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DIST. 18 REGION

W.P. No. 19-76-04

CONT. No. 80-205

W. O. No.

STR. SITE No. 388-122

HWY. No. 638

LOCATION Leeburn Creek

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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FOUNDATION INVESTIGATION
PROPOSED CROSSING
LEEBURN CREEK - HIGHWAY 638
W.P. 19-76-04, SITE 38S-122
DISTRICT 18, SAULT STE. MARIE

Ref. No. 78-6-19
AUGUST 1978

Prepared for:

Ministry of Transportation and Communications

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C O N T E N T S

A P P E N D I X

Ref. No. 78-6-19

ENCLOSURES

1.0 INTRODUCTION

The Ministry of Transportation and Communications of the Province of Ontario contemplates the replacement of an existing bridge on Highway 638 over Leeburn Creek in the Township of Aberdeen, Ontario.

Dominion Soil Investigation Inc. has, at the request of the Engineering Materials Office, carried out a soil investigation with the purpose of determining the subsurface conditions at the location of the proposed structure.

The findings of the investigation, together with our recommendations, are presented in this report.

.../...

2.0 SITE AND GEOLOGY

The site is located in the Township of Aberdeen in the District of Sault Ste. Marie, on Highway 638.

Geologically, the site is located on the Canadian Shield and the bedrock in the area consists of intrusive rocks, such as granite, gneiss, granitized sedimentary or volcanic rocks belonging to the Archean Era.

The topography in the area surrounding the bridge is gently rolling, with ground surface elevations ranging between 656 and 676 ft. above sea level. The vegetation is sparse and consists of grass and light bush.

Small rock outcrops were noted within 600 to 900 ft. (183 to 274 m) of the site to the north and south of Highway 638.

The conditions at the site are illustrated on photographs 1 to 4 in the appendix of this report.

.../...

3.0 METHOD OF INVESTIGATION

3.1 Field Work

Six boreholes and five dynamic cone penetration tests were put down at the site at the locations shown on Drawing No. 197604-A. The boreholes were advanced by both augering, wash-boring and diamond drilling methods.

First, augering was effected until refusal was met. Below the refusal level, the boreholes were advanced by breaking the obstructions with a bi-cone and drilling N-size (3.5" diameter) casings. The debris inside the casings was removed by wash water. Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration test method using a 2-inch (51 mm) O.D. split spoon which was driven into the ground with 350 ft./lb. energy.

The undrained shear strength of cohesive strata was measured in-situ by a vane tester apparatus.

Relatively undisturbed samples of the clay were recovered by means of 2-inch (51 mm) O.D. thin walled tube samplers. The rock was cored by diamond drilling techniques using BXL (1-5/8" I.D.) core bits.

The field work was carried out on June 20 to 25, 1978, under the supervision of a senior soils technician who also located the boreholes in the field. The locations of these were referred to the centre line stakes established by the surveyors of M.T.C.

.../...

Ground surface elevations were referred to geodetic datum, the location of which is shown on M.T.C. Plan E-5620-1.

3.2 Laboratory Testing

The soil samples were shipped in air tight jars to Dominion Soil Investigation Inc. laboratory where they were examined and representative soil samples were selected for testing.

The laboratory testing programme consisted of the determination of the moisture contents, consistency limits and unit weights and sieve and hydrometer analyses. In addition, the undrained shear strength and the compressibility of the clay were determined by means of triaxial compression and consolidation tests carried out on relatively undisturbed soil samples.

The laboratory test results are presented on the Records of Boreholes (Enclosures 1 to 6 inclusive) and on Enclosures 8, 9 and 10.

.../...

4.0 SUBSOIL CONDITIONS

4.1 General

Based on the results of the boreholes, the subsoil profile consists of the following main strata:

1. Surficial Deposits consisting of silty sand, clayey silt and silty clay.
2. Varved Clay
3. Sand and Gravel
4. Granite Bedrock

4.2 Surficial Deposits

4.2.1 Fill

Borehole 5 encountered fill consisting of stiff clayey silt with sand and gravel and frequent boulders. The fill is compact ('N' = 11 blows per foot) and extends to about Elevation 658.4 ft., i.e., 7.5 ft. (2.3 m) below the ground surface. The stiff to very stiff clayey silt encountered in Borehole 3 could also possibly be fill material.

4.2.2 Silty Sand

Borehole 4 encountered loose ('N' = 7 blows per foot) brown to grey silty sand extending to about Elevation 651.0 ft., i.e., about 10 ft. (3 m) below the ground surface.

4.2.3 Clayey Silt and Silty Clay

Boreholes 2 and 6 encountered firm to very stiff ('N' = 8 to 25 blows per foot) silty clay or clayey silt extending to Elevation 659.3 ft.,

.../...

i.e., between 6.3 and 7.5 ft. (1.9 and 3.3 m) below the ground surface. Below the fill in Borehole 5 is a layer of firm ('N' = 6 blows per foot) silty clay extending to Elevation 653.4 ft., i.e., 12.5 ft. (3.8 m) below the ground surface.

4.3 Varved Clay

Below the above described surficial fill and natural deposits the area is underlain by grey reddish mottled varved clay. The clay extends to between Elevations 600.5 and 614.9 ft., i.e., between 47 and 67.7 ft. (14.3 and 20.6 m) below the ground surface.

Based on the results of the Standard Penetration tests, the consistency of the clay is soft to very soft ('N' = less than 1 to 4 blows per foot).

The undrained shear strength of the clay was measured in-situ by field vane tests giving values between 555 and 2035 p.s.f. (average 900 p.s.f.). The undrained shear strength value obtained from laboratory triaxial compression tests performed on relatively undisturbed samples range between 288 and 720 p.s.f. (average 500 p.s.f.). The remoulded shear strengh varies between 148 and 1110 p.s.f. (average 370 p.s.f.).

The plastic properties of the clay as revealed by laboratory Atterberg tests are as follows:

Liquid Limit	25 to 51%
Plastic Limit	14 to 25%
Plasticity Index	7 to 29%

.../...

The natural moisture content ranged between 12 and 71% (average 48%) and the measured unit weight between 100 and 106 p.c.f. (average 103 p.c.f.).

Consolidation tests (Enclosures 9 and 10) carried out on relatively undisturbed samples of the clay gave a coefficient of volume change (m_v) ranging between 0.01 and 0.06 ft.^{2}/ton in the preconsolidated and normally consolidated pressure range of the clay. The test results indicate that the clay stratum has a high plasticity and compressibility and a medium sensitivity. The preconsolidation range of the clay is between 0.6 to 0.9 t.s.f.

4.4 Sand and Gravel

Underlying the clay stratum in Boreholes 1, 3, 4 and 5 a compact to very dense ('N' = 26 to 68 blows per foot) sand and gravel stratum was encountered. In Borehole 1 this stratum contains frequent boulders. The grading characteristics of two typical samples obtained from this deposit are shown on Enclosure 8.

The sand and gravel stratum extends to the surface of the bedrock, which was encountered in Boreholes 1 to 5 inclusive at between Elevations 592.9 ft. (Borehole 1) and 613.2 ft. (Borehole 2), i.e., at depths of between 52.2 and 75.3 ft. (16 and 23 m) below the ground surface.

.../...

4.5 Granite Bedrock

Below the varved clay and sand and gravel deposits, the site is underlain by granite bedrock. The rock was proven by coring in Boreholes 1 to 5 inclusive to depths between 5.7 and 10.2 ft. (1.7 and 3.1 m) below the rock surface.

Generally, the rock is sound, with core recovery ranging between 77 and 100% (R.Q.D. between 61.5 and 100%). In Boreholes 3 and 4, however, the upper 1 to 4 ft. of the bedrock was found to be weathered and extensively fractured.

.../...

5.0 GROUNDWATER CONDITIONS

At the time of the investigation the water level in Leeburn Creek at the proposed centre line was at Elevation 655.5 ft.

Free water surfaces were encountered upon completion in Boreholes 1 and 2 at depths between 7.5 and 11.5 ft. (2.3 and 3.5 m) below the ground surface, i.e., between Elevations 654.1 and 660.7 ft. Borehole 6 bored dry and remained dry during the period of the investigation.

In Boreholes 3, 4 and 5, artesian conditions were encountered between Elevations 605 ft. (Borehole 4) and 610 ft. (Borehole 3). The measured artesian head was between Elevations 662.9 ft. and 674 ft., i.e., between 1 ft. (Boreholes 3 and 4) and about 8 ft. (Borehole 5) above the ground surface.

The measured volume of flow ranged between 1.5 and approximately 10 gallons per minute.

All the recorded groundwater levels are shown on the borehole logs.

.../...

6.0 DISCUSSION OF THE RESULTS

6.1 General

At the time of writing this report, it is proposed that the replacement structure will have a single span supported on closed abutments. The vertical alignment of the road will also be improved and the grade will be raised by about 17 ft. (5.2 m) on the west bank and 14 ft. (4.3 m) on the east bank of the crossing.

At the time of the investigation, the flow in Leeburn Creek was slow and the depth of water was about 2.6 ft. (79 cm). The stream bed along the new alignment is gravelly with some small submerged logs. Boulders up to 2 ft. (61 cm) in diameter (photographs 3 and 4) were noted around the existing abutments and piers within 5 ft. (1.5 m) of the proposed alignment.

At the proposed location of the structure, Boreholes 4 and 5 have indicated that below surficial fill or silty sand deposits the site is underlain by soft to very soft varved clay. The bedrock surface was encountered between Elevation 604 and 606.9 ft., i.e., between 57 and 59 ft. (17.4 and 18 m) below the ground surface.

6.2 Foundations

Because of the low bearing capacity of the soil and the significant consolidation settlements anticipated, spread footing foundations for the structure are not considered to be feasible at this site.

.../...

6.2.1 Friction Pile Foundations

Since a suitable bearing stratum was not encountered in the boreholes within depths of between 50 and 58 ft. below the ground surface, consideration was given to supporting the structure on friction piles.

Although calculations have indicated that 12-inch diameter timber piles could develop a safe working capacity of about 15 tons, because of the large (15 to 23-inches) consolidation settlement of the approach fills at the abutments, it was felt that possible differential settlements and lateral displacements of the soil could result in unacceptably large displacements of the abutments. In view of this, we do not recommend the use of friction piles.

6.2.2 End-Bearing Pile Foundations

The structure can be supported on end-bearing piles driven to practical refusal on the surface of the bedrock. It is expected that the piles will reach sufficient set between Elevation 606 and 603 ft.

Steel tube or H-piles appear to be most suitable for this project.

Recommended working loads for common pile sizes are as follows:

Pile Section	Safe Working Load
8BP36	50 tons
10BP42	60 tons
12BP53	80 tons
12" diameter tube	80 tons

.../...

Piles driven to the bedrock surface should encounter positive refusal and should not be overdriven. Because of the hard driving conditions expected through the sand and gravel stratum, the piles should be equipped with driving shoes. Piles driven to a satisfactory set will settle only negligibly under the working loads.

Unbalanced horizontal forces should be resisted by inclined piles driven in both direction parallel to the centreline of the road.

The piles should be designed to resist additional load due to negative skin friction. The recommended design value for negative skin friction is 560 p.s.f.

6.2.3 Horizontal Earth Pressures

For the calculation of horizontal forces on the abutments, the following design values are recommended:

unit weight of granular backfill	γ = 130 p.c.f.
coefficient of horizontal earth pressure	k = 0.4

The pressure distribution behind the abutments can be considered to be triangular, increasing with depth according to the following formula:

$$P_h = K (\gamma . h + q)$$

where h = depth below the ground surface (ft.)

q = unit surcharge load applied at the ground surface (p.s.f.)

It is recommended that clean, freely draining granular backfill be placed immediately behind abutments and that weep holes be provided to relieve the hydrostatic water pressure.

6.3 Approach Fills

It is our understanding that the proposed centre line grade will be raised to about Elevation 676 ft.

A stability analysis based on total stresses and circular failure planes, and assuming a 36 ft. wide embankment at the top and 2 horizontal in 1 vertical side slopes, gave the following results:

End Slope

The calculated safety factor for 2:1 end slopes is 1.2, which is considered to be adequate. It is recommended that the creek banks be cut back on both sides at 2:1 slopes. In addition, the face of the embankments should be protected against scour and erosion by rip-rap or other suitable means up to the high water level.

Side Slopes

At a slope of 2 horizontal in 1 vertical, the south side of the west approach fill will encroach on the creek bed from about Station

.../...

177+85 to the west abutment. It will, therefore, be necessary either to increase the span of the structure on the west side or to construct a retaining wall along this side of the creek bank.

The stability analysis of the embankment at Station 177+65, i.e., the most critical section, indicates that the safety factor is about 1.3, which is considered to be adequate.

From the consolidation test data, we estimate that the maximum primary consolidation settlement under the approach embankments will be about 6-inches under the west approach and 13-inches under the east approach. Allowance should be made in the design for such movemenets.

DOMINION SOIL INVESTIGATION INC.

I. Rainu, P.Eng.

IR/kmj

REGISTERED PROFESSIONAL ENGINEER
I. RAINU
PROVINCE OF ONTARIO

APPENDIX

Ref. No. 78-6-19

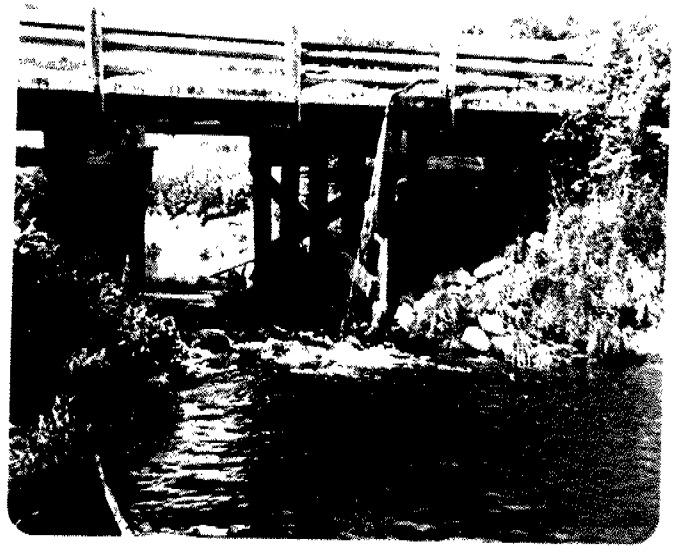
APPENDIX 'A'

PHOTOGRAPHS

Photograph 1
Looking West along the East Embankment

Photograph 2
Looking East along the West Embankment

Photograph 3
Looking Down Stream from the North Side
of Existing Structure



Photograph 4
Looking Upstream from the South
Side of Existing Structure

ENCLOSURES

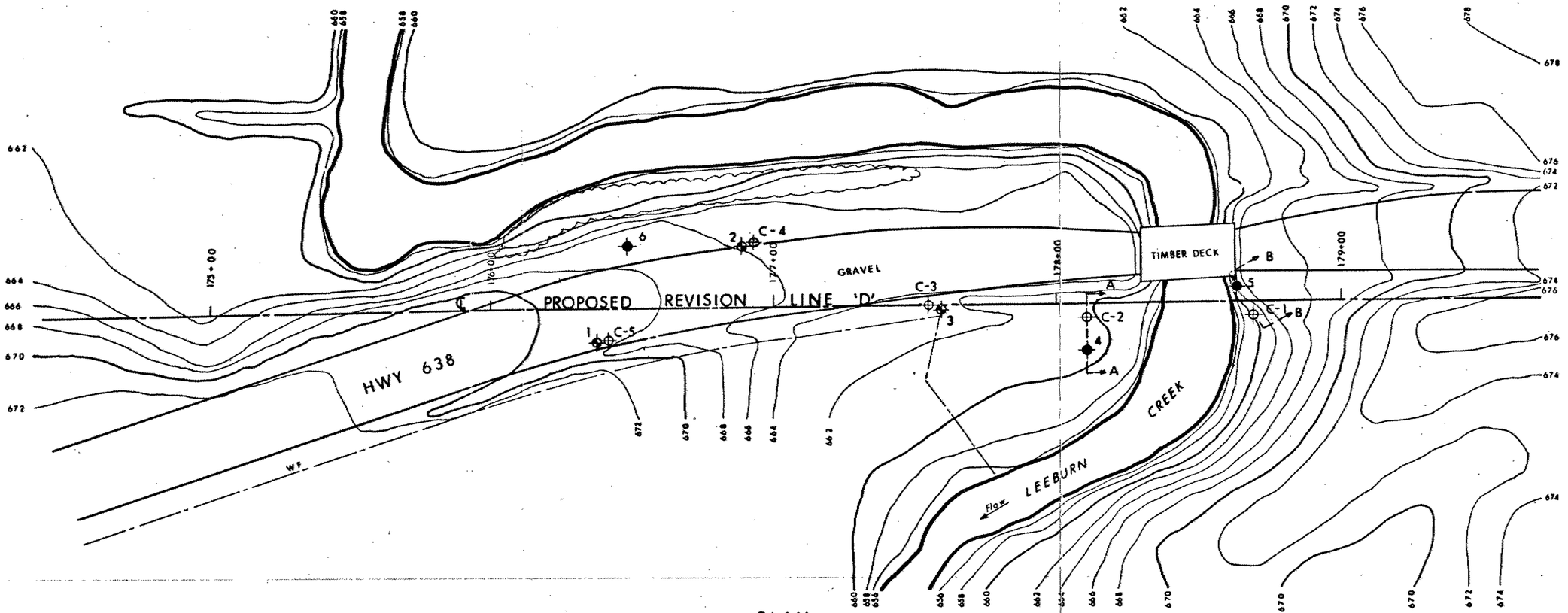
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-308 10-79

CONT No
WP No 19-76-04

LEEBURN CREEK

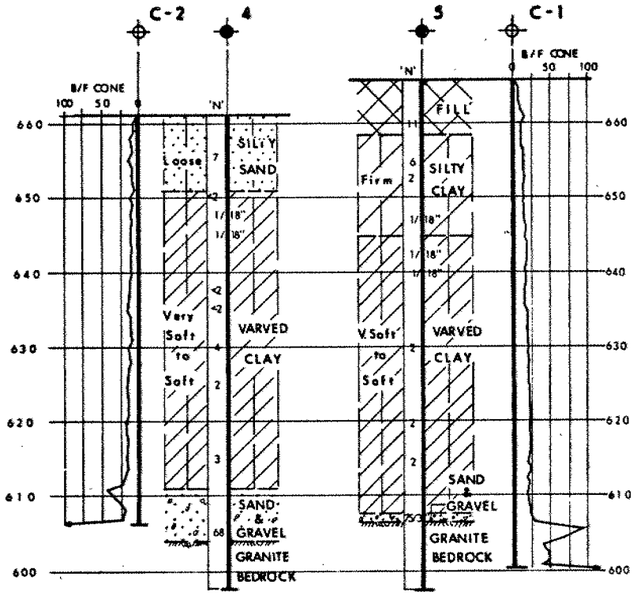
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



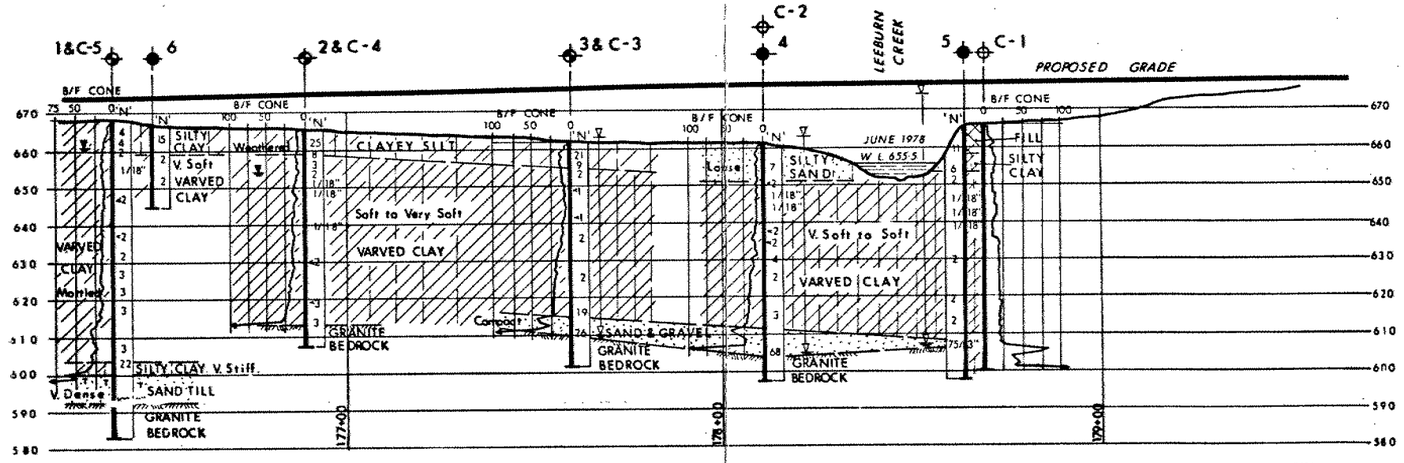
PLAN

20 10 0 SCALE 20 40FT.



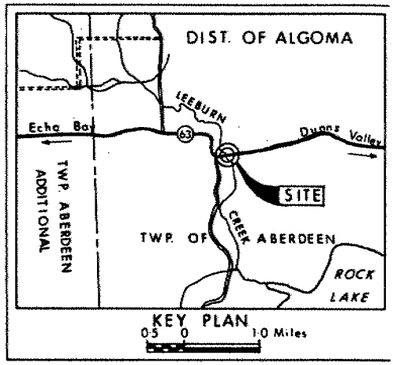
A-A SECTIONS B-B

10 5 0 SCALE 10 20 FT



℄ PROFILE LINE 'D'

20 10 0 SCALE 20 40FT.



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)
- WL at time of investigation JUNE 1978
- Head ARTESIAN WATER Encountered

No	ELEVATION	STATION	OFFSET
1	668·2	176+38	12' RT.
2	665·6	176+89	22' LT.
3	661·9	177+59	1·5' RT.
4	661·0	178+11	16·5' RT.
5	665·9	178+63	7' LT.
6	666·8	176+48	22·5' LT.
C-1	665·9	178+69	5' RT.
C-2	661·0	178+12	5' RT.
C-3	661·9	177+55	℄
C-4	665·6	176+93	23' LT.
C-5	667·8	176+42	11' RT.

-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

HWY No 638			DIST 18
SUBM'D I. R.	CHECKED I.R	DATE JULY, 1978	SITE 38S-122
DRAWN F. L.	CHECKED F.L	APPROVED	DWG 197604-A

Ministry of Transportation and Communications, Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1 & CONE TEST No. 5

W P 19-76-04 LOCATION Sta. 176+38 12' R.T. ℄ Line 'D' ORIGINATED BY N. McC.

DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.

DATUM Geodetic DATE June 24 and 25, 1978 CHECKED BY I.P.L.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
668.2	GROUND LEVEL						
0.0	light brown, weathered and fissured — soft		1	SS	4		
			2	SS	4		
	very soft		3	SS	2		
			4	TW	--		
			5	SS	1/18"		
			6	TW	--		
	Grey varved CLAY, mottled reddish/brown		7	SS	<2		660
			8	TW	--		
			9	SS	<2		650
			10	SS	2		
	soft		11	SS	3		640
			12	SS	3		
			13	SS	3		630
			14	TW	--		
603.7			15	SS	3		620
64.5 / 600.5	Very stiff, grey SILTY CLAY with fine sand		16	SS	22		
67.7			17	RC BXL	0		610
	Very dense SAND and GRAVEL with frequent boulders				100/10"		
692.9			18	SS	100/4"		600
75.3	GRANITE BEDROCK		19	RC BXL	100%		
			20	RC BXL	100%		590
583.1							
85.1	END OF BOREHOLE						

W.L. 660.7 FT

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL 1000 + FIELD VANE × LAB VANE 2000

PLASTIC LIMIT W_p — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%)

UNIT WEIGHT γ

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

augering

wash boring

drilled BW casing and cleaned out with bi-cone

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

Enclosure 2

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2 & CONE TEST No. 4

W P 19-76-04 LOCATION Sta. 176+89 22' L.T. ℄ Line 'D' ORIGINATED BY N. McC.

DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.

DATUM Geodetic DATE June 24, 1978 CHECKED BY I.P.L.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 1000, 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
665.6	GROUND LEVEL										
0.0	Brown/grey Clayey SILT, very stiff weathered		1	SS	25						
659.3	firm		2	SS	8		660				
6.3			3	SS	3			W.L. 654.1 ft.			
			4	SS	2	▼					
			5	SS	1/18"						
			6	SS	1/18"		650				
	Soft to very soft grey varved CLAY mottled reddish brown		7	TW	--						
			8	SS	1/18"		640				
			9	TW	--						
			10	SS	<2		630				
			11	TW	--						
			12	SS	<3		620				
613.2	gravelly		13	SS	3						augering
52.2	GRANITE BEDROCK		14 15	SS RC BXL	50/3"			100/8"			wash boring
607.7			16	RC BXL	89%		610				
57.9	END OF BOREHOLE										

+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 3 & CONE TEST No. 3

W P 19-76-04 LOCATION Sta. 177+59 1.5' R.T. ℄ Line 'D' ORIGINATED BY N. McC.

DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.

DATUM Geodetic DATE June 22 and 23, 1978 CHECKED BY I.P.L.

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 (o UNCONFINED, • QUICK TRIAXIAL 1000, + FIELD VANE, × LAB VANE 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
661.9	GROUND LEVEL										
0.0	Stiff to very stiff brown, organic stained CLAYEY SILT, with some decayed wood(poss. FILL)		1	SS	21		660				
654.5			2	SS	9						
7.5			3	SS	2						
			4	TW	--						
			5	SS	<1		650				
			6	TW	--					106	
	Very soft grey varved CLAY mottled reddish brown		7	SS	<1		640				
			8	SS	2						
			9	TW	--		630				
			10	SS	2						
			11	TW	--		620				
614.9	very stiff, with fine sand seams		12	SS	19						
47.0	Compact, well graded SAND, with fine gravel and silt		13	SS	26	▽	610	100/6"			10 74 16 0
609.9											↑ augering — wash ↓ boring
52.0	broken rock		14	RC BXL	77%						
	GRANITE BEDROCK		15	RC BXL	100%						
601.6			16	RC BXL	100%						
60.3	END OF BOREHOLE										

+3, ×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 4 & CONE TEST No. 2

W P 19-76-04 LOCATION Sta. 178+11 16.5' R.T. ℄ Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 21, 1978 CHECKED BY I.P.L.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL 1000 + FIELD VANE × LAB VANE 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
661.0	GROUND LEVEL										
0.0	Loose brown/grey SILTY SAND organic stained		1	SS	7		660				Artesian condition below Elev. 605.0' Measured Head at Elev. 663.0' Measured volume 2 gallons/ minute
651.0											
10.0	Very soft to soft, grey varved CLAY mottled reddish brown		2	SS	<2		650				
			3	SS	1/18"						
			4	SS	1/18"						
			5	TW	--					111	
			6	TW	--		640			106	
			7	SS	<2						
			8	SS	<2						
			9	SS	4		630				
			10	SS	2						
			11	TW	--		620				
	with dilatant silt layers		12	SS	3						
611.0											
50.0	Very dense SAND and GRAVEL		13	TW	--		610				8 80 12 0
			14	SS	68			100/8"			augering wash boring
604.0											
57.0	GRANITE BEDROCK fractured		15	RC BXL	90%						
			16	RC BXL	77%		600				
			17	RC BXL	88%						
597.4											
63.6	END OF BOREHOLE										

+3, ×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 5

W P 19-76-04 LOCATION Sta. 178+63 7' L.T. ℄ Line 'D' ORIGINATED BY N. McC

DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXT Size) COMPILED BY I.R.

DATUM Geodetic DATE June 20, 1978 CHECKED BY I.P.L.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE (1000, 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
665.9	GROUND LEVEL										
0.0	CLAYEY SILT with Sand and Gravel, frequent boulders FILL compact		1	SS	11		660				Artesian condition below Elev. 608.0' Measured head at Elev. 674.0' Measured volume 10 gallons/ minute
658.4											
7.5	Firm, light brown/grey SILTY CLAY		2	SS	6						
653.4			3	SS	2						
13.5			4	TW	--		650			102	
			5	SS	1/18"					105	
			6	TW	--						
	Very soft grey varved CLAY mottled reddish/brown		7	SS	1/18"						
			8	SS	1/18"		640				
			9	TW	--						
			10	SS	2		630				
			11	SS	--						
			12	SS	2		620				
			13	SS	2						
	with sand and		14	TW	--		610				
607.9	fine gravel inclusions										
58.0	V. Dense SAND & GRAVEL		15	SS	76/3"						augering wash boring
59.0	GRANITE BEDROCK		16	RC	91.1%		600				
597.8											
68.1	END OF BOREHOLE										

+3, x5 : 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 6

W P 19-76-04 LOCATION Sta. 176+48 22.5' L.T. ℄ Line 'D' ORIGINATED BY N. McC.

DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.

DATUM Geodetic DATE June 23, 1978 CHECKED BY I.P.L.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL 1000 + FIELD VANE × LAB VANE 2000	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
666.8	GROUND LEVEL										
0.0	Stiff, grey/brown SILTY CLAY		1	SS	15		660				
659.3			2	TW	--						
7.5	Very soft grey varved CLAY, mottled reddish brown		3	SS	2			+			
			4	TW	--			+			
			5	SS	<2			+			
			6	TW	--		650	+			
644.8			7	TW	--			+			Hole wet at 19'
22.0	END OF BOREHOLE										

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF CONE TEST No. 1

W P 19-76-04 LOCATION Sta. 178+69 5' R.T. ℄ Line 'D' ORIGINATED BY N.McC.

DIST 18 HWY 638 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY I.R.

DATUM Geodetic DATE June 21, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
669.0											
0.0							660				
							650				
							640				
							630				
							620				
							610				
600.4											
65.6	END OF CONE TEST							110/7"			

+3, ×5 : Numbers refer to Sensitivity

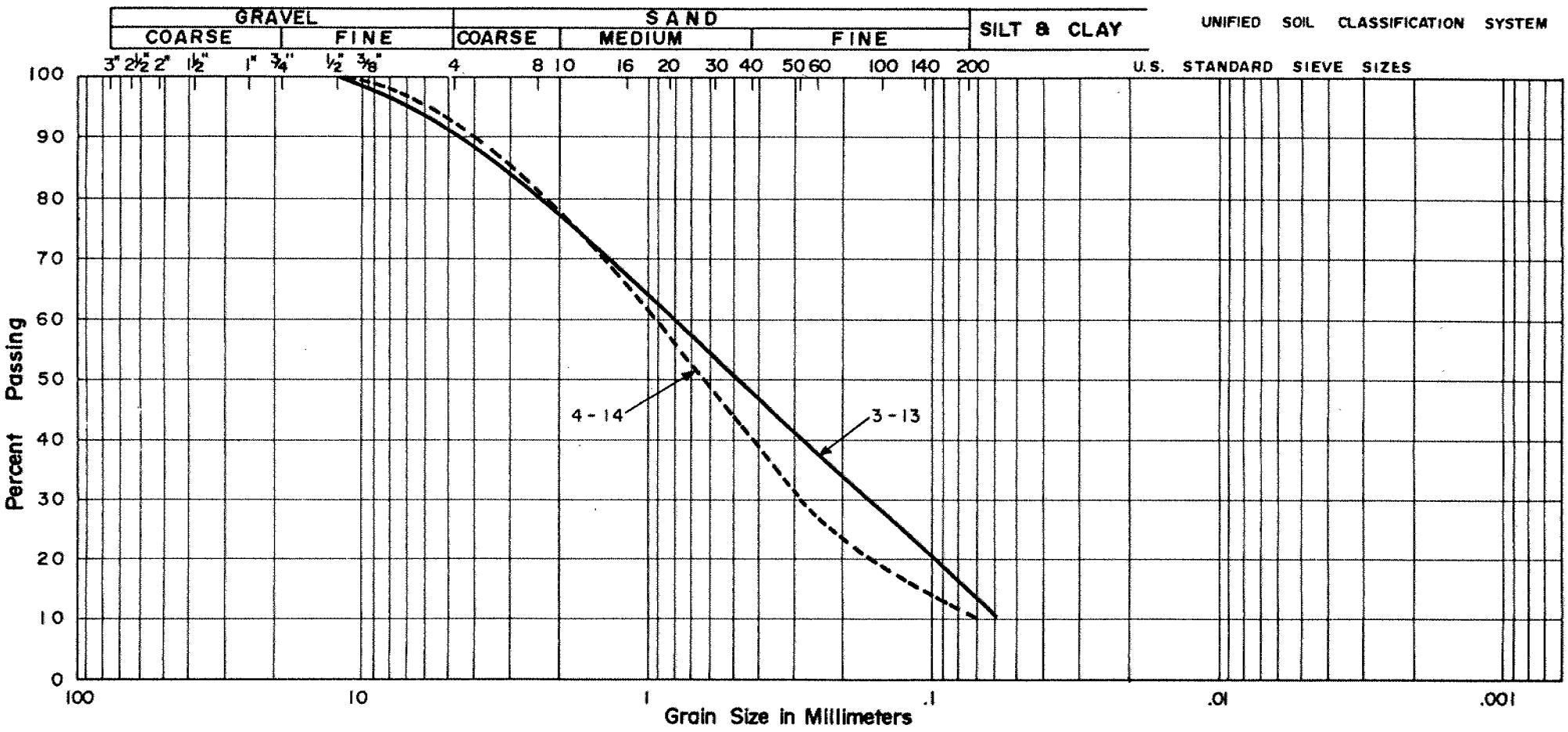
20
15 ◇ S (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE Nº 78-6-19



PROJECT: BRIDGE REPLACEMENT

LOCATION: HWY. 638 & LEEBURN CREEK.

BOREHOLE Nº:	3	4
SAMPLE Nº:	13	14
DEPTH:	51'	56'
ELEVATION:	6109'	605'

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND

well graded, some fine gravel and silt.

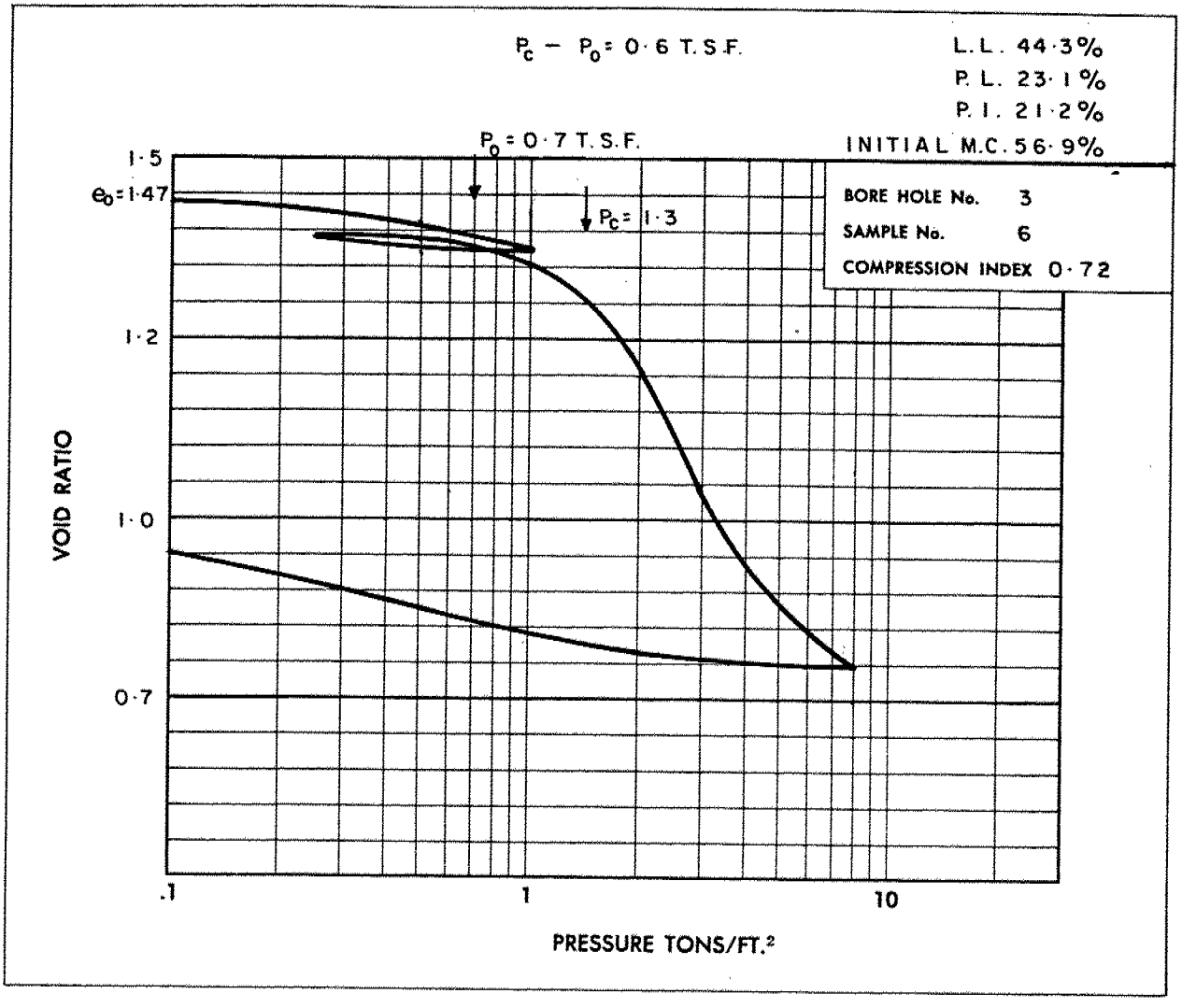
PLASTIC PROPERTIES

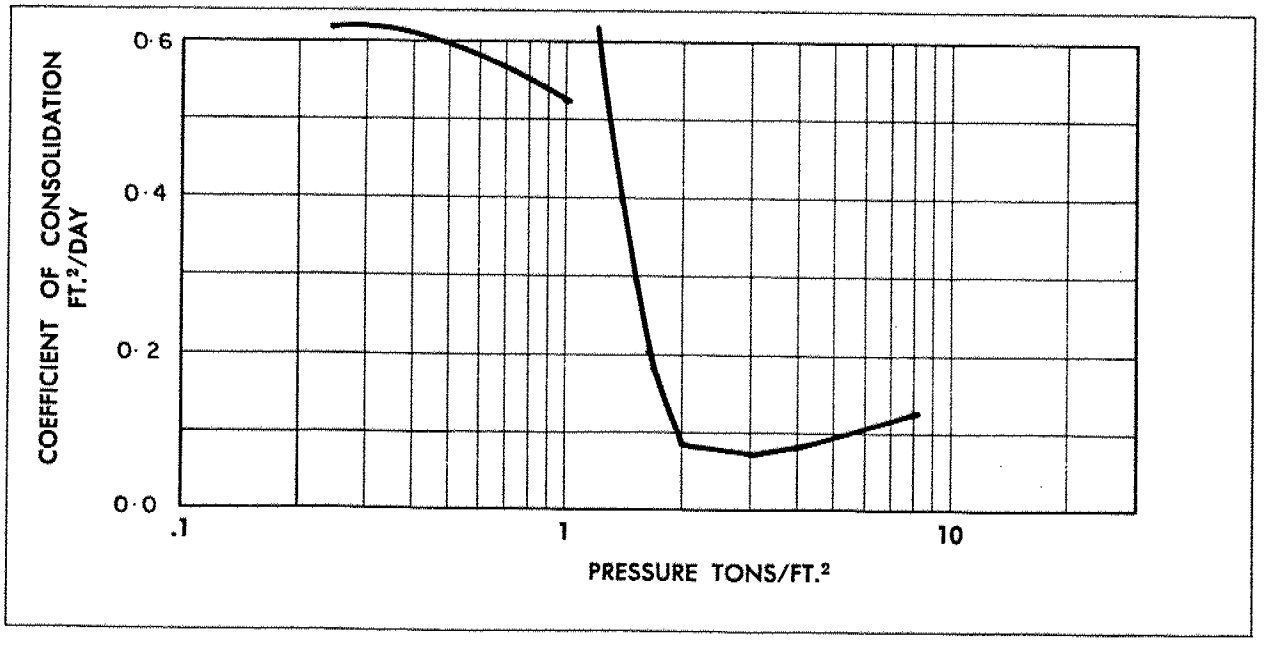
LIQUID LIMIT	%	=
PLASTIC LIMIT	%	=
PLASTICITY INDEX	%	=
MOISTURE CONTENT	%	=

ENCLOSURE Nº 8

DOMINION SOIL INVESTIGATION INC.

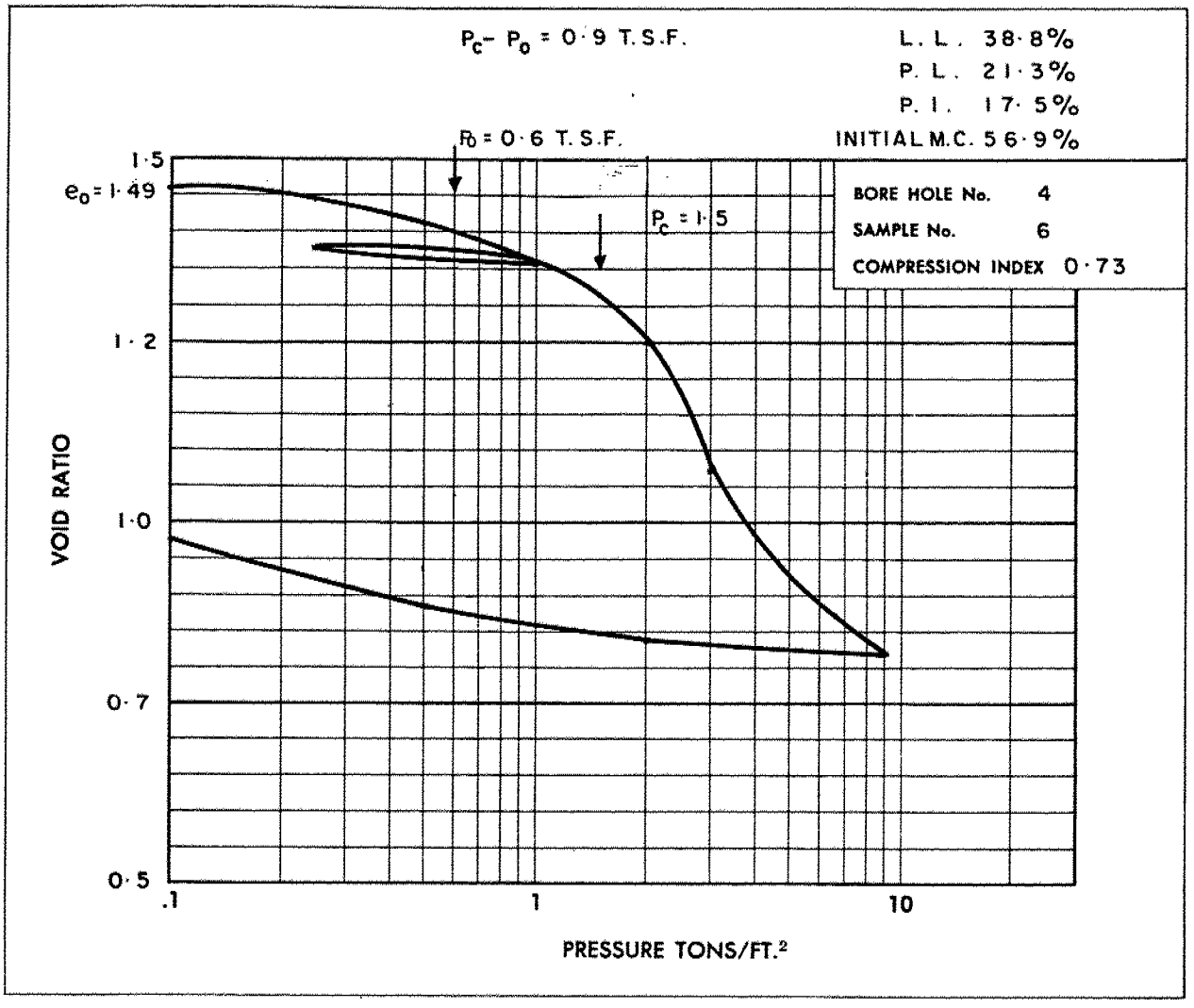
CONSOLIDATION TEST

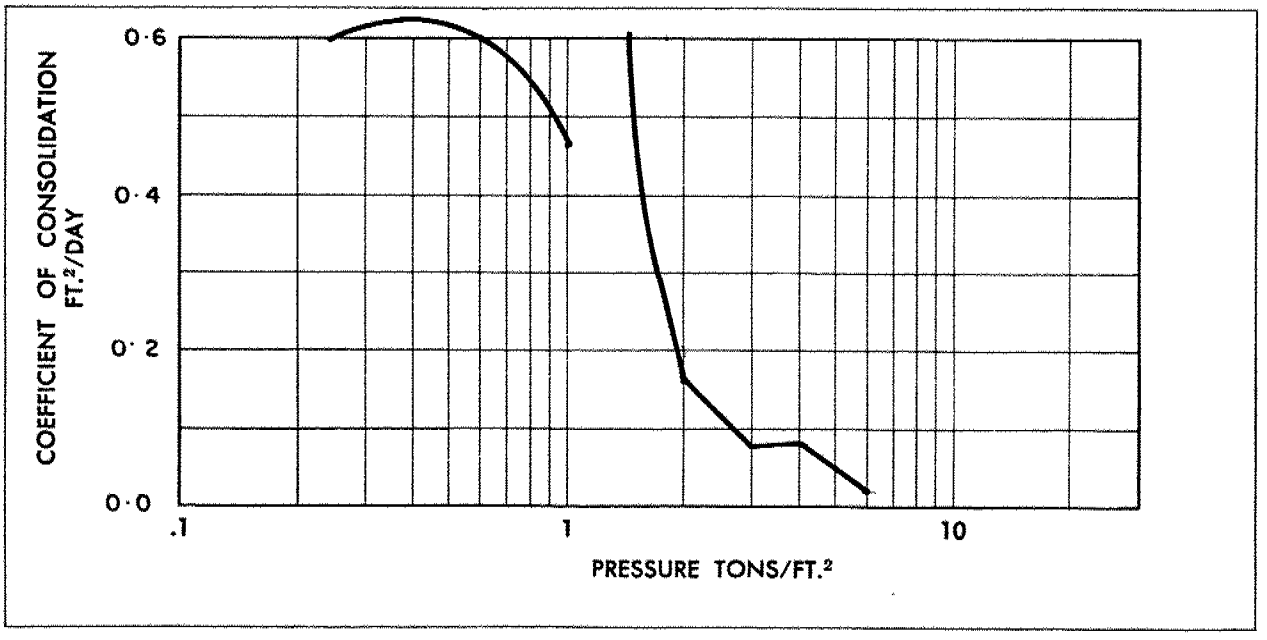


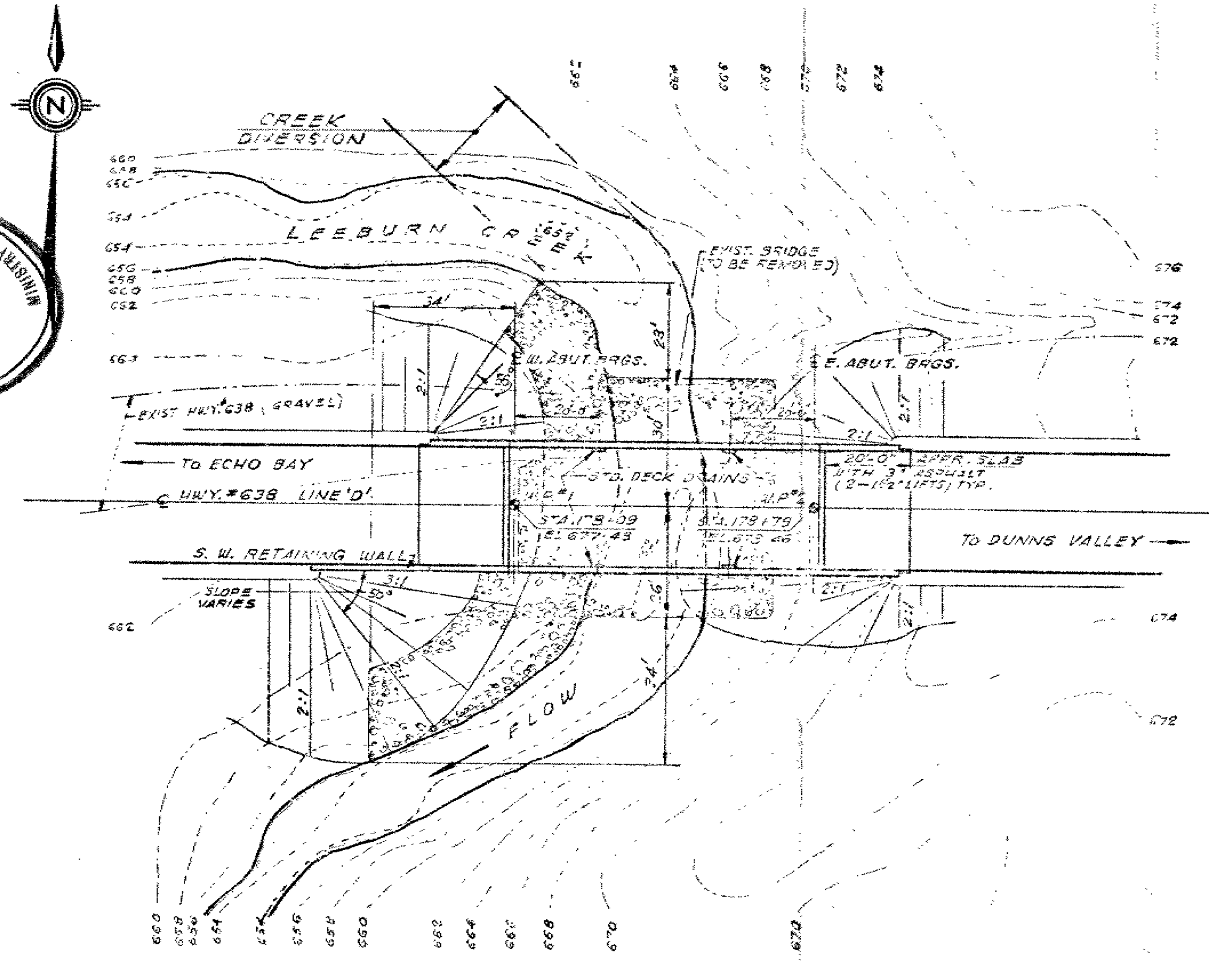


DOMINION SOIL INVESTIGATION INC.

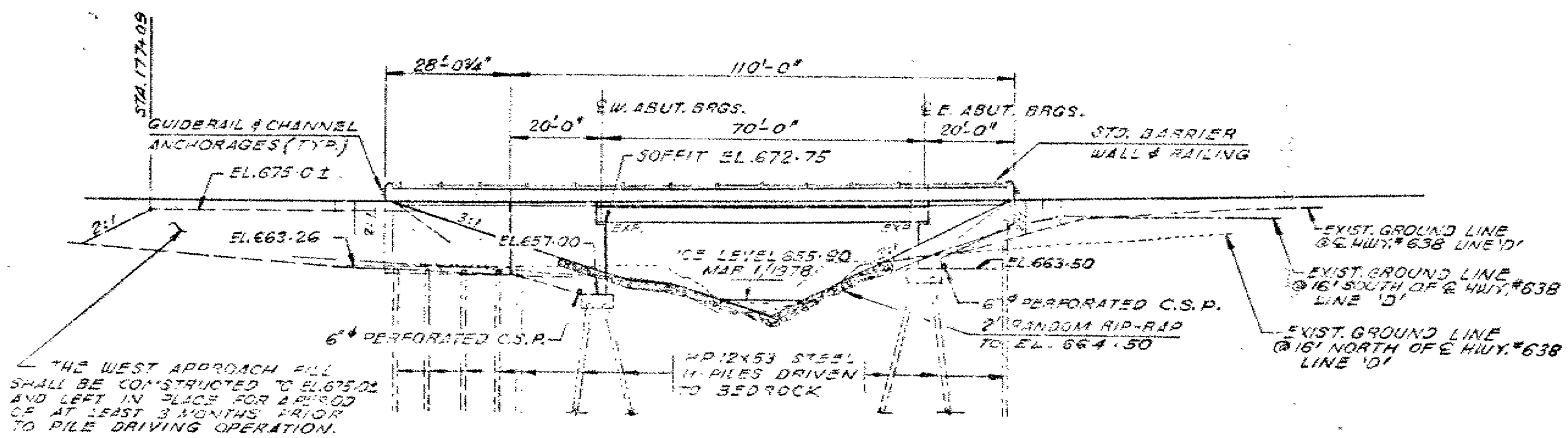
CONSOLIDATION TEST





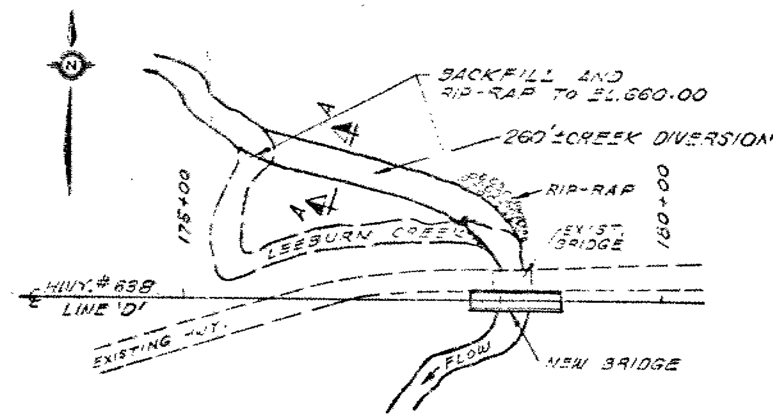


PLAN
1" = 20'-0"

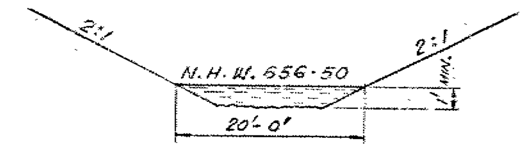


SOUTH ELEVATION
1" = 20'-0"

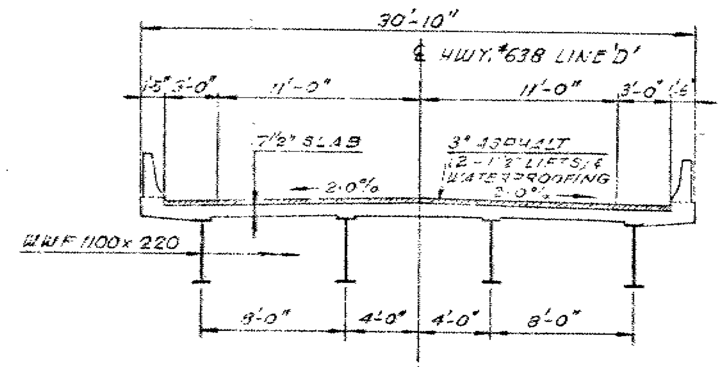
NOTE:
BOULDERS SHALL BE REMOVED & REPLACED WITH GRANULAR MATERIAL WHERE THEY INTERFERE WITH PILE DRIVING.



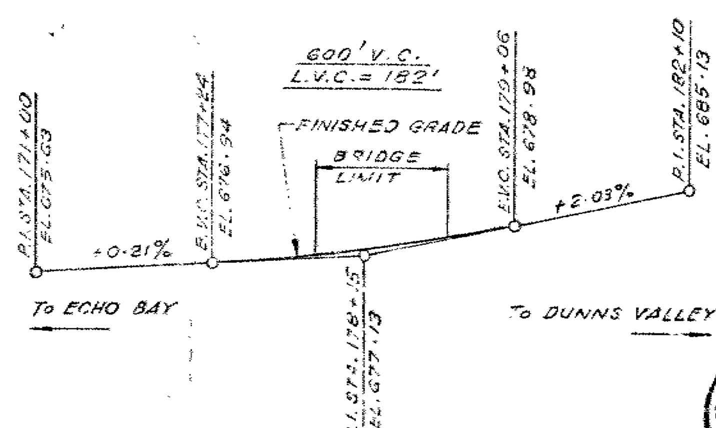
CREEK DIVERSION PLAN
1" = 100'



SECTION A-A
1" = 10'



TYP. DECK SECTION
3/16" = 1'-0"



PROFILE @ € HWY. #638 LINE 'D'
N.T.S.

DIST. 18
CONT No
WP No 19-76-04

LEEBURN CREEK BRIDGE
3.9 MI. WEST OF SEC. HWY. #561
GENERAL LAYOUT

SHEET

NOTES:

REINFORCING STEEL

GRADE 400

REINFORCING BARS WITH THE DESIGNATION 'C' AT THE END OF BAR MARKS SHALL BE COATED BARS.

CLASS OF CONCRETE

DECK & BARRIER WALLS ...... 4000 P.S.I.
REMAINDER .... 3,000 P.S.I.
AND/OR AS NOTED ON DRAWINGS.

CLEAR COVER ON REINFORCING STEEL

FOOTINGS, ABUTMENTS & RETAINING WALL ... 3"
DECK: TOP 2", BOTTOM 1½"
AND/OR AS NOTED ON DRAWINGS.

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEAT DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 1/8".

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

LIST OF DRAWINGS

385-122-1 GENERAL LAYOUT
-2 BORE HOLE LOCATIONS & SOIL STRATA
-3 FOOTING LAYOUT
-4 WEST ABUTMENT
-5 EAST ABUTMENT
-6 S. W. RETAINING WALL
-7 STRUCTURAL STEEL & BEARINGS
-8 DECK
-9 BARRIER WALL (NORTH SIDE)
-10 BARRIER WALL (SOUTH SIDE)
-11 STEEL RAILING (SINGLE TUBE)
-12 20 FT. APPROACH SLAB
-13 AS CONSTRUCTED ELEV. & DIM.
-14 STANDARD DETAILS I
-15 STANDARD DETAILS II

CONCRETE QUANTITIES
FOR LUMP SUM TENDER ITEMS

CONCRETE IN ABUTMENTS, WINGWALLS AND RETAINING WALL ...... 186 C.Y.
CONCRETE IN DECK ...... 59 C.Y.
CONCRETE IN BARRIER WALLS 16 C.Y.
CONCRETE IN APPROACH SLABS .. 35 C.Y.

STRUCTURAL STEEL QUANTITY
21 .... TONNE

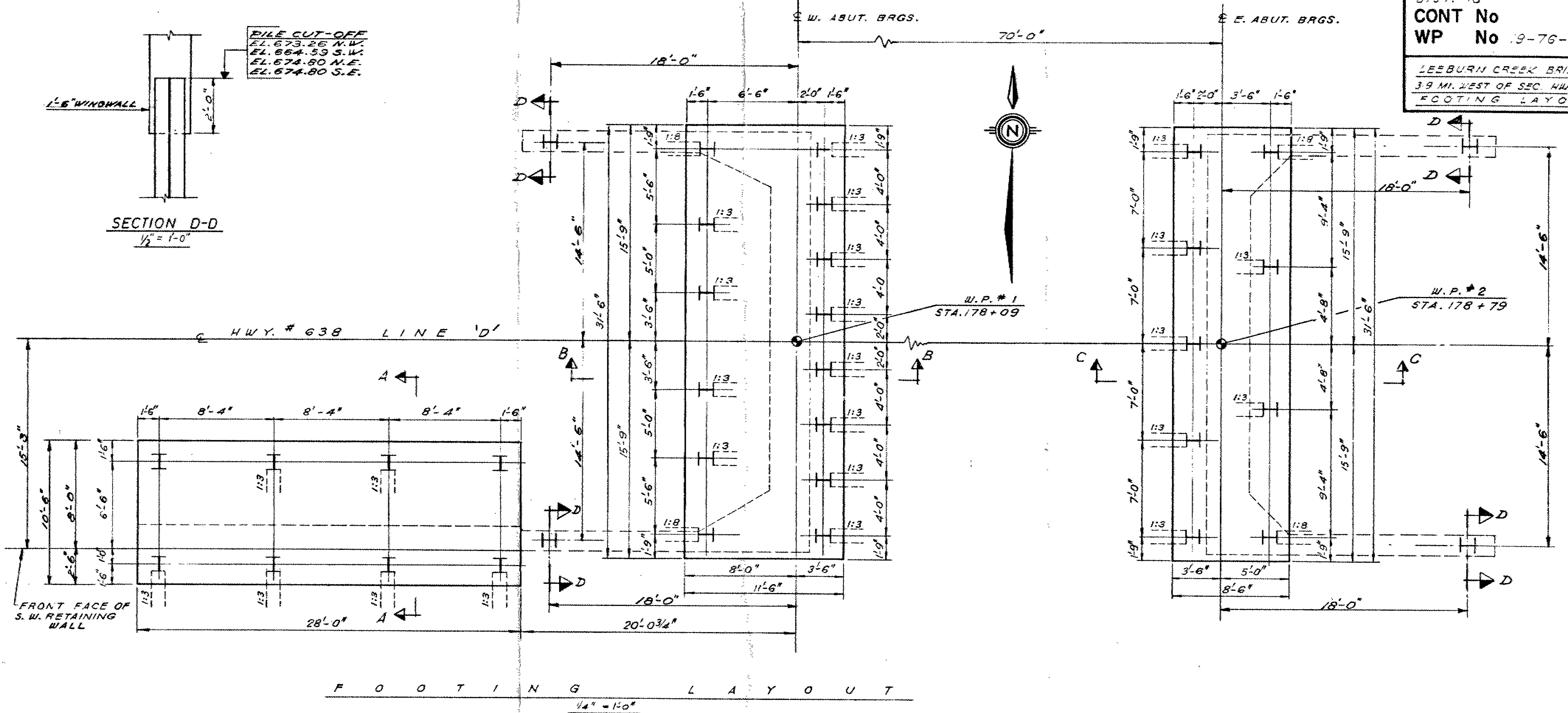
ASPHALT AND WATERPROOFING NOT PART OF THIS CONTRACT

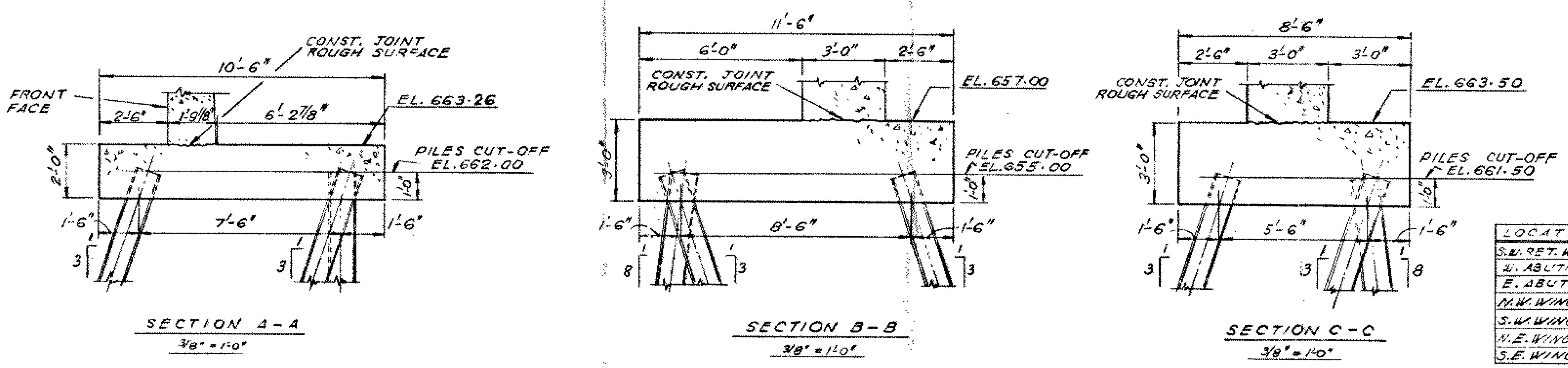
B.M. 674.97
GEODETIC DATUM

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





LIST OF STEEL H-PILES

LOCATION	TYPE	Nº REQ'D	LENGTH	REMARKS
S.W. RET. WALL	HP12×53	8	61'-0"	WITH DRIVING SHOES
W. ABUTMENT	HP12×53	14	57'-0"	
E. ABUTMENT	HP12×53	9	65'-0"	
N.W. WINGWALL	HP12×53	1	71'-0"	
S.W. WINGWALL	HP12×53	1	62'-0	
N.E. WINGWALL	HP12×53	1	75'-0"	
S.E. WINGWALL	HP12×53	1	75'-0"	

NOTE:
PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF.

P. O. LAW

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 3

DIST. 18
CONT No
WP No 9-76-04

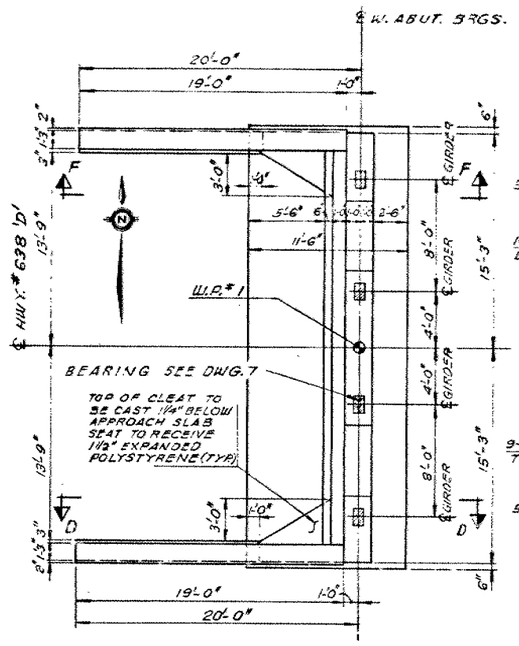
LEEBURN CREEK BRIDGE
3.9 MI. WEST OF SEC. HWY. # 561
FOOTING LAYOUT

SHEET

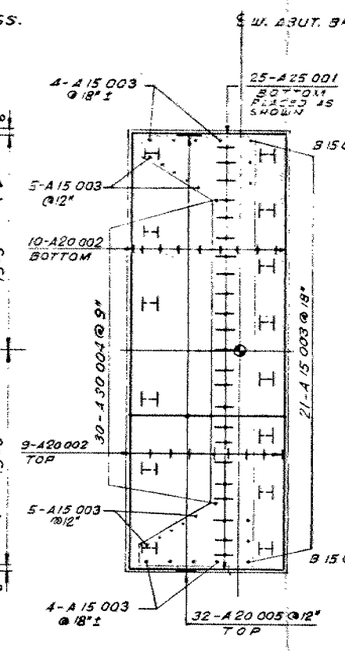
DIST. 18
CONT No
WP No 19-76-04

LEEBURN CREEK BRIDGE
3.9 MI. WEST OF SEC. HWY. #561
WEST ABUTMENT

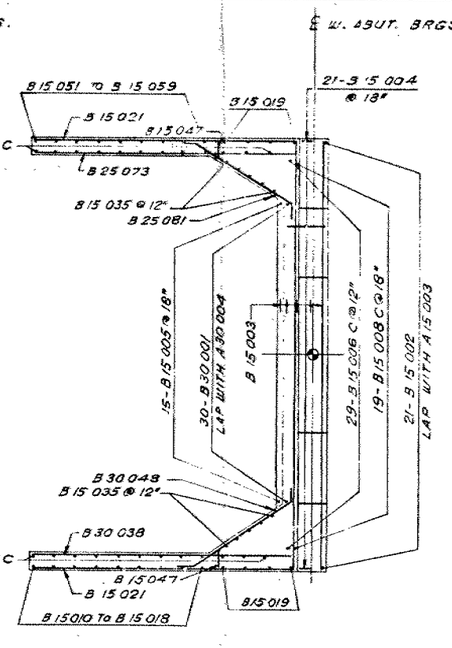
SHEET



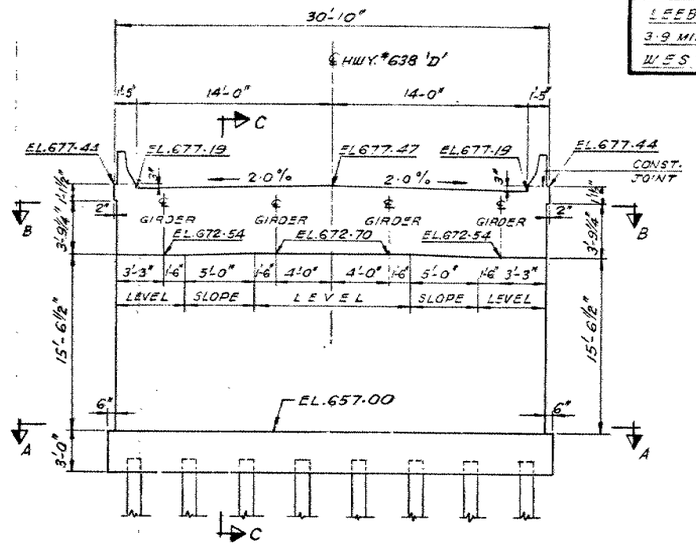
PLAN



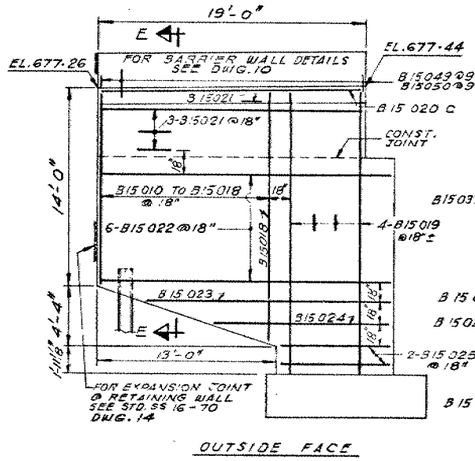
SECTION A-A



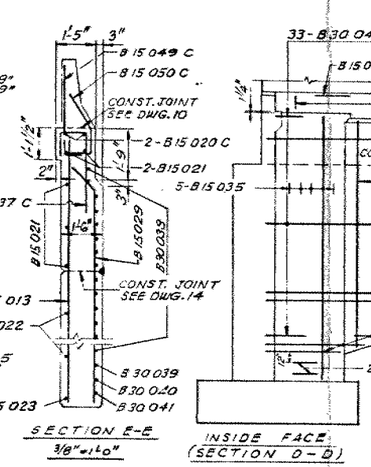
SECTION B-B



FRONT ELEVATION



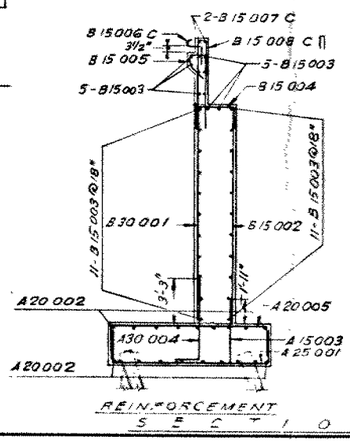
OUTSIDE FACE



SECTION E-E
3/8"=1'-0"

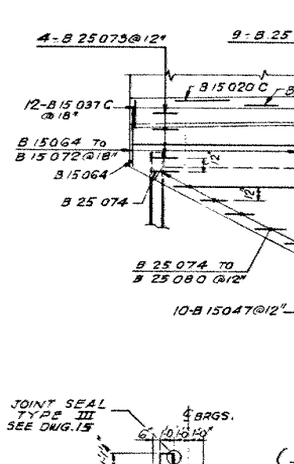
INSIDE FACE (SECTION D-D)

S.-W. WINGWALL DETAILS

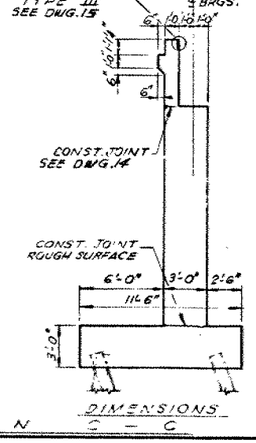


REINFORCEMENT

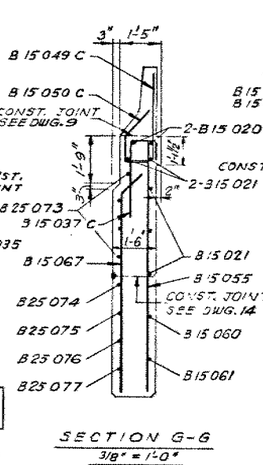
SECTION C-C



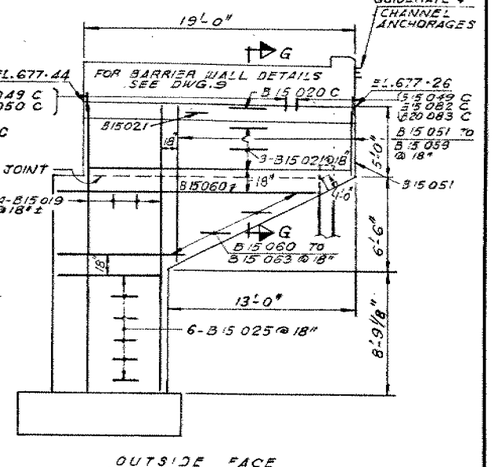
INSIDE FACE (SECTION F-F)



DIMENSIONS



SECTION G-G
3/8"=1'-0"



OUTSIDE FACE

N.-W. WINGWALL DETAILS

SCALE: 3/16"=1'-0"
UNLESS NOTED OTHERWISE

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

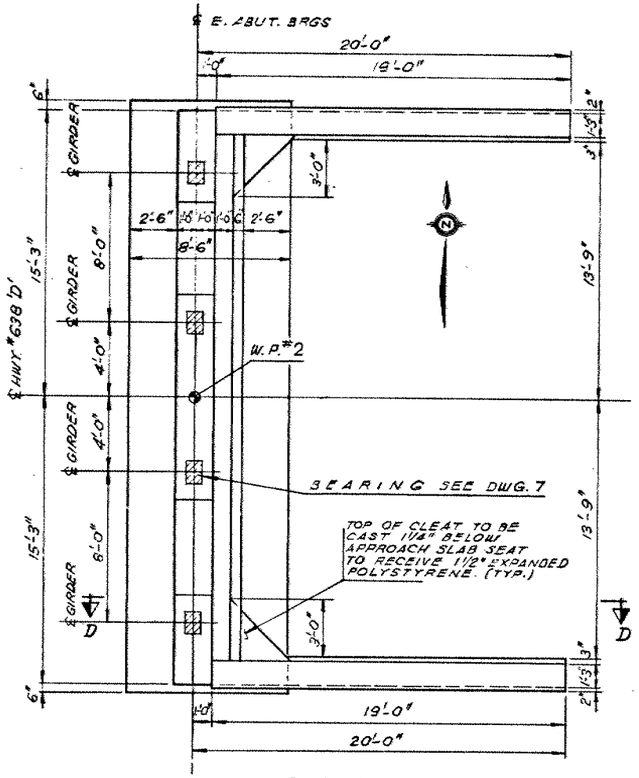
REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG

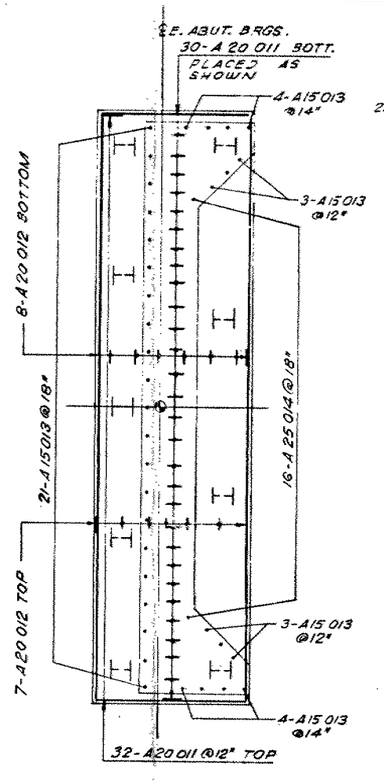
DIST. 18
CONT No
WP No 9-76-04

LEESBURG CREEK BRIDGE
3.9 MI. WEST OF SEC. HWY. #561
EAST ABUTMENT

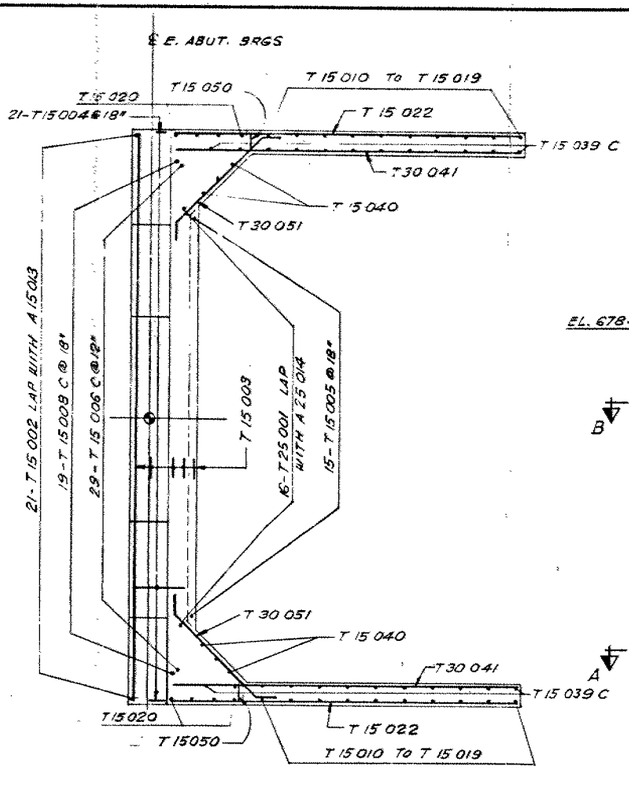
SHEET



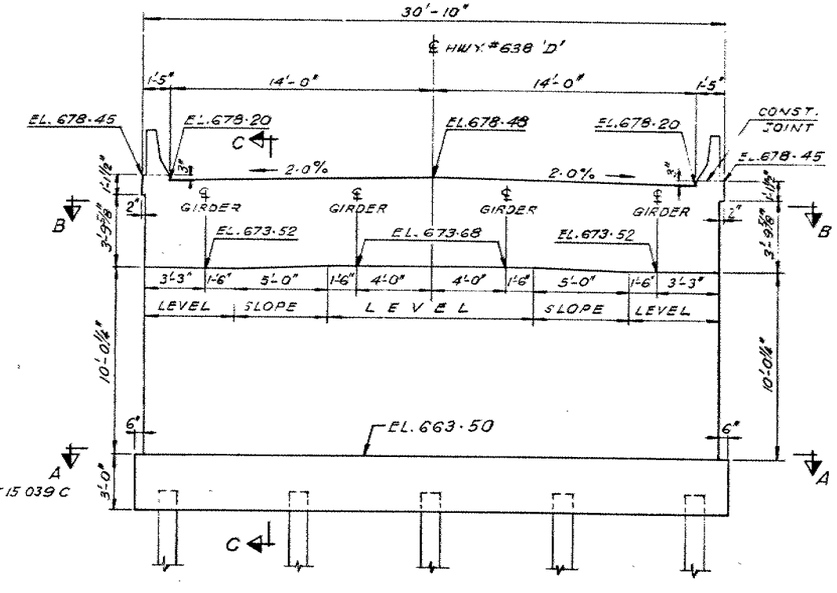
PLAN



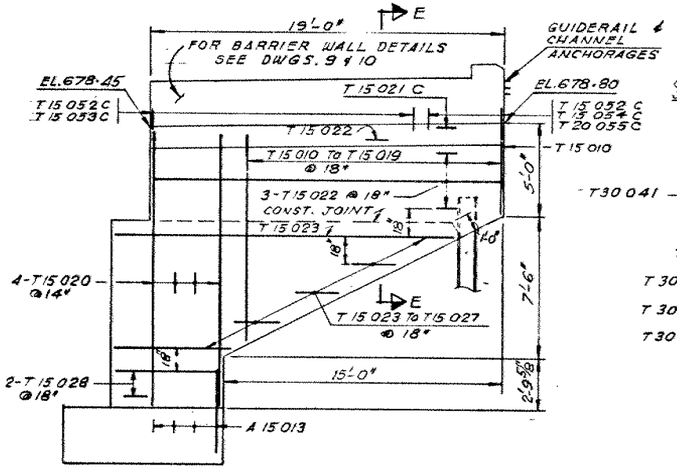
SECTION A-A



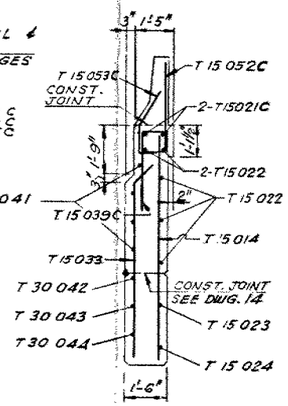
SECTION B-B



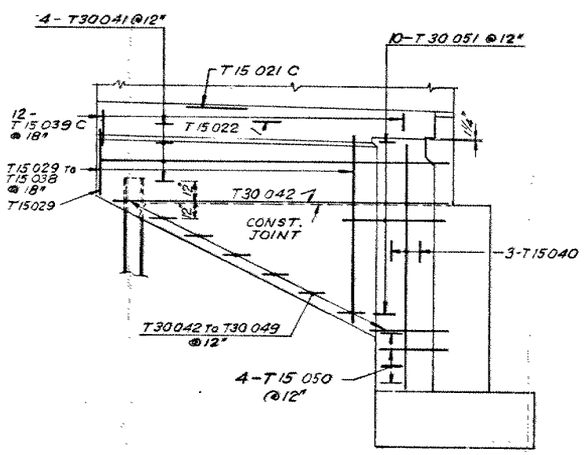
FRONT ELEVATION



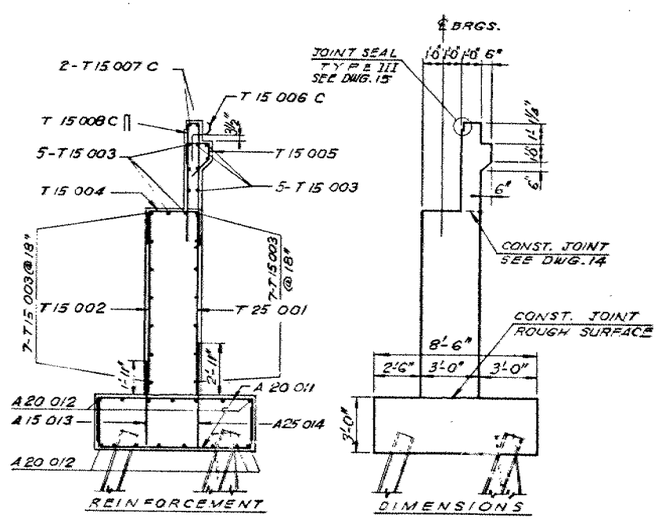
OUTSIDE FACE



SECTION E-E
3/8" = 1'-0"



INSIDE FACE (SECTION D-D)



REINFORCEMENT

DIMENSIONS

SECTION C — C

W I N G W A L L D E T A I L S

SCALE : 1/4" = 1'-0"
UNLESS NOTED OTHERWISE

CIVIL
P. Q. LAW

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 5

Mr. E. Van Beilen
Head, Northern and NW Section
Structural Office
2nd Floor, West Building

Mr. A. Radkowski

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 02 28

Re: Leeburn Creek Bridge
W.P. 19-76-04, Site 38S-122
District 18, Sault Ste. Marie

This memorandum summarizes our recent discussion with you concerning the design and construction of the foundations and the approaches of the above mentioned bridge.

1. Settlement under the approach embankments in the order of 13 inches can be anticipated. In order to minimize post-construction maintenance due to this settlement, it would be advisable that the approach fills be constructed and left in place for a period of at least three months. This preloading requirement was also mentioned in the foundation report and in our memorandum dated 78 11 07.

2. Since settlement of the proposed roadway embankments will be excessive, some negative skin friction forces can be imposed on the end-bearing piles supporting the abutments. These forces, combined with movement of subsoil due to strain imposed by the embankment loading, will generally tend to displace the piles laterally and can cause rotation of the abutments. In view of this, we recommend that consideration be given to supporting the extreme ends of the wing walls on end-bearing piles. Case histories have shown that this will improve the stability of the abutment in the longitudinal direction.

3. The pile length for the east abutment listed in Design Drawing #3 should be increased from 61 feet to 65 feet.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: W. Kulmatickas
C. Smith
D. Jarvis
D. Aspinwall
Files

Mr. A. Radkowski
Design Engineer
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 02 26

Re: Leeburn Creek Bridge
W.P. 19-76-04, Site 38S-122
Hwy. 638, District 18, Sault Ste. Marie

We have reviewed the final bridge plan drawings dated December, 1978 for the above mentioned structure.

The final structure plan is basically identical with the preliminary plan dated 78 10 04. Accordingly, we refer you to our memorandum dated 78 11 07 and recommend proper adherence to its contents.

V. Korlu
Project Engineer

VK/gs

cc: Files

Mr. E. Van Beilen
Head, Northern and NW Section
Structural Office
2nd Floor, West Building

Mr. A. Radkowski

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 11 07

Re: Leeburn Creek Bridge
W.P. 19-76-04, Site 38S-122
District 18, Sault Ste. Marie

We have reviewed the Preliminary Bridge Plan Drawing 38S-122-P1 for this project. Our comments are as follows.

1. Boulders and other debris in the river bed in the vicinity of the existing abutments and piers should be completely removed prior to placing fills and pile driving.

2. The piles should be fitted with reinforced tips.

3. A dewatering scheme may be required for the construction of the west abutment pile cap. Such a scheme could be composed of interlocking steel sheeting driven into the clay deposit to an elevation of 642.

4. The approach fills should be constructed and left in place for as long a period as permitted by project scheduling, preferably not less than three months.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: D.A. Jarvis
D. Aspinwall
Files

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. W. Kulmatickas
Head, Structural Section
Northwestern Region
Thunder Bay

Attention:

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Date: 78 08 11

Our File Ref.

In Reply to

Subject: Re: Foundation Investigation Report for
Proposed New Structure at the Crossing of
Leeburn Creek and Hwy. 638
W.P. 19-76-04, Site 38S-122
District 18, Sault Ste. Marie

The Ministry retained Dominion Soil Investigation Inc. to carry out a foundation investigation at the above mentioned site to provide factual data on the subsoil and the groundwater conditions, as well as to provide recommendations for the structure foundations and the related earthworks. The Consultant has recently submitted a foundation report. Our comments with regard to this report are as follows.

1. The structure should be supported on end-bearing piles driven to bedrock surface. In our opinion, steel H sections would be more suitable than tubular piles because of the artesian conditions encountered in the granular layer immediately above bedrock and the negative skin friction induced on the piles by the consolidation of the compressible layer.

2. The pile capacity should be reduced by 15% to account for the additional loads due to negative skin friction.

3. The existing rip-rap at the abutment locations where piles are to be driven should be removed prior to pile driving.

4. The additional fills required to raise the profile grade would induce large settlements in the underlying subsoil. Therefore, it would be advantageous that the approaches could be preloaded for as long a period as permitted by project scheduling.

The foundation report, in general, appears to be satisfactory for your design purposes. Should you require further clarification, please contact us.

B. Ly

B. Ly
Senior Engineer
BL/gs
cc: C.M. Smith, E. Van Beilen, R.S. Pillar, D.A. Jarvis, G.A. Wrong, R. Hore, W.A. Stewart, B.J. Giroux, Files ✓