



August 29, 2018

## FOUNDATION INVESTIGATION REPORT

### Highway 406 S - Geneva Street N/S Ramp Bridge, Structure Site 18-168 Highway 406 Structural Rehabilitation from Fourth Avenue to Westchester Avenue, St. Catharines, Ontario G.W.P. 2453-13-00

**Submitted to:**  
AECOM  
30 Leek Crescent  
Richmond Hill, ON  
L4B 4N4

REPORT



**GEOCRES:** 30M3-299

**Report Number:** 1541610-1

**Distribution:**

- 1 PDF + 3 Copies - MTO Central Region
- 1 PDF + 1 Copy - MTO Foundations Section
- 1 PDF - AECOM
- 1 PDF - Golder Associates Ltd.





## Table of Contents

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 PREVIOUS INVESTIGATION.....</b>	<b>2</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>3</b>
4.1 Regional Geology .....	3
4.2 Subsoil Conditions .....	3
4.2.1 Topsoil and Fill.....	4
4.2.2 Silty Clay to Clay Containing Organics to Organic Clay .....	4
4.2.3 Clayey Silt to Clay .....	5
4.2.4 Sandy Silt Till .....	6
4.2.5 Groundwater .....	6
<b>5.0 CLOSURE.....</b>	<b>7</b>

### DRAWINGS

Drawing 1 Borehole Locations and Soil Strata

### APPENDICES

#### APPENDIX A

GEOCRESS 30M3-43 Record of Borehole Sheets and

Drawing D-5147-2 Borehole Details

#### APPENDIX B

Drawing D-5147-2 General Plan

Drawing D-5147-3 Foundation Layout



## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the future rehabilitation of nine structures along Highway 406 from Fourth Avenue to Westchester Avenue in the City of St. Catharines, Ontario.

This report presents the geotechnical site conditions at the site of the existing Highway 406 S – Geneva Street N/S Ramp structure. It was developed with information from a foundation investigation completed in 1962 at the bridge site, reported as follows:

- **MTO GEOCREs No. 30M03-43:** *Highway #58 and Geneva Street, Access Ramp at Old Welland Canal, City of St. Catharines, Dist. #4, dated July 12, 1962.*
- **MTO GEOCREs No. 30M03-43:** *Additional Borings, Hwy. 406 and Geneva Street, Access Ramp at Old Welland Canal, City of St. Catharines, Dist. #4, W.P.126-58-1, W.J. 62-F-62, dated October 19, 1962.*

The Terms of Reference and Scope of Work for the foundation engineering services are outlined in MTO's Request for Proposal, dated September 2015 that form part of the Consultant's Agreement (Number 2014-E-0075) for this project. The Scope of Work for the Geneva Street N/S Ramp bridge foundation assessment is comprised of a Desktop Study as reported herein. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for this project, dated June 2016.

## 2.0 SITE DESCRIPTION

The Highway 406 S - Geneva Street (N-S) Ramp structure is located north of the Highway 406 underpass structure at Westchester Avenue and connects Highway 406 northbound vehicle traffic to Geneva Street, near downtown St. Catharines (see Key Plan on Drawing 1). The structure spans the broad gully that was part of the old second Welland Canal (now called the Canal Valley; adjacent to Twelve Mile Creek), of which the crest-to-crest width is about 210 m. The General Plan of the site available in GEOCREs 30M03-43 (Drawing D 5147-2, dated May 1963) show topographic contour lines indicating that the crest of the valley bank was about 8.3 m above the ground surface of the base of the valley. The General Plan drawing shows the location of the original Old Welland Canal and indicates that a culvert was constructed to the east of the Old Welland Canal. It is understood that old Welland Canal discharged to Twelve Mile Creek approximately 680 m to the west of the Ramp Bridge through a three-cell buried structural culvert that was constructed between Piers 1 and 2 of the Ramp Bridge. The General Plan further indicates that Old Welland Canal was filled-in to Elevation 87.5 m, and that in the vicinity of Pier 4 and between Pier 1 and the east abutment the "gravely clay fill, miscellaneous fill, ash and rubble fill" was to be subexcavated to "firm strata" and the subexcavation replaced with "select earth fill".

The existing Ramp structure is a five-span bridge that was constructed in about 1964, and has a total length of approximately 114 m. The current grade of the Ramp is at about Elevation 97 m near the east abutment and the rises to about Elevation 102 m at the west abutment.

Drawing No. D 5147-3 titled "Foundation Layout" indicates that the abutments and piers are supported on pile caps founded on 14BP73 steel H-piles (equivalent to HP360x108), driven into a till stratum underlying the silty clay deposit, to practical refusal as determined by the Hiley Formula (D.H.O. Std. BD 16-3,4).



## FOUNDATION REPORT - HWY 406 S - GENEVA STREET N/S RAMP BRIDGE, G.W.P. 2453-13-00 HIGHWAY 406, ST. CATHARINES ONTARIO.

Golder visited the site on December 2016, to perform a cursory observations of the structure from a foundations perspective. There were no obvious visual signs of foundation-related issues in terms of foundation and embankment instability or settlement at that time.

### 3.0 PREVIOUS INVESTIGATION

The foundation investigations for the GEOCRETS reports referenced in Section 1.0 were conducted between May and October, 1962. During this periods, a drill rig advanced a total of twenty one boreholes using wash-boring techniques, with the exception of Borehole 12 which is indicated as an “augerhole” on the borehole record. The boreholes were advanced to depths between about 2.3 m and 20.3 m below the ground surface. Boreholes 1 and 21 are both located at distant offsets to the south of the structure and are not relevant to the present desk top study nor shown on the Borehole Locations and Soil Strata Drawing.

The GEOCRETS foundation investigation report indicates that soil samples were obtained at 0.75 m to 3 m depth intervals using 50 mm outside diameter split-spoon samplers driven by manual hammers, in accordance with the Standard Penetration Test (SPT) procedure. In the soft to stiff cohesive deposit, thin-walled Shelby tube samples were also taken and in situ field vane testing was conducted to measure the undrained shear strength of the deposit. Dynamic Cone Penetration Testing (DCPT) was conducted from the ground surface in the immediate vicinity of Boreholes 1 to 4 and 6 to 11.

Observations of the water levels in the boreholes were recorded on some boreholes logs; however, piezometers were not installed in any of the boreholes.

Selected samples obtained from the boreholes were subjected to classification testing and the results are resented the Record of Borehole sheets in Appendix A.

The boreholes locations as provided on the Record of Borehole sheets in Station and Off-set were plotted on the General Arrangement Drawing No. R2-1, dated Nov. 2016, provided by MTO on January 31, 2017, and the borehole coordinates were interpreted from the coordinate system superimposed on the plan. The borehole locations in MTM NAD 83 (Zone 10) coordinates, ground surface elevations referenced to Geodetic datum and the drilled depths are as follows:

Borehole No.	MTM NAD83 Northing (m)	MTM NAD 83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m) DCPT Depth (m)
2	4,779,902.1	326,137.8	88.1	10.1 (9.4)
3	4,779,872.8	326,101.6	88.1	14.2 (9.1)
4	4,779,919.8	326,065.0	90.5	15.4 (9.0)
5	4,779,944.1	326,041.6	96.3	20.3
6	4,779,894.3	326,083.7	87.3	20.3 (10.5)
7	4,779,859.3	326,118.1	88.8	15.7 (11.1)
8	4,779,866.7	326,140.7	89.0	15.2 (8.8)
9	4,779,844.5	326,163.9	89.7	15.5 (8.6)
10	4,779,855.2	326,189.6	90.2	15.9 (4.9)
11	4,779,908.1	326,068.2	90.8	18.4 (7.9)
12	4,779,860.7	326,155.0	89.5	15.7





**FOUNDATION REPORT - HWY 406 S - GENEVA STREET N/S  
RAMP BRIDGE, G.W.P. 2453-13-00  
HIGHWAY 406, ST. CATHARINES ONTARIO.**

Borehole No.	MTM NAD83 Northing (m)	MTM NAD 83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m) DCPT Depth (m)
13	4,779,850.7	326,140.0	89.3	4.6
14	4,779,879.9	326,139.3	88.7	3.5
15	4,779,882.6	326,153.6	89.0	3.5
16	4,779,875.5	326,175.7	89.6	4.6
17	4,779,933.1	326,063.1	91.1	3.5
18	4,779,899.4	326,050.5	89.0	5.5
19	4,779,905.9	326,032.6	90.2	14.8
20	4,779,922.9	326,033.8	91.4	2.3

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

This section of Highway 406 is located within the Iroquois Plains physiographic region, as delineated in the *Physiography of Southern Ontario* (Chapman and Putnam, 1984)<sup>1</sup>. The Iroquois Plain extends around the western shores of Lake Ontario. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession. This site is bound to the north by shoreline beach deposits from Glacial lake Iroquois such as the Homer Bar on which downtown St Catharines is located, and the Niagara Escarpment located some 3 km to the south.

Surficial soil in this area of the Iroquois Plain is typically comprised of silty and clayey till of the Halton Till sheet according to the *Quaternary Geology of the Niagara-Welland Area* (Ontario Geological Survey Map 2496; Feenstra, 1984)<sup>2</sup>. The Halton Till sheet is underlain by an older red sandy and silty till, possibly the Wentworth Till sheet (OGS Preliminary Map 764, Feenstra, 1972)<sup>3</sup>. Shallow depressions on the surface of the clay plain upslope of the Homer Bar are infilled with bog sediments while fill materials comprised of earth and rock fill associated with the canal construction occur in the vicinity of the former Welland Canal (OGS Preliminary Map 764, Feenstra 1972)<sup>3</sup>.

### 4.2 Subsoil Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes in the vicinity of and pertinent to the Highway 406 S - Geneva Street (N/S) Ramp bridge structure (i.e. Boreholes 2 to 20, inclusive) and the results of in situ and geotechnical laboratory testing, where available from both of the 1962 reports, are given on the Record of Borehole sheets contained in Appendix A, following the text of this report. In the discussion below, the depth below ground surface is referenced to the ground surface on the borehole logs at the time of the investigation in 1962 and is not referenced to current ground surface.

<sup>1</sup> Chapman, L.J. and Putnam, D. F. 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

<sup>2</sup> Feenstra, B.H. 1984. Quaternary Geology of the Niagara-Welland Area. Ontario Geological Survey, Map 2496, Quaternary Geology Series. Scale 1:50,000

<sup>3</sup> Feenstra, B.H. 1972. Quaternary Geology of the Niagara Area, Southern Ontario. Ontario Division of Mines, Preliminary Map P.764, Geological Survey. Scale 1:50,000



#### **4.2.1 Topsoil and Fill**

Fill was encountered at ground surface in all boreholes with the exception of Boreholes 5 and 20, which were located near the crest of the valley slope near the west abutment. Topsoil was encountered in Borehole 20 at ground surface and it extends to a depth of 0.3 m below ground surface.

The thicknesses of the fill ranges between about 0.6 and 3.4 m, and the deposit extends between about Elevations 90.5 m and 85.0 m.

The fill material is generally cohesive and is described as consisting of sand, clay and gravel, containing ash and/or organic matter. Layers of rubble and refuse were encountered in places, generally as the bottom layer of the fill deposit.

Standard Penetration Test (SPT) "N"-values in the fill deposit are variable, ranging between about 1 blow and 22 blows per 0.3 m of penetration, suggesting a soft to stiff consistency. One SPT "N"-value of 56 blows per 0.3 m of penetration measured in the fill material may be indicative of the split-spoon bouncing on rubble.

Atterberg limits tests were carried out on three (3) samples of the fill material, and measured plastic limits between about 17 per cent and 32 per cent, liquid limits between about 33 per cent and 60 per cent, and corresponding plasticity indices between about 16 per cent and 28 per cent. These test results indicates that this material a portion of the deposit is clayey silt of low plasticity and a portion of the deposit is clay of high plasticity.

The reported measured bulk weight of the fill material is about 16 kN/m<sup>3</sup>. The water content of the fill material ranges from about 22 per cent to 60 per cent. The organic content measured on a sample of the fill is 106 per cent.

#### **4.2.2 Silty Clay to Clay Containing Organics to Organic Clay**

Underlying the fill, a deposit of silty clay to clay containing organic matter described in places as organic clay was encountered in Boreholes 2, 3, 7, 8, 11 to 16 and 19) at depths between 2.3 m and 3.4 m below ground surface (between Elevations 87.9 m and 85.0 m) and extends to depths between 3.2 m and 5.5 m below ground surface (between Elevations 85.8 m and 83.2 m). The thickness of the silty clay to clay containing organics to organic clay ranges from about 0.3 m to 2.1 m.

The SPT "N"-values measured within the organic deposit range from 0 to 14 blows per 0.3 m of penetration. In situ field vane tests carried out within the deposit measured undrained shear strength ranging from 13 kPa to 77 kPa, with sensitivities ranging from 1.7 to 11.2. These field vane test results, together with the SPT "N"-values, indicate that the silty clay to clay containing organics to organic clay deposit has a soft to stiff consistency.

Atterberg limits tests were carried out on eight (8) samples of the silty clay to clay containing organics portion of the deposit, and measured plastic limits between about 22 per cent and 30 per cent, liquid limits between about 42 per cent and 58 per cent, and plasticity indices between about 17 per cent and 30 per cent. These test results indicate that this material is a silty clay of medium plasticity to clay of high plasticity, in places containing organic matters that classifies the material as organic silt of low to high plasticity.

The reported bulk weight of the silty clay to clay containing organics deposit ranges from about 16 kN/m<sup>3</sup> to 19 kN/m<sup>3</sup>. The water content of the silty clay to clay containing organics deposit ranges from about 25 per cent to 62 per cent.



### **4.2.3 Clayey Silt to Clay**

A deposit of clayey silt to clay was encountered at ground surface in Borehole 5 and underlying the fill or silty clay with organics in all of the remaining boreholes advanced for this site at depths ranging between about 0.6 m and 5.5 m below ground surface (between about Elevations 96.3 m and 84.8 m), and extends to between about Elevations 76.7 m and 69.2 m, where fully penetrated. The silty clay contains occasional seams of silt to silty sand, particularly in boreholes advanced near the valley floor. The deposit as shown in the Records of Borehole sheets is considered to be comprising of two layers / zones: an upper crust of higher consistency; and a lower layer of somewhat lower consistency, as described below.

#### ***Upper Crust – Cohesive Deposit***

The upper crust of the cohesive deposit extends to between about Elevations 88.7 m to 82.3 m suggesting the thickness of the crust varies between 1.6 m at Borehole 4 and 7.6 m at Borehole 5. The measured SPT “N”-values of the upper crust range between 10 blows and 42 blows per 0.3 m of penetration. In situ field vane tests carried out within the upper crust of the cohesive deposit measured undrained shear strength ranging from 53 kPa to 143 kPa, with sensitivities ranging from 1.7 to 11.2. The field vane test results together with the SPT “N”-values indicate that the upper weathered crust of the cohesive deposit has a stiff to hard consistency.

Atterberg limits tests were carried out on ten (10) samples of the upper crust, and measured plastic limits between about 19 per cent and 23 per cent, liquid limits between about 42 per cent and 58 per cent and plasticity indices between about 23 per cent and 32 per cent. These test results indicate that this material is predominantly a silty clay of medium plasticity to clay of high plasticity. One Atterberg limits test result of a sample from Borehole 4 measured a plastic limit of about 12 per cent, a liquid limit of about 20 per cent and plasticity index of about 8 per cent, indicating that the portion of the deposit at Borehole 4 is classified as a clayey silt of low plasticity.

The reported bulk weight of the upper crust portion of the cohesive deposit ranges from about 17.7 kN/m<sup>3</sup> to 20.4 kN/m<sup>3</sup>. The water content of the clayey silt to silty clay deposit ranges from about 22 per cent to 32 per cent. The organic content measured on two samples of the upper crust is 0.4 per cent and 3.8 per cent.

#### ***Lower Layer - Cohesive Deposit***

Underlying the upper crust, the cohesive deposit exhibits less plasticity and is described as a clayey silt to clay. The measured SPT “N”-values range between 0 blows in Borehole 14 to 16 blows per 0.3 m of penetration. In situ field vane tests carried out within this lower portion of the cohesive deposit measured undrained shear strengths ranging from about 19 kPa to 143 kPa and sensitivities ranging from 1.3 to 10. The field vane test results together with the SPT “N”-values indicates that the lower layer of the cohesive deposit has a soft to very stiff consistency.

Atterberg limits tests were carried out on fifty two (52) samples of the lower layer of the cohesive deposit, and measured plastic limits between about 15 per cent and 22 per cent, liquid limits between about 20 per cent and 58 per cent, and plasticity indices between about 6 per cent and 36 per cent. These test results indicate that this material is predominantly a silty clay of medium plasticity to clay of high plasticity; however, the test results from two samples (from Borehole 3 and 11) indicate that the material would be classified as a clayey silt of low plasticity.

The reported bulk weight of the clayey silt to clay deposit ranges from about 16.8 kN/m<sup>3</sup> to 22.3 kN/m<sup>3</sup>. The water content of the clayey silt to clay deposit ranges from about 12 per cent to 38 per cent. The organic content measured on two samples of the silty clay portion of the cohesive deposit is 0.7 per cent and 2.3 per cent.



#### **4.2.4 Sandy Silt Till**

A till deposit described as reddish brown sandy silt or silt was encountered underlying the clayey silt to clay deposit in Boreholes 3 to 12 and 19 at depths of between about 12.8 m and 19.8 m below ground surface (between about Elevations of 76.7 m and 69.2 m). These boreholes terminated within the till deposit at depths between about 14.2 m and 20.3 m below ground surface (between about Elevation 76 m and 67.1 m). The till deposit was penetrated for depths between about 0.2 m and 2.6 m.

The measured SPT “N”-values measured in the till deposit range from about 22 blows to 159 blows per 0.3 m of penetration, suggesting that the till deposit has a compact to very dense relative density.

Atterberg limits test were carried out on one sample of the till deposit from Borehole 5, and measured a plastic limit of about 16 per cent, a liquid limit of about 23 per cent and plasticity index of about 7 per cent. This test result indicates that the fines component of this deposit is classified as a clayey silt of low plasticity to silt of slight plasticity.

It is noted that in the Foundation Investigation Report for Highway 406 underpass at Westchester Avenue, located approximately 200 m to the south, the soil deposit encountered at about the elevation at which the sandy silt till deposit was encountered at the Geneva St. Ramp Bridge site was re-classified as a sandy clayey silt till based on grain size distribution analysis and Atterberg limits testing that was carried out on five (5) samples. It is likely that the sandy silt till deposit encountered in the boreholes at the Geneva Street Ramp Bridge site represents the same deposit and could be classified as a sandy clayey silt; however, only one Atterberg limit test was carried out at the Geneva Street Ramp Bridge site and therefore the soil description for this site is based on the information provided on the Record of Borehole sheets from the 1962 investigation.

The reported bulk weight of one sample of the till is about 21 kN/m<sup>3</sup> and the water content of that sample of the deposit is 15 per cent. The water content measured on two other samples of the sandy silt till deposit is 9 per cent and 10 per cent.

#### **4.2.5 Groundwater**

The 1962 foundation investigation indicates that groundwater was encountered in Boreholes 2, 3, 4 and 7 to 16 at depths between about 0.9 m and 3.5 m below the ground surface (between about Elevations 88.4 m and 86.0 m); and Boreholes 17, 18 and 20 are indicated as dry upon completion of drilling. There was no indication that a piezometer was installed in these boreholes, although the borehole location plan from the 1962 foundation investigation indicates that four boreholes were designated as a “piezometer hole”. The groundwater elevations noted in the 1962 report are inferred to represent the water level immediately after drilling with wash boring techniques and therefore do not represent stabilized levels.

The groundwater level is expected to fluctuate seasonally and to be higher during wet periods of the year.



**FOUNDATION DESIGN REPORT - HWY 406 S - GENEVA STREET  
N/S RAMP BRIDGE, G.W.P. 2453-13-00  
HIGHWAY 406, ST. CATHARINES ONTARIO.**

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Sandra McGaghran, M.Eng., P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng, a MTO Foundations Designated Contact and a Senior Consultant of Golder, conducted an independent technical and quality control review of this report.

**GOLDER ASSOCIATES LTD.**



Sandra McGaghran, M.Eng., P.Eng.  
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P.Eng.  
MTO Foundations Designated Contact, Senior Consultant

SMM/JMAC/rb

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

[https://golderassociates.sharepoint.com/sites/19544g/2000 foundation/5 - reports/1 - geneva st ramp desktop/final/1541610 - fidr geneva street bridge- 2018aug30.docx](https://golderassociates.sharepoint.com/sites/19544g/2000%20foundation/5%20-%20reports/1%20-%20geneva%20st%20ramp%20desktop/final/1541610%20-%20fidr%20geneva%20street%20bridge-2018aug30.docx)



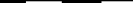


SHEET



HORIZONTAL & VERTICAL SCALE

10 0 10m

A horizontal scale bar with alternating black and white segments. It is labeled with '10' at the left end, '0' in the middle, and '10m' at the right end.

No.	ELEVATION	BOREHOLE CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
12	89.5	4 779 860.7	326 155.0
13	89.3	4 779 850.7	326 141.3
14	88.7	4 779 879.9	326 139.3
15	89.0	4 779 882.6	326 153.6
16	89.6	4 779 875.5	326 175.7
17	91.1	4 779 933.1	326 063.1
18	90.5	4 779 899.4	326 050.5
19	90.2	4 779 905.9	326 032.6
20	91.44	4 779 922.9	326 033.8

No.	ELEVATION	BOREHOLE CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
12	89.5	4 779 860.7	326 155.0
13	89.3	4 779 850.7	326 141.3
14	88.7	4 779 879.9	326 139.3
15	89.0	4 779 882.6	326 153.6
16	89.6	4 779 875.5	326 175.7
17	91.1	4 779 933.1	326 063.1
18	90.5	4 779 899.4	326 050.5
19	90.2	4 779 905.9	326 032.6
20	91.44	4 779 922.9	326 033.8

NO.	DATE	BY	REVISION		
Geocres No. 30M3-299					
Hwy.	HIGHWAY 406		PROJECT NO. 1541610		DIST. Central
SUBW'D.	SMM	CHKD. SMM	DATE: Mar 3/17		SITE: 18-168
DRAWN:	DCH	CHKD. SMM	APPD. JMAC		DWG. 1





# **APPENDIX A**

## **GEOCRE 30M3-43 Record of Borehole Sheets and Drawing D-5147-2 Borehole Details**

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

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

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

### DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKE 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		
	F.H.	SAMPLE ADVANCED HYDRAULICALLY	
	P.M.	SAMPLE ADVANCED MANUALLY	

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

## ABBREVIATIONS USED IN THIS REPORT

### SOIL PROPERTIES

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

IN TERMS OF  
EFFECTIVE STRESS  
 $\tau_f = c' + \sigma' \tan \phi'$

IN TERMS OF  
TOTAL STRESS  
 $\tau_f = c_u + \sigma \tan \phi$

### GENERAL

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

### STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

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

### FOUNDATIONS

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

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

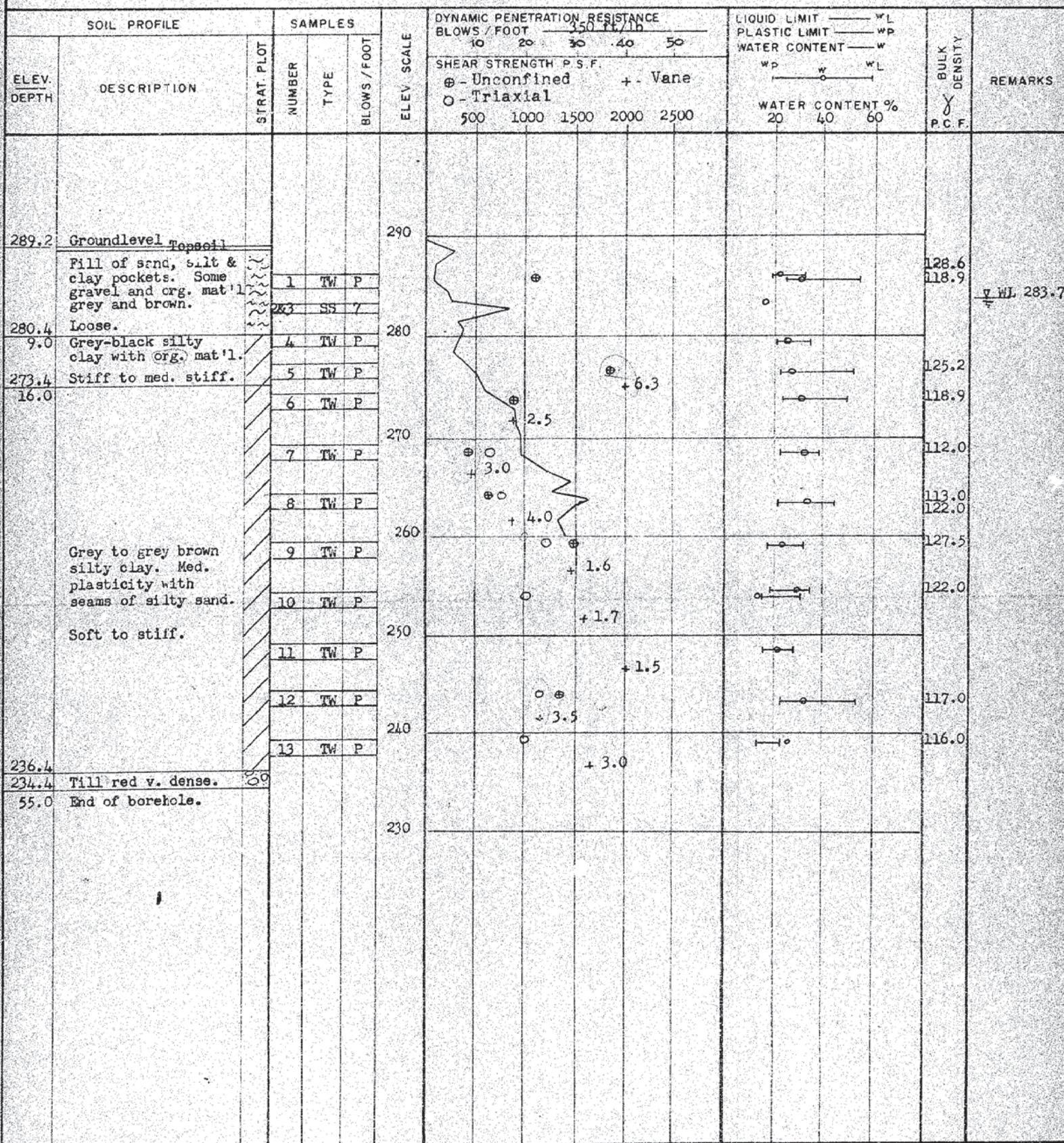


DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 262+35 (143' Lt.) ORIGINATED BY B.K.  
W P 126-58(-1) BORING DATE May 3, 1962. COMPILED BY B.K.  
DATUM Geodetic BOREHOLE TYPE Washboring. CHECKED BY M.D.





FOUNDATION SECTION

CHECKED BY M.D.

[illegible]



















DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 260+79 (48' Lt.) ORIGINATED BY B.K.  
W. P. 126-58-1 BORING DATE June 21, 1962. COMPILED BY B.K.  
DATUM 291.3' BOREHOLE TYPE Washboring. CHECKED BY M.D.

[illegible]







FOUNDATION SECTION

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ⊕ - Unconfined    + - Vane ○ - Triaxial			WATER CONTENT % 20    40    60			
294.3	Groundlevel												
0.0	Fill Ashes, sand, gravel and clay, Very loose.		1	SS	2	290							
288.3			2	TW	P			+ 3.0				113.0	wl 286.3
6.0			3	TW	P								
	Brown to grey-brown silty clay with occasional silt seams.		4	SS	26	280						125.0	3.8% organic content
			5	TW	P			+ 3.5				122.0	0.4% org. content.
	Very stiff to med. stiff.		6	TW	P	270							
			7	TW	P			+ 2.6				131.0	
			8	TW	P	260		+ 2.5				129.0	
			9	TW	P			+ 3.2				118.0	
			10	TW	P	250		+ 2.0					
245.3													
49.0													
243.3	Fill Very dense.		11	SS	159								
51.0	End of borehole.					240							







FOUNDATION SECTION

ORIGINATED BY G.C.

COMPILED BY            G.C.

CHECKED BY M.D.

Lost.



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO

12

FOUNDATION SECTION

JOB 62-F-62

LOCATION Sta. 259 + 70 (10' Lt.)

ORIGINATED BY \* JP

W.P. BORING DATE 27th Sept. and 1st Oct. 1962

COMPILED BY MC

DATUM BOREHOLE TYPE Augerhole

CHECKED BY JP

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ⊕ - Unconfined Field vane test +					WATER CONTENT %			
293.5	Ground level						1000	2000	3000	4000	5000				
0.0	Grey-brown gravelly clay fill														
288.0			1	SS	21	290									
4.5	Rubble fill (ash, clay, gravel sand, organics)		2	SS	14	285									
283.2			3	SS	2										
10.3	Soft black organic clay		4	SS	2										
281.5							+ 3.0								
12.0			5	TW	p	280									
			6	SS	2		+ 2.0								
	grey		7	SS	9	275									
23.0			8	TW	p	270									
			9	SS	6		+ 2.0								
168.5							+ 1.3								
27.0			10	SS	6	265									
	grey with traces of red						+ 2.2								
	Clay		11	TW	p	260									
	silty		12	SS	11										
							+ 1.7								
40.0			13	SS	6										
							+ 2.2								
43.0															
	very silty, many silt seams														
	grey with red seams (varved)		14	SS	9										
	Reddish brown (silt till)		15a			245									
242.5			15b	SS	92										



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 13

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 260 + 00 (50' Lt.) ORIGINATED BY \* JP  
W.P.                      BORING DATE Oct. 1, 1962 COMPILED BY MC  
DATUM                      BOREHOLE TYPE Augerhole CHECKED BY JP

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT _____ WL PLASTIC LIMIT _____ WP WATER CONTENT _____ W _____ WP _____ WL WATER CONTENT %			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.						
293.0	Ground level												
0.0													
	Gravelly clay fill					290							
289.0													
4.0													
	Rubble fill (ash, clay, gravel, sand, organics)		1	SS	6	285							
283.5													
9.5	Organics												
281.7			2	SS	2								
11.3	Soft black organic clay					280							
280.5													
12.5	Soft grey clay												
278.0													
15.0	End of borehole												



DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH DIVISION		RECORD OF BOREHOLE NO. 14		FOUNDATION SECTION	
JOB 62-P-62	LOCATION Sta. 260 + 40 (30' Rt.)	ORIGINATED BY JP			
W.P.	BORING DATE 2nd Oct. 1962	COMPILED BY MC			
DATUM	BOREHOLE TYPE Augerhole	CHECKED BY JP			

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.			WATER CONTENT % WP — W — WL			
291.0 0.0	Ground level												
	Gravelly clay fill, trace of organics					290							
285.5 5.5	Rubble fill (ash, clay, gravel, sand, organics)		1	SS	5	285							285.2 5.8 5/10/62
283.0 8.0	Soft black organic clay												
280.5 10.5	Soft grey clay		2	SS	0	280							
279.5 11.5	End of borehole												



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

JOB 62-F-62

LOCATION Sta. 260 + 00 (50' Rt.)

ORIGINATED BY \* JP

W.P.

BORING DATE 1st October 1962

COMPILED BY MC

DATUM

BOREHOLE TYPE Augerhole

CHECKED BY JP

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.				WP	WL		
292.0	Ground level													
0.0	Miscellaneous fill (clay, gravel, sand, ash, organics) Loose		1	SS	4	290								
283.5						285								
8.5	Soft black organic clay													
281.2														
280.8	Soft grey clay		2	SS	0	280								
11.5	End of borehole													

307  
283  
24

285.7  
6.3  
1/10/62



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 259 + 25 (50' Rt.) ORIGINATED BY \* JP  
 W.P.                      BORING DATE 1st Oct. 1962 COMPILED BY MC  
 DATUM                      BOREHOLE TYPE Augerhole CHECKED BY JP

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT ——— W <sub>L</sub> PLASTIC LIMIT ——— W <sub>P</sub> WATER CONTENT ——— W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.			W <sub>P</sub> ——— W <sub>L</sub> WATER CONTENT %			
294.0	Ground level												
0.0													
	Gravelly clay fill, some organics					290							
288.5			1	SS	13								
5.5	Rubble fill, (clay, gravel, sand, ash, organics)					285							
	Loose		2	SS	4								
282.7													
11.3	Soft black organic clay												
281.0													
13.0	Soft grey clay					280							
279.0													
15.0	End of borehole												

<

286.7  
7.3  
1/10/62



FOUNDATION SECTION

CHECKED BY JP

\* Compiled by Dominion Soil Investigation Limited. Ref: 2-9-L6



DEPARTMENT OF HIGHWAYS - ONTARIO  
 MATERIALS & RESEARCH DIVISION

# RECORD OF BOREHOLE NO. 18

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 263 + 25 (35' Lt.) ORIGINATED BY \* JP  
 W.P.                      BORING DATE 3rd Oct. 1962 COMPILED BY MC  
 DATUM                      BOREHOLE TYPE See remarks CHECKED BY JP

SOIL PROFILE			SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT <u>WL</u>		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT <u>WP</u>	WATER CONTENT <u>W</u>		
297.0	Ground level										
0.0	Fill										
2.0	gravelly										
			1	SS	11						0 - 5'0" - wash bore
			2	SS	20						5'0" - 18'0" - auger
	Stiff Silty Clay with traces of organics - Brown to Grey-Brown.		3	SS	33						297.0 3.0
			4	SS	19						5/10/62 (apparently rain water)
279.0											Open and dry
18.0	End of borehole										3/10/62



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

LOCATION Sta. 263 + 75 (60' Lt.)

ORIGINATED BY \* JP

W P \_\_\_\_\_ BORING DATE 2nd and 3rd Oct. 1902

COMPILED BY \_\_\_\_\_ MC

DATUM \_\_\_\_\_ BOREHOLE TYPE See remarks

CHECKED BY JP

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	WATER CONTENT %		
296.0 0.0	Ground level								0 - 35' 0" auger
291.5 4.5	Sandy gravelly clay fill								35' 0" - 48' 6" washbore
288.5 7.5	Ash		1	SS	1	290			290.0 6.0 5/10/62
281.5 14.5	Layers of brown and black organic clay Soft		2	SS	0	285			
			3	TW	p	280			
			4	SS	10				
			5	SS	11				
	Reddish-brown clay, stiff to very stiff		6	TW	p	270			
			7	SS	11				
			8	TW	p	265			
			9	TW	p	260			
			10	SS	16				
			11	SS	9				
251.5 44.5	Reddish-brown sandy silt till		12	TW	p	250			
247.5 48.5	End of borehole		13	SS	23				
			14	SS	10				



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

# RECORD OF BOREHOLE NO. 20

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 264 + 15 (25' Lt.) ORIGINATED BY \* JP  
W.P.                      BORING DATE 4 October 1962 COMPILED BY MC  
DATUM                      BOREHOLE TYPE Augerhole CHECKED BY JP

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$ $w_p$ ——— $w$ ——— $w_L$ WATER CONTENT %			BULK DENSITY  P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.							
300.0	Ground level													
299.0	Organic clayey topsoil													Open and dry 5/10/62
1.0														
	Stiff brown clay													
							295							
292.8			1	SS 20										
7.5	End of borehole													



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

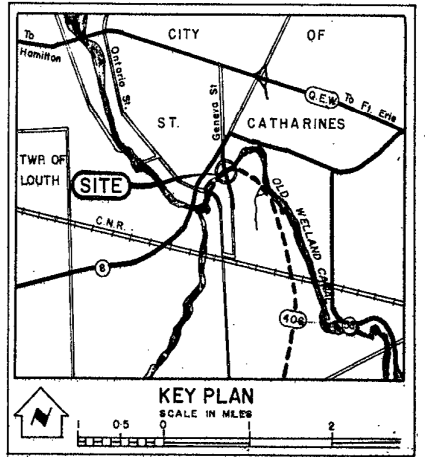
RECORD OF BOREHOLE NO. 21

FOUNDATION SECTION

JOB 62-F-62 LOCATION Sta. 265 + 28 (38' Lt.) ORIGINATED BY \* JP  
W.P.                      BORING DATE 4th October 1962 COMPILED BY MC  
DATUM                      BOREHOLE TYPE Augerhole CHECKED BY JP

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — WL			BULK DENSITY P.C.F.	REMARKS				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT		BLOWS / FOOT					PLASTIC LIMIT — WP						
								20 40 60 80 100					WATER CONTENT — W						
								SHEAR STRENGTH P.S.F.								WP — W — WL			
																WATER CONTENT %			
345.0	Ground level																		
0.0																			
	Miscellaneous refuse, ash, organics, sand, gravel, clay		1	SS	8										Open and dry 4/10/62				
			2	SS	11														
			3	SS	14														
			4	SS	15														
319.2																			
25.8	Stiff grey silty clay		5	SS	21														
315.5			6	SS	21														
29.5	End of borehole																		





LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Piezometer Hole
- Water Levels established at time of field investigation June 1962

NO.	ELEVATION	STATION	OFFSET
2	289.0	260+75	90' RT.
3	289.0	261+46	28' LT.
4	297.0	263+32	38' RT.
5	316.0	264+49	31' RT.
6	286.5	262+35	9' RT.
7	291.3	260+79	48' LT.
8	292.0	260+21	6' LT.
9	294.3	259+25	49' LT.
10	295.8	258+59	5' RT.
11	298.0	262+97	18' RT.
12	293.5	259+70	10' LT.
13	293.0	260+00	50' LT.
14	291.0	260+40	30' RT.
15	292.0	260+00	50' RT.
16	294.0	259+25	50' RT.
17	299.0	263+75	60' RT.
18	297.0	263+25	35' LT.
19	296.0	263+75	60' LT.
20	300.0	264+15	25' LT.

NO'S 1 & 21 NOT SHOWN ON PLAN

BORE HOLE DETAILS

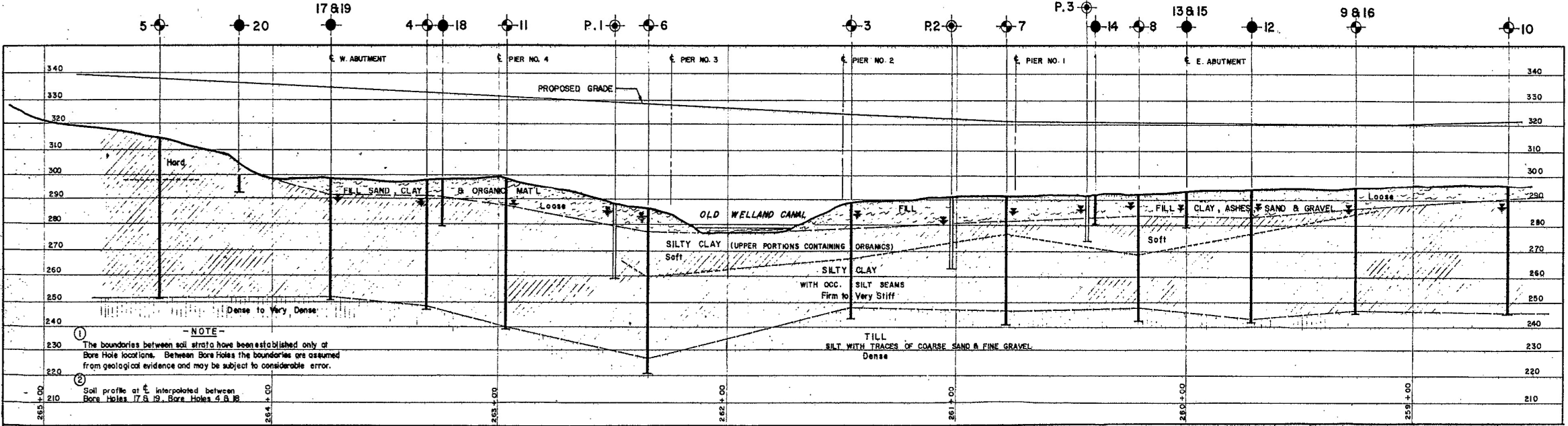
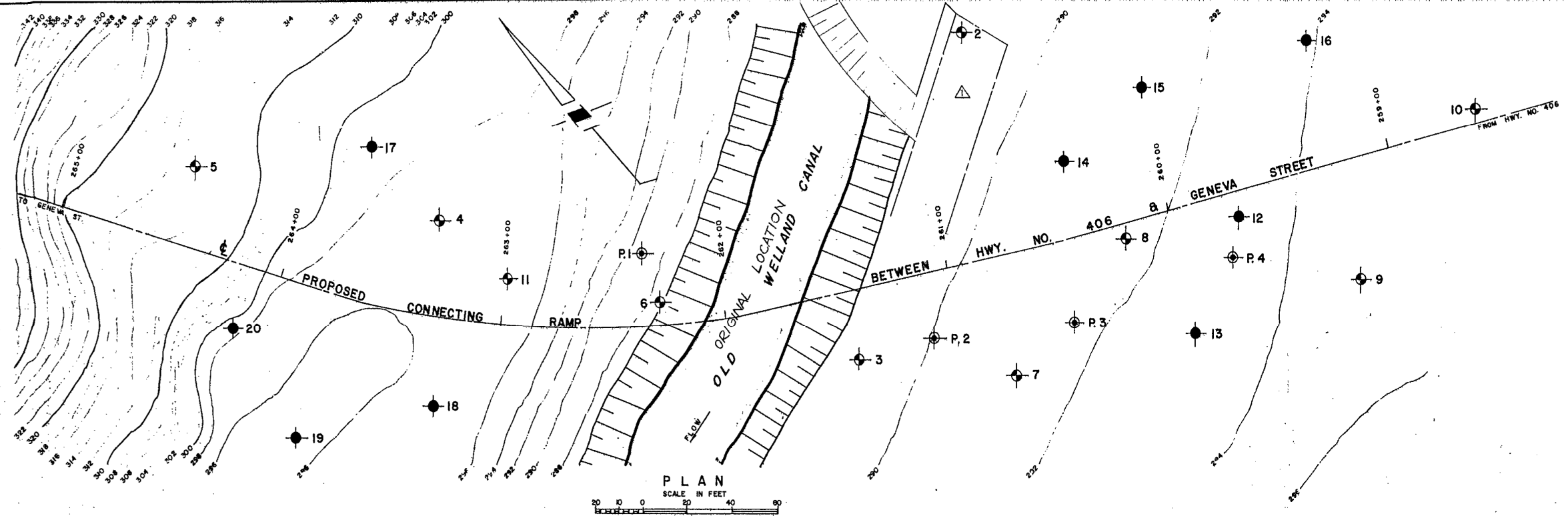
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION

OLD WELLAND CANAL  
AND  
HWY. NO. 406 - GENEVA ST. CONNECTION

ST. CATHARINES

ORIGINATED G. CHERRINGTON	DISTRICT NO. 4	DATE OCT. 12, 1962
DRAWN F. CLARK	BY NO. 274-62	JOB NO. 62-F-62
CHECKED G. G.	CONT. NO. 62-F-62	DRAWING NO.
APPROVED J. J. J.	ST. ST. 62-85	D-5147-2

24/10/62 J.S.G. POSITION OF CANAL EXTN SHOWN  
THIS DRAWING SUPERCEDES DWG 62-F-62A



NOTE  
1 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.  
2 Soil profile at 264+00 interpolated between Bore Holes 17 & 19, Bore Holes 4 & 18

PROFILE

SCALE IN FEET  
0 20 40 60





# **APPENDIX B**

**Drawing D-5147-2 General Plan**

**Drawing D-5147-3 Foundation Layout**



NOTES

CONCRETE WORK ON THIS STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE DISTRICT ENGINEER TO CONTRACTOR. STRUCTURE TO BE BUILT IN ACCORDANCE WITH FORM No. 9 AND THE SPECIAL PROVISIONS, EXTRA COPIES OF WHICH MAY BE OBTAINED FROM THE DISTRICT ENGINEER.

CONCRETE MIX	MINIMUM STRENGTH AT 28 DAYS	MAXIMUM SIZE OF AGGREGATE
DECK	4000 PSI.	3/4"
FOOTINGS, PIERS & ABUTMENTS	3000 PSI.	3/4"

APPROVED ADMIXTURES SUPPLIED BY THE CONTRACTOR WILL  
BE ADDED TO ALL CONCRETE AS SPECIFIED BY THE ENGINEER.

BORING DATA  
THE COMPLETE SOIL INVESTIGATION REPORT FOR THIS STRUCTURE  
MAY BE EXAMINED AT THE BRIDGE OFFICE OR FOUNDATION OFFICE,  
DOWNSVIEW OR AT THE REGIONAL OFFICE AND AT THE HAMILTON  
DISTRICT OFFICE.

CLEAR COVER ON REINFORCING STEEL.  
FOOTINGS-3', ABUTMENTS-3', DECK-1'

CONSTRUCTION NOTES.

ALL EXPOSED EDGES TO BE CHAMFERED  $\frac{1}{4}$ " EXCEPT AS NOTED.

ALL CONSTRUCTION JOINTS MUST BE APPROVED BY THE BRIDGE ENGINEER.

THE GENERAL CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BRIDGE SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF PLUS OR MINUS  $\frac{1}{8}$ " INCH. IF THEY ARE CLOSER TO HIGH THEY SHALL BE GROUND DOWN BY THE GENERAL CONTRACTOR. IF THEY ARE CLOSER TO LOW THE GENERAL CONTRACTOR SHALL PROVIDE FULL BEARING SURFACES TO BRING THEM UP TO THE CORRECT ELEVATIONS. THE USE OF GROUT IS PROHIBITED.

THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING THAT THE FINAL DECK ELEVATIONS COMPLY WITH THE ELEVATIONS SHOWN.

NO CONCRETE SHALL BE PLACED ABOVE THE BRIDGE UNTIL THE STRUCTURAL STEEL HAS BEEN PLACED

SUBEXCAVATION, 1ST STAGE FILL, CULVERT EXTENSION AND CANAL BACKFILL SHALL BE COMPLETED PRIOR TO COMMENCEMENT OF THE BRIDGE PROJECT.

- 1) DRIVE H-PILES. ALL H-PILES FOR PIERS TO BE PLACED PRIOR TO DRIVING H-PILES FOR ABUTMENTS.
- 2) EXCAVATE AND POUR FOOTINGS.
- 3) PLACE SAND CUSHION BACKFILL AT ABUTMENTS UP TO A BERM LEVEL PRIOR TO ERECTION OF STRUCTURAL STEEL.

REVISIONS	9/7/69	RT	AS - CONSTR. Y.T. SHIPPED
	10/11/69	WV	AS STD = 22.5 CHANGED TO 22.5 RAILING.
	11/17/69	MM	AS GLFWH - 11.4' MAX. L.F. 12' 11.4' MAX. FL
	2/10/70	J.G.G.	AS GRADE ROAD REMOVED, PLAN REV.
	2/10/70	J.G.G.	AS NOTES & SOUTH ELEVATION - 1' EV.
	6/6/73	J.G.G.	AS NOTES & ELEVATION REV.
	DATE	BY	DESCRIPTION

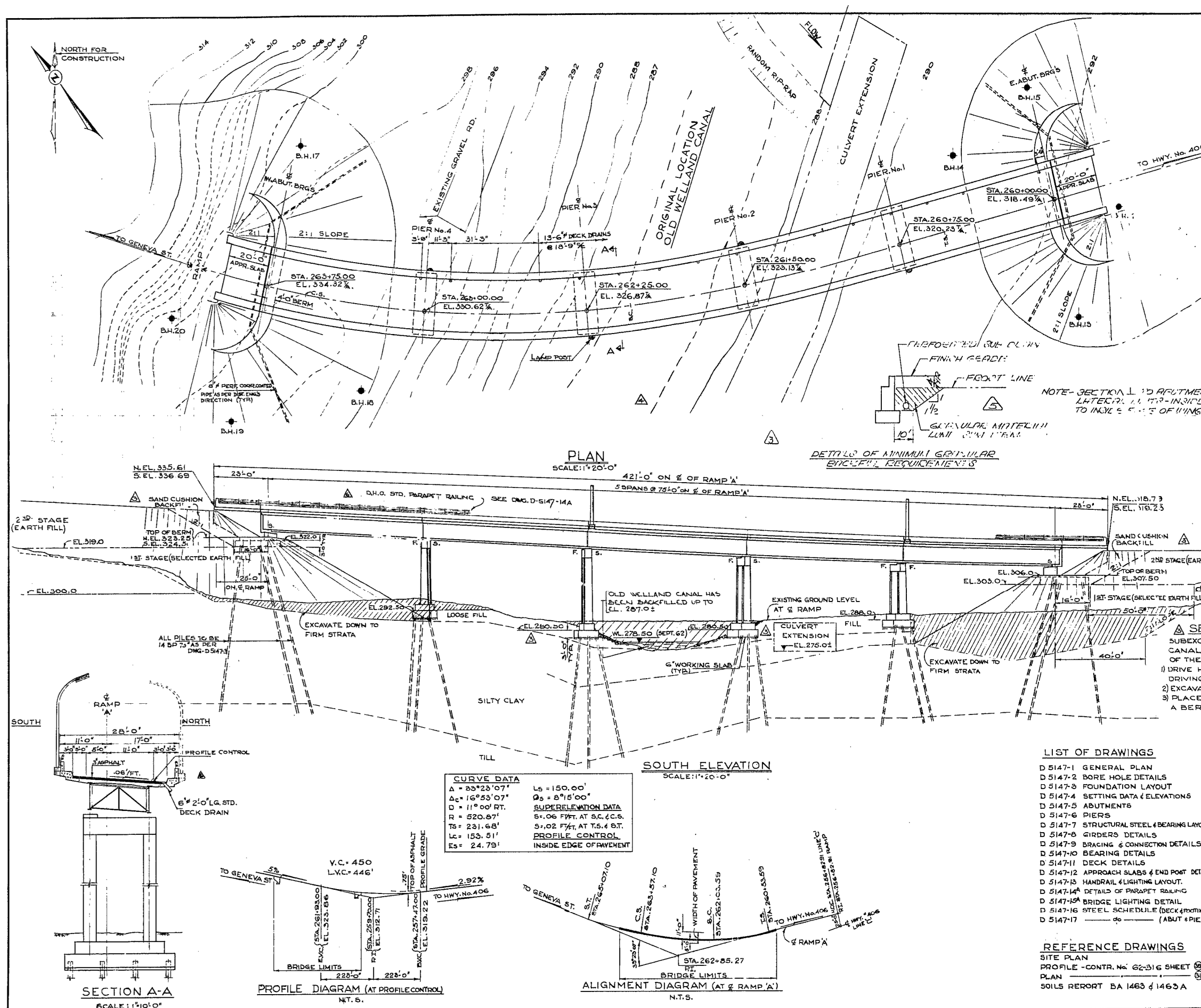
BRIDGE OVER OLD WELLAND CANAL

CONNECTION BETWEEN HWY. No. 406 AND GENEVA ST.  
IN ST. CATHARINES

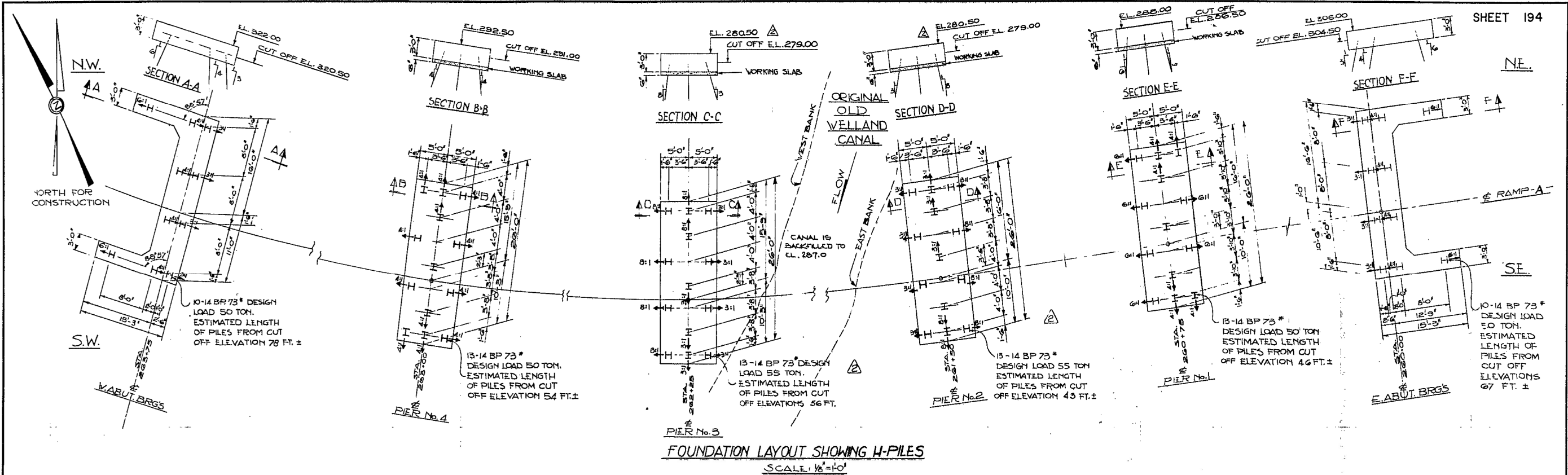
KING'S HIGHWAY No. \_\_\_\_\_ DIST. No. 4

CO. LINCOLN

APPROVED - <i>[Signature]</i>		SITE No.	19-168	W.P. No.	27A-62
BRIDGE ENGINEER					
DESIGN	A. U. CHECK	9.5	CONTRACT	51	51
DRAWING	H. M. CHECK	9.5	No.	1-05	64-295
DATE	MAY 63	LOADING	H 20 A 16	DRAWING	D-51








NOTES:

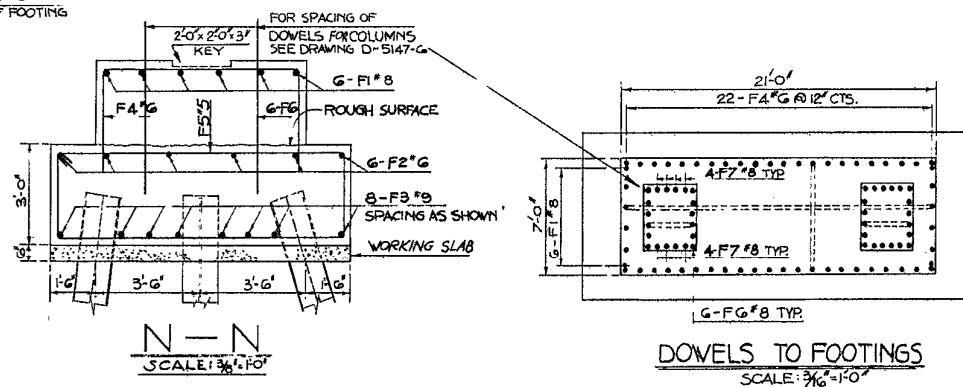
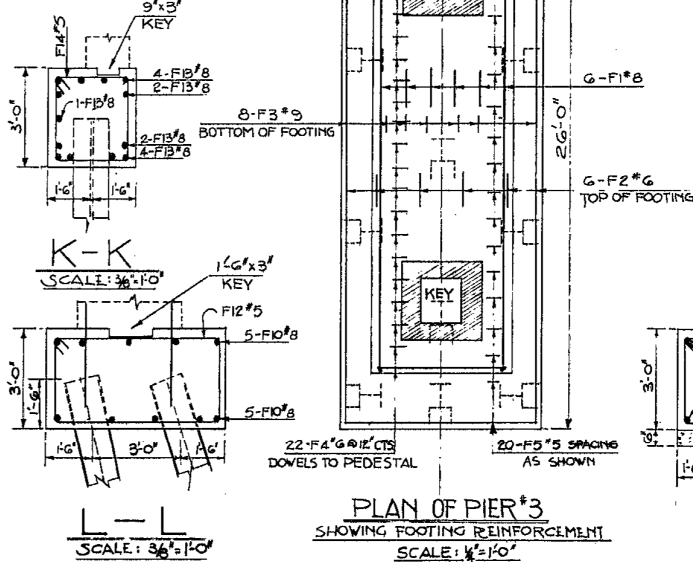
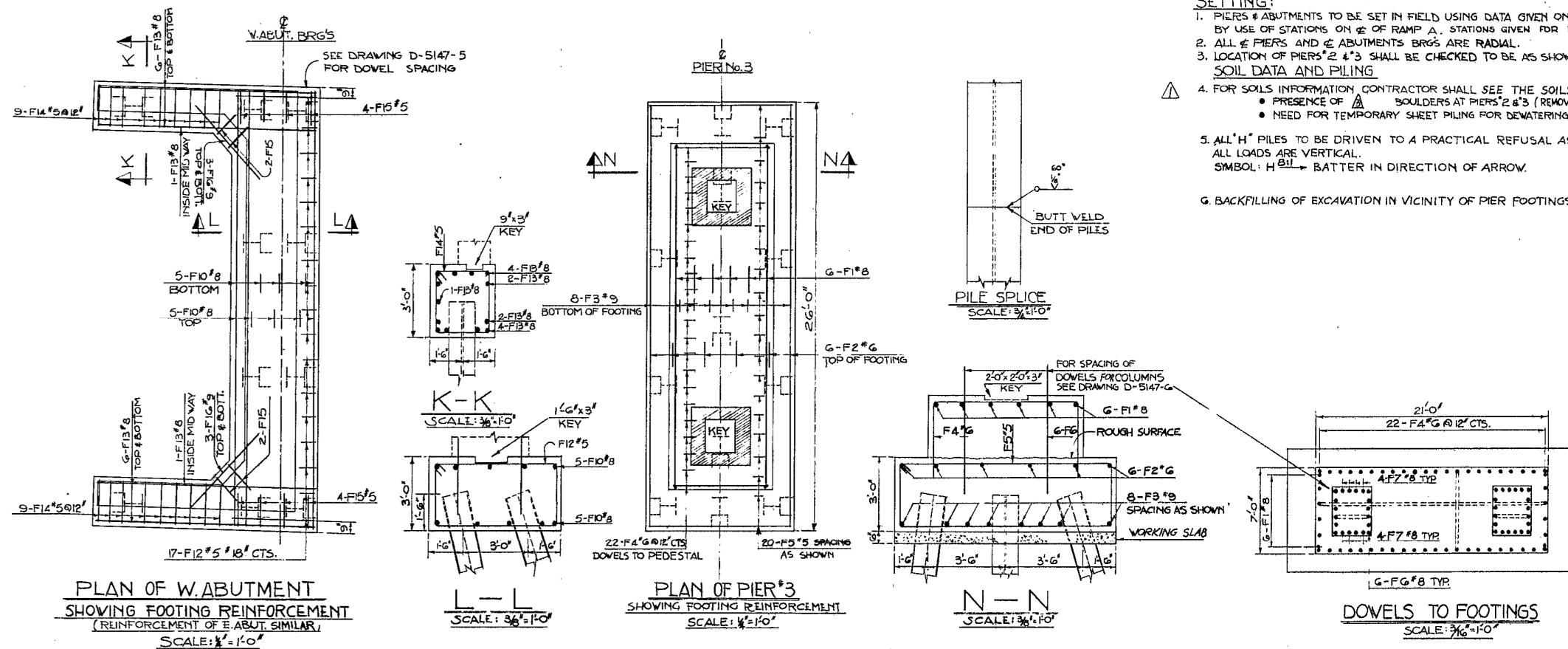
SETTING:

1. PIERS & ABUTMENTS TO BE SET IN FIELD USING DATA GIVEN ON DRAWING D-5147-4 TABLE 2. THESE POINTS SHALL NOT BE SET BY USE OF STATIONS ON & OF RAMP A. STATIONS GIVEN FOR FUTURE REFERENCE ONLY.
2. ALL & PIERS AND & ABUTMENTS BRGS ARE RADIAL.
3. LOCATION OF PIERS\*2 & 3 SHALL BE CHECKED TO BE AS SHOWN ON DRAWINGS IN RELATION TO THE OLD WELLAND CANAL.

## SOIL DATA AND PILING

4. FOR SOILS INFORMATION, CONTRACTOR SHALL SEE THE SOILS REPORT. THE FOLLOWING POINTS ARE MENTIONED IN THE REPORT
- PRESENCE OF  SOULDERS AT PIERS 2 & 3 (REMOVE BEFORE PILING)
  - NEED FOR TEMPORARY SHEET PILING FOR DEWATERING PURPOSES
5. ALL "H" PILES TO BE DRIVEN TO A PRACTICAL REFUSAL AS DETERMINED BY HILEY FORMULA (SEE D.H.O. STD. BD 16-3, 4.) ALL LOADS ARE VERTICAL.
- SYMBOL:  $H \begin{array}{c} \text{O} \\ \text{U} \end{array} \rightarrow$  BATTER IN DIRECTION OF ARROW.

- G. BACKFILLING OF EXCAVATION IN VICINITY OF PIER FOOTINGS TO BE IN 6' COMPACTED LAYERS UP TO TOP OF FOOTING ELEVATIONS.



REVISIONS	DATE	BY	DESCRIPTION
	9.7.69	R.T.	REVISED AS-CONSTR.
	24.10.63	JGG	A WORD 'SURFACE' REMOVED
	29.8.63	A.U.	A REV ELEVATION NOTES - PIER 3. PIER 2
	6.4.63	JGG	A NOTES REV.

DEPARTMENT OF HIGHWAYS ONTARIO  
BRIDGE DIVISION

BRIDGE OVER OLD WELAND CANAL  
CONNECTION BETWEEN HWY. No. 406 AND GENEVA ST.  
IN ST. CATHARINES DIST. No. 4  
KING'S HIGHWAY No. \_\_\_\_\_  
CO. LINCOLN  
~~THE~~ CITY OF ST. CATHARINES LOT \_\_\_\_\_ CON. \_\_\_\_\_

APPROVED <u>Bill H. [Signature]</u> ARCHITECT				SITE No. <u>19-168</u>	W.P. No. <u>274-62</u>
DESIGN <u>AO</u> CHECK <u>P.S.</u>	CONTRACT NO. <u>64-05</u>		<u>64-235</u>		<u>64-235</u>
DRAWING <u>NT</u>	DATE <u>MAY 63</u>		LOADING <u>1-20</u> <u>5-16</u>	DRAWING <u>D-5147-3</u>	



As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit [golder.com](http://golder.com)

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

[solutions@golder.com](mailto:solutions@golder.com)  
[www.golder.com](http://www.golder.com)

**Golder Associates Ltd.**  
**6925 Century Avenue, Suite #100**  
**Mississauga, Ontario, L5N 7K2**  
**Canada**  
**T: +1 (905) 567 4444**

