

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M15-48

DIST. 7 REGION

W.P. No. 7-79-03

CONT. No. 82-03

W. O. No.

STR. SITE No. 21-173

HWY. No. 35/115

LOCATION Wilmut Creek Culvert  
Extension

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

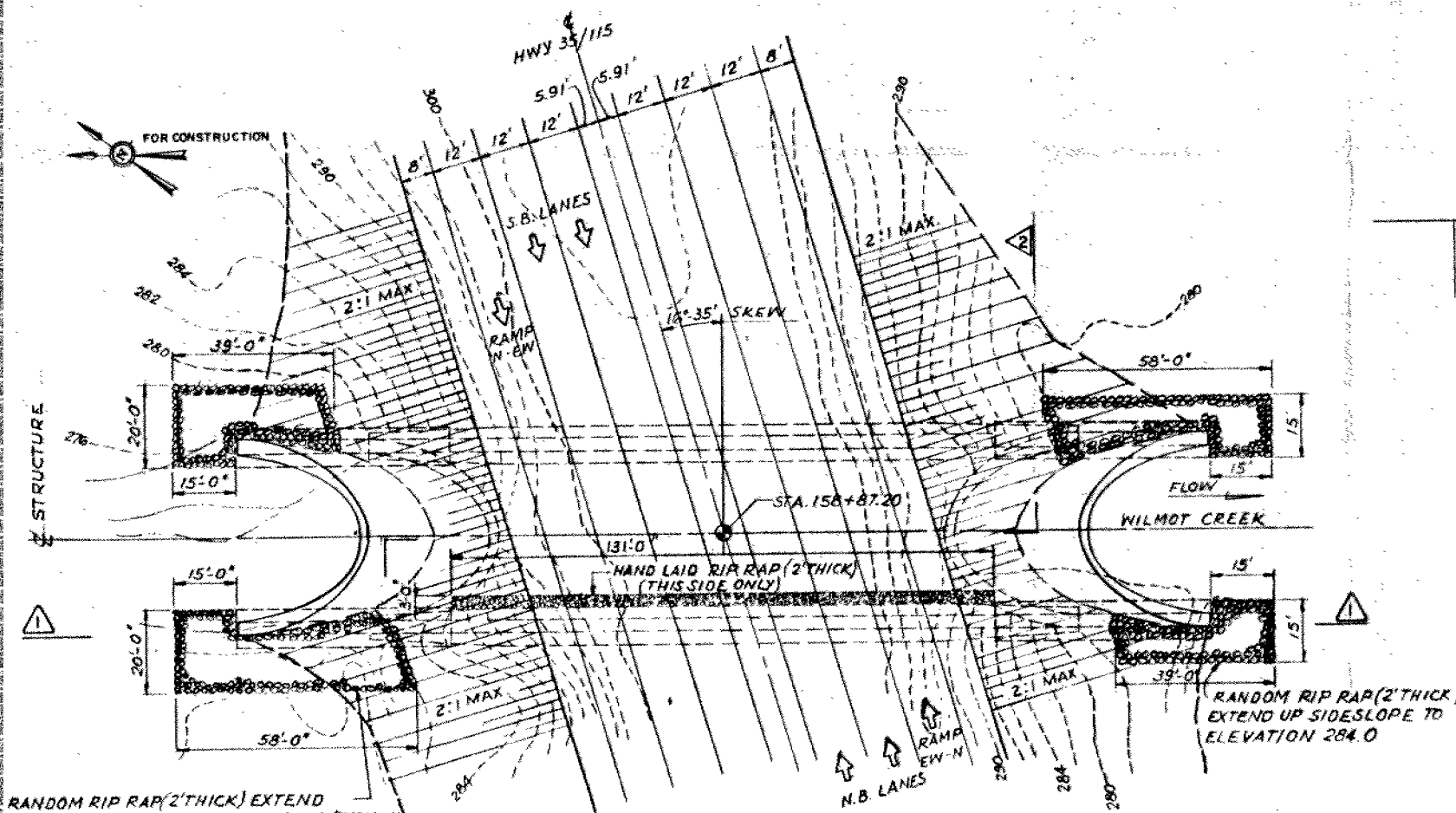
REMARKS:



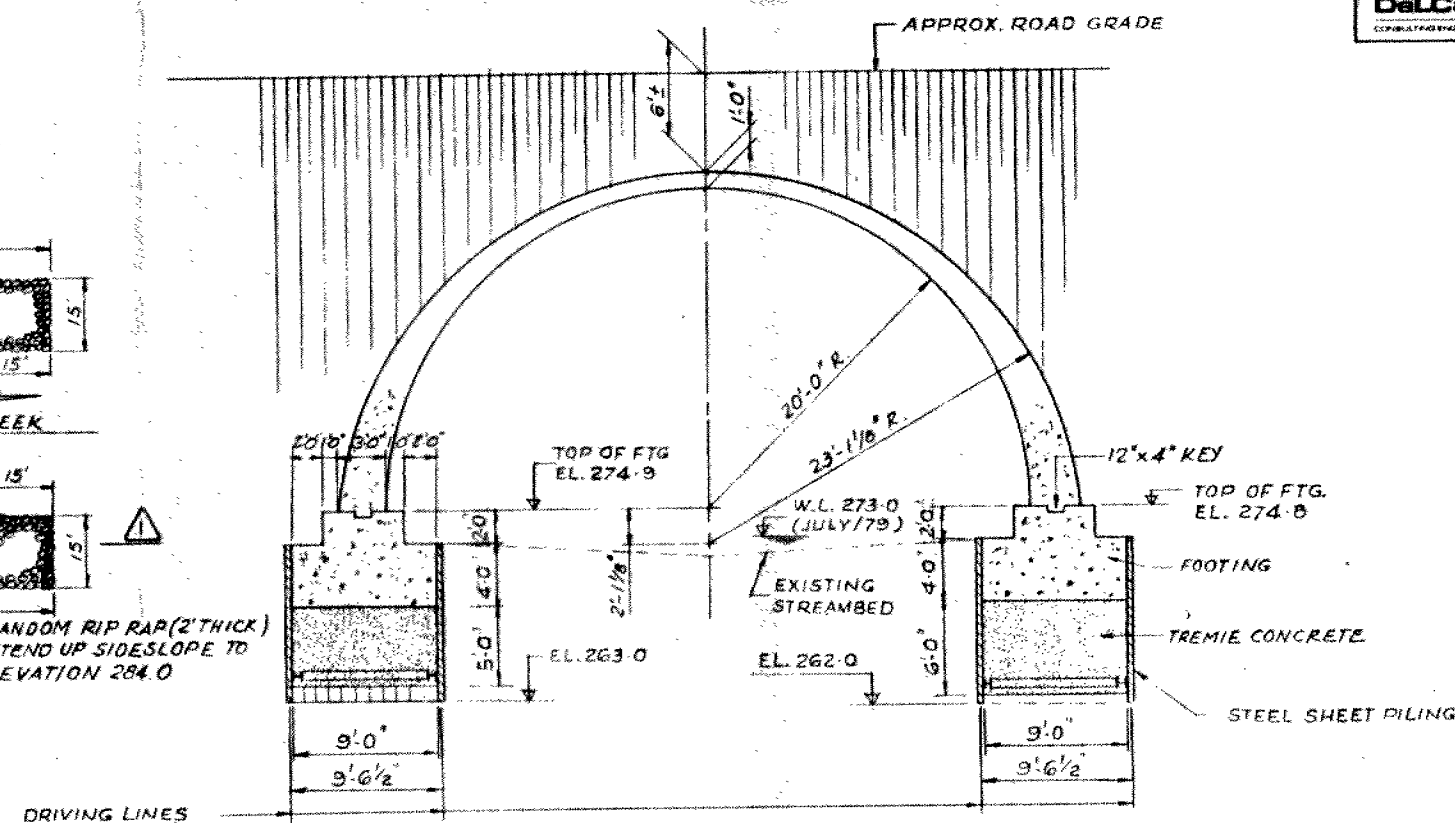
WILMOT CREEK  
ARCH CULVERT EXTENSION  
GENERAL LAYOUT

SHEET

DelCan  
CONSULTING ENGINEERS AND PLANNERS



PLAN  
1" = 20'-0"



1" = 6'-0"

GENERAL NOTES:

CLASS OF CONCRETE	
TREMIE SEAL	20 MPa
FOOTINGS	20 MPa
ARCH CULVERT	30 MPa

REINFORCING STEEL GRADE	
REINFORCING STEEL SHALL BE GRADE 400.	
CLEAR COVER TO REINFORCING STEEL	
FOOTINGS	3"
ARCH CULVERT	2 1/2"

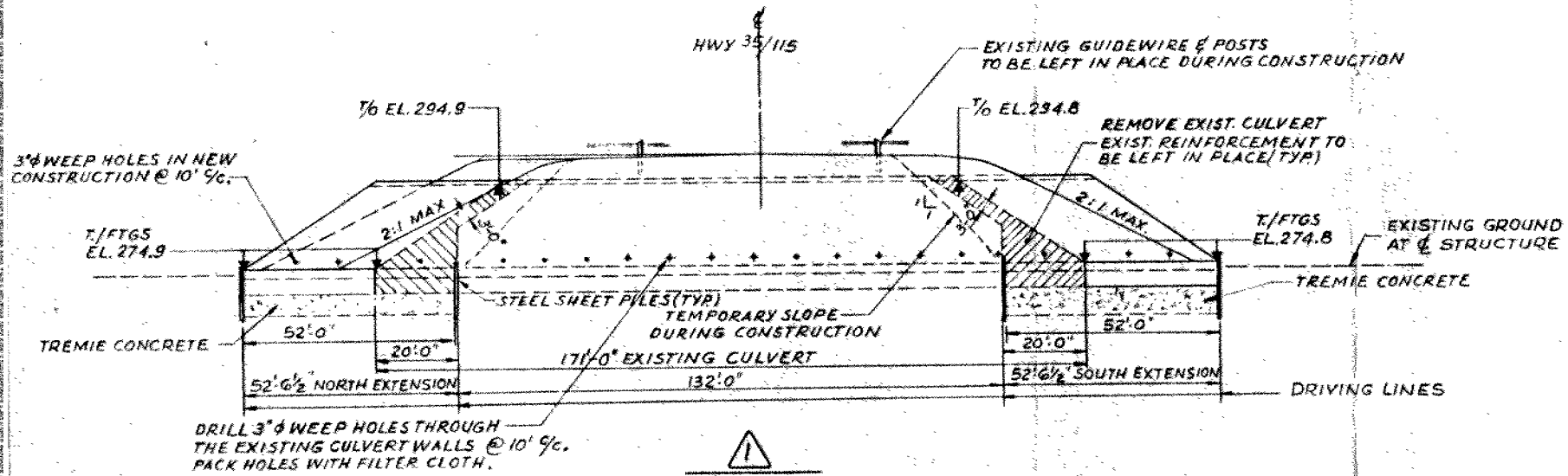
CONCRETE QUANTITIES	
CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE LUMP SUM CONCRETE TENDER ITEMS	
CONCRETE IN CULVERT	335 CU. YARDS.

CONSTRUCTION SEQUENCE:

1. DRIVE OUTSIDE STEEL SHEET PILES.
2. EXCAVATE AS SHOWN ON EXCAVATION DETAILS DRAWING TO ELEVATION 275.
3. DEMOLISH AND REMOVE EXISTING CULVERT (EXCLUSIVE OF FOOTINGS) AS SHOWN. EXISTING EXPOSED REINFORCEMENT SHALL BE LEFT IN PLACE.
4. COMPLETE DRIVING OF ALL STEEL SHEET PILES.
5. DEMOLISH AND REMOVE EXISTING FOOTINGS AS SHOWN.
6. EXCAVATE FOR NEW FOOTINGS AND PLACE BRACING FOR COFFERDAMS.
7. PLACE TREMIE CONCRETE.
8. PLACE REINFORCING BARS AND CONCRETE IN FOOTINGS.
9. ERECT FALSEWORK AND FORMWORK FOR ARCH CULVERT.
10. PLACE REINFORCING BARS AND CONCRETE IN ARCH CULVERT.
11. CUTOFF STEEL SHEET PILES.
12. BACKFILL TO ARCH CULVERT SHALL BE PLACED ON BOTH SIDES SIMULTANEOUSLY. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION OF THE OPPOSITE BACKFILL EXCEED 2 FEET.
13. PLACE RIP-RAP AS SHOWN.
14. CONSTRUCT WEEP HOLES IN EXISTING STRUCTURE.

LIST OF DRAWINGS:

21-173-1	GENERAL LAYOUT
21-173-2	BOREHOLE LOCATION AND SOIL STRATA
21-173-3	EXCAVATION DETAILS
21-173-4	FOUNDATION LAYOUT
21-173-5	DETAILS AND REINFORCEMENT



1" = 20'-0"



DRAWING NOT TO BE SCALED

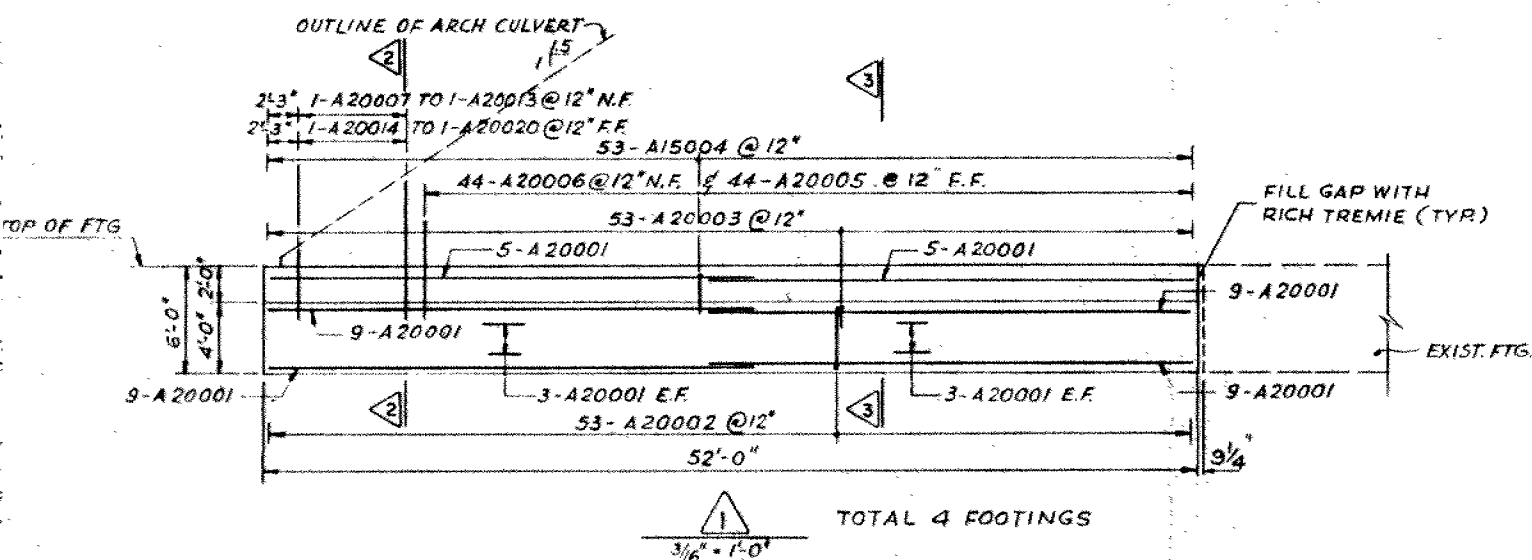
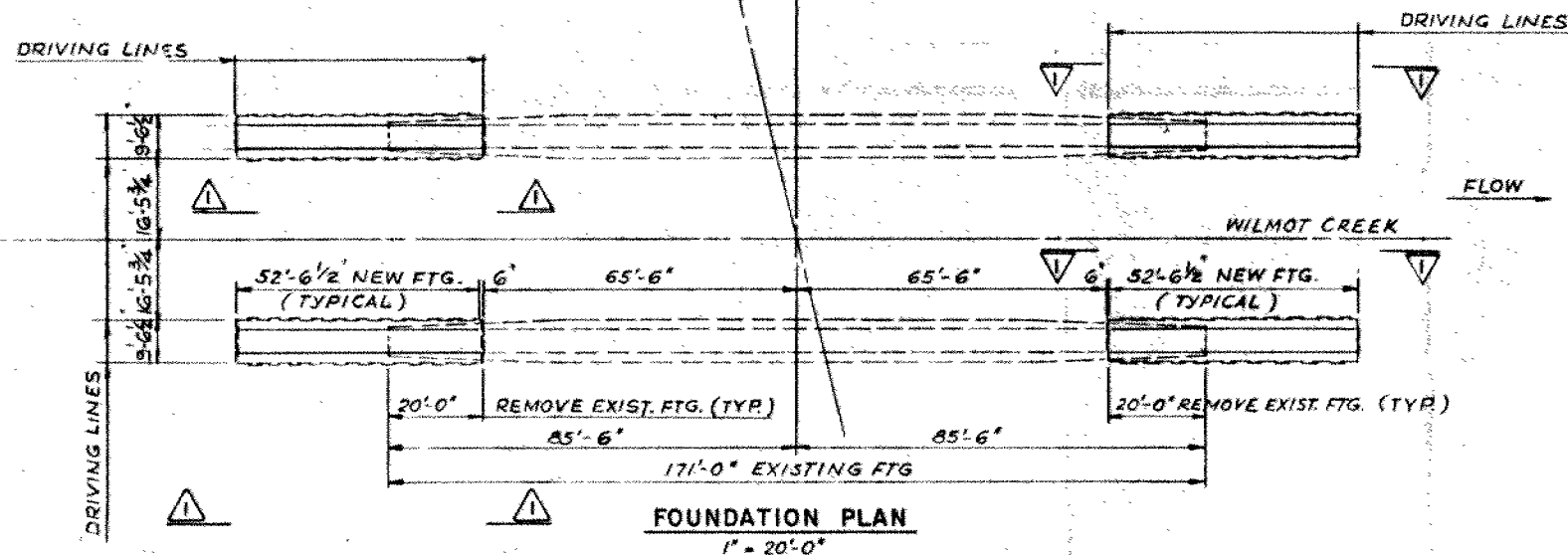


REVISIONS	DATE	BY	DESCRIPTION
DESIGN M.S.	CHECK V.A.	LOADING H.S. 20-44	DATE: 3.8.80
DRAWING R.G.	CHECK M.S.	SITE No 21-173	DWG 1



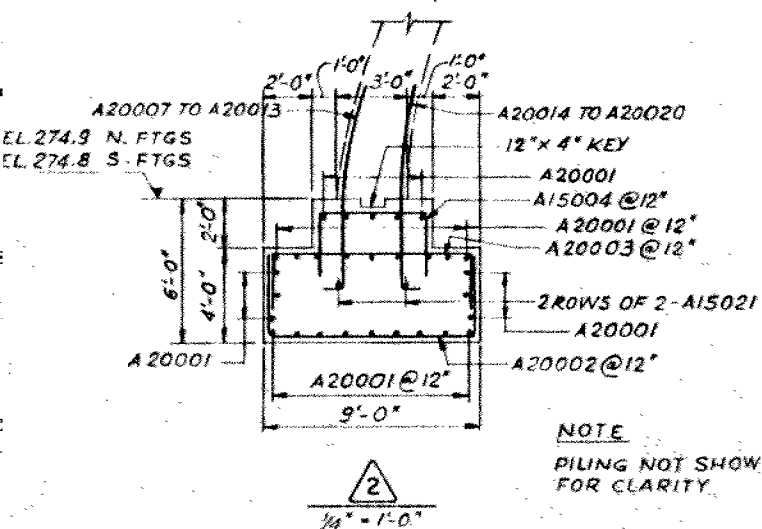


HWY 35/115  
16°35' SKEW

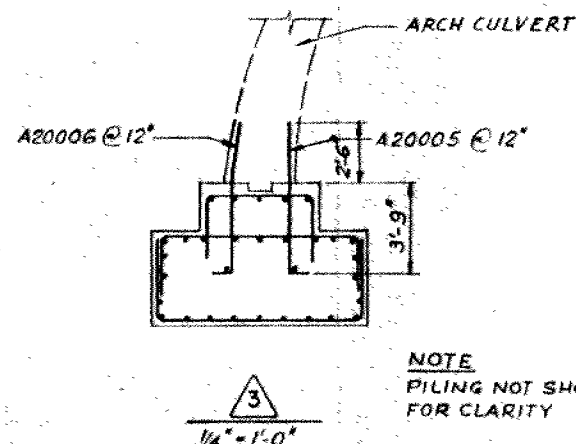


TOTAL 4 FOOTINGS

NOTE  
PILING NOT SHOWN FOR CLARITY



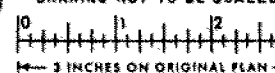
NOTE  
PILING NOT SHOWN  
FOR CLARITY



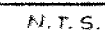
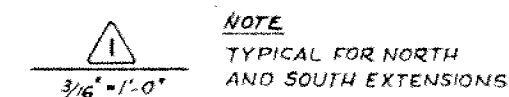
NOTE  
PILING NOT SHOWN  
FOR CLARITY



DRAWING NOT TO BE SCALED



REVISIONS	DATE	BY	DESCRIPTION
1	10/1/80	M.S.	DESIGN
2	10/1/80	R.G.	CHECK
3	10/1/80	M.S.	LOADING
4	10/1/80	M.S.	HS 20-44
5	10/1/80	M.S.	DATE
6	10/1/80	M.S.	DWG



10                      11                      12

[illegible]

cont. 82-03



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# foundation investigation and design report

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	79 11 14	MA
TUBES	—	—
ROCK CORES	the remainder of cont	MA

Cont 82-03

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 7-79-03

DIST 7

HWY 35/115

STR SITE 21-173

Wilmot Creek Culvert Extension

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## FOUNDATION INVESTIGATION REPORT

For

Wilmot Creek Culvert Extension  
W.P. 7-79-03, Site 21-173  
Hwy. 35/115, District 7, Port Hope

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### INTRODUCTION

This report contains the results of a foundation investigation carried out at the above site. Four sampled boreholes, each accompanied by a dynamic cone penetration test were carried out on March 19 to March 22, 1968 using a skid mounted diamond drill for wash boring with NX casing. In addition two sampled borings were also carried out on September 13, 1979 using hollow stem augers to advance the borings. These boreholes were advanced to depths of 10 to 26 feet below ground surface and bedrock was proven by obtaining up to 5 feet of rock core in three of the sampled boreholes.

### SITE DESCRIPTION

The site is located at the present crossing of Hwy. 35/115 over Wilmot Creek, situated about 1.5 miles north of Hwy. 401; within the Town of Newcastle, Regional Municipality of Durham.

The site topography is hilly. Wilmot Creek has cut a channel some 60 to 80 feet wide and up to 10 feet deep below the average ground surface with near vertical banks. To the north-east of the creek the ground rises rapidly at slopes as steep as 1.5:1 to a generally rolling plane some 45 feet above creek level. To the southwest, the ground rises very gradually. Wilmot Creek itself flows southeasterly over a cobble and boulder bed with a depth of water varying from 2 to 24 inches.

The highway crosses the creek at a skew of about 106 degrees. The crossing is facilitated by an existing 38 foot x 20.5 foot concrete arch culvert, some 170 feet long. Associated with this structure are existing fill embankments in the order of



28 feet high which show no signs of instability. Immediately downstream of the Hwy. 35/115 crossing is an abandoned single lane, single span (38') steel beam structure with timber deck . The structure foundations are in good condition.

Physiographically the site is located in the Iroquois Plain. This region is characterized by a clay plain which has been smoothed by wave action. Bordering this plain is Lake Ontario to the south and the old shoreline of glacial Lake Iroquois to the north. The old shoreline is distinguished by cliffs bars and beaches with an undulating till plain above.

#### SUBSURFACE CONDITIONS

##### General

Uniform soil conditions prevail across the site, consisting of 12 to 18 feet of stiff to hard glacial till overlying limestone bedrock. In some areas fill material composed of clayey silt, sand and gravel with organics was found overlying the glacial till.

The boundaries between the various soil and rock types are shown on the attached Record of Borehole Sheets. The locations and elevations of the boreholes are shown on Drawing No. 77903-A together with two stratigraphical sections inferred from the boreholes.

Following is a brief description of the various soil and rock types encountered.

##### Fill Material (Clayey Silt, Sand and Gravel Trace of Organics)

On two borings put down northwest of the highway, fill material was encountered. This surficial stratum is composed of a mixture of brown clayey silt, sand and gravel with organic inclusions and was found to extend to a total depth of about 3 feet in these areas. Dynamic cone penetration tests indicate that the fill material is in a loose state of compaction.

### Creek Bed Deposits (Cobbles and Boulders and Medium Sand, Trace Gravel)

These granular deposits were encountered in the two borings put down southeast of the highway and extends from the creek bed down to the glacial till. These recent alluvial deposits are composed of a zone, up to two feet thick, of cobbles, generally 3 to 5 inches in size, and boulders up to 2 feet in size. In the boring put down southwest of the creek, the creek bed deposit is some 4 feet thick, the lower 2 feet being composed of medium sand with a trace of gravel. Based on the nature of the augering operation, the creek bed deposits are inferred to be in a compact state of relative density.

### Glacial Till

This is the predominate deposit across the site extending from the parent ground surface some 12 to 18 feet down to the limestone bedrock. The texture of material clearly shows the deposit to be of glacial origin, being composed of a heterogeneous mixture of clayey silt, sand and gravel with plasticity generally decreasing with depth. In one borehole, B.H.#5, occasional cobbles up to 6 inches in size were encountered within this deposit below elevation 264.0. The upper 2 to 8 foot zone of this cohesive glacial deposit is in a reworked state and contains occasional sand and gravel seams up to 6 inches thick.

The results of grain size distribution testing on representative samples from this deposit are shown in envelope form on Figure 1 in the Appendix of this report. The results of Atterberg Limit tests are plotted on the Plasticity Chart, Figure 2. These results are summarized below.

		<u>Range</u>	<u>Average</u>
Natural Moisture Content	w%	8 - 15	9
Liquid Limit	w <sub>p</sub> %	9 - 15	12
Plastic Limit	w <sub>L</sub> %	12 - 32	20
Plasticity Index	I <sub>p</sub> %	6 - 16	8

Based on the Atterberg Limit testing, the glacial matrix can

be described as an inorganic clay of low plasticity.

Standard Penetration Testing carried out within this deposit gave 'N' values ranging from 4 to 31 blows per foot in the upper reworked zone and from 56 to over 100 blows per foot in the lower zone. The consistency as inferred from this data is stiff in the upper zone and hard in the lower portion.

#### Limestone Bedrock

Bedrock was proven in three of the borings by obtaining up to 5 feet of AXT or BXL size rock core. Elsewhere the bedrock surface was taken to be at the point of refusal to augering. The bedrock surface was found to be at a depth of 14.5 to 18.5 feet below existing ground surface, corresponding to elevation 257 to 260. The bedrock may be described as limestone, fine to medium texture. The upper 2.5 feet of bedrock in Borehole #5 was found to be in a fractured or jointed condition, elsewhere the bedrock is sound.

#### Groundwater Conditions

Groundwater conditions level observations were carried out during the course of the investigation by measuring in the boreholes. These observations are shown on the Record of Borehole Sheets as well as on Drawing No. 77903-A. During the March, 1968 investigation, the water level was found to be 1.5 to 4.0 feet below ground surface which corresponds to elevation 274 to 277. At this time, the creek water level was measured to be at elevation 273.0 (March, 1968). These observations indicates a steep hydraulic gradient towards the creek. In the recent investigation, the creek water level was found to be at elevation 272.6 (September, 1979).

## DISCUSSION AND RECOMMENDATIONS

It has been proposed to upgrade the existing two lane Hwy. 35/115 to four lane requirements in this general area. The present structure, at the crossing of Wilmot Creek and Hwy. 35/115 will be widened to accommodate future four lane traffic at the crossing. Present proposals are to extend the existing 38 foot span concrete barrel arch culvert some 34 feet at both ends. The grade of Hwy. 35/115 will be maintained at the same elevation as of the existing highway.

Subsoil conditions here consist of up to 18 feet of stiff to hard cohesive glacial till overlying limestone bedrock. In some areas, the glacial till is overlain by a shallow deposit of fill material and in the creek bed, the glacial till is overlain by up to 4 feet of cobbles and boulders or medium sand with a trace of gravel.

### Structure Foundations

The proposed footings of the concrete barrel arch culvert can be supported on spread footings located within the hard glacial till deposit. The base of the footing foundation should be provided with a minimum of 4 feet of earth cover for frost protection purposes. Furthermore, the footing should be located below the possible scour depth. These restraints would place the new footing founding level at approximate elevation 269 which corresponds to the existing footing formation level. This founding level is located within the competent hard glacial till stratum on the northwest of the highway. However, southeast of the highway this founding level is situated within a reworked glacial till stratum.

The northwest extension (upstream end) of the proposed barrel arch footing can be supported on spread footings using an allowable bearing pressure up to 4.0 tsf. However for the southeast extension (downstream end) the spread footing support should be designed for an allowable load of not greater than

2.0 tsf in view of the reworked state of the glacial till deposit. If larger loads are required, the alternative will be to sub-excavate the reworked zone down to elevation 263 ± and replace with mass or tremie concrete to the new footing formation level. In such a case, an allowable bearing pressure of up to 4.0 tsf may also be used for this extension. The anticipated differential settlements for both the alternatives should not exceed ½ inch.

Although differential settlements between the existing culvert and extension will be small, it will be necessary to accommodate them by means of vertical construction joints between the existing culvert and the extension.

For the northwest extension, no major dewatering problems are anticipated because of the relatively impervious nature of the subsoil on this side; although care should be exercised to prevent softening of the foundation material by surface water. However, the southeast extension will require excavations below the water table through a reworked glacial till which contains some sand and gravel seams up to 6 inches thick. Excavation through this material to competent glacial till can be most economically accomplished underwater utilizing tremie concrete to bring up the excavation to the footing founding level. In order to pour the footings in the dry, a temporary stream diversion will be necessary. A temporary earth dike could be utilized, however it will be necessary to check with the Environmental Office to determine if this method is satisfactory from an environmental viewpoint. Alternatively, sheet piling could be adopted to close off the areas for footing construction during excavation. Another method would be to provide temporary pipe of sufficient capacity to carry the creek water.

#### Approach Embankments

The existing embankment fills are in the order of 28 feet above the creek bed. No signs of distress are evident in these embankments. As mentioned previously, the proposed

grade will be approximately at the same grade as existing and no stability problems are anticipated provided the following is adopted:

- 1) Slopes do not exceed 2:1.
- 2) Embankment widening is carried out in accordance with M.T.C. benching standard.

#### MISCELLANEOUS

The fieldwork in March, 1968 was carried out under the supervision of Mr. V. Korlu, Project Foundation Engineer. The fieldwork in September, 1979 was carried out under the supervision of Mr. M. MacLean, Project Foundation Engineer. The equipment used during the 1968 and 1979 investigation was owned and operated by Dominion Soil Investigation, Inc., Toronto.

This report was written by Mr. M. MacLean and reviewed by Mr. M. Devata, Senior Foundation Engineer.



*M Maclean*

M. MacLean, P. Eng.  
Project Foundation Engineer.

*M. Devata*

M. Devata, P. Eng.  
Senior Foundation Engineer.

October, 1979.

APPENDIX

# RECORD OF BOREHOLE No 1

W P 7-79-03 LOCATION Co-ords. N 15,958,321; E 1,234,014 ORIGINATED BY RR  
 DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR  
 DATUM Geodetic DATE September 13, 1979 CHECKED BY ES

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
272.6	Water Level																
0.5	Cobbles some boulders compact						270										
2.5	Medium sand, trace gravel, compact		1	SS	29												
4.5	Heterogeneous mixture. Clayey silt		2	SS	10												
	Stiff		3	SS	31												
	Sand, trace of gravel		4	SS	102		260										3 16 51 30
257.4	Glacial Till		5	SS	100/4												
			6	SS	100/5												
15.2	Refusal to augering. Probable bedrock																
	End of Borehole																

3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 2

W P 7-79-03 LOCATION Co-ords. N 15,958,335; E 1,234,040 ORIGINATED BY RR  
 DIST 7 HWY 35/115 BOREHOLE TYPE Hollow Stem Augers and BXL Rock Core COMPILED BY RR  
 DATUM Geodetic DATE September 13, 1979 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100					
272.6	Water Level															
0.5	Cobbles & Boulders															
2.0	Heterogeneous mixture of Clayey silt, sand		1	SS	25											20 38 31 11
	Stiff		2	SS	8											
	Trace of sand		3	SS	17											
	Hard		4	SS	80											15 29 32 24
258.1	Glacial Till		5	SS	100											
14.5	Limestone bedrock		6	SS	100											
255.6	Sound		7	BX RC	95%											
17.0	End of Borehole															



RECORD OF BOREHOLE No 3 (Formerly B.R.#3 - W.P.301-66-0)

W P 7-79-03 LOCATION Co-ords. N 15,958,469, E 1,233,889 ORIGINATED BY VK  
DIST 7 HWY 35/115 BOREHOLE TYPE Diamond Drill-NX Casing and Cone Test COMPILED BY WH  
DATUM Geodetic DATE March 21, 1968 CHECKED BY PS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
281.0	Ground Level																
0.0	Fill mat'l. clayey silt																
278.0	sand & gr. with some org																
3.0	Heterogeneous mixture of clayey silt, sand and gravel		1	SS	20												
	Stiff		2	SS	59												
	Hard		3	SS	144												
	Glacial Till		4	SS	100	5"											
260.0			5	SS	155												
21.0	(Sound)		6	AXT RC	100% REC												
255.0	Limestone Bedrock																
26.0	End of Borehole																



RECORD OF BOREHOLE No 4

(Formerly B.H.#4 - W.P.301-66-0)

W P 7-79-03 LOCATION Co-ords. 15,958,518; E 1,233,837 ORIGINATED BY VK  
DIST 7 HWY 35/115 BOREHOLE TYPE Diamond Drill - NX Casing and Cone Test COMPILED BY WH  
DATUM Geodetic DATE March 22, 1968 CHECKED BY ES

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
279.3	Ground Level															
0.0	Fill mat'l. (Clayey silt, sand & gr. with organics)															
276.3																
3.0	Heterogeneous mixture of clayey silt, sa. & gr. Glacial Till		1	SS	4											
			2	SS	50											
268.8			3	SS	95											
10.5	End of Borehole															

# RECORD OF BOREHOLE No 5 (Formerly B.H.#1 - W.P.301-66-0)

W P 7-79-03 LOCATION Co-ords. N 15,958,556; E 1,233,900 ORIGINATED BY VK  
 DIST 7 HWY 35/115 BOREHOLE TYPE Diamond Drill - NX Casing and Cone Test COMPILED BY WH  
 DATUM Geodetic DATE March 19 - 20, 1968 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
276.5	Ground Level																
0.0	Heterogeneous mixture of clayey silt, sand and gravel.  Hard, Glacial Till (with boulders up to 6" diameter - below elevation 264).		1	SS	56												
			2	SS	100	2"											
			3	SS	100	6"											
			4	SS	138												
			5	BXL RC	14%												
258.0			6	SS	100	6"											
18.5	(Fractured & Weathered)		7	SS	100	1"											
255.5	(Sound)		8	BXL RC													
21.0			9	AXT RC	100%												
251.5	Limestone Bedrock																
25.0	End of Borehole																

RECORD OF BOREHOLE No 6

(Formerly B.H.#2 - W.P.301-66-0)

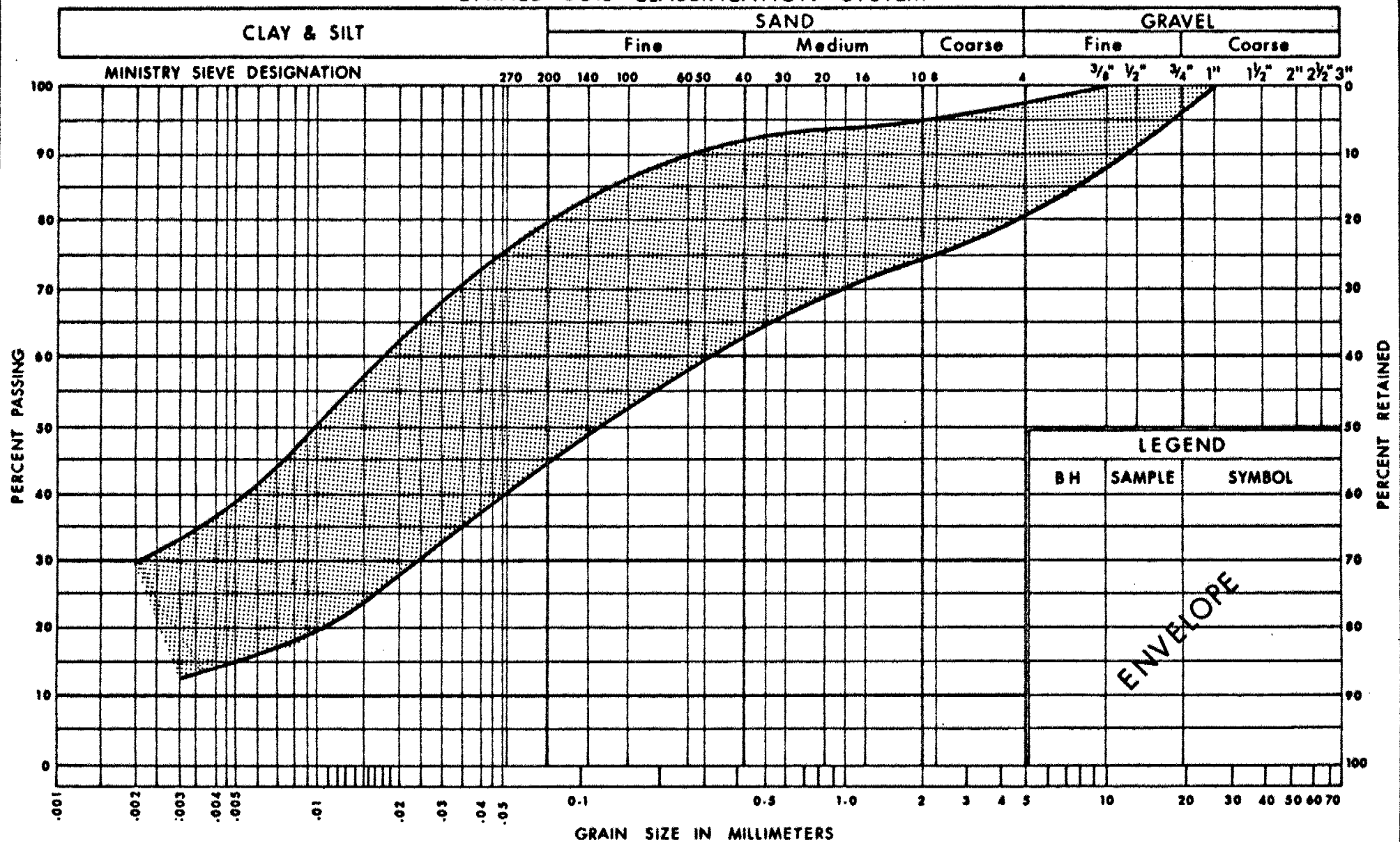
W P 7-79-03 LOCATION Co-ords. N 15,958,517; E 1,233,919 ORIGINATED BY VK  
DIST 7 HWY 35/115 BOREHOLE TYPE Diamond Drill - NX Casing and Cone Test COMPILED BY WH  
DATUM Geodetic DATE March 20, 1968 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
275.0	Ground Level																
0.0	Heterogeneous mixture of clayey silt, sand and gravel. Hard.		1	SS	179		270										0 1 55 44
264.5	Glacial Till		2	SS	100/4"												
			3	SS	100/6"												
10.5	End of Borehole																

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM

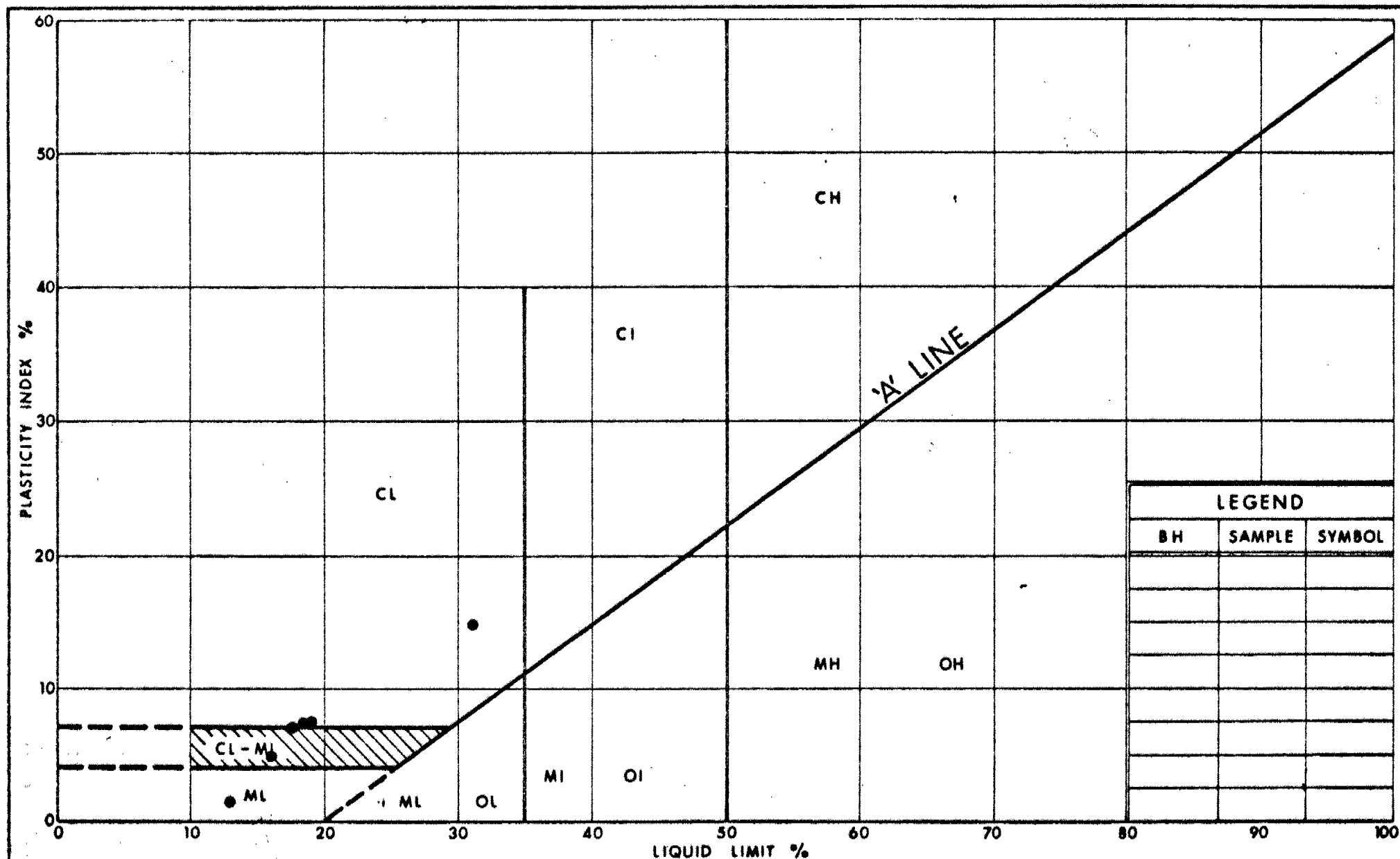


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**GRAIN SIZE DISTRIBUTION**  
**GLACIAL TILL**  
HET MIX OF CLAYEY SILT, SAND & GRAVEL

FIG No 1

W P 7 - 79 - 03



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**PLASTICITY CHART**  
**GLACIAL TILL**  
HET MIX OF CLAYEY SILT, SAND & GRAVEL

FIG No 2

W P 7-79-03

# EXPLANATION OF TERMS USED IN REPORT

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

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

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

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS & SYMBOLS

### LABORATORY TESTING

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

### FIELD SAMPLING

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

### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  ANGLE OF WALL FRICTION  
 $k_o$  COEFFICIENT OF EARTH PRESSURE AT REST  
 $k_A$  COEFFICIENT OF ACTIVE EARTH PRESSURE  
 $k_P$  COEFFICIENT OF PASSIVE EARTH PRESSURE  
 $i$  ANGLE OF INCLINATION OF SURCHARGE  
 $w$  SLOPE ANGLE-BACKFACE OF WALL  
 $\beta$  ANGLE OF SLOPE  
 $N, N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

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

### STRENGTH PARAMETERS

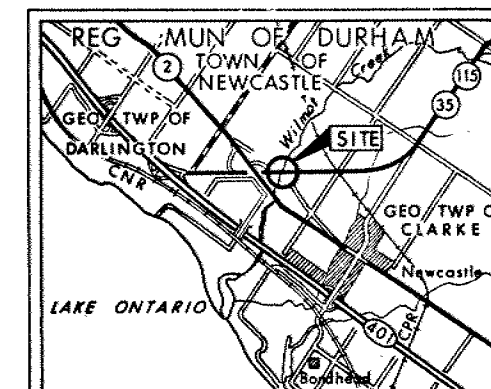
$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  RESIDUAL SHEAR STRENGTH  
 $c$  COHESION INTERCEPT  
 $\sigma_1, \sigma_2, \sigma_3$  NORMAL PRINCIPAL STRESSES  
 $u$  PORE WATER PRESSURE  
 $u_e$  EXCESS  $u$   
 $u_v$  PORE PRESSURE RATIO  
 $q_u$  UNCONFINED COMPRESSIVE STRENGTH  
 $s_u$  UNDRAINED SHEAR STRENGTH  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  POISSON'S RATIO  
 $E$  MODULUS OF ELASTICITY  
 $G$  MODULUS OF SHEAR DEFORMATION  
 $k_s$  MODULUS OF SUBGRADE REACTION  
 $m, n$  STABILITY COEFFICIENTS  
 $A, B$  PORE PRESSURE COEFFICIENTS

### HYDRAULIC TERMS

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

**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\sigma'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'_n$  = EFFECTIVE NORMAL STRESS





KEY PLAN  
1 0.5 0 1 Mile

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350ft lbs energy)
- CONE Blows/ft (60° Cone, 350ft lbs energy)
- W.L. at time of investigation  
For Bore Holes 1 & 2 Sept 1979  
" " " 3, 4, 5 & 6 March 1968

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	272.6	15 958 321	1 234 014
2	272.6	15 958 335	1 234 040
3	281.0	15 958 469	1 233 889
4	279.3	15 958 518	1 233 837
5	276.5	15 958 556	1 233 900
6	275.0	15 958 517	1 233 919

INVESTIGATED  
IN MAR 1968  
WP 301-66

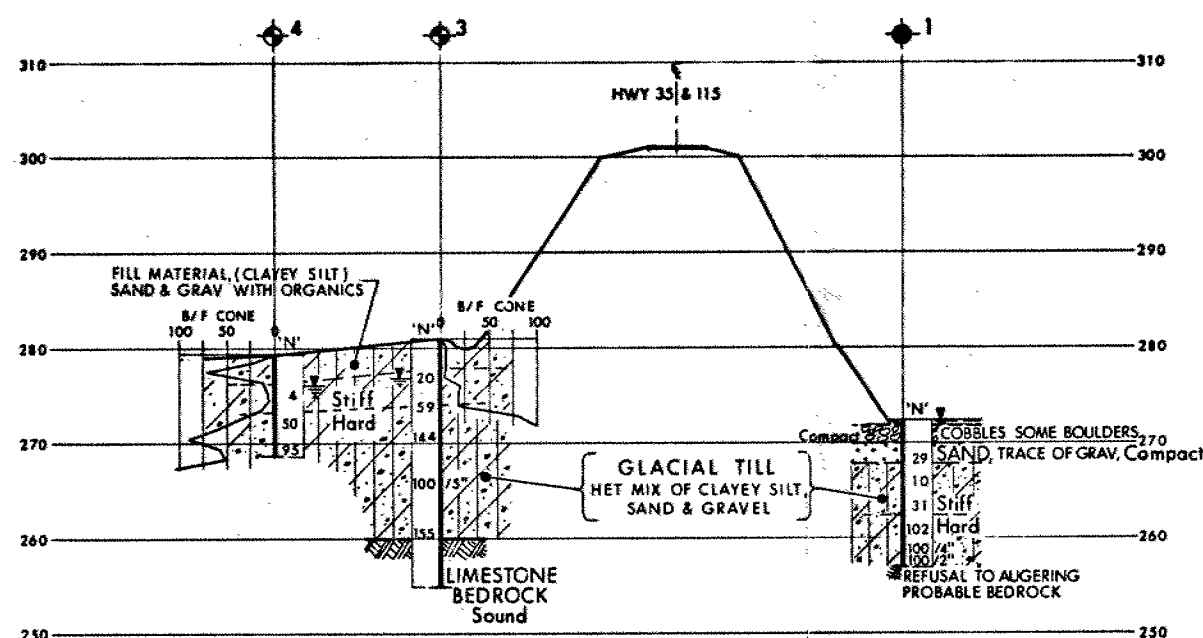
-NOTE-

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

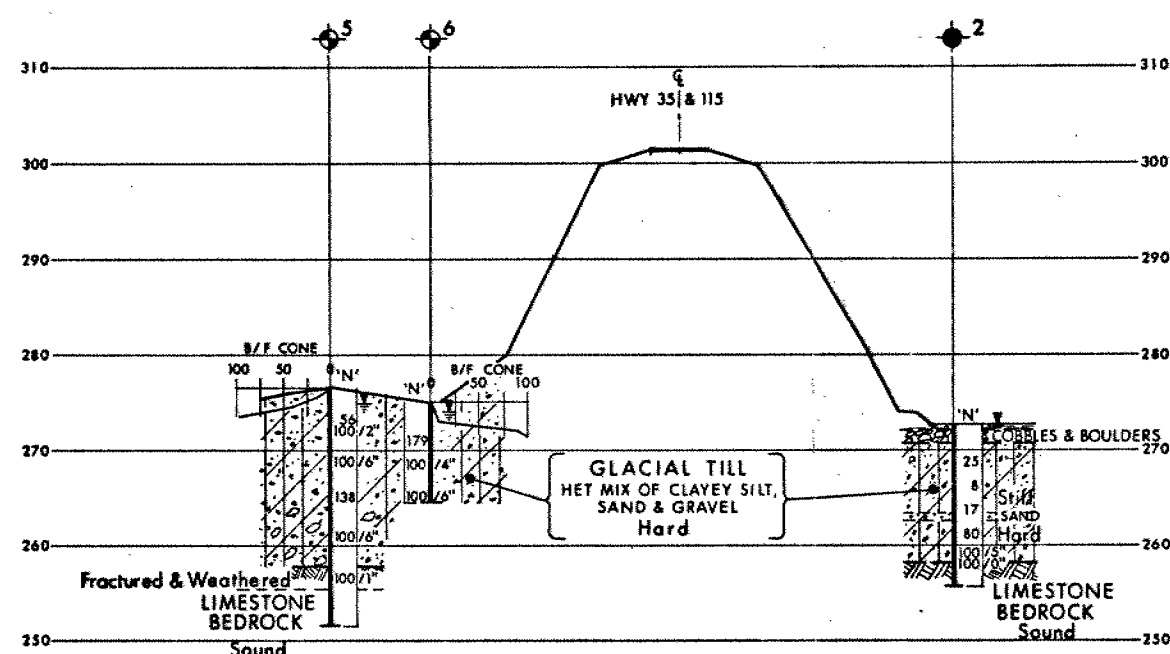
REVISIONS	DATE	BY	DESCRIPTION

GEORES No 30 M15-48

HWY No 35 & 115  
SUBMD MM CHECKED JN DATE Oct 9, 1979  
DRAWN RS CHECKED JN  
DIST 7  
SITE 21-173  
DWG 77903-A

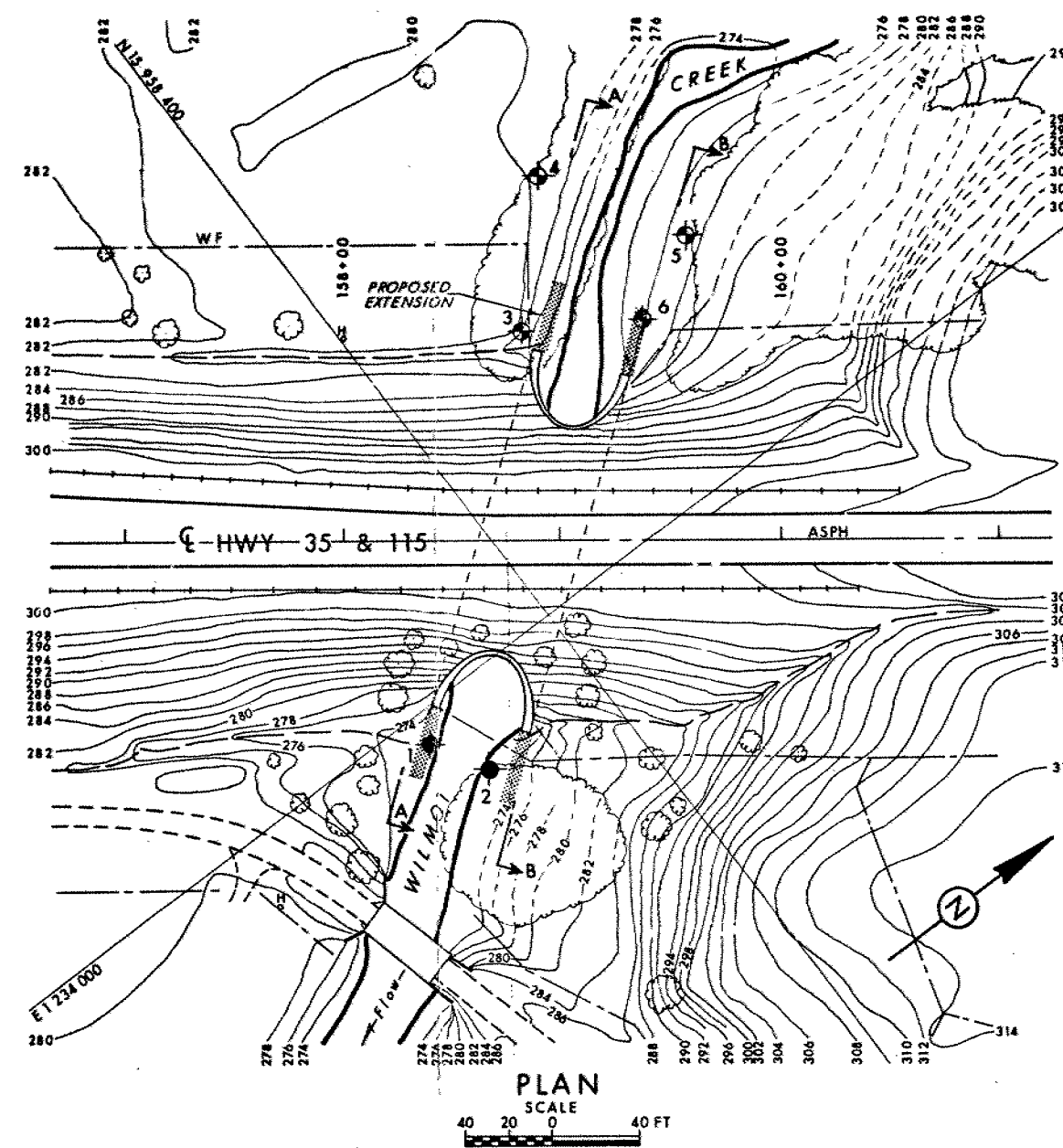


A-A

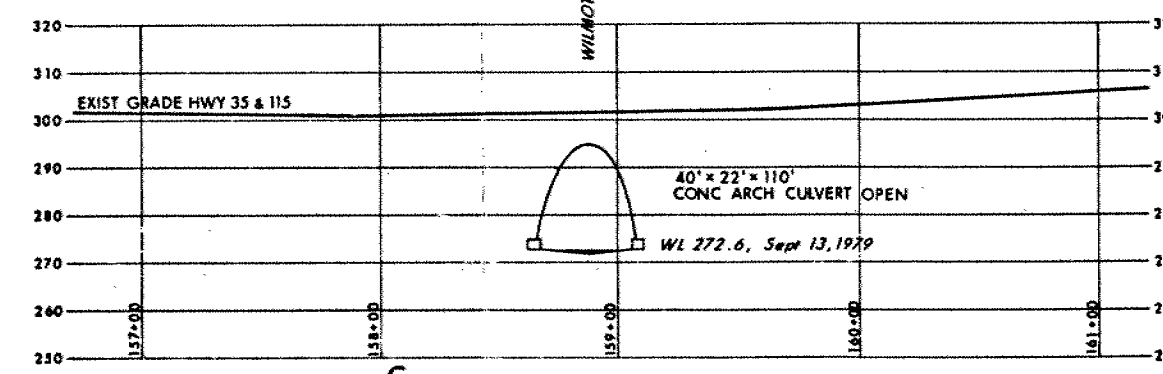


B-B

SCALE  
HOR 40 20 0 40 FT  
VERT 10 5 0 10 FT



PLAN  
SCALE  
40 20 0 40 FT



PROFILE - HWY 35 & 115  
SCALE  
HOR 40 20 0 40 FT  
VERT 20 10 0 20 FT