

MEMORANDUM

TO: Mr. B. R. Davis,  
Bridge Engineer,  
Bridge Division,  
Admin. Bldg.  
Attention: Mr. S. McCombie

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

DATE: June 8, 1967

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Structure at the Crossing of  
Thoroldstone Rd. Revision and Q.E.W.  
Revision Line 'C', County of Welland,  
City of Niagara Falls, Lots 71 & 79,  
District No. 4 (Hamilton)  
W.J. 67-F-27 -- W.P. 155-64-03

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

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

AGS/MdeF

Attach.

cc: Messrs. B. R. Davis (2)  
H. A. Tregaskes  
D. W. Farren  
G. K. Hunter (2)  
H. Greenland  
W. S. Melinyshyn  
T. J. Kovich  
B. A. Singh

Foundations Files  
Gen. Files ✓

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

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FOUNDATION INVESTIGATION REPORT  
For  
Proposed Structure at the Crossing of  
Thoroldstone Rd. Revision and Q.E.W.  
Revision Line 'C', County of Welland,  
City of Niagara Falls, Lots 71 & 79,  
District No. 4 (Hamilton)  
W.J. 67-F-27      --      W.P. 155-64-03

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1. INTRODUCTION:

A request to carry out a foundation investigation for the proposed new underpass at Thoroldstone Road and Q.E.W., was received from Mr. W. S. Melinyshyn, Regional Bridge Location Engineer, in a memo dated February 2, 1967.

It is proposed to reconstruct the existing Q.E.W. as a controlled access highway from Hwy. #405 to the Welland River, City of Niagara Falls. At the crossing of Thoroldstone Road and Q.E.W. this will necessitate removal of the existing Thoroldstone Road underpass structure, and a revision of both lines to accommodate the new structure.

This report contains the results of our field and laboratory investigations, together with our recommendations for the foundations of the new structure.

2. DESCRIPTION OF SITE:

The site is located about 3.5 miles north of the City of Niagara Falls. The topography is flat to undulating. The surrounding area is used for general farming and orchard land.

Physiographically, this area is referred to as the "Haldimand Clay Plain". In this area, moraines formed during the recession of the Lake Ontario ice lobe, overlies bedrock.

cont'd. /2 ...

### 3. FIELD AND LABORATORY WORK:

Five sampled boreholes and nine dynamic cone penetration tests were carried out during the course of the field work. Boring was achieved using both a conventional diamond drill adapted for soil sampling purposes, and a Pennsylvania continuous flight drill auger. A driving energy of 350 ft.-lbs. per blow was used for the dynamic cone penetration tests.

Sampling of both cohesive and non-cohesive materials was achieved using a 2-inch O.D. split-spoon sampler driven according to the specifications of the Standard Penetration Test.

The samples were visually examined in the field and subsequently in the laboratory. Selected representative samples were then tested for Atterberg limits, moisture content, organic content, and grain-size distribution, where applicable. AXT-size rock core samples were obtained to prove bedrock.

The results of the field and laboratory tests are summarized in the Record of Borehole sheets, which are contained in the appendix to this report.

The borehole locations and elevations are given on Dwg. No. 67-F-27A which is also contained in the report appendix.

### 4. SUBSOIL CONDITIONS:

#### 4.1) General:

Subsoil conditions at this site consist of morainic material overlying bedrock. The subsoil is predominantly silt with traces of sand and clay and occasional gravel. However, on the west side of the site, the subsoil becomes sandy silt to silty sand. Where boreholes intersected the approach fill for the existing Thoroldstone Road structure, it was found to consist of silt to clay silt with traces of sand, clay and occasional gravel.

The boundaries between the different deposits are shown on the attached Record of Borehole sheets. The estimated stratigraphical profile shown on Dwg. No. 67-F-27A, is based upon this information.

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

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

From ground level downwards, the different soil deposits are described as follows:

4.2) Silt to Clayey Silt with traces of Sand, Clay, and Occasional Gravel (Fill):

This deposit was only intersected in boreholes No's 1 and 9. It consisted of clayey silt, sand and occasional gravel in the east approach fill, and silt with traces of sand and occasional gravel in the west approach fill.

The 'N' values (No. of blows per foot in the Standard Penetration Test) ranged from 9 - 14, indicating a compact relative density for the silty fill, and stiff consistency for the clayey silt fill.

4.3) Silt to Silty Sand with occasional Gravel:

This deposit was intersected in all boreholes. It was predominantly silt with traces of sand and clay with occasional gravel, but on the west side of the site, it was sandy silt to silty sand, and the upper 7.5 ft. of the layer was clayey silt to silt.

The 'N' values ranged from 14 to 125 blows/ft., indicating a compact to very dense relative density for this deposit. The natural moisture content was approximately 20%. Several grain-size distribution curves for this deposit are included in the report appendix.

4.4) Bedrock:

The bedrock surface was encountered at depths ranging from 38.5 ft. below ground level in the west, to 48.5 ft. depth in the east. These depths correspond to El. 611.1 in the west, and El. 602.5 in the east, respectively. AXT-size rock cores were recovered in boreholes No's 1, 5, and 9. 100% recovery was obtained for all samples.

Bedrock was identified as being the 'Lockport Dolomite' formation.

cont'd. /4 ...

5. GROUNDWATER:

Groundwater levels observed during the course of the investigation, ranged from El. 629.1 to El. 641.1.

The natural groundwater level appears to be depressed below the cutting for the existing Q.E.W.

The observed water levels are recorded on the appropriate Record of Borehole sheets, and also on Dwg. No. 67-F-27A.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a new underpass structure at the revised crossing of Thoroldstone Road and Q.E.W. Present proposals call for a four-span (50'-86'-86'-50') structure having approach fills generally 10 feet higher than existing ground level.

The subsoil conditions at this site consist of compact to very dense silt with traces of sand and clay with occasional gravel to silty sand overlying dolomite bedrock. The bedrock surface increases in depth from west to east.

The subsoil is competent to support spread footing foundations. It is therefore recommended that the piers be supported on spread footings, while the abutments may either be supported on spread footings or can be constructed within the approach fills and supported on end-bearing piles driven to bedrock.

Specific recommendations are made as follows:

6.2) Piers and Abutments on Spread Footings:

The bridge piers and abutments may be supported on spread footings founded at or below the following elevations:

East Abutment	.....	El. 630.0
East Pier	.....	El. 630.0
Central Pier	.....	El. 630.0
West Pier	.....	El. 628.0
West Abutment	.....	El. 628.0



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

6.2) Piers and Abutments on Spread Footings: (cont'd.) ...

However, they should be founded at sufficient depth to ensure adequate frost protection.

A safe bearing pressure of 3.5 tons/ft.<sup>2</sup> may be used for design purposes.

As excavations will be required below groundwater level in a material which is susceptible to boiling, a dewatering scheme is essential. Boiling may be prevented by driving sheeting to a depth below the bottom of the excavation equal to the hydraulic head above it.

Differential settlements are expected to be negligible.

6.3) Perched Abutments on Piles:

Alternatively, the abutments may be constructed within the fills and supported on end-bearing steel H-piles driven to bedrock. The maximum allowable load for the particular pile section adopted may be assumed for design purposes.

The pile caps should be founded at sufficient depth to ensure adequate frost protection.

No bouldery fill should be placed in the area where piles have to be driven.

6.4) Approach Fills:

No stability problems are anticipated for the construction of the approach embankments.

7. SUMMARY:

A foundation investigation of a proposed new structure at Q.E.W. and Thoroldstone Road Revision is reported.

Subsoil at the site consists of compact to very dense silt with traces of sand and clay with occasional gravel to silty sand down to bedrock.

cont'd. /6 ...

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

It is recommended that the piers of the proposed structure be supported on spread footing foundations, while the abutments may either be supported on spread footings, or can be constructed within the approach fills and supported on end-bearing piles driven to bedrock.

Procedures for construction and dewatering have been outlined in this report.

No stability problems are anticipated for the construction of the approach fills.

8. MISCELLANEOUS:

The field work for this project was carried out during the period April 13 - 14, 1967, under the supervision of Mr. V. Korlu, Project Foundation Engineer. The equipment used was owned and operated by Master Soil Investigations Ltd.

This report was written by Mr. A. C. Calder, Senior Foundation Engineer, and was reviewed by Mr. M. Devata, Supervising Foundation Engineer.

June 1967



APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

**MATERIALS & TESTING DIVISION**

JOB 67-F-27

W. P. 155-64-03

DATUM Geodetic

# RECORD OF BOREHOLE NO. 1

LOCATION Thorold Stone Rd. Rev'n., Stn. 31 +35, o/s 43' Lt.

BORING DATE April 14, 1967

BOREHOLE TYPE Washboring, NX & BX Casing

FOUNDATION SECTION

ORIGINATED BY V.K.

COMPILED BY SN, JM

CHECKED BY \_\_\_\_\_

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO		RECORD OF BOREHOLE NO. 2		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION					
JOB	67-F-27	LOCATION	Thorold Stone Rd. Rev'n. Stn. 31+37, o/s 40* Rt.	ORIGINATED BY	V.K.
W.P.	155-64-03	BORING DATE	April 13, 1967	COMPILED BY	SN., JM
DATUM	Geodetic	BOREHOLE TYPE	Cone Penetration Test	CHECKED BY	<i>[Signature]</i>

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

**MATERIALS & TESTING DIVISION**

JOB 67-F-27

W.P. 155-64-03

DATUM \_\_\_\_\_ Geodetic

LOCATION Thorold Stone Rd. Rev'n., Stn. 30±87, o/s 38' Lt.

BORING DATE April 14, 1967

BOREHOLE TYPE Cone Penetration Test

FOUNDATION SECTION

ORIGINATED BY VK

ORIGINATED BY \_\_\_\_\_  
SN, JM  
COMPILED BY \_\_\_\_\_

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— WP	WATER CONTENT ——— W		
651.6	GROUND LEVEL											
0.0						650						
						640						
631.6												
20.0	End of Cone test					630						

DEPARTMENT OF HIGHWAYS - ONTARIO

## MATERIALS &amp; TESTING DIVISION

JOB 67-F-27

155-64-03

DATUM Geodetic

RECORD OF BOREHOLE NO. 4

LOCATION Thorold Stone Rd. Rev'n., Stn. 30+89, o/s 44<sup>th</sup> Rt.

BORING DATE April 13, 1967

BOREHOLE TYPE Pen Drill

**FOUNDATION SECTION**

ORIGINATED BY VK

COMPILED BY SN, JM

CHECKED BY [Signature]

[illegible]

MATERIALS &amp; TESTING DIVISION

**LOCATION** Thorold Stone Rd. Rev'n., Stn. 29+87, o/s 36' Lt.

BORING DATE April 13, 1967

BOREHOLE TYPE Penn Drill & Diamond Drill

FOUNDATION SECTION

ORIGINATED BY VK

COMPILED BY SN, JM

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT % $w_p$ ——— $w$ ——— $w_L$			
633.8	GROUND LEVEL											
0.0	Silt with traces of sand & clay, occ. gravel.  Very dense.		1	SS	85	630						WL. 632.8
			2	SS	143							3 5 90 2
			3	SS	109							0 4 92 4
			4	SS	97	620						
			5	SS	90							
			6	SS	84							
			7	SS	105	610						
608.3												
25.5	Bedrock			AXT	100%							
603.3					Rec							
30.5	End of Borehole					600						

DEPARTMENT OF HIGHWAYS - ONTARIO

**MATERIALS & TESTING DIVISION**

JOB 67-F-27

W.P. 155-64-03

DATUM Geodetic

RECORD OF BOREHOLE NO. 6

LOCATION Thorold Stone Rd. Revn'. , Stn. 29+06, o/s 44' Rt.

BORING DATE April 14, 1967

BOREHOLE TYPE Penn Drill

FOUNDATION SECTION

ORIGINATED BY VK

COMPILED BY SN, JM

CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %			
641.3	GROUND LEVEL											GR.SA.SI.CI
0.0	Silt with traces of clay & sand.		1	SS	25	640						Org. 0.1%
			2	SS	63							0 2 98 0
			3	SS	122							WL.630.3
	Compact to V.Dense		4	SS	161	630						
			5	SS	180							
			6	SS	59							0 4 93 3
			7	SS	43	620						
			8	SS	73							
			9	SS	28	610						
604.8												
36.5	End of Borehole Probable Bedrock					600						



DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

MATERIALS &amp; TESTING DIVISION

JOB 67-F-27 LOCATION Thorold Stone Rd. Rev'n., Stn. 29+04, o/s 63' Lt.ORIGINATED BY VKW.P. 155-64-03 BORING DATE April 14, 1967COMPILED BY SN, JMDATUM Geodetic BOREHOLE TYPE Cone Penetration TestCHECKED BY SR

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P	PLASTIC LIMIT — WP	WATER CONTENT — W		
641.9	GROUND LEVEL						20 40 60 80 100		WP WL	W		
0.0						640						
632.2												
9.7	End of Cone Test					630		100/80				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 67-F-27LOCATION Thorold Stone Rd. Rev'n., Stn. 28+73, o/s 50' Rt.ORIGINATED BY VKW.P. 155-64-03BORING DATE April 13, 1967COMPILED BY SN, JMDATUM GeodeticBOREHOLE TYPE Cone Penetration TestCHECKED BY SL

SOIL PROFILE		SAMPLES				ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — WL PLASTIC LIMIT — WP		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.					WATER CONTENT — W		
641.0	GROUND LEVEL						20 40 60 80 100						WP — W — WL		
0.0						640							WATER CONTENT %		
635.0															
6.0	End of Cone Test					630									

DEPARTMENT OF HIGHWAYS - ONTARIO

**MATERIALS & TESTING DIVISION**

JOB 67-F-27

W.P. 155-64-03

DATUM Geodetic

## RECORD OF BOREHOLE NO. 9

LOCATION Thorold Stone Rd., Rev'n., Stn. 28+71 o/s 38' Lt.

BORING DATE April 13, 1967

BOREHOLE TYPE Penn Drill & Diamond Drill

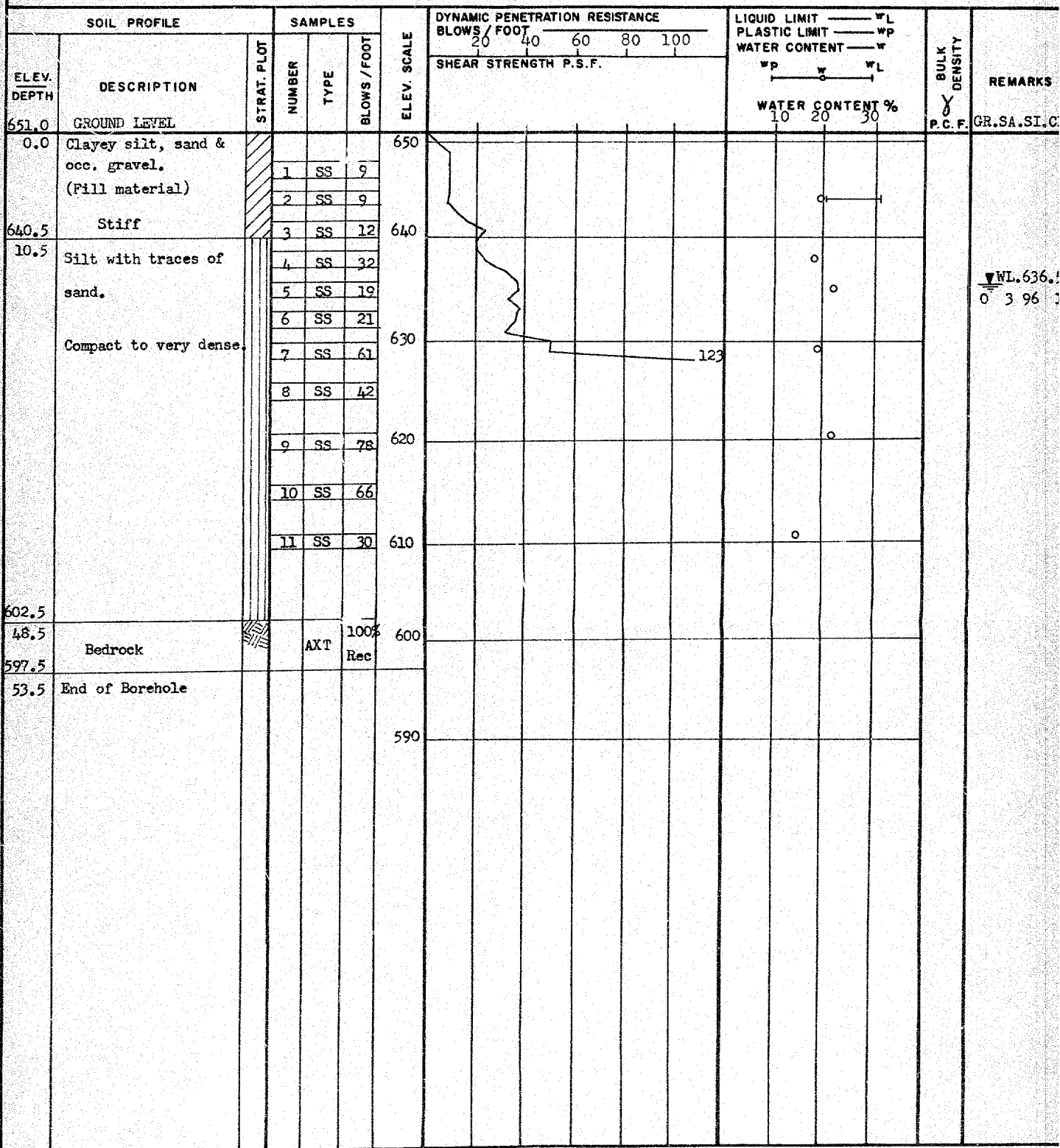
FOUNDATION SECTION

VK

ORIGINATED BY

COMPILED BY SN, JM

CHECKED BY



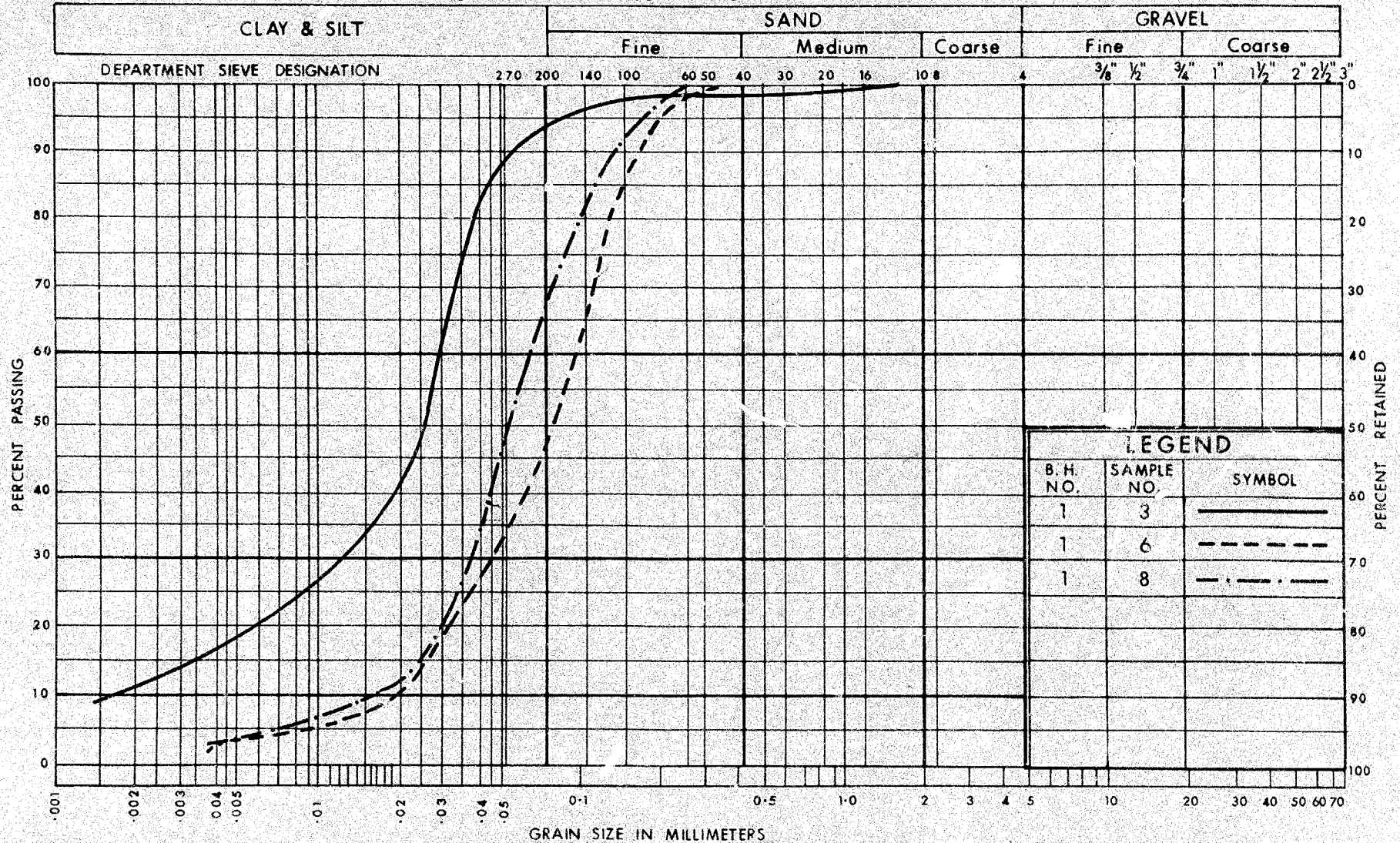
FOUNDATION SECTION

## MATERIALS &amp; TESTING DIVISION

JOB 67-F-27 LOCATION Therold Stone Rd., Rev'n., Stn. 28483 Off 108' Lt. ORIGINATED BY V.K.  
W.P. 155-64-02 BORING DATE Sept. 14, 1965 COMPILED BY \_\_\_\_\_  
DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— WL PLASTIC LIMIT ——— wp WATER CONTENT ——— w			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20    40    60    80    100	$w_p \quad w \quad w_L$				
							SHEAR STRENGTH P.S.F.	WATER CONTENT % 15    30    45				
642.0	Ground Level											
0.0	Silt - Compact to very dense, red brown some dsiccated clayey silt in top 6 ft.		1	SS	20	640						
			2	SS	13							
			3	SS	50/6"							
			4	SS	63/3"	630	39/8"					
			5	SS	54/6"		Hammer Bouncing					
			6	SS	100	620						
			7	SS	41							
	Some very fine sand.		8	SS	54/6"	610						
31.3	Boulders or very extensively weathered bedrock. No resistance to drill.	0-0-0-0	9	RC	No. Rec.							
604.7		0										
37.3	End of Borehole					600						

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
B.H. NO.	SAMPLE NO.	SYMBOL
1	3	—————
1	6	- - - - -
1	8	- . - . -





**GRAIN SIZE DISTRIBUTION**  
**ENVELOPE OF GRADING CURVES—SILT TO SILTY SAND**  
**WITH OCCASIONAL GRAVEL—BOREHOLES NO'S. 4,5,6, & 9**

JOB No. 67-F-27

## 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 SCKET 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

$\gamma$	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
$S_r$	SENSITIVITY

## 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

## STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	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

401 & Keele St.  
Downsview, Ontario

Materials and Testing Division

April 6, 1967

Master Soil Investigation  
104 Fenhar Drive  
Weston, Ontario

Dear Sirs:

This is to confirm our request of April 4, 1967 for the supply of a Diamond Drill together with all necessary equipment, as specified under the terms of our Contract Agreement, at Mountain Rd. and C.E.A. near Niagara Falls on April 4, 1967 at 10 a.m.

This project bears Job Number 67-P-26, and 67-F-27

Yours truly,

Sincerely,

cc: J. Borings  
J. Borings

cc: J. Borings  
J. Borings

M. Savata  
Supervising Foundation Engineer  
for: M. G. Sternac  
Principal Foundation Engineer

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. G. Stermac,  
Principal Foundation Engineer,  
Room 107, Lab. Bldg.

From: Bridge Division,  
Downsview, Ontario.

Date: April 12, 1967

Our File Ref.

In Reply To

Subject: W.P. 155-64, Site 34-26,  
Thoroldstone Road Underpass,  
Q.E.W., District #4.

67-P-27

This will confirm your having received two prints of the Bridge Site Plan E-4771-1 for the above structure, with the location of footings marked thereon in red. Also a copy of the preliminary bridge site investigation report.

Please arrange for a foundation investigation of sufficient scope to enable us to proceed with the design.

WSM/ss  
cc. R. Forrest  
A. Crowley

*J. J. Salsche*  
for W. S. Melinyshyn,  
Reg. Bridge Location Engineer.

*M. Devata*

Telephone: 248-3446

Mr. W. Wigle,  
Program Engineer,  
Administration Bldg.

E.J. McCabe,  
Toronto Regional Road Design.

March 13, 1968.

Re: Queen Elizabeth Way from  
Highway 405 to Fort Erie,  
District 4, Hamilton.

Your letter of February 12, 1968 requesting a program for placement of early fills as recommended by the Foundation Section has been passed on to me for comment.

This afternoon Mr. Devata, Foundations Section, Mr. Melinyshyn, Bridge Planning Section, and the writer met to consider our needs for early fill placement. It was determined that early fill would be placed:

- 1) If required for bridge construction.
- 2) If required for grading purposes. A 6' settlement or more was used as a basis to determine the need for early fill placement for grading purposes.

The following is a summary of our conclusions:

- 1) Mountain Road Interchange - W.P. 154-64.

Bridge Office to decide in one month whether early fill placement required for bridge purposes.

- ✓ 2) Thorold Stone Road - W.P. 155-64-03. 67-F-27

No early fill placement required.

- 3) McLeod Road - W.P. 156-64.
- 4) Northbound West Service Road - W.P. 157-64-2.

Both bridges will be on piles. An 8½' settlement is predicted. We propose delaying the final paving of the fill areas from one to two years.

Continued .... /2

March 13, 1968.


Mr. W. Wigle - Re: Queen Elizabeth Way.

- 5) Lyons Creek - W.P. 158-64-01.
- 6) Beck Road - W.P. 442-65.
- 7) Bossert Road - W.P. 443-65.
- 8) Sodom Road - W.P. 159-64.
- 9) Baker Road - W.P. 445-65.
- 10) Townline Road, Black Creek, Service Road - W.P. 167-64.
- 11) Ridgemount Road - W.P. 165-64.
- 12) Bowen Road
- 13) Sunset Drive - W.P. 447-65.
- 14) Gilmore Road - W.P. 448-65.

Considerable settlement can be anticipated for the above structure sites and approach thereto. We propose that early fill placement be considered two years in advance of the current construction program year.

- 15) West-North and South Ramp - W.P. 162-64-2.
- 16) Thompson Road - W.P. 162-64-1.
- 17) - W.P. 162-64-3.
- 18) C.N.R. Widening - W.P. 162-64-05.
- 19) Concession Road (Erie St.) - W.P. 161-64.
- 20) North Street Revision - W.P. 160-64.

No early fill placement required at these sites.



E.J. McCabe  
Expressway Consultant Control Engineer  
For:  
G.K. Hunter  
Regional Road Design Engineer

EJM/GB

c.c. M. Devata  
W. Melinysnyn  
A.J. Fletcher  
E.A. Fletcher

Department of Highways Ontario

Copy for the information of

Mr. A. Stermac

Mr. W. Malinychyn,  
Reg. Bridge Location Engineer,  
Central Region,  
Administration Building

Bridge Division,  
Downsview, Ontario

June 5, 1968

Thoroldstone Rd. Interchange Underpass  
1.8 Miles North of Highway 20  
W.P. 155-64-3, Site 34-26  
Q.E. District No. 4

67-F-27

Attached herewith are prints of the Preliminary Bridge  
Plan Drawing D-6291-F1 for the above-mentioned structure.

The estimated cost of the proposed structure is \$390,000.  
This cost includes tender, materials, engineering and sundry  
construction.

Any comments or revisions you may have should be submitted  
within three weeks.

CSG:rd

C.S. Grebski,  
Bridge Design Engineer

Attach.

c.c. S. McCombie  
A. Stermac (2)  
J. Anderson

Mr. C. S. Grebski,  
Bridge Design Engineer,  
Bridge Division,  
Admin. Bldg.

Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

June 14, 1968

Thoroldstone Rd. Interchange Underpass  
-- 1.8 Miles North of Hwy. 20 --  
W.P. 155-64-3, Site 34-26, W.J.67-F-27

We have reviewed Preliminary Bridge Plan Drawing D-6291-P1 for the above mentioned structure and submit the following comments.

The West pier footing is shown at elev. 530.0. In the Foundation Report, we have recommended elev. 528.0 for this footing. We presume that you will make the necessary changes on the design drawings.

MD/HdeF

*M. Devata*  
M. Devata,  
SUPERVISING FOUNDATION ENGR.  
For:  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. S. McCombie  
W. S. Melinyshyn

Foundations Files  
Gen. Files



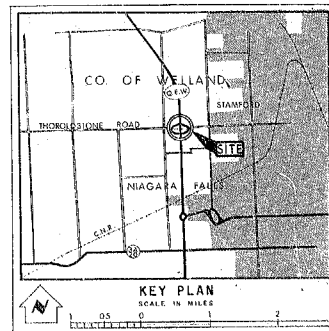
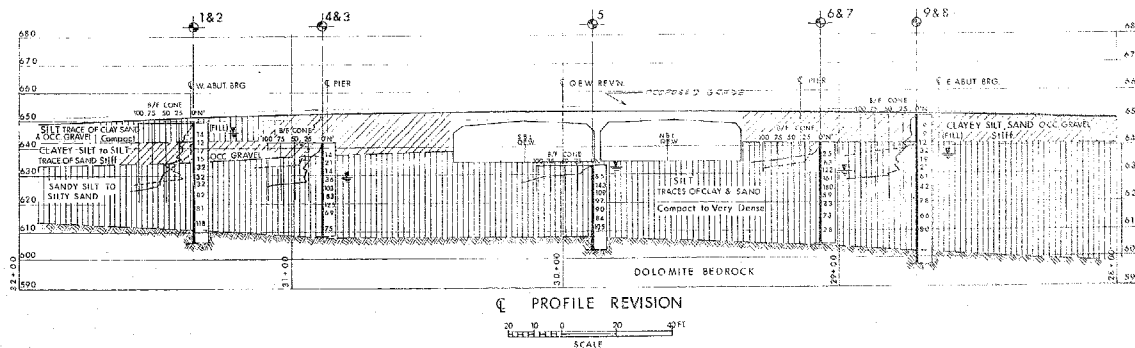
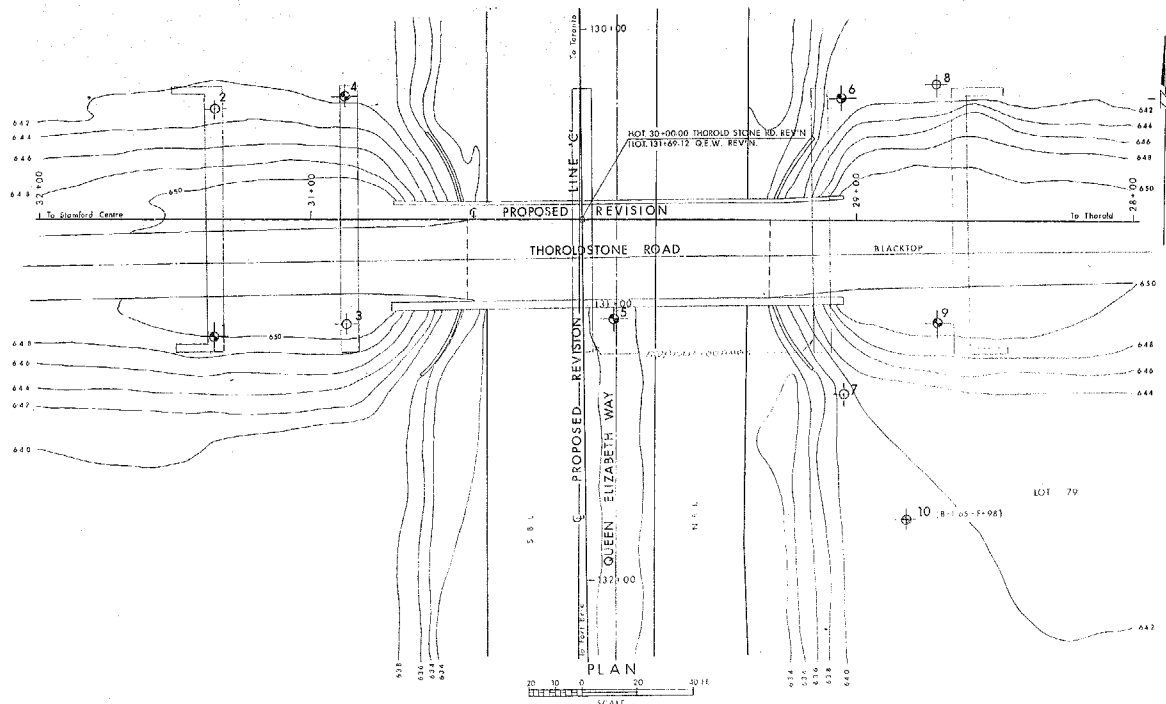
#67-F-27

W.P. #155-64-03

Q.E.W

THOROLD

STONE ROAD



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, April 1967		
NO.	ELEVATION	STATION	OFFSET
1	649.5	31+25	43' LT
2	642.3	31+27	10' RT
3	651.8	30+82	38' LT
4	641.0	30+89	42' RT
5	633.5	29+87	35' LT
6	641.2	29+00	42' RT
7	641.9	29+04	83' LT
8	641.0	28+73	10' RT
9	651.0	28+71	38' LT
10	642.0	29+83	108' LT

**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.

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

**THOROLD STONE ROAD REVISION**

KING'S HIGHWAY NO. Q.E.W. REV. LN. 'C' DIST. NO. 4  
CO. WELLAND  
TWP. NIAGARA FALLS LOT 71 & 79 CON.

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBM'D. V.K. CHECKED *[initials]* W.P. NO. 155-62-03 M.B.T. DRAWING NO.  
DRAWN M.D. CHECKED *[initials]* JOB NO. 67-F-27 67-F-27A  
DATE 6 JUNE 1967 SITE NO. BRIDGE DRAWING NO.  
APPROVED *[signature]* CONT. NO. MINOR, PROBATION, ETC.

REF. NO. 6-4771-1