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W. O. No. _____

STR. SITE No. 49-14

HWY. No. 540

LOCATION Indian Pt. Bridge

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-223

Ontario

Ministry of
Transportation and
Communications

INDEX

NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U)
ISOTROPICALLY (I) OR NOT (A)
AND SHEARED DRAINED (D) OR UNDRAINED (U)
WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS)
EG. $\bar{C}\bar{I}\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED
TRIAXIAL WITH PORE PRESSURE MEASUREMENT
UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S	SPLIT SPOON
W S	WASH SAMPLE
S T	SLOTTED TUBE SAMPLE
B S	BLOCK SAMPLE
C S	CHUNK SAMPLE
T W	THINWALL OPEN
T P	THINWALL PISTON
O S	OSTERBERG SAMPLE
F S	FOIL SAMPLE
R C	ROCK CORE
P H	T.W. ADVANCED HYDRAULICALLY
P M	T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ	COEFFICIENT OF FRICTION
δ	ANGLE OF WALL FRICTION
k_o	COEFFICIENT OF EARTH PRESSURE AT REST
k_A	COEFFICIENT OF ACTIVE EARTH PRESSURE
k_p	COEFFICIENT OF PASSIVE EARTH PRESSURE
i	ANGLE OF INCLINATION OF SURCHARGE
w	SLOPE ANGLE-BACKFACE OF WALL
β	ANGLE OF SLOPE
N_γ, N_q, N_c	BEARING CAPACITY FACTORS
D_f	DEPTH OF FOOTING
B,L	FOOTING DIMENSIONS

INDEX PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G_s	SPECIFIC GRAVITY OF SOLIDS
e	VOIDS RATIO
e_o	INITIAL VOIDS RATIO
e_{max}	e IN LOOSEST STATE
e_{min}	e IN DENSEST STATE
D_r	RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n	POROSITY
w	WATER CONTENT
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
w_s	SHRINKAGE LIMIT
I_p	PLASTICITY INDEX = $w_L - w_p$
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
A_c	ACTIVITY = $\frac{I_p \text{ of soil}}{\% < 2\mu m \text{ Soil Fraction}}$
Om	ORGANIC MATTER CONTENT
S_r	DEGREE OF SATURATION
S	SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ	ANGLE OF SHEARING RESISTANCE
τ_f	PEAK SHEAR STRENGTH
τ_R	RESIDUAL SHEAR STRENGTH
c	COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	NORMAL PRINCIPAL STRESSES
u	PORE WATER PRESSURE
u_e	EXCESS u
r_u	PORE PRESSURE RATIO
q_u	UNCONFINED COMPRESSIVE STRENGTH
s_u	UNDRAINED SHEAR STRENGTH
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO
E	MODULUS OF ELASTICITY
G	MODULUS OF SHEAR DEFORMATION
k_s	MODULUS OF SUBGRADE REACTION
m,n	STABILITY COEFFICIENTS
A,B	PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX
C_r	RECOMPRESSION INDEX
d	DRAINAGE PATH DISTANCE
T_v	TIME FACTOR
U	DEGREE OF CONSOLIDATION
OCR	OVERCONSOLIDATION RATIO (OCR)

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES

(EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)

							GRP SYMB	TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μm)	GRAVELS (MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE				GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING				GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)				GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)				GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS (MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES				SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING				SP	POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)				SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)				SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μm (THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE))	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μm							
	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			
			NONE	QUICK	NONE		ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM		CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
			SLIGHT TO MEDIUM	SLOW	SLIGHT		OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS
		LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK	SLIGHT		MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS
			HIGH	NONE	MEDIUM TO HIGH		CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY
			SLIGHT TO MEDIUM	VERY SLOW	SLIGHT		OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM		MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS
			HIGH TO VERY HIGH	NONE	HIGH		CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM		OH	ORGANIC CLAYS OF HIGH PLASTICITY
HIGHLY ORGANIC SOILS			READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE				Pt	PEAT & OTHER HIGHLY ORGANIC SOILS

INFORMATION REQUIRED FOR DESCRIBING SOILS

GIVE TYPE; NAME, IF NECESSARY, INDICATE APPROX % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESIS.

FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.

GIVE TYPE; NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESIS.

FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS.

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

LABORATORY CLASSIFICATION CRITERIA

DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:

LESS THAN 5%	GW, GP, SW, SP
MORE THAN 12%	GM, GC, SM, SC
5% TO 12%	BORDERLINE CASES REQ. USE OF DUAL SYMBOLS

$C_U = \frac{D_{60}}{D_{10}}$ GREATER THAN 4

$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR GW

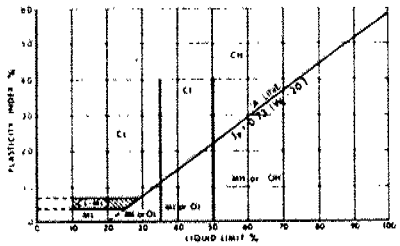
ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	

$C_U = \frac{D_{60}}{D_{10}}$ GREATER THAN 6

$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR SW

ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

Foundation Investigation Report

For

Indian Point Bridge
W.P. 156-77-02, Site 49-14
Hwy. 540, District 17, Sudbury

INTRODUCTION

This report will summarize the factual information obtained from a foundation investigation performed at the above-mentioned structure site during July 5th to 11th, 1967.

Conventional diamond drilling equipment adapted for soil sampling purposes, together with a raft, was used to complete a total of four sampled boreholes and six cone penetration tests on the east side of the existing bridge.

SITE DESCRIPTION AND GEOLOGY

The site is located on Hwy. 540 approximately 2.5 miles east and 1 mile north of the settlement of Evansville, on Manitoulin Island. At this point a penisular (½ mile long), part of Burpee Township, extends northward toward a peninsula (approximately 2 miles long), part of Gordon Township. A rock fill causeway 1/3 mile long and a bridge link the two peninsulas. Wolsey Lake lies to the east and drains naturally into Campbell Bay to the west.

At the time of investigation, the causeway was generally 5 feet above waterlevel and increases to 7 feet above waterlevel near the bridge to raise the grade sufficiently to permit passage of small boats beneath the bridge.

Geologically, the area lies on the northern extension of the Niagara Escarpment; hence, the paleozoic bedrock might be expected to be overlain by some glacial deposits and recent lacustrine deposits.

SUBSURFACE CONDITIONS

General

In general, 8 to 15 feet of water overlies a thin lacustrine deposit underlain by 11.5 to 17 feet of a till-like deposit and then bedrock. Some boulders were encountered on the lake bottom in the vicinity of the causeway.

The boundaries between the various soil types as encountered at the time of investigation, insitu and laboratory test results, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings along with an estimated stratigraphical profile based on borehole data, are shown on Drawing No. 2.

Sand, Gravel and Boulders

This is a thin lacustrine deposit of sand and gravel with some organics. The boulders encountered, are presumed to be part of the fill for the causeway. The deposit was 1 to 5 feet thick and of a compact relative density.

Heterogeneous Mixture of Silty Clay, Sand and Gravel - (Glacial Till)

This deposit was encountered in all boreholes and varied in thickness from 11.5 to 17 feet. The consistency of the deposit was very stiff to hard (predominantly hard) with 'N' values of 23 to much in excess of 100 blows per foot. Atterberg limits were consistent throughout the deposit with liquid limits between 16.5% and 17.6%, and plastic limits between 11.2% and 11.8%. Typical grain-size distribution results indicated 4% to 13% gravel sizes, 28% to 31% sand sizes, 42% to 50% silt sizes, and the remainder clay sizes (about 14% to 19%). Occasional boulders were encountered throughout this stratum. Typical grain size distribution curves for this deposit are plotted in envelope form on Figure 1.

Bedrock

Bedrock was proven for 5 to 10 feet in all boreholes by drilling AXT-size rock core. Bedrock surface was encountered at depths ranging from 29.5 to 30.9 corresponding to elevations of 549.1 and 547.7 respectively. The bedrock was interbedded dolomite, shale (red and green), gypsum and anhydrite, and is part of the Cabot Head Formation (Cataract Group) from the Silurian system of Paleozoic age. The bedrock encountered was generally intact with core recovery of 76% to 93%.

Groundwater Condition

Water levels recorded at the crossing on July 10, 1967 corresponded to elevation 578.6.

Tom Kazmierowski, P. Eng.
Foundations Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

W P 156-77-02 LOCATION Sta. 250 + 05 ℄ Hwy. 540 o/s 49' Lt. ORIGINATED BY Z.O.

DIST 17 HWY 540 BOREHOLE TYPE NX,BX,AX Casing, Washboring, Diamond Drilling AXT R.C. & Cone Test COMPILED BY Z.O.

DATUM Geodetic DATE 67 07 05 CHECKED BY H.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
578.6	Water Level										
0.0	Water						570				
567.3	Bottom of Lake										
11.3	Sand, Gravel, Boulders										
	Heterogeneous mix. of Clayey Silt, Sand & Gravel. Occasional boulders.		1	SS	80						
			2	SS	100/5.5"		560	110/11"			
			3	SS	92						
	Hard		4	SS	100						5 31 50 14
	(Glacial Till)		5	SS	100/9"		550				
547.7											
30.9	Bedrock - Interbedded Dolomite, shale, gypsum & anhydrite		6	AXT RC	76% Rec						
	Sound		7	AXT RC	83% Rec		540				
538.1											
40.5	End of Borehole						530				

ATTENTION IS DRAWN TO THE FOLLOWING:
THE NEW MTC SOIL CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE ACTUAL SYSTEM USED IS GIVEN IN THE CONTRACT REPORT. THE MORE PERTINENT DIFFERENCES BETWEEN THE OLD AND NEW SOIL CLASSIFICATION SYSTEMS IS SHOWN IN THE TABLE BELOW.

SYMBOL	DESCRIPTION OF SOIL	
	NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ⊹ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2

W P 156-77-02 LOCATION Sta. 249 + 76 ℄ Hwy. 540 o/s 39' Lt. ORIGINATED BY Z.O.
DIST 17 HWY 540 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY Z.O.
DATUM Geodetic DATE 67 07 10 CHECKED BY H.R.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
578.6	Water Level										
0.0	Water						570				
565.1	Bottom of Lake										
13.5							560				
556.7											
21.9	End of Cone Test						550				

ATTENTION IS DRAWN TO THE FOLLOWING:
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SYMBOL	DESCRIPTION OF SOIL: NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

W P 156-77-02 LOCATION Sta. 249 + 75 ℄ Hwy. 540 o/s 15' Lt. ORIGINATED BY Z.O.

DIST 17 HWY 540 BOREHOLE TYPE NX,BX,AX Casing; Washboring, Diamond Drilling AXT R.C. & Cone Test COMPILED BY Z.O.

DATUM Geodetic DATE 67 07 07 CHECKED BY H.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
578.6	Water Level										
0.0	Water						570	Cone at Sta. 249 + 77 26' Lt.			
563.7	Bottom of Lake										
14.9	Sand, Gravel, Some Org.		1	SS	27						4 33 44 19
	Heterogeneous mixture of Clayey Silt, Sand & Gravel Occasional boulders Hard		2	SS	79		560				10 31 44 15
			3	RC	9" Rec.						
			4	SS	100/4"						9 30 47 14
			5	SS	49						
	(Glacial Till)		6	SS	56		550				
548.1			7	~~AXT~~ RC	~~67%~~ Rec						
30.5	Bedrock. Interbedded dolomite, shale, gypsum & anhydrite		8	AXT RC	93% Rec						
542.2											
36.4	End of Borehole						540				

OFFICE REPORT ON SOIL EXPLORATION

TO THE FOLLOWING

THE NEW M.T.C. SOIL CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE ACTUAL SYSTEM USED IS GIVEN IN THE CONTRACT REPORT. THE MORE PERTINENT DIFFERENCES BETWEEN THE OLD AND NEW SOIL CLASSIFICATION SYSTEMS IS SHOWN IN THE TABLE BELOW.

SYMBOL	DESCRIPTION OF SOIL	
	NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4

W P 156-77-02 LOCATION Sta. 249 + 20 ℄ Hwy. 540 o/s 29' Lt. ORIGINATED BY Z.O.

DIST 17 HWY 540 BOREHOLE TYPE NX,AX Casing; Washboring, Diamond Drilling AXT COMPILED BY Z.O.

DATUM Geodetic DATE 67 07 10 R.C. & Cone Test CHECKED BY H.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
578.6	Water Level										
0.0	Water						570				
562.7	Bottom of Lake										
15.9	Sand, Gravel, Trace Organics		1	SS	23		560				6 28 49 17
	Heterogeneous mixture of Clayey Silt, Sand and Gravel		2	SS	88						13 28 44 15
			3	SS	62						
	Hard		4	SS	65			then 100/9"			6 31 48 15
548.5	(Glacial Till		5	SS	53		550				
30.1	Bedrock - Sound Interbedded dolomite shale, gypsum and anhydrite		6	AXT RC	Rec 75%						
539.0			7	AXT RC	Rec 93%		540				
39.6	End of Borehole										

ATTENTION IS DRAWN TO THE FOLLOWING:
THE NEW MTC SOIL CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE ACTUAL SYSTEM USED IS GIVEN IN THE CONTRACT REPORT. THE MORE PERTINENT DIFFERENCES BETWEEN THE OLD AND NEW SOIL CLASSIFICATION SYSTEMS IS SHOWN IN THE TABLE BELOW.

SYMBOL	DESCRIPTION OF SOIL	
	NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \frac{20}{10} 5$ (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

W P 156-77-02 LOCATION Sta. 249 + 16 ℄ Hwy. 540 o/s 16' Lt. ORIGINATED BY Z.O.

DIST 17 HWY 540 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY Z.O.

DATUM Geodetic DATE 67 07 10 CHECKED BY H.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl; WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
578.6	Water Level										
0.0	Water						570				
565.2	Bottom of Lake										
13.4							560	128			
555.6											
23.0	End of Cone Test						550	100/9"			

ATTENTION IS DRAWN TO THE FOLLOWING:
THE NEW MTC SOIL CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE ACTUAL SYSTEM USED IS GIVEN IN THE CONTRACT REPORT. THE MORE PERTINENT DIFFERENCES BETWEEN THE OLD AND NEW SOIL CLASSIFICATION SYSTEMS IS SHOWN IN THE TABLE BELOW.

SYMBOL	DESCRIPTION OF SOIL	
	NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

W P 156-77-02 LOCATION Sta. 248 + 88 ℄ Hwy. 540 o/s 50' Lt. ORIGINATED BY Z.O.

DIST 17 HWY 540 BOREHOLE TYPE NX, AC Casing, Washboring, Diamond Drilling AXT R.C. & Cone Test COMPILED BY Z.O.

DATUM Geodetic DATE 67 07 11 CHECKED BY H.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
578.6	Water level										
0.0	Water						570				
565.8	Bottom of Lake										
12.8	Sand, Gravel & Boulders Some Organics		1	SS	16						
560.9			2	SS	20		560				
17.7	Heterogeneous mixture of Clayey Silt, Sand and Gravel. Hard		3	SS	67						
			4	SS	80				o		10 30 42 18
	(Glacial Till)		5	SS	100/4"						
549.1			6	SS	117/9"		550				
29.5	Bedrock - Sound Interbedded dolomite, shale, gypsum & anhydrite		7	AXT R.C.	Rec 92%						
543.8											
34.8	End of Borehole						540				

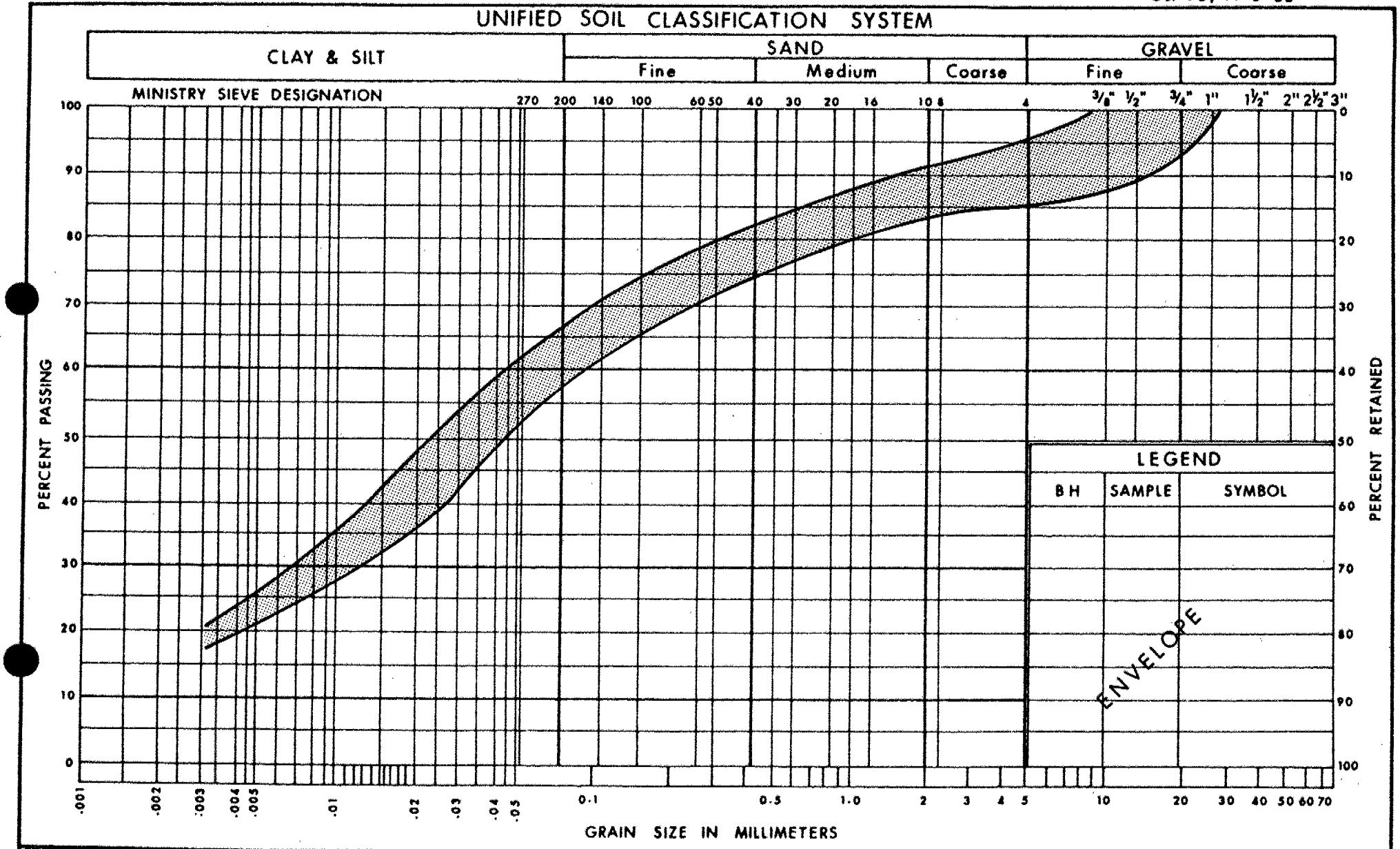
ATTENTION IS DRAWN TO THE FOLLOWING:
THE NEW MTC SOIL CLASSIFICATION SYSTEM IS NOT USED ON THIS DRAWING. THE ACTUAL SYSTEM USED IS GIVEN IN THE CONTRACT REPORT. THE MORE PERTINENT DIFFERENCES BETWEEN THE OLD AND NEW SOIL CLASSIFICATION SYSTEMS IS SHOWN IN THE TABLE BELOW.

SYMBOL	DESCRIPTION OF SOIL	
	NEW SYSTEM	SYSTEM USED HERE
ML	SILT, CLAYEY SILT, SANDY SILT	SILT, SANDY SILT
CL	SILTY CLAY	CLAYEY SILT
CI	SILTY CLAY	SILTY CLAY
CH	CLAY	CLAY

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
GLACIAL TILL

FIG No 1
W P 156-77-02

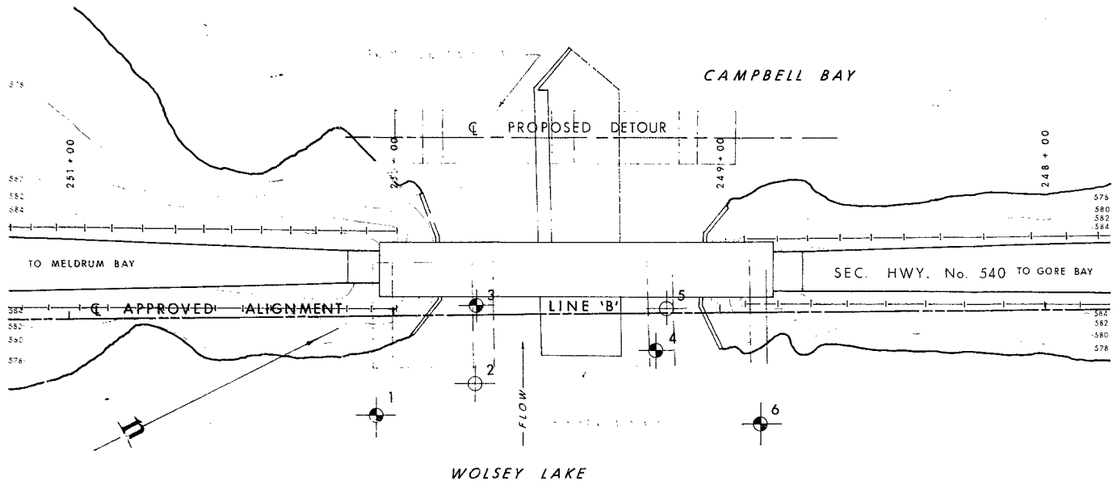
#67-F-58

W.P. #236-64

SEC. HWY. #540

INDIAN POINT

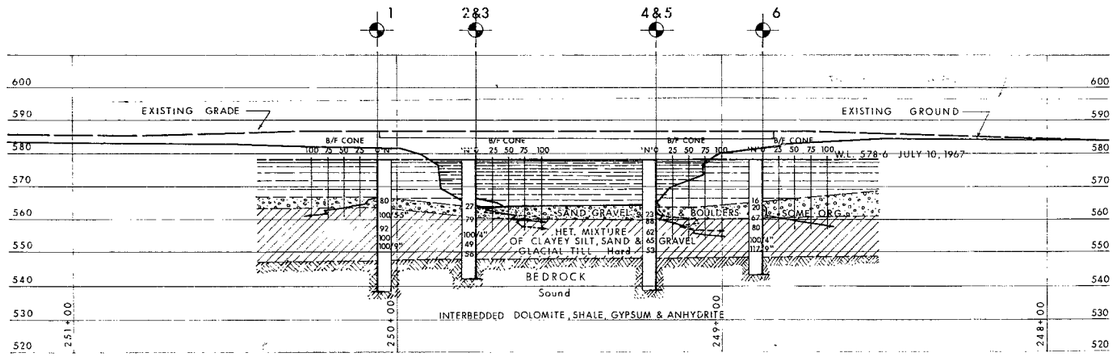
BRIDGE



PLAN

SCALE

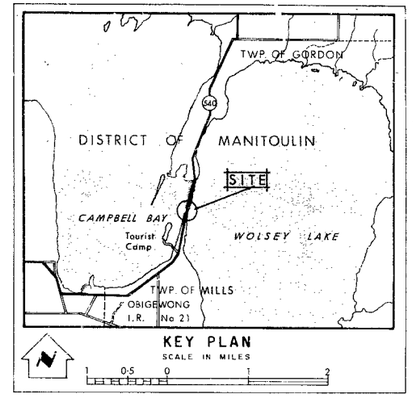
20 10 0 20 40 FT.



℄ PROFILE REVISION LINE 'B'

SCALE

20 10 0 20 40 FT.



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. July 1967

NO.	ELEVATION	STATION	OFFSET
1	567·3	250+05	30'LT.
2	569·1	249+76	20'LT.
3	563·7	249+75	3'RT.
4	562·7	249+20	12'LT.
5	565·2	249+16	1'RT.
6	565·8	248+88	34'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.

PRINT RECORD

NO.	FOR	DATE

REVISIONS

DATE	BY	DESCRIPTION

REF. No. E-4459-1

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & TESTING DIVISION – FOUNDATION SECTION

INDIAN POINT BRIDGE

KING'S HIGHWAY NO. SECONDARY 540 LINE 'B' DIST. NO. 17

DIST. MANITOULIN OBIGEWONG I.R. No. 21

TWP. GORDON LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D Z. O.	CHECKED	W.P. NO 236-64	M.B.T. DRAWING NO. 67-F-58A
DRAWN P.G.O.	CHECKED	JOB NO. 67-F-58	
DATE AUGUST 31, 1967		SITE NO	BRIDGE DRAWING NO.
APPROVED		CONT NO	

cc: GEN. FILES

W.P. 236-64.

DEPARTMENT OF HIGHWAYS ONTARIO

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: August 30, 1967

Our File Ref.

In reply to SEP - 6 1967

Subject:

FOUNDATION INVESTIGATION REPORT
For
Indian Point Bridge
Highway No. 540
District No. 17 (Sudbury)
W.J. 67-F-58 -- W.P. 236-64

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

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

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
H. McArthur
T. A. Sharpe
J. B. Curtis
E. R. Saint
B. A. Singh

Foundations Files
Gen. Files ✓

TABLE OF CONTENTS

FOUNDATION INVESTIGATION REPORT
For
Indian Point Bridge
Highway No. 540
District No. 17 (Sudbury)
W.J. 67-F-58 -- W.P. 236-64

1. INTRODUCTION:

A request, dated June 23, 1967, to conduct a foundation investigation at the proposed bridge site, was received from the Bridge Planning Section (Mr. J. B. Curtis, Regional Bridge Location Engineer.)

The existing one-lane bridge is to be replaced by a three-span, two-lane structure with a grade increase of about 10 feet. During construction, traffic will be maintained on an adjacent detour and temporary Bailey bridge.

Subsequently, a foundation investigation was conducted at the proposed site to determine the subsoil conditions. Field and laboratory test results, together with discussion and recommendations for the structure foundations, are reported herein.

2. TOPOGRAPHY AND GEOLOGY:

The site is located on Hwy. 540 approximately 2.5 miles east and 1 mile north of the settlement of Evansville, on Manitoulin Island. At this point a peninsula (1/2 mile long), part of Burpee Township, extends northward toward a peninsula (approximately 2 miles long), part of Gordon Township. A rock fill causeway 1/3 mile long and a bridge link the two peninsulas. Wolsey Lake lies to the east and drains naturally into Campbell Bay to the west.

The causeway is generally 5 feet above water level and increases to 7 feet above water level near the bridge to raise the grade sufficiently to permit passage of small boats beneath the bridge.

cont'd. /2 ...

2. TOPOGRAPHY AND GEOLOGY: (cont'd.) ...

Geologically, the area lies on the northern extension of the Niagara Escarpment; hence, the paleozoic bedrock might be expected to be overlain by some glacial deposits and recent lacustrine deposits.

3. FIELD AND LABORATORY WORK:

Conventional diamond drilling equipment adapted for soil sampling purposes, together with a raft, was used to complete a total of four sampled boreholes and six cone penetration tests on the east side of the existing bridge. A driving energy of 350 ft.-lbs./blow was used for the dynamic cone penetration tests.

Samples were obtained using a 2-inch O.D. split-spoon sampler driven, using an energy of 350 ft.-lbs./blow in accordance with the specifications of the Standard Penetration Test.

AXT-size rock core samples were obtained from all the boreholes to prove the bedrock.

Samples were visually examined and identified in the field as well as in the laboratory. Tests were carried out in the laboratory on a selection of samples to determine, where applicable,

i) Atterberg Limits
ii) Natural Moisture Content
iii) Grain-Size Distribution

Results of the laboratory and field tests, together with the location and elevations of the boreholes, are appended to this report.

cont'd. /3 ...

4. SUBSOIL CONDITIONS:

4.1) General:

In general, 8 to 15 feet of water overlie a thin lacustrine deposit underlain by a till-like deposit and then bedrock. Some boulders were encountered on the lake bottom in the vicinity of the causeway.

4.2) Sand, Gravel and Boulders:

This is a thin lacustrine deposit of sand and gravel with some organics. The boulders encountered, are presumed to be part of the fill for the causeway. The deposit was 1 to 6 feet thick and of a compact relative density.

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

This deposit was encountered in all boreholes and varied in thickness from 11.5 to 17 feet. The consistency of the deposit was very stiff to hard (predominantly hard) with 'N' values of 23 to much in excess of 100 blows per foot. Atterberg limits were consistent throughout the deposit with liquid limits between 16.5% and 17.6%, and plastic limits between 11.2% and 11.8%. Typical grain-size distribution results indicated 4% to 13% gravel sizes, 28% to 31% sand sizes, 42% to 50% silt sizes, and the remainder clay sizes (about 14% to 19%). Occasional boulders were encountered throughout this stratum.

4.4) Bedrock:

Bedrock was proven for 5 to 10 feet in all boreholes by drilling AXT-size rock core. The bedrock was interbedded dolomite, shale (red and green), gypsum and anhydrite, and is part of the Cabot Head Formation (Cataract Group) from the Silurian system of Paleozoic age. The bedrock encountered was generally sound with core recovery of 76% to 93%.

cont'd. /4 ...

5. DISCUSSION AND RECOMMENDATIONS:

5.1) General:

It is proposed to replace the existing single-lane, two-span structure with a two-lane, three-span (30'-55'-30') structure. New grades will be about 17 feet above the water level or about 10 feet above the existing grade. Subsoil at the site consists of a thin deposit of sand and gravel underlain by a glacial till and then bedrock.

5.2) Abutments:

The proposed abutments will be located partially on the old rock fill and partially on new fill. There are two alternatives for the abutments as follows:

i) Pile-type Foundation - Because of the probable difficulty of driving piles through the existing fill, it is recommended to remove all rock fill in the abutment locations where piles are to be driven. Steel H-piles with reinforced driving tips are recommended and should be driven to practical refusal. For design purposes, it may be assumed that the piles will penetrate to elevation 550. The piles may be designed for the maximum allowable load for the pile section chosen.

ii) Spread Footing-type Foundation - Spread footings may be used for the abutment foundations provided that the footings are founded on at least 3 feet of compacted granular fill. This could necessitate the removal of some of the existing embankment. The footings may be designed for a safe load of 2 t.s.f.

5.3) Piers:

The piers may be founded on either a pile-type or spread footing-type foundation as detailed on the following page:

cont'd. /5 ...

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

5.3) Piers: (cont'd.) ...

i) Pile-type Foundation - Tubular steel piles 12-3/4" O.D. with 1/4" wall thickness, are recommended to be driven to practical refusal at about elevation 550. Piles may be designed for the maximum allowable load for the section chosen.

ii) Spread Footing-type Foundation - The piers may be founded on spread footings on the glacial till stratum at elevation 560, where an allowable load of 4 t.s.f. may be used. A dewatering scheme will be necessary. If sheeting is required for scour purposes, it could be incorporated in the dewatering scheme. For dewatering purposes, the steel sheeting should be driven at least 3 feet below the bottom of the footing elevation. A working slab should be cast as soon as possible after the excavated elevation is reached.

5.4) Embankments:

No stability problems are anticipated for the proposed approach fills with standard 2:1 slopes for earth fill and 1-1/4:1 for rock fill. Granular or rock fill should be used below water level.

5.5) Bailey Bridge:

Due to adverse weather conditions, it was not possible to conduct an investigation in this area. Since subsoil conditions are very uniform and favourable, no problems are anticipated for the proposed detour and temporary Bailey bridge, supported on rock fill timber cribs.

cont'd. /6 ...

6. SUMMARY:

A foundation investigation at the site of the proposed Indian Point Bridge on Hwy. 540, is reported.

Subsoil at the site is overlain by 8 to 15 feet of water and is, in general, a thin lacustrine deposit of sand and gravel with boulders underlain by 11.5 to 17 feet of glacial till and then bedrock.

Alternative pile-type or spread footing-type foundations are proposed for the structure abutments and piers. A dewatering scheme may be required for the piers.

No stability problems are anticipated for the proposed embankments.

No foundation problems are anticipated for the proposed detour and temporary Bailey bridge.

7. MISCELLANEOUS:

Field work was completed in the period from July 5 to July 11, 1967, under the direction of Mr. Z. Ozden, employing a drilling machine and raft owned and operated by Master Soil Investigations Ltd.

The report was prepared by Mr. Ozden and Mr. L. Palmer, Project Foundation Engineer.

The entire project was under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who also reviewed this report.

August 1967

APPENDIX I

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 67-F-58
W.P. 236-64
DATUM Geodetic

LOCATION Sta. 250 + 05 ℄ Hwy. 540 o/s 49' Lt.
BORING DATE July 5, 1967
BOREHOLE TYPE NX,BX,AX Casing, Washboring, Diamond Drilling
AXT R.C. & Cone Test

ORIGINATED BY ZO
COMPILED BY ZO.
CHECKED BY AK.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % (10 20 30)	BULK DENSITY γ P.C.F.	REMARKS
578.6	Water Level									
0.0										
567.3	Ground Level					570				
11.3	Sand, Gravel, Boulders. Heterogeneous mix. of clayey silt, sand & gravel. Occasional boulders. Hard. (Glacial Till)		1	SS	80					
			2	SS	100/5.5"	560	110/11"			
			3	SS	92					
			4	SS	100					Gr.5, Sa.31 Si.50, Cl.14
547.7			5	SS	100/9"	550				
30.9	Bedrock - Interbedded dolomite, shale, gypsum & anhydrite. Sound		6	AXT RC	76% Rec					
			7	AXT RC	83% Rec	540				
538.1										
40.5	End of Borehole									

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 67-F-58 LOCATION Sta. 249 + 76 ℄ Hwy. 540 o/s 39' Lt. ORIGINATED BY ZO
W.P. 236-64 BORING DATE July 10, 1967 COMPILED BY ZO
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY HK.

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
578.6	Water Level									
0.0						570				
565.1	Ground Level									
13.5						560				
556.7										
21.9	End of Cone Test					550				

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 67-F-58 LOCATION Sta. 249 + 75 ℄ Hwy. 540 o/s 15' Lt. ORIGINATED BY ZO
W.P. 236-64 BORING DATE July 7, 1967 COMPILED BY ZO
DATUM Geodetic BOREHOLE TYPE NX, BX, AX Casing; Washboring, Diamond Drilling AXT R.C. & Cone Test CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS Gr.Sa.Si.Cl.
578.6	Water Level									
0.0										
563.7	Ground Level						Cone at Sta. 249+77 26' LT.			
14.9	Sand, Gravel, some org.		1	SS	27					4 33 44 19
	Heterogeneous mixture of clayey silt, sand & gravel. Occasional boulders. Hard		2	SS	79	560	then 75/3"	o		
			3	RC	9" Rec.					10 31 44 15
			4	SS	100/4"			o		
			5	SS	49			o		9 30 47 14
548.1	(Glacial Till)		6	SS	56	550				
30.5	Bedrock. Interbedded dolomite, shale, gypsum & anhydrite		7	AXT RC	61% Rec.					
542.2			8	AXT RC	93% Rec.					
36.4	End of Borehole									

FORM OB-MT-125
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 67-F-58 LOCATION Sta. 249 + 20 ℄ Hwy. 540 o/s 29' Lt. ORIGINATED BY ZO
W.P. 236-64 BORING DATE July 10, 1967 COMPILED BY ZO
DATUM Geodetic BOREHOLE TYPE NX, AX Casing; Washboring, Diamond Drilling CHECKED BY
AXT R.C. & Cone Test

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
578.6	Water Level									Gr.Sa.Si.Cl
0.0										
562.7	Ground Level									
15.9	Sand & Gravel, trace org.		1	SS	23	560				6 28 49 17
	Heterogeneous mixture of clayey silt, sand and gravel. Hard. (Glacial Till)		2	SS	88					
			3	SS	62					13 28 44 15
			4	SS	65		then 100/9"			
548.5			5	SS	53	550				6 31 48 15
30.1	Bedrock - Sound Interbedded dolomite shale, gypsum and anhydrite		6	AXT RC	Rec 75%					
539.0			7	AXT RC	Rec 93%	540				
29.6	End of Borehole									

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 67-F-58
W.P. 236-64
DATUM Geodetic

LOCATION Sta. 249 + 16 ℄ Hwy. 540 o/s 16' Lt.
BORING DATE July 10, 1967
BOREHOLE TYPE Dynamic Cone Penetration Test

ORIGINATED BY ZO
COMPILED BY ZO
CHECKED BY [illegible]

SOIL PROFILE			SAMPLES						
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.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
578.6	Water Level									
0.0										
565.2	Ground Level									
13.4										
555.6										
23.0	End of Cone Test						12⅜ then 100/9"			

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

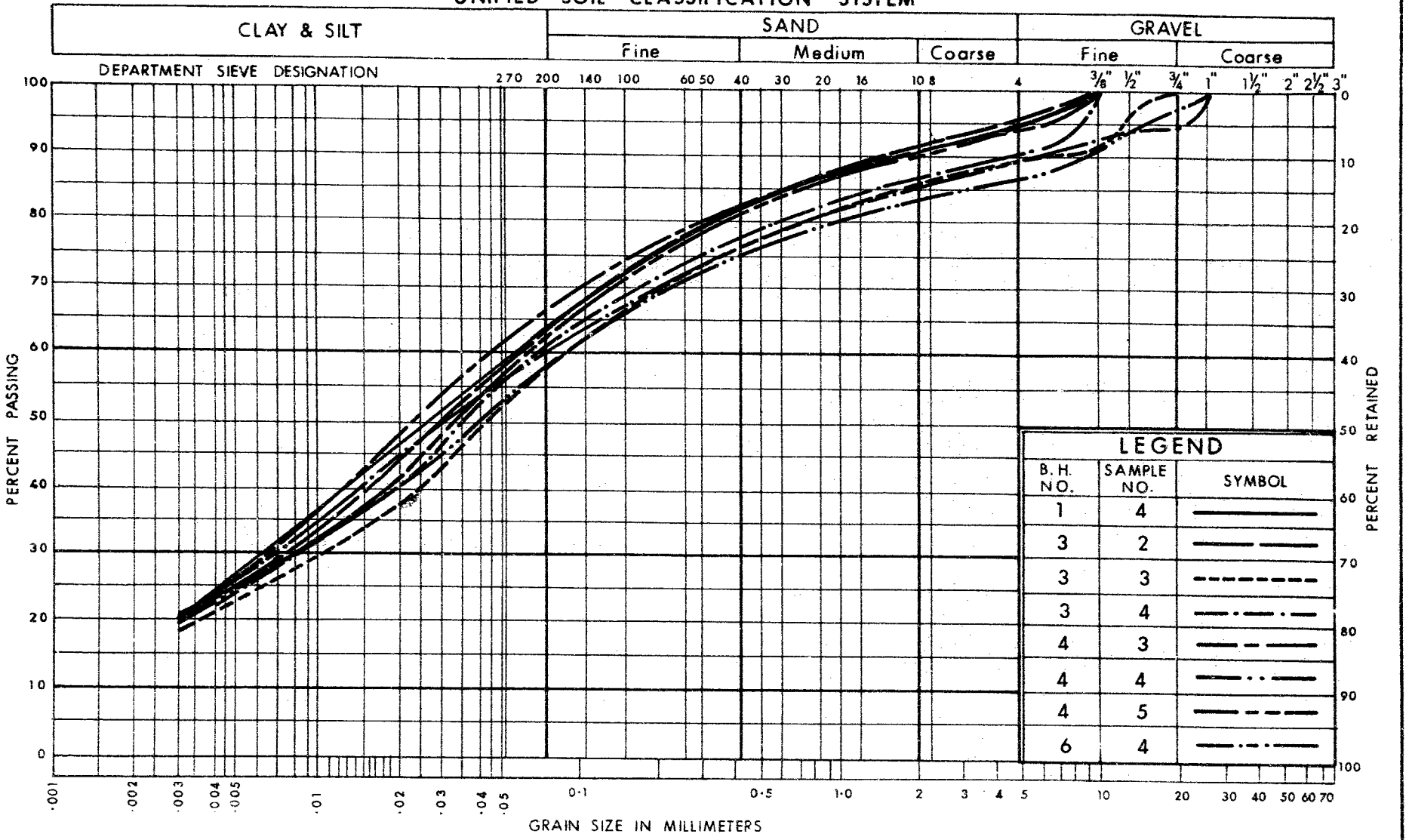
FOUNDATION SECTION

JOB 67-F-58 LOCATION Sta. 248 + 88 @ Hwy. 540 o/s 50' Lt. ORIGINATED BY ZO
W.P. 236-64 BORING DATE July 11, 1967 COMPILED BY ZO
DATUM Geodetic BOREHOLE TYPE NX AC Casing, Washboring, Diamond Drilling, AXT R.C. & Cone Test CHECKED BY MR

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
578.6	Water Level									
0.0										
565.8	Ground Level									
12.8	Sand, gravel & boulders		1	SS	16					
560.9	some organics.		2	SS	20					
17.7	Heterogeneous mixtures of clayey silt, sand and gravel. Hard.		3	SS	67	560				Gr.10,Sa.30 Si.42,Cl.18
			4	SS	80			o		
	(Glacial Till)		5	SS	100/4"					
549.1			6	SS	117/9"	550				
29.5	Bedrock - Sound Interbeded dolomite,		7	AXT R.C.	Rec 92%					
543.8	shale, gypsum & Anhydrite									
34.8	End of Borehole									

FORM OB MT-17
REV. APR. 1965
65-414

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

GRAIN SIZE DISTRIBUTION

W.P. No. 236-64
JOB No. 67-F-58

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

67-F-58

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A.G. Stermac,
Principal Foundation Engr.
Lab. Building, Downsview.

From: Bridge Planning Section,
Northern Region.

Date: June 23, 1967.

Our File Ref.

In reply to

Subject:

Indian Point Bridge,
Highway 540, Br. Site 49-14,
W.P. 236-64, District 17.

Would you kindly arrange a foundation investigation carried out at the above noted site in order to enable us to design the new structure and the proposed detour structure.

A probable layout of the footings for the proposed structure and the detour is shown on the enclosed drawings. A detour is proposed to be constructed on the west side of the existing structure. This necessitates the construction of the approach fills and bailey structure as shown for one lane traffic. The line will be somewhat vague in the field, however, the probable footings will be easily located relative to the existing bridge.

Accomodation and food are available at Gore Bay, some 12 miles distant from the crossing.

If we can be of any further assistance in this matter, kindly advise.

J.B. CURTIS,
REG. BRIDGE LOCATION ENGINEER.

DY/jm
Enc.

cc: R. Forrest
A. Crowley
S. McCombie

ASSIGNMENT DATE JULY 12/67.
COMPLETION DATE SEPT 5/67.

SX

WX DOWN JUNE 30/67 1025A VR

SUDB 2 T A SHARPE DIST ENGR ATTN N NEILANS MTCE ENGR

COPY TO :

WBAR 2 E R SAINT RGN MAT ENGR

RE C P R OVERHEAD AT DOWLING WP183-63-02 BRIDGE SITE 46-226
WJ67-F-59 HWY 144 DIST 17 SUDBURY

INDIAN POINT BRIDGE HWY 540 BRIDGE SITE 49-14 WP236-64 WJ67-F-58
DIST 17 SUDBURY

FIELD INVESTIGATION WORK FOR THE ABOVE MENTIONED PROJECTS WILL COMMENCE ON JULY 4/67.

M DEVATA SUPVR FOUNDATION ENGR MAT AND TEST

FOR A J STERMAC PRINCIPAL FOUNDATION ENGR MAT AND TEST

SB

Foundation File

401 & Keele St.
Downsview, Ontario

July 6, 1967

Johnston Drilling Co. Ltd.
377 Munster Ave.
Toronto, Ontario

Dear Sirs:

This is to confirm our request of June 29, 1967 for the supply of a Diamond Drill and Raft together with all necessary equipment, as specified under the terms of our Contract Agreement, at Gore Bay, Ontario, on July 5, 1967, 8 a.m.

This project bears Job Number 67-F-58.

Yours truly,

M. Devata

MD:mt

M. Devata
Supervising Foundation Engineer
for: A. G. Stermac
Principal Foundation Engineer