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Ontario

Ministry of
Transportation and
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foundation investigation and design report

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WO 7117-79-01

DIST 13

HWY

STR SITE

Sturgeon River Bridge at Crystal Falls

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FOUNDATION INVESTIGATION REPORT

For

Sturgeon River Bridge at Crystal Falls
W.O. 7117-79-01
District 13, North Bay

INTRODUCTION

This report contains the results of a foundation investigation performed at the above mentioned site. Fieldwork was carried out from June 26 to July 5, 1979, consisting of a total of six boreholes. Four of the boreholes were located on the riverbanks. They were advanced by means of an auger machine equipped with 3¼" I.D. hollow stem augers. The remaining two boreholes which were located in the river were drilled by means of a diamond drill rig mounted on a raft using wash-boring techniques. The depth of the boreholes ranged from 30 feet to 63 feet below river bed or ground surface. Disturbed samples of the overburden were recovered by means of a split spoon sampler. Bedrock was proven by recovering BXL size rock core samples. When drilling was obstructed by cobbles and boulders, diamond drilling techniques were employed to break up these obstacles.

SITE DESCRIPTION

The site is at the crossing of Crystal Falls Road and the Sturgeon River, about 1½ miles east of Hwy. 64 and 6½ miles north of the Town of Sturgeon Falls. The original bridge at this crossing was built in the mid 1920's, which was a three span, wooden deck structure supported on rockfilled timber cribs. This bridge was washed out in the spring floods of 1979.

The terrain on either side of the river is flat to very gently undulating. A rock outcrop is visible within 200 feet on the north side of the west approach. The area east of Crystal Falls Road on the east side of the river is generally wet and swampy.

The riverbanks are about five to eight feet above the normal river water level (elev. 728⁺) and are relatively steep. The river water level is controlled by a hydro dam located some 3/4 of a mile downstream of the site. At the bridge crossing, the depth of water in the channel is variable and in some places as deep as 30 feet. The flow of water during the time of field investigation was estimated to be about one foot per second.

SUBSURFACE CONDITIONS

In general, the site is underlain by silts and sands of a glacio-lacustrine origin, followed by gneiss bedrock. The thickness of the overburden increases from west to east, ranging from about 50 feet on the west riverbank to more than 63 feet on the east riverbank. In the riverbed, due to scouring action by the river, the upper portion of the fine grained granular subsoil has been eroded, resulting in an overburden thickness of only 20 to 25 feet. Subsoil apparently has been subjected to some degree of sorting by water in the geological past. A transition in particle sizes from fine grained to coarse grained soil with depth can be observed.

The location and elevation of the boreholes, as well as the estimated subsoil stratigraphy, are shown in Drawing 71177901-A. A description of the subsurface conditions as revealed by our borings is as follows.

West River-Bank

Underneath a five foot thick layer of granular fill material consisting of silty sand, subsoil on the west riverbank is mainly composed of 29 feet of uniform fine sand with some partially decomposed vegetation, followed by a five foot thick layer of clay, which in turn is underlain by an 11 foot thick stratum of medium sand with some gravel and occasional cobbles and boulders. At a depth of 50 feet (elev. 687⁺) below ground surface, sound gneiss bedrock was encountered.

The fill is composed of local material and was poorly compacted

Typical grain size distribution curves for material from the upper granular stratum of uniform fine sand and the lower granular stratum of sand with some gravel are shown in Figure 2. Based on the 'N' values of one to three blows per foot recorded in the uniform fine sand and eight to 24 blows per foot in the sand with some gravel, it is estimated that the relative density of the upper granular stratum is very loose and that of the lower granular deposit is loose to compact.

The cohesive subsoil sandwiched between the granular strata was found to have a moisture content of 65%, a liquid limit of 67% and a plastic limit of 20%. These Atterberg limits were also plotted on a plasticity chart (Figure 1). The plot indicates that the cohesive subsoil is a clay with a high plasticity (CH). According to the results of a field vane test carried out, the undrained shear strength of the clay is in the order of 800 psf. Based on this, the consistency of the clay is estimated to be firm.

The gneiss bedrock underlying the overburden has a high recovery ratio and rock quality designation (RQD), both being close to 100%. In addition, the rock appears to be hard, sound and massive.

River Channel

As mentioned earlier, the depth of water in the river is variable. In the area investigated, the eastern portion of the channel was found to be about 25 feet deep and the western portion about 20 feet deep. The overburden in the riverbed has a thickness of 20 to 25 feet, and is mainly composed of sand to sand and gravel mixed with cobbles and boulders. Because of the presence of these coarse particles, diamond drilling techniques were employed to penetrate this stratum. Typical grain size distribution curves for the granular subsoil, excluding coarse gravel, cobbles and boulders, are shown on Figure 2. According to the very high

'N' values, which are frequently in excess of 100 blows per foot, and the great difficulty in advancing the boreholes, it is inferred that the relative density of the granular subsoil is very dense. At a depth of 45 to 47 feet (corresponding to elev. 683+ and elev. 681+ respectively) below river water surface, gneiss bedrock was encountered. Based on the relatively high recovery ratios and RQD values of the rock cores, bedrock is sound and of good quality.

East Riverbank

The overburden on the east riverbank was investigated to a depth of 63 feet and was found to be composed mainly of sands and silts containing seams of clay. Below elev. 690+ (about 44 feet below ground surface) the granular subsoil becomes noticeably coarser, being mainly sand and gravel. At a depth of 53 feet (elev. 681+) below ground surface, the deposit contains random cobbles and boulders. Typical grain size distribution curves for the granular subsoil are shown on Figure 2. The Standard Penetration Test 'N' values generally increase with depth. In the upper 44 feet, the 'N' values ranged from less than one blow per foot to 19 blows per foot. Below that depth, the 'N' values varied from 81 blows per foot to more than 100 blows per foot. Based on these 'N' values it is estimated that the upper 44 feet of the overburden of sands and silts has a relative density in the range of very loose to compact, whereas the lower granular stratum of sand and gravel has a relative density of very dense.

In one location in the swampy area immediately east of Crystal Falls Road, two distinct five foot thick layers of clayey silt were observed, one being immediately below ground surface and the other at a depth of 22 feet below ground surface. The cohesive subsoils have a low plasticity and a firm to stiff consistency.

Groundwater Conditions

In general, the groundwater level is closely related to the river water level (elev. 728₊), except in the swampy area located on the east side of the river the groundwater was encountered at or below the ground surface. This high groundwater table in the swampy area is attributed to the presence of a cohesive mantle which tends to prevent any downward drainage of the surface water and runoff.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a new structure immediately south of the old bridge which was washed out during the heavy floods of spring, 1979. The new bridge will be a three span structure (100'-130'-100') with a clear width of 16 feet. Our preliminary recommendations for the new structure at this location were already provided in a memorandum to Mr. J.C. McAllister dated July 12, 1979.

The subsoil at the site consists of sands and silts of a glacio-lacustrine origin. The overburden in the river ranges from 20 to 25 feet and at the river banks the overburden is in the order of 50 to over 63 feet. The overburden is generally coarser with depth and at the lower portion the granular deposit contains random cobbles and boulders. The overall relative density varies from very loose becoming denser with depth. The water depth in the river at the crossing varies from 20 to 25 feet. The river water is controlled by the hydro dams located at the upstream end, as well as the downstream end of the proposed crossing.

The subsoil conditions at this site are not favourable for spread footing type of foundations. In view of this end-bearing type of deep foundations are recommended to support the new three span structure.

Abutments

The east abutment and the west abutment should be supported on end-bearing piles. Because of the presence of cobbles and boulders in the lower portion of the overburden, steel H section piles such as 12 BP 74 or heavier, fitted with MTC shoes or their equivalent, should be used. These piles can be designed for their maximum allowable structural capacity. For example, a 12 BP 74 can be designed for 130 tons per pile. Piles for the west abutment should be driven to bedrock surface (elev. 687+). Those for the east abutment should be driven into the very dense sand and gravel stratum. Driving of the east abutment piles should be controlled by Hiley formula in order to ensure that

they develop their design capacity. For estimation of pile lengths the approximate tip elevation of the east abutment piles should be at elevation 673₊. The underside of the abutment pile caps should have a minimum of six feet of earth cover for frost protection purposes. No major dewatering problems are anticipated since the pile caps will be situated above the prevailing water level.

Piers

In the design of pier foundations, in addition to the bearing capacity for vertical loads, the lateral resistance of the foundations will be a major concern. The embedment of the pier foundations should be sufficiently deep so as to ensure adequate lateral resistance. Therefore, a minimum embedment of 20 feet below the river bottom should be provided for the pier foundations. If piles are to be used they should be composed of steel H piles such as 12 BP 74 or heavier which should be fitted with driving shoes such as Hard-Bite HP 77750 manufactured by the Associated Piles and Fittings Corp. or the equivalent. Related information about the driving shoes are included in the Appendix. It should be noted that the presence of cobbles and boulders may obstruct the pile to penetrate to the required depth. Preaugering or jetting is not thought to be practicable because of the coarse granular nature of the subsoil. In view of this, if steel H piles (12 BP 74 or heavier) are to be used, they should have adequate batter to ensure lateral resistance and further, they should be cross braced so as to provide adequate rigidity.

The other alternative of achieving the desired depth of penetration, in addition to the use of reinforced tips, is by means of churn drilling techniques. If steel 'H' piles are used as foundation support for the pier, a tender item for churn drilling per foot should be included in the contract. This will facilitate the piles to reach the minimum embedment as specified elsewhere.

The piers can also be supported by large diameter concrete caissons founded on bedrock (at elev. 682₊). These caissons may have to be advanced by churn drilling techniques with the use of

a heavy liner due to the presence of cobbles and boulders in the overburden. This liner will have to be left in place after the founding level is reached. Assuming a $\frac{1}{2}$ inch thick steel liner is used, a 30 inch diameter concrete caisson can be designed for a safe load of 250 tons and a 24 inch diameter caisson for a safe load of 180 tons. To minimize the dewatering requirements, placing concrete in the caissons underwater can be done by tremie concrete techniques. It should be noted the concrete should have a 28 day crushing strength of at least 5000 psi. The caissons can be capped immediately above the water level, or can be extended up to the underside of the bridge deck.

Approaches

No stability problems are anticipated for the approach fills if they are constructed with 2:1 side and forward slopes. The toe of the forward slopes, however, should be kept at least five feet away from the river water. Further, the approaches should be protected with rip-rap up to the high water level.

It should be noted in the area where piles are to be driven, the approach fill material should be free from particles larger than three inches in size.

Settlements under the approach fills are expected to be small and take place in a relatively short time. They should not pose as a major concern as the temporary Bailey Bridge is quite flexible and the permanent bridge will be constructed at a later date. In order to minimize the downward drag on the piles due to settlements of the subsoil, it is desirable that the approach fills be constructed to the abutment foundation elevation and left in place as long a period as possible before piles are driven.

Other Considerations

The recently proposed alignment for the new bridge is located some 50 feet downstream of and parallel to the washed out bridge. The present investigation was carried out for an alignment supplied by the Region which was at a skew angle to the washed out bridge and was located further downstream of the new alignment. Further, at the time of investigation, the exact location of the abutments and the piers was not available. According to our borehole data and examination of the adjacent bedrock outcrop, bedrock surface appears to be sloping down from west to east. In view of this, variation in bedrock surface elevation at the various footing locations than those reported in the report can be anticipated.

B. Ly

B. Ly, P. Eng.
Senior Engineer



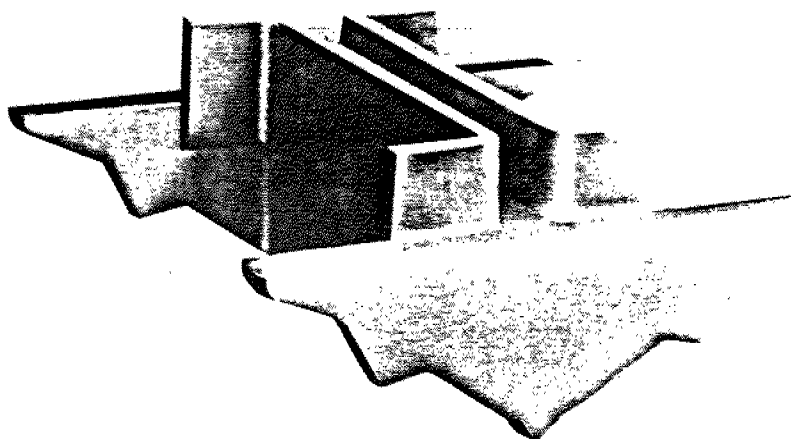
M. Devata

M. Devata, P. Eng.
Supervising Engineer

July, 1979

APPENDIX

A new improvement in H-pile protection is the HARD-BITE line of driving points. Made of cast steel with tough teeth, they break obstructions and bite into the bearing stratum to seat the pile and prevent sliding. This feature is especially valuable where the axis of the pile is at a sharp angle to the supporting material, whether vertical or batter piles.



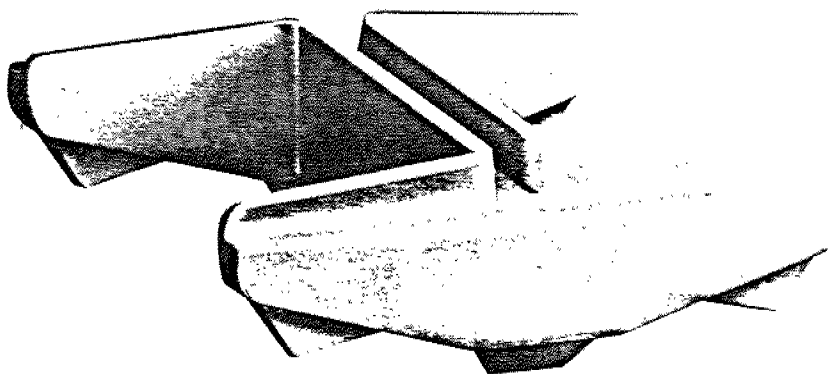
HARD-BITE HP77750 has a slim configuration that will break debris and boulders to better penetrate compressible strata overlying the desirable bearing material.

Patented and Patent Pending

The latest developments in H-pile protection . . .

HARD-BITE HP77600 is more compact with steel concentrated below the flange and web providing a greater base area to evenly distribute the load. Both styles are available for all sizes of H-piles.

Patented and Patent Pending



the points of tomorrow, here today!



RECORD OF BOREHOLE No 1

WO 7117-79-01 LOCATION Sta. 106+63, o/s 158' Rt. of Crystal Falls Road ORIGINATED BY BL
DIST 13 HWY BOREHOLE TYPE Washboring With HX and BX Casings COMPILED BY BL
DATUM Geodetic DATE June 27, 1979 CHECKED BY JS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)						
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE								
728.1	River Water Level																		
0.0	Water						720												
							710												
703.1	River Bed																		
25.0	Sand and Gravel Mixed With Occasional Cobbles and Boulders		1	SS	60/	6"	700												
	Very Dense		2	BXL	-														
			3	SS	110/	10"													
			4	BXL	-														
			5	SS	95/	2"	690									12 56 (32)			
			6	SS	128/	10"													
681.6			7	SS	75/	1"													
46.5	Gneiss Bedrock		8	BXL	Rec.	100%													
47.5	End of Borehole Note: 1. Very Difficult to Drive HX and BX Casings 2. Borehole Was Advanced With the Use of a Bi-Cone and Occasionally With Diamond Coring Technique																		



RECORD OF BOREHOLE No 2

WO 7117-79-01 LOCATION STA 103+73, o/s 40' RT & CRYSTAL FALLS ROAD ORIGINATED BY B L
DIST 13 HWY BOREHOLE TYPE Wash-Boring with HX and BX Casings COMPILED BY BL
DATUM Geodetic DATE July 3, 1979 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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					
727.3	River Water Level																
0.0	Water																
707.3	River Bed																
20.0	Sand to Sand and Gravel, Mixed with Occasional Cobbles and Boulders. Very Dense		1	SS	41												
			2	SS	125												
			3	BXL													
			4	SS	125/ 2"												
			5	SS	100/ 2"												
682.8			6	BXL	Rec. 5%												
44.5	Gneiss Bedrock Sound		7	BXL	Rec. 100%												
			8	BXL	Rec. 80%												
673.8			9	BXL	Rec. 100%												
53.5	End of Borehole																
	<p><u>Note:</u></p> <ol style="list-style-type: none">1. Very Difficult to Drive HX and BX Casings.2. Borehole was Advanced with the Use of a Tri-Cone and a Bi-Cone and Also Occasionally With Diamond Coring Technique.																

RECORD OF BOREHOLE No 10

WO 7117-79-01 LOCATION Sta. 107+44; o/s 20' E. of Crystal Falls Road ORIGINATED BY BL
DIST 13 HWY BOREHOLE TYPE 3 1/2" Hollow Stem Auger and Cone Test COMPILED BY BL
DATUM Geodetic DATE June 26, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	45	60	80	100					
733.9	Ground Surface																
0.0	Silty Fine Sand Very Loose																
727.9			1	SS	4		730										
6.0	Sandy Silt to Silt With Seams of Clay & Peat Silty Clay		2	SS	3		720										0 2 (98)
720.9	Very Loose																
13.0	Uniform Silty Fine Sand With Occasional Seams of Clay and Silt, Very Loose to Loose		3	SS	1/	18"	720										
			4	SS	9		710										
			5	SS	9												
702.9			6	SS	5		700										
31.0	Uniform Sand Occasional Gravel Compact		7	SS	17												0 98 (2)
			8	SS	19		690										
689.9																	
44.0	Sand and Gravel Very Dense		9	SS	88												
			10	SS	81												
							680										
	Mixed With Some Cobbles and Boulders		11	SS	60/	4"											
			12	SS	60/	2"											
670.9																	
63.0	End of Borehole																
	Note: Refusal to Augering at 63 Feet Probable Bedrock																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 11

W0 7117-79-01 LOCATION STA 107+75, o/s 34' LT & CRYSTAL FALLS ROAD ORIGINATED BY BL
DIST 13 HWY BOREHOLE TYPE 3 1/2" Hollow Stem Auger COMPILED BY BL
DATUM Geodetic DATE June 27, 1979 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	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					
731.4	Ground Surface																
0.0	Clayey Silt, Some Sand Seams and Trace of Organics. Firm.		1	SS	4		730										
724.4																	
7.0	Silty Sand to Sandy Silt, Stratified Occasional Clay Seams. Very Loose to Compact.		2	SS	1		720										
			3	SS	19												
			4	SS	7												
709.4							710										
22.0	Clayey Silt, Firm to Stiff. Grey.		5	SS	6												
703.4																	
28.0	Medium Sand Loose.		6	SS	7		700										
700.9																	
30.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 12

WO 7117-79-01 LOCATION Sta. 102+61 o/s 8' Rt. of Crystal Falls Road ORIGINATED BY BL
DIST 13 HWY BOREHOLE TYPE 3 1/2" Hollow Stem Auger and Cone Test COMPILED BY BL
DATUM Geodetic DATE June 27, 1979 CHECKED BY J.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
736.9	Ground Surface																GR SA SI CL
0.0	Fill: Brown Silty Sand to Sandy Silt																
731.4			1	SS	3		730										0 77 (23)
5.5	Uniform Fine Sand Very Loose With Some Partially Decomposed Vegetation Occasionally Stratified		2	SS	2		720										
			3	SS	<1												
			4	SS	<1												
			5	SS	2		710										
			6	SS	1												0 32 (68)
702.9																	
34.0	Clay Firm		7	SS	<1		700										
698.4	Very Plastic																
38.5	Medium Sand With Some Gravel and Cobbles, Loose to Compact		8	SS	8												
			9	SS	24		690										21 57 (22)
686.9	Containing Boulders																
50.0	Gneiss Bedrock Hard and Sound		10	SS	Bouncing												
681.4			11	BXL	Rec= 100% RQD= 100%												
55.5	End of Borehole Note: Augering Became Difficult Below 47 Feet																

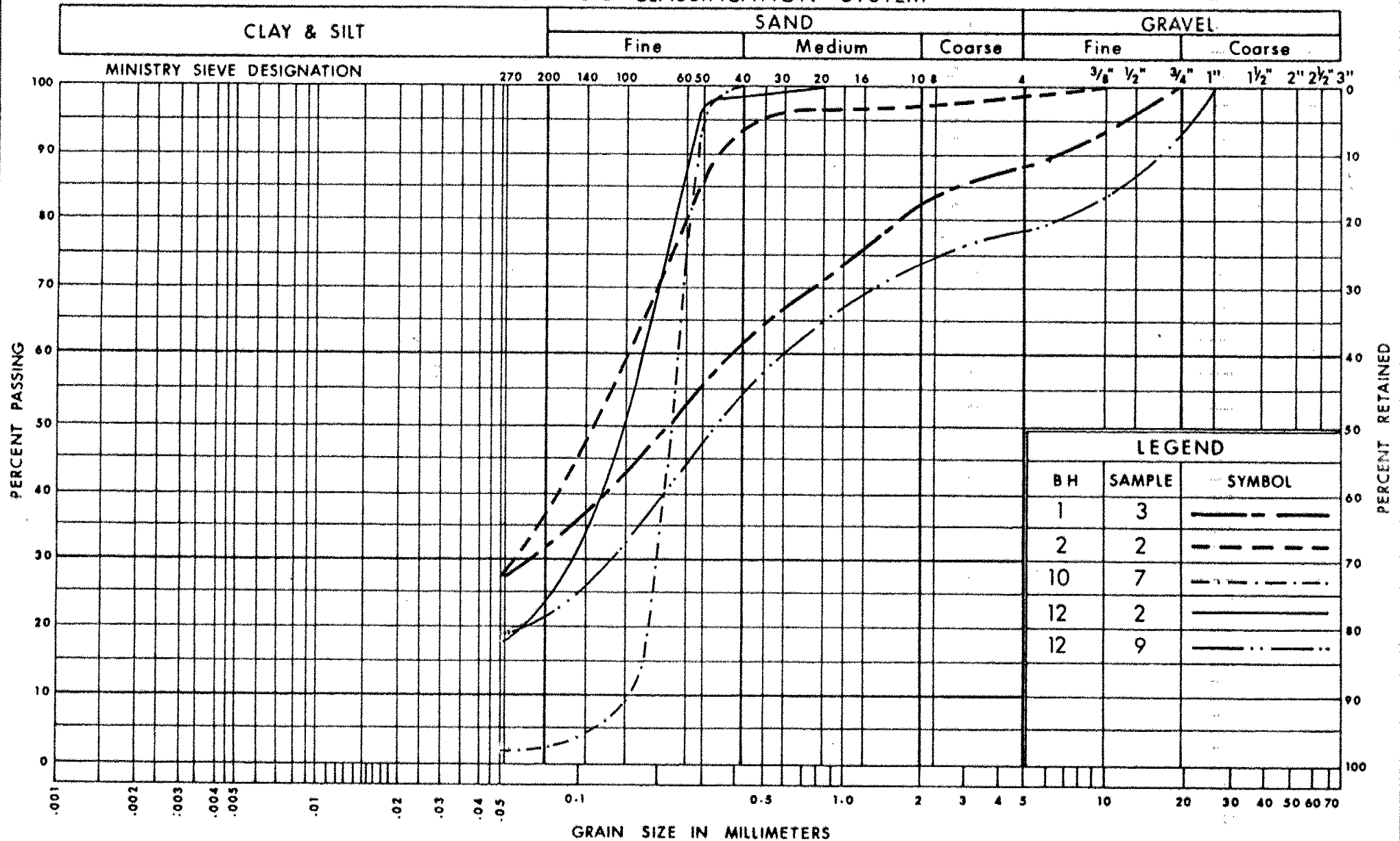
OFFICE REPORT ON SOIL EXPLORATION

W O 7117-79-01 LOCATION Sta. 102+58, o/s 12' Lt. of Crystal Falls Road ORIGINATED BY BL
DIST 13 HWY BOREHOLE TYPE Solid Stem Auger COMPILED BY BL
DATUM Geodetic DATE June 27, 1979 CHECKED BY JS

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM

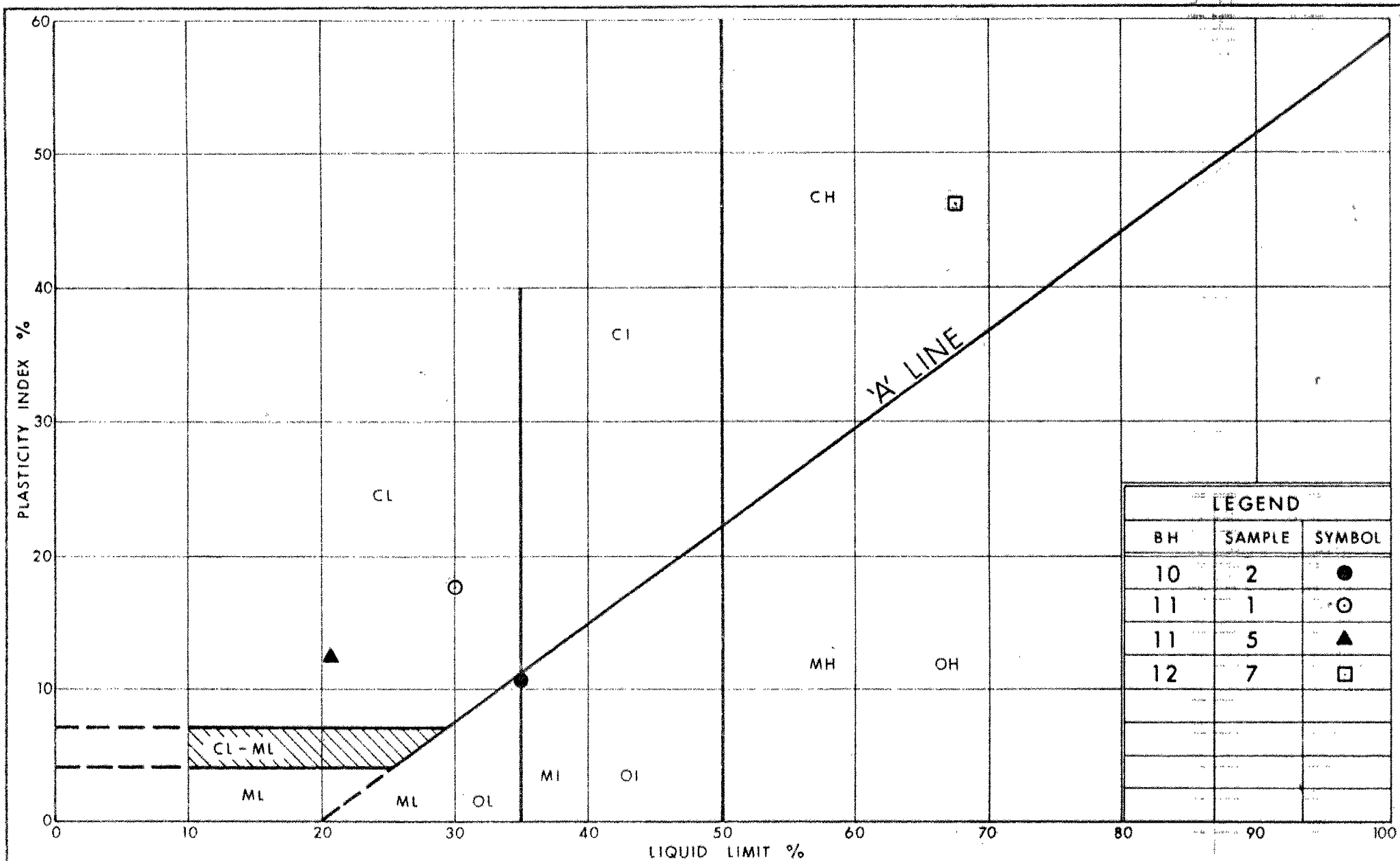


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GRAIN SIZE DISTRIBUTION
UNIFORM SAND OR SAND & GRAVEL

FIG No 1

WO 7117-79-01



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PLASTICITY CHART

FIG No 2

WO 7117-79-01

EXPLANATION OF TESTS 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. A119.43): 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. $C\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLE
BS BLOCK SAMPLE
CS CHUNK SAMPLE
TW THINWALL OPEN
TP THINWALL PISTON
OS OSTERBERG SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
FH T.W. ADVANCED HYDRAULICALLY
FM T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

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

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

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

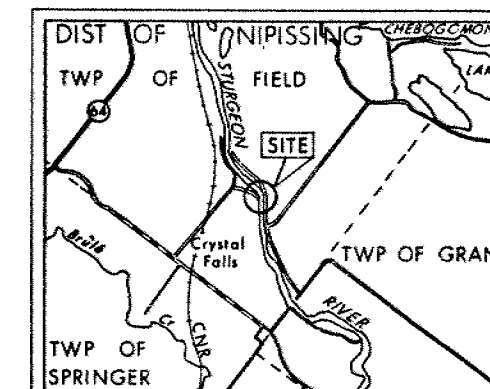
CONT No
WO No 7117-79-01

STURGEON RIVER

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



KEY PLAN
1 0.5 1 Mile

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation June & July 1979
- W.L. NOT Established for Bore Hole No 13

No	ELEVATION	STATION	OFFSET EXISTING
1	728.1	106 + 63	158' RT
2	727.3	103 + 73	40' RT
10	733.9	107 + 44	20' RT
11	731.4	107 + 75	34' LT
12	736.9	102 + 61	8' RT
13	736.5	102 + 58	12' LT

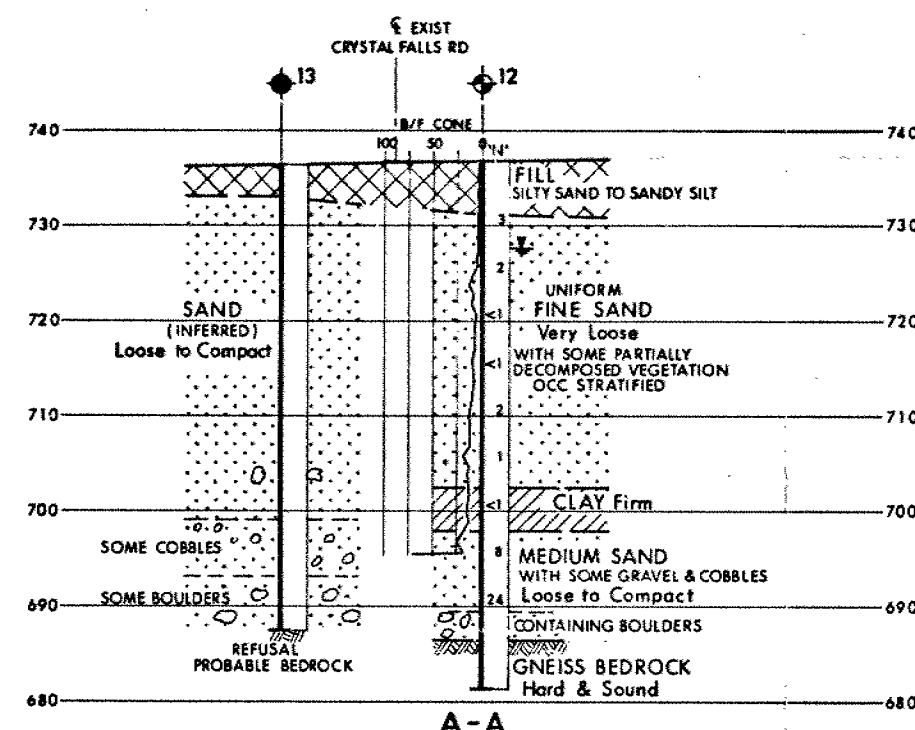
-NOTE-

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

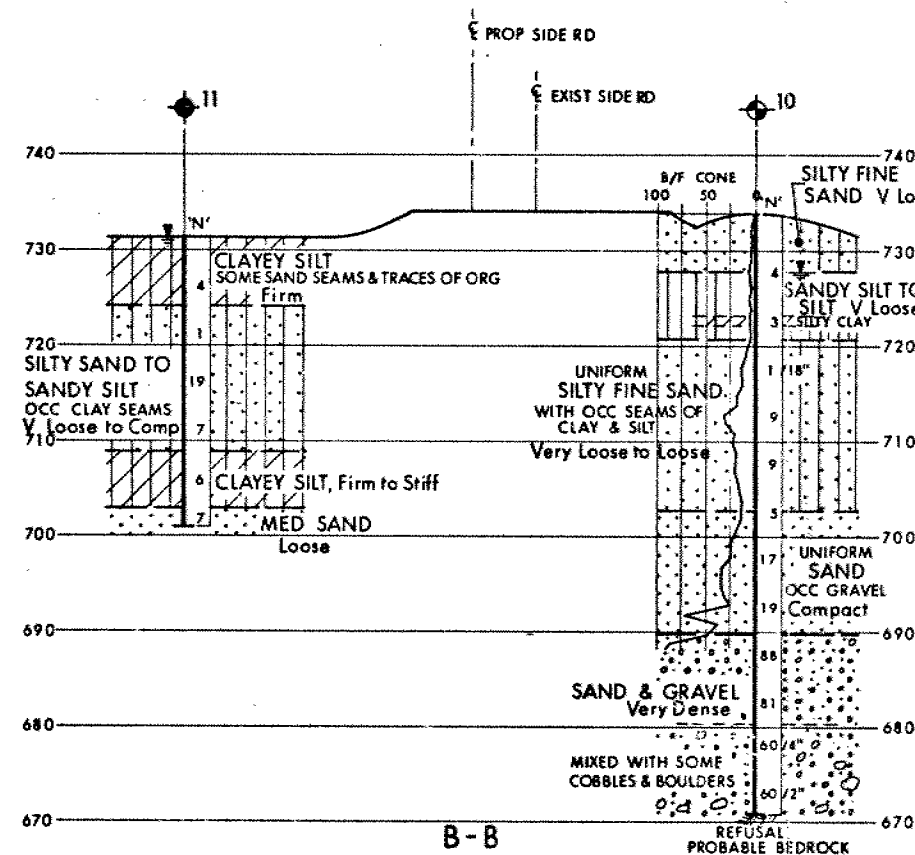
REVISIONS	DATE	BY	DESCRIPTION

GEOCRE No 31L-44

HWY No CRYSTAL FALLS ROAD DIST 13
SUBMD B.L. CHECKED DATE July 26, 1979 SITE
DRAWN R.S. CHECKED APPROVED DWG 71177901-A

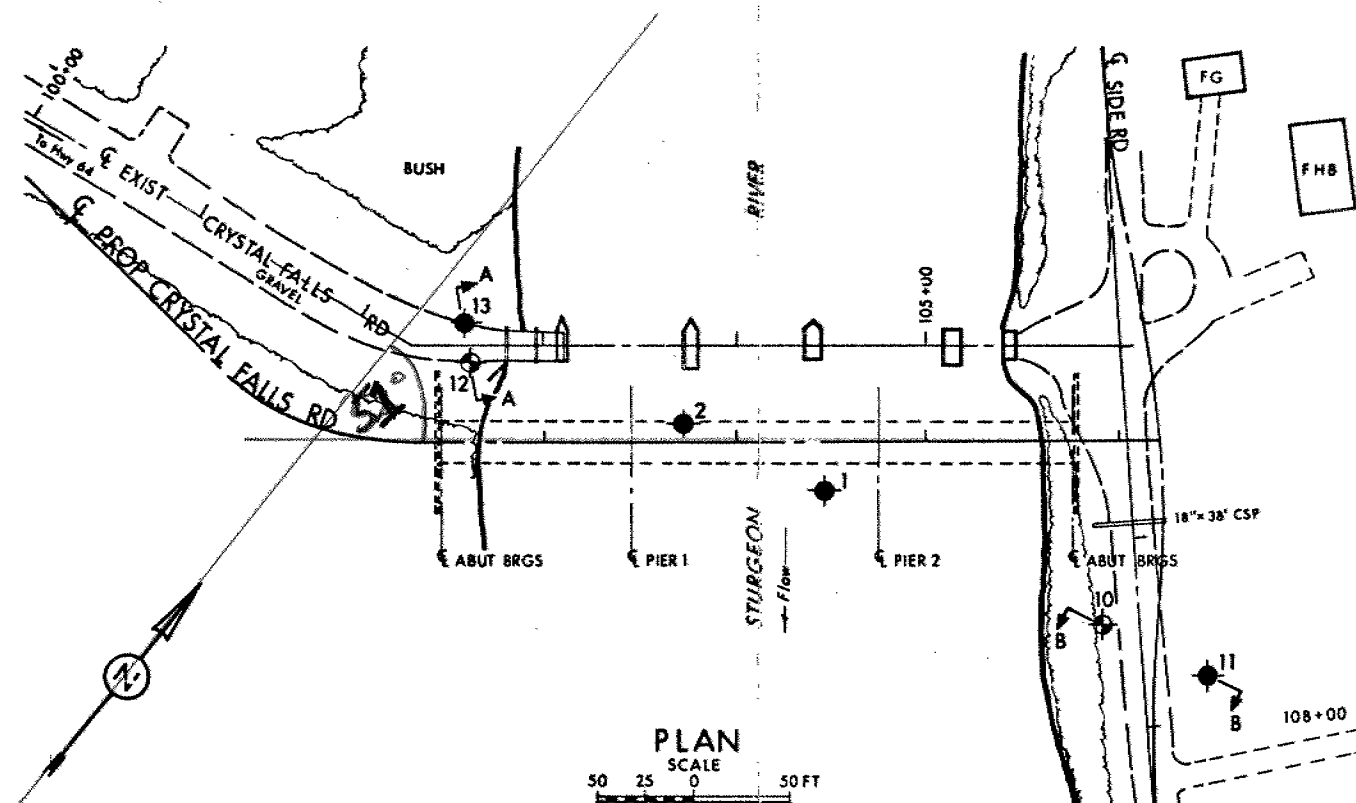


A-A



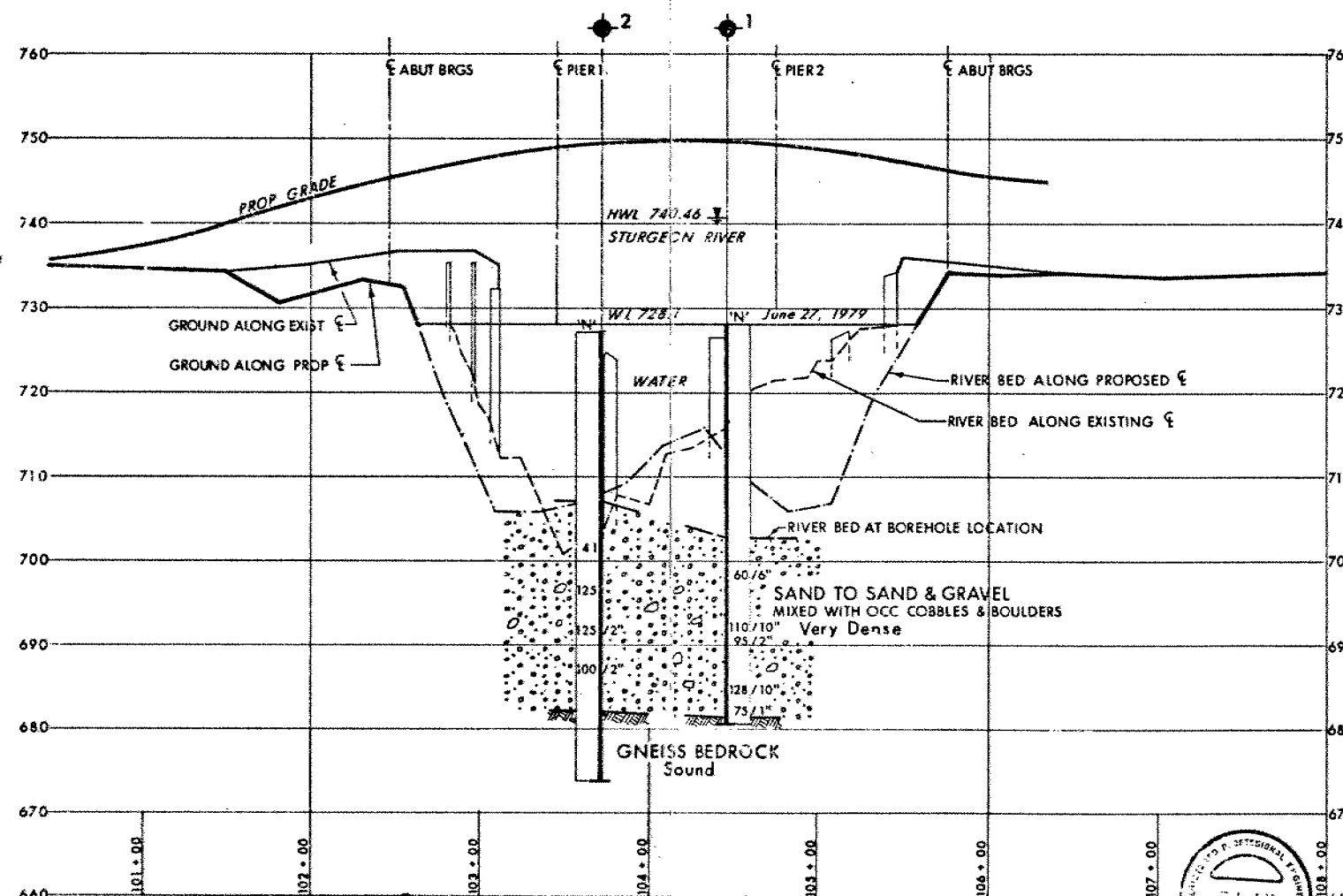
B-B
SECTIONS

SCALE 10 5 0 10 FT



PLAN

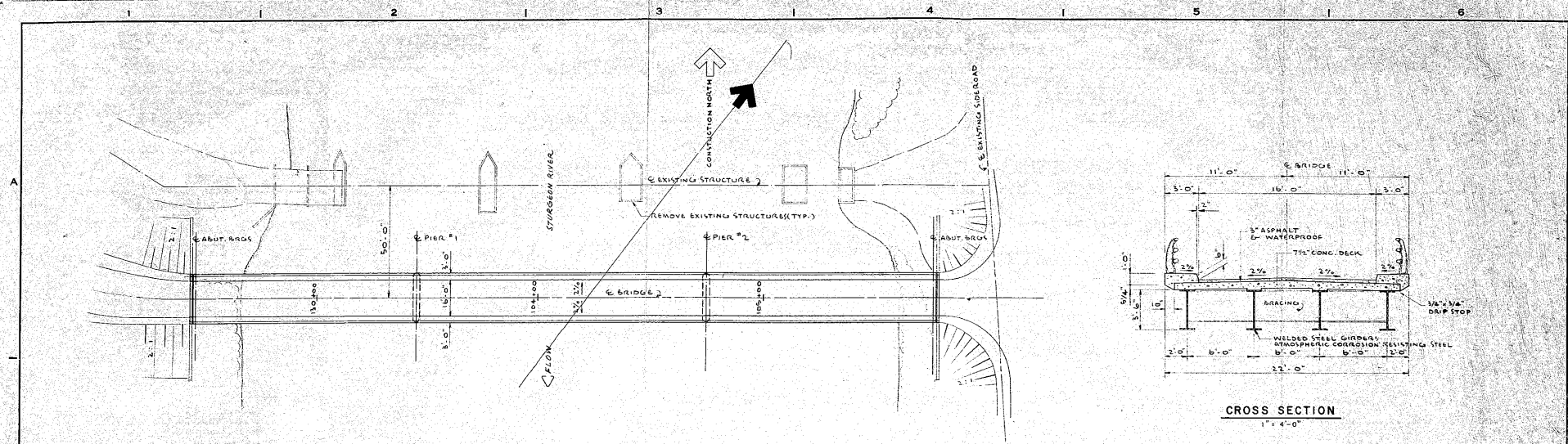
SCALE 50 25 0 50 FT



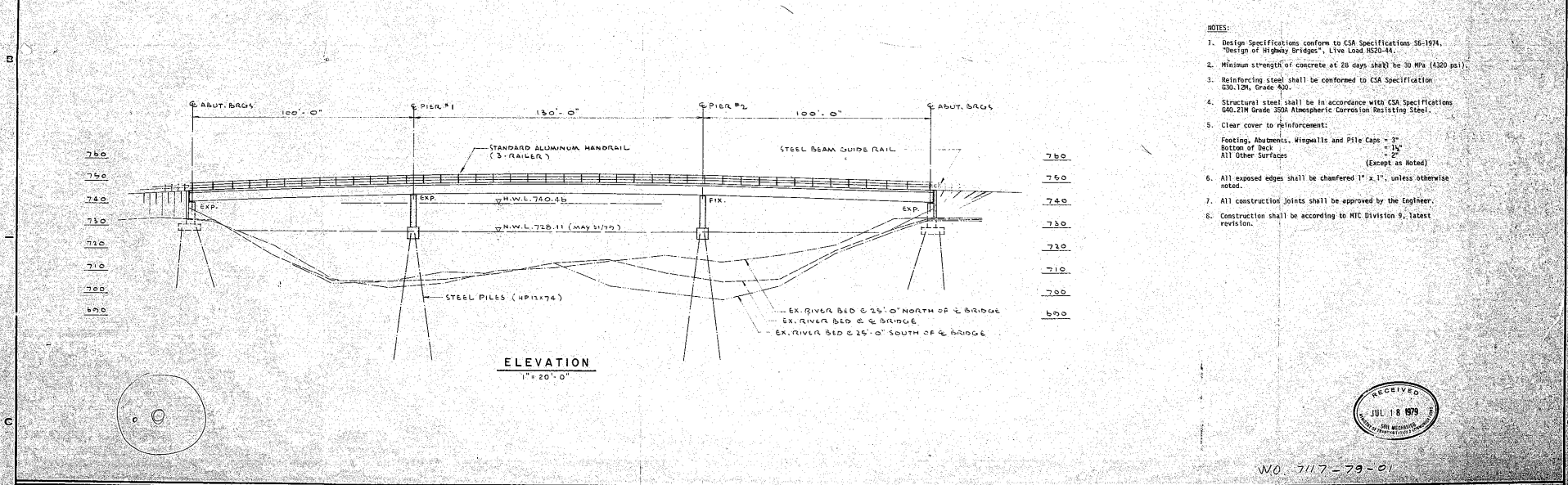
PROFILE - PROPOSED CRYSTAL FALLS ROAD

SCALE 50 25 0 50 FT
VERT 10 5 0 10 FT

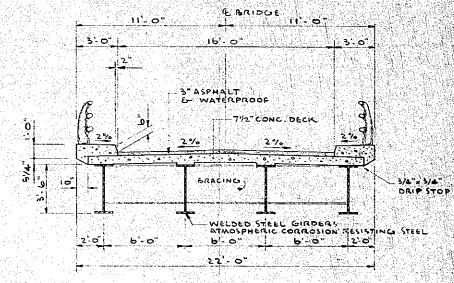
REF No B-786-0-1 June 1979 &
B-79326-P1 July 12, 1979 PROCTOR & REDFERN LTD



PLAN
1" = 20'-0"



ELEVATION
1" = 20'-0"



CROSS SECTION
1" = 4'-0"

- NOTES:**
- Design Specifications conform to CSA Specifications S6-1974.
 - Design of Highway Bridges - Live Load HS20-A19.
 - Minimum strength of concrete at 28 days shall be 30 MPa (4320 psi).
 - Reinforcing steel shall be conform to CSA Specification G40.21M Grade 350k Atmospheric Corrosion Resisting Steel.
 - Clear cover to reinforcement:
- | | |
|---------------------------------------------------|-------------------|
| Footings, Abutments, Wingwalls and Pier Caps - 3" | |
| Bottom of Deck | 1 1/2" |
| All Other Surfaces | 2" |
| | (Except as Noted) |
- All exposed edges shall be chamfered 1" x 1", unless otherwise noted.
 - All construction joints shall be approved by the Engineer.
 - Construction shall be according to NTC Division 9, latest revision.



W.O. 1117-79-01

<p>Notes</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">No.</td> <td style="width: 30%;">Revision</td> <td style="width: 10%;">Date</td> <td style="width: 10%;">Initial</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	No.	Revision	Date	Initial													<p>Approved</p>	<p style="text-align: center; border: 1px solid black; padding: 5px;">PRELIMINARY</p>	<p style="text-align: center;">TOWNSHIP OF FIELD</p> <p style="text-align: center;">CRYSTAL FALLS BRIDGE</p> <p style="text-align: center;">GENERAL ARRANGEMENT</p>	<p style="text-align: center;">Proctor & Redfern Limited</p> <p style="text-align: center;">Consulting Engineers</p> <p style="text-align: center;">Toronto</p> <p style="text-align: center;">Scale: AS NOTED Date: 12 JULY 1979</p> <p style="text-align: center;">Drawn By: C.R.G. Field Book: 8-72529-31</p>
No.	Revision	Date	Initial																		