DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M3-169

DIST. 4 REGION

W.P. No. 46-74-35

CONT. No. 82-33

W. O. No.

STR. SITE No. 18-268

HWY. No. 406

LOCATION St. Catharines

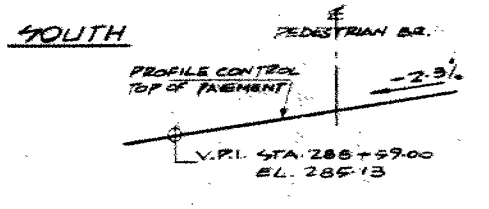
No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

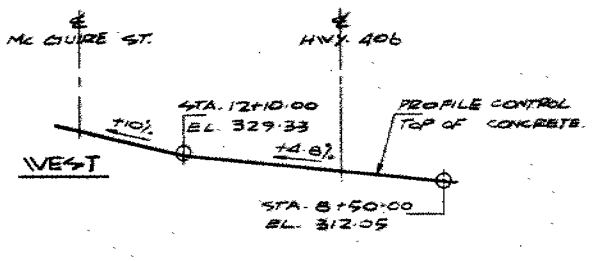
REMARKS:

DISTRICT 4
CONT No
WP No 45-74-35
SHEET

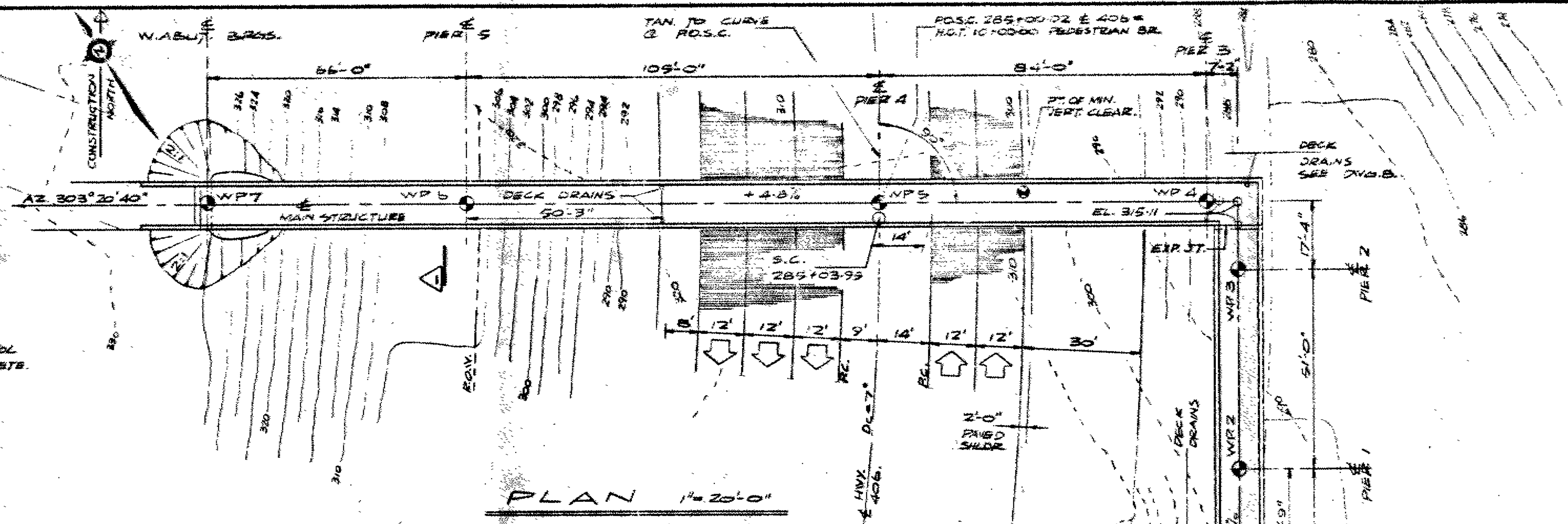
HWY. 406 PEDESTRIAN CROSSING UNDERPASS (approx. 850' east of the Burgoyne Bridge) GENERAL DRAWING

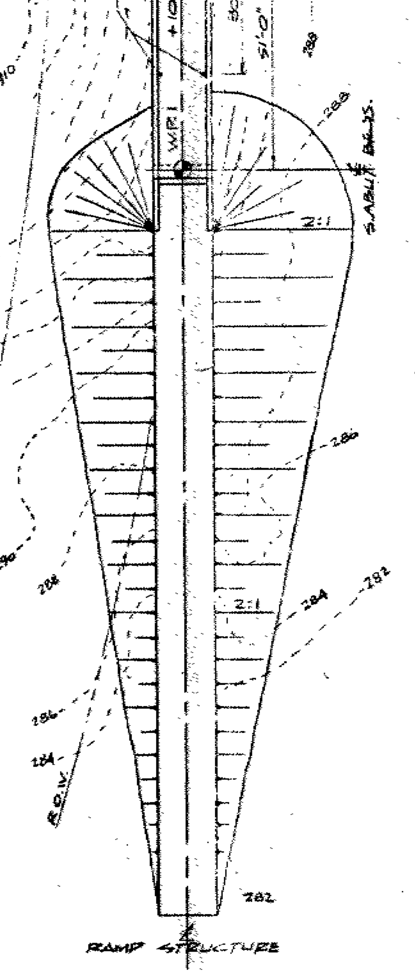


PROFILE HIGHWAY 406 n.t.s.

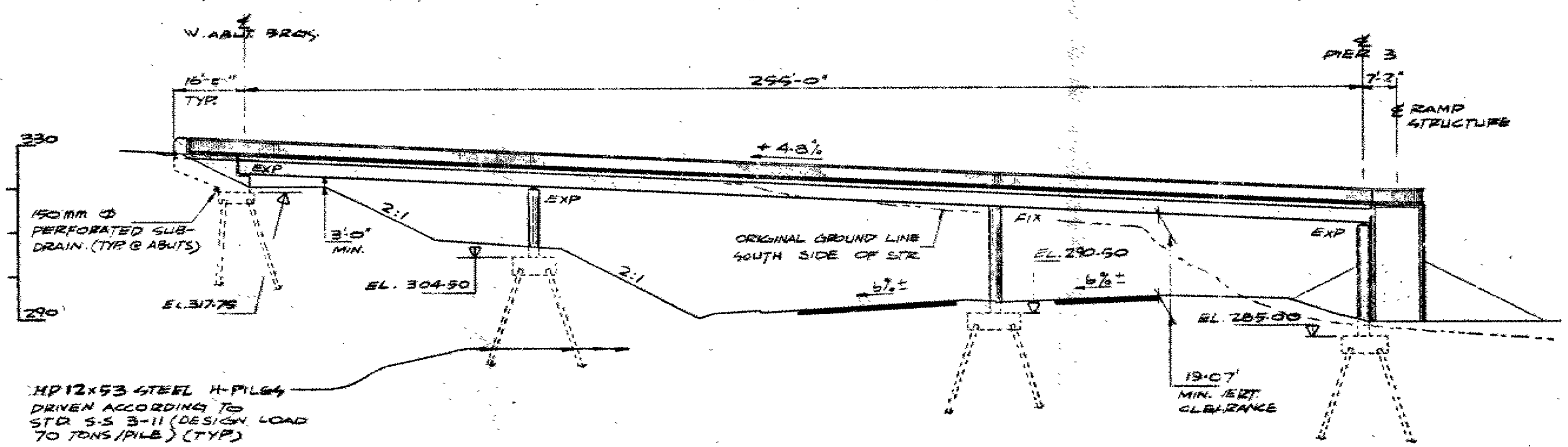


PROFILE PEDESTRIAN BRIDGE n.t.s.



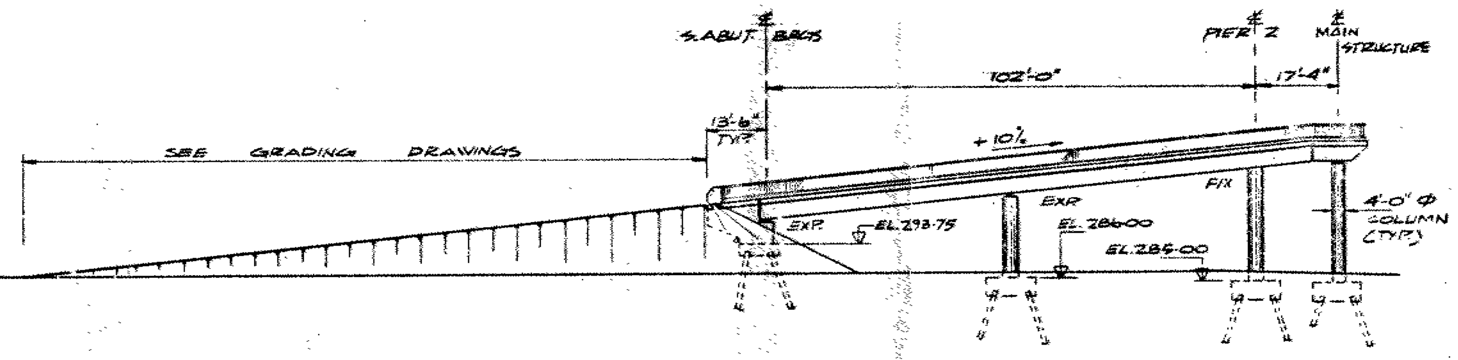


PLAN 1" = 20'-0"



FRONT ELEVATION 1" = 20'-0"

POINT	STATION	ELEVATION
WP 1	7 +89.50	303.90
WP 2	8 +40.50	309.00
WP 3	8 +91.50	314.10
WP 4	9 +16.00	315.22
WP 5	10 +00.00	319.25
WP 6	11 +05.00	324.29
WP 7	11 +71.00	327.46



SIDE ELEVATION 1" = 20'-0"

CONCRETE QUANTITIES

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

ABUTMENTS & WINGWALLS	-	49 C.Y.
PIERS	-	52 C.Y.
DECKS	-	503 C.Y.

GENERAL NOTES

CLASS OF CONCRETE

DECK & PIER COLUMNS.	- 35 MPa
ABUTMENTS & END POSTS.	- 30 MPa
PIER FOOTINGS.	- 25 MPa
ABUTMENT FOOTINGS.	- 20 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS & ABUTMENTS.	- 3"
PIER COLUMNS.	- 2½"
DECK TOP.	- 2½"
DECK BOTTOM.	- 2"

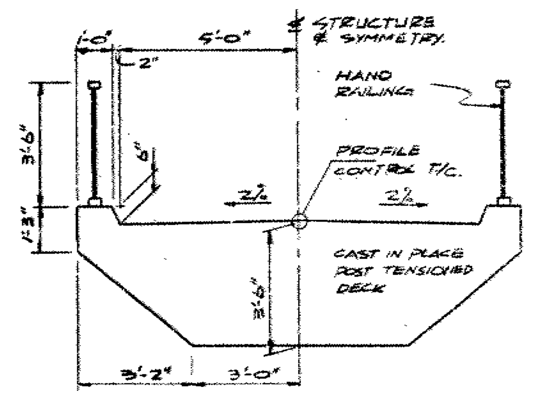
REINFORCING STEEL SHALL BE GRADE 400.
BAR MARKS WITH THE SUFFIX "C" SHALL BE COATED BARS.

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 1/8".

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

LIST OF DRAWINGS



3/8" = 1'-0"

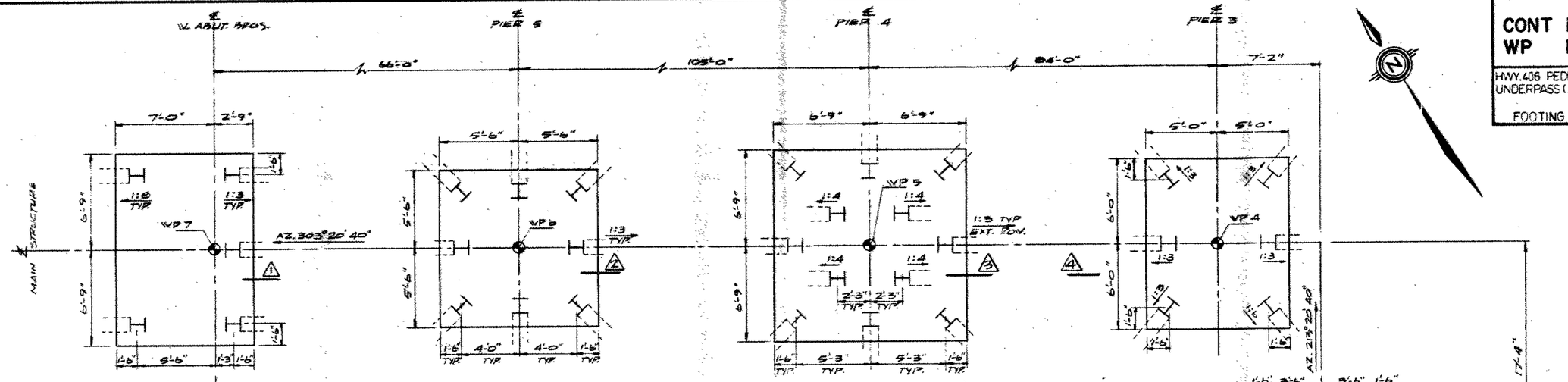
FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG

CONT No
WP No 46-74-35

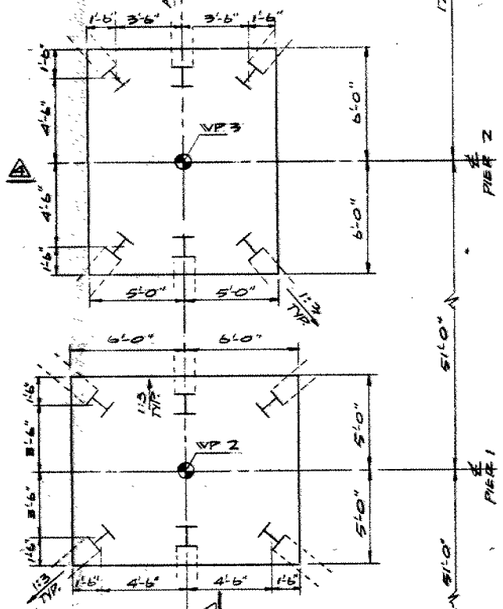
HWY.406 PEDESTRIAN CROSSING UNDERPASS (approx.650' east of the Burgoyne Bridge)
FOOTING LAYOUT

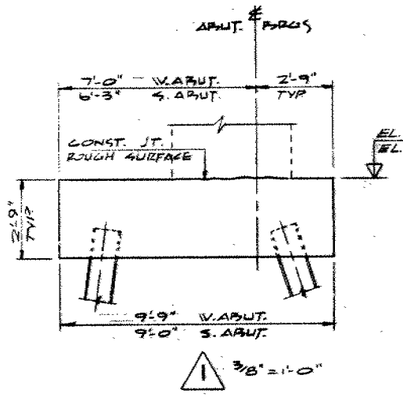
SHEET



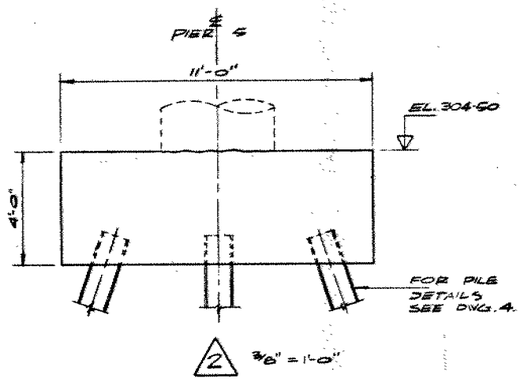
FOOTING LAYOUT

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



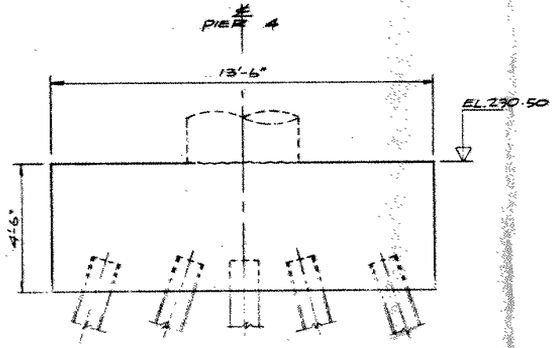


1 3/8" = 1'-0"

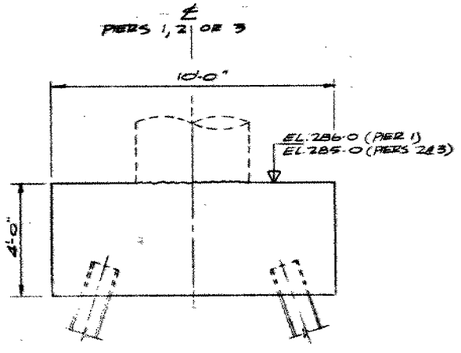


2 3/8" = 1'-0"

POINT CO-ORDINATES			
POINT	STATION	NORTH	EAST
WP 1	7+89.50	679655.30	68377.14
WP 2	8+40.50	679612.69	68349.11
WP 3	8+91.50	679570.09	68321.08
WP 4	9+16.50	679559.82	68306.14
WP 5	10+00.00	679605.72	68235.39
WP 6	11+05.00	679663.44	68147.87
WP 7	11+71.00	679599.71	68092.54



3 3/8" = 1'-0"

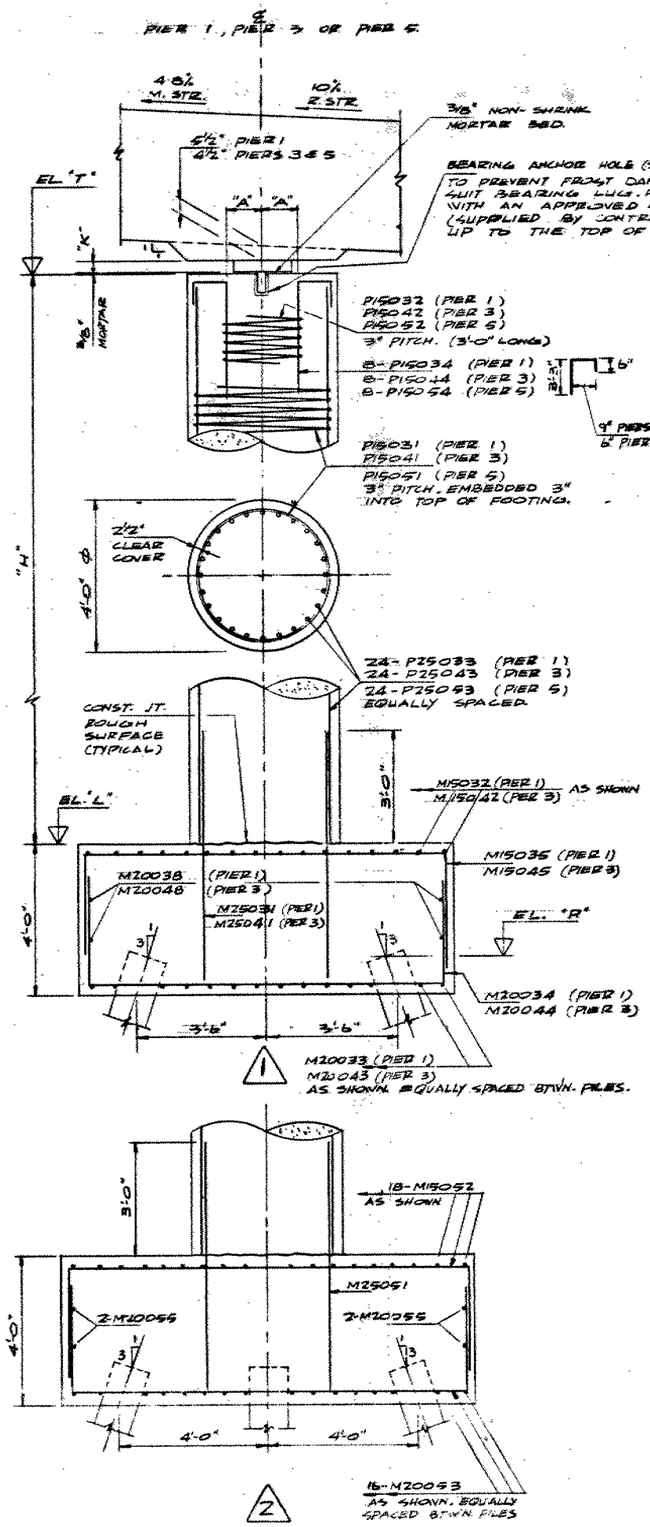


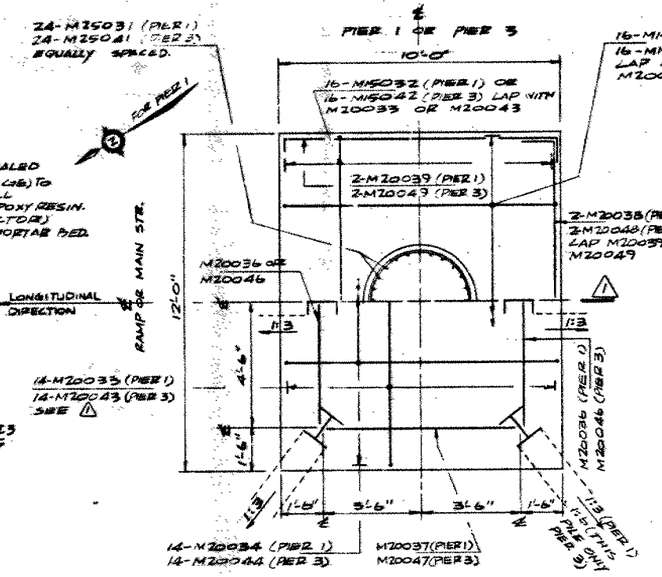
4 3/8" = 1'-0"

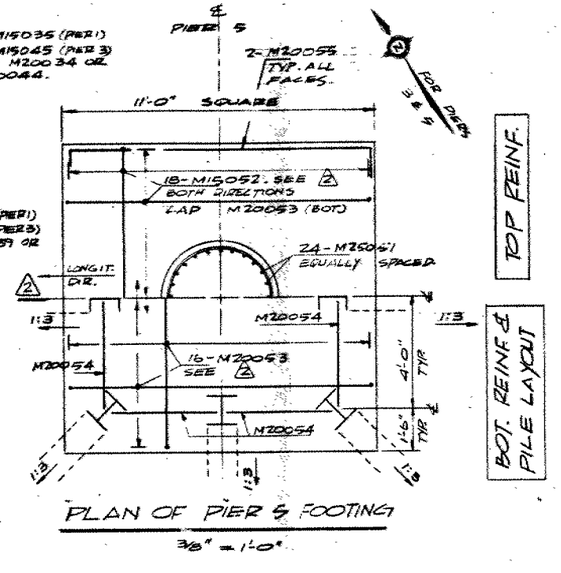
FOR REDUCED PLAN
USE SCALE BELOW
10 11 12 13
3 INCHES ON ORIGINAL PLAN

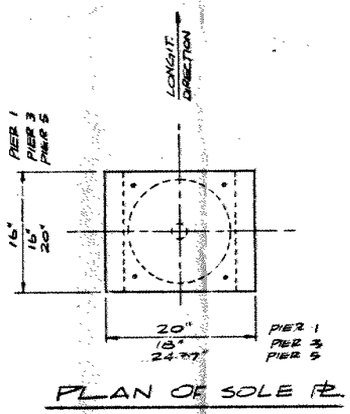
REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN		CHECK	LOADING
DRAWING		CHECK	SITE No

DATE
DWG









CONT No	
WP No	46-74-85

HWY 406 PEDESTRIAN CROSSING UNDERPASS (approx. 850' east of the Burgoyne Bridge)
PIERS 1 & 3 & 5 & BEARING DATA

SHEET

NOTES:

BEARINGS TO BE CONENCO ROTATIONAL TYPE, GUIDED EXPANSION STEEL POT BEARINGS, OR AN APPROVED EQUAL.

SHOULD AN APPROVED ALTERNATE BEARING BE USED WITH A THICKNESS "K" DIFFERENT FROM THE APPROPRIATE VALUE SHOWN ABOVE, THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CHANGES REQUIRED TO THE COLUMN REINFORCING STEEL. DRAWINGS SHOWING ALL PROPOSED CHANGES SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO ERECTION.

BEARING SETTING PROCEDURE:

PLACE A 3/8" MORTAR BED (USE NON-SHRINK, NON-STAINING MORTAR THROUGHOUT).

FILL ANCHOR HOLES WITH EPOXY.

PLACE BEARINGS DEAD LEVEL AS SHOWN. USE OF SHIMS IS PROHIBITED.

BEARINGS ARE TO BE PLACED SUCH THAT LONGITUDINAL MOVEMENT AS SHOWN IN THE TABLE TAKES PLACE PARALLEL TO THE ℄ PEDESTRIAN BRIDGE MAIN STRUCTURE OR RAMP STRUCTURE.

SCALE: ½" = 1'-0" UNLESS NOTED OTHERWISE.

BEARING DATA			
	PIER 1 RAMP STR.	PIER 3 MAIN STR	PIER 5 MAIN STR.
BEARING TYPE	SPF 200	SPF 150	SPF 300
BEARING CAPACITY	450 KIPS	338 KIPS	675 KIPS
NO. REQUIRED	1	1	1
LONGIT. MOV'T.	± ½"	± 1¼"	± 1¼"
DEAD LOAD	320 KIPS	275 KIPS	520 KIPS
MAX. LOAD	385 KIPS	324 KIPS	621 KIPS
THICK. "K"	3 7/8"	3 3/8"	4 1/8"

DIMENSIONAL DATA

ELEV. "T"	304.69	311.03	320.04
ELEV. "L"	286.00	285.00	304.50
DIM. "H"	18'-8¼"	26'-0 3/8"	15'-6½"
ELEV. "P"	283.00	282.00	301.50
DIM. "A"	1'-0"	1'-0"	1'-3"

HP12x53 PILE DATA			
LOCATION	No.	LENGTH	BATTER
PIER 1	6	51'-0"	1:3
PIER 2	6	50'-0"	1:3
PIER 3	4	50'-0"	1:3
	1	48'-0"	1:6
PIER 4	8	55'-0"	1:3
	4	54'-0"	1:4
PIER 5	8	70'-0"	1:3

NOTE:
PILE SPACING MEASURED AT UNDERSIDE OF FOOTING.

PILE LENGTH SHOWN ON THE DRAWINGS IS THE THEORETICAL LENGTH ABOVE PILE CUT-OFF.

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

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG 4

H.D.-1-10/5 3M0-8/78

777 96 00
643 2 00

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 46-74-35 DIST 4

HWY 406 STR SITE 18-268

Pedestrian Crossing Underpass
850 Ft. East of the Burgoine Bridge

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SAMPLE DISPOSITION NOTICE

TYPE	DISCARD AFTER	RECOMM. BY
JARS	77-07-30	LMS
TUBES	77-07-30	LMS
ROCK CORES	77-07-30	LMS

GEOCRES 30M3-169

DATE JUL 3 0 1979

FOUNDATION INVESTIGATION REPORT

For

Pedestrian Crossing Underpass
850 Feet East of the Burgoine Bridge
W.P. 46-74-35, Site 18-268
Hwy. 406, District 4, Hamilton

INTRODUCTION

This report provides recommendations for the design and construction of the above named structure. It is based on three sampled boreholes advanced on September 25 and 26, 1963; June 23 and 24, 1971; and February 5, 1979. These boreholes were originally part of preliminary investigations for line selection purposes or were part of investigations for other projects in the area.

SITE DESCRIPTION

The site is located in central St. Catharines approximately 800 feet southeast of the intersection of Ontario and St. Pauls Streets. It is on the side of a valley with overall slopes of three horizontal to one vertical but which has areas with local slopes much steeper. A stone lock and open channel located in the valley floor below remain from an early Welland Canal which followed this route. Parts of the valley slopes are covered with brush and occasional trees.

SUBSOIL

The upper layer of subsoil consists of clayey silt to silty clay which extends to elevation 245. Since the structure is located on a side hill this layer varies from 40 to 80 feet in thickness within the length of the structure.

A brown desiccated crust up to 25 feet in thickness has developed. Undrained shear strength in this crust varies from 2000 to 5000 psi. Beneath the crust the soil is grey with an undrained shear strength ranging from 1500 to 2500 psf.

The clayey silt to silty clay layer is underlain by silt to clayey silt containing some sand and a trace of gravel. Its glacial origin is reflected in its very dense to hard consistency with Standard Penetration 'N' values ranging from 35 to in excess of 100 blows per foot.

In the area bordering the open channel there is a deposit of organically contaminated clayey silt to silty clay. Its moisture content ranges from 25 to 35 percent and it has an undrained shear strength ranging from 800 to 2000 psf.

Reference should be made to the Record of Boreholes Sheets which are contained in the report Appendix. They show the boundaries between different soil types, as well as a summary of all field and laboratory tests performed. Reference should also be made to Drawing 467435-A which shows the location and elevation of the borings, as well as an inferred subsoil stratigraphy.

RECOMMENDATIONS

1. To insure the stability of the slope the geometry of the cut, including the 25 foot bench, must be maintained under the structure.
2. The structure should not be constructed for a minimum of six months following the excavation of the cut to allow the groundwater in the slope to stabilize.
3. The location of piers on the two horizontal to one vertical cut slopes should be avoided.
4. The northwest abutment footing should be placed so that its lower front edge is a minimum of 10 feet horizontally from the 2:1 cut slope.
5. The structure should be supported on steel H-piles or steel tube piles (minimum wall thickness ¼ inch) with a design loading of 70 tons per pile. Driving should be controlled by SS 3-11. It is estimated the required load will be achieved at approximate elevation 235. Consideration should be given to extending the pier piles to deck level to form a tressel structure. If it is desired that H-piles be encased in concrete for esthetic reasons, the encasement should be extended a minimum of six feet below grade.
6. The base of all footings should have a minimum of four feet of cover for frost protection purposes.

P.J. Stuart, P. Eng.
Project Engineer

K.G. Selby, P. Eng.
Supervising Engineer

July, 1979

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 15

W P 46-74-35 LOCATION Coords. N 15 679 748; E 1 068 355 ORIGINATED BY PJS

DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS

DATUM Geodetic DATE February 5, 1979 CHECKED BY GP.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
282.7	Ground Level					
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	9	
			2	SS	5	
270.7			3	SS	4	
12.0	Clayey Silt to Silty Clay Stiff		4	SS	13	
			5	SS	8	
			6	SS	7	
			7	SS	7	
			8	SS	5	
243.7						
39.0 / 241.2	Silt to Clayey Silt Hard (Glacial Till)		9	SS	36	
41.5	End of Borehole Note: Water Level Not Established					

ELEVATION SCALE: 280, 270, 260, 250

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH PSF
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT Wl
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 204

W P 46-74-35 LOCATION Coords. N 15 679 550; E 1 068 105 ORIGINATED BY K.N.

DIST 4 HWY 406 BOREHOLE TYPE Penndrill COMPILED BY A.K.B.

DATUM Geodetic DATE June 23-24, 1971 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)	γ PCF	GR SA SI CL
315.6	Ground Level							20 40 60 80 100 / 400 800 1200 1600 2000	20 40 60		
0.0	Clayey Silt to Silty Clay, Traces of Sand and Gravel		1	SS	21		310				
	Random Pockets of Sand		2	SS	38						
	Hard to Stiff		3	SS	37						
	Brown Becoming Grey		4	SS	36						
			5	SS	32		300				
			6	SS	31						6 26 49 19
			7	SS	13	▽ 291.8	290				
			8	TW	PH			+ s=3.1		122	
			9	TW	PM		280	+ s=2.1		122	
			10	SS	13			> + 2000			0 5 48 47
			11	TW	PM		270	+ s=2.7		129 / 130	
			12	SS	19						
			13	SS	26		260				
			14	SS	31						8 44 25 23
			15	SS	17		250				
245.6			16	TW	PH				OH		
70.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till)		17	SS	102					124	
			18	SS	118		240				
			19	SS	168						
235.6	Reddish Brown		20	SS	150/5"						4 21 61 14
80.0	End of Borehole										

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 308

W P 46-74-35 LOCATION Coords. N 15 679 590; E 1 068 190 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY M.W.
DATUM Geodetic DATE September 25-26, 1963 CHECKED BY RS

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 PSF (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
317.7	Ground Level										
0.0 / 315.2	Heterog. Fill Compr. of Chunks of Br.Sa.Si. Brick and Concrt. Fragments to 3 inch size										
2.5			1	SS	16						
			2	SS	21		310				
			3	SS	19						
	Silty Clay to Clayey Silt Trace of Sand and Gravel		4	TW	PH		300				
			5	SS	25						
	Stiff to Very Stiff		6	TW	PH			+s=2.3		120	
							290				
			7	SS	8	W.L. in standpipe 'A' @ elev. 285.8 Oct. 25/63		+ s=2.4			
			8	TW	PH					119	
						W.L.	280				
			9	SS	9	in standpipe 'B' @ elev. 273.8		+ s=2.6			
			10	TW	PH						
			11	SS	14		270				
			12	SS	18						
						268					
			13	SS	16		260				
			14	TW	PM						
			15	SS	11			+ s=2.8			
			16	SS	11		250				
245.7											
72.0			17	SS	96						
	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till) Reddish Brown		18	SS	87		240				
			19	SS	93						
227.7			20	SS	66	230	230				
90.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

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. $\overline{CIU}$ = 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 = $\frac{I_p \text{ of soil}}{\%\text{ of } 2\mu m \text{ Soil Fraction}}$
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

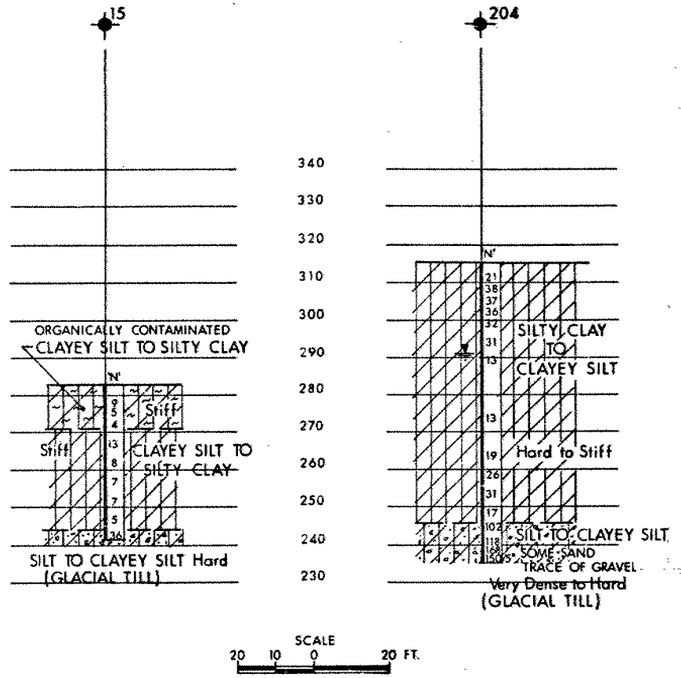
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION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

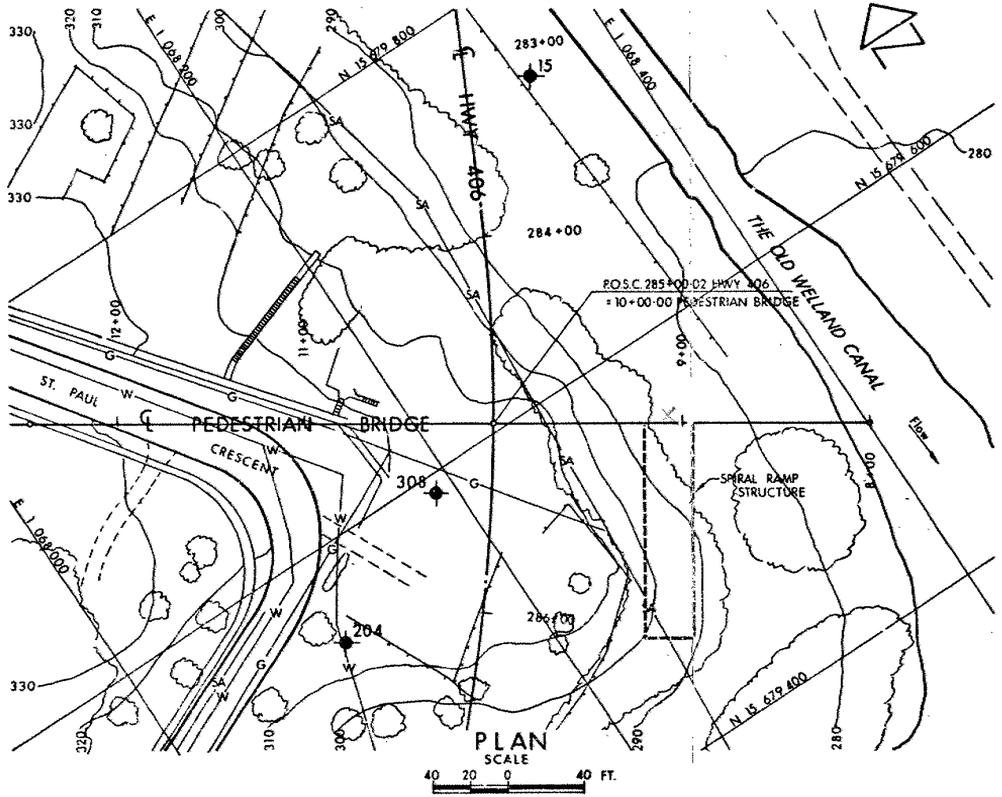
CONT No
WP No 46-74-35

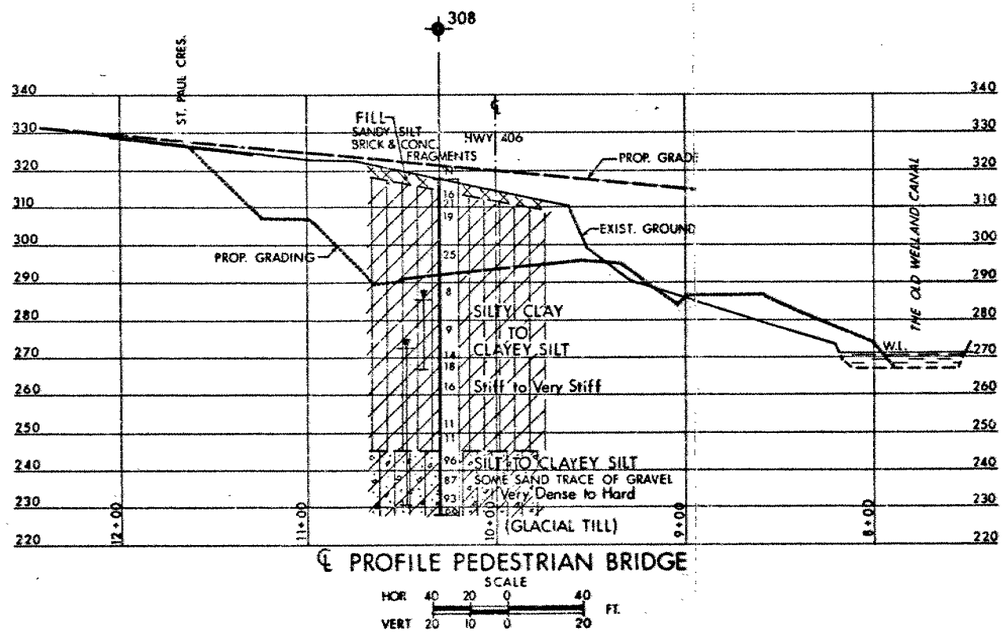
PEDESTRIAN BRIDGE
OVER HWY 406

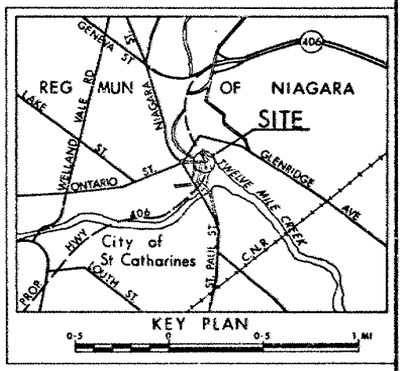
BORE HOLE LOCATIONS & SOIL STRATA

SHEET









LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L at time of investigation
  BH No 204 JUNE 1971
  BH No 308 OCT. 1963
  NO W.L established BH No 15
- WL IN STANDPIPE

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
15	282·7	15 679 748	1 068 355
204	315·6	15 679 550	1 068 105
308	317·7	15 679 590	1 068 190

-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	

GEOCRES NO 30M3-169

HWY No 406			DIST 4
SUBM'D P. S.	CHECKED	DATE 79 07 24	SITE 18-268
DRAWN O. J.	CHECKED	APPROVED	DWG 467435-A

memorandum

Ontario

To: Henry Guise
Project Supervisor
Contract 82-33
c/o R. McGoey
MTC District Office
Burlington, Ontario

Date: 83 06 07

From: Pavement & Foundation Design Section
Room 315
Central Building
Downsview, Ontario

Re: Slope Failure, Hwy 406, NBL
Contract 82-33
District 4, Hamilton

This will confirm recommendations given to you verbally by the writer on 83 05 27 with regard to the cut slope failure at approximate Stas. 308-309, Hwy 406 NBL on Contract 82-33.

The failure is confined to the portion of the slope below the line of a sanitary sewer which was installed prior to MTC grading operations. It is believed that groundwater which has collected within the granular bedding of the sewer has been seeping into the slope below and by the imposition of seepage forces and by softening the cohesive subsoil has caused the failure. The failure appears to be relatively shallow and has resulted in a depression about 2 m deep at the edge of the sewer line and a corresponding bulge in the lower portion of the slope adjacent to the shoulder of the road. It is recommended that repairs be effected after providing controlled drainage from the bedding of the sanitary sewer in the form of 1 m minimum depth french drains spaced 15 m apart across the failed area. 100 mm plastic perforated pipes should be placed in the french drains and these should discharge into the existing subdrain at the toe of the slope. The french drains should be 0.6 metres wide and be filled with Granular 'A'. Following installation of the french drains the slope may be regraded to its original configuration. All soft and wet soil and all topsoil in the failure zone should be discarded however, cohesive soil similar to the natural soil in the slope may be used as backfill provided that it can be compacted to 95 percent Standard Proctor Density. In regrading the failed area, excavation and backfilling should proceed more or less simultaneously from the bottom of the slope to the top so as not to create interim unstable conditions. It will be necessary to construct benches in the existing slope before placing the new fill.

K. G. Selby

K. G. Selby, P.Eng.
Senior Foundation Engineer

KGS:gm

cc: P. F. Weber
H. Chyc (attn. K. Newman)

Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin St., Downsview

Mr. M.D. Bendayan

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 06 28

Re: Pedestrian Crossing Underpass Located
850 Feet East of the Burgoine Bridge
W.P. 46-74-35, Site 18-268
Hwy. 406, District 4, Hamilton

The proposed pedestrian crossing is in an area where Hwy. 406 is cut into the valley slope. Subsoil in this area consists of a deep deposit of hard to stiff clayey silt to silty clay extending to approximate elevation 245. Below this elevation there is a hard deposit of silt to clayey silt of glacial origin. Local deposits of organically contaminated clayey silt up to 20 feet in thickness border the abandoned Welland Canal located at the toe of slope.

The following recommendations are made for the design and construction of the proposed structure.

1. The geometry of the cut including the 25 foot bench must be maintained under the structure.

2. The location of piers on the cut slope should be avoided.

3. The lower front edge of the northwest abutment footing should be located a minimum of 10 feet horizontally back of the cut slope.

4. The structure should not be constructed for a minimum of six months following the excavation of the cut in this area.

5. The structure should be supported on either steel H piles of steel tube piles (minimum wall thickness ¼ inch) with a design loading of 70 tons per pile. Driving should be controlled by SS 3-11. It is estimated the design load will be achieved by approximate elevation 235. Consideration should be given to extending the pier piles to deck level to form a tressel structure. In this case H piles could be encased in concrete to improve their esthetics.

cont'd.....

6. The base of all footings should have a minimum of four feet of cover for frost protection purposes.

P.J. Stuart
Project Engineer

PJS/gs

cc: J. Patkowski
R. Fitzgibbon
Files