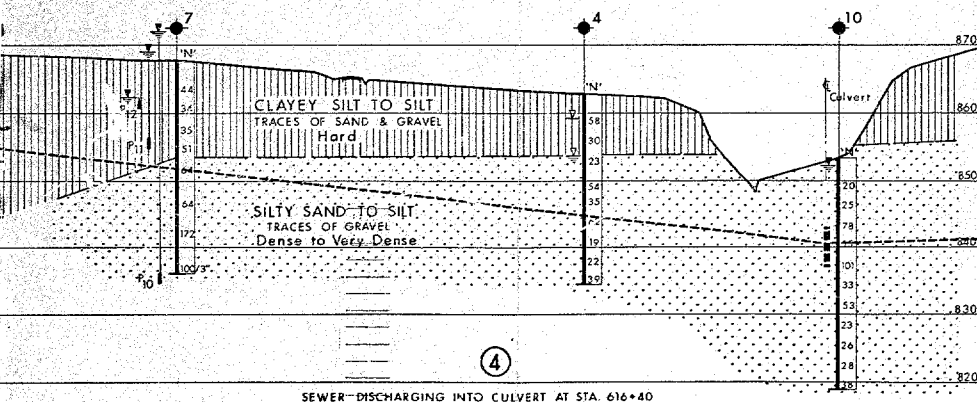
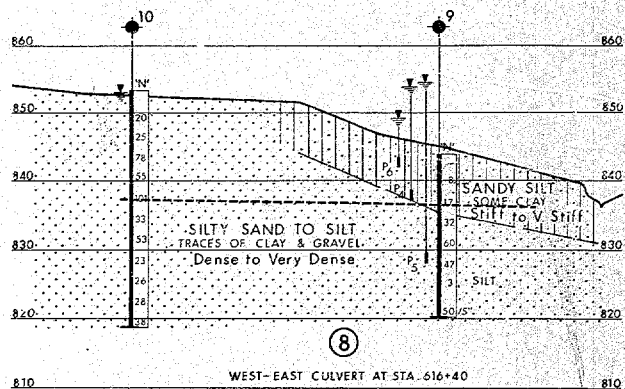
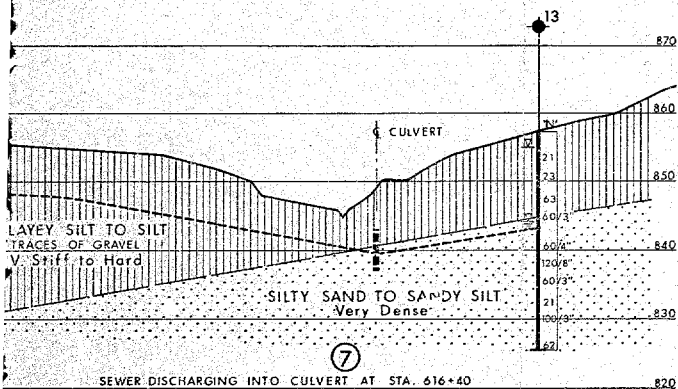
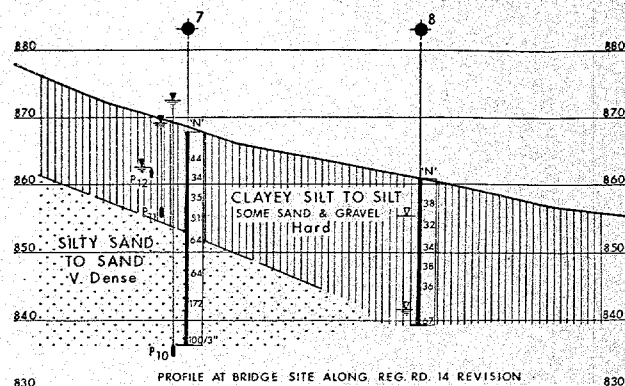
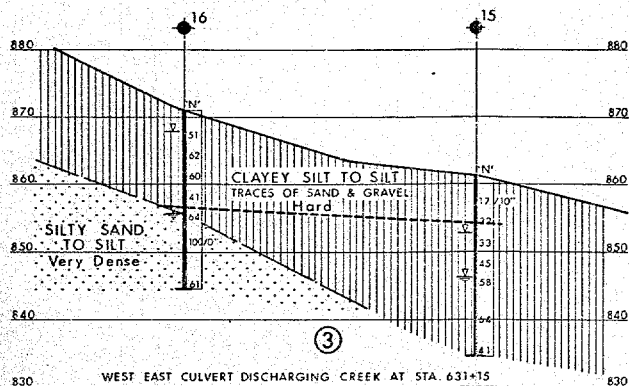
SEWER ALONG RAMP 5-14-W DISCHARGING INTO CULVERT AT STA. 616+40



SEWER DISCHARGING INTO CULVERT AT STA. 616+40

SECTIONS

SCALE
HORIZ. 100 50 0 100 200 FT.
VERT. 10 5 0 10 20 FT.



— 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.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

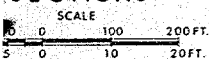
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REGIONAL ROAD 14 (GORMLEY ROAD)

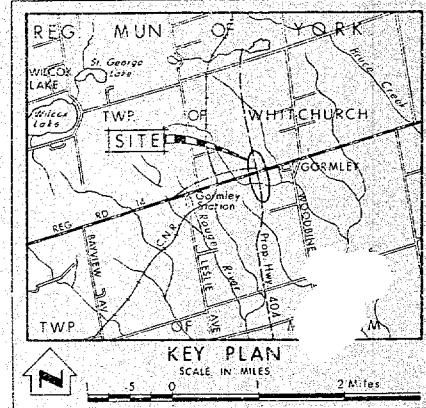
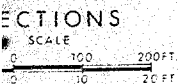
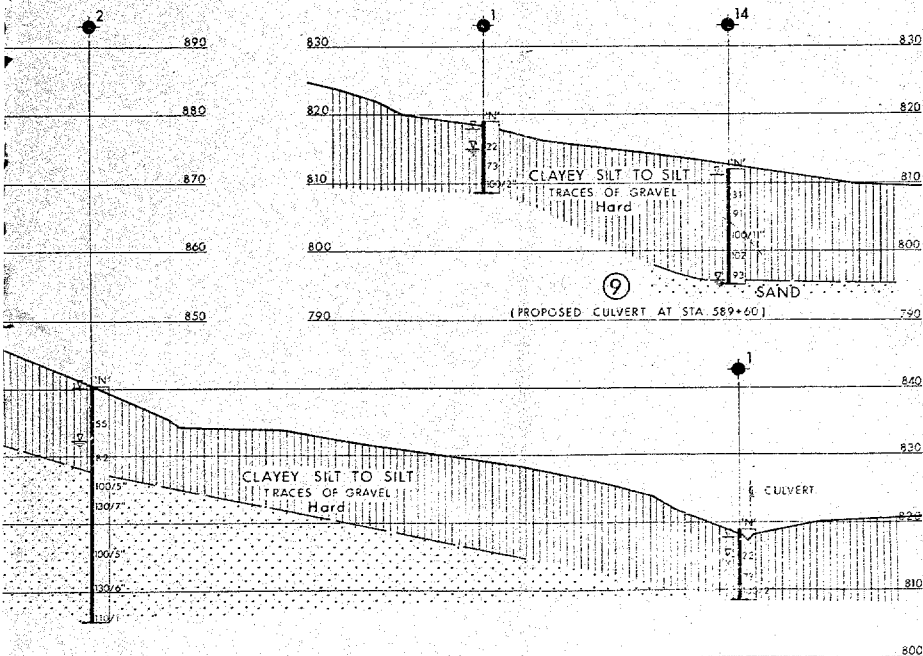
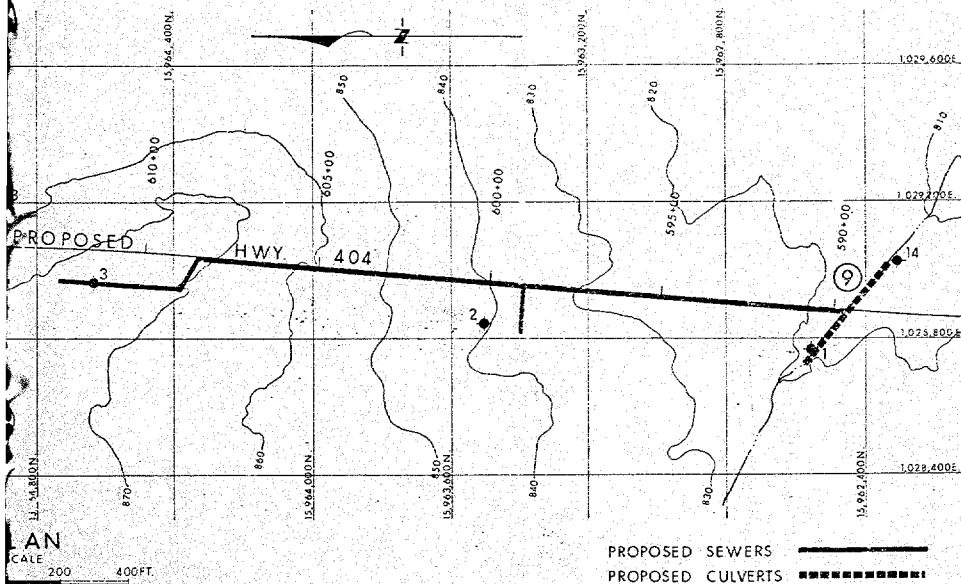
HIGHWAY NO. Prop. 404 DIST. NO. 6
Reg. Mun. of YORK
TWP. MARKHAM & WHITCHURCH

SECTIONS & SOIL STRATA

SUBMIT A 8	CHECKED	WP NO. 290-61	DRAWING NO.
DRAWN	CHECKED	JOB NO. 71-11089	71-11089B
DATE Oct. 25, 1971	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	PRINCIPAL FOUNDATION ENGINEER	CONT. NO.	

SECTIONS





LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation Aug. & Sept. 71		
	Piezometer		
	Head Artesian Encountered		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	819.0	962,558	28,760
2	840.5	963,500	28,839
3	872.5	964,628	28,961
4	863.0	965,465	28,938
5	868.5	966,362	28,852
6	873.6	967,438	28,622
7	867.9	966,042	28,824
8	860.7	966,194	29,144
9	843.8	965,175	29,301
10	853.4	965,077	28,853
11	848.4	965,767	29,532
12	855.3	965,716	29,175
13	857.2	964,892	29,187
14	812.2	962,303	29,015
15	861.1	966,595	29,125
16	871.0	966,565	28,687
17	876.0	966,182	28,585

REVISIONS	DATE	BY	DESCRIPTION
22/3/72 P.L.C.			PROPOSED SEWERS LAYOUT & CULVERT REVISED "N.R.S." Method List

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

ARTESIAN CONDITIONS STUDY

REGIONAL ROAD 14 (GORMLEY ROAD)

HIGHWAY NO. Prop. 404 DIST. NO. 6

Regional Municipality of YORK

TWP. MARKHAM & WHITCHURCH

BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT A.B. CHECKED	W.P. NO. 290-61	DRAWING NO.
DRAWN BY	CHECKED	JOB NO. 71-11089
DATE Oct. 21, 1971	SITE NO.	BROGE DRAWING NO.
APPROVED	CONT. NO.	

New W.P. 160-74-04

Mr. C.S. Grebski
Structural Engineer
Structural Office
West Building

Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

77 08 24

Hwy. 404 Crossing at Beaver Creek
W.P. 160-74-24, Site 37-277
Hwy. 404, District 6

We have reviewed the final bridge drawings for this project, and submit the following comments:

1. Pile driving should be controlled by Hiley formula and this should be shown on Dwg. 37-377-3.
2. The estimated pile lengths as shown should all be increased by 2 feet to allow for probable damages to the pile heads caused by driving.
3. Organic subsoil within the base width of the approach fills and within a distance of 50 feet behind the abutments should be subexcavated to its full depth and replaced with compacted clean earth fill material.

B. Ly
Senior Engineer

BL/kr

cc: Files ✓



Memorandum

To: File

From: G. Pearce,
Planning and Design Section,
Central Region

Attention:

Date: 1977-10-26

Our File Ref.

In Reply to

Subject: RE: Minutes of Technical Review,
W.P. 160-74-04 ✓ Hwy. 404
From Hwy. 7 Northerly to
Regional Road 14
District 6, Toronto

Date: October 24, 1977 at 9:00 A.M.

Place: Conference Room 'A' Second Floor
3501 Dufferin Street

Attendees:

J. Geo. Celmins	Planning and Design - Central Region
N.D. Smith	"
C.A. Rayman	"
D. MacDonald	Construction Office - Central Region
S. Dunham	"
B. Emo	"
M. Bendayan	Structural Section - Central Region
W. Lin	Structural Office
P. Penev	Geotechnical Office - Central Region
J. Elston	"
L. Wedgbury	Engineering Audit
B. Jones	Environmental Office - Central Region
W. Kelly	Priority Development
W. Korlu	Foundations Office
R. McCormick	McCormick, Rankin & Assoc. Ltd.
J. Cousins	"
G. Pearce	Contract Review Section

Supplementary Legend - indicate symbol for burning off bituminous pavement.

Indicate a typical section for each stockpile.

Geotechnical Office to check on the soil erodability at Rouge River and report to McCormick Rankin.

Raise sewer outlet into Rouge River 1 foot.

Profile of Rouge River required.

Sheet 27 Raise the invert of the sub-drain outlet

Sheet 33 Geotechnical Office to supply borings (Location and data) to consultant.



hak.
on

Minutes of Meeting Technical Review W.P. 160-74-04

Remove complete foundation within the limits of the new building.

Change all references to "borrow" to "excavation".

All stockpiles to be seeded.

Sheet 57 Place note - "Structure not part of this contract".
Note: "Relocate Hydro tower".

Sheet 78 Define ditch relocation outside the culvert ends.

Sheet 80 Remove hatched area and note referring to dense material.

Sheet 81 Indicate burn-off location and depth.

Sheet 90 Define ditch relocation outside the culvert ends.

Sheet 93 & 94 indicate paylines on the culvert.

Geotechnical Office to confirm types of bedding for sewers.

Sheet 153 Bell Canada to be contacted Re: Buried cable, to be salvaged by them or disposed of by contractor.

Change depth of granular to 18" on detours.

Special provision in forming the contractor of the frost subseptical soil. Indicate station to station limits.

Change culvert #11 from 421A to 421B.

Sewerpipes under 30"Ø, under the roadway should be backfilled with granular.

Detail hydro mulching and seeding and mulching on Misc. 4 sheet.

Electrical - No comment.

Beaver Creek Structures - No comment

Sixteenth Avenue - No comment

Nineteenth Avenue - Structural Office to check on items 214 and 216 and inform consultant

Regional Road #25 Structure - Structural Office to check on items 185 and 187 and inform consultant.

Remove item #79 quantity to be included in item #3

Add to "Environmental Protection" "Special provision no rip-rap to be placed in the area where piles are to be driven.

RE: Minutes of Meeting Technical Review W.P. 160-74-04

S.P. "Abandoned field tile" specify location of field tiles.

Under handlaid rip rap use 200 NA filter fabric.

Under random rip rap use 300 NA filter fabric.

S.P. Driving steel tube piles Par. 1 change 2" to 3".

Working days - 250

Contract size books - 50 Central Region Construction
Large size prints - 20 (Co. Mr. Stu Dunham)

Planning and Design contract size books - 12.

Engineering costs - \$650,000 (approx)



G. Pearce
Contract Review Officer

GP:sm

cc All Attendees
J.E. Callaghan

Meeting of
Structural Review Committee

Time: 9:00 a.m., September 28, 1977.

Place: Boardroom "B", West Building.

Attending: Messrs.

A. E. McKim	- Construction Branch
K. Luczka	- Construction Branch
K. Carter	- Regional Construction Branch
D. A. McDonald	- Regional Construction Branch
W. Lin	- Structural Office (part time)
E. C. Lane	- Structural Office
N. Zoltay	- Structural Office
M. Devata	- Soil Mechanics Section
H. Shah	- Hydrology Section (part time)
P. Roy	- Structural Maintenance Section.

Projects Reviewed.

Group W.P. 160-74-04

W.P. 160-74-24, Site 37-277,
Beaver Creek Bridge.

W.P. 160-74-21, Site 37-666,
16th Ave. O'pass.

W.P. 160-74-26, Site 37-347,
Rouge River Bridge.

W.P. 160-74-27, Site 37-278,
Regional Road #25 U'pass.

W.P. 160-74-28, Site 37-279,
Regional Road #49 U'pass,

W.P. 160-74-29, Site 37-882,
19th Ave. O'pass.

Highway 404, District 6.

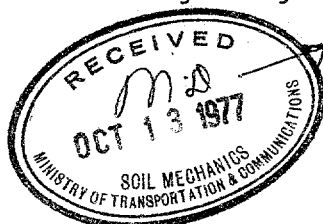
Mr. W. Lin presented the bridges pointing out the design features and related pertinent data.

The following points were put forth as noted below with recommendations where applicable.

Beaver Creek Bridge (W.P. 160-74-24)

Foundations

- (a) The driving tolerance of the piles was reviewed and the Committee recommended that the tolerance be changed to 3" instead of 2" as called for in the design.
- (b) The Designer is to ensure that the muck excavations and backfillings, - as recommended by the foundation report - are indicated on the grading drawings.



..... 2

Hydrology

Mr. Shah recommended that the rip-rap be extended throughout the creek bed in order to avoid erosion.

Structure

Drawing #1.

Clear cover on reinforcing steel in barrier wall is to be changed to read: "as noted".

Drawing #3.

Driving tolerance of piles is to be changed to 3".

Drawing #4.

- (a) Section A. In order to accommodate pile tolerances, the horizontal dimension of the pile cap in abutment is to be increased by 3" at both directions.
- (b) The Construction Branch recommended optional vertical construction joint in abutment.

The bridge is to be machine finished.

Special Provisions and D4

Special SP. Driving Steel Tube Piles.

Paragraph (1) is to be changed to read: "Section 903.09 (g) "Accuracy of Driving" - tops of the piles shall not be out of position shown on the plan more than 3 inches after driving".

Rouge River Bridge (W.P. 160-74-26)

Foundations

Same comment as for W.P. 160-74-24 paragraph (a).

Hydrology

Toe wall dimensions of the rip-rap is to be changed to 4' deep and 6' wide.

Structure

Drawing #1

Same comment as for W.P. 160-74-24, Drawing #1.

Drawing #9. - Concrete Barrier Wall.

The Committee recommends 2" cover for bar E 4002. If the 2" cover can not be achieved the bar should be galvanized in order to prevent corrosion. The Designer is to review the above with the Standards Engineer (Mr. McCune).

The bridge is to be machine finished.

Special Provisions and D4

Same comment as for W.P. 160-74-24.

16th Avenue Overpass (W.P. 160-74-25)

Foundations

The piling requirements may be revised in accordance with the result of the pile load test.

Structure

Drawing #1.

Same comment as for W.P. 160-74-24, Drawing #1.

Drawing #4.

The two bearings at each end of a box girder present construction problems. The Designer is to review the feasibility of having one bearing.

Drawing #5.

Sketch of Typical Expansion Joint is to be changed to comply with the latest Ministry standard.

The bridge is to be machine finished.

Special Provisions and D4

Special SP - Steel Barrier Rails.

SP is to be changed to read:

MTC Form 908 is amended as follows:

- (a) Section 908.04 "Measurement for payment" is deleted.
- (b) Section 908.05 "Basis of Payment" is amended in that the words "unit price per linear foot".....
... shall read..... "contract price"..... .

17th Avenue Underpass (W.P. 160-74-27)

Foundations

The Regional Planning and Design Office should review the sequence of construction as it is desirable to complete the grading excavation prior to structure excavation, otherwise the Contractor's attention is to be called into the fact that if he completes the structure excavation prior to grading excavation he may encounter water problems.

Structure

Drawing #1.

Same comment as for W.P. 160-74-24, Drawing #1.

Drawing #3.

Vertical gap in abutment is to be clarified.

Drawing #5.

- (a) The Designer is to review the geometric of the granular material under structure to ensure that it is consistent for other structures in this project.
- (b) Expansion joint between abutment and retaining wall is to be shown.

Drawing #8.

Note for stressing sequence is to be changed so that all ducts are grouted after longitudinal stressing is completed.

Drawing #9.

- (a) The S curve of cables A and P is to be changed to straight slope.
- (b) Note is to be added for a request of jacking.

Designer is to review and if necessary update standards. Expansion joint standard is to be added.

The deck is to be machine finished.

Special Provisions and D4

No comments.

18th Avenue Underpass (W.P. 160-74-28)

Foundations

Due to the boiling condition of soil the contractor will encounter unwatering problems during pier excavation.

Structure

Drawing #1.

Same comment as for W.P. 160-74-23, Drawing #1.

Drawing #8.

Same comment as for W.P. 160-74-27, Drawing 8.

The deck is to be machine finished.

Special Provisions and D4

- (a) The Construction Branch is requested to provide tender item for unwatering foundations.
- (b) The following items are to be added to the list of Material supplied by MTC.

"Materials for Telephone Ducts as follows:
(from Bell Canada)

Ducts
Wobble joints
Plastic Caps
Pull rope
Duct seal
Epoxy impregnated tape.

19th Avenue Underpass (W.P. 160-74-29)

Foundations

The design complies with the recommendations of the foundation report.

Structure

Drawing #1

Same comment as for W.P. 160-74-24, Drawing #1.

Drawing #3.

Same comment as for W.P. 160-74-27, Drawing #5, paragraph (a).

Drawing #9.

Same comment as for W.P. 160-74-27, Drawing #8.

The deck is to be machine finished.

Special Provision and D4.

No comments.



NZ/im

N. Zoltay,
Structural Contract
Specifications Engineer.

c.c. All present
J. B. Wilkes
R. A. Dorton
C. S. Grebski
K. G. Bassi
E. Van Beilen
M. R. Erenesaks
D. E. Thrasher
W. McFarlane



Memorandum

To: Mr. G.C.E. Burkhardt
Regional Structural Planning Engineer
Central Region

From: Soil Mechanics Section
West Bldg.
Downsview

Attention:

Date: 77 05 12

Our File Ref.

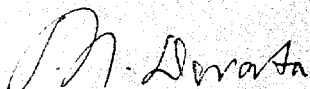
In Reply to

Subject:

Subsurface Investigation Report
For

Study of the Artesian Conditions
At the vicinity of Regional Road #14
(Gormley Rd.) and Hwy. 404
Dist. #6 (Toronto), W.P. 160-74-04
(Formerly W.P. 290-61)

This section carried out a detailed study of the artesian conditions at the above mentioned location. The factual data and recommendations were submitted in a report dated Nov. 1, 1971 under W.P. 290-61, W.O. 71-11089. The W.P. 290-61 is now changed to new W.P. 160-74-04. Our report is still valid for the new concept of Hwy. 404 and therefore request you to make the necessary corrections with regard to W.P. number on your copy submitted to you dated Nov. 1, 1971.


M. Devata
Supervising Engineer

MD/bp

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher
C.S. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar
R. Hore
R. Fitzgibbon
J. Anderson
G. Sloan

Files
Record Services



Memorandum

To: Mr. G.C.E. Burkhardt
Regional Structural Planning Engineer
Central Region
3501 Dufferin Street, Downsview

From: Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

Attention:

Date: February 14, 1977

Our File Ref.

In Reply to

Subject: Hwy. 404 and Beaver Creek Crossing
W.P. 160-74-24, Site 37-277
District 6, Toronto

A meeting was held in the Region on December 17, 1976 with regard to Hwy. 404 new concept from Hwy. 7 northerly to Regional Road No. 14. At this meeting it was agreed that this Section will provide preliminary foundation recommendations for the above mentioned structure by not later than February 15, 1977, taking into account the new design concepts developed since the submission of original foundation report (W.P. 37-277, dated February 9, 1971).

Based on the recent field investigations carried out by this Section, our preliminary recommendations for the new concept of the above mentioned structure are as follows:

At this site Hwy. 404 will cross the realigned Beaver Creek by means of a culvert structure.

The culvert structure for the new concept will have a total length of about 220 feet. The proposed grade of Hwy. 404 at this location will be approximately at elevation 626.0, i.e. a maximum fill height of about 15 feet. The recent subsurface investigation carried out at the new site revealed that the sub-soil consists of, on the east side, under a thin topsoil, a compact silty fine sand deposit about 24.0 feet thick underlain by very stiff to hard cohesive glacial till which was proven to extend to a depth in excess of 17.0 feet. On the west side, under about 2 feet of topsoil, a layer of loose sand or soft to firm organic clayey silt, 4.0 to 5.0 feet thick is underlain by loose to compact silty fine sand of 3.0 to 6.6 feet thick. This granular stratum is underlain by very stiff to hard cohesive glacial till which was proven to extend to a depth in excess of 15.0 feet.

The groundwater level was observed to vary between elevation 606.5 and 610.0 or 3 to 10 feet below existing ground level. The creek water level was found to be at elevation 606.0.

Two alternatives are considered for this crossing:

1. Rigid frame open structure can be supported on spread footings within the granular deposit at or below elevation 605.0. Spread footings so founded may be designed using an allowable bearing pressure of up to 3 t.s.f. In any event, a minimum of 4 feet of earth cover should be provided to the underside of the footings for frost protection purposes.

cont'd.....

The footing excavations will extend below the groundwater level. Due to the granular nature of the immediate subsoil a dewatering scheme will be necessary to control the seepage and/or the hazard of "boiling" of the base due to the unbalanced hydrostatic water pressure head. In order to prevent the "boiling" at the base of the excavation, it is recommended that the sheeting be driven to a depth below the base equal to the unbalanced hydrostatic head existing above this level.

If a structure is designed as a rigid frame, then a coefficient of earth pressure at rest (K_o) of 0.5 should be assumed for the granular material placed behind the wall when designing the wall structure. However, if some movement of the top of the wall is allowed, then a coefficient of active earth pressure (K_a) of 0.33 can be used. In all cases the design should incorporate the full effect of the surcharge located above the walls. In order to relieve the buildup of excess hydrostatic pressure behind the walls, suitable drainage measure should be provided. One way would be by placing weep holes at the base of the walls.

The foundation soil, in the immediate vicinity of the footings, should be protected against the scour action of the Beaver Creek diversion. A properly designed and placed rip-rap cover could be used for this purpose.

2. Multi-plate pile arch culvert is the second alternative.

With regard to bedding requirements, excavation for the pipe should be taken down to one foot below the invert level and should have a minimum width at this depth extending 5 feet on either side of the pipe. The bedding should be placed as follows:

- a) For the width of the area under the bottom radius of the pipe arch the bed should be levelled and left uncompacted.
- b) The area adjacent to the haunches of the pipe and under the portion of the sloping invert should be compacted by means of hand tamping.
- c) Apart from the areas mentioned above the bedding material should be machine compacted on both sides of the pipe simultaneously in equal lifts.

The fills along either approach to the structure will have a maximum height of about 15 feet. Fills of this height will be inherently stable with respect to a deep seated failure within the foundation subsoil, provided that the upper organic subsoil should be subexcavated and replaced with properly compacted material and constructed with 2:1 slopes.

cont'd.....

This Section will submit the final foundation report for the new concept by April 18, 1977.

V. Korlu
V. Korlu
Project Engineer

For: M. Devata
Supervising Engineer

VK/gs

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

Files ✓
Record Services



Memorandum

To: Mr. C. Mirza
Head, Soil Mechanics Section
West Building

From: C.F. Farrell
Structural Planning Office
3501 Dufferin Street

Attention: Mr. M. Devata

Date: December 23rd, 1976

Our File Ref.

In Reply to

Subject: HWY. 404 FROM HWY. 7 N'LY
TO REG. ROAD 14
W.P. 160-74-04
DISTRICT 6, TORONTO :

The undersigned met on December 14, 1976 with Mr. M. Devata to brief him on the revised concept of subject project, namely the reduction of the ultimate Hwy. 404 median width from the original 82' to the now accepted 50' dimension. This results basically in moving the bridge abutments closer to the Hwy. centreline with the piers remaining at the centre of same.

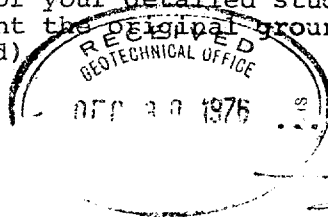
The following summarizes the major points discussed:

1. The seven major structures that fall within above stretch of Hwy. 404 are, in a south to north sequence;

	W.P.	Site
Beaver Creek Crossing	160-74-24	37-277
Hwy 404 O'Pass at 16th Ave	160-74-25	37-666
Rouge River Crossing	160-74-26	37-347
Hwy 404 U'Pass at Reg. Road 25	160-74-27	37-278
Hwy 404 U'Pass at 18th Ave	160-74-28	37-279
Hwy 404 U'Pass at 19th Ave	160-74-29	37-882
Hwy 404 U'Pass at Reg. Road 14	160-74-30	37-280

These W.P.'s are as per the Design Criteria dated November 1976 and supersede the ones used in the previous design.

2. Very small changes, if any, will be made in the basic profile of Hwy. 404 and only minor ones may take place at the crossing roads. Chainages at the different intersections remain unaltered except at the Beaver Creek Crossing (which will be relocated some 200 ft. n'ly, under contract 76-107 to be awarded next month). For this reason updated alignment, contour and profile drawings (as extracted from the respective Contract Book) are herewith enclosed to cover the realignment of the Beaver Creek. A plan view of this site at a scale of 1" = 40' is also attached for your detailed study (the contour lines shown represent the original ground when contract 76-107 is completed)



3. It was accepted the idea of providing you with available preliminary plans (containing contour lines at a 1" = 200' scale) as well as profiles of the different structure sites by December 30, 1976.

On the plan drawing, sketches have been stuck on at each Hwy. 404 crossing depicting the particular bridge arrangement (s) (including possible future deck expansions).

4. It was understood that, due to the new design concepts developed since the preparation of the original foundation reports, plus the fact that the location drawings have to be updated, it would be desirable to issue new ones.
5. The extent of possible field work would be left up to your office and will depend on the feasibility of using available data to the new designs.
6. Due to possible revision to the structural types (twin structural plate pipe - arches) used in 1971 at both river crossings, your recommendations should cover the three alternate designs suggested on the attached 1" = 200' scale drawing. In particular it would be convenient to know if forward slopes of 1.5:1 can be used under the bridge alternatives.
7. Due to urgent nature of this project and in order not to delay the structural design, it was emphasized the need to obtain preliminary foundation recommendations as soon as possible, although the final reports could be issued during the preparation of the Preliminary Bridge Drawings. This idea was discussed further at the Presentation Meeting held on December 17, 1976 and it was then the consensus to extend such dates after the Preliminary Bridge Drawing has been issued. On the other hand, and to assist the revised Hydrology Studies of the Beaver Creek and Rouge River it was agreed to give priority to these crossings. The date of February 15, 1977 has been set for the Preliminary Foundation recommendations re. these two crossings. The dates set for the other five structures are contained in the overall Pre-Engineering Program forwarded to your office by Mr. R. Fitzgibbon, Regional Co-Ordinator.

We will be glad to provide additional information or assistance during your revised study, should it be required.

M.D. Bendayan

c.c. R.D. Gunter
N.D. Smith
R. Fitzgibbon
J. Anderson
Z. Byblow

M.D. Bendayan
STRUCTURAL PLANNING ENGINEER
for:
C.F. Farrell
ACT.REG.STRUCTURAL PLANNING
ENGINEER

DATE _____

GEOCKES No. 3-4-51

DIST 6 REGION CENTRAL

W.P. No. 14-21

CONT. No. 7-41

W.O. No. _____

STR. SITE No. 3-27

HWT. No. 4-4

LOCATION DEANER CREEK BRIDGE

Contract between No. 12 PERCENT AND ONE PERCENT 3

REMARKS _____

30M14-53

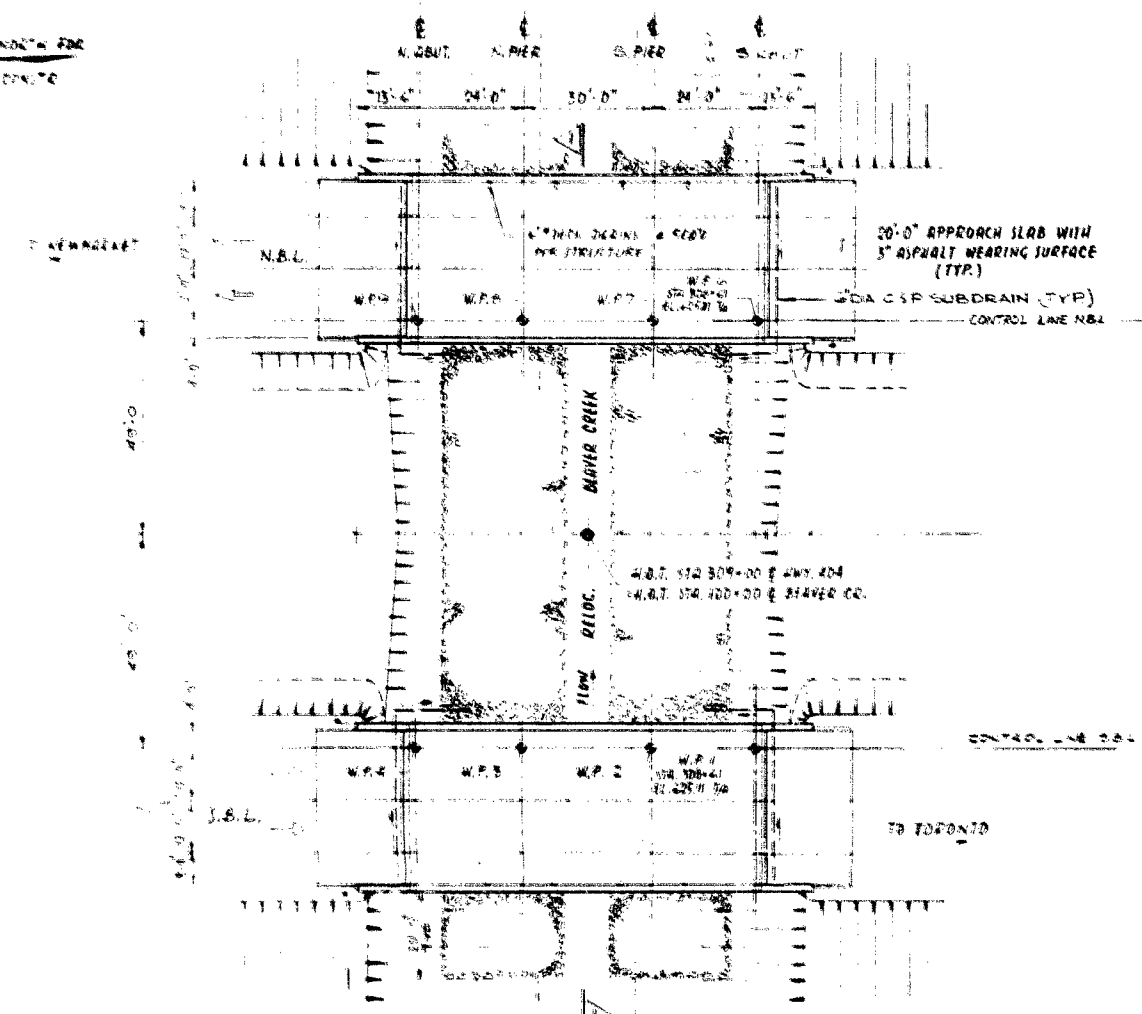
DIST. 6		
CONT No		
WP No 160-74-24		SHEET
HWY 404 CROSSING AT BEAVER CREEK		
GENERAL LAYOUT		
McCORMICK, RANKIN & ASSOCIATES LIMITED consulting engineers		

MARKHAM TWP B.M. M-50.
ELEV 644.751

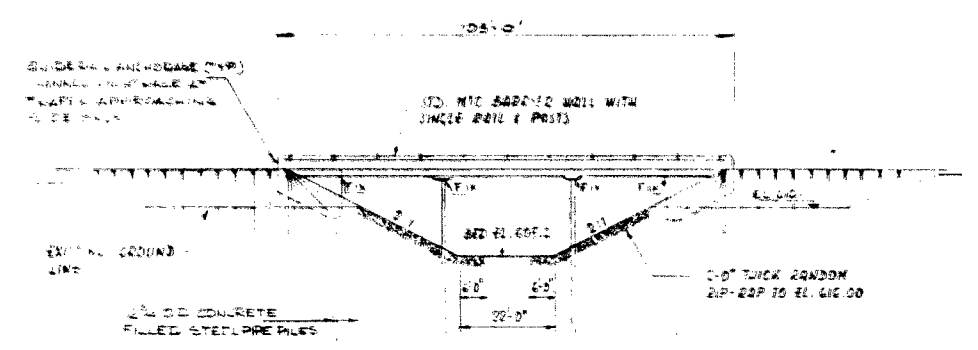
TWO STOREY WHITE BRICK BUILDING (MARKHAM TOWNSHIP OFFICE) ON EAST SIDE OF DON MILLS RD. TABLE IS SET HORIZONTALLY (BY MARKHAM TWP) IN WEST FACE OF CONCRETE PILLAR AT SOUTH-WEST CORNER OF BUILDING, BEING 0.8 FEET NORTH OF SOUTH-WEST CORNER OF PILLAR AND 2.7 FEET ABOVE PAVEMENT.

NOTES:

- W.P. DENOTES WORKING POINT
- T/A DENOTES TOP OF ASPHALT WEARING SURFACE.



PLAN
SCALE: 1" = 20'



ELEVATION
SCALE: 1" = 20'

CONCRETE QUANTITIES

(FOR LUMP SUM CONCRETE TENDER ITEMS)

	N.B. STRUCT	S.B. STRUCT
1. CONCRETE IN ABUTMENTS & WINGWALLS	70 C.Y.	70 C.Y.
2. CONCRETE IN DECK	162 C.Y.	162 C.Y.
3. CONCRETE IN BARRIER WALLS	16 C.Y.	16 C.Y.
4. CONCRETE IN APPROACH SLABS	46 C.Y.	46 C.Y.

GENERAL NOTES

CLASS OF CONCRETE	
DECK AND BARRIER WALLS	4,000 P.S.I.
REMAINDER	3,000 P.S.I.

CLEAR COVER ON REINFORCING STEEL

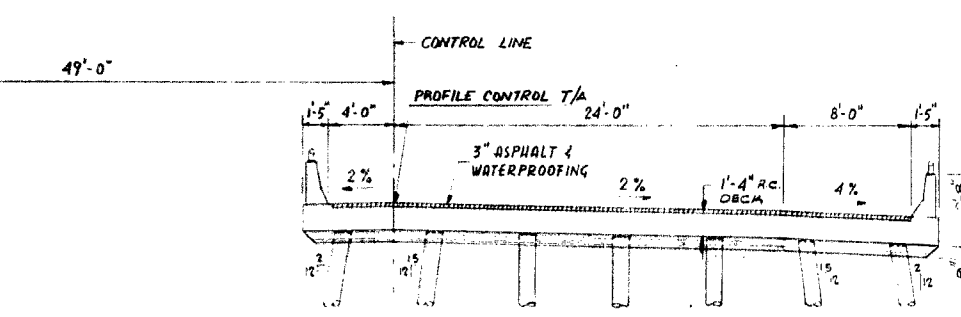
DECK	(TOP) 2"
	(BOTTOM) 1 1/2"
BARRIER WALLS	1 1/2"
APPROACH SLABS	2"
REMAINDER	3"

REINFORCING STEEL SHALL BE C.S.A.G.30 SERIES GRADE 60

NOTE: TO ACHIEVE THE MIN. CLEAR COVER OF 2" SPECIFIED THE TOP LAYER OF DECK, RE-BARS SHALL BE PLACED PRIOR TO CONCRETING, WITH A CLEAR COVER OF 2 1/2" ± 1/2" TOLERANCE.

LIST OF DRAWINGS

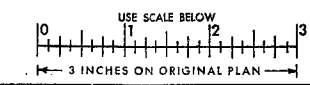
1. GENERAL LAYOUT.
2. BOREHOLE LOCATIONS & SOIL STRATA.
3. FOUNDATION LAYOUT.
4. ABUTMENTS
5. DECK.
6. APPROACH SLABS.
7. CONCRETE BARRIER WALLS.
8. STEEL RAILING.
9. AS CONSTRUCTED ELEV. & DIMENSIONS
10. STANDARDS.
11. STANDARDS



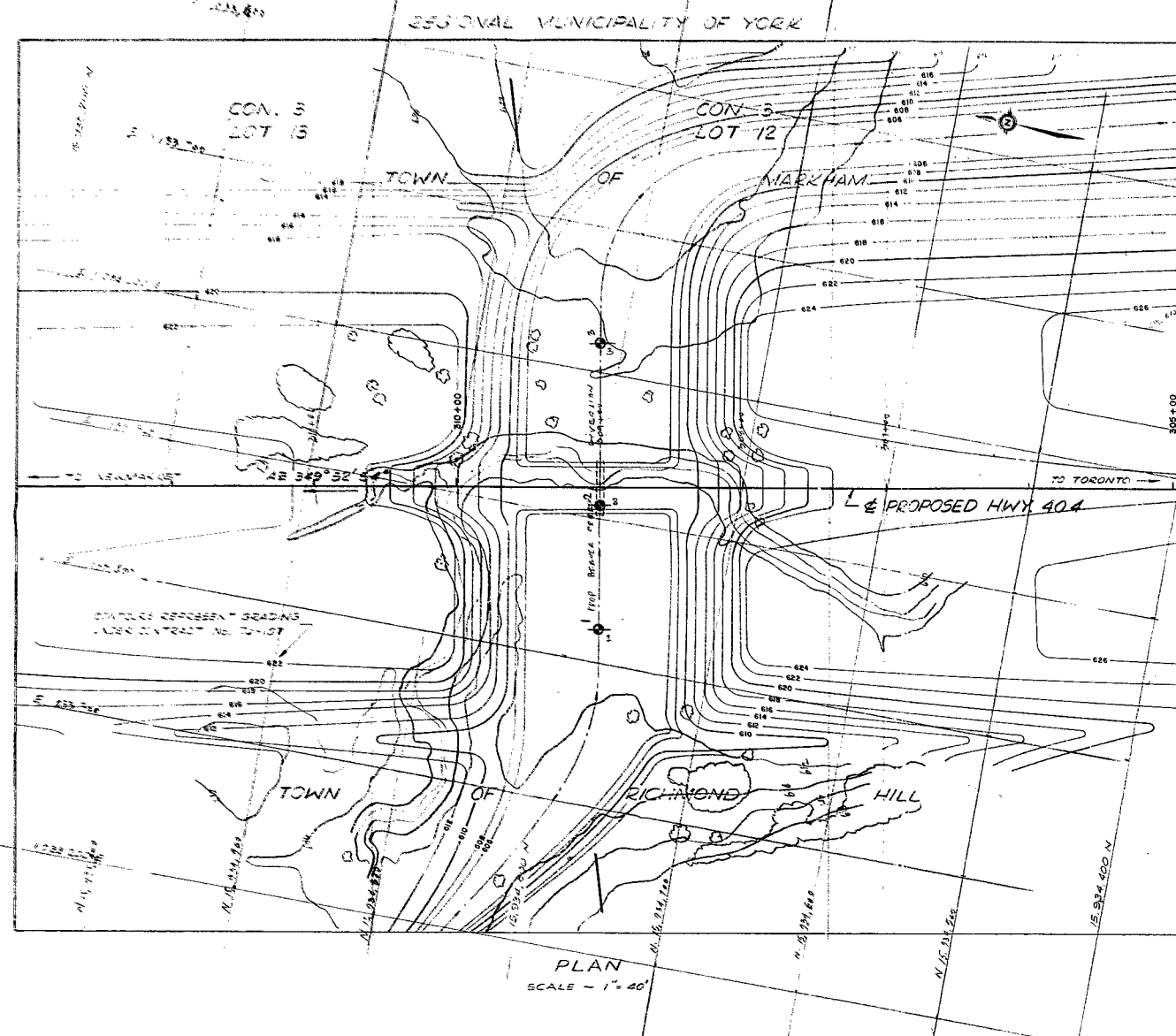
PROFILE OF HWY. 404
N.T.S.



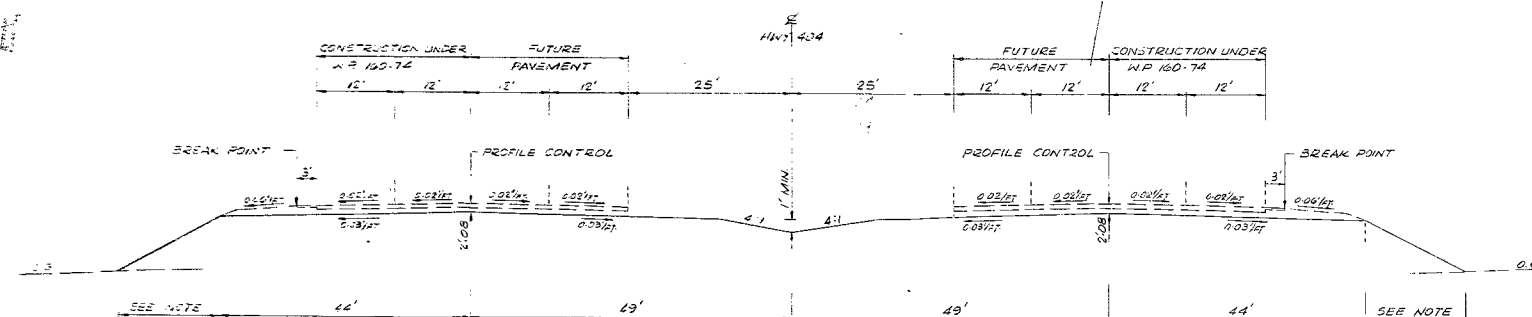
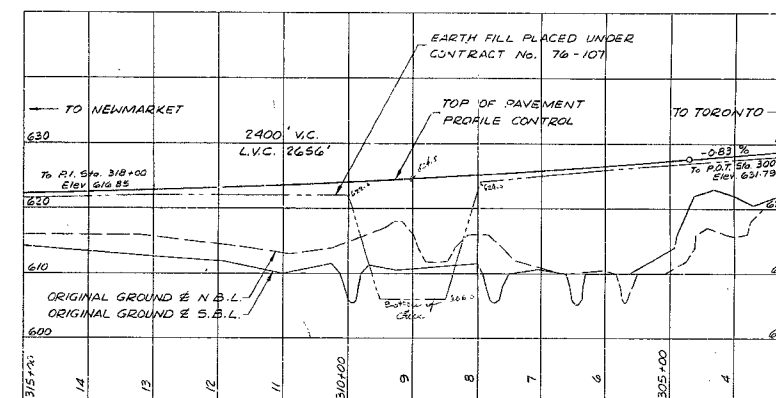
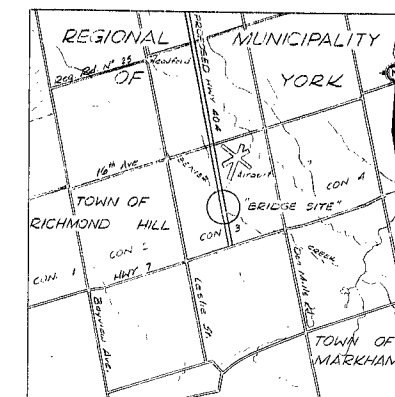
FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION
DESIGN R.S.	CHECK J.W.T.	LOADING HS.20-44	DATE JUNE/77
DRAWING W.C.D.	CHECK J.W.T.	SITE No 37-277	DWG. I.



CO-ORDINATES		
POINT	NORTH	EAST
STA. 305+00 & 404	934,404.53	1,033,591.81
" 309+00 "	934,798.31	1,033,521.54
" 313+00 "	935,192.09	1,033,451.27



NOTE -
SLOPES - 1:1 OR LESS, 4:1
6' TO 12' VAR. (Maintain Top of Slope 24")
12' OR GREATER, 2:1

MARKHAM TWP. B.M. M-50
ELEV. 644.751

TWO STOREY WHITE BRICK BUILDING (MARKHAM TOWNSHIP OFFICE) ON EAST SIDE OF DON MILLS RD. (REG. RD. #8) IN THE HAMLET OF BUTTONTVILLE, BEING 0.45 MILES NORTH OF JCT. OF HWY. #7 AND DON MILLS RD. (REG. RD. #8), 0.5 MILES SOUTH OF 16th AVENUE AND 103 FEET EAST OF CENTERLINE OF DON MILLS RD. (REG. RD. #8). TABLET IS SET HORIZONTALLY (BY MARKHAM TWP.) IN WEST FACE OF CONCRETE PILLAR AT SOUTH-WEST CORNER OF BUILDING, BEING 08 FEET NORTH OF SOUTH-WEST CORNER OF PILLAR AND 27 FEET ABOVE PAVEMENT.

30414-53 W.P. 160-74-24

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

BRIDGE SITE

PROPOSED HWY. 404
AT
BEAVER CREEK

CON. 3 LOT 12 TOWN OF MARKHAM REGIONAL MUNICIPALITY OF YORK

SCALE DATE DWG NO.

AS SHOWN FEB. 1977 M-404-BC

MCCORMICK, RANKIN & ASSOCIATES
LIMITED
CONSULTING ENGINEERS
MISSISSAUGA OTTAWA

