

DOCUMENT MICROFILMING IDENTIFICATION

G.I-30 SEPT. 1976

GEOCRES No. 3195-77

DIST. 9 REGION EASTERN

W.P. No. 433-64-02

CONT. No. 74-151

W. O. No. 71-11077

STR. SITE No. \_\_\_\_\_

HWY. No. 417

LOCATION CREEK CROSSINGS

HWY 417 & REG ROAD 9

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. NO

REMARKS: 13 documents to be unfiled  
before microfilmed

MEMORANDUM

TO: Mr. T. C. Kingsland, (2) FROM: Foundations Office,  
Regional Bridge Planning Engineer, Design Services Branch,  
Eastern Region, Central Bldg., Downsview.  
Kingston, Ontario.  
ATTENTION: DATE: November 26, 1971.  
OUR FILE REF. IN REPLY TO NOV 30 1971

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Creek Crossings Along  
Hwy. #417 and Regional Road #9 (Line 'B')  
Townships of Nepean and March  
Reg. Mun. of Ottawa-Carleton  
District No. 9 (Ottawa)  
W.O. 71-11077 - W.P.'s 433-64-02 (Hwy. #417)  
432-64-07 (Reg. Rd. #9)

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.

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

cc: Messrs. D. W. Ferren  
B. R. Davis  
A. Rutka  
S. J. Markiewicz  
J. E. Callaghan  
B. J. Giroux  
E. R. Saint  
G. A. Wrong  
B. A. Singh  
Foundations Files  
Documents

## TABLE OF CONTENTS

1. INTRODUCTION.
2. DESCRIPTION OF THE SITE AND GEOLOGY.
3. FIELD AND LABORATORY WORK.
4. SUBSOIL AND BEDROCK CONDITIONS.
  - 4.1) General.
  - 4.2) Surficial Deposits.
  - 4.3) Silty Clay to Clayey Silt (Sensitive).
  - 4.4) Glacial Till.
  - 4.5) Bedrock.
5. GROUNDWATER CONDITIONS.
6. DISCUSSION AND RECOMMENDATIONS.
  - 6.1) General.
  - 6.2) Crossings at Hwy. #417 (E.B.L. and W.B.L.) and Watts Creek (Stations 236+00 to 240+00):
    - 6.2.1) General.
    - 6.2.2) Fills - Stability and Settlement Considerations.
    - 6.2.3) Culverts (C.S.P.).
    - 6.2.4) Cut Sections.
  - 6.3) Crossing at Reg. Rd. #9 (Line 'B') and Watts Creek (Stations 73+00 to 75+00).
    - 6.3.1) General.
    - 6.3.2) Fill - Stability and Settlement Considerations.
    - 6.3.3) Culvert (C.S.P.).
  - 6.4) Crossing at Reg. Rd. #9 (Line 'B') and Water Course (Stations 119+00 to 121+00).
    - 6.4.1) General.
    - 6.4.2) Fill - Stability and Settlement Considerations.
    - 6.4.3) Culvert (C.S.P.).
7. MISCELLANEOUS.

# FOUNDATION INVESTIGATION REPORT

For

Proposed Creek Crossings Along  
Hwy. #417 and Regional Road #9 (Line 'B')  
Townships of Nepean and March  
Reg. Mun. of Ottawa - Carleton  
District No. 9 (Ottawa)

W.O. 71-11077

W.P.'s 433-64-02 (Hwy. #417)  
432-64-07 (Reg. Rd. #9)

## 1. INTRODUCTION:

The Foundation Section was requested to carry out subsurface investigations at three creek crossings, one along Hwy. #417 and two along Regional Road #9 (Line 'B'), in the Regional Municipality of Ottawa-Carleton. The request for the crossings was contained in a memo from Mr. T. C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated August 3, 1971. Subsequently investigations were carried out by this office to determine the subsoil, bedrock and groundwater conditions at the respective sites.

The factual results obtained from the investigations are presented in this report. In addition, the engineering considerations associated with fill and cut sections are discussed.

## 2. DESCRIPTION OF THE SITE AND GEOLOGY:

The area under investigation is located in the vicinity of Regional Road #9, approximately 1 mile north of Hwy. #7, in the Regional Municipality of Ottawa-Carleton. The area is located on the floor of a broad north-south trending valley. The floor of this valley, which is grass covered, is gently undulating in relief between elevations 270 and 310.

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

Two north flowing tributaries of Watts Creek traverse this area, one east and the other west of Regional Road #9. In addition, other minor tributaries and creeks are located in this region. The valleys vary 75 to 300 feet in width and 15 to 18 feet in depth, with slopes that range from 2:1 to 3:1. The creek channels themselves are generally 30 to 40 feet wide; the water was about 3 to 4 feet deep at the time of the investigation.

Regional Rd. #9 has two paved lanes, while the Ottawa Queensway located immediately east of Reg. Rd. #9, is a divided highway with two paved lanes in both the east as well as west-bound direction.

This region has, in the past, been subjected to geologic disturbances giving rise to numerous folds and faults in the bedrock. From Ottawa westerly to Pembroke, for instance, a block 35 miles in width, has been down dropped, forming a depression which is geologically known as the Ottawa-Bonnechere graben. The Ottawa River is situated in this down-dropped block. West of Ottawa the main fault passes through the hamlet of Hazeldean and forms the northern flank of the Carp Valley. It is not uncommon to have marked variations in the bedrock elevation from point to point in this general area.

The major portion of this valley is situated in the physiographic region known as the "Ottawa Valley Clay Plains." There extensive clay deposits are interrupted by ridges of sand and rock. The sensitive marine clay, which was deposited in

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

the geologic past in the Champlain Sea, varies markedly in thickness over the area; in some localized zones it is known to extend to depths in excess of 200 feet. The clay is generally underlain by glacial till.

The overburden is underlain by gneiss bedrock of the Precambrian Period. This rock mass has been intruded by numerous dikes and sills, the bedrock encountered in such intrusions varies from diabase to granite.

The drainage in the area is controlled by the numerous rivers and creeks which eventually drain into the Ottawa River.

3. FIELD AND LABORATORY WORK:

A total of 10 sampled boreholes, three of which were accompanied by a dynamic cone penetration test, were put down to investigate the vertical and lateral extent of the overburden and bedrock conditions at the three creek crossing sites in question. The boreholes and the cone tests were advanced by means of diamond drill rigs adapted for soil sampling purposes.

Samples of the cohesive stratum, as well as the lower glacial till deposit, were obtained, at required intervals, in a 2 inch O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. This testing procedure was supplemented by obtaining some 2" I.D. Shelby tubes in the cohesive portion of the overburden. These tubes were either manually

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

pushed into the soil or advanced using a fixed piston sampler. In addition, field vane tests were carried out, where possible, to determine the undrained shear strength of the clay stratum.

Bedrock was proven in three of the boreholes by obtaining between 3 and 10.5 feet of BX size rock core samples.

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. An artesian groundwater condition was encountered at a number of the boring locations. The artesian flow, in the open bore holes, was properly sealed at the source following the sampling and drilling operations.

The soil, bedrock and groundwater conditions encountered at the boring locations, are presented on the Record of Borelog sheets appended to this report. The location and elevation of the boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a Geodetic datum.

The location of all the borings put down at the various sites are plotted on Drawing No. 71-11077A. Stratigraphical sections, inferred from the boring data, are also plotted on the aforementioned drawing.

All the samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following

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

engineering properties of the overburden:

Bulk Density.

Natural Moisture Content.

Atterberg Limits.

Grain-Size Distribution.

Undrained Shear Strength.

Shear Strength Parameters - in terms of  
Effective Stresses.

The results of the testing are plotted on the Record of Borelog sheets and summarized on Figures Nos. 1, 2, 3 and 4; all contained in the Appendix of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The predominant stratum at the three sites investigated is composed of a firm to very stiff silty clay to clayey silt. The vertical extent of the deposit is variable at the three sites, ranging from 16 feet at station 120+00, to 98 feet at Station 74+00 (Regional Rd. #9 chainages). The cohesive stratum is occasionally overlain by surficial deposits of loose sand or stiff clayey silt; where encountered the thickness of these deposits ranged from 2 to 6 feet.

The cohesive stratum is underlain by a competent glacial till sheet, which varies from 1 to 29.5 feet in thickness. The glacial till is, in turn, followed by bedrock.

4. SUBSOIL AND BEDROCK CONDITIONS: (Cont'd) ...

4.1) General: (Cont'd) ...

The stratigraphy encountered in the borings are plotted on the Record of Borelog sheets. Inferred stratigraphical sections, at the respective sites, are shown on Drawing No. 71-11077A. A resume of the subsoil and bedrock conditions, encountered from ground surface downward at the sites, is presented in the following sub-sections.

4.2) Surficial Deposits:

The sites are covered by between 0.5 and 1 foot of topsoil.

At the crossing of Hwy. #417 and Watts Creek the topsoil is followed by a 2 to 4.5 feet thick deposit of loose to compact ('N' valves 2 to 23 blows/ft.) sand, with occasional thin (1/8 inch thick) silt seams throughout.

At the crossing of proposed Regional Rd. #9 (Line 'B') and Watts Creek the topsoil is underlain by a 2.5 to 6 feet thick deposit of stiff clayey silt with occasional layers of sand, up to 3 inches thick, throughout.

4.3) Silty Clay to Clayey Silt (Sensitive):

The surficial deposits are underlain by the predominant stratum across the sites, which is composed of a sensitive marine clayey silt to silty clay, with a trace of sand as well as organic mottlings. The vertical extent of the stratum varies markedly from one site to the other. Further the upper portion of the cohesive subsoil has often been subjected to desiccation. A summary of the range in thickness, encountered at the various

4. SUBSOIL AND BEDROCK CONDITIONS: (Cont'd) ...

4.3) Silty Clay to Clayey Silt (Sensitive): (Cont'd) ...

sites, is presented below:

<u>Approx. Thickness</u>		
<u>Site Location</u>	<u>Desiccated Zone</u>	<u>Lower Zone</u>
Hwy. #417 and Watts Creek (Stations 236+00 to 240+00)	5.5' to 12.5'	38' to 56.5' Valley Floor 49' to 63' Valley Banks
Reg. Rd. #9 (Line 'B') and Watts Creek (Stations 73+00 to 75+00)	-	74' to 98' Valley Floor
Reg. Rd. #9 (Line 'B') and Creek (Stations 119+00 to 121+00)	8' to 10'	3' to 6' Valley Floor

Seams and layers of sand, up to 6 inches thick, are present throughout the stratum. Grain size distribution testing was carried out for samples of the cohesive subsoil, the results are plotted in envelope form on Figure #1, located in the Appendix of this report.

The properties of the cohesive stratum, as determined by field and laboratory testing, are plotted on the Borelog sheets. A brief resume, presented in tabular form, follows:

4. SUBSOIL AND BEDROCK CONDITIONS: (Cont'd) ...

4.3) Silty Clay to Clayey Silt (Sensitive): (Cont'd) ...

<u>Identity Tests</u>	<u>Upper Desiccated Zone Range (Average)</u>	<u>Lower Zone Range (Average)</u>
Bulk Density ( $\gamma$ ) (p.c.f.)	117-139 (124)	107-124 (117)
Liquid Limit ( $W_L$ ) (%)	24-37 (32)	24-42 (30)
Plastic Limit ( $W_p$ ) (%)	15-24 (20)	15-25 (19)
Natural Moisture Content ( $W$ ) (%)	20-34 (25)	28-46 (33)
Liquidity Index ( $I_L$ )	0-1.1 (0.9)	1.1-1.5 (1.3)
<u>Undrained Shear Strength (<math>c_u</math>)</u> (p.s.f.)		
1) Field Tests	>2,000	575->2,000
2) Lab Tests	1,500->2,000	500-1,800
<u>Sensitivity (<math>S_t</math>)</u>	4-10	5-26
<u>Standard Penetration Resistance Testing (<math>'N'</math>)</u>		
Blows/ft.)	5-34	1-6

The Atterberg limit tests are plotted on the Plasticity Chart, Figure #2. These results indicate that the cohesive subsoil is essentially inorganic with a plasticity that varies from low to intermediate. The natural moisture content, in the zone below the upper desiccated portion, is consistently above the liquid limit; this is indicative of a sensitive material

The results of the undrained shear strength testing carried out indicates that the consistency of the lower portion of the cohesive stratum varies from firm to very stiff. In the upper desiccated zone, however, the consistency is in the stiff to hard range.

4. SUBSOIL AND BEDROCK CONDITIONS: (Cont'd) ...

4.3) Silty Clay to Clayey Silt (Sensitive): (Cont'd) ...

In addition to the more routinely employed tests previously described, an additional laboratory programme was carried out to determine the engineering properties of the cohesive stratum in terms of effective stresses. This was done by carrying out a series of isotropically consolidated-undrained triaxial compression tests, in which the excess pore water pressure build-up, due to applied load, was monitored throughout (CIU tests). The results of this testing are plotted on Figures #3 and 4, and summarized below:

$c'$  (Apparent Effective Cohesive Intercept) - 0

$\phi'$  (Apparent Effective Angle of Friction) -  $34\frac{1}{2}^{\circ}$

4.4) Glacial Till:

The cohesive stratum is, at all the sites, underlain by a deposit of compact to very dense ('N' values 15 blows/ft. to 100 blows for 5 inches) glacial till composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. The thickness of the glacial till was found to vary from about 1 foot (Reg. Rd. #9 - Sta.'s 119+00 to 121+00) to 30 feet (Hwy. #417 and Watts Creek - Sta.'s 236+00 to 240+00). The lower portion of the deposit is often bouldery in nature, particularly at those locations where the till is most extensive. The boulders encountered in the borings varied from 6 to 9 inches in size.

4. SUBSOIL AND BEDROCK CONDITIONS: (Cont'd) ...

4.5) Bedrock:

Bedrock was proven at 3 of the boring locations by obtaining between 3 and 10.5 feet of BX size rock core samples. The surface of the bedrock was found to be quite variable from site to site, ranging from elevation 178.5 (Reg. Rd. #9 - Watts Creek - Sta.'s 73+00 to 75+00) and elevation 251.5 (Reg. Rd. #9 - Creek - Sta.'s 119+00 to 121+00); corresponding to depths of 115.5 and 16.5 feet below ground surface, respectively.

The bedrock is primarily composed of grey granitic gneiss. At B.H. #7, however, the bedrock was composed of quartzite. In some areas the upper 2 to 3 feet is in a fractured condition, below this upper zone (where present) the bedrock is sound as evidenced by the high percentage of core recovery.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. The observations are presented on the individual borelog sheets as well as on Drawing No. 71-11077A. The results indicate that the groundwater level, in the surficial deposits and cohesive stratum, varies from 2 to 10 feet below existing ground surface, being deepest on the valley banks and shallowest on the valley floor.

An artesian groundwater pressure head was encountered in the deepest boreholes put down along the floor of Watts Creek (BH's #1, 2 and 8). The artesian condition was encountered in

5. GROUNDWATER CONDITIONS: (Cont'd) ...

the lower portions of the non-cohesive glacial till deposit which overlies bedrock. Once the borings penetrated into this zone water rose instantaneously in the casing. It eventually stabilized itself at a level between 6 and 9 feet above the valley floor. It is pertinent to note that the glacial till is relatively pervious with respect to the overlying cohesive stratum as well as the underlying bedrock. It is inferred that the glacial till, at these locations, is acting as a confined aquifer which is being charged with groundwater from the surrounding terrain, which is at a higher elevation.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

Proposed Hwy. #417 is to traverse the area under investigation. An underpass structure is to be constructed at the crossing of this highway and revised Regional Road #9 (Line 'B'). A subsurface investigation was carried out at this structure location. The factual data obtained, as well as recommendations pertaining to foundation design and the stability and settlement considerations associated with the approach fills, were presented in our report No. 71-11049, dated October 22, 1971.

Highway #417 and revised Regional Road #9 will cross a number of natural valleys located in the Townships of Nepean and March, namely:

<u>C r o s s i n g</u>	<u>S t a t i o n s</u>
Hwy. #417 and Watts Creek	236+00 and 240+00
Reg. Rd. #9 and Watts Creek	73+00 to 75+00
Reg. Rd. #9 and Water Course	119+00 to 121+00

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

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

The proposed profile grades for Hwy. #117 and Regional Road #9, in this area, were given on two unnumbered profiles; these grade lines are shown on Drawing No. 71-11077A. At these grades fills between 12 and 20 feet in height will be required to cross the three natural valleys. It is understood that the water in the various creeks will be carried through these fill areas using corrugated steel pipe (C.S.P.).

The predominant stratum at the three sites is a firm to very stiff clayey silt to silty clay stratum. The vertical extent of this deposit is variable, ranging from 16 feet at Station 120+00 to 98 feet at Station 74+00 (Regional Rd. #9 chainages). The cohesive subsoil is often overlain by thin (2 to 6 feet thick) surficial deposits of variable composition. The cohesive stratum is underlain by a competent glacial till stratum which, in turn, is followed by bedrock of Precambrian Age.

The presence of the compressible cohesive stratum, at a shallow depth below ground surface, is the governing factor, since it will be necessary to ensure that it is not overstressed by the embankment fill loadings. In this regard, comments as to stability and settlement considerations associated with the fill - culvert complex, at each of the sites, will be discussed separately in the sub-sections to follow.

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

6.2) Crossings at Hwy. #417 (E.B.L. and W.B.L.)  
and Watts Creek (Stations 236+00 to 240+00):

6.2.1) General:

Referring to Drawing No. 71-11077A it can be seen that two possible profile grades are proposed for both the W.B.L. and E.B.L. of Hwy. #417 in this area. The fills across the Watts Creek valley will be of the order of 12 and 16 feet for the high and low grade line, respectively. In addition, the highway will be in a cut section, both east and west of the natural valley. The maximum depth of the cuts will range from 3 to 7 feet for the high and low grade lines, respectively.

6.2.2) Fills - Stability and Settlement  
Considerations:

The critical condition for stability of an embankment on slightly over-consolidated cohesive soils, as is the case at this site, generally occurs during or immediately after construction. This being the case, a total stress stability analysis ( $\phi = 0$ ) provides a suitable means of assessing the stability of the embankment section. In this method of analysis, stability is governed by the applied loads and by the stress-strain and undrained shear strength characteristics of the foundation and embankment soils.

Analyses have been carried out, therefore, in terms of total stresses, making use of the electronic computer, to determine the stability of the approaches. For computation purposes it was assumed that the compacted in-place bulk unit weight of the fill would be of the order of 110 p.c.f.

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

6.2) Crossing at Hwy. #117 (E.B.L. and W.B.L.)  
and Watts Creek (Stations 236+00 to 240+00): (Cont'd) ...

6.2.2) Fills - Stability and Settlement  
Considerations: (Cont'd) ...

The results of the analyses indicated that, fills of the height contemplated (maximum 16 feet), will be stable, provided standard 2:1 slopes are employed.

The underlying compressible clay stratum will settle due to the loading of the fills, over a long term period. The compressibility characteristics of this subsoil would indicate that the magnitude of the induced loading will fall within the preconsolidation range. This being the case, the settlement will be primarily of a recompressional nature. The estimated maximum consolidation settlements within the foundation subsoil, beneath the centre line of the roadway, are summarized below:

<u>Profile Grade</u>	<u>Maximum Height of Fill</u>	<u>Consolidation Settlement</u>
High	16 ft.	2 to 3 inches (in 7 yrs.)
Low	12 ft.	1 to 1½ inches (in 7 yrs.)

6.2.3) Culverts (C.S.P.):

No major complications are envisaged with regard to the placement and performance of the culverts. The bedding and backfilling for the culverts should be carried out in accordance with current D.T.C. practices, namely Type 2 - Earth Excavation, Standard No. DD-808A.

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

6.2) Crossing at Hwy. #417 (E.B.L. and W.B.L.)  
and Watts Creek (Sta.'s 235+00 to 240+00): (Cont'd) ...

6.2.4) Cut Sections:

The nominal cuts (3 to 7 ft. deep) on either bank of Watts Creek will extend through the surficial sand deposit down into the upper desiccated portion of the cohesive stratum. The base of the cut sections will be located above the groundwater level recorded during the period of the investigation. No stability problems are anticipated, provided the permanent slopes are maintained at 2:1. It is recommended that the slopes be sodded in order to protect them against surficial erosion which could be caused by uncontrolled surface run-off. Further, positive drainage measures should be provided in accordance with current D.T.C. practices.

The excavated sand and desiccated portion of the clayey silt could probably be used as fill elsewhere on this project. Its suitability as potential fill material should be determined by the Materials Section (Eastern Region).

6.3) Crossing at Reg. Rd. #9 (Line 'B') and  
Watts Creek (Stations 73+00 to 75+00):

6.3.1) General:

The profile grade of Reg. Rd. #9 in this area will vary between elevations 307 and 313, i.e. the maximum fill height will be approximately 19 feet.

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

6.3) Crossing at Reg. Rd. #9 (Line 'B') and Watts Creek (Stations 73+00 to 75+00): (Cont'd) ...

6.3.2) Fill - Stability and Settlement Considerations:

The fill will be placed directly on an extensive firm to very stiff cohesive stratum. Stability analyses were carried out using the methods described in subsection 6.2.2).

The following assumptions were made:

Soil Properties

<u>Elevation</u>	<u>Soil</u>	<u>Bulk Density (pcf)</u>	<u>Parameters</u>	
			<u>Undrained Shear Strength (in psf)</u>	<u>Effective Angle of Internal Friction (°)</u>
309-290	Embankment Fill (Glacial Till Material - Slopes 2:1)	140	-	30°
290-283	Clayey Silt	105	550	-
283-273	Clayey Silt to Silty Clay	115	740	-
273-260	" " " " "	125	800	-
260-	" " " " "	125	950 and above	-

Note: 1) Approximate Ground Water Level - Elevation 286.

2) Tension Crack - 7 feet deep.

The results of the computations indicate that:

i) Fills up to 16 feet in height will be stable (F.S. = 1.3), providing 2:1 slopes are employed.

ii) Fills above 16 feet in height will require berms to stabilize the sections. For example, a mid-height berm of 10 feet in length will be required for a fill height of 19 feet (all slopes 2:1). The berms should slope towards the toe of the

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

6.3) Crossing at Reg. Rd. #9 (Line 'B') and  
Watts Creek (Stations 73+00 to 75+00): (Cont'd) ...

6.3.2) Fill - Stability and Settlement  
Considerations: (Cont'd) ...

slope at a grade of 20:1. Further, a smooth transition should be effected between the varying berm requirements for different heights of fill.

The underlying compressible clay stratum will settle due to the loading of the fill, over a long term period. Computations were, therefore, carried out to determine the magnitude of the consolidation settlement, this is summarized in tabular form below:

Consolidation Settlement Beneath Centre Line of Approach  
Fills (Max. Ht., 19 ft. - In Place Bulk Unit Wt., 140 pcf)

<u>Time</u>	<u>Settlement</u>
2 to 3 inches	2 years
4 to 6 inches	6 years
8 to 10 inches (max.)	40 years

6.3.3) Culvert (C.S.P.):

No major complications are envisaged with regard to the placement and performance of the culvert. As discussed above, considerable settlement will be induced in the cohesive foundation subsoil by the fill loading. Taking into consideration the magnitude quoted previously it is estimated that the differential settlement, along the culvert, could be as much as 9 inches. Therefore, it is recommended that the culvert be provided with a 9 inch camber.

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

6.3) Crossing at Reg. Rd. #9 (Line 'B') and  
Watts Creek (Stations 73+00 to 75+00): (Cont'd) ...

6.3.3) Culvert (C.S.P.): (Cont'd) ...

The bedding and backfilling for the culvert should be carried in accordance with the regulations outlined in sub-section 6.2.3).

6.4) Crossing at Reg. Rd. #9 (Line 'B') and  
Water Course (Stations 119+00 to 121+00):

6.4.1) General:

The natural valley at this location was originally 175 feet wide and 12 feet deep with side slopes varying between 2:1 and 3:1. In July and August, 1971, the eastern portion of this valley was filled with rock fill (refer to profile of fill area shown on Drawing No. 71-11077A). The present width of the valley is approximately 100 feet.

The proposed profile grade of Reg. Rd. #9, in the vicinity of this valley, is to range from elevation 285 to 286. At this grade the maximum height of fill (above the valley floor) will be 20 feet.

6.4.2) Fill - Stability and Settlement  
Considerations:

The fill will be placed directly on a firm to hard cohesive stratum. Stability analyses were carried out using the methods described in sub-section 6.2.2). The results of the analyses indicated that, fills of the height contemplated, will be inherently stable, provided standard 2:1 slopes are employed.

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

6.4) Crossing at Reg. Rd. #9 (Line 'B') and  
Water Course (Stations 119+00 to 121+00): (Cont'd) ...

6.4.2) Fill - Stability and Settlement  
Considerations: (Cont'd) ...

The underlying compressible clay stratum will settle due to the loading of the fill, over a long term period. The compressibility characteristics of this subsoil would indicate that the magnitude of the induced loading will fall within the preconsolidation range. This being the case the settlement will be primarily of a recompression nature. It is estimated that the maximum consolidation settlement within the foundation subsoil, beneath the centre line of the roadway, could be of the order of  $1\frac{1}{2}$  to 2 inches. This settlement should be realized within a 5-year period following placement.

6.4.3) Culvert (C.S.P.):

Comments made with regard to the placement of a C.S.P. culvert beneath a fill, given in sub-section 6.2.3), pertain to this site as well.

7. MISCELLANEOUS:

The field work for this project was carried out during the periods of June 3 to 18 and August 20 to 26, 1971, under the supervision of Messrs. W. Hutton, Project Foundation Engineer, and M. Logan, Student Technician (Field).

The drilling equipment was owned and operated by Dominion Soil Investigation Ltd. and Canadian Longye. Company Ltd., both of Toronto.

7. MISCELLANEOUS: (Cont'd) ...

This report was written by Mr. B. T. Darch,  
Senior Foundation Engineer. The entire project was carried  
out under the supervision of Mr. M. Devate, Supervising  
Foundation Engineer, who also reviewed this report.

*B. T. Darch*

B. T. Darch, P. Eng.

*M. Devate*

M. Devate, P. Eng.



BTD/efm

November 25/71

APPENDIX I



JOB 71-11077

LOCATION

Sta. 227 + 74 2 E.D.L. (Hwy. 117)

ORIGINATED BY ML

W.P. 433-64-02

BORING DATE

June 9 &amp; 10, 1971

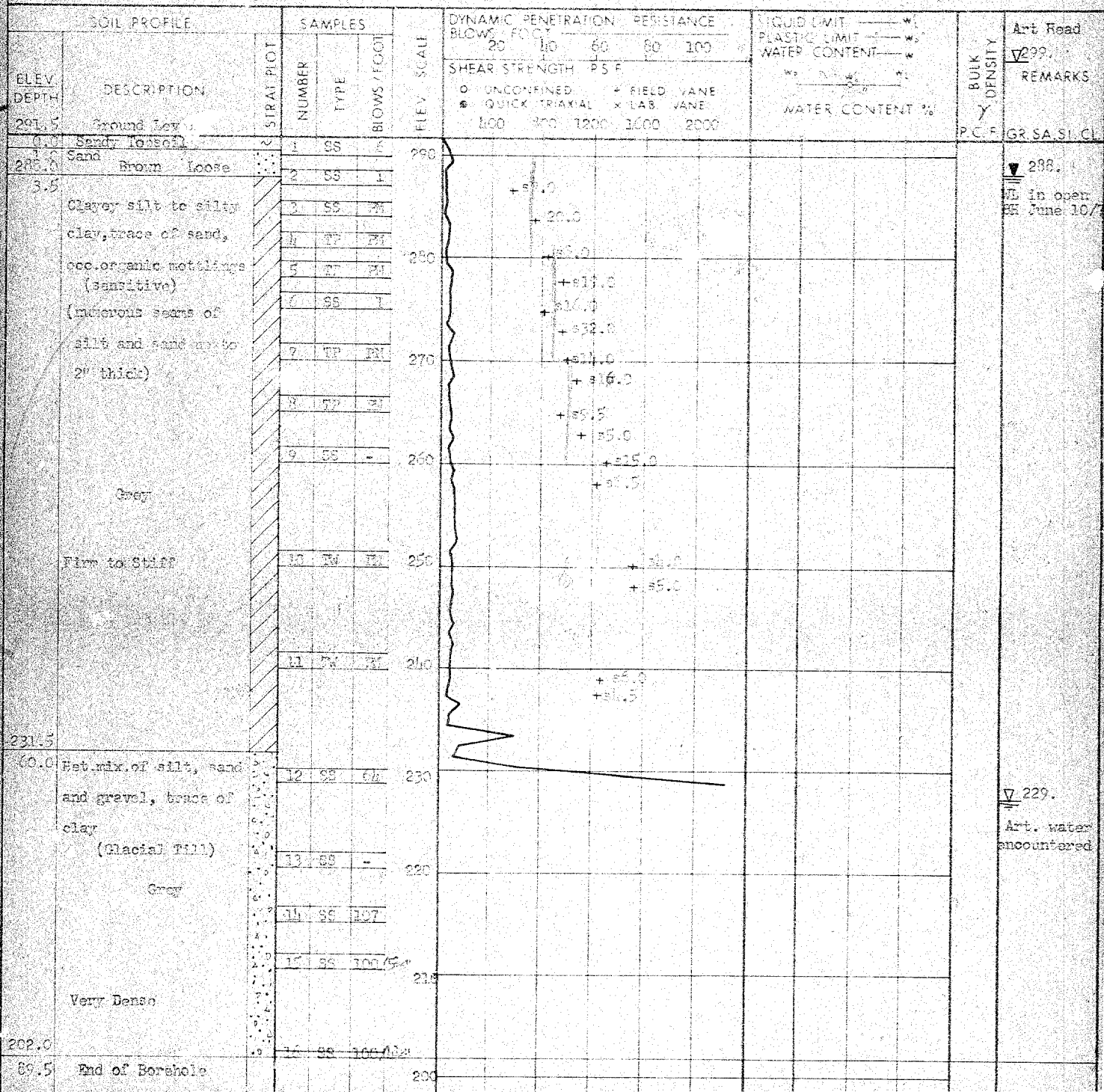
COMPILED BY HR

DATUM Geodetic

BOREHOLE TYPE

Washboring, NE &amp; EX Casings Cone

CHECKED BY



FOUNDATION SECTION

JOB	71-11077	LOCATION	Sta. 240 + 20.6' Lt. W.B.L. (Hwy. 117)	ORIGINATED BY	AED
W.P.	433-64-02	BORING DATE	August 24, 1971	COMPILED BY	ME
DATUM	Geodetic	BOREHOLE TYPE	Washboring, NW - Casing	CHECKED BY	

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— %	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	SIRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
						O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	WATER CONTENT %		
306.6	Ground Level					100 800 1200 1600 2000	20 40 60		
305.6	Sandy Topsoil		1	SS	9				
304.7	Sand Compact		2	SS	24				
2.5	Desiccated Zone		3	SS	26				
	Mottled Grey-Brown		4	SS	5				
	Stiff to Very Stiff								
	Clayey silt to silty		5	SS	2	+ \$24.0	+ \$9.5		
	clay, trace of sand,		6	TN	FN				
	occ. organic mottlings								
	(sensitive)		7	TN	FM	+ \$8.0			
	Numerous sand seams					+ \$12.0			
	up to 4" thick		8	TN	FM	+ \$25.0			
	throughout.					+ \$37.0			
	Grey					+ \$15.0			
	Firm		9	TN	PM	+ \$13.0			
						+ \$4.5			
			10	TN	FM	+ \$36.0			
268.6						+ \$21.0			
38.0	End of Borehole					+ \$22.0			

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11677

LOCATION Sta. 239 + 30 E.B.L. Hwy. 417

ORIGINATED BY AED

W.P. 133-41-02

BORING DATE August 24 &amp; 25, 1971

COMPILED BY HR

DATUM Geodetic

BOREHOLE TYPE Washboring, NW Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— w <sub>L</sub> PLASTIC LIMIT ——— w <sub>p</sub> WATER CONTENT ——— w		BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %			
							○ UNCONFINED      * FIELD VANE ● QUICK TRIAXIAL    x LAB VANE 400    800    1200    1600    2000		No      *      * 20    40    60			
306.8	Ground Level		1	SS	16							
305.8	Sandy loess soil		2	SS	27							
304.2	Desiccated Zone		3	SS	32							
	Mottled Grey-Brown		4	SS	15	300						0 52 33 15 ▼ 299.8
	Sand, contains up to 5" size		5	SS	15/1							
	Stiff to Very Stiff		6	SS	5							0 8 68 21
	Clayey silt, trace of sand, occasional organic mottlings (sensitive)		7	TM	24	290		+s12.0				
	numerous seams of silt and sand up to 2" thick.		8	TM	24	280		+s1.0				
			9	TM	24	270		+s20.0				
			10	SS	24	260		+s11.0				117.5 0 5 70 25
			11	TM	24	250		+s16.0				
	Grey					240		+s30.0				
	Firm					230		+s12.5				
266.8	End of Borehole					220		+s10.0				
						210		+s21.0				
						200		+s30.0				
						190		+s1.0				
						180		+s20.0				

FOUNDATION SECTION

ORIGINATED BY ASD

COMPILED BY 102

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — % PLASTIC LIMIT — % WATER CONTENT — %		BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH PS.F		WATER CONTENT %		
								<div>○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB. VANE</div>			
309.9	Ground Level							400   600   1200   1600   2000	20   40   60		
308.9	Sandy Topsoil	2	1	SS	14						
306.2	Sand Brown Compact	3	2	SS	23						
307.7	Desiccated Zone	4	3	SS	23						
	Mottled Grey-Brown	5	4	SS	13						
	Very Stiff to Stiff	6	5	SS	5	360					
	Clayey silt to silty clay, trace of sand, occ. organic mottlings (sensitive)	7	6	TN	12						
	numerous sand seams & layers up to 6" thick throughout.	8	7	SS	12	290					
	Grey	9	8	TN	12	230					
	Firm to Stiff	10	9	TN	12	270					
267.2	End of Borehole		11	TN	12	200					

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 71-11077

LOCATION Sta. 235 + 60 C.F.R.I. (Hwy. 417)

ORIGINATED BY AED

W.P. 133-67-02

BORING DATE August 26, 1971

COMPILED BY HR

DATUM Geodetic

BOREHOLE TYPE Washboring, NW Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$  $w_p$ ——— $w$ ——— $w_L$	BULK DENSITY  $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH — PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000				
302.8	Ground Level										
300.7	Sand, brown, compact		1	SS	8						P.C.F. GR. SA. SI. C.
298.5	Desiccated Zone		2	SS	19						Org. M. in open 0.3% FH Aug. 26/77
	Mottled Grey-Brown		3	SS	10						
	Very stiff to stiff		5	TM	71	300				117	300. 11 65 2h
			6	TM	75					121	7 76 17
	Clayey silt to silty clay, trace of sand, occ. organic mottlings (sensitive)		7	TM	21	290				115	
			8	SS	11						
	numerous sand & silt seams and layers up to 6" thick throughout		9	SS	75	280					
270.9	Grey Firm to Stiff		10	TM	75					107.5	5 55 40
30.0	End of Borehole					270					

ORIGINATED BY ML

COMPILED BY HS

CHECKED BY

▼ 289.  
WL in open  
BH June 3/71

DEPTH		STR	NO	TY	BLOW	ELEV	QUICK TRIAXIAL x LAB. VANE 400 800 1200 1600 2000	WATER CONTENT %	P.C.F.	GR. SA. SI. CL.
294.2	Ground Level									
287.2	Clayey silt, trace of sand (occ. layers sand up to 3" thick) Grey-Brown. Stiff to Firm		1	SS	4	290				▼ 289.
7.0			2	TW	PM		+4.8			WL in open BH June 3/71
	Clayey silt to silty clay, trace of sand, occasional organic mottlings (Sensitive)		3	SS	1		+12			
			4	TW	PM	280	+18			
			5	SS	1		+46			
	Numerous seams of silt and sand up to 1/2" thick throughout		6	SS	-	270	+17			
			7	TP	PM		+20			
			8	SS	PM		+16			
			9	TP	PM	260	+4.2			
	Grey		10	SS	2		+17			
			11	TP	PM		+15			
			12	SS	2	250	+6			
			13	TP	PM		+10			
	Firm to Very Stiff		14	SS	6	240	+vis			
			15	TP	PM		+3			
			16	SS	6	230	+3			
			17	TP	PM	220	+3			
			18	SS	6	210	+3			
			19	TP	PM		+5			
			20	SS	6	200	+4			
			21	TP	PM		+5			
			22	EX	86%	190				
105.0	Het. mix. of silt, sand & gravel, trace of clay (Glacial Till) Boulders up to 2" in size below el. 187) Grey. Compact to V. Dense.		23	EX	-					
173.7			24	EX	87%					
119.5	fractured		25	EX	100%	170				
	Quartzite Bedrock									
	Grey									
168.2	Sound									
126.0	End of Borehole									

\_\_\_\_\_

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION		RESISTANCE		LIQUID LIMIT		PLASTIC LIMIT		WATER CONTENT		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100	WATER CONTENT %	WATER CONTENT %			
285.1	Ground Level															
281.6	Clayey silt, trace of sand, grey-brown		1	SS	2	280	277	275	272	270	268	266	264	262	260	258
281.6	Clayey silt to silty clay, trace of sand, occ. organic mottlings		2	SS	2	270	270	270	270	270	270	270	270	270	270	268
	numerous seams of silt and sand up to 3" thick throughout.		3	SS	2	260	260	260	260	260	260	260	260	260	260	258
	Grey		4	SS	2	250	250	250	250	250	250	250	250	250	250	248
	Firm to Very Stiff		5	SS	2	240	240	240	240	240	240	240	240	240	240	238
			6	SS	2	230	230	230	230	230	230	230	230	230	230	228
			7	SS	2	220	220	220	220	220	220	220	220	220	220	218
			8	SS	2	210	210	210	210	210	210	210	210	210	210	208
			9	SS	2	200	200	200	200	200	200	200	200	200	200	198
			10	SS	2	190	190	190	190	190	190	190	190	190	190	188
			11	SS	2	180	180	180	180	180	180	180	180	180	180	178
			12	SS	2	170	170	170	170	170	170	170	170	170	170	168
			13	SS	2	160	160	160	160	160	160	160	160	160	160	158
			14	SS	2	150	150	150	150	150	150	150	150	150	150	148
			15	SS	2	140	140	140	140	140	140	140	140	140	140	138
			16	SS	2	130	130	130	130	130	130	130	130	130	130	128
			17	SS	2	120	120	120	120	120	120	120	120	120	120	118
			18	SS	2	110	110	110	110	110	110	110	110	110	110	108
			19	SS	2	100	100	100	100	100	100	100	100	100	100	98
			20	SS	2	90	90	90	90	90	90	90	90	90	90	88
			21	SS	2	80	80	80	80	80	80	80	80	80	80	78
			22	SS	2	70	70	70	70	70	70	70	70	70	70	68
			23	SS	2	60	60	60	60	60	60	60	60	60	60	58
			24	SS	2	50	50	50	50	50	50	50	50	50	50	48
			25	SS	2	40	40	40	40	40	40	40	40	40	40	38
			26	SS	2	30	30	30	30	30	30	30	30	30	30	28
			27	SS	2	20	20	20	20	20	20	20	20	20	20	18
			28	SS	2	10	10	10	10	10	10	10	10	10	10	8
			29	SS	2	0	0	0	0	0	0	0	0	0	0	0
			30	SS	2	0	0	0	0	0	0	0	0	0	0	0
			31	SS	2	0	0	0	0	0	0	0	0	0	0	0
			32	SS	2	0	0	0	0	0	0	0	0	0	0	0
			33	SS	2	0	0	0	0	0	0	0	0	0	0	0
			34	SS	2	0	0	0	0	0	0	0	0	0	0	0
			35	SS	2	0	0	0	0	0	0	0	0	0	0	0
			36	SS	2	0	0	0	0	0	0	0	0	0	0	0
			37	SS	2	0	0	0	0	0	0	0	0	0	0	0
			38	SS	2	0	0	0	0	0	0	0	0	0	0	0
			39	SS	2	0	0	0	0	0	0	0	0	0	0	0
			40	SS	2	0	0	0	0	0	0	0	0	0	0	0
			41	SS	2	0	0	0	0	0	0	0	0	0	0	0
			42	SS	2	0	0	0	0	0	0	0	0	0	0	0
			43	SS	2	0	0	0	0	0	0	0	0	0	0	0
			44	SS	2	0	0	0	0	0	0	0	0	0	0	0
			45	SS	2	0	0	0	0	0	0	0	0	0	0	0
			46	SS	2	0	0	0	0	0	0	0	0	0	0	0
			47	SS	2	0	0	0	0	0	0	0	0	0	0	0
			48	SS	2	0	0	0	0	0	0	0	0	0	0	0
			49	SS	2	0	0	0	0	0	0	0	0	0	0	0
			50	SS	2	0	0	0	0	0	0	0	0	0	0	0
			51	SS	2	0	0	0	0	0	0	0	0	0	0	0
			52	SS	2	0	0	0	0	0	0	0	0	0	0	0
			53	SS	2	0	0	0	0	0	0	0	0	0	0	0
			54	SS	2	0	0	0	0	0	0	0	0	0	0	0
			55	SS	2	0	0	0	0	0	0	0	0	0	0	0
			56	SS	2	0	0	0	0	0	0	0	0	0	0	0
			57	SS	2	0	0	0	0	0	0	0	0	0	0	0
			58	SS	2	0	0	0	0	0	0	0	0	0	0	0
			59	SS	2	0	0	0	0	0	0	0	0	0	0	0
			60	SS	2	0	0	0	0	0	0	0	0	0	0	0
			61	SS	2	0	0	0	0	0	0	0	0	0	0	0
			62	SS	2	0	0	0	0	0	0	0	0	0	0	0
			63	SS	2	0	0	0	0	0	0	0	0	0	0	0
			64	SS	2	0	0	0	0	0	0	0	0	0	0	0
			65	SS	2	0	0	0	0	0	0	0	0	0	0	0
			66	SS	2	0	0	0	0	0	0	0	0	0	0	0
			67	SS	2	0	0	0	0	0	0	0	0	0	0	0
			68	SS	2	0	0	0	0	0	0	0	0	0	0	0
			69	SS	2	0	0	0	0	0	0	0	0	0	0	0
			70	SS	2	0	0	0	0	0	0	0	0	0	0	0
			71	SS	2	0	0	0	0	0	0	0	0	0	0	0
			72	SS	2	0	0	0	0	0	0	0	0	0	0	0
			73	SS	2	0	0	0	0	0	0	0	0	0	0	0
			74	SS	2	0	0	0	0	0	0	0	0	0	0	0
			75	SS	2	0	0	0	0	0	0	0	0	0	0	0
			76	SS	2	0	0	0	0	0	0	0	0	0	0	0
			77	SS	2	0	0	0	0	0	0	0	0	0	0	0
			78	SS	2	0	0	0	0	0	0	0	0	0	0	0
			79	SS	2	0	0	0	0	0	0	0	0	0	0	0
			80	SS	2	0	0	0	0	0	0	0	0	0	0	0
			81	SS	2	0	0	0	0	0	0	0	0	0	0	0
			82	SS	2	0	0	0	0	0	0	0	0	0	0	0
			83	SS	2	0	0	0	0	0	0	0	0	0	0	0
			84	SS	2	0	0	0	0	0	0	0	0	0	0	0
			85	SS	2	0	0	0	0	0	0	0	0	0	0	0
			86	SS	2	0	0	0	0	0	0	0	0	0	0	0
			87	SS	2	0	0	0	0	0	0	0	0	0	0	0
			88	SS	2	0	0	0	0	0	0	0	0	0	0	0
			89	SS	2	0	0	0	0	0	0	0	0	0	0	0
			90	SS	2	0	0	0	0	0	0	0	0	0	0	0
			91	SS	2	0	0	0	0	0	0	0	0	0	0	0
			92	SS	2	0	0	0	0	0	0	0	0	0	0	0
			93	SS	2	0	0	0	0	0	0	0	0	0	0	0
			94	SS	2	0	0	0	0	0	0	0	0	0	0	0
			95	SS	2	0	0	0	0	0	0	0	0	0	0	0
			96	SS	2	0	0	0	0	0	0	0	0	0	0	0
			97	SS	2	0	0	0	0	0	0	0	0	0	0	0
			98	SS	2	0	0	0	0	0	0	0	0	0	0	0
			99	SS	2	0	0	0	0	0	0	0	0	0	0	0
			100	SS	2	0	0	0	0	0	0	0	0	0	0	0
			101	SS	2	0	0	0	0	0	0	0	0	0	0	0
			102	SS	2	0	0	0	0	0	0	0	0	0	0	0
			103	SS	2	0	0	0	0	0	0	0	0	0	0	0
			104	SS	2	0	0	0	0	0	0	0	0	0	0	0
			105	SS	2	0	0	0	0	0	0	0	0	0	0	0
			106	SS	2	0	0	0	0	0	0	0	0	0	0	0
			107	SS	2	0	0	0	0	0	0	0	0	0	0	0
			108	SS	2	0	0	0	0	0	0	0	0	0	0	0
			109	SS	2	0	0	0	0	0	0	0	0	0	0	0
			110	SS	2	0	0	0	0	0	0	0	0	0	0	0
			111	SS	2	0	0	0	0	0	0	0	0	0	0	0
			112	SS	2	0	0	0	0	0	0	0	0	0	0	0
			113	SS	2	0	0	0	0	0	0	0	0	0	0	0
			114	SS	2	0	0	0	0	0	0	0				

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11977

LOCATION Sta. 120 + 80 W (Reg. Tbl. 2 Line B)

ORIGINATED BY AED

W.P. 433-64-07

BORING DATE Aug. 20 &amp; 22, 1971

COMPILED BY HS

DATUM Geodetic

BOREHOLE TYPE Washboring - NW Casing - BX Rock Core

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — % PLASTIC LIMIT — % WATER CONTENT — %		BULK Y DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH — PSF		WATER CONTENT %			
272.1	Ground Level Top Soil						O UNCONFINED      X FIELD VANE ● QUICK TRIAXIAL      X LAB VANE		20      40      60			
0.5	Desiccated Zone		1	SS	21	270	100      300      1200      1600      2000					
	Mottled Gray & Brown		2	SS	29							
	Hard to Very Stiff		3	SS	31							
	Clayey silt to silty		4	SS	15							
	clay, trace of sand.		5	SS	7	260						
256.2	Firm to Stiff		6	SS	5		+ 3.5					
255.5	Glacial till, dense		7	SS	15				10		112	
254.5	Unconsolidated		8	SS	15							
253.1	Fractured		9	BX	70							
19.0	End of Borehole					250						

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

# RECORD OF BOREHOLE No. 10

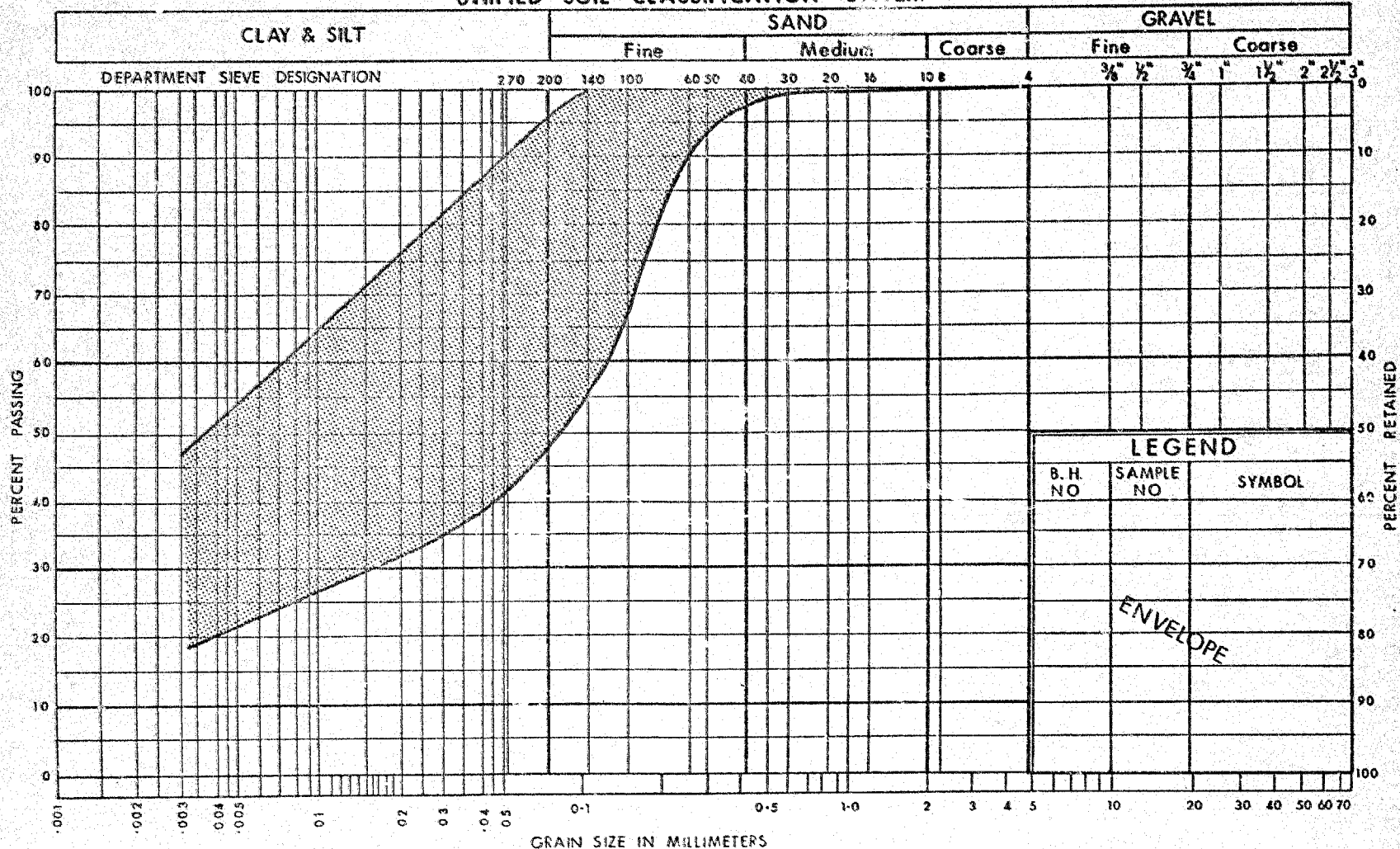
FOUNDATION SECTION

JOB 71-11977 LOCATION Sta. 120 + 37.0 (Reg. B.S. Line B) ORIGINATED BY AED  
W.P. 433-64-07 BORING DATE August 23, 1971 COMPILED BY JS  
DATUM Geodetic BOREHOLE TYPE Washboring - WS Casing CHECKED BY

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — % PLASTIC LIMIT — % WATER CONTENT — %		BULK DENSITY X	REMARKS	
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH — P.S.F. ○ UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB. VANE						WATER CONTENT %
266.6	Ground Level						100	500	1200	1600	2000		
266.0	Topsoil		1	SS	5								
1.0	Desiccated Zone		2	SS	8								
	Mottled Grey-Brown		3	SS	10								
	Stiff to Very Stiff		4	SS	1								
	Clayey Silt to silty		5	SS	4								
255.0	clay. Grey. Firm		6	SS	1								
254.1	Glacial Till, Compact		7	SS	1								
12.5	End of Borehole												
	Probably Bedrock												

266.0  
WL in open  
on Aug. 24/71

# UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT  
OF  
TRANSPORTATION AND COMMUNICATIONS



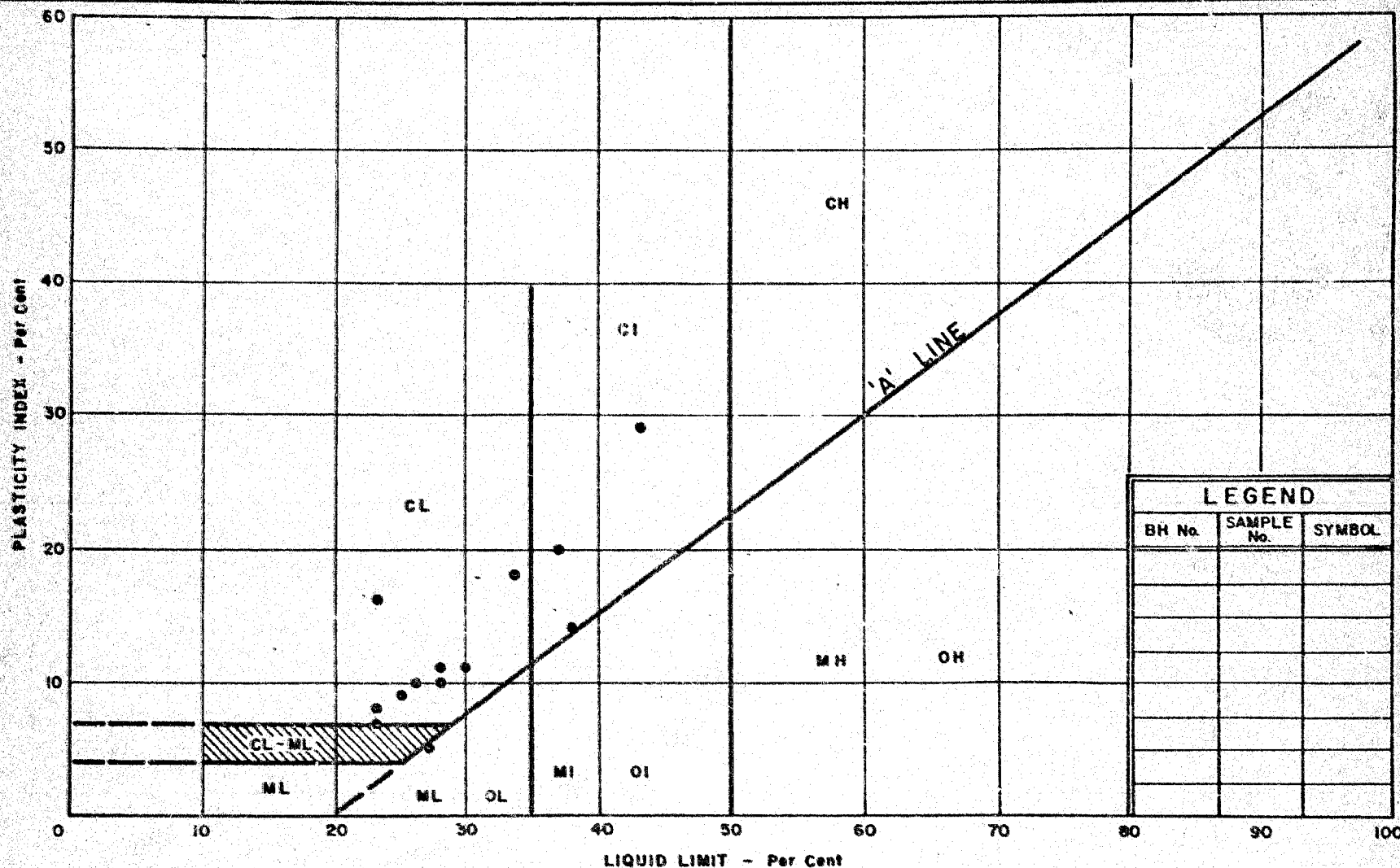
DESIGN SERVICES  
BRANCH

## GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SILTY CLAY

W.P. No. 433-64-02 & 433-64-07

JOB No. 71-11077

FIG. 1



DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

# PLASTICITY CHART CLAYEY SILT TO SILTY CLAY STRATUM

WP No. 433 - 64 - 02 & 07

JOB No. 71-11077

FIG. 2

# CONSOLIDATED UNDRAINED TRIAXIAL TEST (WITH PORE WATER PRESSURE MEASUREMENTS)

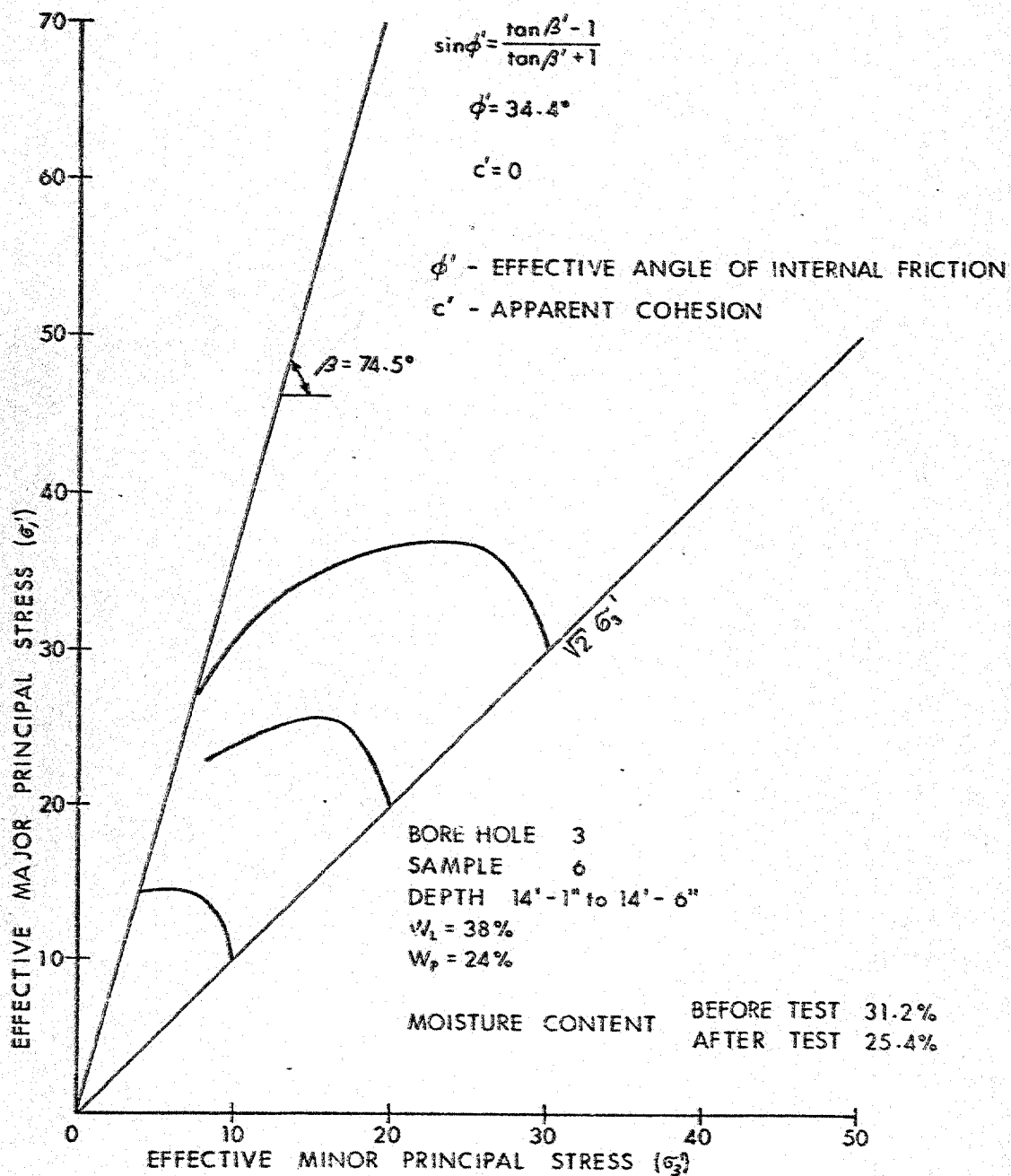


FIG. 3

JOB No: 71-11077

# CONSOLIDATED UNDRAINED TRIAXIAL TEST (WITH PORE WATER PRESSURE MEASUREMENTS)

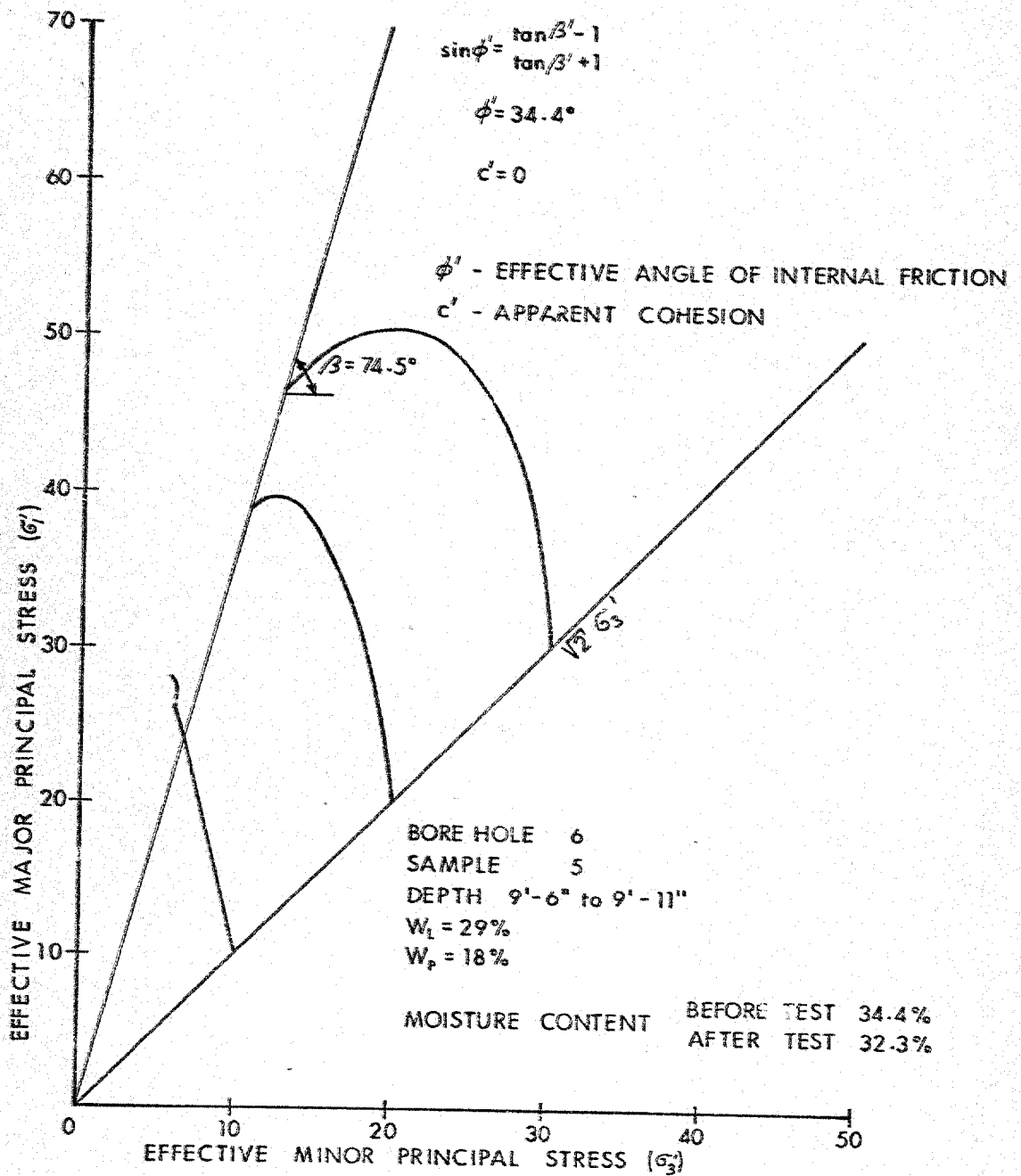


FIG. 4

JOB No: 71-11077

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_i$	SENSITIVITY

## GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF $\sigma$
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF $\sigma$ 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
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

## 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.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

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

Q PROFILE - LINE 'B'

☿ PROFILE - LINE 'B'

PLAN

100 50 0 SCALE 100 200 FT

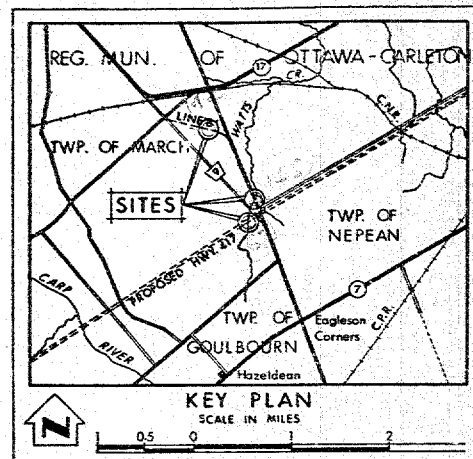
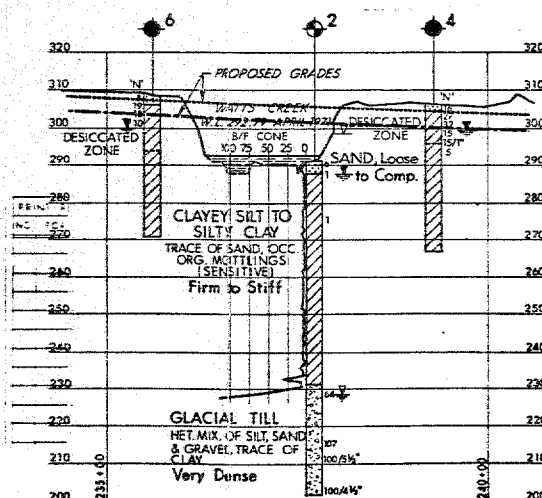
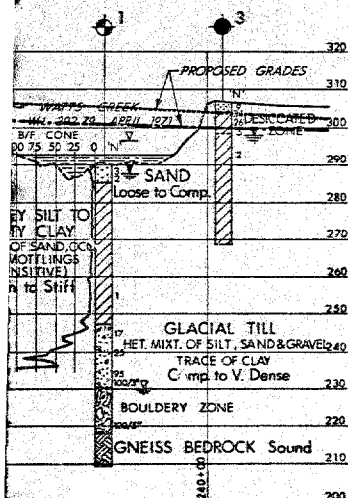
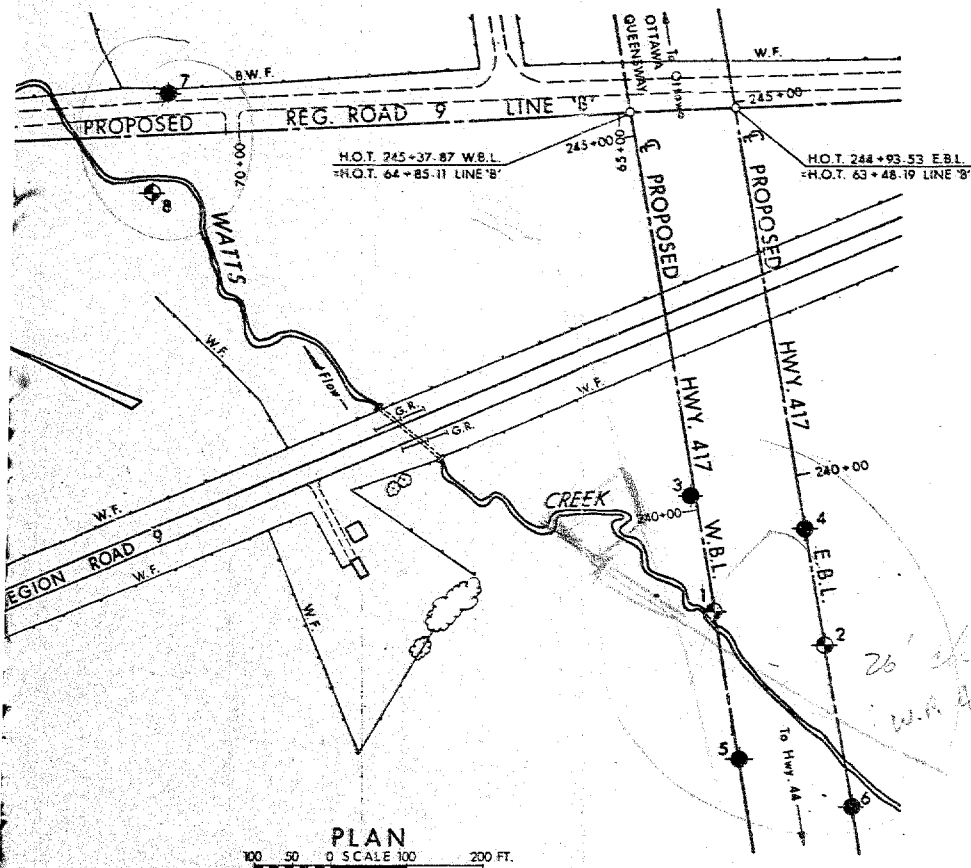
€ PROFILE - HWY. 417 W.B.L.

₹ PRC

**PROFILES**

HORIZ. 100 50 0 SCALE 100 200 FT.

VERT. 20 10 0 20 40 FT.



## LEGEND

- Bore Hole
- ⊕ Cone Penetration Test
- ⊕ Bore Hole & Cone Test
- Water Levels established at time of field investigation, June & Aug. 1971.
- ▽ Head
- ▽ Encountered

NO.	ELEVATION	STATION	OFFSET
1	290.3	238+66	W.B.L.
2	291.5	237+74	E.B.L.
3	306.6	240+20	W.B.L.
4	306.8	239+30	E.B.L.
5	309.9	236+70	W.B.L.
6	308.8	235+60	E.B.L.
7	294.2	70+90	RT. LINE 'B'
8	285.1	71+20	LT. LINE 'B'
9	272.1	120+80	LINE 'B'
10	266.6	120+37	LINE 'B'

## 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

## CREEK CROSSINGS

HIGHWAY NO. 417 & REG. ROAD 9 DIST. NO. 9  
REG. MUNICIPALITY OF OTTAWA-CARLETON  
TWP. MARCH & NEPEAN LOT CON.

## BORE HOLE LOCATIONS &amp; SOIL STRATA

SUBMD. B.T.D. CHECKED	W.P. NO. 433-04-02	DRAWING NO.
DRAWN S.R. CHECKED	JOB NO. 71-11077	71-11077A
DATE OCT. 28, 1971	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.	



CONT. No. 73-28  
W. P. No. 432-64-07



SHEET  
30

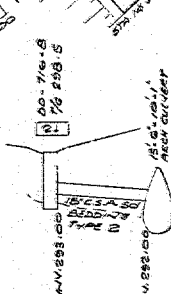
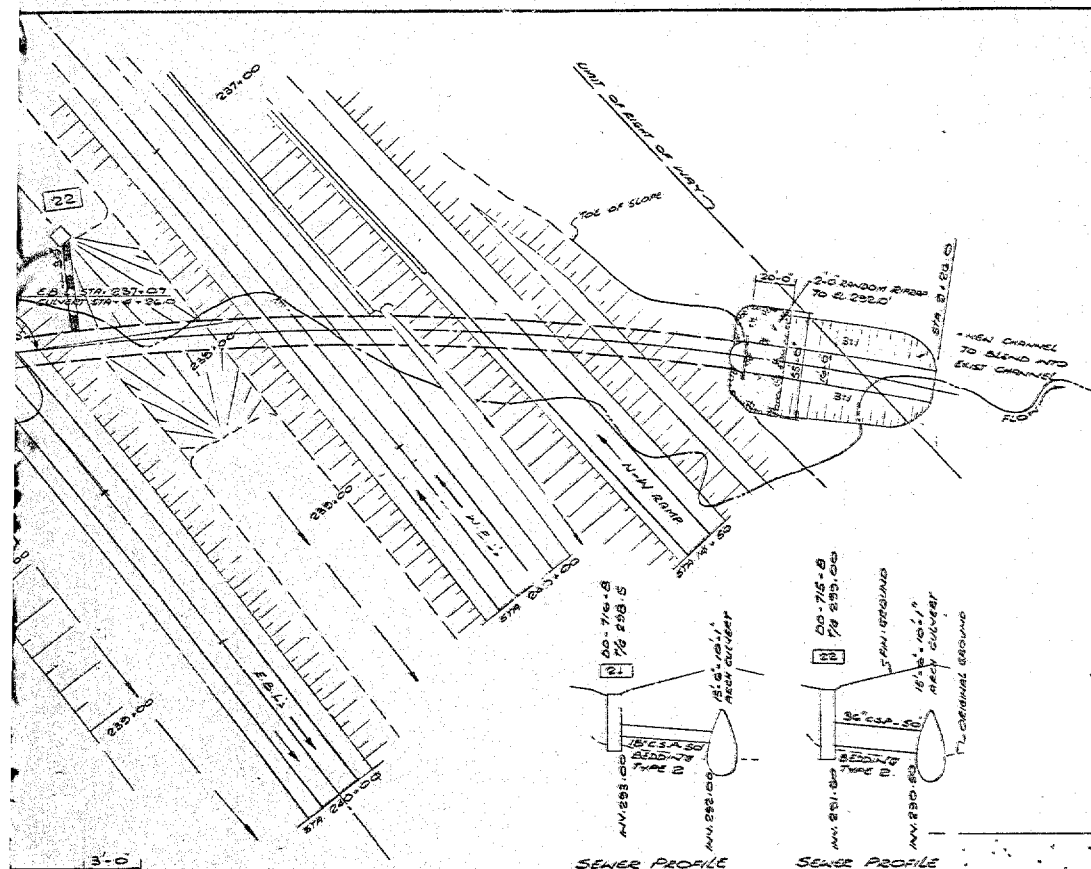
CULVERT No. 1  
HWY. 417 - STA. 237+07 E.B.L.

Giffels, Davis & Jorgensen Limited  
Consulting Engineers

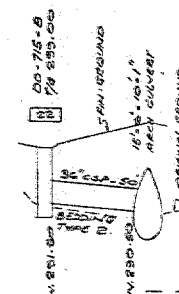
7-11077

# NOTES

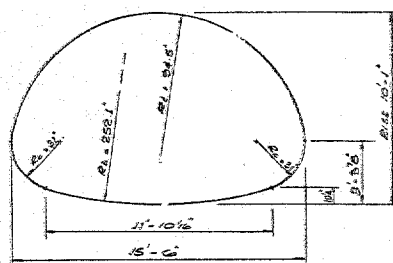
- CLAS. OF CONCRETE - 3000 P.S.I. @ 28 DAYS.
- CLEAR COVER TO REINFORCING STEEL = 3"
- STEEL PIPE TO BE 15'-6" 10'-1" PLAIN GALV. PLATE
- STEEL PIPE TO BE STRUCT. 12" P.P.E. GAUGE #10
- CULVERT SHALL BE ASSEMBLED ON SITE IN THE FINAL LOCATION SHOWN ON THE DRAWINGS.
- THE 6" CURVE FOR THE CULVERT IS TO BE REMOVED BY USING THE FLEXIBILITY OF THE CORRUGATION.



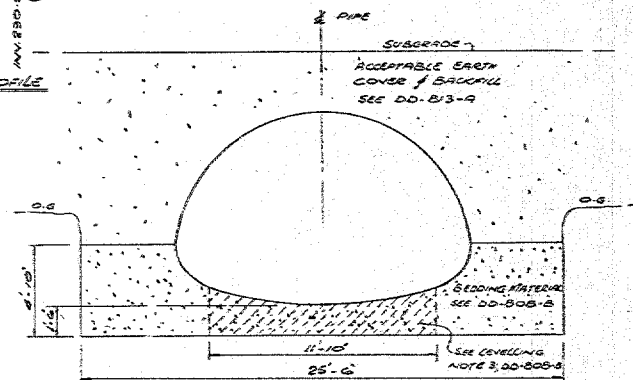
SEWER PROFILE



SEWER PROFILE

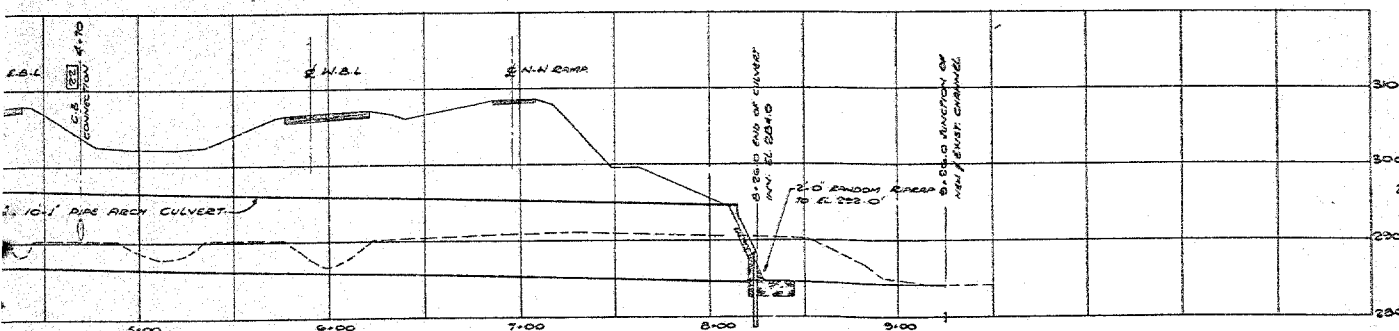


N.T.S.

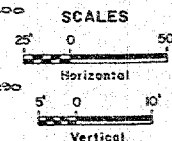


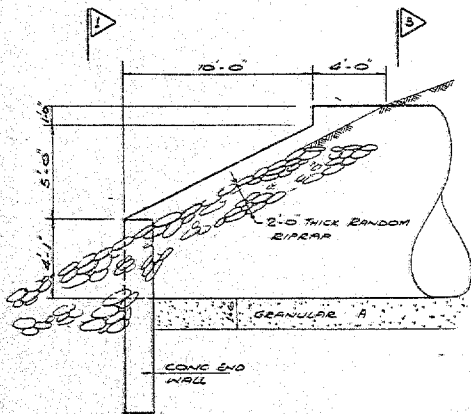
BEDDING & BACKFILL DETAILS

N.T.S.



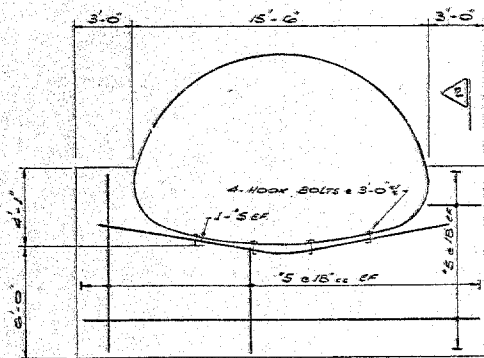
PROFILE



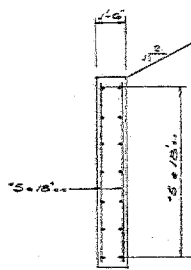


TYPICAL END DETAIL

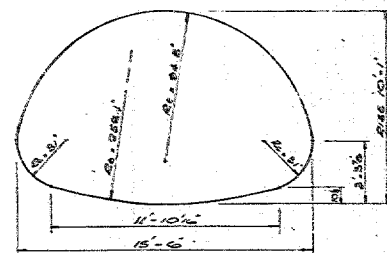
N.T.S.



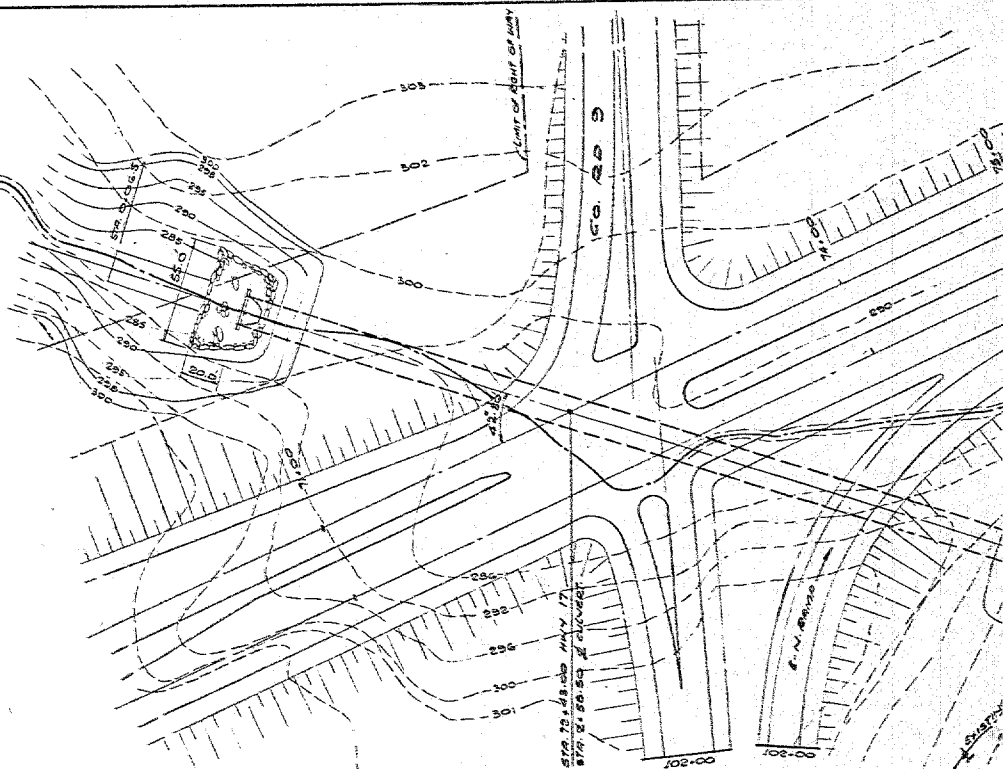
1 N.T.S.



2 N.T.S.



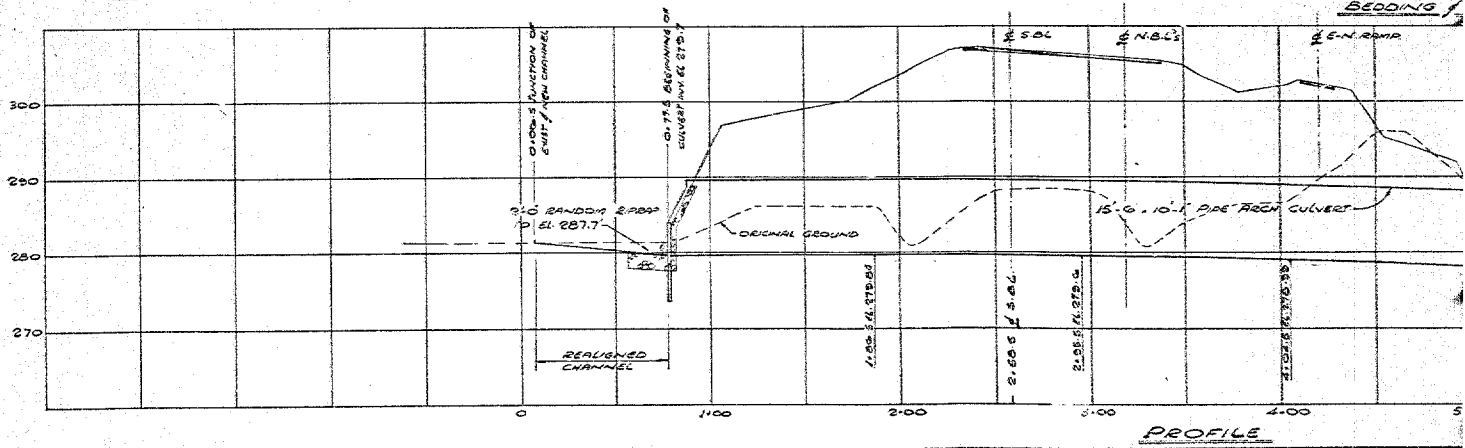
3 N.T.S.



PLAN

SCALE - 1" = 40'-0"

CULVERT NO. 2



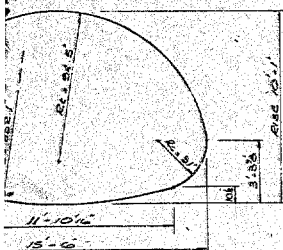
PROFILE

①-ZD

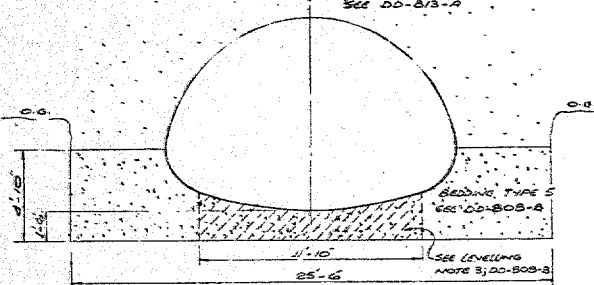
SHEET  
31

⑥

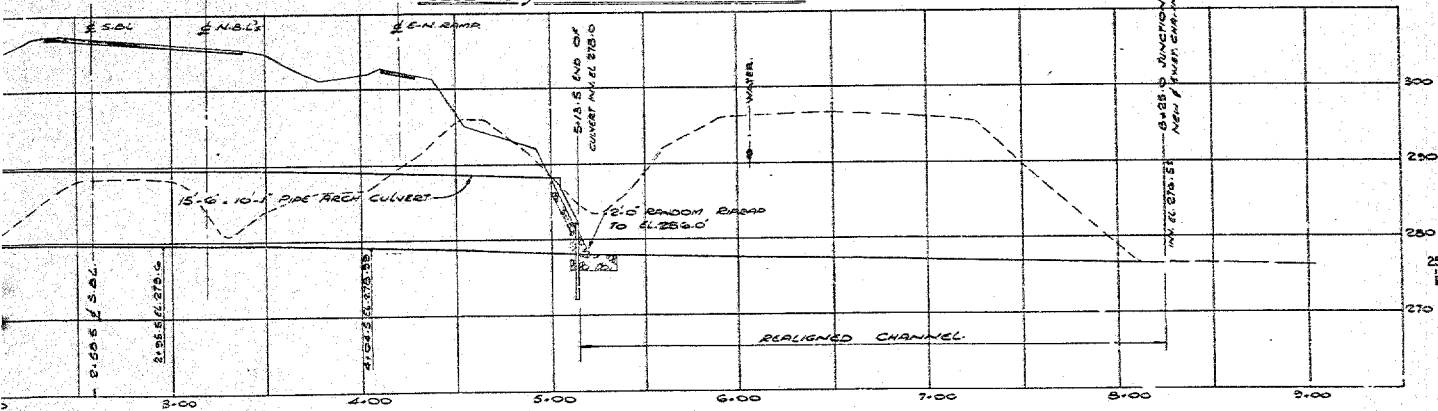
BUILD A PLATEAU TO EL. 292.0  
BOUNDED BY HWY 17, THE NEW  
REALIGNED DITCH, AND THE  
E-N RAMP



- CLASS OF CONCRETE - 3000 P.S.I @ 28 DAYS.
- CLEAR COVER TO REINFORCING STEEL - 3"
- STEEL PIPE TO BE 15" O.D. 10" I.D. 10 GA. PLATE STEEL, PIPE TO BE STRUCT. 10 PIPE GAUGE 10
- CULVERT SHALL BE ASSEMBLED ON SITE IN THE FINAL LOCATION SHOWN ON THE DRAWING.

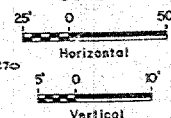


BEDDING & BACKFILL DETAILS.



## PROFILE

## SCALES





CONT. No. 73-28  
W. P. No. 432-64-C7



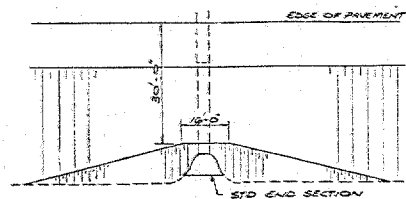
EXTENSION - CULVERT N° 4  
HWY. 417 - STA. 249+50 E.S.L.

SHEET  
32

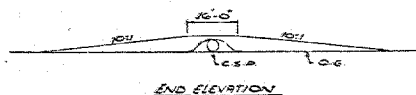
Giffels, Davis & Jorgensen Limited  
Consulting Engineers

NOTES:-

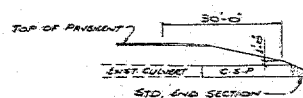
- STEEL PIPE TO BE 72"  $\phi$  C.I. 11' L. S.W. 10 GAUGE



PLAN

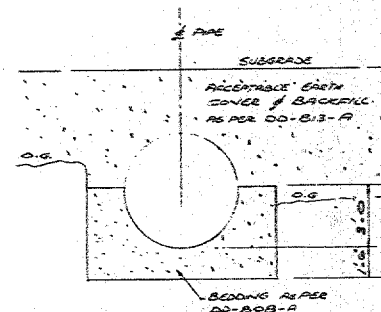


END ELEVATION



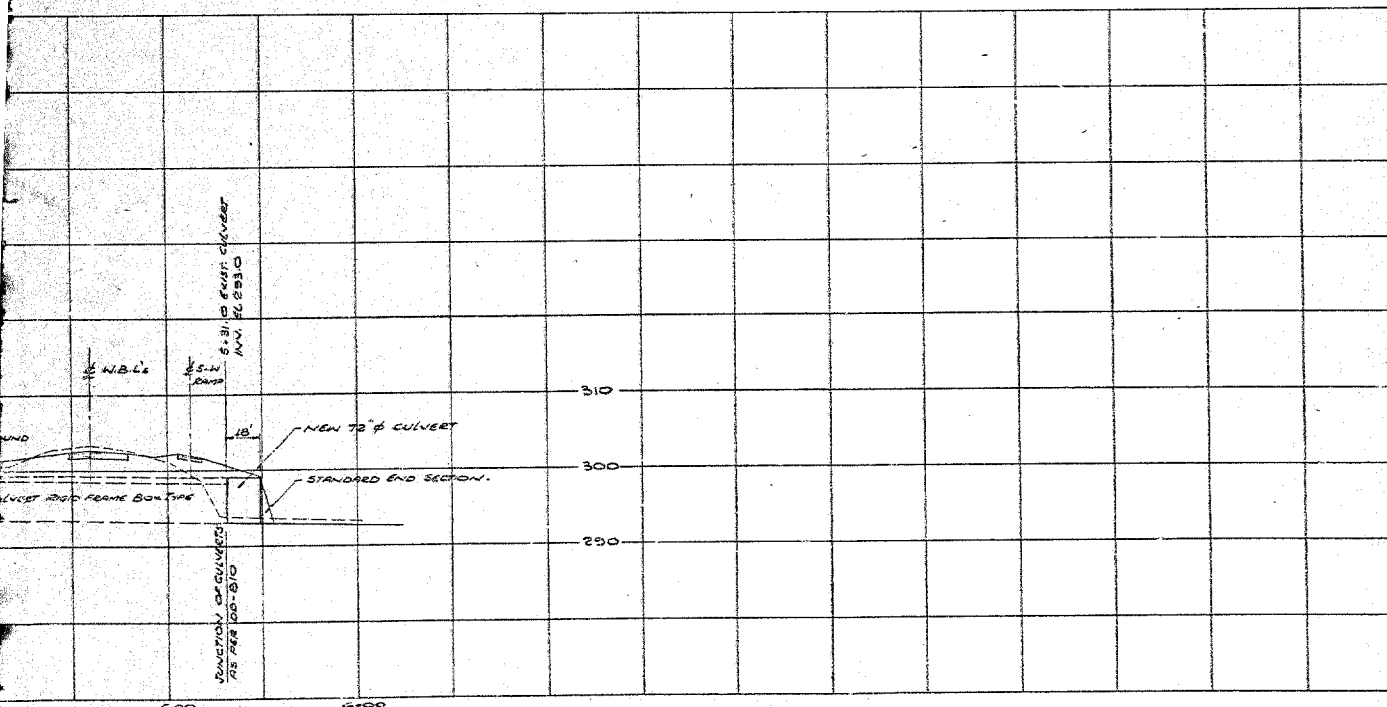
CROSS SECTION

CULVERT END TREATMENT  
(NORTH END ONLY)  
N.T.S.

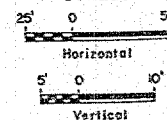


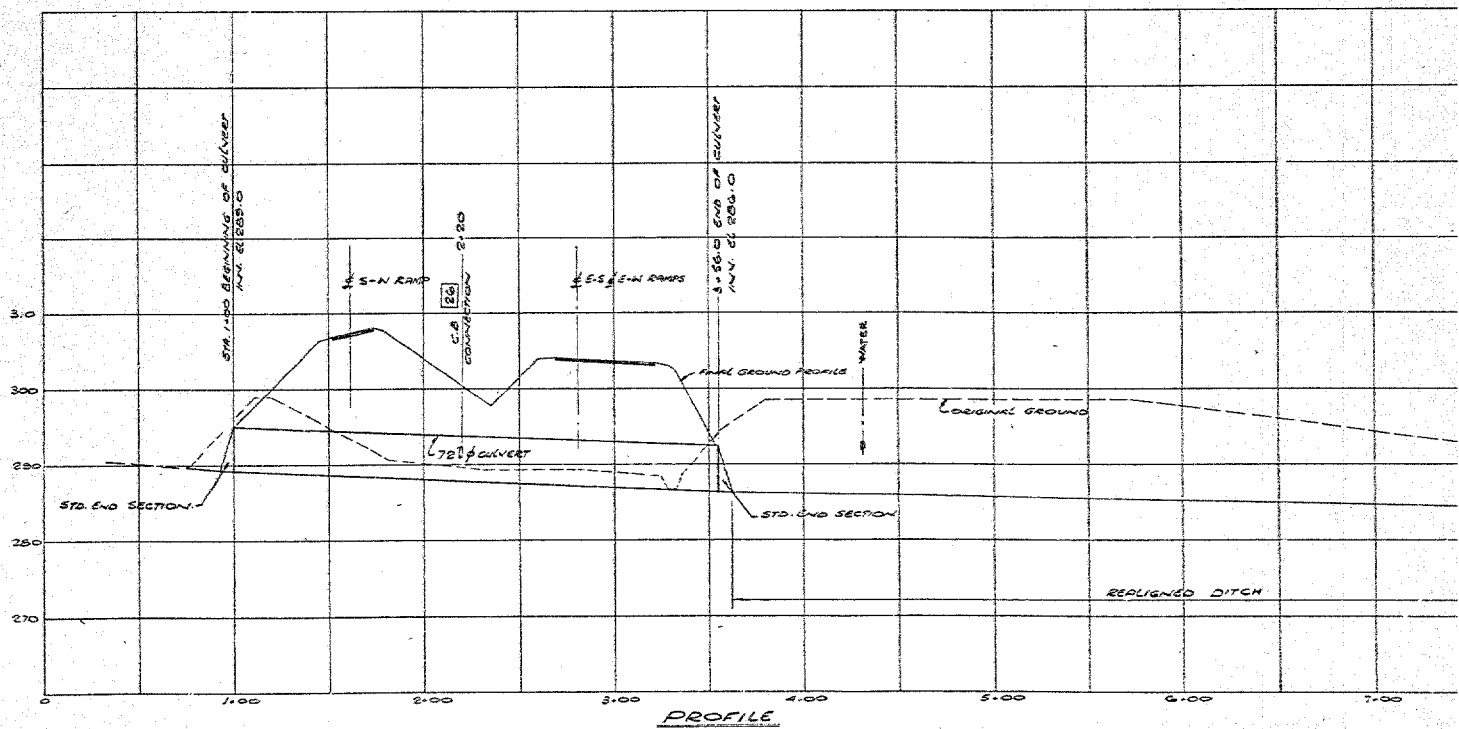
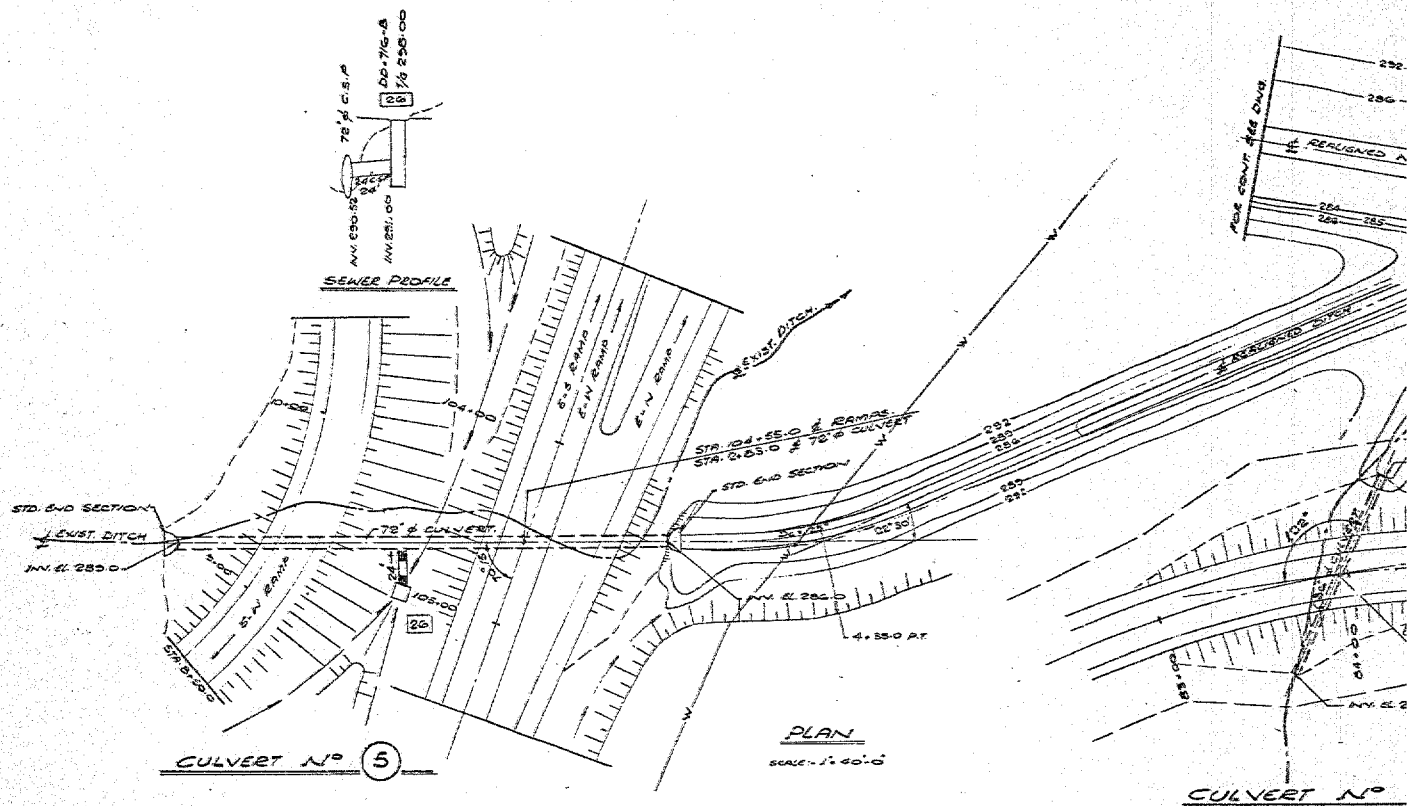
BEDDING & BACKFILL DETAILS

N.T.S.



SCALES





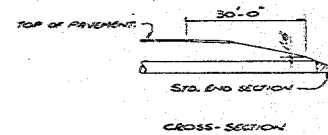
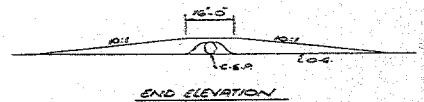
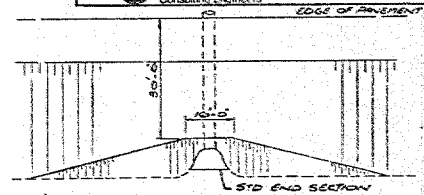
CONT. No. 73-28  
W. P. No. 432-64-07



SHEET  
33

CULVERT No 5  
HWY. 417-STA. 104+55 E-N-S RAMP  
CULVERT No 6  
CORKSTOWN RD. - STA. 83+95

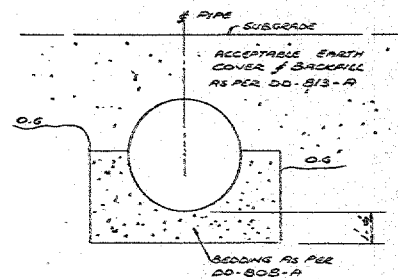
Giffels, Davis & Jorgensen Limited  
Consulting Engineers



#### CULVERT END TREATMENT

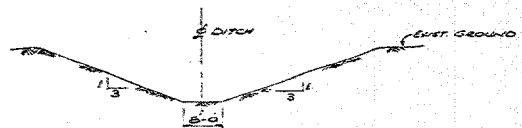
##### CULVERT (5) SOUTH END.

N.T.S.



#### BEDDING & BACKFILL DETAILS

N.T.S.

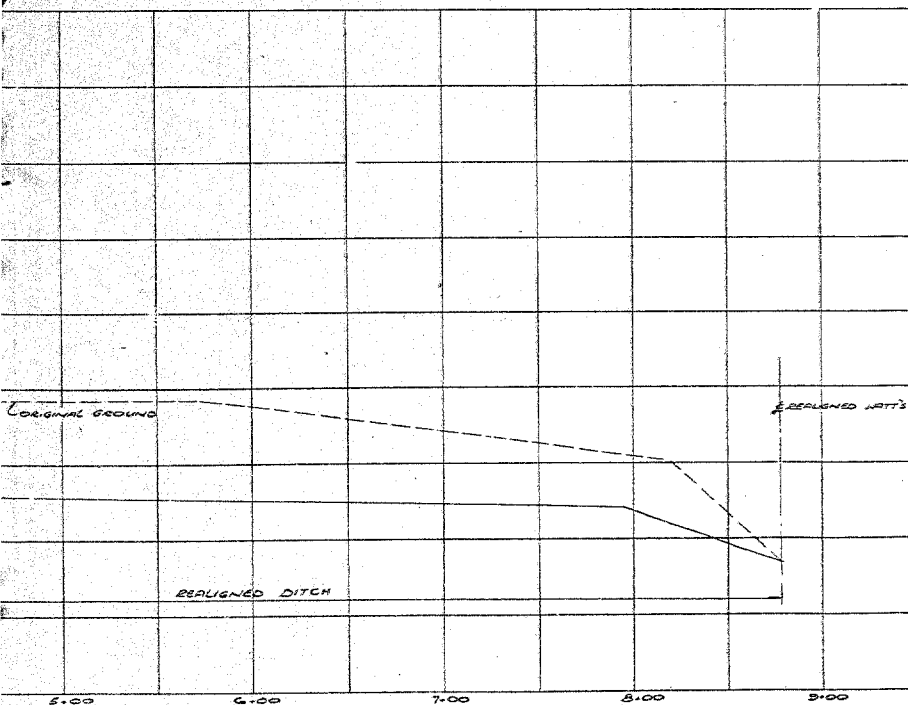
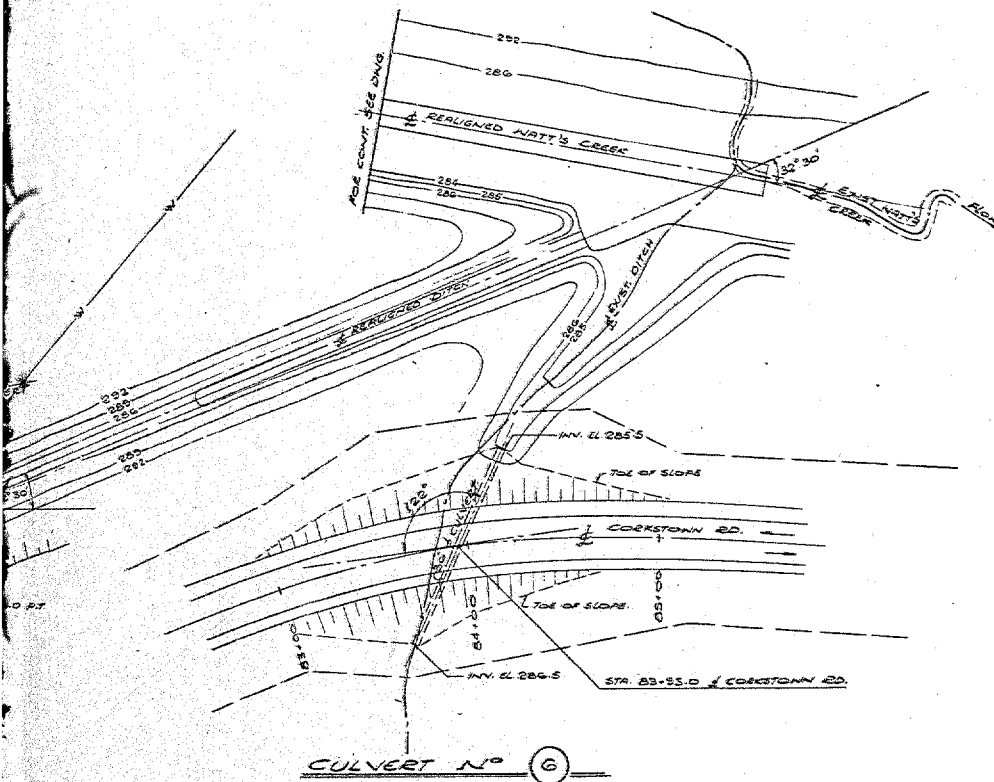
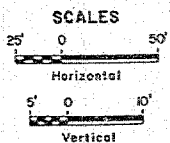


#### SECT. THRU REALIGNED DITCH

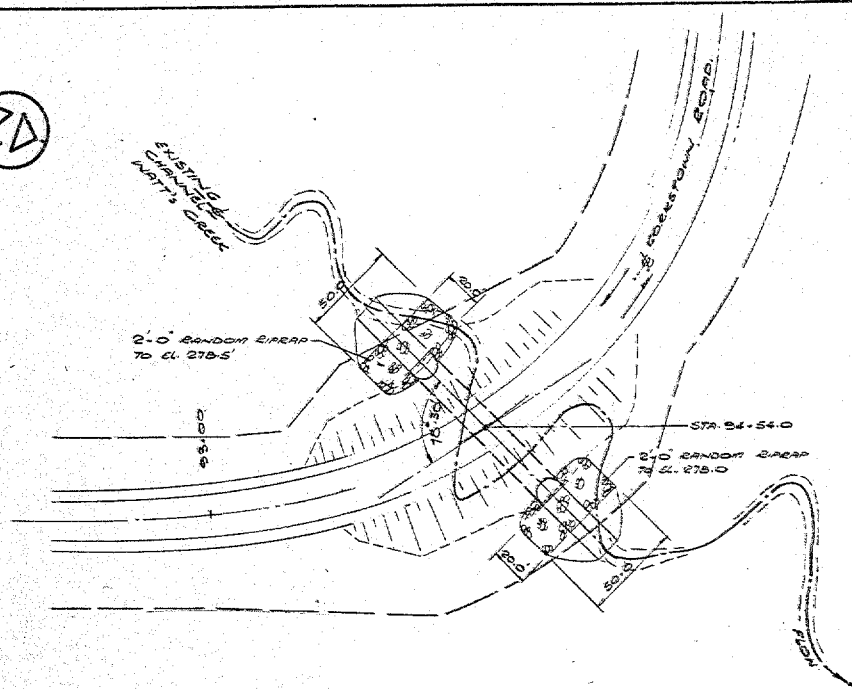
N.T.S.

#### NOTES:-

- (5) STEEL PIPE TO BE 72" C.S.P. PLAN GALV. GAUGE #10
- (6) STEEL PIPE TO BE 36" C.S.P. A.C. #10 GAUGE #10



20



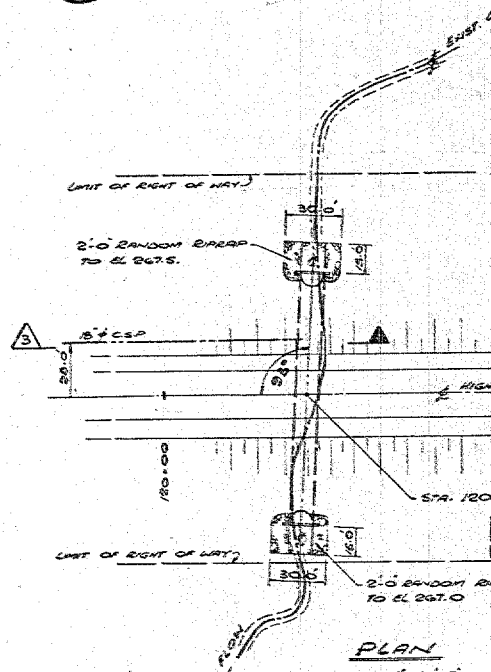
PLAN

SCALE: 1" = 40'-0"

CULVERT NO. 3

20

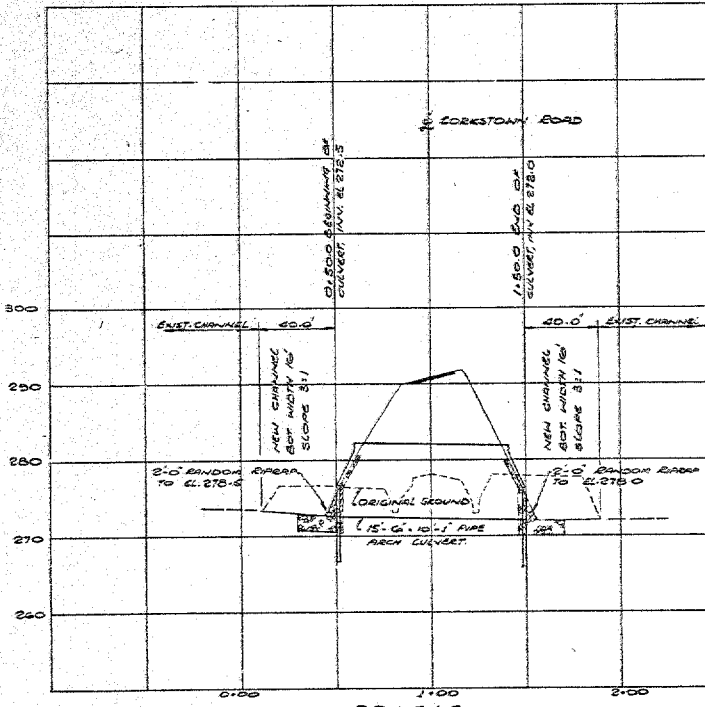
Half size



PLAN

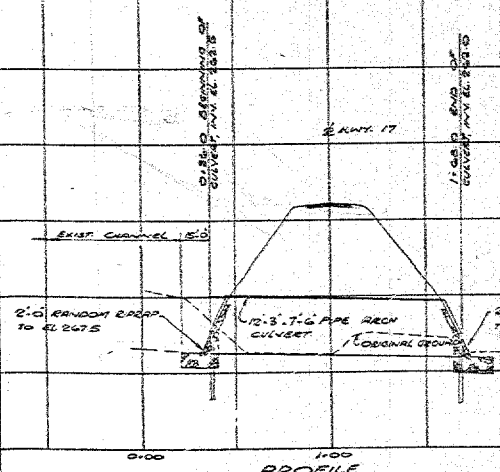
SCALE: 1" = 40'-0"

CULVERT NO. 7



PROFILE

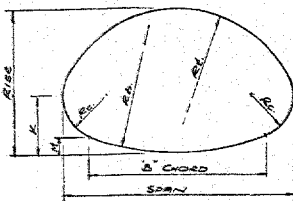
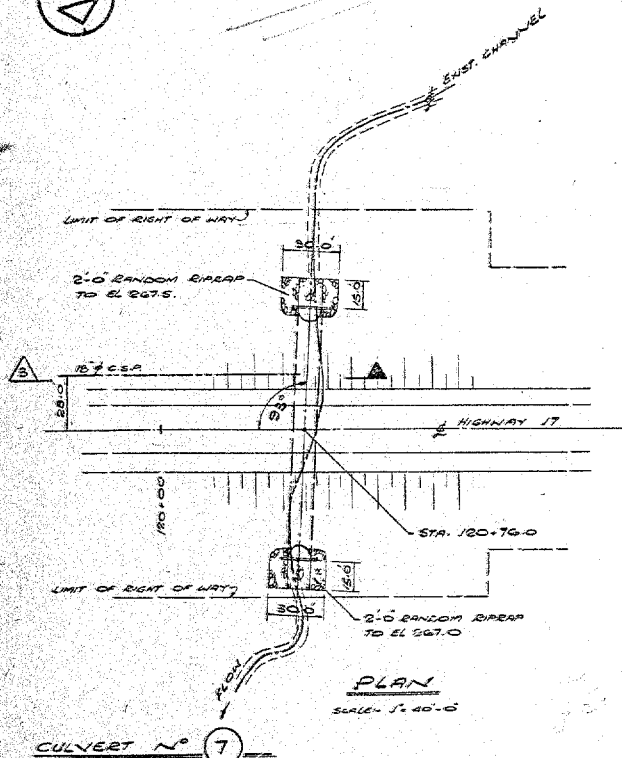
20.W



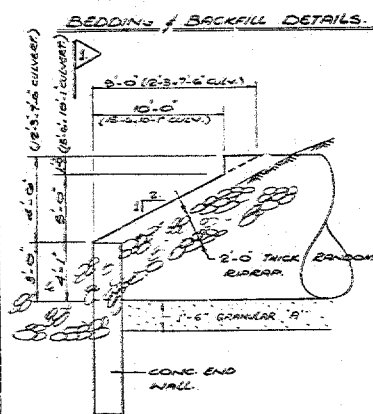
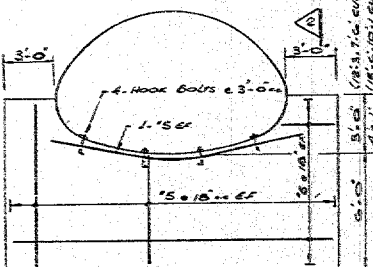
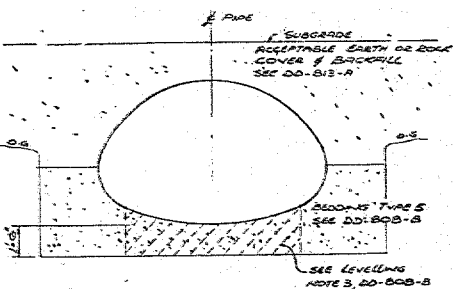
PROFILE

7

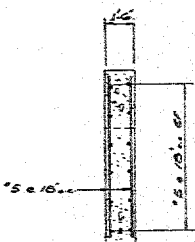
Half size!



SPAN	RISE	R1 (IN)	R2 (IN)	R3 (IN)	R4 (IN)	B	K	M
12'-3"	7'-6"	150.3	27	50.1	5'-4 1/2"	35'	10 1/2"	
15'-0"	10'-0"	252.1	31	94.5	11'-10 1/2"	35'	10 1/2"	

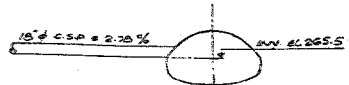


TYPICAL END DETAIL



N.T.S.

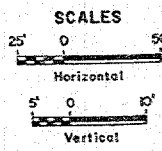
N.T.S.



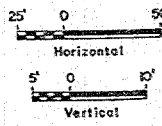
N.T.S.

NOTES:-

- CLASS OF CONCRETE - 3000 P.S.I. @ 28 DAYS
- CLEAR COVER TO REINFORCING STEEL - 3"
- STEEL PIPE TO BE 15'-0" x 10'-0" PLAIN GALV. R; STEEL PIPE TO BE STRUCT. R PIPE GAUGE 10' x 12'-3" x 7'-6" PLAIN GALV.
- R; STEEL PIPE TO BE STRUCT. R PIPE GAUGE 12'
- CULVERT SHALL BE ASSEMBLED ON SITE IN THE FINAL LOCATION SHOWN ON THE DRAWING



SCALES



CONT. No. 73-28  
W. P. No. 432-64-07

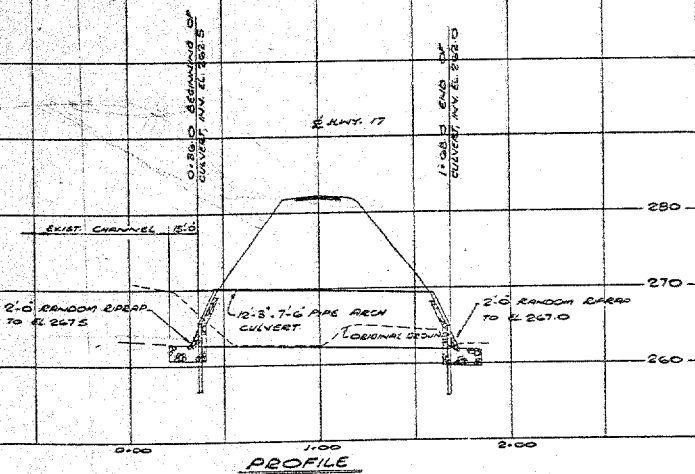
CULVERT No. 3  
CORKSTOWN RD. - STA. 94+54  
CULVERT No. 7  
HWY. 17 - STA. 120+76

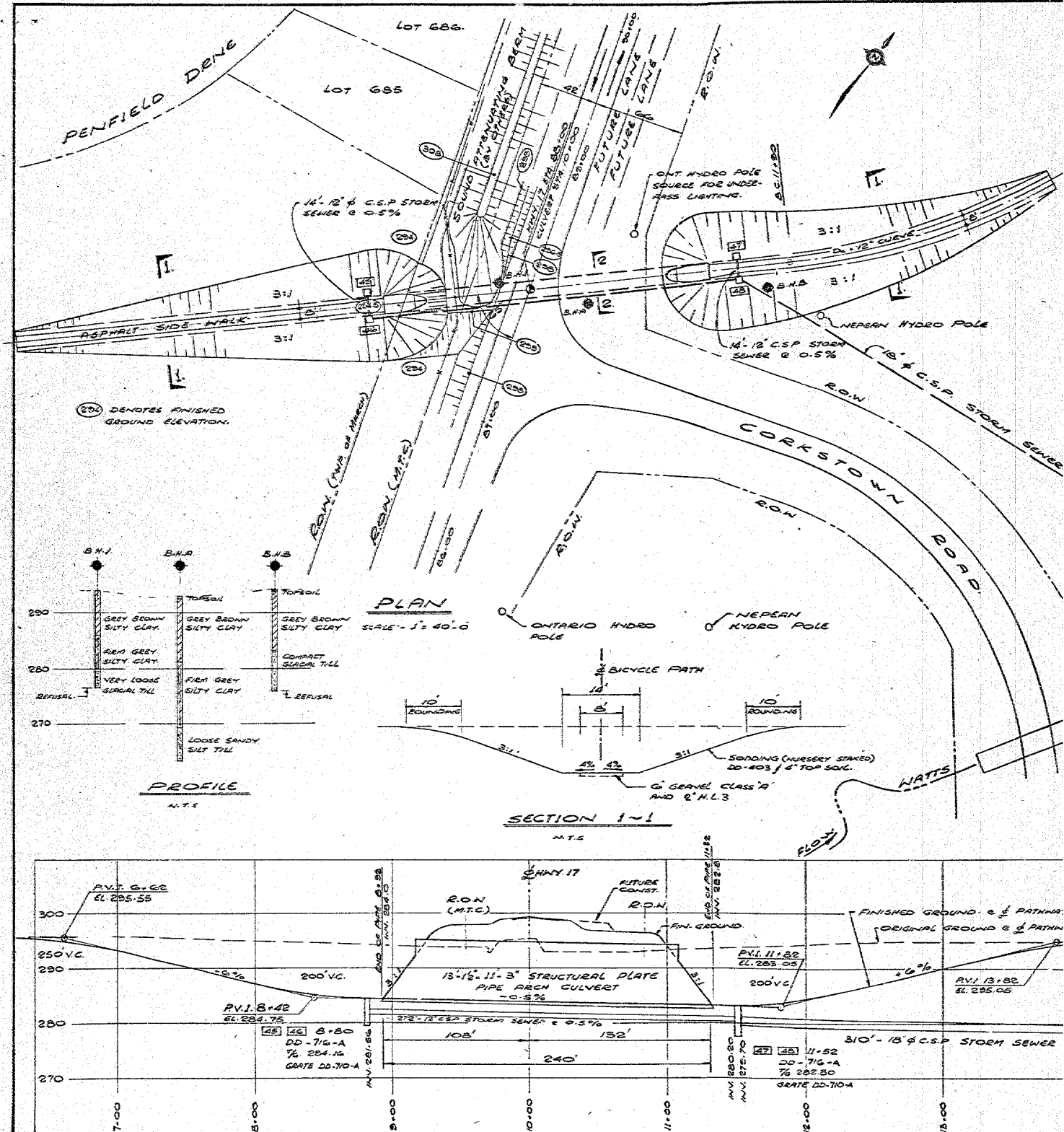
Giffels, Davis & Jorgensen Limited  
Consulting Engineers

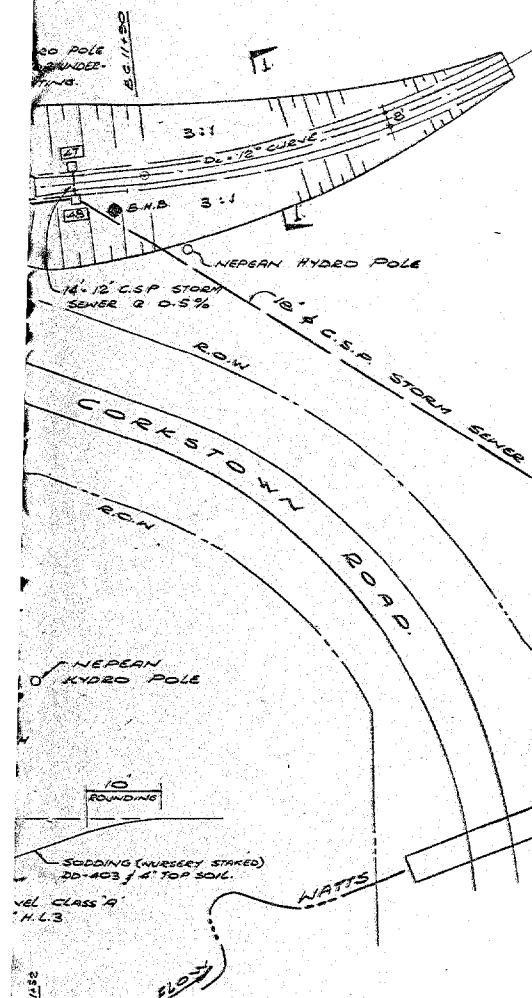
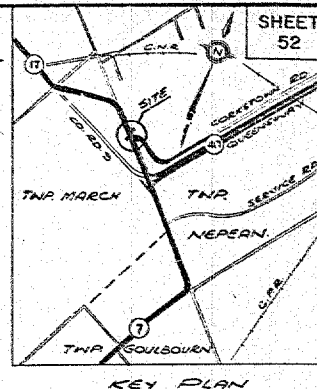
SHEET  
34



R.O.W.

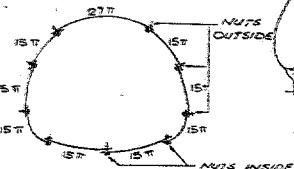
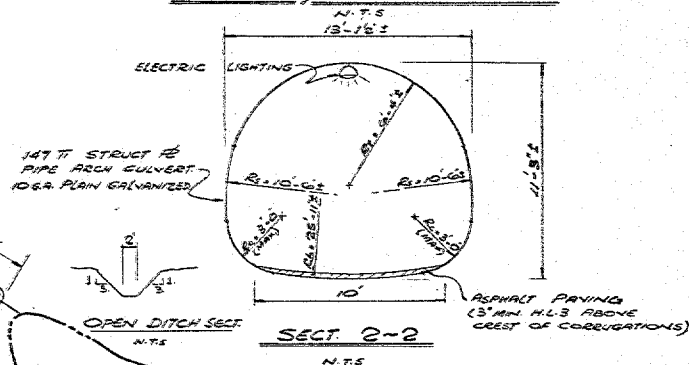




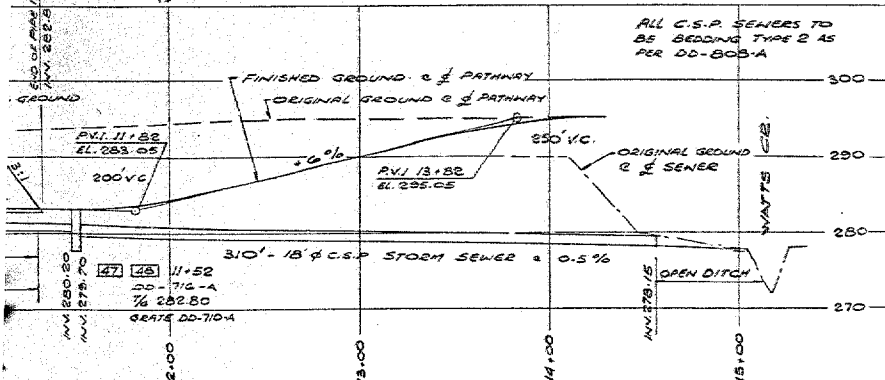
GRANULAR 'A' BEDDING  
MATERIAL1" G MIN OR AS  
DIRECTED BY THE  
ENGINEERBEDDING TYPES  
SEE DD-808-BSEE LEVELLING  
NOTE 3  
DD-808-BSUBGRADE  
ACCEPTABLE EARTH  
COVER & BACKFILL  
SEE DD-813-A12" STORM  
SEWER

KEY PLAN

## BEDDING &amp; BACKFILL DETAILS

TYP. LAPS  
& BOLTING ARRGT.

N.T.S.

ALL C.S.P. SEWERS TO  
BE BEDDING TYPE 2 AS  
PER DD-808-A

REV.	REVISION	DATE	BY
------	----------	------	----

**National Capital Commission**  
Commission de la Capitale nationale

BIKEWAY UNDERPASS  
HIGHWAY 17 AND CORKSTOWN RD.  
(STRUCTURE INSTALLATION & GRADING DETAILS)Giffels, Davis & Jorgensen Limited  
Consulting Engineers

DESIGNED BY G. R. TILLY	SCALE HORIZ. - 1" = 40'
DRAWN BY A. L. C.	VERT. - 1" = 10'
CHECKED BY VENNIE PAR	DRAWING NO. W 7207-1
DATE JULY 25 / 1972	DESIGN NO.

MATERIALS & TESTING OFFICE  
EASTERN REGION

W.O. 71-11077

SOILS DESIGN REPORT

W. P. 432-64-07

Hwy. 417 N'ly. to 0.2 Mi. S. C.N.R. Crossing

Reg. Rd. 9 (Prop. Hwy. 17) G. D. GB. P & APP. I

71-11-077

DISTRIBUTION

S. J. Markiewicz (2)  
D. W. Farren  
A. G. Stermac  
F. G. Allen  
T. C. Muir  
D. A. Barr  
J. E. Callaghan (2)  
A. J. Percy

*H. A. Meyer*.....  
H. A. Meyer,  
Project Soils Engineer

Z. L. Katona  
B. J. Giroux  
A. R. Rutka  
G. A. Wrong  
R. J. Forrest  
H. B. McKay  
P. D. Billings

*E. R. Saint*.....  
E. R. Saint,  
Regional Materials Engineer

*A. M. Batten*.....  
A. M. Batten,  
Senior Soils Supervisor

*Jan 24/72*.....  
Date

# SOILS DESIGN REPORT

Hwy. 417 N'ly. to 0.2 Mi. S. of C. N. R. Crossing

W. P. 432-64-07

Regional Road # 9 (Prop. Hwy. 17)

Proposed G., D., G.B., Pav., & App. Project

<u>Surveys Profile</u>	<u>Soils Plan and Profile</u>	<u>Station to Station</u>	<u>Line</u>	<u>Township</u>	<u>Surveys Plan</u>
C-64-17-2	17K9-4-2	47+85 to 150+15.10	'F'	Nepean	B-64-6
				& March	
C-52-35	417K9-4-1	66+80 to 100+00	Twp.	Nepean	B-64-6
			Road		

## GENERAL DATA

It is our understanding that the following will be included with this project.

1. Placement of approach fills for future Hwy. 417, Regional Road 9 interchange structure (W. P. 431-64-00).
2. Placement of interchange leg fills in excess of 7' in height in order to allow for the maximum consolidation settlement before paving of the interchange.
3. Grading and paving of relocated Regional Road 9 (Proposed Hwy. 17).
4. Grading and paving of E-N, S. ramp.
5. Grading and paving of S-E ramp.
6. Grading and paving of median cross-over such that the E.B.L. of the Q'Way is linked to the W. B. L.
7. Relocation of Corkstown Road (Soils Profile 417K9-4-1).

Cont'd.....

The Foundation Section have completed investigations and issued reports on the following:

1. Interchange structure site (W. P. 431-64-00)
2. Crossing at Regional Road 9 and Watts Creek at Stations 73+00 to 75+00.
3. Crossing at Regional Road 9 and Water Course at Stations 119+00 and 121+00.

These foundation reports contain details regarding stability and berm requirements and anticipated settlement of proposed embankment fills. Recommendations for bedding of culverts at the creek crossings are also indicated in the foundation reports.

The proposed Hwy. 17 alignment is mainly on cross country revision located on the east side of former County Road # 9. It is proposed to construct a 24' wide pavement surface with 8' shoulders plus 2' shoulder rounding on this section.

Anticipated A.A.D.T. before Hwy. 417 is completed ranges from 10,000 to 12,000. After Hwy. 417 is completed it is anticipated that residual A.A.D.T. will range from 5,000 in 1975 to 12,000 in 1990.

#### SOILS INVESTIGATION

Power and hand auger equipment was used in November 1971 to carry out a soils survey on this project. Borings were generally placed in cuts to 4' minimum below profile grade, and in fill areas to 4' minimum below original ground unless stopped by bedrock or boulders. The results of this investigation have been plotted on the soils profile.

#### PHYSIOGRAPHY AND SOILS DATA

This project is located within the physiographic region known as the Ottawa Valley Clay Plains. This region lies along the southern margin of the Canadian Shield.

Cont'd.....

The topography in the immediate vicinity of the project is generally flat to undulating, containing relatively deep, meandering water courses through the area. Bedrock outcrops occur near the north and south limits and in the vicinity of Sta. 128. The clay plains consist of silty clay known locally as "Leda" clay. The consistency of the silty clay varies from soft to stiff and is very compressible. Fills placed over this silty clay are therefore expected to settle over a long period due to consolidation of the silty clay. Excavations in the silty clay for roadway cuts is expected to be difficult since the field moisture content of most of this material is at least 10% above the plastic limit of the soil.

#### BORROW MATERIALS

Clay materials in the immediate vicinity of this project are unacceptable for use as earth borrow due to their high field moisture content. Borrow will likely be acquired from the sand deposits at Fallowfield and north of Stittsville at an average haul distance of approximately 5 miles.

#### GRANULAR MATERIALS

Material suitable for use as Granular 'B' and for producing Granular 'A' is located in pits along Regional Road 5, at an average haul distance of approximately 6 miles. Most of the granular located within this deposit is qualitatively unsuitable for asphalt aggregate.

Material suitable for use as asphalt coarse aggregates is located in commercial quarries to the south of Bell's Corners at an average haul distance of approximately 8 miles.

Cont'd.....

### GRADELINE

The gradeline set by Functional Planning in November, 1969, for Regional Road 9 and indicated on our soils profile issued in March, 1970, is generally satisfactory from soil's considerations. Functional Planning have now lowered the gradeline considerably in conjunction with a proposed berm adjacent to Regional Road 9 to lessen the traffic noise.

From soil's considerations, it is recommended that the gradeline be raised as close as possible to that suggested on the soils profile for the following reasons.

1. Reduce extensive excavation in wet clay and silt cuts.
2. Reduce the total granular requirements.
3. Better structural performance expected in shallow fills instead of clay cut.

The soils design has been based on the proposed soils grade. Any adjustment of this grade would seriously affect the subgrade uniformity and the condition of the subsoil material near the subgrade level such that a heavier design would result.

It is assumed that the Township Road Connections which are located within the gradeline revision sections of Regional Road 9 will also require minor gradeline revisions.

### CONSTRUCTION FEATURES

In view of the poorly drained terrain on much of the project, ditching should be carried out in advance of roadway grading as much as possible. Earth fill should be placed to at least the original ground level immediately after stripping to minimize water ponding on the subsoils within the grading area during construction operations.

Cont'd.....

## RECOMMENDATIONS

### 1.1 Type of Granular Materials

It is recommended that the granular materials on this project consist of Granular 'A' and Granular 'B'.

### 1.2 Depths and Widths of Granular Materials

It is recommended that the granular materials be placed for the full width of the roadbed to the following depths.

#### (a) Regional Road 9 and Hwy. 417 Connecting Legs

Clay Cuts	- 6" Granular 'A' over 24" Granular 'B'
Sandy Cuts	- 6" Granular 'A' over 12" Granular 'B'
Earth Fills	- 6" Granular 'A' over 12" Granular 'B'
Rock Cuts & Rock Fills	- 6" Granular 'A' over 6" Granular 'B'

#### (b) Corkstown Road and Twp. Rd. Connections

Earth Cuts	- 6" Granular 'A' over 12" Granular 'B'
Fills	- 6" Granular 'A' over 6" Granular 'B'

### 1.3 Type of Culvert Backfill

All granular material required for culvert bedding and backfill should consist of Granular 'B'.

### 2.1 Asphalt Pavements - Types and Depths

#### (a) Regional Road 9 and Permanent Hwy. 417 Connection Legs

Binder Course	- 1 " Sand Asphalt
Binder Course	- 1½ " H. L. 8

Cont'd.....

Binder Course	- 1½ " H. L. 8
Surface Course	- 1½ " H. L. 1
	—
Total	5½ "

(b) Hwy. # 417 Interchange Legs (To be Built Under This Project)

Binder Course	- 1 " Sand Asphalt
Binder Course	- 1½ " H. L. 8
Binder Course	- 1½ " H. L. 8
Binder Course	- 1½ " H. L. 3
	—
Total	5½ "

(c) Temporary Connections - Conn. 1 and Conn. 2

Binder Course	- 2 " H. L. 8
Surface Course	- 1½ " H. L. 3
	—
Total	3½ "

(d) Other Township Road Connections

Surface Course Only	- 1½ " H. L. 3
---------------------	----------------

3.1 Use of Cut Materials

The silty clay soils and sandy silt soils are generally unacceptable for fill purposes due to high field moisture content and frost susceptibility. These materials could be utilized outside the 1:1 of earth fill slopes on fills up to 7' high and outside rock fill slopes as per DD-224 provided the material can be shaped and compacted. If there is an excess of silty clay and sandy silt soils

Cont'd....

which cannot be utilized as described for flattening fill slopes, it is understood that it will be made available to the municipality for purposes of constructing a noise attenuating berm along Regional Road # 9. The silty clay soils and sandy silt soils are not suitable for any portions of the fills or stabilizing berms to be placed across Watt's Creek and the approach fills to the proposed interchange structure.

### 3.2 Proposed Hwy. # 417 Cut Construction

It is proposed to excavate the Hwy. # 417 cuts in the vicinity of the former County Road # 9 interchange after the structure has been constructed in order to minimize the falsework requirement for the structure construction. The cut material in this area consists of sensitive silty clay materials. The in-situ moisture content generally ranges from 10 to 15 percent above the plastic limit. The proposed cuts are approximately 10' deep in the vicinity of the proposed structure crossing.

It is anticipated that this cut excavation will be carried out with a dragline in view of the wet and plastic condition of the clay material. It is therefore recommended that as much as possible that this excavation be carried out in advance of the structure construction as a part of the main Hwy. # 417 grading contract (W.P. 433-64-02). This procedure would have the added advantages that maximum use of the wet clay materials could be made outside the roadbed portion as outlined in recommendation 3.1 and maximum drying of the cut subgrades would occur before the granular subbase is placed. Drainage should be provided for the cut subgrade in the interim between

Cont'd.....

grading and granular base construction.

### 3.3 Cut Slope Stability

Some surface stability problems may be encountered on the Hwy. # 417 cut slopes through the wet clay materials. It is anticipated that the slope surfaces will be sufficiently stable provided that they are sodded. If during construction, surface problems are encountered with trimming the cut slopes in this vicinity, additional treatment should be determined by the District Construction and Regional Materials and Testing staff. It may be necessary to provide a free draining granular blanket on some portions of the cut slopes.

### 3.4 Cut Subgrade Treatment

If construction scheduling permits, it is proposed to carry out a test section of lime treatment on the Hwy. #417 wet clay cut subgrade materials in the vicinity of County Road # 9.

Construction of such a test section should be carried out on the completed subgrade soon after the excavation is completed in order to obtain maximum information with respect to beneficiation of the material and performance of the treated material through the local climatic cycles. It would probably be carried out on a day labour and equipment rental basis.

Specific recommendations as to construction of such a test section will be made after the construction schedule is more firmly determined and further laboratory analysis is received.

Cont'd....

#### 4.1 Early Placement of Higher Fills

Fills higher than 7' to be placed over clay foundations' conditions should be placed as early as possible to attain the maximum amount of consolidation settlement before follow-up paving. This would apply to the approach fills at the Hwy. 417 interchange structure and all fills across Watt's Creek.

It is suggested that a special provision be inserted in the contract to require that these fills be placed within 3 months after the contract is awarded.

#### 5.1 Stockpiling Of Materials

A special provision should be inserted to limit the heights of stockpiled material to 12' due to the underlying weak clays. In addition, stockpiles should not be permitted within 200' of creek banks and gullies or within 200' of proposed cut slopes.

#### 6.1 Culvert Types and Bedding

The following recommendations apply to culvert sites not covered by investigations and reports by the Foundation Section.

##### Till Foundation Soil

Any type of culvert suitable from foundation considerations - bedding in accordance with DD-808-A and B

##### Clay Foundation Soils

- Box type concrete or C. S. P. culverts
- bedding with minimum of 12" Granular 'B'. Excavation width for this bedding with pipe culverts, should be twice the diameter of the pipe to be placed.

Cont'd.....

### 7.1 Topsoil Stripping in Ditches

It is recommended that the organic at the bottom of all existing ditches and creeks be stripped to at least subgrade width under proposed fills in Regional Road 9 and Hwy. 417 Connecting Legs. This requirement should be indicated on the contract drawings.

### 7.2 Topsoil Depths for Stripping

The depth of topsoil has been noted on the soils profile. An average depth of 9" should be assumed for estimating purposes.

### 8.1 Treatment of Earth Pockets Within Rock Cuts

Excavate to bedrock or a maximum of 4' below profile grade and backfill to subgrade with rock fill.

### 8.2 Transition Point Treatment

Grade point treatment as per Standard DD-411-A and D to 3' and DD-411-B to 4' is recommended for this project.

A thickness of 24" for organic leached and accumulation layers should be assumed for estimating purposes.

### 9.1 Compaction Equipment

For design estimating purposes, the following distribution is recommended:

Sheepsfoot Rollers - 15%

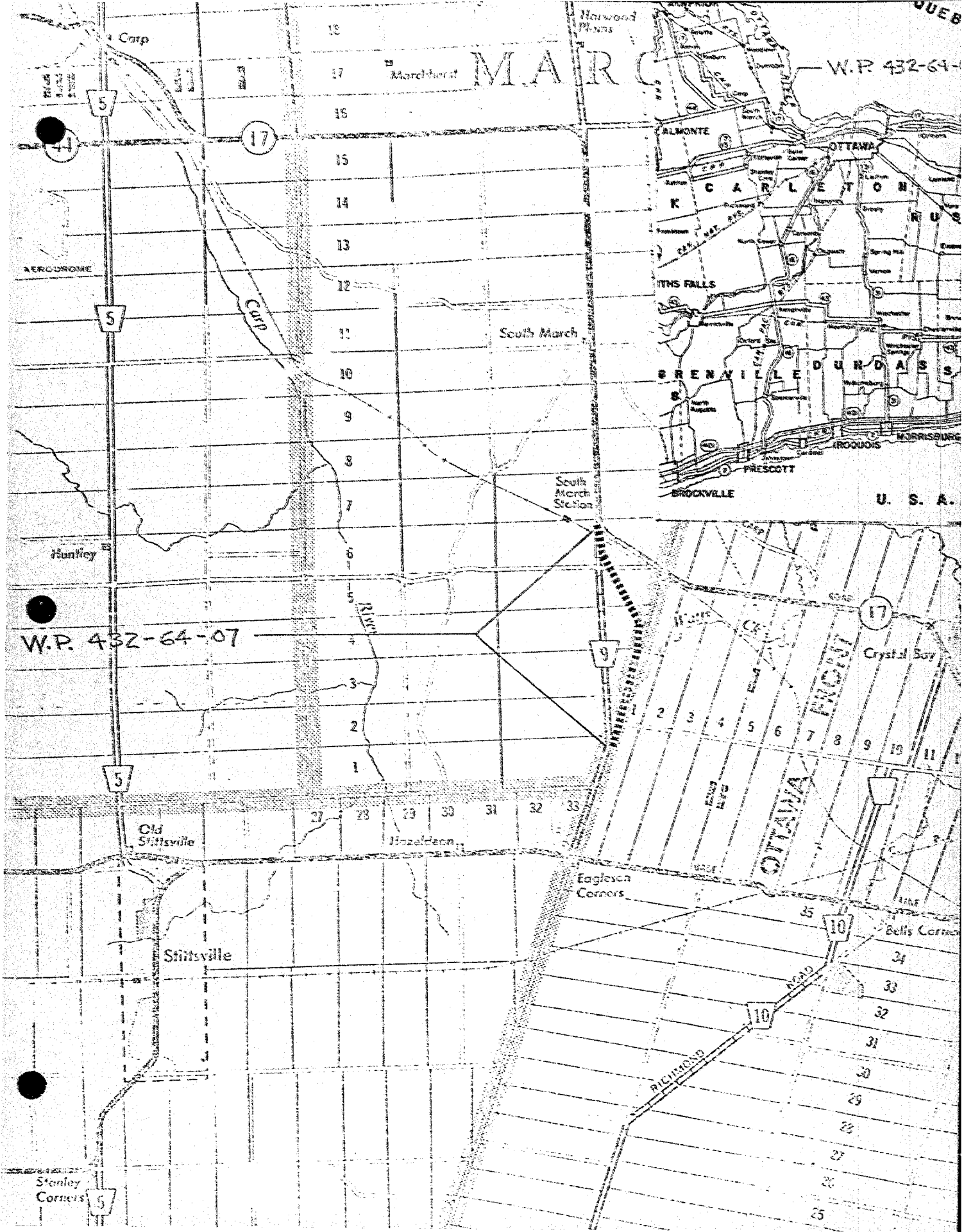
Wobble-Wheel Rollers - 85%

### 10.1 Drainage

It is understood that the pavement lanes being built under this project may form part of a 4 lane roadway and that all of the future widening would be

Cont'd.....

constructed on the east side of the initial 2 lane construction. If these plans are anticipated, it is recommended that the subgrade be shaped to provide cross fall drainage from the future centreline of the 4 lane section. It is also understood that a modified roadside ditch may be required to accommodate construction of a berm on the left of centreline. It will be necessary to provide positive subgrade drainage with standard ditches or subdrains in view of the plastic type subgrade materials on the project.



GIFFELS, DAVIS & JORGENSEN LIMITED

SOIL INVESTIGATION

PROPOSED BIKEWAY UNDERPASS

MARCH TOWNSHIP

ONTARIO.

Distribution:

5 copies - Giffels, Davis & Jorgensen Ltd.,  
Toronto, Ontario.

2 copies - H. Q. Golder & Associates Ltd.,  
Ottawa, Ontario.

July, 1972

72807

# Golder Associates

CONSULTING GEOTECHNICAL ENGINEERS

H. Q. GOLDER  
V. MILLIGAN  
J. L. SEYCHUK  
C. O. BRAUNER  
D. L. TOWNSEND

F. J. McFEERNAN  
B. E. W. DOWSE  
J. B. DAVIS

July 21, 1972.

Giffels, Davis & Jorgensen Limited,  
60 Adelaide Street East,  
Toronto 210, Ontario.

Attention: Mr. G. R. Tilly, P. Eng.

RE: SOIL INVESTIGATION,  
PROPOSED BIKEWAY UNDERPASS,  
MARCH TOWNSHIP, ONTARIO.

Dear Sirs:

This letter reports the results of a soil investigation carried out at the site of a proposed bikeway underpass which intersects relocated Regional Road No.9 about 2000 ft. north of the Ottawa Queensway in March Township, Ontario. The purpose of this investigation was to determine the soil and groundwater conditions at the site and, based on this information, to make recommendations for the design and construction of the proposed underpass from a geotechnical viewpoint.

## PROCEDURE

The field work for this investigation was carried out on June 30, 1972. Two boreholes (named A and B) were put down to practical refusal with a mobile power auger machine, supplied and operated by the F. E. Johnston Drilling Co. Ltd., of Ottawa. One borehole ( borehole 1 ) had been put down previously for a sound attenuation barrier near the western end of the proposed underpass. Standard drive open samples were taken in the clay and till subsoils present at the site. In situ vane tests were carried out in borehole A to determine the shear strength profile of the clay deposit. The water levels were observed in the open boreholes to determine the groundwater conditions at the bikeway crossing at the time of the investigation.

A detailed log of boreholes A, B, and 1 (put down previously) is given on the Record of Borehole sheets following

the text of the report. The locations of the borings are shown on Fig. 1 together with a section of the inferred soil stratigraphy along the underpass.

The samples obtained during this investigation were brought to our laboratory for detailed examination and testing. The results of the laboratory testing are shown on the Record of Borehole sheets and on Fig. 2.

The elevations given in this report are referred to the existing centerline grade on Regional Road No.9, Geodetic datum.

#### SITE AND GEOLOGY

The proposed bikeway underpass is to cross relocated Regional Road No.9 at a 25 degree skew angle, about 2000 ft. north of the Ottawa Queensway and just south of the residential housing on the west side of Regional Road No.9. The topography in the area is gently undulating.

From available geological information it is known that this area lies within the physiographic region known as the Ottawa Valley Clay Plain, characterized by flat clay plains occasionally interrupted by ridges of rock or sand. Bedrock in this area is undifferentiated, probably consisting of Precambrian crystalline limestones, granites, and gneisses and is generally overlain by a mantle of glacial till. The till is in turn overlain by variable thicknesses of marine clays which extend to the ground surface.

#### SOIL CONDITIONS

The detailed soil stratigraphy encountered in each borehole is given on the Record of Borehole sheets and is illustrated on the stratigraphic section shown on Fig. 1.

#### Sensitive Silty Clay

The principal subsoil stratum at this site is the firm to stiff grey sensitive silty clay which was found to be 11 to 24 ft. thick at the borehole locations. The upper portion of this clay, some 12 ft. in thickness, has been weathered to a very stiff crust of fissured brown to grey brown silty clay. The water content of the weathered crust increases with depth from about 36 percent near the ground surface to 50 percent near the base of the desiccated stratum.

Below a depth of about 12 ft. the colour of the silty clay changes from grey brown to grey and the consistency decreases

to firm to stiff. In situ vane shear strength values below the crust are plotted on the Record of Borehole sheets. These values ranged from about 1,300 lb/sq.ft. at the base of the crust to 600 lb/sq.ft. at depth. The results of an Atterberg limit test carried out on a sample of the grey clay indicate that the plasticity of this material is high (liquid limit value of 50 and plasticity index of 28). The moisture content of the grey clay ranged from 58 to 44 percent, being generally above the liquid limit value which is typical of the sensitive clays of the Ottawa Valley.

#### Sandy Silt Till

The Champlain Sea clay is underlain by a stratum of glacial till which was found to be 3 to 8 ft. thick. All borings were taken to practical refusal on what is considered to be the surface of the bedrock. The till material is well graded as shown on Fig. 2, consisting of sandy silt with some gravel, and a trace of clay. Occasional cobbles and boulders exist within this till stratum. Standard penetration resistances or N values obtained within this deposit ranged from 2 blows/ft. to 11 blows/ft., indicating a very loose to compact relative density.

#### GROUNDWATER CONDITIONS

The water levels observed in the open boreholes at the time of the investigation indicate that the groundwater level was about 6 to 10 ft. below present ground surface.

#### PROPOSED BIKEWAY UNDERPASS

##### a) General

It is understood that the proposed bikeway underpass at relocated Regional Road No.9 is to consist of a structural platepipe arch about 12 ft. high, 13 ft. in width, and some 215 ft. in length. The approach cut grade is at 6 percent with 3 horizontal to 1 vertical sodded side slopes proposed.

##### b) Foundations

The excavation for the pipe arch to bedding subgrade will involve excavation into the silty clay to a total depth of about 13 ft. in the central portion of the structure and through the silty clay into the glacial till material and about 2 ft. at the eastern end and western section of the structure.

No unusual problems are anticipated in excavation

into the silty clay material at the site to a depth of about 15 feet. Excavations extending into the very loose sandy silt deposit and below the water table will experience some water inflow. This groundwater inflow should be handled by pumping from sumps.

Pipe arch structures typically transmit considerable corner pressures into the subgrade soils. In this case the corner pressures generated by the overburden pressure, live loads, and pipe geometrics were calculated by Giffels, Davis, and Jorgensen Ltd. personnel to be about 2,000 lb/sq.ft. The maximum allowable bearing pressure in the firm grey silty clay and the very loose glacial till material near the proposed invert level is 1,200 lb/sq.ft. In accordance with D.T.C. practice for similar pipe arch culverts in this area it is recommended that excavation and bedding for the proposed culvert follow D.T.C. modified specification DD-808-B which includes 18 inches of granular bedding material. It is recommended that the clay subgrade along the central part of the cut be inspected by a Soils Engineer at the time the excavation takes place. Depending on the condition of the clay subgrade it may be necessary to subexcavate up to 1 foot of material along this central section of the underpass. The underpass culvert should then be backfilled and covered with acceptable sandy earth borrow material according to D.T.C. specifications DD-813-A.

Based on the moderate fill height above the pipe which is largely offset by the weight of the soil removed by the pipe, it is considered that the differential settlement along the pipe arch should be minor.

#### c) Side Slope Stability

Based on the shear strength measured in the boreholes put down at the site, the 3 horizontal to 1 vertical side slopes proposed for the approach cut sections of the underpass have an adequate factor of safety against instability. Sodding of these side slopes will minimize surficial erosion and slumping caused by snowmelt and rainwater running down the face of the slope. In this regard, it is recommended that grading be carried out at the top of the side slopes to provide drainage back from the crest of the slope, avoiding excessive runoff on the face of the side slopes.

A sound attenuation barrier embankment is proposed for the west side of Regional Road No.9 near the proposed bikeway underpass. The southern limit of this earth embankment

may extend to within about 25 ft. of the north slope of the bikeway underpass, reducing the overall stability of these slopes. Stability calculations have been carried out for an overall height of slope of 30 feet in 110 feet, with glacial till existing at the toe of the slope. The factor of safety against instability has been calculated as 1.5, including a 20 percent allowance for end effects in this slope section of limited width. This stability is considered to be adequate.

It is recommended that some form of drainage be provided from the underpass structure to carry away snowmelt and rainwater accumulations.

We trust that this report contains sufficient soils information for your design purposes. Should you have any questions concerning this report or if we can be of further assistance to you on this project, please call us.

Yours very truly,

H. Q. GOLDER & ASSOCIATES LTD.



F. J. Heffernan, P. Eng.

GSW/FJH/ml  
72807  
July, 1972.



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

### I. SAMPLE TYPES

<i>AS</i>	auger sample
<i>CS</i>	chunk sample
<i>DO</i>	drive open
<i>DS</i>	Denison type sample
<i>FS</i>	foil sample
<i>RC</i>	rock core
<i>ST</i>	slotted tube
<i>TO</i>	thin-walled, open
<i>TP</i>	thin-walled, piston
<i>WS</i>	wash sample

### II. PENETRATION RESISTANCES

**Dynamic Penetration Resistance:** The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

**Standard Penetration Resistance, *N*:** The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

<i>WH</i>	sampler advanced by static weight—weight, hammer
<i>PH</i>	sampler advanced by pressure—pressure, hydraulic
<i>PM</i>	sampler advanced by pressure—pressure, manual

### III. SOIL DESCRIPTION

#### (a) *Cohesionless Soils*

<i>Relative Density</i>	<i>N, blows/ft.</i>
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) *Cohesive Soils*

<i>Consistency</i>	<i>c<sub>u</sub>, lb./sq. ft.</i>
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

### IV. SOIL TESTS

<i>C</i>	consolidation test
<i>H</i>	hydrometer analysis
<i>M</i>	sieve analysis
<i>MH</i>	combined analysis, sieve and hydrometer <sup>1</sup>
<i>Q</i>	undrained triaxial <sup>2</sup>
<i>R</i>	consolidated undrained triaxial <sup>2</sup>
<i>S</i>	drained triaxial
<i>U</i>	unconfined compression
<i>V</i>	field vane test

#### NOTES:

<sup>1</sup>Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

<sup>2</sup>Undrained triaxial tests in which pore pressures are measured are shown as  $\bar{Q}$  or  $\bar{R}$ .

## LIST OF SYMBOLS

### I. GENERAL

$\pi$	= 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

### II. STRESS AND STRAIN

$u$	pore pressure
$\sigma$	normal stress
$\sigma'$	normal effective stress ( $\bar{\sigma}$ is also used)
$\tau$	shear stress
$\epsilon$	linear strain
$\epsilon_m$	shear strain
$\nu$	Poisson's ratio ( $\mu$ is also used)
$E$	modulus of linear deformation (Young's modulus)
$G$	modulus of shear deformation
$K$	modulus of compressibility
$\eta$	coefficient of viscosity

### III. SOIL PROPERTIES

#### (a) Unit weight

$\gamma$	unit weight of soil (bulk density)
$\gamma_s$	unit weight of solid particles
$\gamma_w$	unit weight of water
$\gamma_d$	unit dry weight of soil (dry density)
$\gamma'$	unit weight of submerged soil
$G_s$	specific gravity of solid particles $G_s = \gamma_s / \gamma_w$
$e$	void ratio
$n$	porosity
$w$	water content
$S_r$	degree of saturation

#### (b) Consistency

$w_L$	liquid limit
$w_P$	plastic limit
$I_P$	plasticity index
$w_S$	shrinkage limit
$I_L$	liquidity index = $(w - w_P) / I_P$
$I_C$	consistency index = $(w_L - w) / I_P$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$D_r$	relative density = $(e_{max} - e) / (e_{max} - e_{min})$

#### (c) Permeability

$h$	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

#### (d) Consolidation (one-dimensional)

$m_v$	coefficient of volume change = $-\Delta e / (1 + e) \Delta \sigma'$
$C_c$	compression index = $-\Delta e / \Delta \log_{10} \sigma'$
$c_c$	coefficient of consolidation
$T_v$	time factor = $c_c t / d^2$ ( $d$ , drainage path)
$U$	degree of consolidation

#### (e) Shear strength

$\tau_f$	shear strength
$c'$	effective cohesion
$\phi'$	effective angle of shearing resistance, or friction
$c_u$	apparent cohesion*
$\phi_u$	apparent angle of shearing resistance, or friction
$\mu$	coefficient of friction
$S_s$	sensitivity

$\left. \begin{array}{l} \text{in terms of effective stress} \\ \tau_f = c' + \sigma' \tan \phi' \end{array} \right\}$

$\left. \begin{array}{l} \text{in terms of total stress} \\ \tau_f = c_u + \sigma \tan \phi_u \end{array} \right\}$

\*For the case of a saturated cohesive soil,  $\phi_u = 0$  and the undrained shear strength  $\tau_f = c_u$  is taken as half the undrained compressive strength.

## RECORD OF BOREHOLE A

LOCATION See Figure 1

BORING DATE JUNE 30, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE		SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.				COEFFICIENT OF PERMEABILITY, K, CM./SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
	ELEV'N DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FT.	20 40 60 80				1x10 1x10 1x10 1x10					
								SHEAR STRENGTH Cu, LB./SQ.FT.		NAT. V. - + Q-⊕ REM. V. - ⊕ U-○		WATER CONTENT, PERCENT					
							500 1000 1500 2000					20 40 60 80					
POWER AUGER 4.5" DIAM. (UNCASED)	293.4	GROUND SURFACE															
	0.5	TOP SOIL															
		VERY STIFF GREY BROWN SILTY CLAY (WEATHERED CRUST)		1	2" D.O.	15											
				2	"	7											
	281.4 12.0																
		FIRM GREY SILTY CLAY		3	"	P.M.											
				4	"	P.M.											
	269.4 24.0	VERY LOOSE SANDY SILT, SOME GRAVEL AND CLAY (SANDY SILT T.LL)		5	"	2											
	263.4 30.0	END OF HOLE. AUGER REFUSAL PROBABLY BEDROCK		6	"	1000											

 W.L. IN OPEN  
BOREHOLE AT  
ELEV. 286.7  
JULY 11, 1972

/MH

## RECORD OF BOREHOLE B

LOCATION See Figure

BORING DATE JUNE 30, 1972

DATUM      GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.	COEFFICIENT OF PERMEABILITY, K., CM./SEC.	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	ELEV'N DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FT.		20 40 60 80	1x10 1x10 1x10 1x10		
								SHEAR STRENGTH Cu, LB./SQ.FT.	NAT. V. - + REM.V. - • U-O		
POWER AUGER 4-5 DIAM. (UNCASED)	294.2	GROUND SURFACE					295				BOREHOLE CAVED AND DRY TO ELEV 286.2 JULY 11, 1972
	0.5	TOP SOIL									
		VERY STIFF GREY BROWN SILTY CLAY (WEATHERED CRUST)		1	"	15	290				
				2	"	28	285				
	282.7 11.5	COMPACT GREY SANDY SILT, SOME GRAVEL AND CLAY (SANDY SILT TILL)		3	"	11	280				
	275.2	END OF HOLE AUGER REFUSAL PROBABLY BEDROCK					275				
	19.0						270				

## RECORD OF BOREHOLE 1

LOCATION See Figure 1

BORING DATE JUNE 27, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 79 IN.

[illegible]

PROPOSED  
APPROACH CUT

PROPERTY LINE

SOUND ALTERNATING BERM

PROPOSED BIG  
PATH UNDER

B.H. 1

B.H. A

PROPE

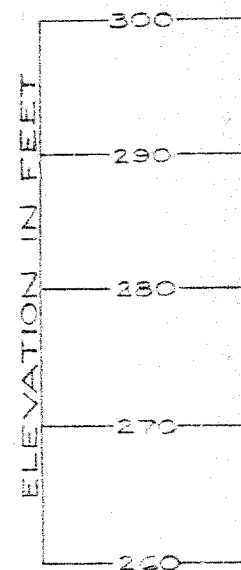
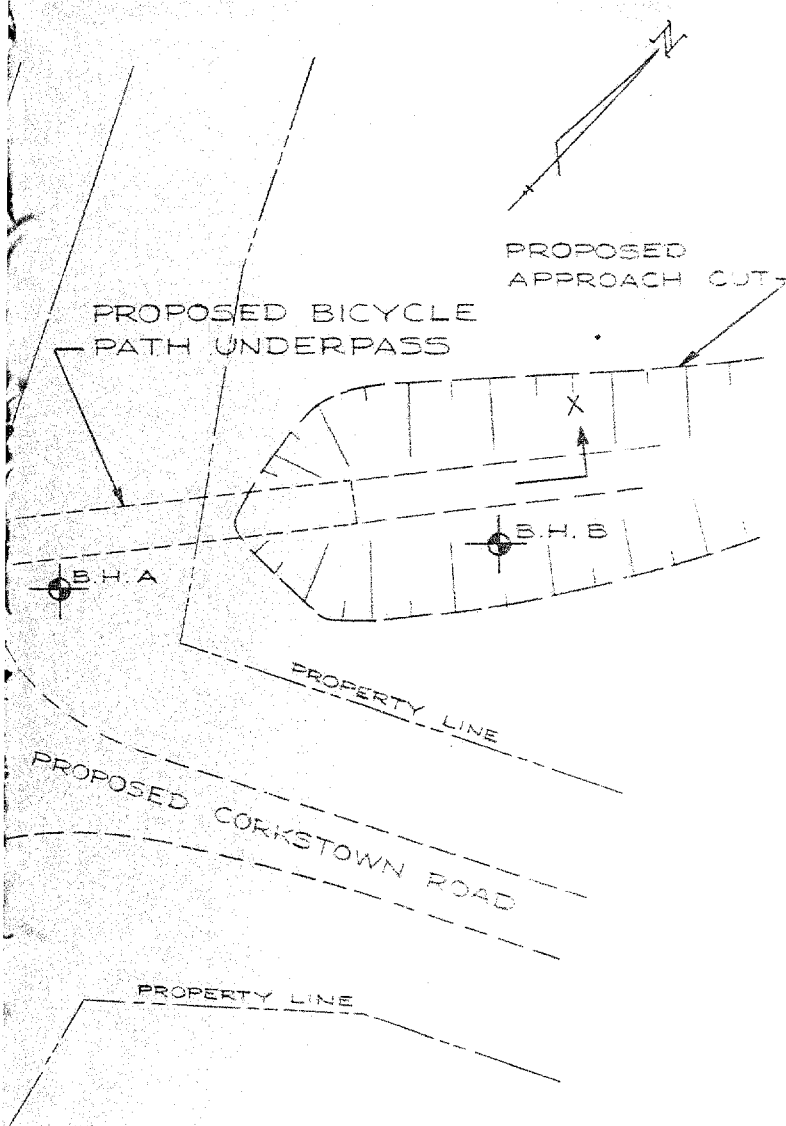
PROPOSED CORKSTOV

PROPERTY LINE

RELOCATED REGIONAL ROAD 9

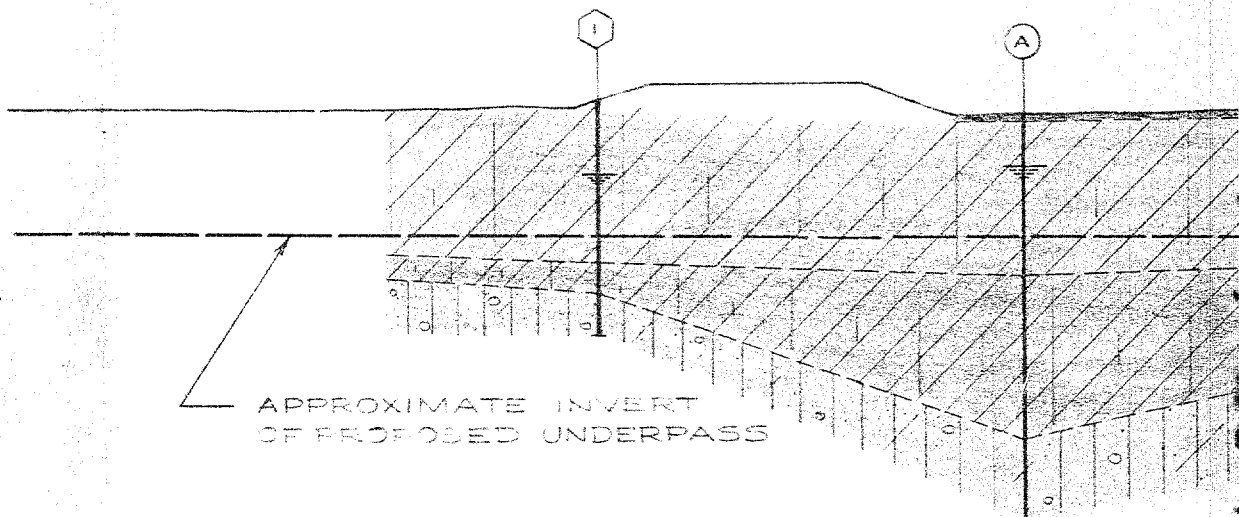
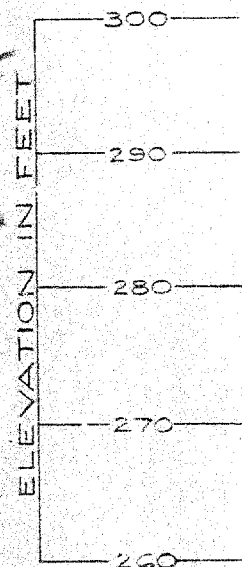
PLAN

SCALE : 1" To 40'



IN

"To 40'



APPROXIMATE INVERT  
OF PROPOSED UNDERPASS

## SECTION X-X

SCALE: HORIZ. 1" TO 20'  
VERT. 1" TO 10'

### STRATIGRAPHY



TOPSOIL



VERY STIFF GREY BROWN SILTY CLAY  
(WEATHERED CRUST)



FIRM TO STIFF GREY SILTY CLAY

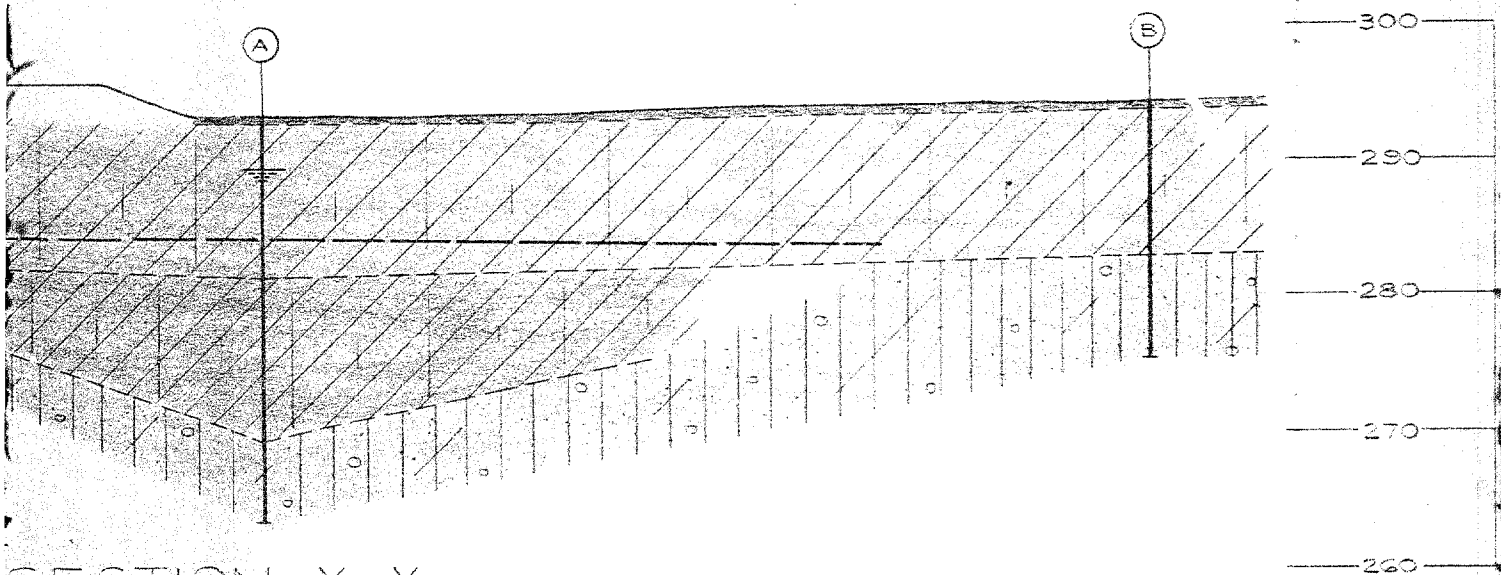


VERY LOOSE TO COMPACT SANDY SILT,  
SOME CLAY AND GRAVEL (SANDY SILT TILL)

#### SPECIAL NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION  
WITH ACCOMPANYING REPORT.

# BORING PLAN, SOIL STRATIGRAPHY



## SECTION X-X

SCALE: HORIZ. 1" TO 20'  
VERT. 1" TO 10'

SILTY CLAY

CLAY

SANDY SILT,  
(SANDY SILT TILL)

### LEGEND



BOREHOLE IN PLAN (PRESENT INVESTIGATION)



BOREHOLE IN PLAN (PREVIOUS INVESTIGATION)



BOREHOLE IN ELEVATION (PRESENT INVESTIGATION)



BOREHOLE IN ELEVATION (PREVIOUS INVESTIGATION)



WATER LEVEL IN ELEVATION, JULY 11, 1972

### NOTE

Data concerning the various strata have been obtained at borehole locations only. The soil stratigraphy between the boreholes has been inferred from geological evidence and so may vary from that shown.

For detailed stratigraphy at each borehole location refer to the record of borehole sheets.

### SPECIAL NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION  
WITH ACCOMPANYING REPORT.

Date JULY 14, 1972

Golden



	BOREHOLE IN PLAN (PRESENT INVESTIGATION)
	BOREHOLE IN PLAN (PREVIOUS INVESTIGATION)
	BOREHOLE IN ELEVATION (PRESENT INVESTIGATION)
	BOREHOLE IN ELEVATION (PREVIOUS INVESTIGATION)
	WATER LEVEL IN ELEVATION, JULY 11, 1972

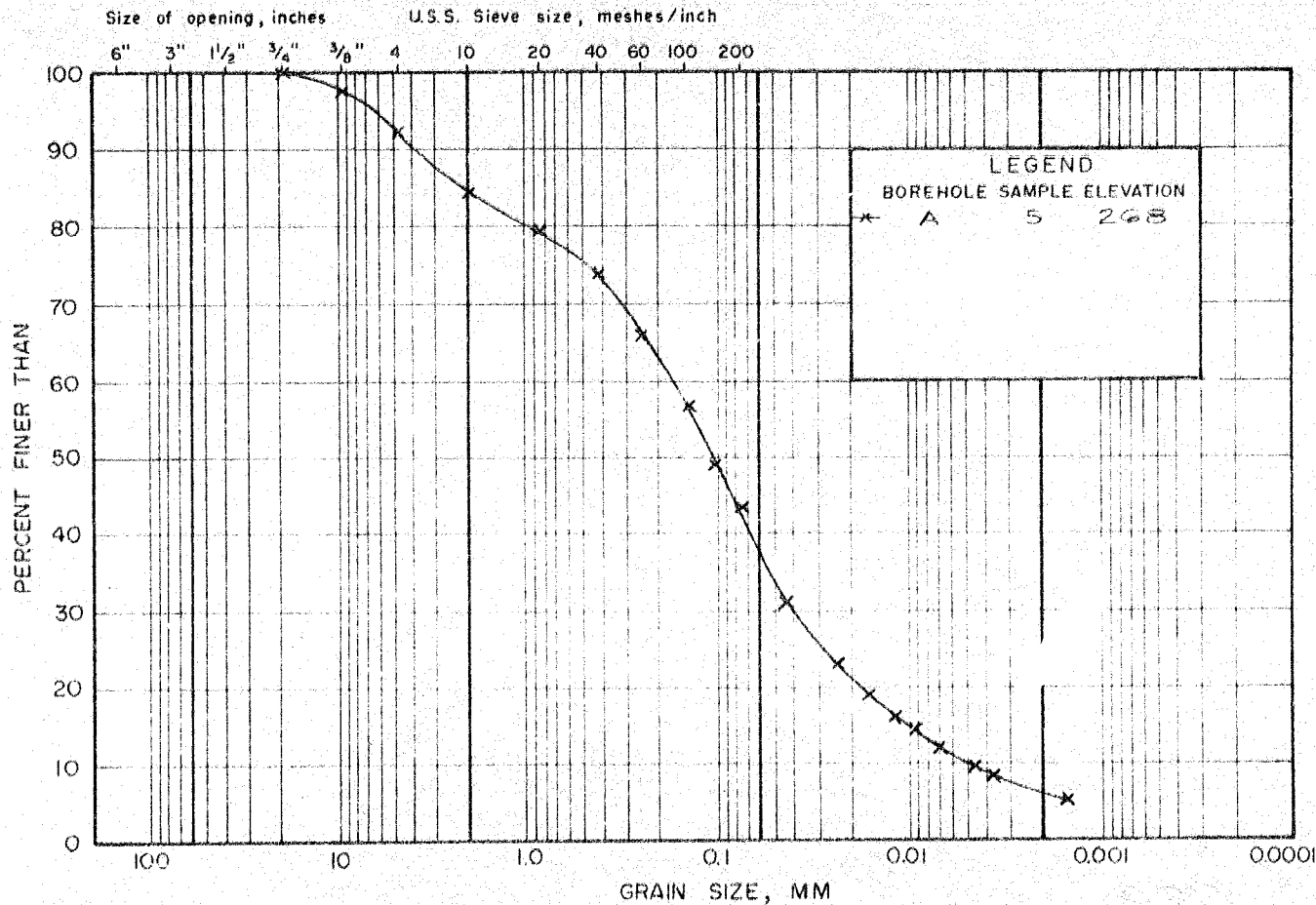
Date concerning the version 1970s have been obtained of borehole locations only. The spatial stratigraphy between the boreholes has been inferred from geological evidence and so may vary from that shown.

For detailed stratigraphy at each borehole location refer to the record of borehole sheets.

## Golder Associates

Drawn  
Chkd.  
Appd.

## M.I.T. GRAIN SIZE SCALE



SANDY SILT TILL

GRAIN SIZE DISTRIBUTION

FIGURE 2

J. L. RICHARDS & ASSOCIATES LIMITED  
SOIL INVESTIGATION  
PROPOSED SOUND ATTENUATION BARRIER  
MARCH TOWNSHIP                      ONTARIO.

Distribution:

- 5 copies - J. L. Richards & Associates Limited,  
Ottawa, Ontario.
- 2 copies - H. Q. Golder & Associates Ltd.,  
Ottawa, Ontario.

August, 1972

72778

# Golder Associates

CONSULTING GEOTECHNICAL ENGINEERS

H. Q. GOLDER  
V. MILLIGAN  
J. L. SEYCHUK  
C. O. DRAWNER  
D. L. TOWNSEND

F. J. HEFFERNAN  
B. E. W. DOWSE  
J. B. DAVIS

August 2, 1972.

J. L. Richards & Associates Limited,  
864 Lady Ellen Place,  
Ottawa, Ontario.  
K1Z 5M2

Attention: Mr. J. R. Allen, P. Eng.

RE: SOIL INVESTIGATION,  
PROPOSED SOUND ATTENUATION BARRIER,  
REGIONAL ROAD NO.9,  
MARCH TOWNSHIP, ONTARIO.

Dear Sirs:

This letter reports the results of a soil investigation carried out along the central and northwestern sections of relocated Regional Road No.9 in March Township, Ontario. A sound attenuation barrier embankment is proposed for this road where residential housing is close to this heavily travelled Highway 17 link with the Ottawa Queensway. The purpose of this investigation was to determine the soil and groundwater conditions along the route of the proposed embankment and, based on this information, to determine the stability of this embankment and to make recommendations for the design and construction of the sound attenuation barrier from a geotechnical viewpoint.

## PROCEDURE

The field work for this investigation was carried out between June 27 and July 4, 1972. Twelve boreholes (numbered 1 to 12 inclusive) were put down to about 40 ft. depth or practical refusal whichever occurred first. Boreholes 1 to 6 inclusive and 10 and 11 were put down with a mobile power auger and boreholes 7 to 9 and 12 were advanced with a portable

electric auger machine. Both machines were supplied and operated by the F. E. Johnston Drilling Co. Ltd., of Ottawa. Standard drive open and auger samples were taken in the clay and till subsoils present at the site. In situ vane tests were carried out at each borehole with the exception of boreholes 2 and 9 to determine the shear strength profile of the clay deposit. A standpipe was installed in borehole 10 to determine the groundwater conditions at the time of the investigation in the vicinity of the watercourse crossing. The field work was supervised throughout by a member of our engineering staff.

A detailed log of each boring is given on the Record of Borehole sheets following the text of this report. The locations of the borings are shown on Fig. 1.

The samples obtained during this investigation were brought to our laboratory for detailed examination and testing. The results of the laboratory testing are shown on the Record of Borehole sheets and on Fig. 3.

The elevations given in this report are interpolated from the D.T.C. contract drawings for the relocation of County Road No.9. These elevations are referred to Geodetic datum.

#### SITE AND GEOLOGY

The proposed sound attenuation barrier embankment is to flank the central and western sections of relocated Regional Road No.9 in March Township, Ontario, beginning near Station 88+0 (about 2000 ft. north of the Ottawa Queensway). The topography in this area is gently undulating. A steep sided drainage course crosses the proposed route near Station 121+00.

From available geological information it is known that the site lies within the physiographic region known as the Ottawa Valley Clay Plain, characterized by flat clay plains occasionally interrupted by ridges of rock or sand. Bedrock in this area is undifferentiated, probably consisting of Precambrian crystalline limestone, granites, and gneisses and is generally overlain by a mantle of glacial till. The till is in turn overlain by variable thicknesses of marine clays which extend to the ground surface.

#### SOIL CONDITIONS

The detailed soil stratigraphy encountered in each borehole is given on the Record of Borehole sheets. Following is a summarized account of the soil conditions encountered at the site.

### Earth Fill

In anticipation of this project, earth fill has been end dumped along the west side of relocated Regional Road No.9 between the start of the project (at about Station 88+00) and the turn to the northwest (Station 108+00). A bulk sample of this fill material was taken opposite borehole 2 and borehole 12 was advanced through the fill to 7 ft. depth. This fill generally consists of grey brown silty clay with sand, gravel, boulders, wood, scrap metal, etc. added. The fill material is very loose as it existed in place at the time of the investigation. The moisture content percent of clay samples taken from this fill ranged from 19 to 31 percent.

### Sensitive Silty Clay

The principal subsoil stratum at this site is the firm to stiff grey sensitive silty clay which was found to be at least 40 ft. thick at borehole 6 which was terminated within this deposit. The upper portion of this clay, some 8.5 to 16 ft. thick has been weathered to a very stiff crust of fissured brown to grey brown silty clay. The water content of the weathered crust increases with depth from about 30 percent near the ground surface to 40 percent near the base of this desiccated stratum.

Below this crust the colour of the silty clay changes from grey brown to grey and the consistency decreases to firm. In situ vane shear strength values below the crust generally ranged from 500 lb/sq.ft. to 1,200 lb/sq.ft. In borehole 8 put down in the bottom of the watercourse, a shear strength value of 320 lb/sq.ft. was measured at 5 ft. depth. A plot of shear strength versus elevation is shown on Fig. 2. Atterberg limit tests indicate that the plasticity of the grey silty clay is medium (liquid limit values ranging from 29 to 48 and plasticity indices ranging from 11 to 29). The moisture content of the grey clay increases with depth from about 40 to 53 percent. At depth the moisture content is well above the liquid limit value, typical of the sensitive clays of the Ottawa area.

### Sandy Silt Till

The Champlain Sea clay is underlain by a stratum of glacial till which was generally penetrated for 3 ft. before auger refusal was encountered. As indicated by the grain size distribution curve on Fig. 3, this till is well graded. Standard penetration resistance or N values obtained within this

4.  
deposit ranged from 2 blows/ft. to 45 blows/ft., indicating a very loose to dense relative density.

#### GROUNDWATER CONDITIONS

A standpipe was installed in borehole 10 and the water levels were observed in the open boreholes at the time of the investigation. The water levels, observed during the field work indicate that the groundwater level was at some 7 to 12 ft. depth. The water level in borehole 10 at the crest of the bank of the watercourse was at 12 foot depth, that is, near the water level in the creek.

#### PROPOSED SOUND ATTENUATION BARRIER

##### a) General

It is understood that an earth fill embankment is to be constructed for sound reflection purposes along the west side of relocated Regional Road No.9 and within about 200 ft. of a residential subdivision. This embankment is to be about 11 ft. above finished road grade on relocated Regional Road No.9 and about 13 to 16 ft. above existing ground surface. A shallow storm sewer will exist between the embankment and the roadway.

##### b) General Embankment Stability

Based on a design shear strength value for the silty clay material of 600 lb/sq.ft., a total embankment height of up to 19 ft. may be built above present ground surface. The factor of safety against instability under these conditions has been calculated to be 1.5. Thus, the 11 ft. high sound barrier proposed for this road may be accommodated above finished road grade along the entire route with the exception of the watercourse crossing (near Station 121+00). The differential settlements resulting from the embankment loading are expected to be in the order of 6 inches to 1 foot. It is recommended that the excavation for and installation of the storm sewer between the roadway and the embankment take place before the embankment is constructed.

##### c) Watercourse Crossing

Near Station 121+00 on the northwestern leg of the embankment route, a watercourse crossing is encountered. This drainage course is from 12 to 14 ft. deep from the crest of the side slopes to the ravine floor and about 100 ft. across. Finished road grade at this crossing is designed to be at about

elevation 284 that is, from 5 to 6 ft. above the present ground surface at the crest of the ravine slopes. Thus, a 20 ft. high fill is required from the floor of the watercourse to finished road grade. The proposed sound barrier embankment is to be built on additional 11 ft. above finished road grade. Based on an average shear strength value of 400 lb/sq.ft. near the base of the silty clay deposit in the ravine bottom, the maximum embankment height that can be supported by the floor of the watercourse is about 13.5 ft. In order to construct the 30 ft. high earth fill embankment at this crossing it is recommended that the 5 ft. of soft grey silty clay material encountered in the ravine bottom be excavated down to the glacial till deposit for the full width of the earth embankment and roadway. The embankment and roadway could then be constructed on the glacial till stratum, using well compacted acceptable earth fill. Provided that suitable earth fill material, properly compacted in shallow lifts, is employed for the berm, the side slopes may be taken as 2 horizontal to 1 vertical. An alternative to this design would be the use of a composite sound barrier for the section of embankment at the watercourse crossing. We understand that composite sound barriers have been found to be less satisfactory but it is considered that a composite structure could be used for this relatively short section. This would avoid overstressing the soft clay below the ravine floor.

#### d) Embankment Materials

The sound barrier embankment should be constructed with acceptable earth borrow material, placed in shallow horizontal lifts of 6 to 9 inches and compacted to at least 90 percent of the standard Proctor dry density. Side slopes of 2 horizontal to 1 vertical will be stable under these conditions.

To date earth fill has been end dumped to heights varying from 3 ft. to about 10 ft. along the southern section of the route where the alignment will remain unchanged. This fill material is a loose heterogeneous mixture of variable density, consisting mainly of silty clay. The moisture content of this material is up to 10 percent above the optimum moisture content for compaction. It is recommended that this existing berm material be removed from its present position. Dry and suitable portions of the fill may be used for adjacent berm reconstruction along this area. Wet and unsuitable materials should be wasted from the site. It is further recommended that close quality control be employed on selection of materials for the remaining berm construction.

6.

We trust that this report contains sufficient soils information for your design purposes. Should you have any questions concerning this report, or if we can be of further assistance to you on this project, please call us.

Yours very truly,

H. Q. GOLDER & ASSOCIATES LTD.

GSW/FJH/ml  
72778  
August, 1972.

F. J. Heffernan, P. Eng.



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

### I. SAMPLE TYPES

AS auger sample  
CS chunk sample  
DO drive open  
DS Denison type sample  
FS foil sample  
RC rock core  
ST slotted tube  
TO thin-walled, open  
TP thin-walled, piston  
WS wash sample

### II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

WH sampler advanced by static weight—weight, hammer  
PH sampler advanced by pressure—pressure, hydraulic  
PM sampler advanced by pressure—pressure, manual

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

Relative Density	<i>N</i> , blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) Cohesive Soils

Consistency	<i>c<sub>u</sub></i> , lb./sq. ft.
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

### IV. SOIL TESTS

C consolidation test  
H hydrometer analysis  
M sieve analysis  
MH combined analysis, sieve and hydrometer<sup>1</sup>  
Q undrained triaxial<sup>2</sup>  
R consolidated undrained triaxial<sup>2</sup>  
S drained triaxial  
U unconfined compression  
V field vane test

### NOTES:

<sup>1</sup>Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

<sup>2</sup>Undrained triaxial tests in which pore pressures are measured are shown as  $\bar{Q}$  or  $\bar{R}$ .

## LIST OF SYMBOLS

### I. GENERAL

$\pi$	= 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

### II. STRESS AND STRAIN

$u$	pore pressure
$\sigma$	normal stress
$\sigma'$	normal effective stress ( $\bar{\sigma}$ is also used)
$\tau$	shear stress
$\epsilon$	linear strain
$\epsilon_{xy}$	shear strain
$\nu$	Poisson's ratio ( $\mu$ is also used)
$E$	modulus of linear deformation (Young's modulus)
$G$	modulus of shear deformation
$K$	modulus of compressibility
$\eta$	coefficient of viscosity

### III. SOIL PROPERTIES

#### (a) Unit weight

$\gamma$	unit weight of soil (bulk density)
$\gamma_s$	unit weight of solid particles
$\gamma_w$	unit weight of water
$\gamma_d$	unit dry weight of soil (dry density)
$\gamma'$	unit weight of submerged soil
$G_s$	specific gravity of solid particles $G_s = \gamma_s / \gamma_w$
$e$	void ratio
$n$	porosity
$w$	water content
$S_r$	degree of saturation

#### (b) Consistency

$w_L$	liquid limit
$w_P$	plastic limit
$I_P$	plasticity index
$w_S$	shrinkage limit
$I_L$	liquidity index = $(w - w_P) / I_P$
$I_C$	consistency index = $(w_L - w) / I_P$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$D_r$	relative density = $(e_{max} - e) / (e_{max} - e_{min})$

#### (c) Permeability

$h$	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

#### (d) Consolidation (one-dimensional)

$m_v$	coefficient of volume change = $-\Delta e / (1 + e) \Delta \sigma'$
$C_c$	compression index = $-\Delta e / \Delta \log_{10} \sigma'$
$c_c$	coefficient of consolidation
$T_v$	time factor = $c_d / d^2$ ( $d$ , drainage path)
$U$	degree of consolidation

#### (e) Shear strength

$\tau_f$	shear strength
$c'$	effective cohesion intercept
$\phi'$	effective angle of shearing resistance, or friction
$c_u$	apparent cohesion*
$\phi_u$	apparent angle of shearing resistance, or friction
$\mu$	coefficient of friction
$S_s$	sensitivity

$\left. \begin{array}{l} \text{in terms of effective stress} \\ \tau_f = c' + \sigma' \tan \phi' \end{array} \right\}$

$\left. \begin{array}{l} \text{in terms of total stress} \\ \tau_f = c_u + \sigma \tan \phi_u \end{array} \right\}$

\*For the case of a saturated cohesive soil,  $\phi_u = 0$  and the undrained shear strength  $\tau_f = c_u$  is taken as half the undrained compressive strength.

## RECORD OF BOREHOLE 1 &amp; 2

LOCATION See Figure 1

BORING DATE JUNE 27, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.				COEFFICIENT OF PERMEABILITY, K., CM./SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	ELEV'N DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.		20 40 60 80				1x10 1x10 1x10 1x10					
								SHEAR STRENGTH Cu., LB./SQ.FT.				WATER CONTENT, PERCENT					
								500 1000 1500 2000									
POWER AUGER 4" DIAM (UNCASED)											B.H. 1						
	294.8	GROUND SURFACE					295										
	0.0																
		VERY STIFF GREY BROWN SILTY CLAY (WEATHERED CRUST)		1	2"	16	290										
				2	"	3	285										
	282.8																
	12.0	FIRM TO STIFF GREY SILTY CLAY						+		+							
	280.3							+	+								
	14.5	VERY LOOSE GREY SANDY SILT SOME CLAY TRACE GRAVEL TO SOME GRAVEL		3	"	2	280										
	277.3	SANDY SILT TILL		4	"	100											
	17.5	END OF HOLE REFUSAL PROBABLY BEDROCK					275										
POWER AUGER 4" DIAM (UNCASED)											B.H. 2						
	295.5	GROUND SURFACE					295										
	0.0																
		COMPACT BROWN SILTY SAND		1	2"	100	290										
	289.6																
	5.9	END OF HOLE REFUSAL PROBABLY BEDROCK					285										

W.L. IN OPEN HOLE AT ELEVATION 289.3 JULY 11, 1972.

W.L. IN OPEN  
HOLE AT  
ELEVATION  
289.3 JULY 11,  
1972.

## RECORD OF BOREHOLE 3 &amp; 4

DATUM GEODETIC

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

[illegible]

## 65

BORING DATE

JUNE 28, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

[illegible]

# RECORD OF BOREHOLE 6

LOCATION See Figure 1

SORING DATE JUNE 28, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE			SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.				COEFFICIENT OF PERMEABILITY, K., CM./SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
	ELEV'N DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FT.	20 40 60 80				1x10 1x10 1x10 1x10					
								SHEAR STRENGTH Cu., LB./SQ.FT.				WATER CONTENT, PERCENT					
								500 1000 1500 2000				20 40 60 80					
POWER AUGER 4 1/2" DIAM (UNCASED)							290										
	287.7	GROUND SURFACE															
	0.5	BROWN CLAY LY TOP SOIL															
		VERY STIFF GREY BROWN SILTY CLAY (WEATHERED CRUST)					285										
			1	DO	17												
	279.2						280										
	8.5																
			2	"	3												
							275	+	+								
								+	+								
			3	"	PM												
							270	+	+								
								+	+								
		FIRM TO SOFT GREY SILTY CLAY															
			4	"	PM												
						265	+	+									
							+	+									
		5	"	"													
						260	+	+									
							+	+									
		6	"	"													
						255	+	+									
							+	+									
		7	"	"													
						250	+	+									
							+	+									
		8	"	"													
	245.7																
	42.0	PROBABLY SILTY FINE SAND, SOME CLAY					245										
	241.7																
	46.0	END OF HOLE															

POWER AUGER  
4 1/2" DIAM (UNC. SED)

## RECORD OF BOREHOLE 7, 8 &amp; 9

LOCATION See Figure

SPRING DATE JULY 4, 1972

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

[illegible]



# RECORD OF BOREHOLE 11 & 12

LOCATION See Figure 1

BORING DATE JUNE 29, &amp; JULY 4, 1972

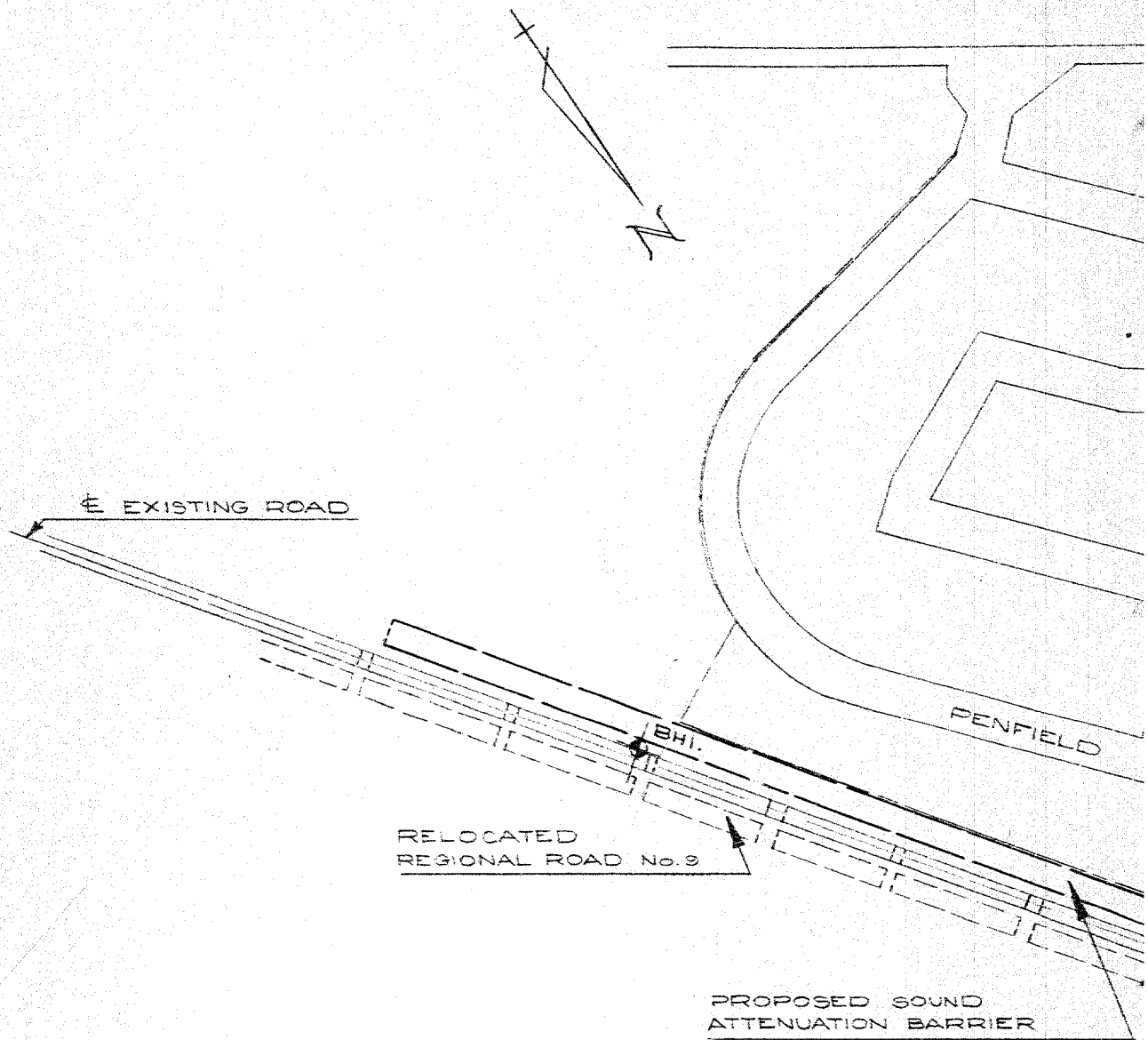
DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.				COEFFICIENT OF PERMEABILITY, K, CM./SEC.				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	ELEV'N. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.		20 40 60 80				1x10 1x10 1x10 1x10					
								SHEAR STRENGTH C <sub>u</sub> , LB./SQ. FT.				WATER CONTENT, PERCENT					
								500	1000	1500	2000	20	40	60	80		
POWER AUGER 4 1/2" DIAM (UNCASED)	287.4	GROUND SURFACE															
	8.0																
	286.4	BROWN SANDY TOPSOIL															
	1.0																
		VERY STIFF GREY BROWN SILTY CLAY (WEATHERED CRUST)		1	2"	20											
	274.4			2	"	6											
	13.0																
		STIFF TO FIRM GREY SILTY CLAY		3	"	4											
			4	"	PM												
			5	"	PM												
	258.4																
	29.0	PROBABLY SANDY SILT TILL															
	20.5	END OF HOLE AUGER REFUSAL PROBABLY BEDROCK															
POWER AUGER 4 1/2" DIAM (UNCASED)	301.2	GROUND SURFACE															
	00	FIRM TO SOFT GREY BROWN SILTY CLAY WITH SAND, GRAVEL, COBBLES, WOOD ETC. (MISCELLANEOUS FILL)		1	AS	-											
	293.2			2	AS	-											
	8.0	END OF HOLE AUGER REFUSAL PROBABLY BOULDER															

6  
5 Percent axial strain at failure



EXISTING REGIONAL ROAD No 9

PENFIELD

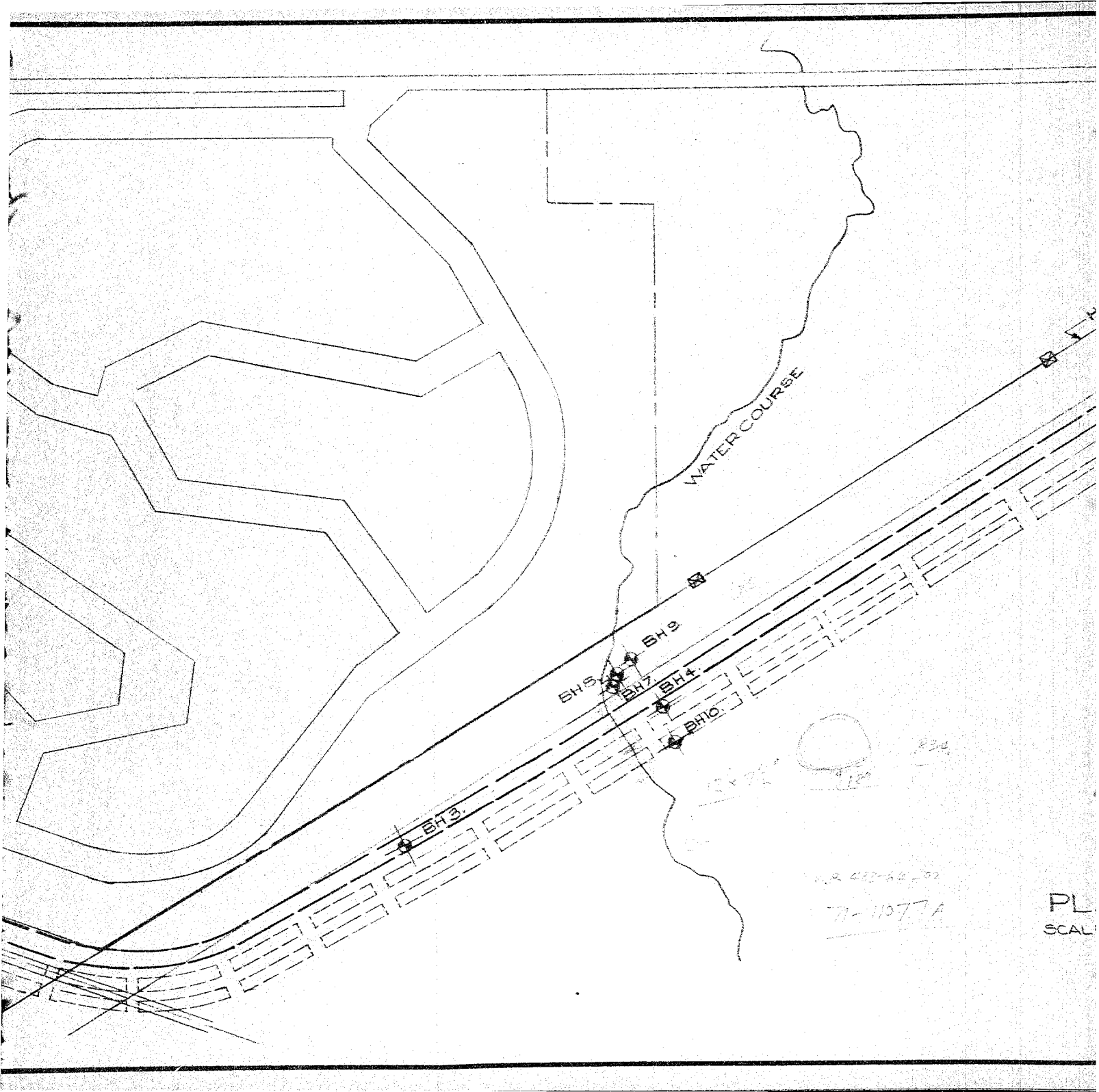
DRIVE

POSED SOUND  
NUATION BARRIER

BH2

BH12.

BH11.



WATER COURSE

BH15  
BH7  
BH9  
BH4  
BH10

BH3

U.S. 432-60-02

71-11577A

PL  
SCALE

BORING

BO

REFER

HYDRO TRANSMISSION LINE

PROPOSED SOUND  
ATTENUATION BARRIER

BH5

BH6

R24

18"

MR 433-64-02

71-11077A

PLAN  
SCALE: 1"=200'

Date JULY 29, 1971

# BORING PLAN

FIGURE 1

## LEGEND



BOREHOLE IN PLAN

REFERENCE: PLAN OF QUEENSWAY ACCESS  
HIGHWAY NOISE REDUCTION BARRIER  
SUPPLIED BY J.L. RICHARDS AND  
ASSOCIATES LTD. CONSULTING  
ENGINEERS DATED FEBRUARY 16, 1972.  
DRAWING No. 68-1064-072.

### SPECIAL NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION  
WITH ACCOMPANYING REPORT.

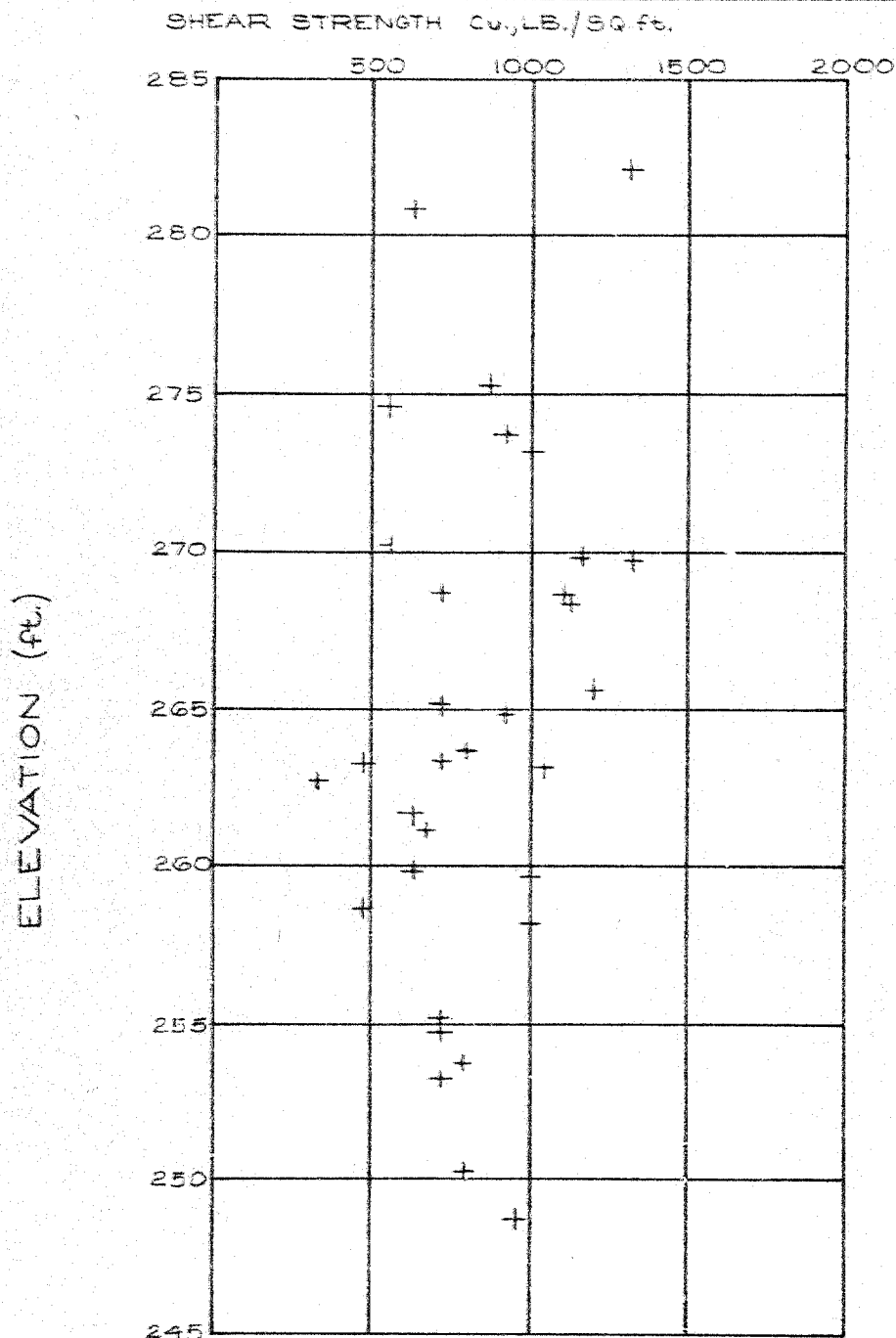
Date JULY 24, 1972.

**Golder Associates**

Drawn G.E.  
Chkd. [Signature]  
Appd. [Signature]

# SHEAR STRENGTH VERSUS ELEVATION

FIGURE 2



LEGEND  
+ IN SITU FIELD VANE TEST

Date JULY 25, 1972

**Golder Associates**

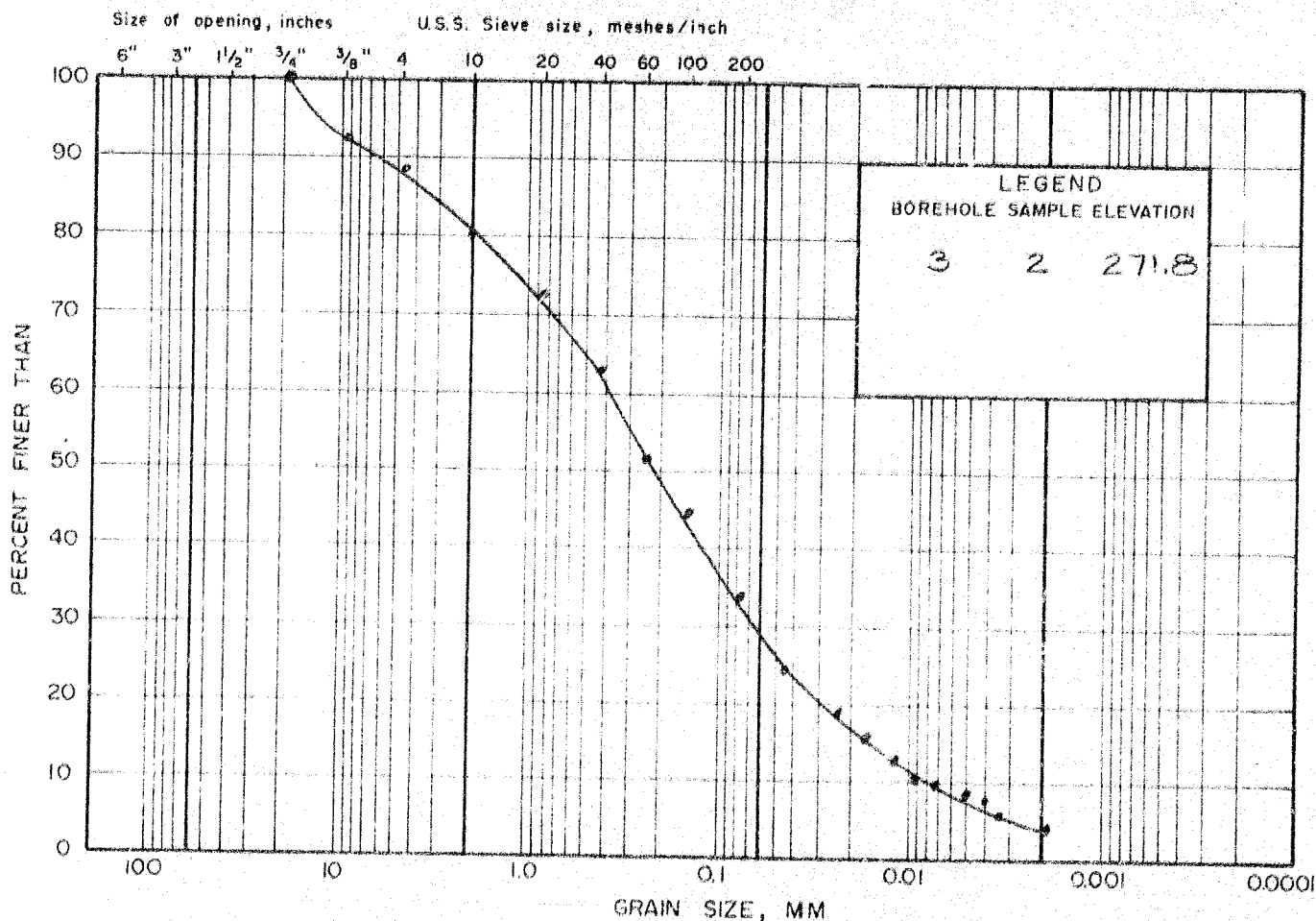
Drawn G.F.  
Chkd. J.S.W.  
Appd. \_\_\_\_\_

M.I.T. GRAIN SIZE SCALE

SANDY SILT TILL

GRAIN SIZE DISTRIBUTION

FIGURE 9



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE		CLAY SIZE	
GRAVEL SIZE				SAND SIZE			FINE GRAINED			

Golder Associates

MEMORANDUM

7/11077 RAG

To: Mr. A.G. Stermac  
Principal Foundation Engineer  
Downsview, Ontario

FROM: Bridge Section  
Kingston, Ontario

ATTENTION: Mr. M. Devata

DATE: 3 August, 1971

OUR FILE REF.

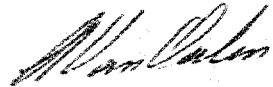
IN REPLY TO

SUBJECT: W.P. 433-64-07, Former County Road 9  
District #9, Ottawa

Further to our telephone conversation of August 3, 1971 we are now sending you one print of Plan B64-6 and one print of the proposed profile for Former County Road 9.

We would be pleased if you will make arrangements for a foundation investigation to determine the stability under the projected fill of the creek crossing area at approx. station 119 + 58, about 1 mile North of the proposed Former County Road 9 Interchange.

The area concerned has been encircled in red on the plan.



A. VanDalen  
for T.C. Kingsland  
Reg. Bridge Plan. Eng.

c.c. Mr. S. McCombie  
Mr. R. Forrest

MEMORANDUM

TO: Mr. T. C. Kingsland (2)  
Regional Bridge Planning Engr.  
Eastern Region  
Kingston, Ontario

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

ATTENTION:

DATE: December 14, 1971

OUR FILE REF.

IN REPLY TO

SUBJECT: Correction - Foundation Investigation Report  
W. O. 71-11077 - W.P.'s 433-64-02 (Hwy. #417)  
433-64-07 (Reg.Rd., #9)

---

Please delete Page 14 of the above report and replace  
with the attached amended page.

MD:mt  
Attach.

*M. Devata*

M. Devata  
Supervising Foundation Engineer

cc: Messrs. D. W. Farren  
B. R. Davis  
A. Rutka  
S. J. Markiewicz  
J. E. Callaghan  
B. J. Giroux  
E. R. Saint  
G. A. Wrong  
B. A. Singh

Foundation Files  
Documents

71-11077  
DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

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

FROM: Bridge Section,  
Kingston, Ontario.

ATTENTION: Mr. M. Devata

DATE: February 9, 1972.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 433-64-02, From Former County Road 9 Westerly  
Highway 417, District 9 - Ottawa

Enclosed please find two partial prints of Plan 9-FP-230 on which is shown the relocation of the Corkstown Road. It will be noted that this relocation crosses the Watts Creek just east of the former County Road 9.

The Regional Systems Design Section has requested that a foundation investigation be made at this site. We would be pleased if you could arrange such an investigation and let us have your findings in due course.

  
A. Van Dalen

For: T. C. Kingsland  
Regional Bridge Planning Engineer

AV/TCK/hl

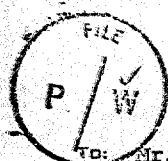
Encls.

c. c. - S. J. Markiewicz - Att. G. McMillan  
J. Anderson  
R. Forrest  
C. S. Grebski

*To per telephone conversation with Mr T.C. Kingsland  
that there no need to carry out any additional borings  
since soil office carried sufficient auger holes.  
M. Devata  
14th Feb/72*

## DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

## MEMORANDUM



TO: Mr. T. C. Kingsland,  
Regional Bridge Planning Engineer,  
KINGSTON, Ontario.

FROM: Systems Design Section,  
KINGSTON, Ontario.

ATTENTION:

DATE: February 14, 1972.

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 433-64-02 - Hwy. 417 - From Former County Road 9 Westerly -  
District #9, Ottawa

I have discussed the Wett's Creek crossing on Corkstown Road with Mr. Batten and he feels that the information we have for the area is sufficient to ensure that no problems will be encountered.

The investigation requested recently is therefore not necessary.

G. McMillan,  
FOR: S. J. Markiewicz,  
REGIONAL SYSTEMS DESIGN ENGINEER

cc. Mr. M. Batten  
Mr. M. Devata  
Mr. G. Tilly

D.H.O.  
KINGSTON  
RECEIVED

FEB 15 1972

BRIDGE  
OFFICE

## MEMORANDUM

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

FROM: Bridge Section,  
Kingston, Ontario.

ATTENTION: Mr. M. Devata

DATE: February 15, 1972.

OUR FILE REF.

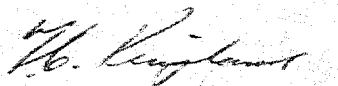
IN REPLY TO

SUBJECT: W.P. 433-64-02 - From Former County Road 9 Westerly  
Highway 417, District 9 - Ottawa

71-11-077

Further to my letter dated February 9, 1972 requesting a foundation investigation at the intersection of relocated Corkstown Road and Watts Creek, I enclose a copy of memorandum dated February 14 received from Systems Design Section indicating that the investigation requested will not now be required.

I shall be glad therefore if you will cancel arrangements for this investigation.



T. C. Kingsland  
Regional Bridge Planning Engineer

TCK/hl

Encl.

c.c. S. J. Markiewicz - Att. G. McMillan  
E. R. Saint - Att. M. Batten  
J. K. Anderson  
R. Forrest  
C. S. Grebski

Copy for the information of

M. DEVATA

**Systems Design Office, Postal Bag 4000,  
Kingston, Ontario. K7L 5A3.**

**May 31st, 1973.**

**J. L. Richards & Associates,  
864 Lady Ellen Place,  
Ottawa, Ontario.  
K1Z 5M2.**

**Attention: Mr. J. Allen, P. Eng.**

**Dear Sir:**

**RE: Contract 73-38, Relocation of Former  
County Road 9; District #9 - Ottawa.**

Having reviewed your submission on the design of the berm bordering this project, the following is a list of areas of concern which we would want reviewed in detail before any approvals would be forthcoming from this office.

- 1) If it is proposed to construct the berm south of the N. C. C. Bikeway, the soils investigation should be extended accordingly.
- 2) In conjunction with point 1), your proposal for a wall or a composite design over the N. C. C. Bikeway should be analysed for its effects on the underpass structure and its foundation.
- 3) The present proposed location of the southerly termination of the earth berm should be reviewed for longitudinal stability. For your information, H. Q. Golder and Associates, in a previous report issued during the design of the N. C. C. Bikeway (#72807) indicated that from preliminary data it was

recommended that the toe of slope of the berm be located 25' from the top of slope of the underpass and that the end slope be in the order of 4:1.

- 4) We agree with Golder's recommendation that the existing stockpiled material be removed from its present location and that close quality control be employed in reconstructing the berm.
- 5) In our opinion, it is imperative that the berm construction be restricted until such time as the storm sewer system is completely installed. In this regard we would suggest a limiting height of the berm equivalent to the roadway grade.
- 6) The manner of draining the resident's side of the berm should be investigated since this will, in all possibility, determine the actual berm height.
- 7) Your design indicates a concrete pipe connecting to the culvert at this location whereas it is recommended that a CSP and a saddle branch be employed as proposed for similar installations in the Ministry's contract.
- 8) From the creek to Richardson's Sideroad, your design should allow for a ditch bottom 2' below our granular. If this is not provided a sub-surface system will be required.

For your further information, we would advise that as a result of H. Q. Golder's analysis in the vicinity of the creek, Sta. 125+75, the Ministry will be reviewing its proposals at this location and will inform you of the outcome as soon as possible.

Also as an aid to you in resolving the berm design around the curve, we will be forwarding to you copies of the up-to-date sections in this area, since during the design there was a minor revision to the highway alignment.

Finally, as noted in your letter, the contractor is about to commence construction and if any revisions are anticipated, the details will be required immediately. It is recommended, therefore, that urgent action be taken on the above points, with copies of your further proposals and the additional required soils analysis being forwarded to this office for review and approval.

Yours truly,

c. c. to: E. Saint, J. Childs, M. Devata, G. Tilly.

G. McMillan  
for: S. J. Markiewicz  
Sr. Project Design Engineer.

GM/SJM/ss



**Golder Associates**  
CONSULTING GEOTECHNICAL ENGINEERS

71-11-077

June 4, 1973.

Ministry of Transportation  
and Communications,  
Materials and Testing Division,  
Hwy. 401 and Keele Street,  
Downsview, Ontario.

Attention: Mr. M. Devata

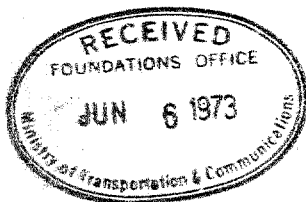
RE: SOUND ATTENUATION BARRIER  
QUEENSWAY ACCESS HIGHWAY  
TWP. OF MARCH, ONTARIO

Dear Sirs:

Further to our telephone conversation today, we enclose herewith a copy of our soils reports for the proposed sound attenuation barrier and for the proposed bikeway underpass. A copy of each is also being sent to Mr. J. Cruikshank.

The stability at the creek crossing at about station 121+00 is in question along the berm. At the bikeway underpass, a wall structure will be used in lieu of earth fill adjacent to the underpass cut.

When you have had an opportunity to review this information, please call us.



FJH/cn  
Encl.

cc: Mr. J. Cruikshank  
Mr. G. McMillan

Yours very truly,

H.Q. GOLDER & ASSOCIATES LTD.

F.J. Heffernan, P.Eng.

MEMORANDUM

TO: Mr. A. J. Percy  
Regional Manager, Systems Design  
Kingston Region  
ATTENTION: Mr. G. McMillan

FROM: Regional Materials & Testing Office  
Kingston Region

DATE: February 28, 1974

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 433-64-02, Hwy # 417, From  
Former County Road # 9, Westerly  
#####

We have reviewed available soils data between Goulbourn Road (Sta. 160±) and County Road # 9 (Sta. 243±) in order to assess various gradeline proposals at 5', 10', 15' and 20' below the presently established profile grade for Highway #417.

From Station 160± to Station 180±, subsurface materials consist of variable depths of clay type overburden over a sandstone type of bedrock. Any lowering of the gradeline in this area would involve rock subgrade construction. Excavation of earth material to 4' below profile grade and backfill with rock fill would be required. Within earth sections that are excavated for rock backfill, drainage of the rock backfill would be required. Subdrains or French drains outletting to a roadside ditch could be considered. The overburden within this section would be difficult to handle and unsuitable for highway fill construction due to high moisture content and its sensitive nature.

From Station 180± to Station 240±, the alignment traverses a low, poorly drained area. Subsoils consist of wet sensitive marine clay materials. There are pockets of shallow organic deposits over the parent clay. It is difficult to appreciate all of the design considerations with the limited soils data available. If a decision is made to construct a gradeline 10' lower than the one that is now proposed, additional field investigation would be required to ascertain pertinent mechanical properties of the subsoils for design purposes. The following may be considered for preliminary assessment purposes:

1. On any lower gradelines, the hydrology should be fully assessed in order to allow positive drainage of the roadway to a minimum of 5' below

78-11-077

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. T.C. Fowle  
Materials Officer  
Structural Office  
West Bldg.

FROM: Structural Office  
West Bldg.

ATTENTION:

DATE: March 13/74

OUR FILE REF.

IN REPLY TO

SUBJECT: Schoonertown Bridge (Mottawasaga River)  
River Road West - Mosely Street Connection  
W.P. 61-70-04, Site 30-445  
Village of Wasaga Beach - Township of Sunnidale  
District #5, Owen Sound

Subsequent to completing the design of the above structure we were advised by the Foundation Section that in their opinion the estimated pile tip elevations should be lower than that originally given for HP 12 x 74 piles in their Foundation Investigation Report, W.O. 70-11077.

After discussion with Mr. M. Devata, February 8, 1974, it was agreed by the undersigned that the estimated tip elevations used for determining the pile lengths for the west abutment and both piers be ten feet lower than originally used in determining the pile lengths shown on structure drawing 30-445-3, "Footings and Pile Layout". It was also agreed that no change would be necessary at the east abutment as the pile lengths shown on structure drawing would be within about three feet of the revised lower (estimated) pile tip elevation.

As the piles were ordered to suit the lengths shown on structure drawing 30-445-3, and were delivered in the fall of 1973, it will be necessary to supply additional piling to have on hand for this structure incase that it is required. Accordingly, would you kindly arrange to have the following additional piling supplied for this structure:

Section HP 12 x 102	8 pieces @ 50 ft. each
Section HP 12 x 74	4 pieces @ 50 ft. each

J. Keen  
Regional Structural Design Engineer

JLF:MFP

c.c. J. Curtis  
M. Devata  
M. Stoyanoff

