DOCUMENT MICROFILMING IDENTIFICATION

G.I-30 SEPT 1976

GEOCRES No. 31G05-103

DIST. 9 REGION Eastern

W.P. No. 436-64-00

CONT. No. 77-85

W. O. No.

STR. SITE No.

HWY. No.

LOCATION March - Huntley Twp. Line Underpass

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 4

REMARKS (1) documents to be unfolded before microfilming

(2) TO BE ADDED TO EXISTING MICROFILM

Department of Transportation and Communications

MEMORANDUM

Foundations File

To: Mr. T. C. Kingsland, (2)
Regional Bridge Location Engineer,
Eastern Region,
Kingston, Ontario.

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

Attention:

Date: January 28, 1972.

Our File Ref.

In reply to

Subject:

Site 3-291

Proposed Culvert at the
Creek Crossing of Huntley-March Township Rd.
Sta. 94+50
W.O. 71-11052 -- W.P. ~~53-64-02~~ 3
District No. 9 (Ottawa)

80

1. INTRODUCTION:

The Foundation Office was requested to carry out an investigation for the proposed culvert location at the crossing of the creek and Huntley-March Township Rd., Station 94+50, in the Regional Municipality of Ottawa-Carleton. The request was contained in a memo, dated November 12, 1972, from Mr. T. C. Kingsland, Regional Bridge Location Engineer, Eastern Region. The site is located approximately 2 miles north of the Village of Stittsville, and the general area is flat to gently undulating.

An investigation was carried out by this Office to determine the subsoil conditions at this site. Presented in this memo are the results of this investigation together with our recommendations pertaining to the foundations of the culvert and the stability and settlement considerations for the proposed approach fill.

2. SUBSOIL CONDITIONS:

One sampled borehole accompanied by dynamic cone

.....2

penetration test was carried out using a diamond drill rig adapted for soil sampling purposes.

Subsoil at this site consists of 5 feet of fill material (silty clay with occasional boulders), followed by a 24 ft. thick stratum of grey soft to stiff silty clay. The cohesive subsoil is underlain by a grey compact to very dense granular glacial till deposit. The thickness of this stratum was not determined, but the investigation carried out for the main structure (W.P. 436-64-00) revealed that the glacial till deposit is at least 21 to 33 feet in thickness. Groundwater level was recorded in the open borehole and was found to be at elevation 316; i.e. some 5 feet below existing ground surface.

3. RECOMMENDATIONS:

It is proposed to construct a multi-plate pipe arch culvert at the creek crossing and Huntley-March Township Road, in the Regional Municipality of Ottawa-Carleton. The existing 13' x 8' reinforced concrete open footing culvert will be demolished and replaced with a new pipe arch culvert, prior to the construction of approach fills for the underpass structure at this location. According to available information the stream bed elevation for the new culvert will be at approximate elevation 311. The approach fill will, therefore, have a maximum fill height of 20 feet in the transverse direction.

The presence of relatively compressive material at a shallow depth below ground surface is the governing factor from the Foundation point of view, since it will be necessary to ensure that it is not overstressed by either the embankment or the structure foundation loadings. These aspects will be discussed in detail in the subsections to follow.

Embankment Stability and Settlement Considerations:

Analyses have carried in terms of total stresses ($\phi = 0$) with standard side slopes of 2:1. The results of the computations indicate the following:

i) In the proximity of the creek crossing due to the presence of soft to firm silty clay, fills up to 17 feet in height will be stable with standard 2:1 slopes.

ii) Fills in excess of 17 feet in height will require a mid-height berm in order to ensure the stability of the fill section. The details of the berm requirements at various stations are as follows:

94 + 25	no berm
94 + 50	15 ft. mid-height berm
94 + 75	no berm

A smooth transition should be provided between no berm to full 15 feet berm at Station 94+50.

The estimated consolidation settlement due to 20 feet of embankment fill will be of the order of 8 to 9 inches in a maximum period of 5 years. Approximately fifty percent of the settlements should take place in a period of 12 months.

Culvert Foundations

The proposed pipe arch culvert should be supported on granular pad having a minimum thickness of 24 inches. This granular pad should extend a minimum base width of at least 18 inches on either side of the base width of the culvert. The granular pad should consist of well compacted granular 'A' material. Bedding and placing of backfill material around the culvert should be carried out as per current D.T.C. standards. In order to accommodate the anticipated consolidation settlement of the embankment loading, the culvert should be provided with a camber of 9 inches in the middle.

This memo should be appended with our foundation report W.O. 71-11052.

Shaheen Ahmad.

SA/ao
cc: T. C. Kingsland
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
G. Tilley

For: Shaheen Ahmad,
Project Foundation Engineer,
M. Devata,
Supervising Foundation Engineer.
(Giffels Associates Ltd.)

FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

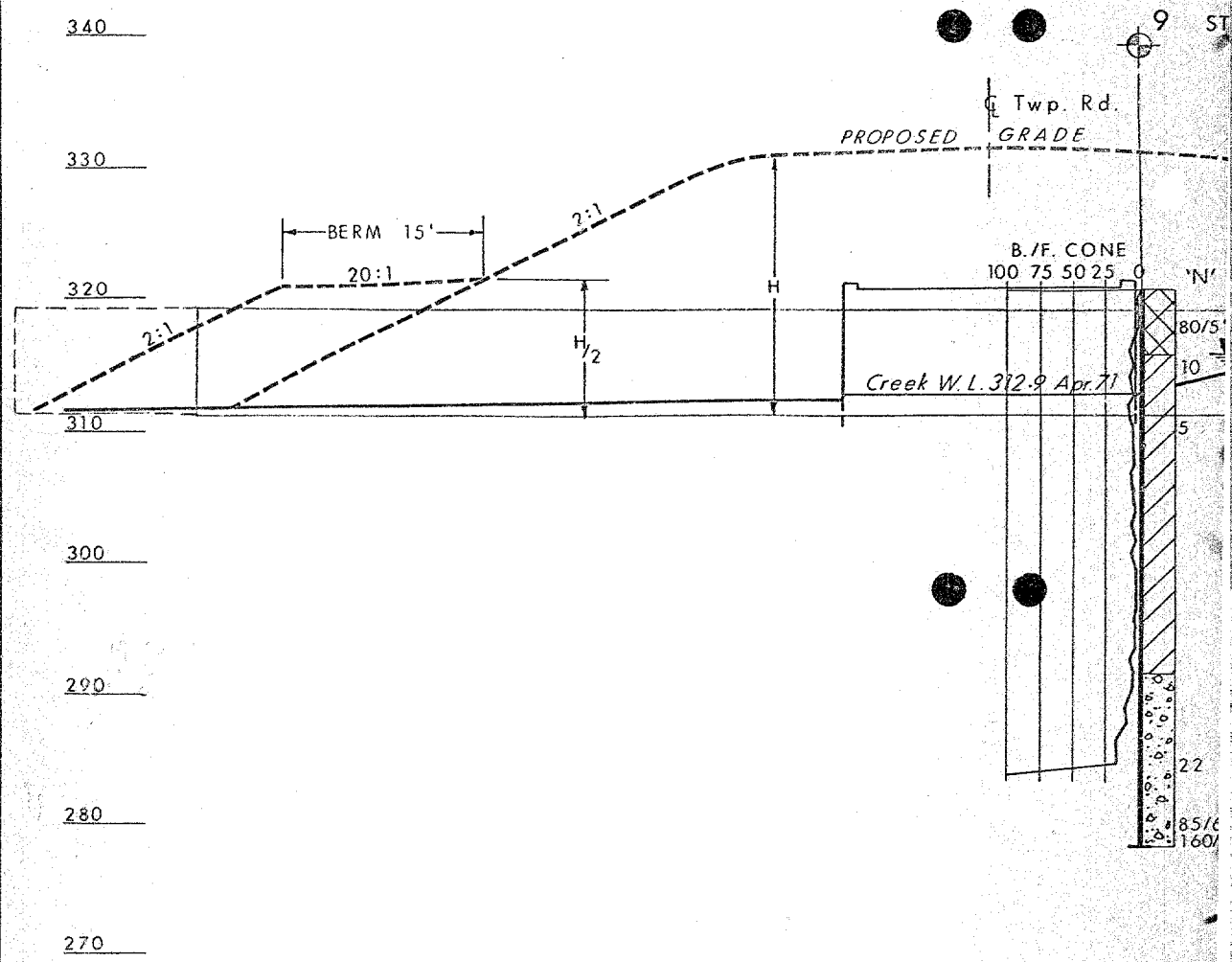
DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

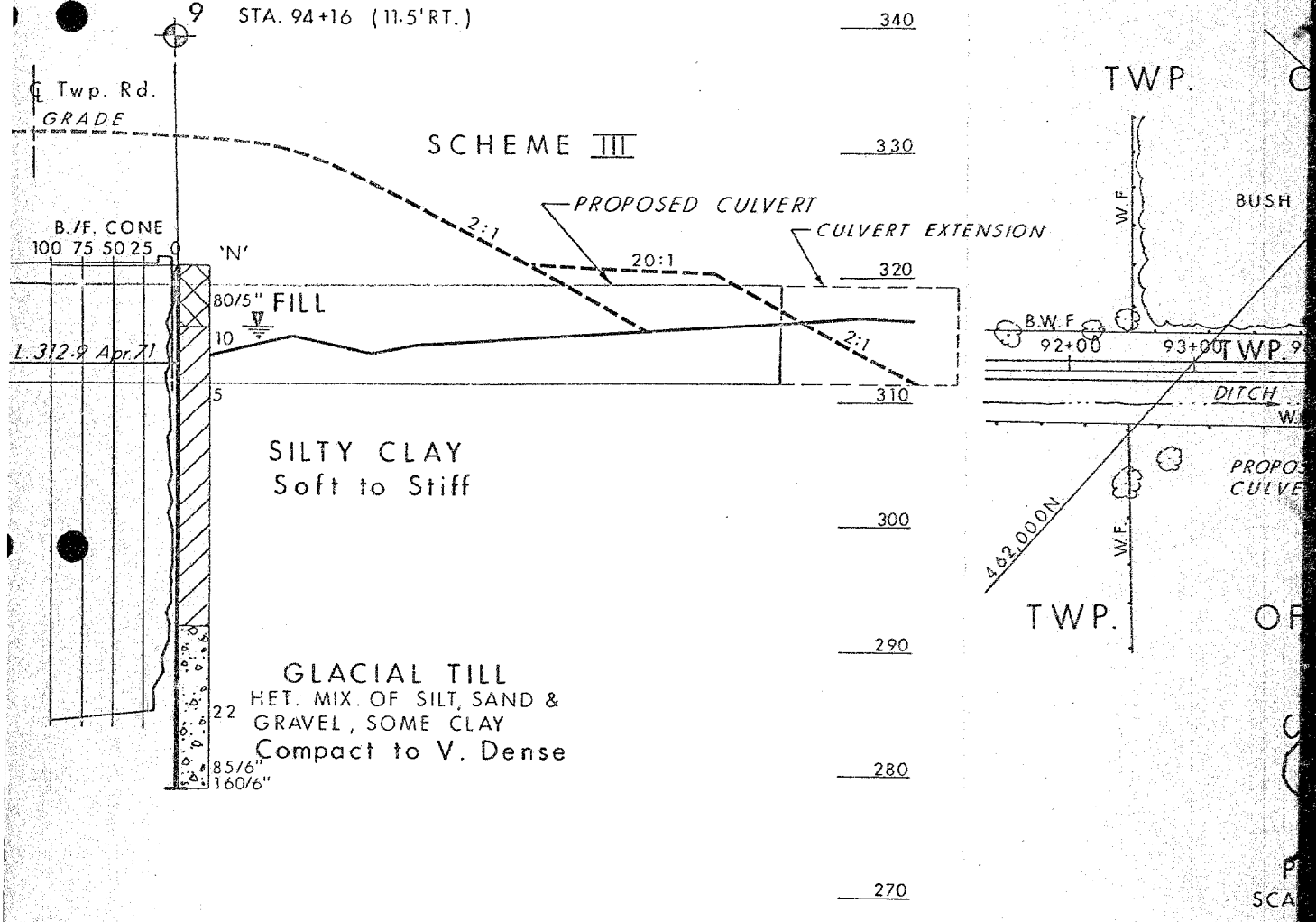
JOB 71-11052 LOCATION 11.5' Rt. of Sta. 94 + 16 (Twp. Road Ch'g) ORIGINATED BY VS
W.P. 433-64-02 BORING DATE Dec. 20, 1971 COMPILED BY SAA
DATUM Geodetic BOREHOLE TYPE Washboring-NX & BX Casing CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F. (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE; 400 800 1200 1600 2000)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P w w_L); WATER CONTENT % (15 30 35)	BULK DENSITY γ P.C.F.	REMARKS / GR.SA.SI.CL.
320.7	Ground Level									
0.0	Fill - Silty clay with occ. boulder.		1	SS	80/5"	320				
315.7	Dense Brown									▼ 315.7 Open BH Dec.21/71
5.0	Silty clay		2	SS	10			o		
			3	SS	5	310	+σ●			
			4	TW	PM		+		114	
			5	TW	PM		+		104	
	Soft to Stiff Grey		6	TW	PM		σ +	o		0 2 5 7
			7	TW	PM	300	+			
			8	TW	PM		σ● +	o	108	
291.7										
29.0	Het.mix.of silt, sand & gravel, with some clay. Glacial Till		9	TW	PM	290		o		
			10	SS	22			o		
	Compact to Very Dense Grey		11	SS	35/3"		100/8"			0 6 8 4 10
278.7			12	SS	100/6"	280		o		15 49 24 12
42.0	End of Borehole									



SECTION A

SCALE: 1" = 10'-

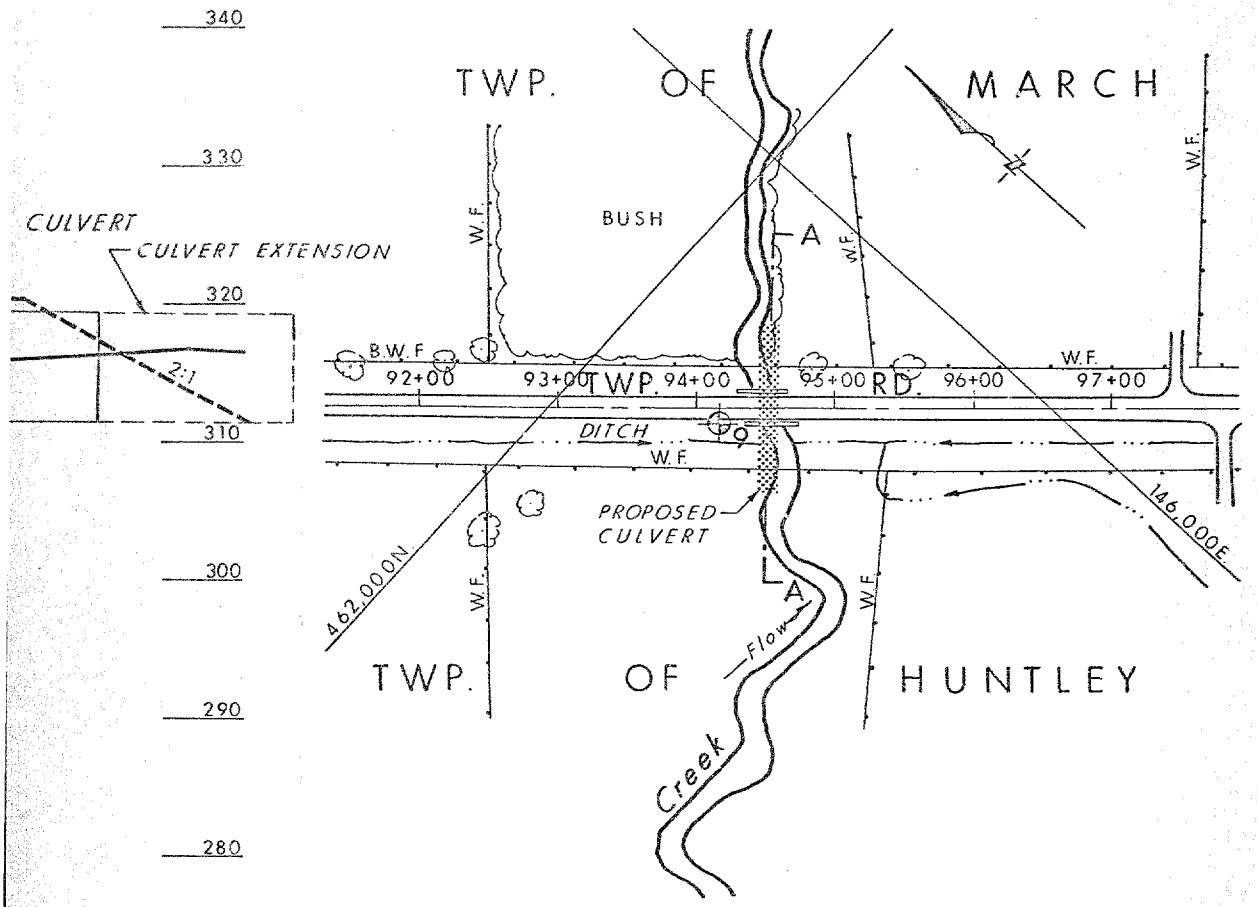


SECTION A-A STA. 94+50

SCALE: 1" = 10'-0"

DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING OFFICE
ONTARIO

DATE Jan. 24, 19



PLAN
SCALE: 1"=100'-0"

DEPARTMENT OF HIGHWAYS MATERIALS and TESTING OFFICE ONTARIO	PROPOSED CULVERT STA. 94+50 HUNTLEY MARCH TOWNSHIP ROAD SCHEME III
DATE Jan. 24, 19	W.P. NO. 433-64-02 DRAWING NO. 71-11052B

Ontario
Department of Transportation and Communications
XXXXXXXXXXXXXXXXXXXXX
Ontario

MEMORANDUM

3165-103

TO: Mr. T. C. Kingsland,
Regional Bridge Planning Engr.,
Eastern Region,
KINGSTON, Ontario.

FROM: Foundation Section,
Design Services Branch,
Downsview, Ontario.

ATTENTION:

DATE: August 26, 1971

OUR FILE REF.

IN REPLY TO AUG 30 1971

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
The Underpass Structure at the
Crossing of Hwy. #417 & Township Rd.
Twp's of March & Huntley - Reg. Mun.
Ottawa - Carleton
District No. 9 (Ottawa)
W.O. 71-11052 -- W.P. 436-64-00

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 feel free to contact our Office.

AGS/ht
Attach.
c.c. Messrs. T.C. Kingsland (2)
B.R. Davis
F.G. Allen
D.W. Farren
S.J. Markiewicz
J.E. Callaghan
E.R. Saint
J. Percy
B.J. Giroux (2)
B.A. Singh

Foundations Files
Documents

A.G. Stermac
PRINCIPAL FOUNDATION ENGINEER

George Tilly
Giffels and

TABLE OF CONTENTS

FOUNDATION INVESTIGATION REPORT
For
The Underpass Structure at the
Crossing of Hwy. #417 & Township Rd.
Twp's of March & Huntley - Reg. Mun.
Ottawa - Carleton
District No. 9 (Ottawa)
W.O. 71-11052 -- W.P. 436-64-00

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the site of the proposed underpass structure at the crossing of Hwy. #417 and the township road on the boundaries of Huntley and March Townships, in the Regional Municipality of Ottawa-Carleton. The request was contained in a memo from Mr. T. C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated July 20, 1971. An investigation was subsequently carried out by this Section to determine the subsoil, bedrock and groundwater conditions at this site.

This report contains the factual results obtained from the investigation, together with recommendations pertaining to the foundations of the proposed structure as well as the stability and settlement considerations associated with the approach fills.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located in the vicinity of the township road located on the boundary between the Townships of Huntley and March, specifically 2 miles north of the Village of Stittsville and ½ mile west of the Carp River. The terrain in this area is flat to gently undulating in relief between about elevations 324 and 326. The surrounding land is cultivated and being used for farming purposes.

..... 2.

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

The existing township road is a two-lane (approximately 25 feet wide) gravel surfaced roadway. The road is elevated about 2 to 3 feet above the surrounding terrain.

This area is situated in the physiographic region known as the 'Ottawa-Valley Clay Plains'. In this region extensive clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region; in some localized areas it is known to extend to depths in excess of 200 feet. In the area under consideration, however, it is generally of the order of 30 to 50 feet deep. The clay is underlain by glacial till.

The overburden deposits are underlain by limestone bedrock of the Trenton and Black River groups, Ordovician Period.

3. FIELD AND LABORATORY WORK:

Eight sampled boreholes, six of which were accompanied by a dynamic cone penetration test, were put down at this site using conventional diamond drill rigs adapted for soil sampling purposes.

Samples of the upper desiccated portion of the cohesive stratum, as well as the lower glacial till deposit were obtained, at specified 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. In the lower portion of the cohesive stratum the testing programme was supplemented

..... 3.

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

by taking 2-inch I.D. Shelby tubes, which were manually pushed into the soil. In addition, field vanes were carried out, where possible, to determine the undrained shear strength of the clay stratum. Bedrock was proven in 6 of the boreholes by obtaining BX size rock core samples.

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes.

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 various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a Geodetic datum. The boring locations and elevations are shown on Drawing No. W.O. 71-11052A. Stratigraphical sections, inferred from the boring data, are also presented 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 engineering properties of the overburden:

Bulk Density

Natural Moisture Content

Atterberg Limits

Grain-Size Distribution

Undrained Shear Strength

Consolidation Characteristics

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

The results of this testing are plotted on the Record of Borelog sheets and summarized on Figures No. 1 to 6, inclusive, all contained in the Appendix of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The predominant stratum across the site is composed of a very stiff to firm grey clay to silty clay. The thickness of this stratum varies from 36 to 41 feet. The cohesive subsoil is underlain by a loose to very dense non-cohesive glacial till deposit, whose thickness ranges from 21.5 to 33 feet. The glacial till is, in turn, underlain by sound limestone bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying borehole sheets. The stratigraphical sections, shown on Drawing No. W.O. 71-11052A, are inferred from this data.

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

4.2) Clay to Silty Clay (Sensitive Leda Clay):

Directly beneath the one foot thick surficial clayey topsoil cover is the predominant stratum across the site, which is composed of a clay to silty clay of marine origin. The overall thickness of the cohesive soil varies from 36 to 41 feet. The upper 9.5 to 14 feet of the stratum is mottled grey and brown in colour which is an indication that this upper zone has been subjected to desiccation. Beneath this desiccated zone the clay is grey. Numerous partings and seams of silt, up to 2" thick, are present

..... 5.

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

4.2) Clay to Silty Clay (Sensitive Leda Clay): (cont'd) ... throughout the deposit. Further, at B.H. #8 a 3 foot thick layer of silt was encountered near the base of the stratum. Grain-size distribution curves for samples of the cohesive subsoil are shown on Figure #2, located in Appendix 1 of the report.

The properties of the upper desiccated, as well as the lower portion of the stratum, as determined by field and laboratory testing, are summarized on Figure #1. A brief resumé, presented in tabular form, follows:

Identity Tests		Upper Desiccated Zone Range (Average)	Lower Zone Range (Average)
Bulk Density (p.c.f.)	(γ)	106 - 116	102.5-109.5 (106)
Liquid Limit (%)	(W_L)	38 - 45 (41)	38 - 63 (47)
Plastic Limit (%)	(W_P)	19 - 28 (24)	18 - 26 (23)
Natural Moisture Content (%)	(W)	36 - 55 (44)	43 -- 60 (52)
Liquidity Index	(I_L)	0.7 - 2.0(1.3)	0.8 - 1.8 (1.3)
Consolidation Characteristics			
Initial Void Ratio	(e_o)	---	1.2 to 2.1
Compression Index	(C_c)	---	0.55 to 2.25
Degree of Preconsolidation (p.s.f.)	(P_c-P'_o)	---	1,200 to 4,000
Undrained Shear Strength (Cu) (p.s.f.)			
1) Field Tests		1,750 ->2,000	750 - ->2,000
2) Lab. Tests		1,350 - 1,700	600 - 850

..... 6.

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

4.2) Clay to Silty Clay (Sensitive Leda Clay): (cont'd) ...

	Upper Desiccated Zone Range (Average) (cont'd)	Lower Zone Range (Average) (cont'd)
Standard Penetration Resistance Testing (Blows/ft.)	4 - 15	-----

The Atterberg limit tests are also plotted on the Plasticity Chart, Figure #3. These results indicate that the cohesive subsoil is essentially inorganic with a plasticity that varies from intermediate to high. The natural water content is consistently at or above the liquid limit throughout the stratum; this is indicative of a sensitive material.

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

The consolidation characteristics of the stratum were determined by carrying out five laboratory tests, the results of which are shown as Void Ratio vs. Pressure plots on Figures #4 and 5. The results of these tests indicate that the clay stratum is preconsolidated by about 3,000 to 4,000 p.s.f. in excess of existing overburden pressure, immediately below the desiccated zone, decreasing to approximately 1,200 p.s.f. with depth. In the upper desiccated zone the degree of preconsolidation would be higher than the ranges quoted above. The relatively high values for the initial void ratio (e_o) and the compression index (C_c) compare favourably with those of other cohesive deposits in this area, and are a further indication of the sensitive nature of the stratum

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

4.3) Heterogeneous Mixture of Silt, Sand and Gravel, Trace of Clay (Glacial Till):

The clay stratum is underlain by a non-cohesive glacial till deposit composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. The overall thickness of this deposit ranges from 21.5 to 33 feet. The upper 3 to 5.5 feet of the glacial till is in a "reworked" condition - i.e., it was once exposed to the atmosphere and subjected to weathering. Occasional layers and seams of silty sand to sandy silt, between 2 and 6 inches in thickness, are present throughout the deposit. At B.H. #7 a 3 feet thick layer of silt was encountered immediately above the glacial till deposit. At borehole #1 the lower 8 feet of the glacial till is bouldery in nature. The boulders in this zone were up to 7 inches in size. Grain-size distribution curves for samples of the glacial till, as well as the layers and seams of silty sand and sandy silt in the till, are each plotted in envelope form on Figure #6.

The Standard Penetration Tests, carried out within the glacial till deposit are plotted on the Record of Borelog sheets, as well as on Figure #1. This testing gave 'N' values which ranged from 2 to 12 blows/ft., in the upper 'reworked' zone of the glacial till, and from 16 blows/ft. to 138 blows for 8 inches in the lower portion. Based on these values it is estimated that the relative density of the upper 'reworked' zone varies from loose to compact and the lower zone ranges from compact to very dense.

4.4) Limestone Bedrock:

The glacial till is directly underlain by bedrock which

.....8.

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

4.4) Limestone Bedrock: (cont'd) ...

was proven in 6 of the boreholes, by obtaining 4 to 5 ft. of BX size rock core samples. Over the site the bedrock surface was found to vary between elevations 256.5 and 265.5, which corresponds to depths below ground surface of from 61.5 to 70 feet.

The bedrock is composed of limestone with occasional irregular shaly interbeds. The bedrock was sound throughout 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. W.O. 71-11052A. The results indicate that the water level, across the site, varies between elevations 319.5 and 323. These water levels correspond to depths below ground surface of from 4 to 6.5 feet.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a 32 foot wide two-span (113' - 113') underpass structure at the crossing of the East and Westbound lanes of Hwy. #417 and the township road on the boundary between Huntley and March Townships, in the Regional Municipality of Ottawa-Carleton. It is understood that the profile grade of the Hwy. #417 lanes, in the vicinity of the crossing, will be between elevations 327 and 328. Further, the profile grade of the township

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

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

road is to vary between elevations 347 and 350. The associated approach fills will, therefore, have a maximum height of the order of 22 feet above finished grade in the longitudinal direction. In the transverse direction, however, the fills will be as much as 24 feet above the existing ground surface.

The predominant stratum across the site is composed of a very stiff to firm grey sensitive clay to silty clay, which varies from 36 to 41 feet in thickness. The cohesive stratum is underlain by a 21.5 to 33 feet thick non-cohesive glacial till deposit, which, in turn, is underlain by sound limestone bedrock.

The presence of the relatively compressible cohesive stratum, at a shallow depth below ground surface, is the governing factor from a foundation point of view, since it will be necessary to ensure that it is not overstressed by either the embankment or structure foundation loadings. These aspects will be discussed in detail in the sub-sections to follow:

6.2) Approach Embankments:

6.2.1) Stability Considerations:

The critical condition for stability of an embankment on slightly overconsolidated clays, as is the case with this clay stratum, generally occurs during or immediately after construction. This being the case, a total stress analysis ($\emptyset = 0$) provides a suitable means of assessing the stability of the embankment sections. In this method of analysis, stability is governed by the applied loads and by the stress-strain and undrained shear

..... 10.

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

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

6.2.1) Stability Considerations: (cont'd) ...

strength properties of the foundation and embankment soils.

Analyses have been carried out, therefore, in terms of total stresses, both manually and by the use of the electronic computer, to determine the stability of the fill sections.

The following assumptions were made:

Soil Properties (West Approach Embankment)

Elevation	Soil	Bulk Density (p.c.f.)	Parameters: Undrained Shear Strength (Cu - p.s.f.)	Parameters: Effective Angle of Internal Friction (Ø - 0)
349-325	Embankment Fill (2:1 slopes)	145	--	30
325-315	Clay (Desiccated)	110	1,300	--
315 - 292	Clay	105	850	--
292-288.5	Clay	110	1,000	--
288.5 --	Glacial Till	135	--	40

Note:
Approximate Ground Water Level - Elevation 320

The results of the computations indicate that, earth fills with a maximum height of 22 and 24 feet in the longitudinal and transverse direction, respectively, would be stable with standard 2:1 slopes.

6.2.2) Settlement Considerations:

The underlying compressible clay stratum will settle due to the surcharge loading of the approach fills, over a long-term period. In addition, some settlement will take place in the underlying

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

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

6.2.2) Settlement Considerations: (cont'd) ...

granular glacial till deposit. This settlement will be elastic in nature and negligible in magnitude. The estimated consolidation settlements due to embankment loading, are summarized in tabular form:

Consolidation Settlement Beneath Centre-Line of Approach Fills (Maximum Height 24 feet)

Time	Consolidation Settlement
1 year	4 to 4½ inches
2 years	6 to 6½ inches
5 years	8 to 9 inches (max.)

Referring to the above table, it can be seen that a high percentage of the total predicted consolidation settlement will take place in a relatively short period of time - e.g. approximately 50 percent within 12 months. In order to minimize post-construction maintenance costs, consideration should be given, if scheduling permits, to constructing the fills at least 12 to 18 months prior to the structure foundations. In any event, final paving operations of the roadway should be delayed for as long a period as possible.

6.3) Structure Foundations:

The presence of the very stiff to firm compressible clay at a shallow depth below ground surface will dictate the necessity of supporting the structure abutments and centre pier on end-bearing piles.

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

6.3) Structure Foundations: (cont'd) ...

6.3.1) Centre Pier (Refer to B.H.'s 3 and 4):

This pier can be supported on end-bearing piles driven to bedrock. For estimating purposes the pile tips can be assumed to be at an elevation between 258 and 260. Allowable loads will depend on the pile section chosen (eg. 14BP74 steel H-piles may be designed for 95 tons per pile).

At least 4 feet of earth cover should be provided to the underside of the pile cap for frost protection purposes.

The base of the pile cap excavation will be slightly above the groundwater level recorded during the period of the investigation. Therefore, no major dewatering problems are anticipated. Any minor groundwater seepage or surface run-off occurring in the excavation could be handled using standard techniques such as pumping from sumps. In any case a lean concrete slab should be placed immediately after the pile cap excavation is completed, in order to prevent softening of the foundation base material.

6.3.2) Abutments:

The abutments can be 'perched' within the approach fills and supported on end-bearing Steel 'H' piles driven into the lower competent portion of the glacial till stratum or to the bedrock surface. The estimated pile tip elevations, at the east and west abutment locations are given below.

..... 13.

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

6.3) Structure Foundations: (cont'd) ...

6.3.2) Abutments: (cont'd) ...

Location	Estimated Pile Tip Elev. (Possible Range)
West Abutment (B.H. #1 and 2)	256 to 260
East Abutment (B.H.'s 5 and 6)	263 to 265 (to bedrock)

The pile driving during construction, specifically in the case of the west abutment, should be controlled by employing the Hiley Dynamic Pile Driving Formula, in accordance with current Department Standards, in order to attain the required loads.

The allowable loads will be dependent on the pile section chosen. In view of the anticipated settlements at the approaches and the consequent negative skin frictional forces, it would be desirable to reduce the design loads by 25% of the maximum allowable load of the pile section selected. Consideration also should be given to supporting the extreme ends of the wing walls on piles to prevent any tilting of the abutments.

No bouldery or rock fill should be placed in areas where piles are to be driven.

7. MISCELLANEOUS:

The field work for this project was carried out during the period of June 23 to July 5, 1971, under the supervision of Messrs. S.A. Ahmad, Project Foundation Engineer and M. Logan, Student Technician, Field.

..... 14.

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

The equipment used was owned by Dominion Soil Investigation ltd., Toronto.

This report was written by Mr. B.T. Darch, Senior Foundation Engineer and reviewed by Mr. M. Devata, Supervising Foundation Engineer.

August, 1971

FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

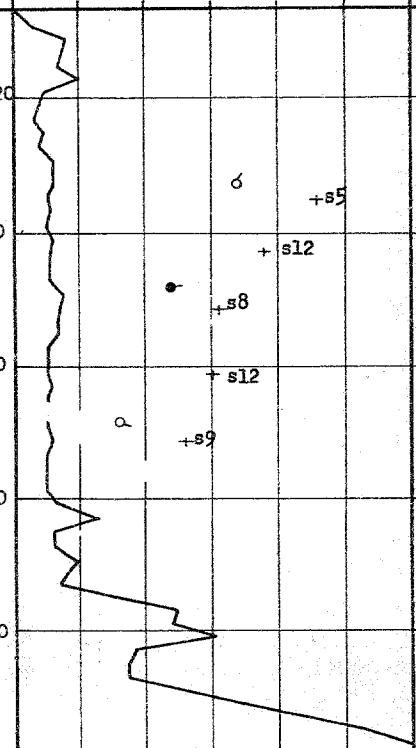
RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 99+56 ℄ Township Rd. o/s 16' Rt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE June 23, 24, 1971 COMPILED BY HT
DATUM Geodetic BOREHOLE TYPE Washboring-NX,BX Casing, BX Rock Core; Cone CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
326.3	Ground Level					
0.0	Topsoil					
1.0	Desiccated Zone		1	SS	13	
	Mottled Grey & Brown		2	SS	14	320
	Stiff to Very Stiff		3	SS	5	
			4	TW	PM	
	Silty clay to clay (sensitive)		5	TW	PM	310
	trace of sand		6	TW	PM	
	Grey		7	TW	PM	300
	Firm to Stiff		8	TW	PM	
289.3			9	TW	PM	290
37.0	Reworked Zone Loose		10	SS	8	
	Het.mix.of silt, sand & gravel, trace of silt (Glacial Till) Grey		11	SS	22	280
			12	SS	39	
	Compact to Very Dense		13	SS	88	270
			14	SS	141	
	Bouldery Zone (Boulders up to 7" in size)		15	BX	10%	260
256.3						
70.0	Bedrock- Limestone with shale interbeds		16	BX	100%	
251.3	Sound					
75.0	End of Borehole					250

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE
400 800 1200 1600 2000



LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.	REMARKS	GR. SA. SI. CL.
	▼ 319.8 WL in open BH July 6/71	
105		
107		
105		0 5 59 36
		26 30 38 6

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 99 + 56 ℄ Township Rd. o/s 16' Lt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE June 23 - 28, 1971 COMPILED BY HT
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing - BX Rock Core; Cone CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
325.7	Ground Level					
0.0	Clayey Topsoil					
1.0	Desiccated Zone Mottled Grey & Brown Stiff to Very Stiff		1	SS	15	320
			2	SS	14	
			3	SS	6	
	Clay to silty clay, trace of sand (sensitive)		4	TW	PM	
			5	TW	PM	310
	Occ. silt partings throughout.		6	TW	PM	
	Grey		7	TW	PM	300
	Firm - Stiff		8	TW	PM	
287.7			9	SS	-	290
38.0	Reworked Zone Loose		10	SS	8	
	Het.mix. of silt, sand and gravel (Glacial Till) occ. layers silty sand & sandy silt up to 2' thick throughout. Grey		11	SS	35	280
			12	SS	60	
			13	SS	140	270
			14	SS	138/8"	
256.7	Dense to Very Dense		15	SS	138	260
69.0	Bedrock - Limestone		16	BX	100%	
251.7	Sound					
74.0	End of Borehole					250

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000
+s10 +s8 +s9 +s16 +s12 +s4

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.

110.5
107.5
102.5

REMARKS GR. SA. SI. CL.

▼ 320.2
WL in open BH July 6/71

6 53 31 10

20
15 ⊕ 5 % STRAIN AT FAILURE
10

FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 100+69 ℄ Township Rd. o/s 16' Rt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE June 24, 25 & 28, 1971 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing-BX Rock Core; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
326.6	Ground Level					
0.0	Topsoil					
1.0	Desiccated Zone Mottled Grey & Brown Stiff to Very Stiff		1	SS	12	
			2	SS	11	320
			3	SS	8	
	Clay to silty clay, trace of sand (sensitive) occ. silt partings throughout Grey Firm to Stiff		4	TW	PM	
			5	TW	PM	310
			6	TW	PM	
			7	TW	PM	300
			8	TW	PM	
			9	TW	PM	290
286.6						
40.0	Reworked Zone Loose		10	SS	4	
	Het.mix.of silt, sand & gravel, trace of clay (Glacial Till) occ. layers of silty sand to sandy silt up to 3" thick below elev. 270. Grey		11	SS	20	280
			12	SS	50	
			13	SS	55	270
			14	SS	168	
259.8	Compact to Very Dense		15	SS	160	
66.8 255.6	Bedrock - Limestone with interbeds of shale Sound		16	BX	100%	260
71.0	End of Borehole					250

DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F. 400 800 1200 1600 2000
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE
+s9 +s11 +s10 +s3 +s3 +s3

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
	WL in open BH ▼320.0 0 19 44 37
108	
106.5	
106	
	4 52 37 7

20
15 ⊹ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 100 + 69 ℄ Township Rd. o/s 16' Lt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE June 29 and 30, 1971 COMPILED BY HT
DATUM Geodetic BOREHOLE TYPE Washboring-NX,BX Casing-BX Rock Core; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
324.2	Ground Level					
0.0	Clayey Topsoil					
1.0	Desiccated Zone		1	SS	13	320
	Mottled Grey & Brown		2	SS	7	
	Stiff to Very Stiff		3	TW	PM	
			4	TW	PM	310
	Clay to silty clay, trace of sand (sensitive)		5	TW	PM	
			6	TW	PM	
	occ. silt partings throughout.		7	TW	PM	300
	Grey		8	TW	PM	
	Firm to Stiff		9	TW	PM	290
285.2						
39.0	Reworked Zone Compact		10	SS	12	
	Het.mix.of silt, sand & gravel, trace of clay (Glacial Till)		11	SS	23	280
	Grey		12	SS	30	
			13	SS	125	270
	Compact to Very Dense		14	SS	170	
258.4						260
65.8	Bedrock - Limestone interbeds of shale		15	BX	100%	
253.2	Sound					
71.0	End of Borehole					250

DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F. 400 800 1200 1600 2000
○ UNCONFINED ⊕ FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
s5 s3 s4 s4 s4 s7

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
	▼319.7 WL in open BH July 6/71
106	
107	
109.5	
106.5	

% STRAIN AT FAILURE 20 15 5 10

FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 101 + 82 ℄ Township Rd. o/s 16' Rt. ORIGINATED BY SA
W.P. 436-74-00 BORING DATE June 29 and 30, 1971 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing-BX Rock Core; Cone CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
327.3	Ground Level				
0.0	Topsoil				
1.0	Desiccated Zone		1	SS	6
	Mottled Grey & Brown		2	SS	4
	Stiff to Very Stiff		3	TW	PM
	Clay to silty clay,		4	TW	PM
	trace of sand (sensitive)		5	TW	PM
	occ. silt partings throughout.		6	TW	PM
	Grey		7	TW	PM
	Firm to Stiff		8	TW	PM
			9	TW	PM
285.3			10	SS	1
42.0	Reworked Zone		11	SS	2
	Loose				
	Het. mix. of silt, sand & gravel (Glacial Till)		12	SS	21
	occ. layers of silty sand to sandy silt up to 2" thick throughout		13	SS	18
263.3	Compact to Very Dense		14	SS	106
64.0	Bedrock - Limestone, interbeds of shale		15	BX	100%
258.3	Sound				
69.0	End of Borehole				

ELEV. SCALE: 320, 310, 300, 290, 280, 270, 260, 250

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

+> 2000
+> 2000
+s6
+s10
+s6
+s14
+s5
+s4
+s6

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.
107
109.5
117

REMARKS
GR. SA. SI. CL.
320.7 WL in open BH July 6/71
38 36 16 10

20
15 ✛ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

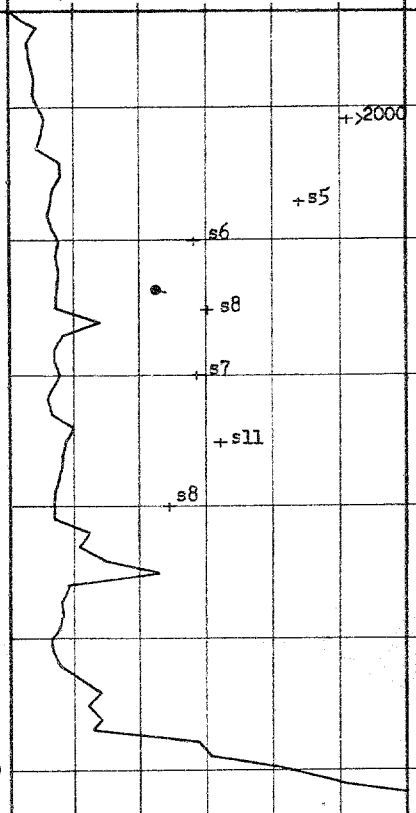
RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

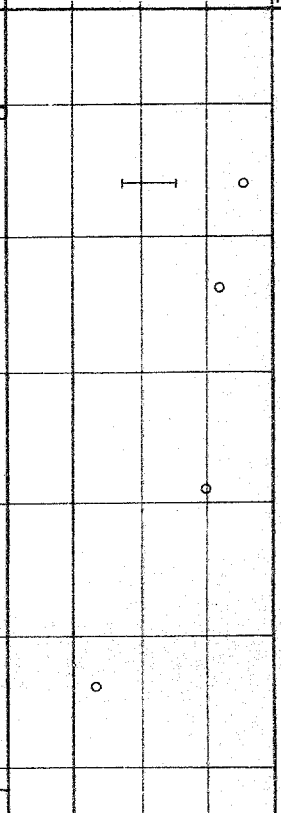
JOB 71-11052 LOCATION Sta. 101 + 82 ℄ Thownship Rd. o/s 16' Lt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE July 1 & 5, 1971 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring-NX,BX Casing-BX Rock Core; Cone CHECKED BY

SOIL PROFILE ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
327.0	Ground Level					
	Topsoil					
1.0	Desiccated Zone		1	SS	4	
	Mottled Grey & Brown		2	SS	11	320
	Stiff to Very Stiff		3	SS	13	
			4	SS	15	
	Clay to silty clay,		5	TW	PM	310
	trace of sand		6	TW	PM	
	(sensitive)					
	occ. partings and		7	TW	PM	300
	seams of silt up to					
	2" thick throughout.		8	TW	PM	
	Grey		9	TW	PM	290
287.0	Firm to Stiff					
40.0	Reworked Zone		10	SS	6	
	Loose					
	Het.mix.of silt,sand		11	SS	16	280
	and gravel					
	(Glacial Till)		12	SS	24	
	occ. layers of silty					
	sand to sandy silt up		13	SS	42	270
	to 2" thick throughout					
265.5	Compact to Very Dense		14	SS	75	
61.5	Bedrock - Limestone		15	BX	100%	
261.5	Sound					
65.5	End of Borehole					260

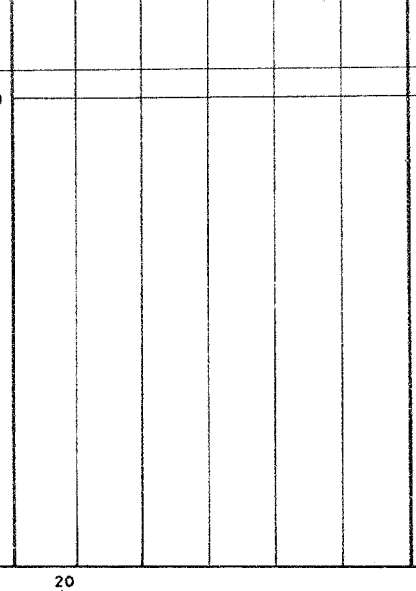
DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000



LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_P w w_L
WATER CONTENT %
15 30 45



BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
	▼ 323.0 WL in open BH July 6/71
106	
	0 98 (2)



FORM OD-MT - 126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 71-11052 LOCATION Sta. 102 + 32 ℄ Township Rd. o/s 16' ORIGINATED BY SA
W.P. 436-64-00 BORING DATE July 1, 1971 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing CHECKED BY

SOIL PROFILE ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
327.3	Ground Level					
	Desiccated Zone Mottled Grey & Brown		1	SS	6	320
	Stiff to Very Stiff		2	TW	PM	
	Clay to silty clay, trace of sand (sensitive)		3	TW	PM	310
			4	TW	PM	
	occ. partings of silt throughout.		5	TW	PM	300
	Grey		6	TW	PM	
288.3	Firm to Stiff		7	TW	PM	290
39.0	Silt, Grey, Compact		8	SS	15	
	Het.mix.of silt,sand & gravel,trace of clay (Glacial Till)		9	SS	19	280
			10	SS	27	
	occ. sand seams up to 6" thick.		11	SS	19	270
265.5	Grey Compact to Very Dense		12	SS	72	
61.8	End of Borehole Probable Bedrock					260

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

321.0
WL in open BH July 7/71

116
103
103.5

0 3 92 5
14 45 30 11

20
15 ⊕ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

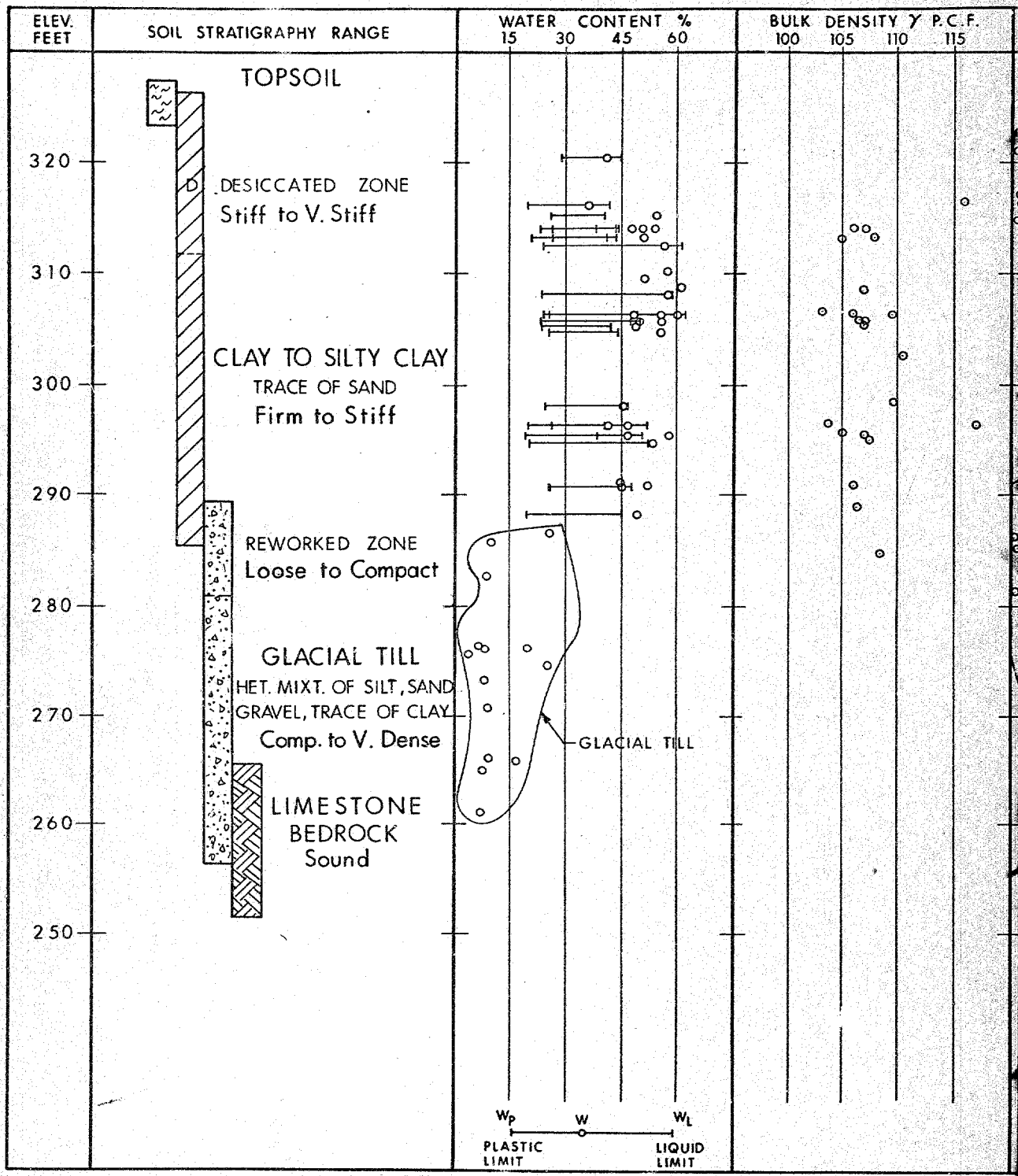
JOB 71-11052 LOCATION Sta. 99 + 06 ℄ Township Rd. o/s 16' Rt. ORIGINATED BY SA
W.P. 436-64-00 BORING DATE July 5, 1971 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring-NX, BX Casing CHECKED BY

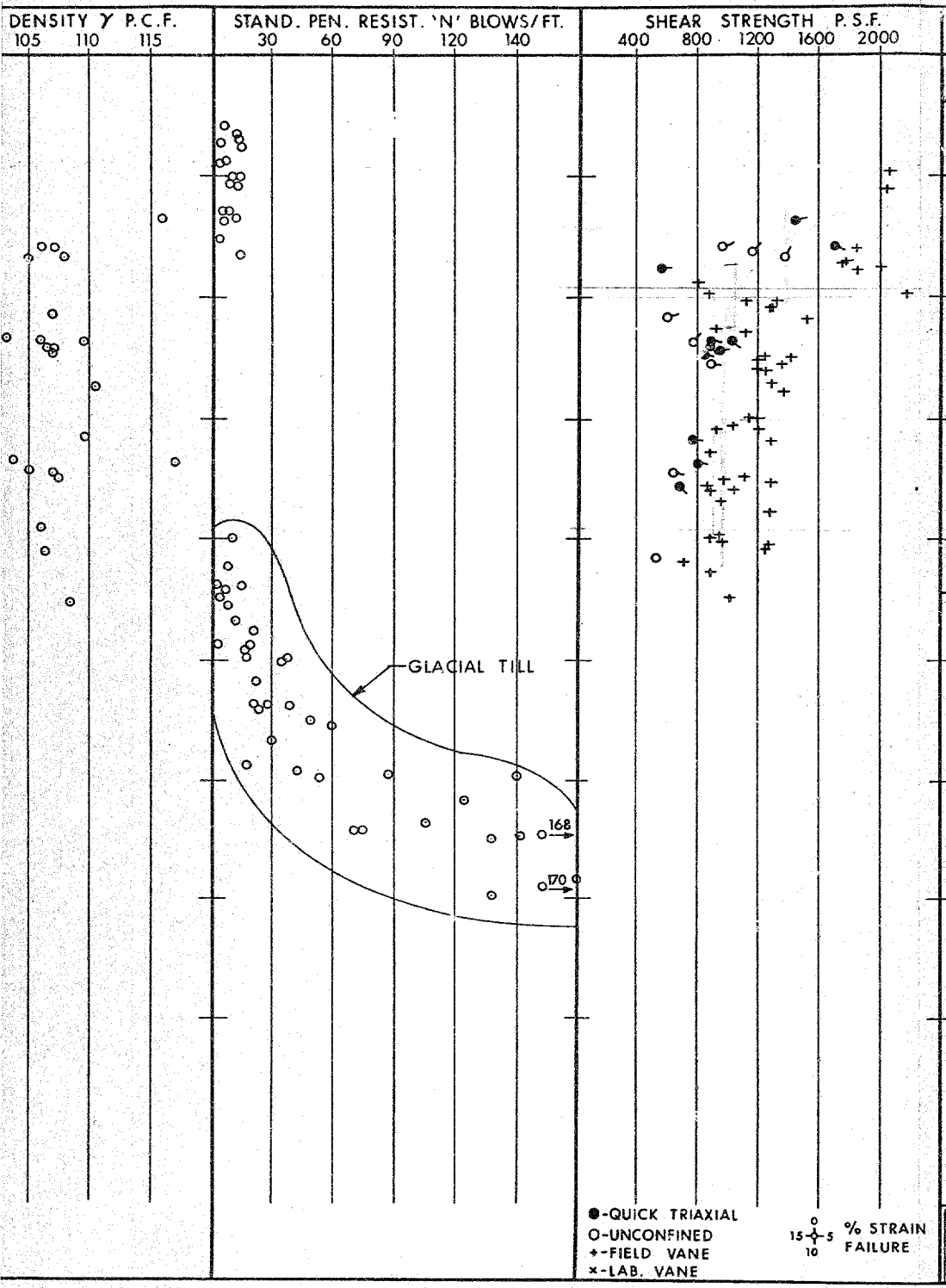
ELEV. / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F. (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) 400 800 1200 1600 2000	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % 15 30 45	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
326.3	Ground Level									
0.0	Clayey Topsoil									
1.0	Desiccated Zone		1	SS	10	320				▼320.3 WL in open BH July 6/71
	Mottled Grey & Brown									
	Stiff to Very Stiff		2	SS	4		+s4	o		
	Silty clay, trace of sand (sensitive)		3	TW	PM	310	+s4			
	occ. silt and sand partings.		4	TW	PM		•, +s6	o	107	
	Grey		5	TW	PM	300	+s8			
	Firm to Stiff		6	TW	PM		+s3	o	107	1 19 44 36
	Silt, Grey, Compact		7	SS	10	290	+s8			
287.3										
39.0	Reworked Zone Loose		8	SS	5			o		6 52 32 10
	Het. mix. silt, sand and gravel, trace of clay (Glacial Till)		9	SS	38	280				
276.3	Dense									
50.0	End of Borehole					270				

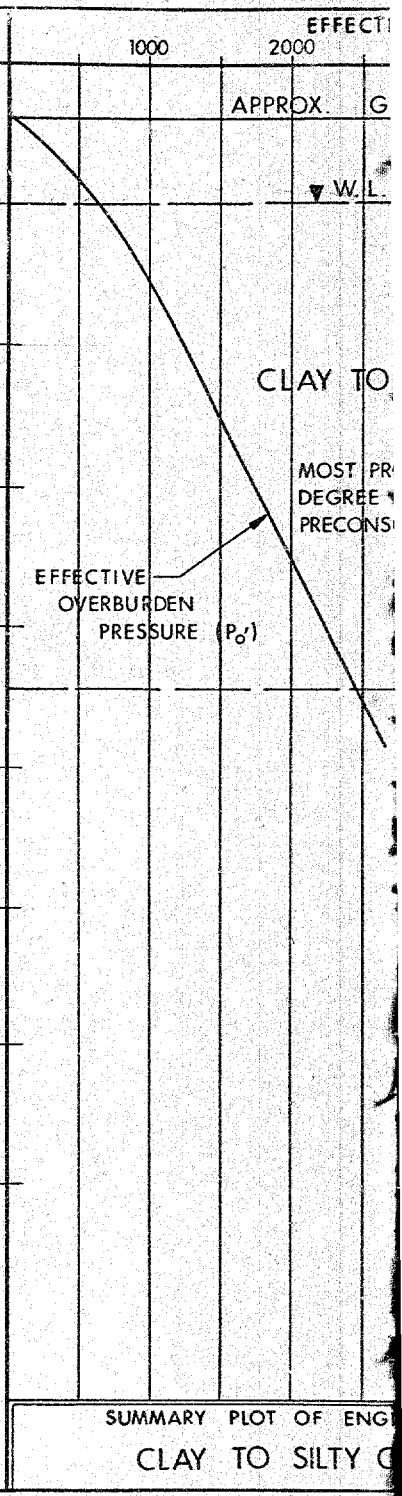
20
15 ⊹ 5 % STRAIN AT FAILURE
10

F.D. 28

SUMMARY PLOT OF ENGINEERING PROPERTIES

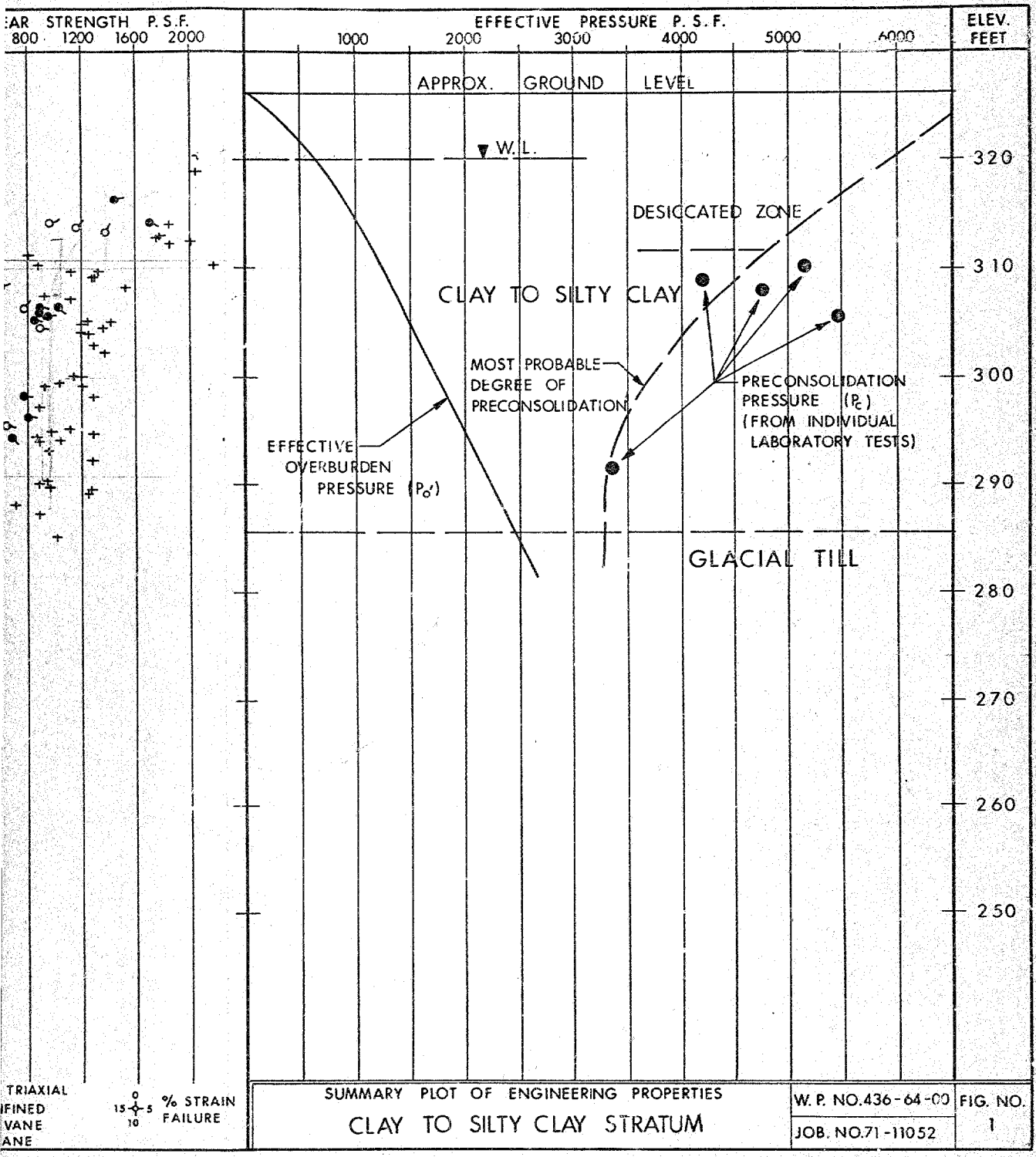






SUMMARY PLOT OF ENG

CLAY TO SILTY C



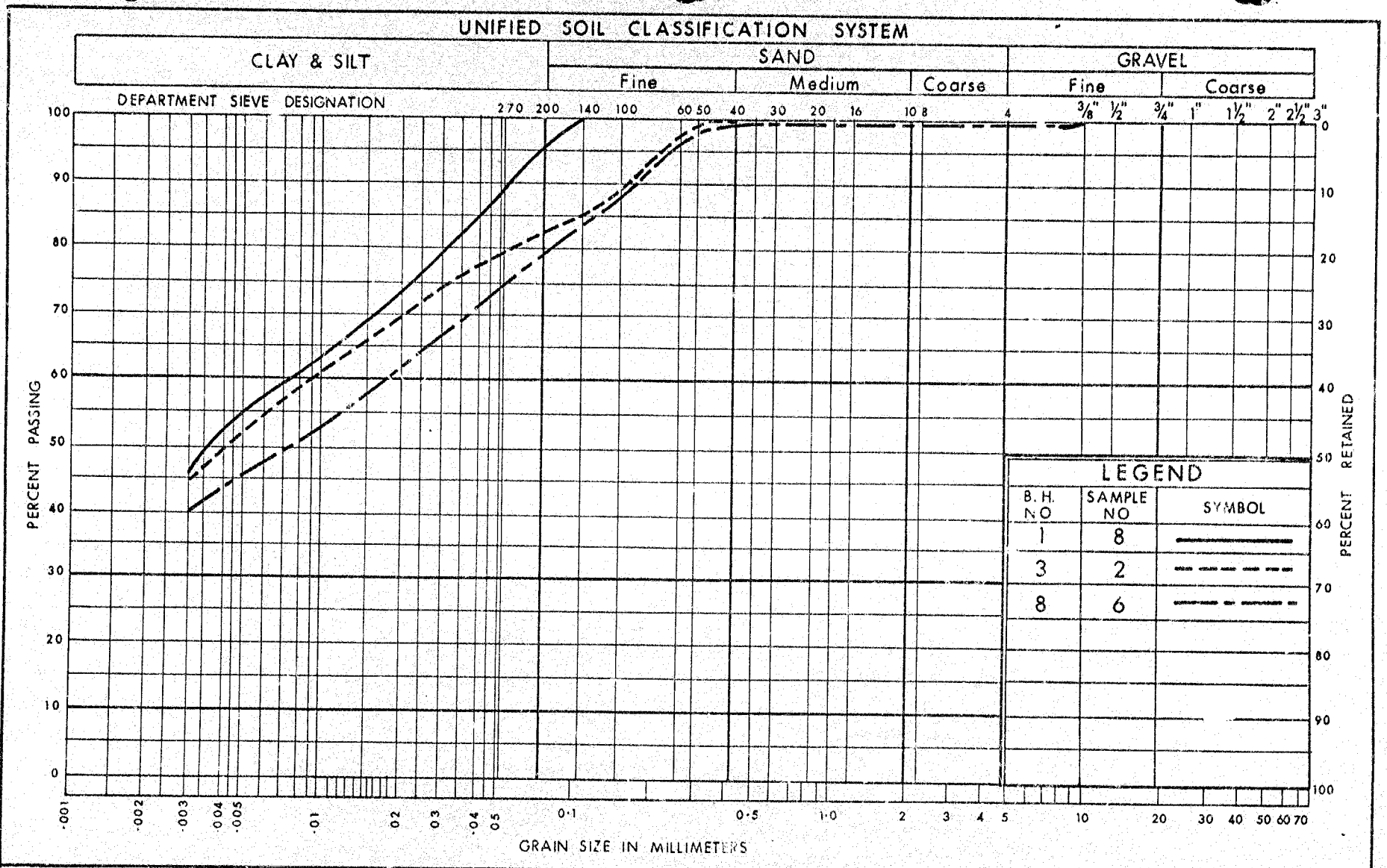
SUMMARY PLOT OF ENGINEERING PROPERTIES

CLAY TO SILTY CLAY STRATUM

W. P. NO. 436-64-00

JOB. NO. 71-11052

FIG. NO. 1



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION

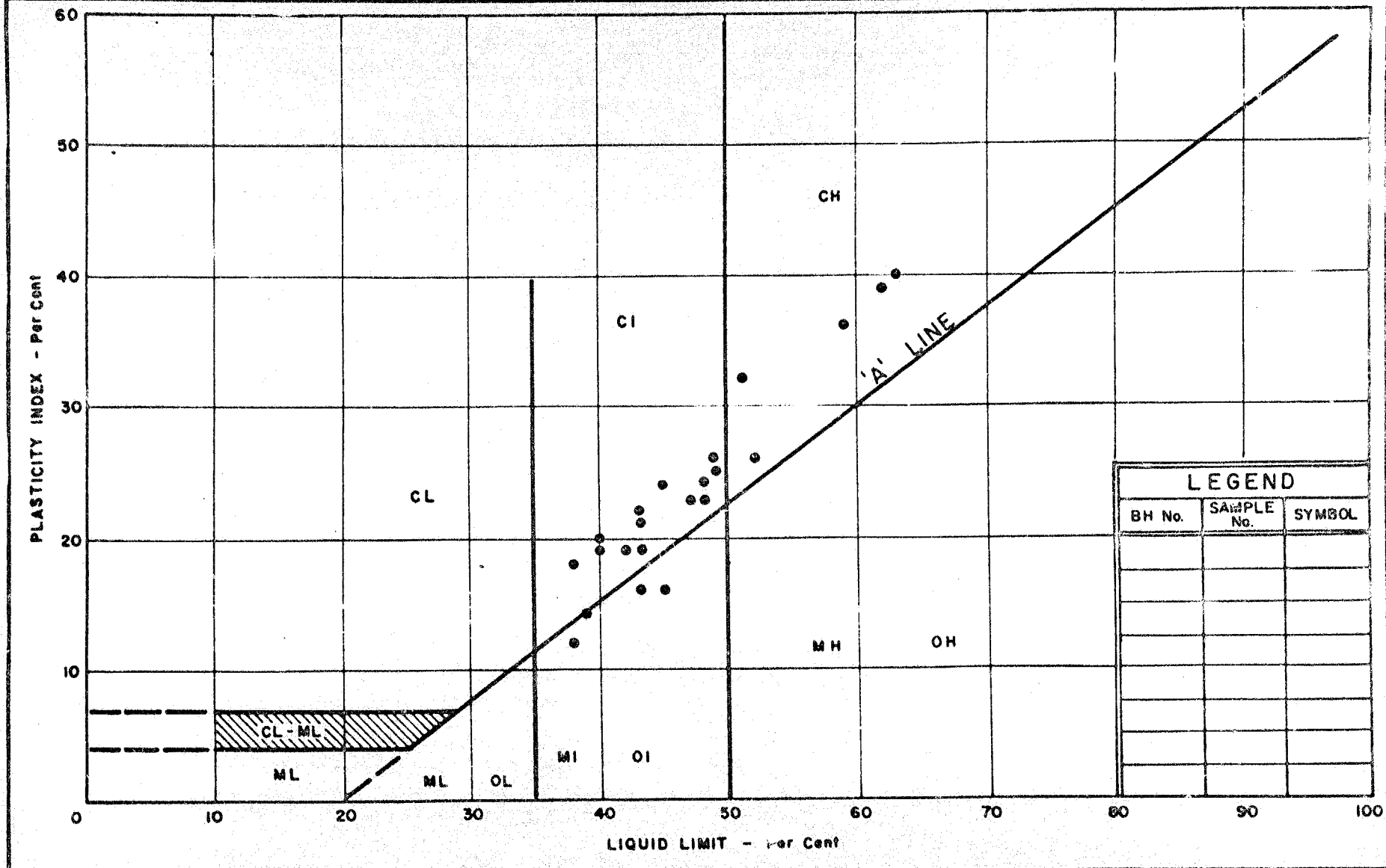
CLAY TO SILTY CLAY (SENSITIVE)

W.P. No. 436 - 64 - 00

JOB No. 71 - 11052

FIG. 2

REVISED JULY, 1966



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

CLAY TO SILTY CLAY (SENSITIVE)

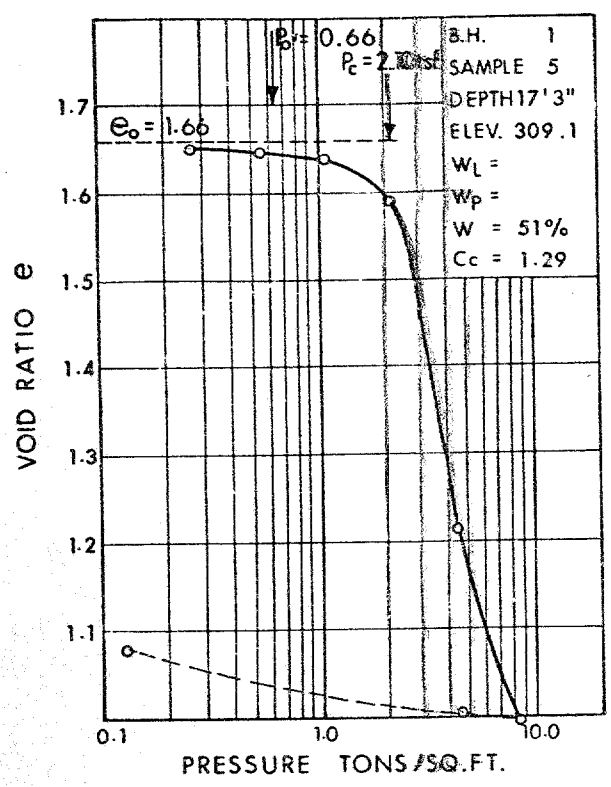
W.P. No. 436 - 64 - 00

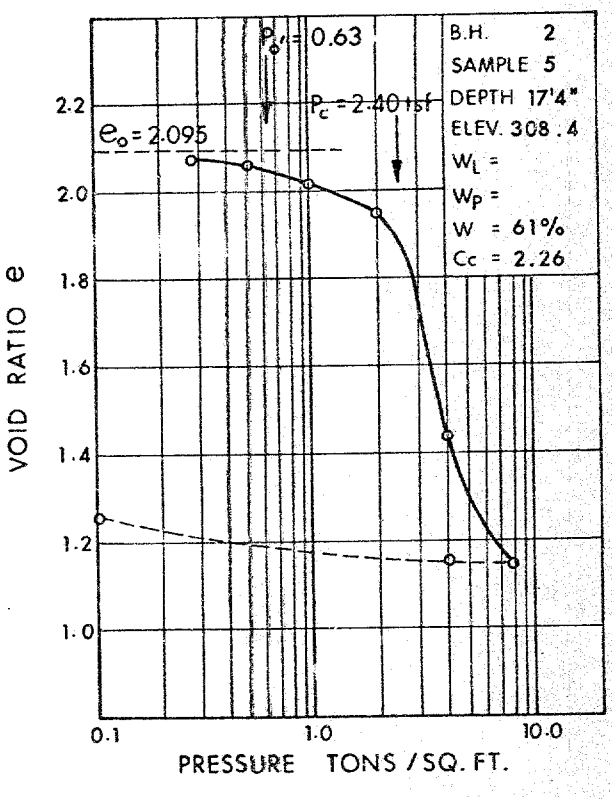
JOB No. 71 - 11052

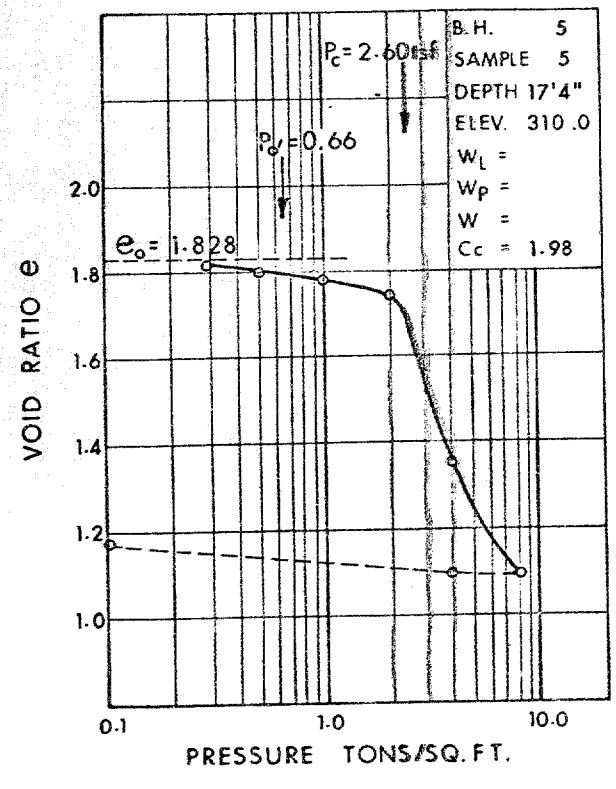
FIG. 3

VOID RATIO – PRESSURE CURVES

JOB NO. 71-11052







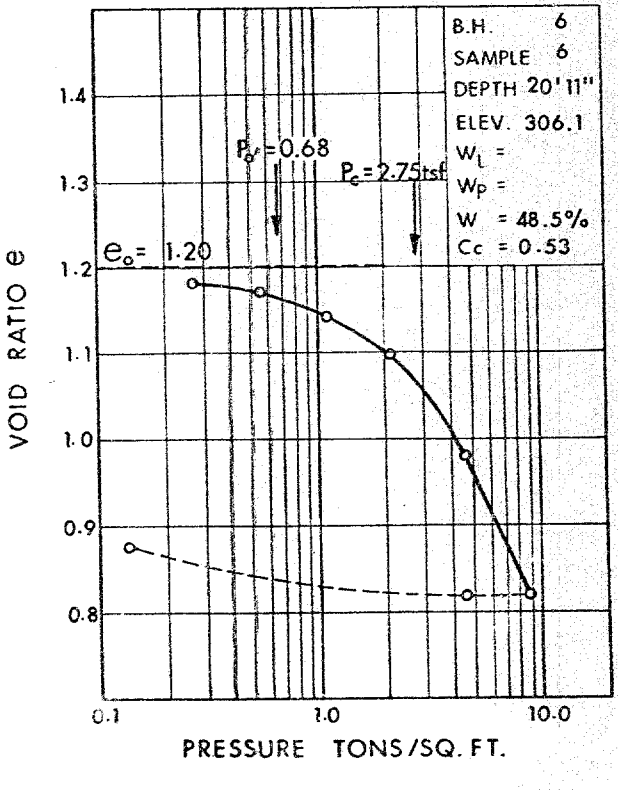
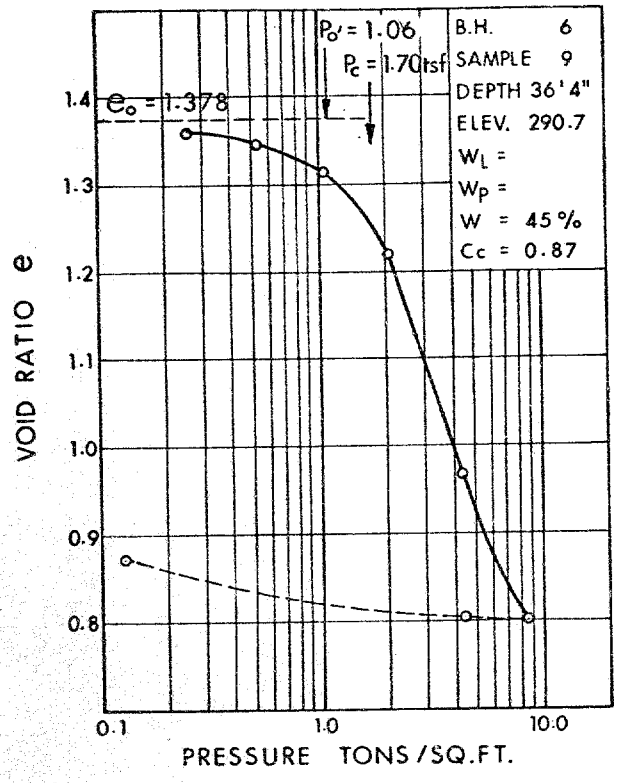
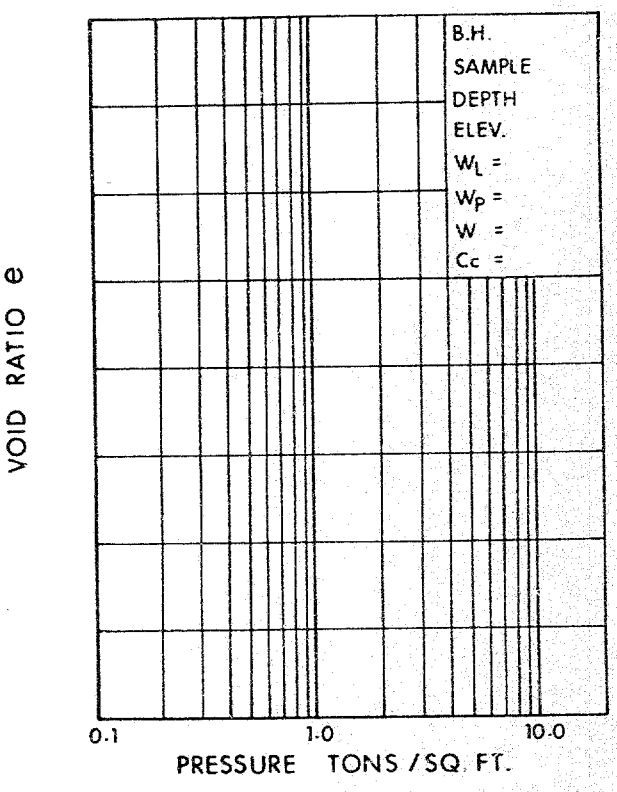
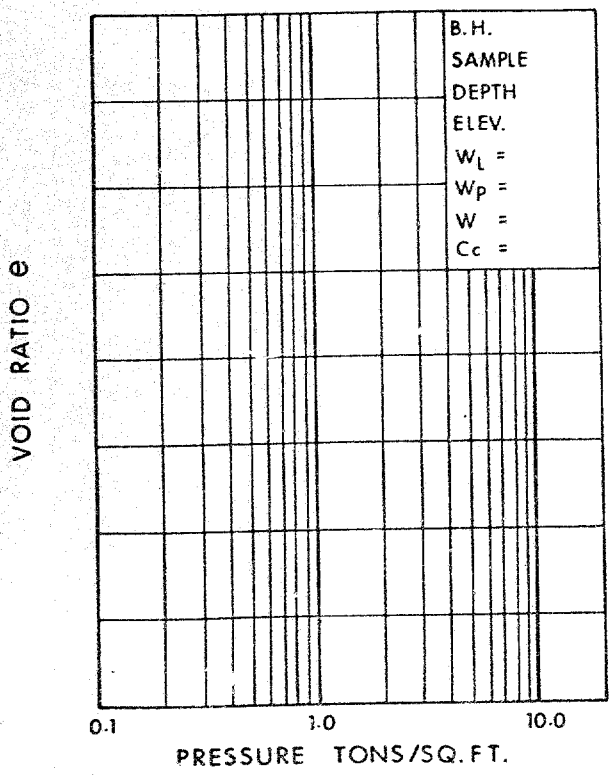
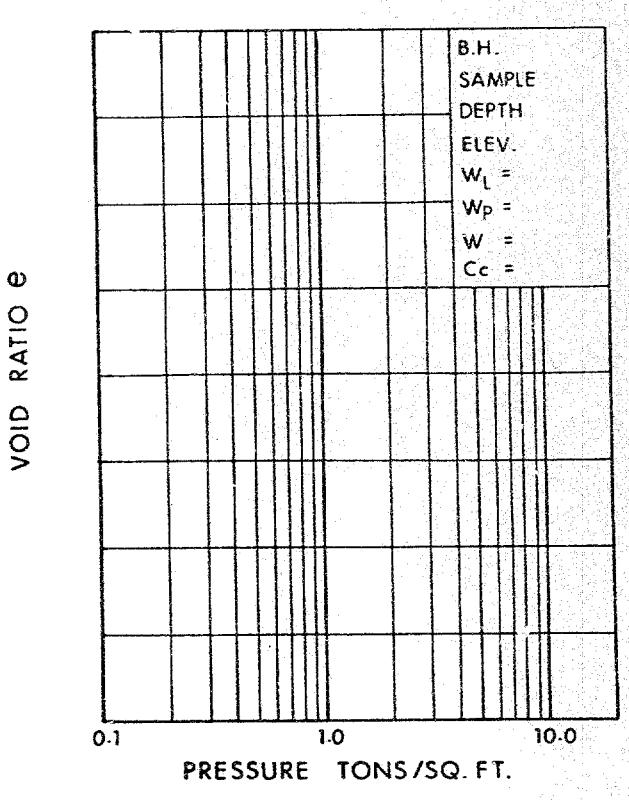


FIG. 4







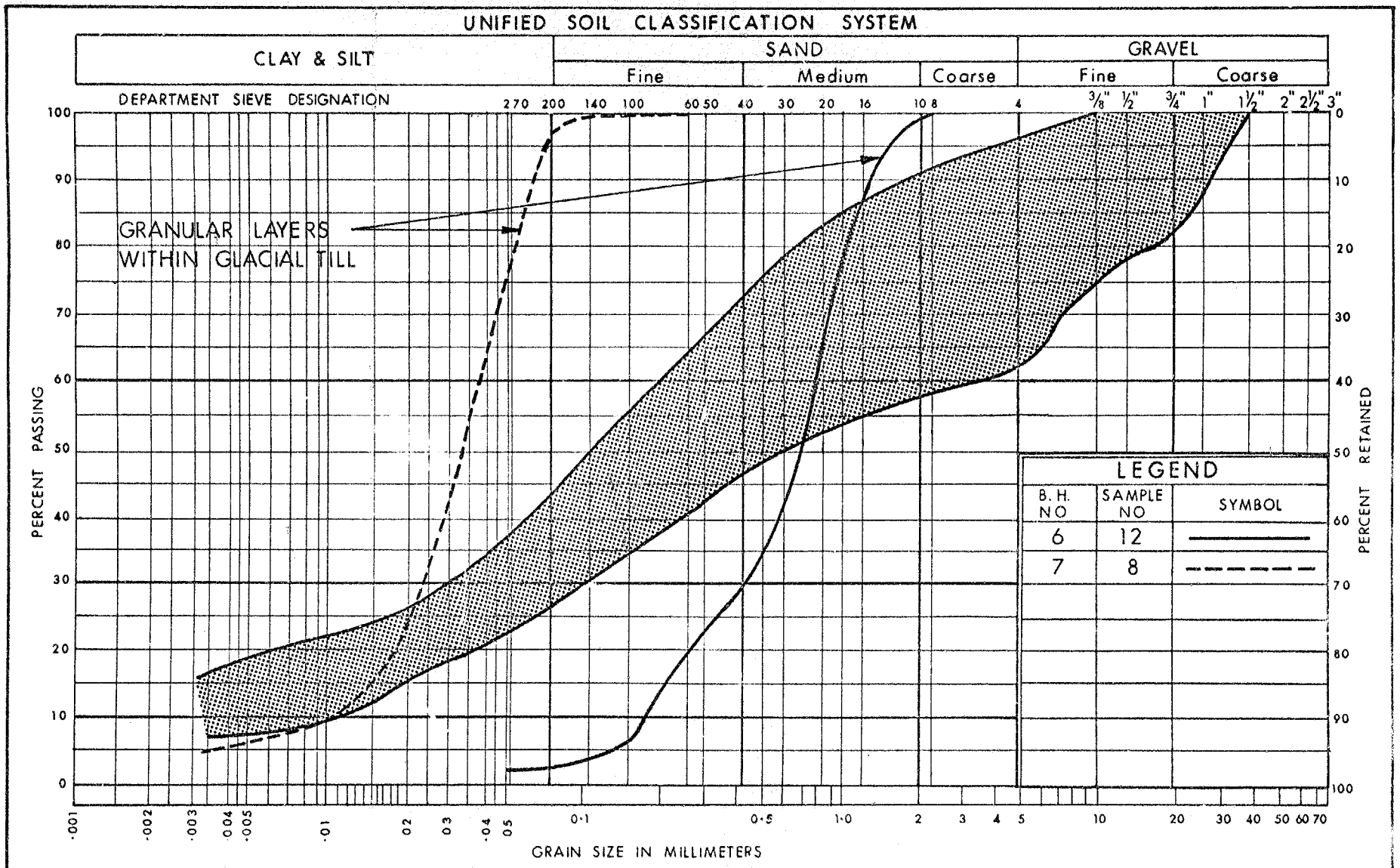


VOID RATIO – PRESSURE CURVES

JOB NO. 71 - 11052

B.H. 6
SAMPLE 9
DEPTH 36' 4"
ELEV. 290.7
W_L =
W_P =
W = 45 %
Cc = 0.87

FIG. 5



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION

GLACIAL TILL

HET. MIXT. OF SILT, SAND & GRAVEL, TRACE OF CLAY

W.P. No. 436 - 64 - 00

JOB No. 71 - 11052

FIG. 6

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

CONSISTENCY	'N' BLOWS/FT.	c LB./SQ. FT.	DENSENESS	'N' BLOWS/FT.
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

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

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

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

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

EARTH PRESSURE

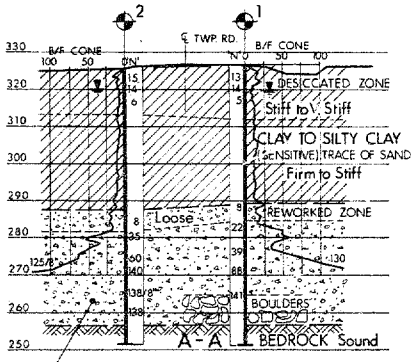
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

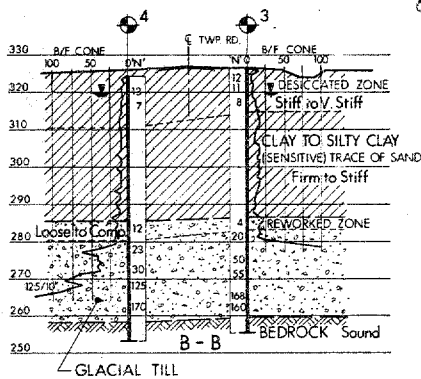
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY. DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

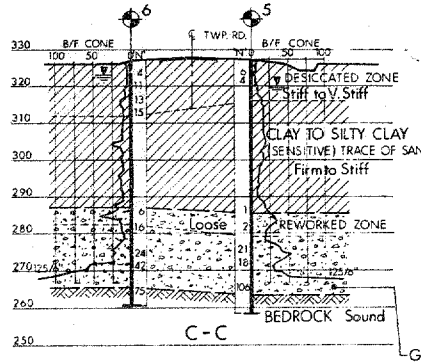
H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



GLACIAL TILL
HET. MIXT. OF SILT, SAND, GRAVEL & TRACE OF CLAY
Comp. to Very Dense

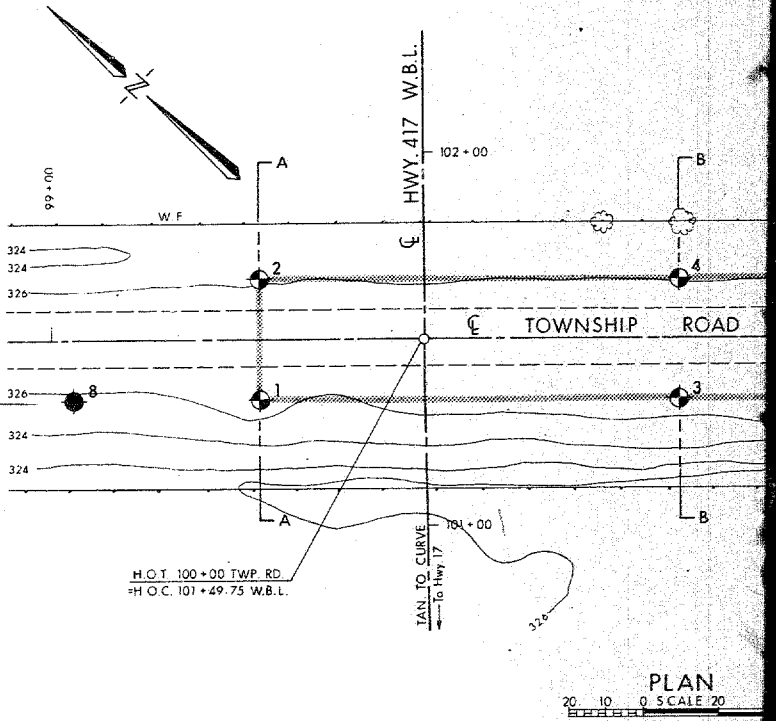


GLACIAL TILL
HET. MIXT. OF SILT, SAND, GRAVEL & TRACE OF CLAY
Comp. to Very Dense

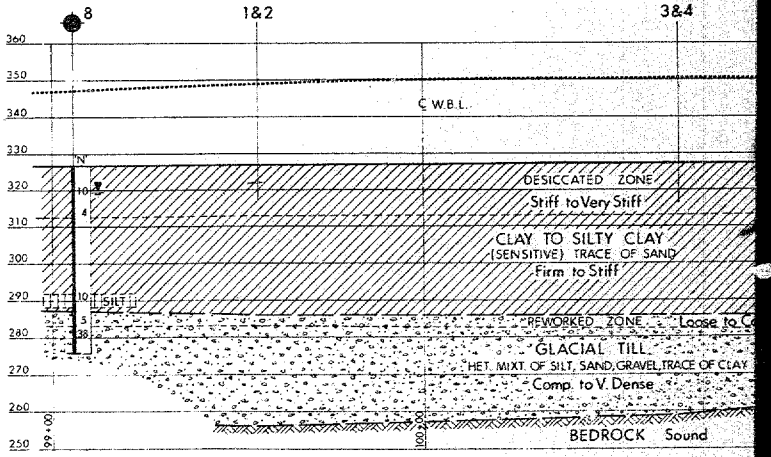


GLACIAL TILL
HET. MIXT. OF SILT, SAND & GRAVEL
Comp. to Very Dense

SECTIONS
20 10 0 SCALE 20 40 FT.

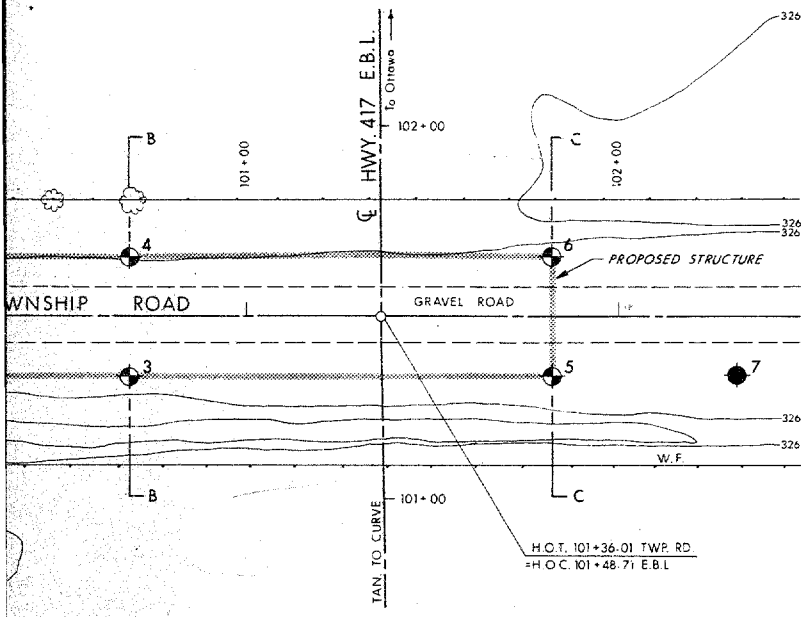


PLAN
20 10 0 SCALE 20



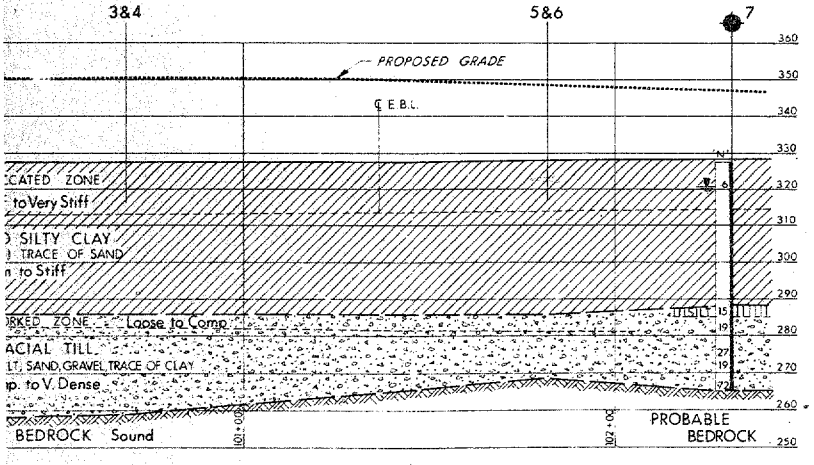
℄ PROFILE - TWP
20 10 0 SCALE 20

PRINT RECORD		
NO	FOR	DATE



PLAN

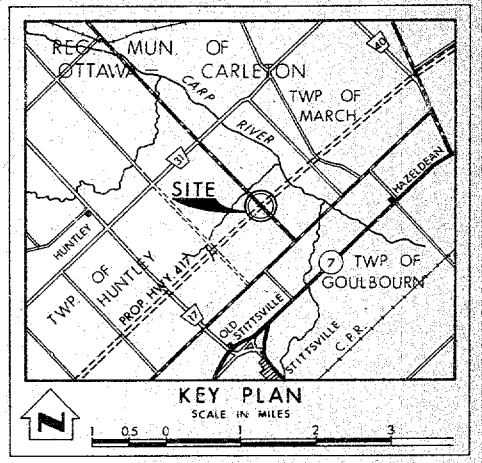
20 10 0 SCALE 20 40 FT.



PROFILE - TWP. ROAD

20 10 0 SCALE 20 40 FT

REF. No. E - 5212 - 1



LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of Field investigation. June & July 1971.

NO.	ELEVATION	STATION	OFFSET
1	326.3	99+56	16' RT.
2	325.7	99+56	16' LT.
3	326.6	100+69	16' RT.
4	324.2	100+69	16' LT.
5	327.3	101+82	16' RT.
6	327.0	101+82	16' LT.
7	327.3	102+32	16' RT.
8	326.3	99+06	16' RT.

— NOTE —

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

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION SECTION

TOWNSHIP ROAD

HIGHWAY NO. PROP. 417 DIST NO. 9
REG. MUNICIPALITY OF OTTAWA - CARLETON
TWP. MARCH & HUNTLEY LOT 3 CON. 1

BORE HOLE LOCATIONS & SOIL STRATA

SUBMTD S.A.	CHECKED	W.P. NO. 436 - 64 - 00	DRAWING NO. 71 - 11052 A
DRAWN S.R.	CHECKED	JOB NO. 71 - 11052	
DATE AUGUST 4, 1971		SITE NO.	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

Dr. D
Jan 31/72

GIFFELS, DAVIS & JORGENSEN LIMITED

CONSULTING ENGINEERS
SIXTY ADELAIDE STREET EAST, TORONTO 210, ONTARIO, PHONE (416) 864-1166

January 28, 1972

Mr. M. Devata, P.Eng.
Supervising Foundation Engineer
Foundations Office
Department of Transportation
and Communications
Downsview 464, Ontario

Re: Stability of Approach Fills to W.P. 436-64-00, Underpass on March/Huntley Twp. Road, on W.P. 433-64-02, Hwy. 417. Your W.O. 71-11052
Our Job No. C1024

Gentlemen:

We enclose a copy of contours in the vicinity of the culvert on the March/Huntley Twp. Road, approximately 550 ft. north of Highway 417.

We anticipate that the culvert will be an 11'-5" x 7'-3" corrugated metal pipe-arch. We trust this will be of assistance in your investigation of the slope stability at this location.

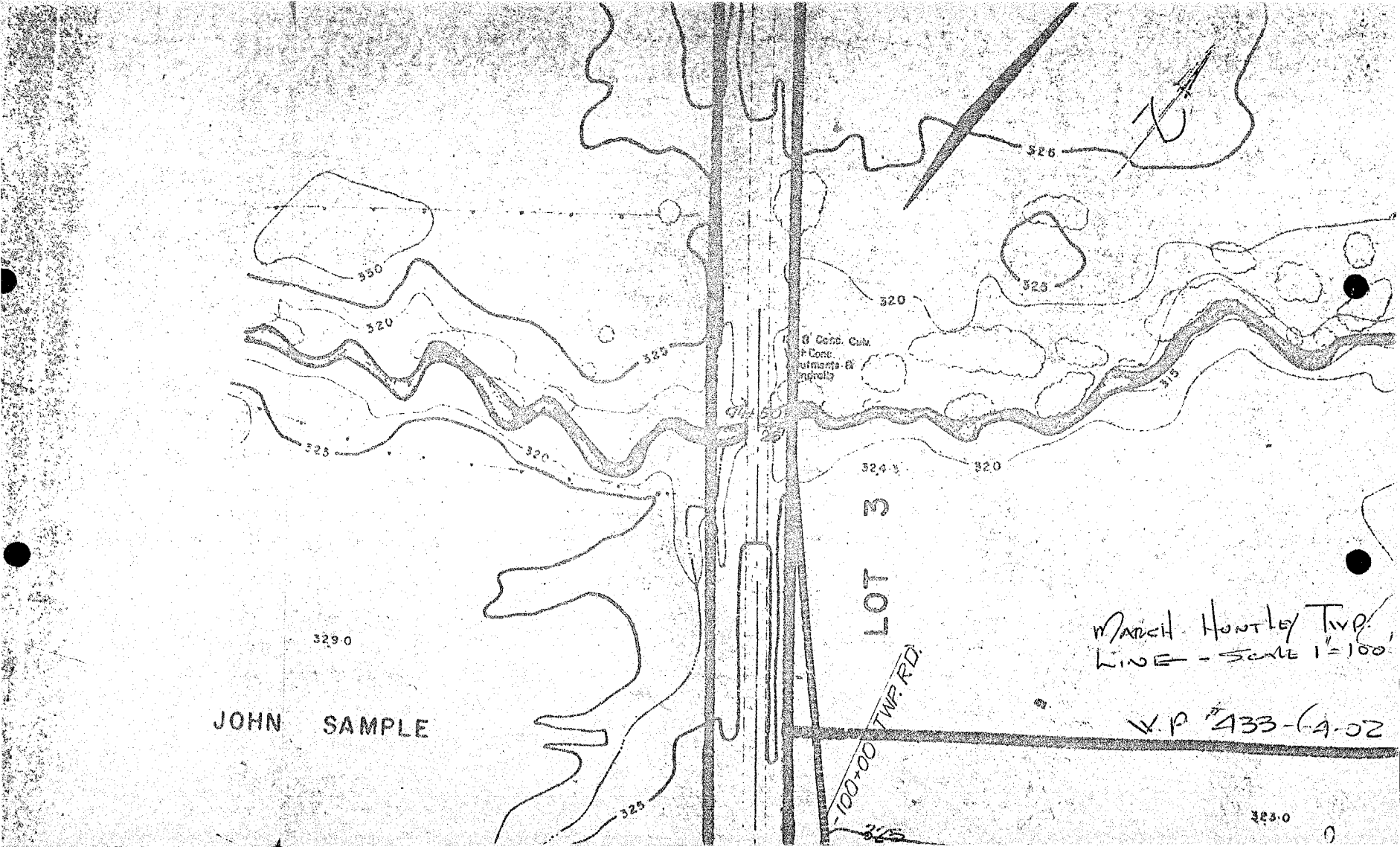
Yours very truly

GIFFELS, DAVIS & JORGENSEN LIMITED

G.R. Tilly, P.Eng.
Project Manager

GRT:cfw
encl.

cc: Mr. G. McMillan - D.T.C.


326
350
320
325
320
325
320
325
320
325
320
315
324.5
320
LOT 3
329.0
JOHN SAMPLE
325
100+00 TWP. RD.
323.0
March Huntley Twp.
Line - Scale 1"=100'
W.P. #433-04-02

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

71-1105

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

From: Bridge Section,
Kingston, Ontario.

Attention: Mr. M. Devata

Date: July 20, 1971.

Our File Ref.

In Reply To

Subject: 1) W.P. 431-64-00, Site 3-260, Reg. Rd. 9 Int. Underpass,
2) W.P. 434-64-00, Site 3-289, Goulbourn Arterial Int. U'Pass,
3) W.P. 435-64-01, (EBL) Site 3-290, Carp River Bridges,
-02 (WBL)
4) W.P. 436-64-00, Site 3-291, March-Huntley Twp. Line U'Pass, Highway 417, District 9 - Ottawa

71-11-052

Referring to our recent discussions on the foundation investigations at the above sites, I confirm that I have discussed the dates with Mr. R. Forrest, Regional Schedule Co-ordinator, and we have agreed that the due dates for the foundation reports should be re-established at August 31, 1971, due to the various circumstances which have necessitated delaying the investigations.

With regard to the Regional Road 9 Interchange Underpass, we are presently considering whether to relocate the structure in the light of the results obtained from your extensive investigation at this site. The location of the structure will be finally decided within the next few days and I will then contact you to enable you to complete the investigation at this site.

The Carp River bridge has been issued to design from this office prior to the completion of the foundation investigation report on the basis of verbal information supplied by you and as further information becomes available at this site, I shall be glad if you will pass it on to Mr. K. Bassi since I shall be on vacation during the next three weeks.

T. C. Kingsland
Regional Bridge Planning Engineer

TCK/hl
c.c.-
C.S. Grebski - Att. K. Bassi
A.J. Percy - Att. C.E. Pritchard
E.R. Saint
S. McCombie

DOCUMENT IDENTIFICATION

GEOCRES No. 31G 05 - 103

DIST. 9 REGION EASTERN

W.P. No. 436 - 64 - 00

CONT. No. 77-85

W. O. No.

STR. SITE No.

HWY. No.

LOCATION MARCH - HUNTLEY TWP. LINE UNDERPASS

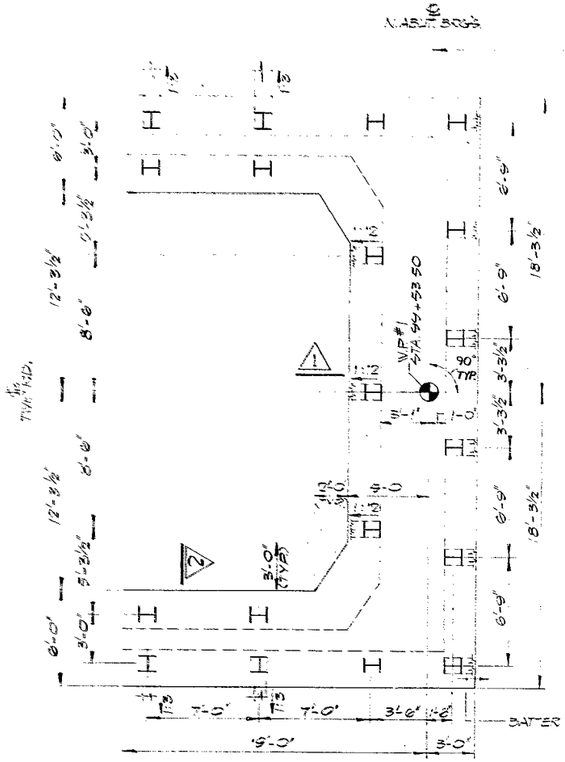
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT 4

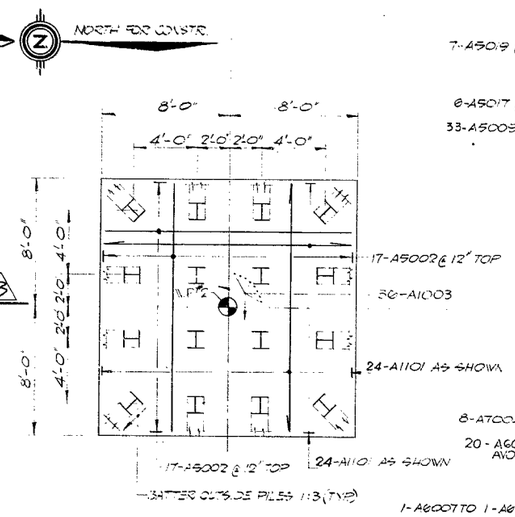
REMARKS:

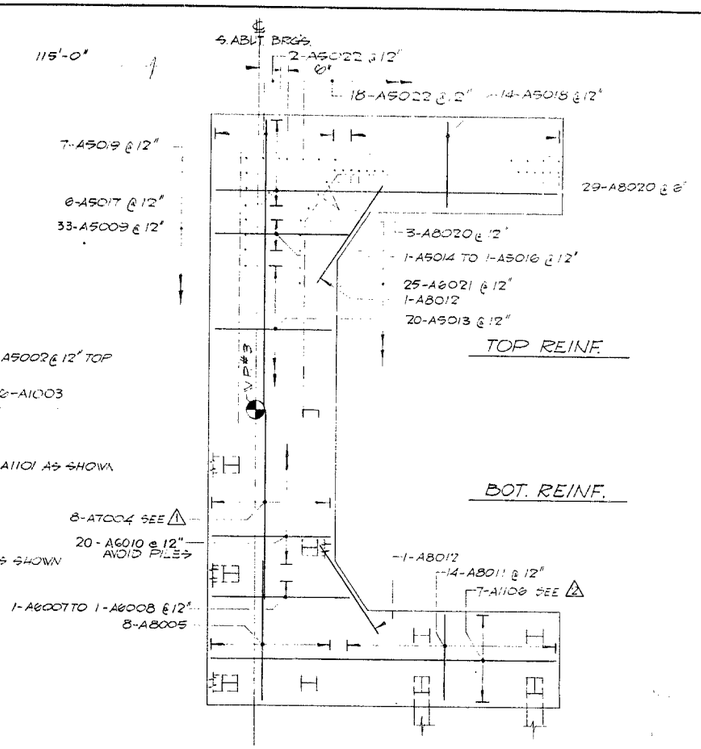
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DB-BR-19 4-75

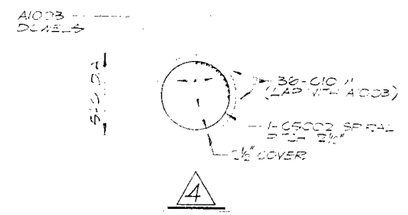
31G-05-103

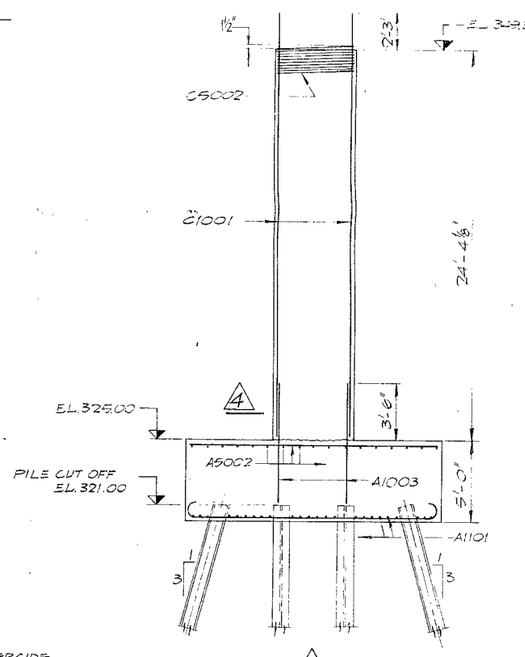
CONT No WP No 436-64-00	12
BYPASS AT MARCH HUNTLEY TWP LINE (7.0 Miles West of Hwy 15) FOUNDATION LAYOUT, REINF. & PIER	SHEET



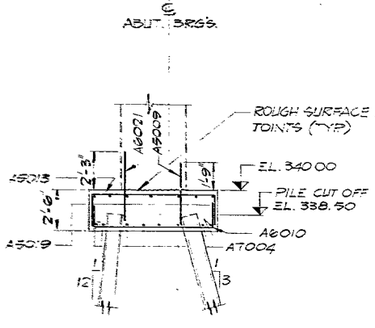


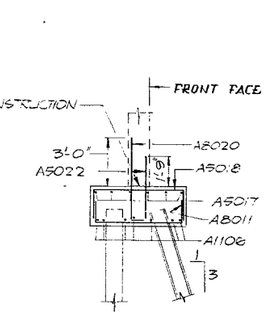






PLAN





PILES

LOCATION	QTY.	TYPE	BATTER	LENGTH	
N. ABUT.	6	HP12x53	VERT.	85'-0"	✓
	3		1:12	85'-0"	✓
	10		1:3	90'-0"	✓
PIER	4	HP12x74	VERT	65'-0"	✓
	12		1:3	68'-0"	✓
S. ABUT.	6	HP12x53	VERT.	76'-0"	✓
	3		1:12	76'-0"	✓
	10		1:3	80'-0"	✓

NOTES:

- PILE SPACINGS TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
- PILES TO BE DRIVEN TO BEDROCK (PIER & S.-ABUT. ONLY)
- PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 3-11 ON DWG. 15 USING DESIGN LOAD 70 TONS/PILE (N.-ABUT. ONLY)
- REINFORCEMENT AND PILE LAYOUT SIMILAR FOR N. & S.-ABUTS.

SCALE: ¼" = 1'-0"

FOR REDUCED PLAN
USE SCALE BELOW
10 11 12 13
3 INCHES ON ORIGINAL PLAN

REGISTERED PROFESSIONAL ENGINEER R. M. H. KAN PROVINCE OF ONTARIO

REVISIONS			
	DATE	BY	DESCRIPTION
DESIGN R.K.	CHECK K.P.	LOADING H520-44	DATE APRIL '76
DRAWING T.L.	CHECK R.K.	SITE No 3-291	DWG 3

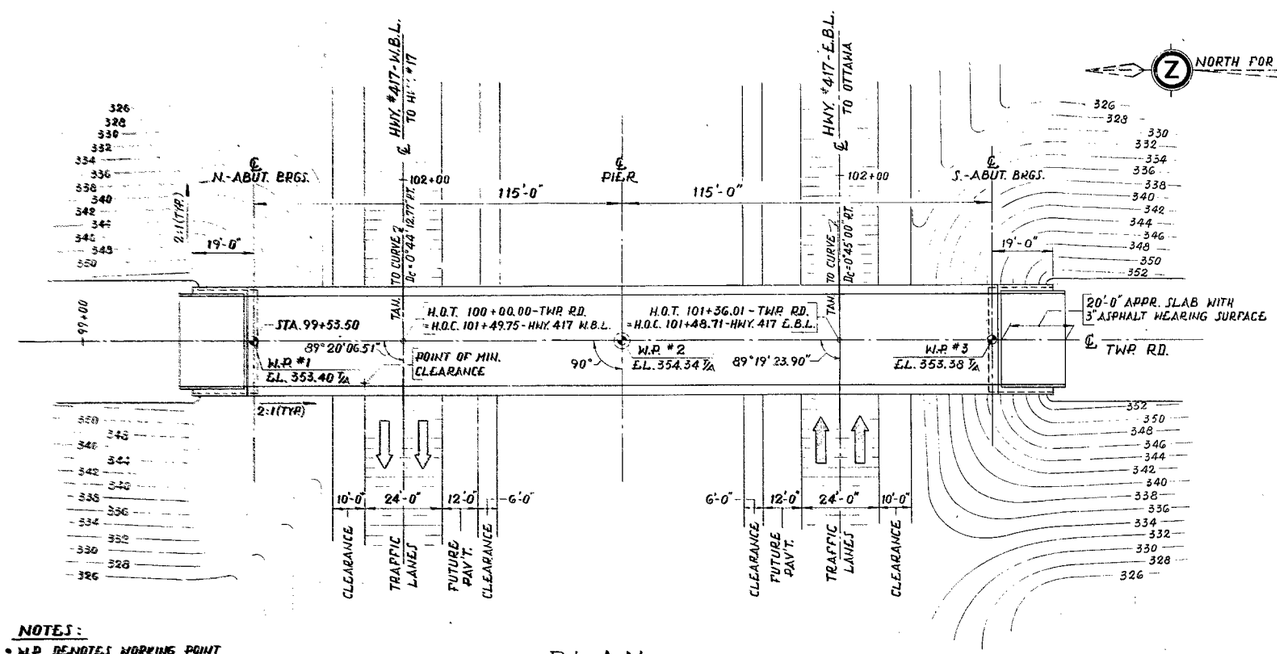
RECEIVED CENTENNIAL OFFICE APR 29 1976 SOIL MECHANICS MINISTRY OF TRANSPORTATION & COMMUNICATIONS

TRANSLAN 1M-5-75

DIST. 9
CONT No
WP No 436-64-00

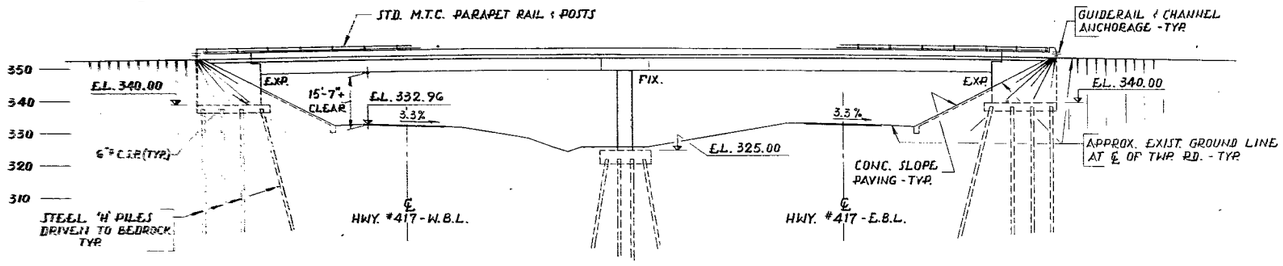
U'PASS AT MARCH/HUNTLEY TWP LINE
(7.0 miles west of hwy. 15)
GENERAL PLAN

SHEET



NOTES:
- W.P. DENOTES WORKING POINT
- ℄ DENOTES TOP OF ASPHALT WEARING SURFACE

PLAN
SCALE : 1" = 20'-0"



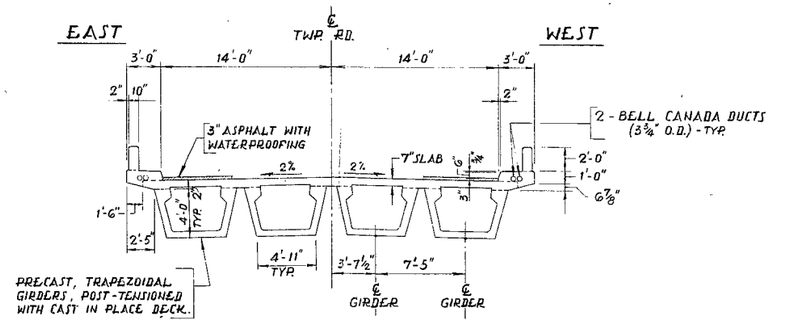
ELEVATION
SCALE : 1" = 20'-0"

LIST OF CONC. QUANTITIES

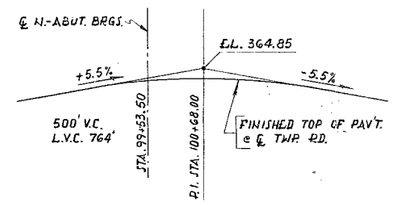
CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS:

1. CONCRETE IN PIER, ABUTMENTS AND WINGWALLS	5000 P.S.I. —	18.0 cu. yds.
	3000 P.S.I. —	138.0
	4000 P.S.I. —	8.0
2. CONCRETE IN DECK	—	334.0
3. CONCRETE IN PARAPET WALLS	—	34.0
4. CONCRETE IN APPROACH SLABS	—	38.0
5. CONCRETE IN SLOPE PAVING	—	34.0 cu. yds.

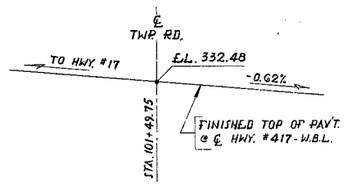
REFERENCE BENCH MARK
G.B.M. 70-U-238 ELEV. 319.808
TABLET SET IN S.E. CORNER OF E. FACE OF S. ABUTMENT OF CONC. BRIDGE 533' LT. OF 101+53 W.B.L.



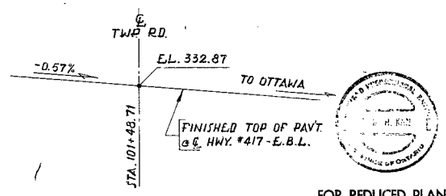
TYP. DECK SECTION
SCALE : 3/16" = 1'-0"



PROFILE OF TWP. RD.
N.T.S.



PROFILE OF HWY. #417-W.B.L.
N.T.S.



PROFILE OF HWY. #417-E.B.L.
N.T.S.

NOTES

REINF. STEEL GRADE

DECK SLAB TRANSVERSE	— 60
PRECAST GIRDERS	— 40
REMAINDER	— 50

CLASS OF CONCRETE

DECK, CURBS, PARAPET WALLS	— 4000 P.S.I.
PIER COLUMN	— 5000 P.S.I.
PRECAST GIRDERS	— 6000 P.S.I.
REMAINDER	— 3000 P.S.I.

CLEAR COVER TO REINF. STEEL

FOOTINGS, ABUTMENTS & WINGWALLS	— 3"
COLUMN	— 2½"
PRECAST GIRDERS	— 1"
DECK — TOP 2", BOTT. 1½"	
CURBS — 2", PARAPET WALLS	— 1½"

UNLESS NOTED OTHERWISE

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ⅛"±.

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN DECK HAS BEEN PLACED, STRESSED & GROUTED.

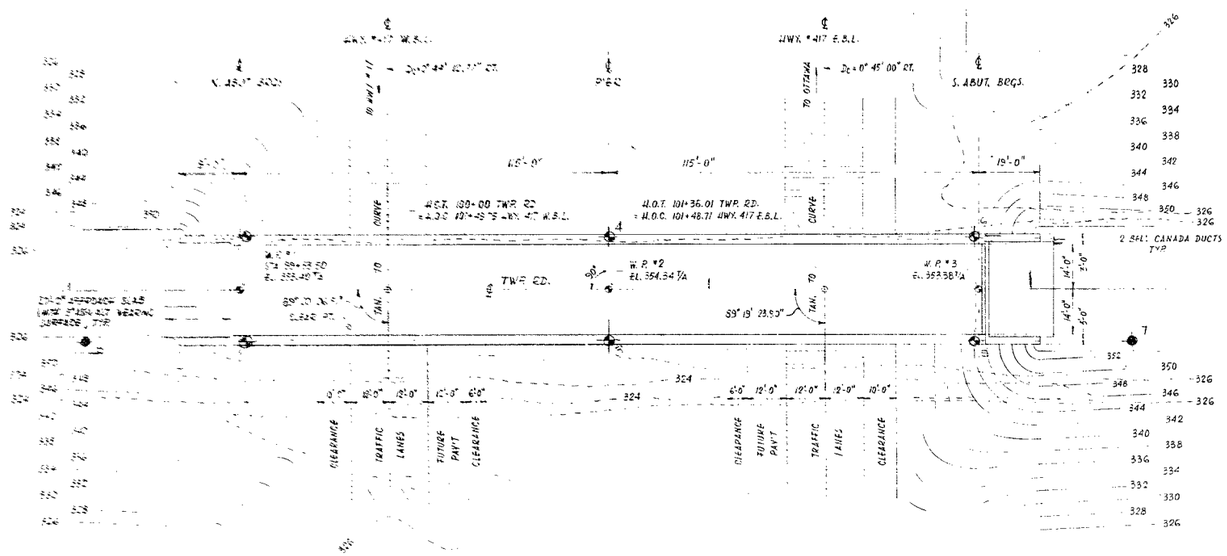
LIST OF DRAWINGS

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

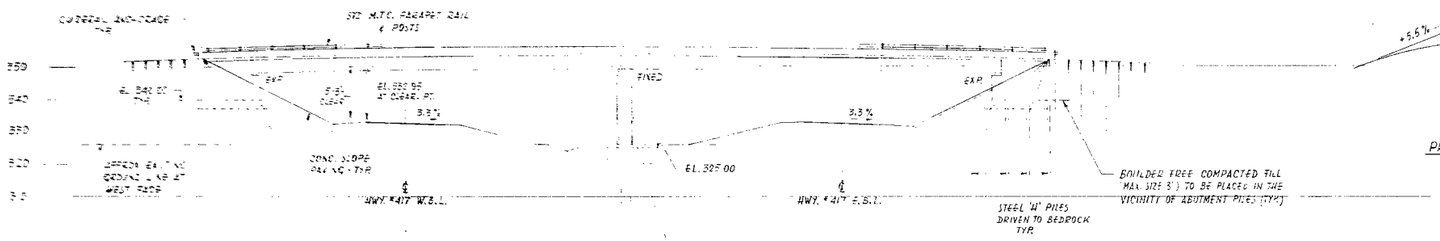
REVISIONS		
DATE	BY	DESCRIPTION

DESIGN R.K.	CHECK K.R.	LOADING HS 20-44	DATE APR/76		
DRAWING A.A.	CHECK R.K.	SITE No 3-291	DWG 1		

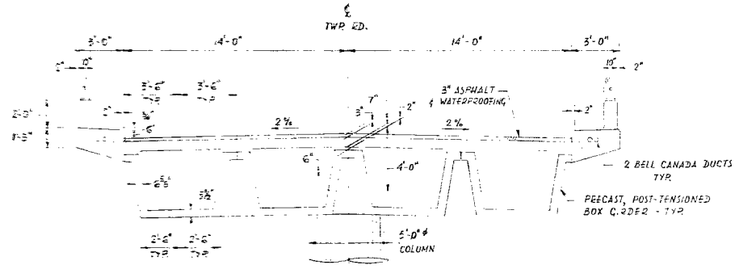
TRANSLAR 1M-4-75



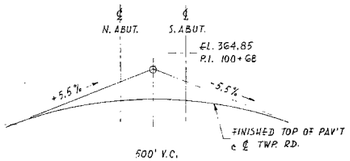
PLAN
SCALE: 1" = 20 FT.



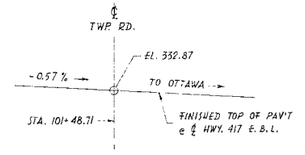
ELEVATION
SCALE: 1" = 20 FT.



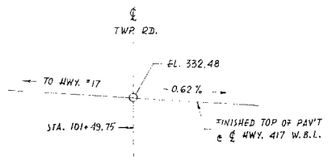
TYP. DECK SECTION
SCALE: ¾" = 1'-0"



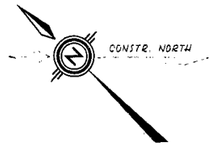
PROFILE OF TWP. RD.
N.T.S.



PROFILE OF HWY. #417 E.B. LANES
N.T.S.

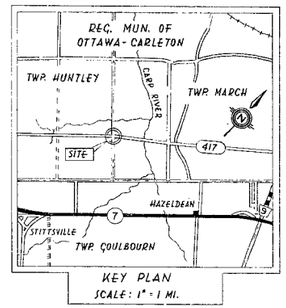


PROFILE OF HWY. #417 W.B. LANES
N.T.S.



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

LIST OF DRAWINGS



KEY PLAN
SCALE: 1" = 1 MI.

REFERENCE BENCH MARK

G.B.M. 70-U-23°, EL. 319.808

GEODETIC DATUM

TABLET SET IN S.E. CORNER OF E. FACE OF S. ABUTMENT OF CONC. BRIDGE 533' LT. OF 101+53 W.B.L.

NOTES:

CLASS OF CONCRETE

GIRDERS	5000 P.S.I.
COLUMNS	5000 P.S.I.
DECK, CURBS, PARAPET WALLS	4000 P.S.I.
REMAINDER	3000 P.S.I.

OR AS INDICATED.

CLEAR COVER ON REINF. STEEL

FOOTINGS, ABUTMENTS & WINGWALLS	3"
COLUMNS & CURBS	2"
GIRDERS	1"
DECK-TOP, PARAPET WALLS	1½"
DECK-BOT.	1"

OR AS NOTED.

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ⅛" ±

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, STRESSED AND GROUTED.

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

31G05-103 71-11-052

UNDERPASS AT MARCH/HUNTLEY TOWNSHIP LINE
(7.0 MILES WEST OF HWY. 15)

KING'S HIGHWAY No. 417 DIST. No. 9
CO. REG. MUN. OF OTTAWA-CARLETON
TWP. MARCH & HUNTLEY LOT 3 CON. 1

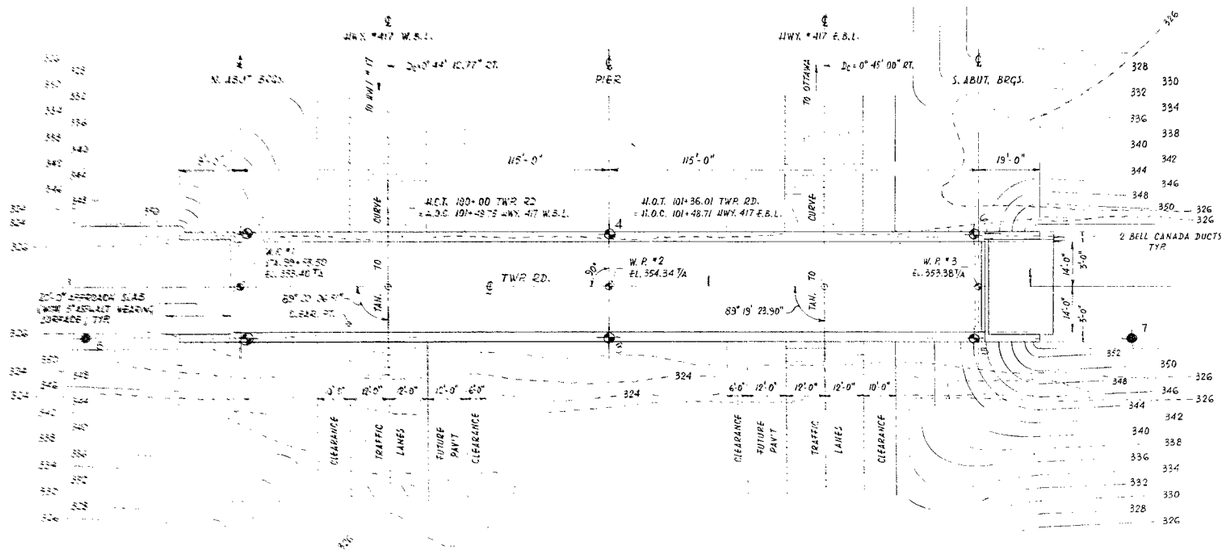
GENERAL LAYOUT

APPROVED _____ STRUCTURAL ENGINEER

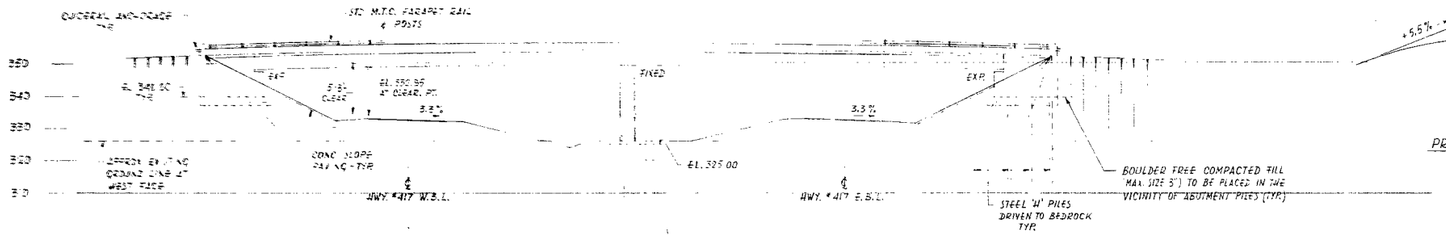
DESIGN	R.S.R.	CHECK	G.A.	SITE No. 3-291	W.P. No. 436-G4-00
DRAWING	P.K.	CHECK	R.S.R.	CONTRACT No.	
DATE	JAN. 1973	LOADING	H120-44	DRAWING No.	D-7083-1

R. S. REEL — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

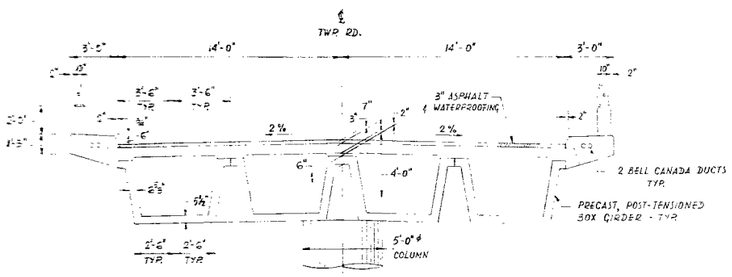
FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN



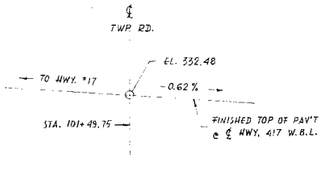
PLAN
SCALE: 1" = 20 FT.



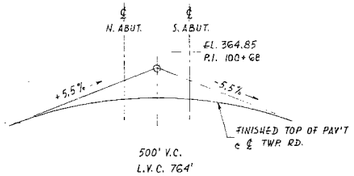
ELEVATION
SCALE: 1" = 20 FT.



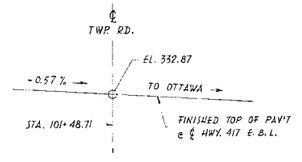
TYP. DECK SECTION
SCALE: 1/4" = 1'-0"



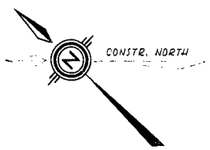
PROFILE OF HWY. #417 W.B. LANES
N.T.S.



PROFILE OF TWP. RD.
N.T.S.



PROFILE OF HWY. #417 E.B. LANES
N.T.S.

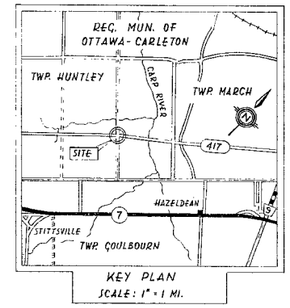


CONSTR. NORTH

LIST OF DRAWINGS

D-7083-1	GENERAL LAYOUT
-2	BORE HOLE LOCATIONS & SOIL STRATA
-3	FOUNDATION LAYOUT & PIER
-4	ABUTMENTS
-5	GIRDERS - CABLE DETAILS - BEARINGS
-6	GIRDERS - REINFORCEMENT
-7	DECK DETAILS & TRANS. CABLES
-8	DECK REINF. & CONSTRUCTION SEQUENCE
-9	PARAPET WALL DETAILS
-10	STANDARD STEEL PARAPET RAIL
-11	DETAILS OF CONC. SLOPE PAVING
-12	STANDARD DETAILS - 1/2
-13	STANDARD DETAILS - 2/2
-14	APPROACH SLAB

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



KEY PLAN
SCALE: 1" = 1 MI.

REFERENCE BENCH MARK
G.B.M. 70-U-238 EL. 319.808

GEODETIC DATUM
TABLET SET IN S.E. CORNER OF E. FACE OF S. ABUTMENT OF CONC. BRIDGE 533' LT. OF 101+53 W.B.L.

NOTES:

CLASS OF CONCRETE

GIRDERS	5000 P.S.I.
COLUMNS	5300 P.S.I.
DECK, CURBS, PARAPET WALLS	4000 P.S.I.
REMAINDER	3000 P.S.I.

OR AS INDICATED.

CLEAR COVER ON REINF. STEEL

FOOTINGS, ABUTMENTS & WINGWALLS	3"
COLUMNS & CURBS	2"
GIRDERS	1"
DECK-TOP, PARAPET WALLS	1½"
DECK-BOT.	1"

OR AS NOTED.

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ⅛" ±

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, STRESSED AND GROUTED.

PRINT RECORD

NO.	FOR	DATE

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

31GOS-103 71-11-052

UNDERPASS AT MARCH/HUNTLEY TOWNSHIP LINE
(7.0 MILES WEST OF HWY. 15)

KING'S HIGHWAY No. 417 DIST. No. 9
CO. REG. MUN. OTTAWA-CARLETON
TWP. MARCH & HUNTLEY LOT 3 CON. 1

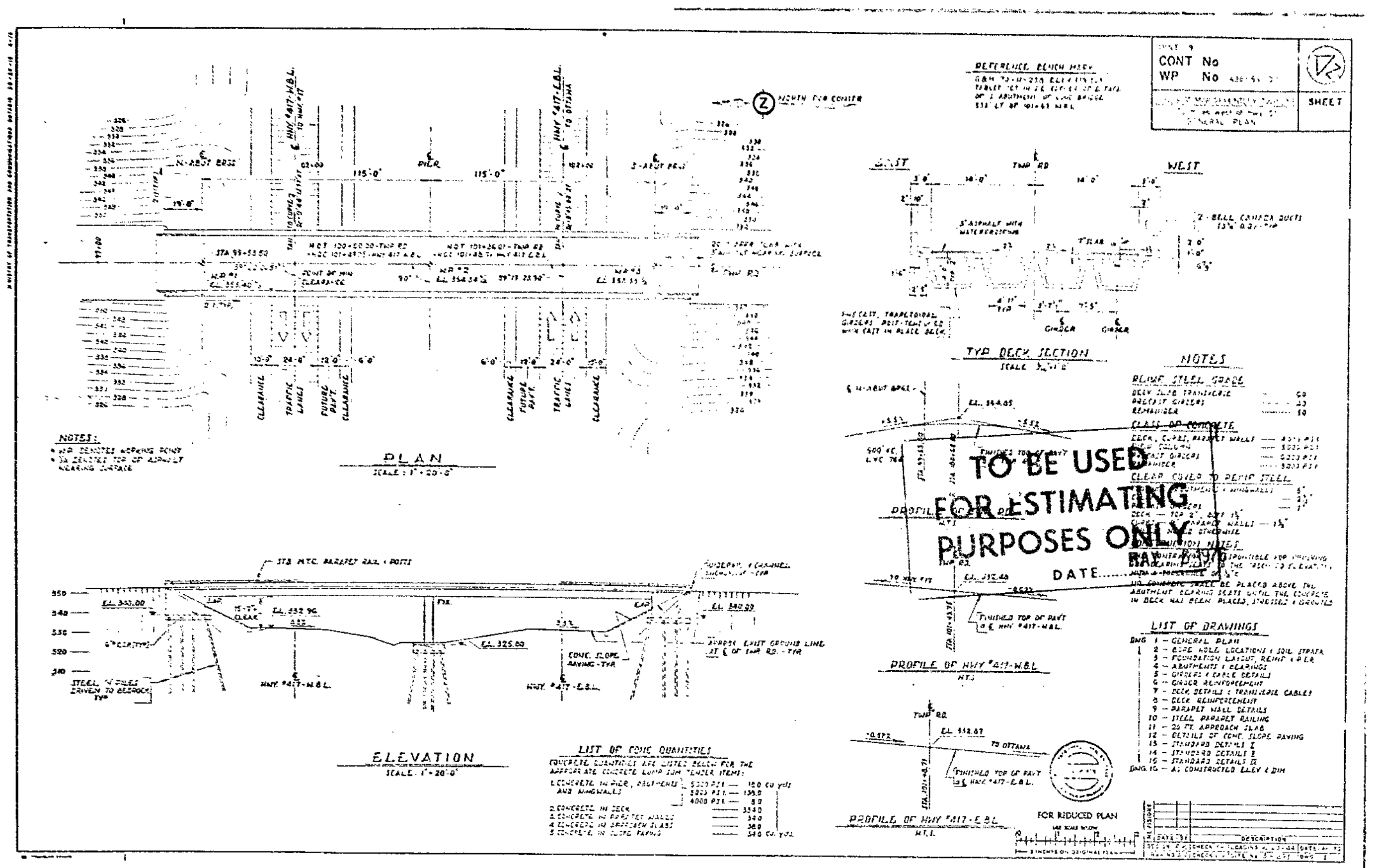
GENERAL LAYOUT

APPROVED ..... STRUCTURAL ENGINEER

DESIGN	R.S.R.	CHECK	G.R.	SITE No. 3-291	W.P. No. 436-64-00
DRAWING	P.K.	CHECK	R.S.R.	CONTRACT Nos.	
DATE	JAN. 1973	LOADING	HS 20-44	DRAWING No.	D-7083-1

REGISTERED PROFESSIONAL ENGINEER R S REID PROVINCE OF ONTARIO

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN



PLAN
ELEVATION
TYP DECK SECTION
EAST
WEST
NOTES
LIST OF DRAWINGS
LIST OF CONC QUANTITIES
REFERENCE BENCH MARK
CONT No
WP No
SHEET
TO BE USED
FOR ESTIMATING
PURPOSES ONLY
DATE
FOR REDUCED PLAN