

MEMORANDUM

TO: Mr. G. C. E. Burkhardt, (3) FROM: Foundations Office,
Regional Structural Planning Eng., Design Services Branch,
Central Region, West Bldg., Downsview.
3501 Dufferin St.,
ATTENTION: Downsview, Ontario. DATE: April 19, 1973.
OUR FILE REF. IN REPLY TO MAY - 7 1973

SUBJECT:

FOUNDATION INVESTIGATION
For
The Proposed Structure
Hwy. 401 E.B. Collector and Sub-Collector
Over Hwy. 410 (Bridge No. 29)
Town of Mississauga, County of Peel
District #6 (Toronto)
W.O. 72-11166 -- W.P. 127-66-22
CONT-75-16 Site #24-324

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

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

A. C. Stermac

A. C. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/ao
Attch.

c.c. E. J. Orr
B. R. Davis
A. Rutka
R. S. Pillar
H. Greenland
B. J. Giroux
C. Mirza
G. A. Wrong
B. A. Singh

Foundations Files
Documents

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FOUNDATION INVESTIGATION
For
The Proposed Structure
Hwy. 401 E.B. Collector and Sub-Collector
Over Hwy. 410 (Bridge No. 29)
Site #24-324
Town of Mississauga, County of Peel
District #6 (Toronto)
W.O. 72-11166 -- W.P. 127-66-22

1. INTRODUCTION:

The present proposals for the construction program of Hwy. 401 - Hwy. 403 complex will require a major interchange in the vicinity of the intersection of Hwy. 401 and Heart Lake Road. This interchange, designated as 401/410/403 complex, will incorporate some twenty-one structures.

The foundations Office was requested to carry out a subsurface investigation at the site of the proposed Bridge No. 29 (Hwy. 401 E.B. Collector and Sub-Collector over Hwy. 410) of the above-mentioned interchange. The request was contained in a memo from Mr. G.C.E. Burkhardt, Regional Structural Planning Engineer, Central Region, dated February 12, 1973. Subsequently, an investigation was carried out by this Office to determine the subsoil, bedrock and groundwater conditions in this area.

This report presents the factual information obtained from this investigation together with recommendations pertaining to the foundation design of the proposed structure and stability considerations associated with the approach cuts.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The area under investigation is located approximately 1 mile east of the existing Hwy. 401/Hwy. 10 interchange and

immediately south of existing Hwy. 401, in the Town of Mississauga, County of Peel. The terrain is flat to gently undulating in relief between about elevation 602 to 608. The land is developed for farming purposes.

The site is located in the physiographic region known as the "Peel Plain." The characteristic deposit in the vicinity of the area under investigation, is composed of a cohesive glacial till whose thickness is, in general, less than 10 feet. In this region, the Credit River, Oakville Creek and Etobicoke Creek have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area, although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by dark grey shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

3. FIELD AND LABORATORY WORK:

Eight sampled boreholes, each accompanied by dynamic cone penetration testing, were put down during the course of field investigation. The borings were advanced by means of a continuous flight auger machine adapted for soil sampling purposes.

Samples of the overburden were obtained in a 2" O.D. split-spoon sampler at required depths. The sampler was hammered into the soil with a driving energy of 350 ft. lb. per blow, in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration testing. Bedrock was proven at four of the boring locations by obtaining BXL 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 in the Record of Borehole sheets. The location and elevation of the various boreholes were surveyed by District #6 (Toronto), Construction personnel. The elevations in this report are referenced to a Geodetic Datum. Boring locations, tied into a coordinate system, and elevations

together with estimated stratigraphical sections, are shown on Drawing No. 72-11166A.

All the samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, various laboratory tests were carried out on selected representative samples to determine the physical properties of the overburden; namely,

Natural Moisture Content

Atterberg Limits

Grain-Size Distribution

The results of this testing are plotted on the Record of Borehole sheets and summarized on Figures No. 1 and 2, all of which are contained in the Appendix of this report.

Bedrock core samples were examined by Mr. K. W. Ingham, Geologist.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The predominant stratum across the site is a heterogeneous mixture of clayey silt to silty clay with some sand and gravel of glacial origin, the thickness of which varies from 5 to 9 feet. This cohesive deposit is underlain by shale bedrock.

The boundary of the various deposits, as determined in the boreholes, are shown on the accompanying Record of Borehole sheets. The stratigraphical sections, shown on Drawing No. 72-11166A have been inferred from this data. From ground surface downwards, the soil and bedrock encountered are as follows.

4.2) Heterogeneous Mixture of Clayey Silt to Silty Clay, Some Sand and Traces of Gravel (Glacial Till):

This is the predominant stratum across the site. It is composed of a heterogeneous mixture of clayey silt to silty clay, some sand and traces of gravel (glacial till). The thickness of this deposit varies from 4.5 feet (B.H. #4) to 9.5 feet (B.H. #1).

Grain-size distribution curves, for samples of this cohesive stratum obtained with 2" O.D. sampling equipment, are shown on Figure No. 2 in the Appendix. Atterberg Limit Tests were also performed on samples of the glacial till. The results, which are shown on the Record of Borehole sheets and on the Plasticity Chart (Figure No. 1), are tabulated below:

	<u>Range</u>	<u>(Average)</u>
Liquid Limit (W_L) %	28 - 41	(34)
Plastic Limit (W_p) %	18 - 25	(21)
Natural Moisture Content (W) %	6 - 15	(12)

Based on the above values, it is estimated that the cohesive deposit has a matrix, which is inorganic and of low to intermediate plasticity.

The standard penetration tests, carried out within this glacial deposit, are plotted on the Record of Borehole sheets. The testing gave 'N' values ranging from 8 blows per foot to 100 blows per 1 inch.

It is estimated that the consistency of the glacial till varies from stiff to hard.

4.3) Bedrock:

The cohesive glacial till stratum is directly underlain by bedrock which was proven at four of the boring locations by obtaining up to 26 feet of BXL size core samples. In addition, the surface of the bedrock, at the other boring locations, was inferred to exist at the level where the hammer driven sampler or the power auger met practical refusal. Over the site, the bedrock surface was found to vary between elevation 593 (B.H. #1) and elevation 601 (B.H. #5). The bedrock is composed of a dark grey interbedded shale and limestone - the upper 3 to 4 feet of which is, in general, in a weathered condition.

5. GROUNDWATER CONDITIONS:

The groundwater level conditions across the site, during the period of field investigation (February 1973), were observed

by taking readings in the open boreholes. The results of the readings are shown on the borelog sheets, as well as on Drawing No. 72-11166A.

The observations indicate that the four shallow holes (B.H.'s #2, #3, #6 and #7) were dry during the period of field investigation. Elsewhere, the groundwater level was found to vary between elevations 595 and 602, which corresponds to levels ranging from 5 to 8 feet below existing ground surface. It should be noted that the overburden is relatively impermeable in nature and therefore, the figures quoted above may not represent the true groundwater level existing at the site.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

In conjunction with the construction program of Hwy. 401 and Hwy. 403, the existing Hwy. 401 from Hwy. 27 westerly to Hwy. 10, is to be developed as a 16-lane basic core-collector. A number of interchanges are proposed for this portion of Hwy. 401, specifically:

- i) Hwy. 401/Hwy. 403/Hwy. 410 Complex
- ii) Hwy. 401/Dixie Road Interchange
- iii) Hwy. 401/Airport Entrance/Little Etobicoke Creek Complex
- iv) Hwy. 401/First Line Interchange.

This report will deal with the proposed Bridge No. 29 (Hwy. 401 E.B. Collector and Sub-Collector over Hwy. 410) in the Hwy. 401/Hwy. 403/Hwy. 410 complex. The 99-foot wide structure is to have three spans (92' - 144' - 118'). The proposed profile grade of Hwy. 401 E.B. Collector and Sub-Collector, in the vicinity of the structure, will vary from elevations 588 to 594, while that of Hwy. 410 N.B.L. & S.B.L. will be at elevations 568 and 571, respectively. The existing ground surface varies from elevation 602 to 608. Therefore, cuts up to 13 feet high will be necessary for Hwy. 401. An additional cut of 24 feet will be required to reach the proposed grades for Hwy. 410 in the vicinity of the structure.

The predominant stratum across the site is composed of a 5 to 9 feet thick cohesive glacial till which is underlain by shale bedrock.

In the subsections to follow the foundation support for the underpass structure will be discussed. In addition, the stability considerations associated with the approach cuts will be presented.

6.2) Structure Foundations:

In the vicinity of the structure, the proposed profile grade of Hwy. 401 is below the bedrock surface. Therefore, it is recommended that the piers and abutments be supported on spread footing type of foundation located within the sound shale bedrock. A minimum of 4 feet earth cover should be provided to the underside of the footings, since the shale is considered susceptible to frost action. Therefore, the footings should be founded at or below the elevations given in the following table.

<u>Location</u>	<u>Recommended Founding Elevation</u>	<u>Refer to B.H.'s</u>
East Abutment	584	1 & 2
East Pier	564	3 & 4
West Pier	566	5 & 6
West Abutment	590	7 & 8

An allowable bearing value of up to 10 t.s.f. may be used in designing the footings, founded as recommended. The horizontal resistance of the footing may be computed using a coefficient of friction of 1.0 between rough concrete surface and shale.

In order to simplify dewatering for the footing excavations, it is recommended that the approach cuts be completed to profile grades prior to the construction of the structure foundations. If this procedure is followed, the resulting depth of excavation for the footings will be in the order of 4 feet below the finished grade. Any minor groundwater seepage or surface runoff into the excavations can be handled by ordinary pumping methods.

The settlement of the footings will be negligible in magnitude, provided that measures are exercised to prevent the shale from being softened by groundwater seepage or uncontrolled surface runoff. It may be advantageous to protect the shale, at the footing foundation level, by covering it with a lean concrete working slab immediately after the completion of the excavation.

6.3) Approach Cuts:

6.3.1) Hwy. 401:

The approach cuts for Hwy. 401, up to 13 feet deep, will be made through the cohesive glacial till and partially into the upper weathered shale bedrock. No stability problems are anticipated for this portion of the cuts provided standard 2:1 slopes are used.

6.3.2) Hwy. 410:

As mentioned previously (Section 6.1), an additional cut of up to 24 feet deep will be required in the vicinity of the structure in order to reach the proposed grades of Hwy. 410. This cut will be made through the shale bedrock.

According to experience gained by District Construction personnel from the construction of the 427-Q.E.W. interchange, the shale, once it was exposed to the atmosphere, appeared to be susceptible to weathering and erosion. The shale bedrock encountered at the proposed structure site is of the same formation as that of the shale existing at the 427-Q.E.W. interchange. Therefore, it is recommended that the cuts through the shale bedrock be treated as earth cuts and be constructed with 2:1 slopes. It is further recommended that the cut slopes be protected with an adequate cover of topsoil and sodded.

The groundwater level established during the period of field investigation, is some 27 feet above the bottom of the proposed approach cut. Some seepage through, and consequently


local sloughing of the shale can, therefore, be expected. However, this problem will be temporary in duration and minor in nature, since the excavation will result in a general lowering of the groundwater level across the site.

7. MISCELLANEOUS:

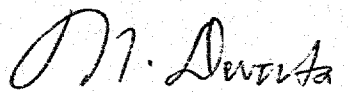
The field work was carried out between February 20 and February 28, 1973, under the supervision of Mr. V. Korlu, Project Foundations Engineer.

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

This report was prepared by Mr. C. S. Poon, Project Foundations Engineer, and reviewed by Mr. M. Devata, Supervising Foundations Engineer.


C. S. Poon, P. Eng.




M. Devata, P. Eng.

CSP/ao
April 19, 1973.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 72-11166

LOCATION Co-ords. 856,321 N; 957,867 E.

ORIGINATED BY WK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, Cone Test and BXL Rock Core

 CHECKED BY *OK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L	
602.3	Ground Level														
0.0	(Glacial Till)														
	Het. mix. of silty clay														
	some sand & gravel.		1	SS	8	600									25 16 39 20
	Brown														
	Stiff to Hard		2	SS	26	595									11 5 55 26
592.8			3	SS	133										594.3
9.5	Bedrock		4	RC BXL	92%	590									28 15 39 18
	Interbedded shale and limestone.		5	BXL	98%										
			6	BXL	100%	585									
	Dark Grey		7	BXL	92%	580									
	Sound		8	BXL	100%										
			9	BXL	97%	575									
571.9	End of Borehole					570									
30.4															

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 72-11166

LOCATION Co-ords. 856,244 N; 957,970 E.

ORIGINATED BY VE

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger and Cone Test

CHECKED BY *VE*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L	
603.8	Ground Level														
0.0	(Glacial Till) Het. mix. of silty clay with some sand and gravel.		1	SS	47	600									Hole dry at time of investigation
	Brown		2	SS	142/8"										14 10 51 25
595.2	Stiff to Hard		3	SS	100/11"										0 6 64 30
8.6	End of Borehole Probable Bedrock					595									

FOUNDATIONS OFFICE

JOB 72-11166

LOCATION Co-ords. 856,279 N; 957,756 E.

ORIGINATED BY VK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger and Cone Test.

CHECKED BY S

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

RECORD OF BOREHOLE NO 5

JOB 72-11166

LOCATION Co-ords. 856,230 N; 957,642 E.

ORIGINATED BY VK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, Cone Test & BXL Rock Core

CHECKED BY SK

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT	BLOWS / FOOT			WATER CONTENT %				
						20	40	60	80	100	W _p		
						SHEAR STRENGTH P.S.F.			PLASTIC LIMIT			Y	GR. SA. SI. CL.
						○ UNCONFINED + FIELD VANE			WATER CONTENT %				
						● QUICK TRIAXIAL × LAB VANE			10 20 30			P.C.F	
606.7	Ground Level												
0.0	Glacial Till	[Symbol]											
	Ret. mix. of clayey silt, some sand & gravel.												
600.7	Brown Stiff to Very Stiff		1	SS	23								
6.0	Bedrock	[Symbol]											
	Shale												
596.8	dark grey weathered		2	RC EXL	80%								
9.9	Interbedded shale and limestone		3	EXL	84%								
	Dark Grey		4	EXL	95%								
	Sound		5	EXL	93%								
			6	EXL	88%								
576.7	End of Borehole												
30.0													

20
15 ϕ 5 % STRAIN AT FAILURE
10

OFFICE REPORT • SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 6

JOB 72-11166

LOCATION Co-ords. 856,151 N; 957,719 E.

ORIGINATED BY VK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger and Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L	BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
607.8	Ground Level									
0.0	(Glacial Till)									
	Het. mix. of clayey silt, some sand and gravel.		1	SS	36					
	Brown									
600.2	Stiff to Hard		2	SS	151.0"					
7.6	End of Borehole Probable Bedrock									

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 7

JOB 72-11166

LOCATION Co-ords. 856,198 N; 957,556 E.

ORIGINATED BY VK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger and Cone Test

CHECKED BY *W*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
605.7	Ground Level									
0.0	(Glacial Till) Het. mix. of clayey silt, some sand and gravel. Brown Stiff to Hard		1	SS	32	605				Hole dry at time of investigati
598.2			2	SS	11.9	600				15 27 38 20 12 28 40 20
7.5	End of Borehole Probable Bedrock					595				

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 8

JOB 72-11166

LOCATION Co-ords. 856,119 N; 957,633 E.

ORIGINATED BY VK

W.P. 127-66-22

BORING DATE Feb. 20, 1973

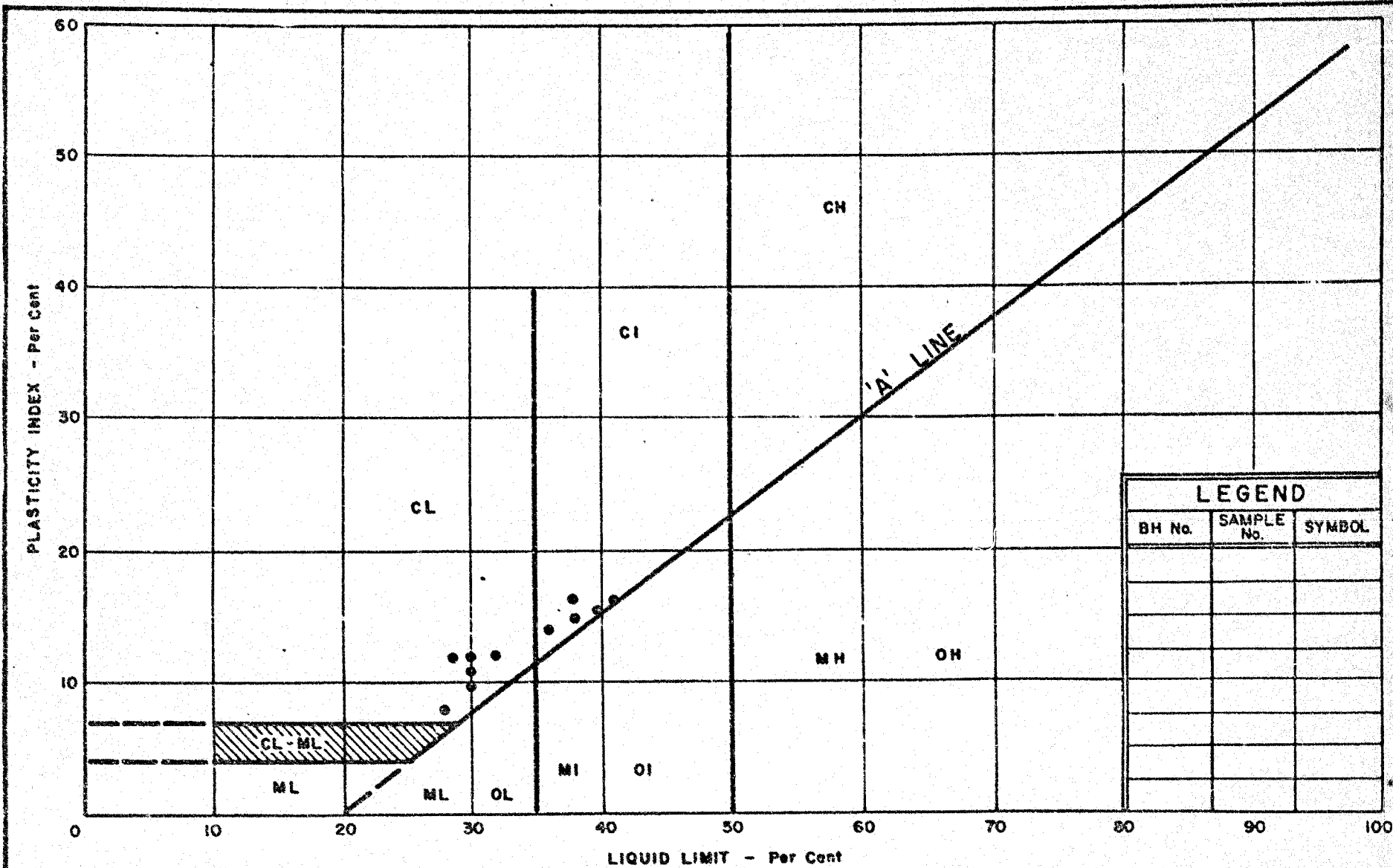
COMPILED BY DB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger, Cone Test & BXL Rock Core

CHECKED BY *DB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L		
606.1	Ground Level															
0.0	(Glacial Till) Het. mix. of clayey silt, some sand and gravel, (with cobbles below el. 603.)					605										
600.1	Brown. Stiff to Hard					600										
6.0	Bedrock - Shale															
596.9	Dark Grey		2	RC BXL	Rec. 100%											
9.2	Weathered															
	Bedrock		3	BXL	70%	595										
	Interbedded shale and limestone		4	BXL	90%	590										
	Dark Grey															
	Sound		5	BXL	100%	585										
			6	BXL	100%	580										
578.1																
28.0	End of Borehole					575										

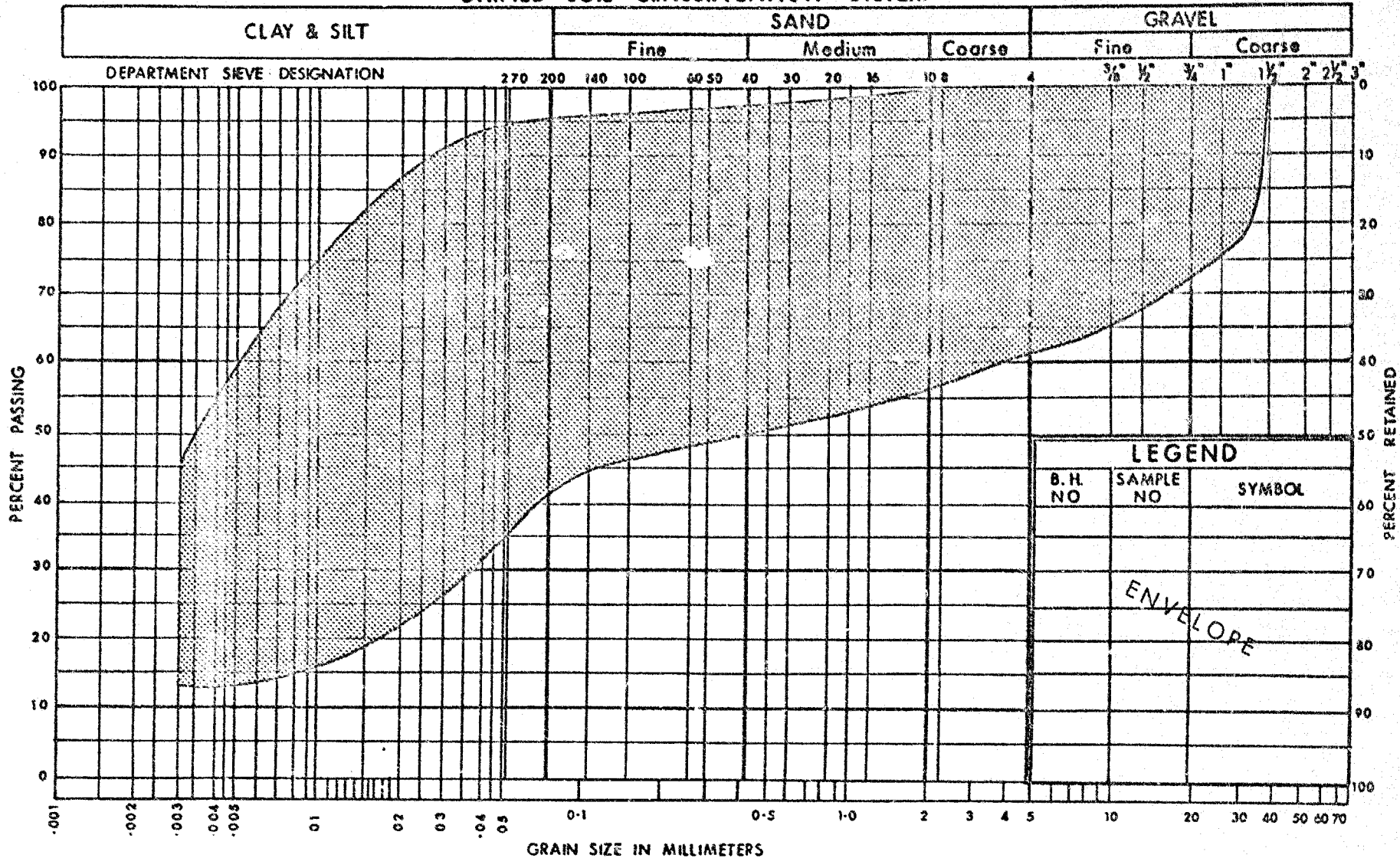


DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART
GLACIAL TILL
HET. MIX. OF CLAYEY SILT TO SILTY CLAY, SOME SAND & GRAVEL

WP No. 127 - 66 - 22
JOB No. 72 - 11166
FIG. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION

GLACIAL TILL

W.P. No. 127 - 66 - 22

JOB No. 72 - 11166

FIG. 2

Rev. Jan. 73

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" " ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

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

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

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

EARTH PRESSURE

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

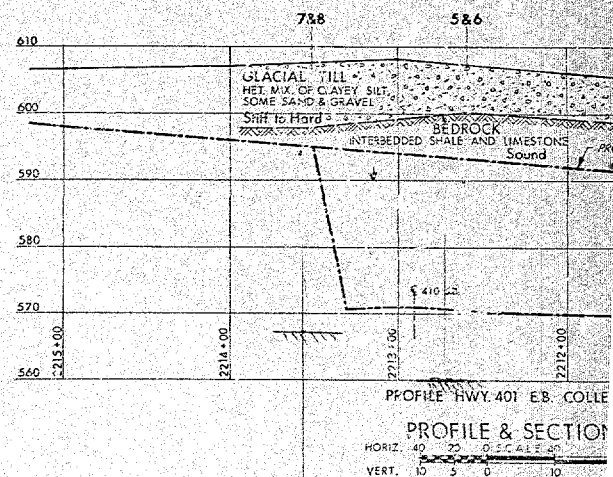
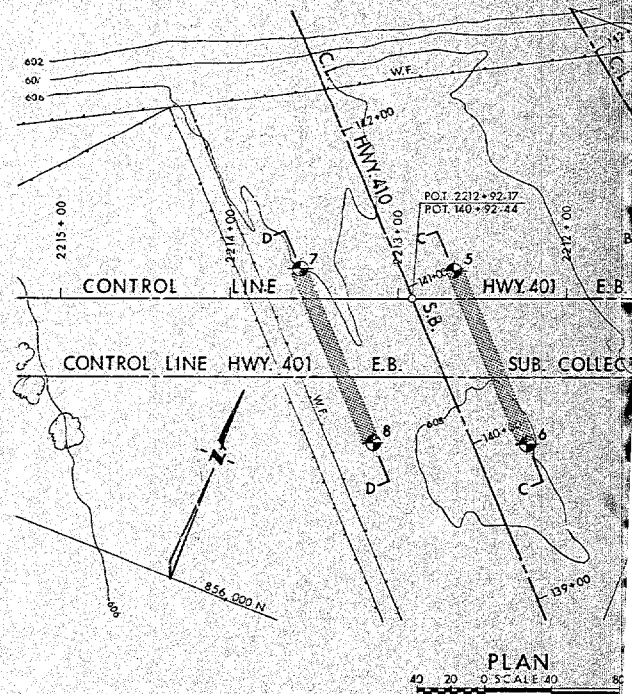
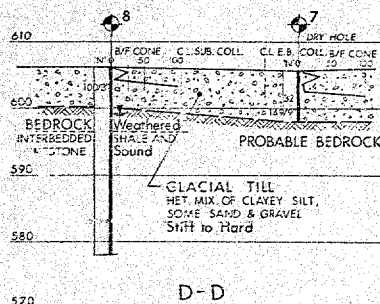
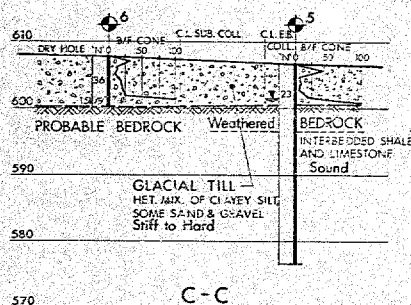
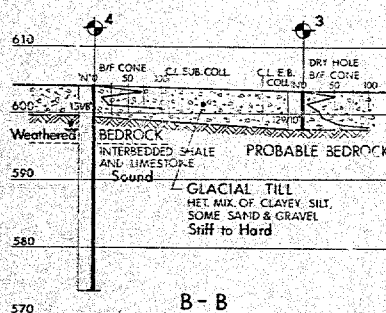
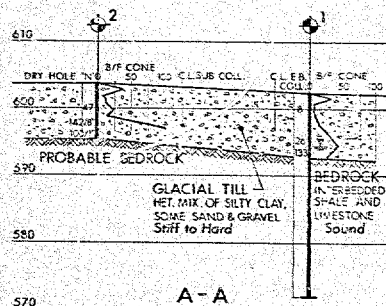
FOUNDATIONS

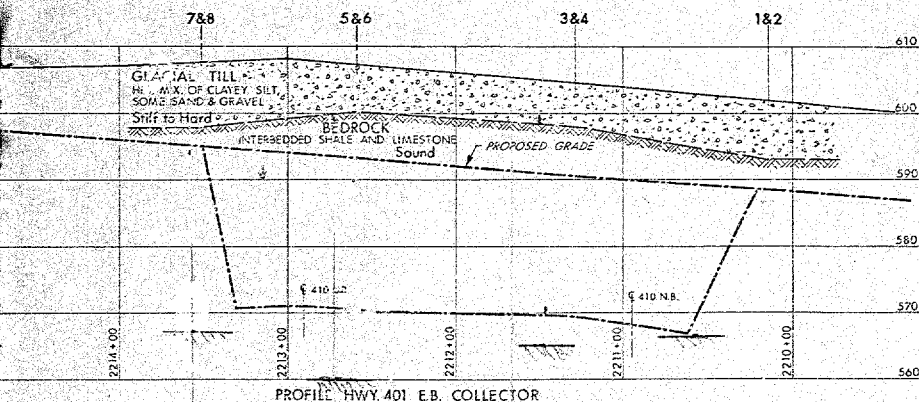
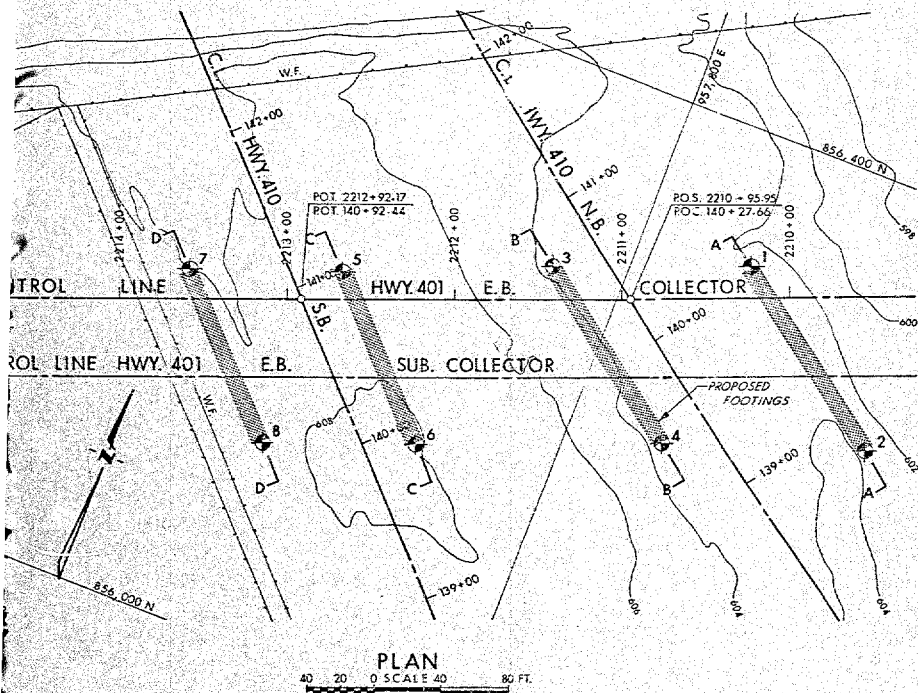
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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

APPENDIX II





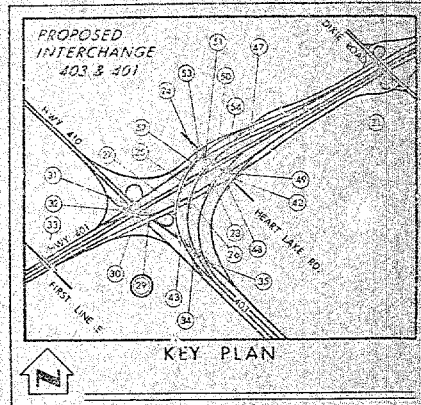
PROFILE & SECTIONS

HORIZ. 0 20 40 80 FT.

VERT. 10 5 0 10 20 FT.



REF No: Fencol No. 3923-K-6



LEGEND

- Bore Hole
- ⊕ Cone Penetration Test
- ⊕ Bore Hole & Ccne Test
- ⬆ Water Levels established at time of field investigation, Feb. 1973

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	602.3	856, 321	957, 867
2	603.8	855, 244	957, 970
3	603.2	856, 279	957, 758
4	604.1	856, 205	957, 855
5	605.7	856, 230	957, 642
6	607.8	856, 151	957, 719
7	605.7	856, 196	957, 556
8	606.1	856, 119	957, 633

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO
DESIGN SERVICES BRANCH - FOUNDATIONS OFFICE

BRIDGE No. 29

E.B. COLLECTOR & SUB. COLLECTOR OVER HWY 410

HIGHWAY NO. 401 DIST. NO. 6

CO. PEEL TOWN OF MISSISSAUGA CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. V.K. CHECKED	W.P. NO. 127-66-22	DRAWING NO.
DRAWN S.R. CHECKED F.	W.D. NO. 72-11166	72-11166 A
DATE APR 16, 1973	SITE NO.	BRIDGE DRAWING NO.
APPROVED: [Signature]	CONT. NO.	

MEMORANDUM

72-11166

TO: Mr. A. G. Stermac,
Principal Foundation Engineer,
West Building.

FROM: G. C. E. Burkhardt,
Structural Planning Office,
3501 Dufferin Street.

ATTENTION: Mr. M. Devata

DATE: February 12, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT: Hwy. 401 East Bound Collector
and Sub Collector Overpass over Highway 410,
Bridge #29,
Site 24-324, W.P. 127-66-22,
District 6, Toronto.

The above structure is a part of the Highway 401 - 403 interchange as covered by W.P. 127-66-01. The location of the structure is shown on the attached "Scheme of the Interchange".

You are kindly requested to prepare the Foundation Report for this structure. Attached are also two copies of "Fenco Drawing No. 3983-3K-6" on which the following information are shown:

- a) Proposed structural type of bridge and footing locations (marked in red, .
- b) Profiles of all intersecting roads.
- c) Co-ordinates of control points and road alignments.

Points 1, 2, 3 and 4, as marked in red on drawing have been staked out by Fenco.

Co-ordination of boreholes will be carried out on your request by District Forces under the supervision of Mr. I. Tremain - District 6.

According to the information available there are no buried utilities in this area.

The property is owned by our Ministry and the subject site can be entered along the hydro line from the south.

MAA:lc
Attach.

M. A. Almer, *M. A. Almer*
STRUCTURAL PLANNING ENGINEER,
for:
G. C. E. Burkhardt,
REG. STRUCTURAL PLANNING ENG.

C.C. W. Roters
J. Barclay
R. Fitzgibbon
J. Anderson

Design Services Branch,
1201 Wilson Avenue,
Downsview, Ontario,
M3W 1Y8

February 20, 1973.

Telephone: 248-3282.

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

Dear Sirs:

This letter confirms our request of February 16, 1973,
for the supply of a C.M.E. auger machine together with all
necessary equipment, as specified under the terms of our
Contract Agreement, at Hwy. 401 and Dixie Rd. on February 19,
1973.

Mobilisation will be from our previous job 72-11024.

Our Project Number is W.O. 72-11168. ⁶✓

Yours truly,

MD/ao

cc: W. W. Fry
(Attn: Mrs. M. Andrews)
Foundations Files
Documents

M. Devata
M. Devata,
Supervising Foundations Eng.,
For: A. G. Sternad,
Principal Foundations Eng.

Design Services Branch,
1201 Wilson Avenue,
Downsview, Ontario.
M3M 1J8

February 26, 1973.

Telephone: 248-3282.

Master Soil Investigation,
104 Kenhar Drive,
Woodbridge, Ontario.

Dear Sirs:

This letter confirms our request of February 16, 1973,
for the supply of a C.M.E. auger machine together with all
necessary equipment, as specified under the terms of our
Contract Agreement, at Hwy. 401 and Dixie Rd. on February 20,
1973.

Mobilization will be from the yard.

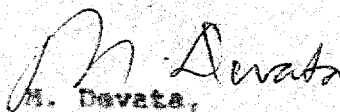
Our Project Numbers are W.O. 72-11166, 72-11168 &
72-11166.

Yours truly,

MD/ao

cc: W. W. Fry
(Attn: Mrs. M. Andrews)

Foundations Files
Documents


M. Devata,
Supervising Foundations Engineer,
For: A. G. Starnac,
Principal Foundations Engineer.

NOTE: Please disregard our letter dated February 20, 1973.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. M. Devata,
Sup. Foundation Engineer.

FROM: K. W. Ingham

ATTENTION:

DATE: April 16, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT: Foundation Investigation 72-11166
Hwy. 401 and Hwy. 410 Overpass

A brief description is given below for 4 boreholes drilled to bedrock at this site, together with the appropriate bedrock elevation.

Hole No. 1

Bedrock at 592.8

- 9.5 - 12.3 Limestone; light grey, fine grained, medium bedded, dip approx. 10° , thin shale seams between beds, open vertical fracture 11.5 - 12.3 ft.
- 12.3 - 13.8 Shale; dark grey, thin to platy bedded, minor thin limestone layers, occasional moderately weathered and fractured layers throughout.
- 13.8 - 14.8 Limestone; medium grey, fine grained, thin to medium bedded, thin shale seams between beds.
- 14.8 - 16.9 Shale; dark grey, thin bedded, minor thin limestone layers, moderately fractured in the upper 0.4 ft.
- 16.9 - 17.7 Limestone; dark grey, shaly.
- 17.7 - 21.9 Shale; dark grey, thin bedded, minor thin limestone layers, slightly weathered sections.
- 21.9 - 22.9 Limestone; medium grey, fine grained, thin to medium bedded, thin shale seams between beds.
- 22.9 - 24.2 Interbedded dark grey shale and light grey limestone, thin bedded, evidence of weathering along some bedding planes.

- 24.2 - 25.1 Limestone; medium grey, fine grained, slightly silty.
- 25.1 - 26.0 Shale; dark grey, thin bedded.
- 26.0 - 26.8 Limestone; medium grey, fine grained, thin bedded, thin shale layers between beds.
- 26.8 - 30.4 Shale; dark grey, thin to medium bedded, minor thin limestone layers.

Hole No. 4

Bedrock at 599.7

- 4.4 - 8.8 Limestone; light grey, fine grained, thin bedded, frequent thin interbeds of badly weathered shale, moderately fractured throughout.
- 8.8 - 10.4 Limestone; light grey, fine grained, thin to medium bedded, minor thin badly weathered shale layers between beds.
- 10.4 - 12.8 Limestone; medium grey, fine grained, thin bedded, silty, occasional thin layers of shale and shaly limestone, evidence of weathering along some bedding planes.
- 12.8 - 15.0 Shale; dark grey, thin to platy bedded, minor thin limestone layers, occasional moderately weathered sections.
- 15.0 - 18.3 Shale; dark grey, thin bedded, occasional thin limestone layers, prominent vertical fracture.
- 18.3 - 20.8 Limestone; medium grey, fine grained, thin to medium bedded, minor thin shale seams between beds.
- 20.8 - 24.2 Interbedded shale and limestone, thin bedded, evidence of weathering along some bedding planes.

- 24.2 - 24.9 Limestone; medium grey, fine grained,
thin to medium bedded, slightly silty.
- 24.9 - 25.9 Shale; dark grey, thin bedded.
- 25.9 - 26.5 Limestone; dark grey, thin to medium
bedded, shaly.
- 26.5 - 30.5 Shale; dark grey, thin to medium bedded,
minor thin layers of limestone and
shaly limestone.

Hole No. 5

Bedrock at 600.7

- 6.0 - 9.9 Limestone; light grey, fine grained,
thin to medium bedded, frequent thin
badly weathered layers of shale.
- 9.9 - 13.8 Interbedded dark grey shale and limestone;
thin bedded, moderately weathered through-
out, occasional badly weathered layers.
- 13.8 - 17.0 Limestone; medium grey, fine grained,
medium bedded, thin shale seams between
beds.
- 17.0 - 23.7 Shale; dark grey, thin to medium bedded,
minor thin limestone layers.
- 23.7 - 24.5 Limestone; dark grey, shaly.
- 24.5 - 26.8 Limestone; medium grey, thin to medium
bedded, occasional to frequent layers
of shale 0.1 to 0.2 ft. in thickness.
- 26.8 - 30.0 Shale; dark grey, thin to medium bedded,
occasional layers of limestone 0.1 to 0.2
ft. in thickness.

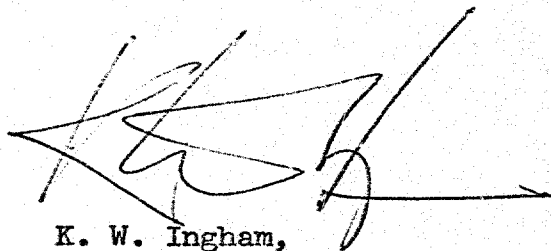
Hole No. 8

Bedrock at 600.1

- 6.0 - 9.2 Limestone; light grey, fine grained,
thin bedded, occasional badly weathered
layers of shale.
- 9.2 - 10.0 Interbedded dark grey shale and limestone;
thin bedded, moderately weathered throughout.

- 10.0 - 15.0 Limestone; thin to medium bedded, occasional thin moderately weathered shale layers.
- 15.0 - 17.5 Limestone; medium grey, fine grained, thin bedded, thin shale seams between beds.
- 17.5 - 19.0 Interbedded shale and limestone; thin bedded, occasional moderately weathered layers.
- 19.0 - 20.0 Limestone; medium grey, fine grained, thin to medium bedded.
- 20.0 - 25.0 Shale; dark grey, thin bedded, minor thin limestone layers, evidence of weathering along some bedding planes.
- 25.0 - 26.4 Limestone; medium grey, fine grained, minor thin shale layers.
- 26.4 - 28.0 Shale; dark grey, thin bedded, occasional limestone layers 0.1 to 0.2 ft. in thickness.

KWI:nr



K. W. Ingham,
Geologist.

Mr. G. Burkhardt
3501 Dufferin Street
Downsview, Ontario

Structural Office
West Bldg., Downsview

September 5th, 1973

F.R. Collector and Sub Collector over
Hwy. 410
Bridge #29
W.P. # 127-66-22, Site #24-324
Hwy. 401, District #6

72-11-166

Attached herewith are prints of the Preliminary Bridge
Plan Drawing D-24-324-P1 for the above-mentioned structure.

The estimated cost of the proposed structure is \$1,115,000
which includes tender, materials, engineering, and sundry construction.

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

C.S. Grebski,
Structural Design Engineer

CSG:AMF
Attached.

c.c. B.R. Davis
W.D. Birch
A.E. McKim
W. McFarlane
M. Stoyanoff
A. Stermac
J. Anderson
R. Fitzgibbon

No comments
M.D.
BAK



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. J. L. Latta
Geotechnical Office
Test Bldg.

FROM: Structural Office
Test Bldg.

ATTENTION:

DATE: APR. 21/78

OUR FILE REF.

IN REPLY TO

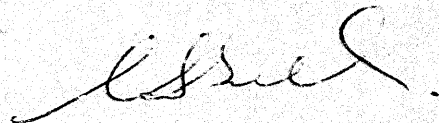
SUBJECT:

L.P. Collector & Sub collector
Over Hwy. 410
Hwy. 127-66-22, Site 24-324
Hwy. 401, District C

72-11-166

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.



C.S. Grebski
Structural Design Engineer.

CSC: WJ

Attached

c.c. Foundation Office.

for comments
M.A.
V.K.

Mr. D. Hopper
Manager
Contract Control Office

W.P. 12766-22
Soil Mechanics Section
Geotechnical Office

April 4, 1975

INFORMATION TO CONTRACTOR DURING PERIOD OF TENDER CALLING

This is to confirm the information given to you by telephone on March 26, 1975 that the following foundation reports were examined by Mr. Henry Shelegy, P. Eng., Division Manager of Kilmer Van Nostrand Co. Limited, at our office on March 25, 1974:

- 1) Bridge #51; Structure Site 24-314, W.P. 127-66-06, Dist. #6
- 2) Bridge #49; Structure Site 24-316, W.P. 127-66-08, Dist. #6
- 3) Bridge #31; Structure Site 24-323, W.P. 127-66-20, Dist. #6
- 4) Bridge #29; Structure Site 24-324, W.P. 127-66-22, Dist. #6.

H. DEYATA
Supervising Engineer.

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30112-25

DIST. 6 REGION CENTRAL

W.P. No. 127-66-22

CONT. No. 75-16

W. O. No. 72-11166

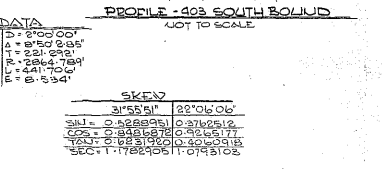
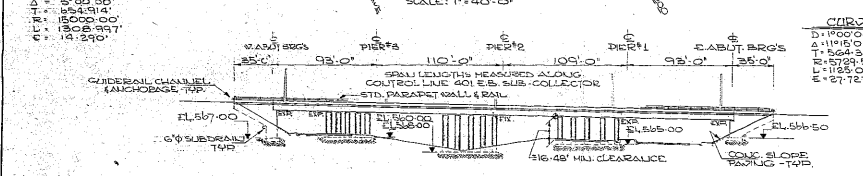
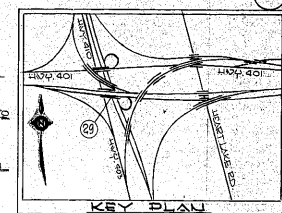
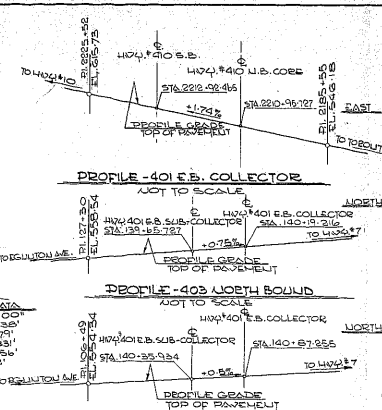
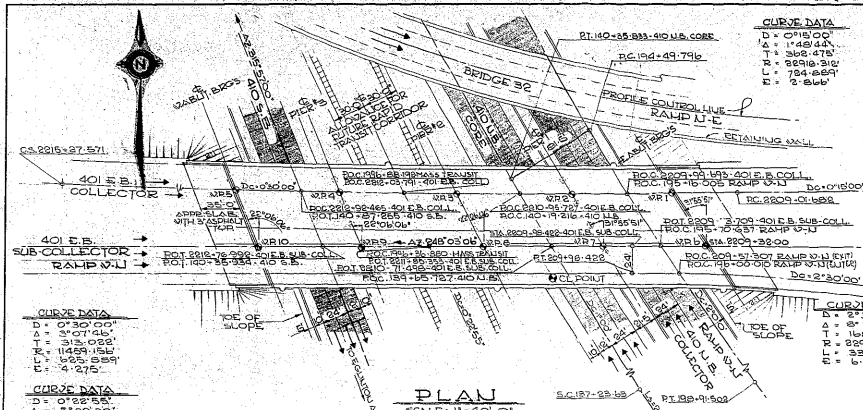
STR. SITE No. 24-324

HWY. No. 401

LOCATION COLLECTOR OVERPASS

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT 2

REMARKS Documents to be completed before
microfilmed



GENERAL NOTES

CLASS OF CONCRETE
 DECK, CURBS, PARAPET WALLS AND CULVERTS - 5000 PSI
 PIERS & APPROACH SLABS - 4000 PSI
 BEAMS - 5000 PSI

CLEAR COVER TO REINFORCING STEEL
 TOP OF SLABS - 3"
 PIER COLUMNS - 2"
 CURBS & APPROX. SLABS - 2"
 TOP OF DECK - 2", BOTTOM - 1 1/2" PARAPET WALLS - 1 1/2"

CONSTRUCTION NOTES
 • THE CONTRACTOR IS RESPONSIBLE FOR FURNISHING BEARING SEATS TO THE SPURTED SLABS WITH A TOLERANCE OF 1/8".
 • ALSO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, SPRESSED AND CURED.

30712-21
 24 APR 1974

B.M. TYPH 413 EL. 225.85
 TABLET ON S.W. CORNER OF CONCRETE CULVERT 88' LT. STA. 259+88.2 EXISTING L.W. 41.401

DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
 ONTARIO

401 COLLECTOR AND SUB-COLLECTOR OVER HWY 403 BRIDGE #29

KING'S HIGHWAY NO. 401
 CO. REEL 401
 TWP. MISSISSAUGA

CONTRACT NO. 107-5
 SHEET NO. 24-52A

GENERAL PLAN

APPROVED: [Signature]
 DRAWN: [Signature]
 DATE: [Date]

DATE: [Date]
 SHEET: 24-52A

DATE: [Date]
 SHEET: 24-52A

DATE: [Date]
 SHEET: 24-52A

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 SHEET: 24-52A

DATE: [Date]
 SHEET: 24-52A

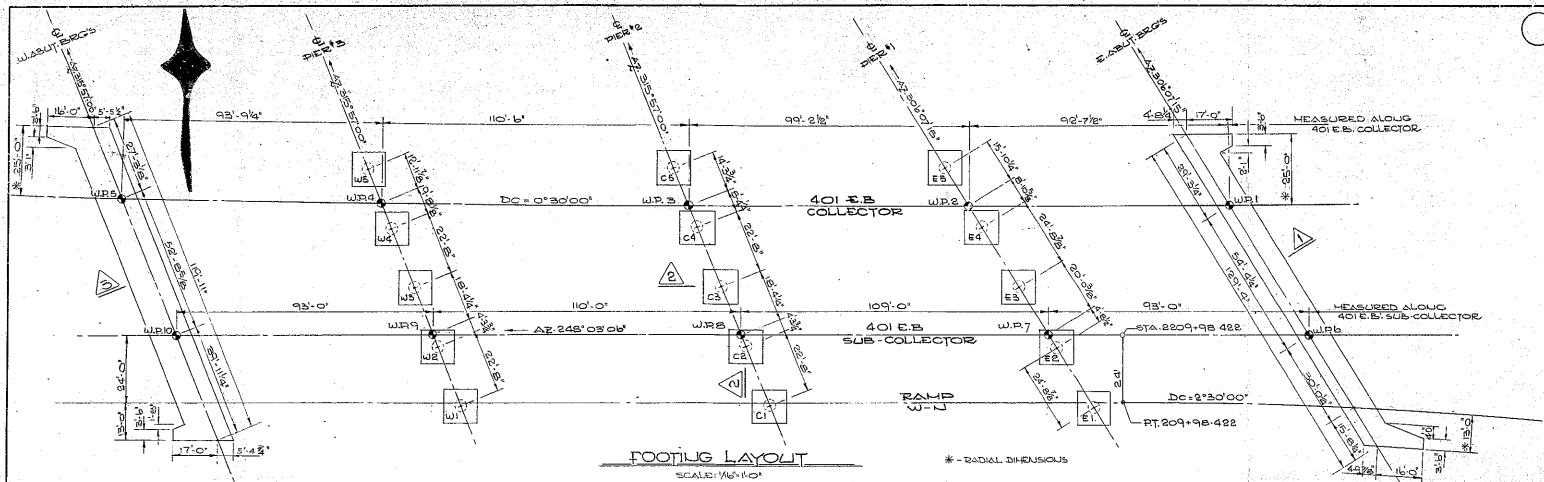
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 SHEET: 24-52A

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 SHEET: 24-52A

DATE: [Date]
 SHEET: 24-52A



FOOTING LAYOUT

SCALE: 1/4" = 1'-0"

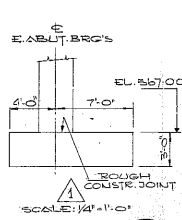
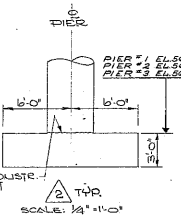
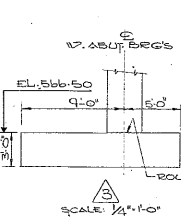
* - RADIAL DIMENSIONS

NOTE TO CONTRACTOR
TO PREVENT SOFTENING OF THE FOUNDATION
MATERIAL OF OR HARD SOIL SHALL BE PLACED
WITHIN THREE FEET OF EXPOSURE OF SHALE AT
THE BOTTOM OF FOOTING EXCAVATION.

PROVINCIAL CO-ORDINATES
OF CENTER POINT COLUMNS

W.P. PROVINCIAL CO-ORDINATES		
W.P. STATION	CO-ORDINATES	
1	2209+54.29	856222.79
2	2210+49.52	856221.62
3	2211+48.72	856224.73
4	2212+51.23	856214.57
5	2213+53.01	856151.57
6	2209+32.00	856224.73
7	2210+35.00	856234.91
8	2211+34.00	856215.25
9	2212+44.01	856172.13
10	2213+37.00	856143.37

POINT	STATION	CO-ORDINATES	
		NORTH	EAST
E1	2210+09.42	856222.63	957921.33
E2	2210+52.51	856227.21	957901.34
E3	2210+55.59	856271.50	957881.35
E4	2210+42.63	856260.31	957851.34
E5	2210+61.77	856300.77	957831.36
C1	2211+23.55	856193.56	957815.19
C2	2211+32.38	856161.15	957798.43
C3	2211+40.90	856232.44	957783.53
C4	2211+49.43	856248.73	957767.92
C5	2211+57.95	856255.02	957752.10
W1	2212+33.66	856155.74	957713.16
W2	2212+42.39	856175.03	957697.40
W3	2212+50.41	856191.32	957681.64
W4	2212+59.44	856207.61	957665.88
W5	2212+67.97	856223.90	957650.12



POINT	RECORD
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

30112-75
SHEET No.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

E.B. COLLECTOR AND SUB-COLLECTOR OVER HWY. 403
BRIDGE #29

KING'S HIGHWAY No. 401
CO. E.E.L.
TWP. 15N/55E/L. 6E LOT 15 CON. 11 E.

FOOTING LAYOUT

APPROVED: [Signature] PROJECT ENGINEER
DESIGNED: [Signature] CHECKED: [Signature]
DATE: 11/20/74 DRAWING: 2510-44 SITE No. 24-324 SHEET 3



FOR REDUCED PLAN

