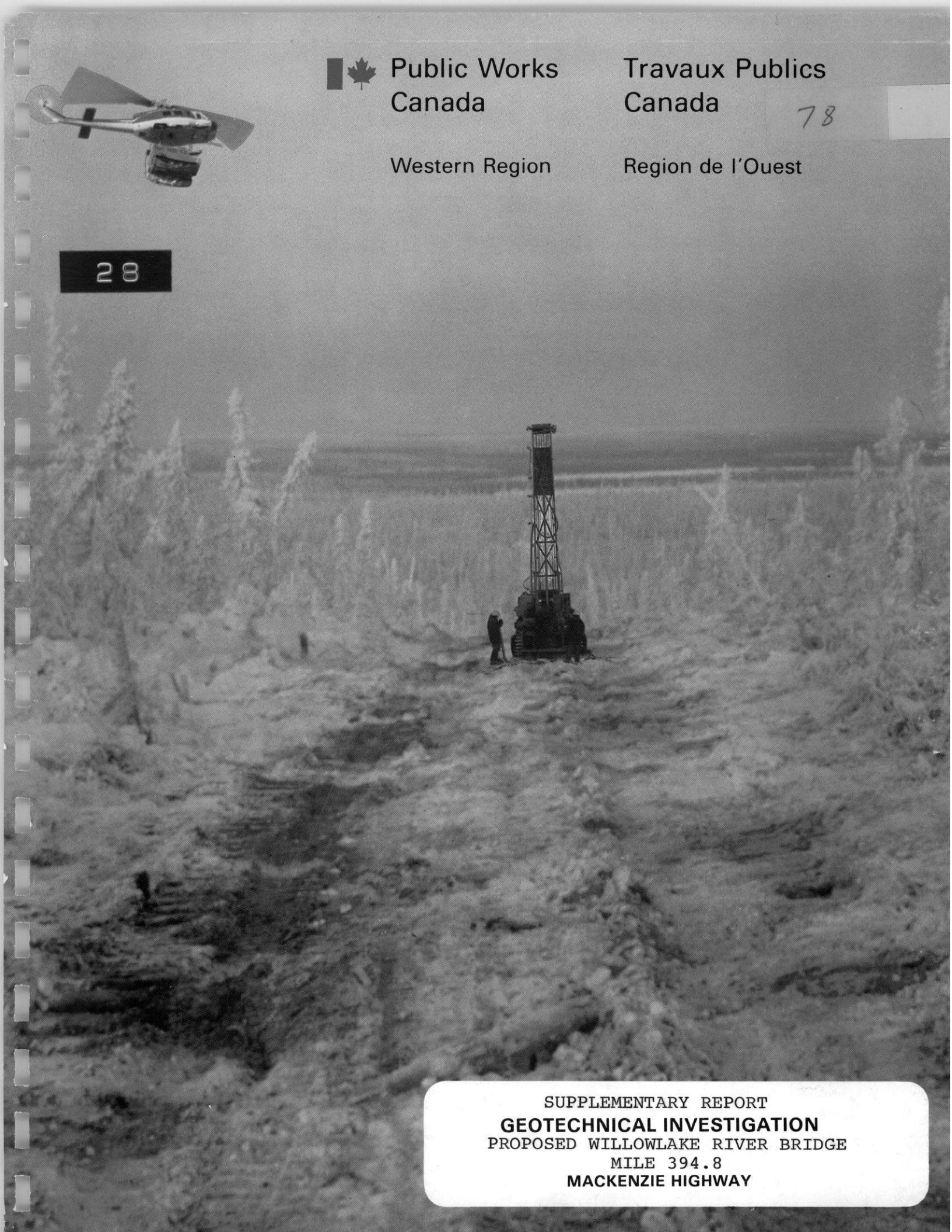

Public Works Canada

Travaux Publics Canada

Western Region

Region de l'Ouest

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SUPPLEMENTARY REPORT

GEOTECHNICAL INVESTIGATION

PROPOSED WILLOWLAKE RIVER BRIDGE

MILE 394.8

MACKENZIE HIGHWAY

PUBLIC WORKS CANADA

WESTERN REGION

SUPPLEMENTARY REPORT

FOUNDATION INVESTIGATION

PROPOSED WILLOWLAKE RIVER BRIDGE

MILE 394.8, MACKENZIE HIGHWAY

Submitted By: R. D. Cook, P. Eng.
Soils Engineer
Special Services
Western Region

May, 1976

TABLE OF CONTENTS

APPENDICES

I PRELIMINARY

The initial foundation investigation at Willowlake River was undertaken by Acres Consulting Services Ltd. in January 1973 and summarized in a foundation report dated June, 1973. The text of that report has been included herein and this report should be considered as an addendum to the original.

Six test holes were drilled by Public Works Canada at the proposed crossing site to augment the initial subsoil data; three in February, 1975 and three in March, 1976. A profile of the site showing boreholes from all drilling programmes, and the inferred subsoil stratigraphy, has been included on Drawing No. A-1 in Appendix A, and borehole logs are included in Appendix B.

A temporary crossing utilizing a Bailey Bridge design founded upon pile bent piers is currently proposed at the Willowlake River. Two designs have been provided by Bailey Bridge & Pitts Associates Ltd.:

1. A 1000' Deck Truss with 24 ft. roadway allowing two way traffic, requires 4 piers (i.e. 5 - 200' spans) and weighs roughly 1.8 kips per foot.

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2. A 1000' Through Truss with a 13'-9" roadway allowing single lane traffic only, requires 5 piers (i.e. 6-170' spans) and weighs roughly 1.5 kips per foot.

The pier design provided by Bailey Bridge and Pitts would utilize 14 piles per pier, and after making allowances in 1. and 2. above for decking and live loads, the maximum load per pile is estimated in the order of 60 kips per pile. Either steel H-piles (14BP73) or concrete filled steel pipe piles (3/8" wall) have been recommended by Bailey Bridge and Pitts.

II SUBSOIL CONDITIONS AND FOUNDATION RECOMMENDATIONS - ACRES CONSULTING SERVICES LTD.

The following 10 pages are taken from the foundation report by Acres Consulting Services and summarizes subsoil conditions as inferred from boreholes by their crews, and the foundation recommendations for bridge foundations based upon that information.

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1.0 INTRODUCTION

This report contains the results of the foundation investigation and recommendations for foundation and embankment design for the Willow Lake River crossing at Mile 394 on the Mackenzie Highway, Northwest Territories. The field investigation at this site was part of an overall geotechnical investigation conducted by Acres Consulting Services from Mile 346 to Mile 450 of the Mackenzie Highway for the Department of Public Works, Government of Canada.

The purpose of the investigation was to determine the site foundation, permafrost and groundwater conditions and to provide recommendations on the design and construction of the proposed bridge abutments, piers and approach embankments.

2.0 SITE AND GEOLOGY

The Willow Lake River crossing site is located at Mile 394.7 (chainage 985 + 00) on the Mackenzie Highway. This site is approximately one mile upstream from the junction of Willow Lake River with the Mackenzie River.

The stream bed elevation at the proposed crossing site is approximately 250 ft. (D.P.W. datum). The length of the bridge is 900 feet and 4 spans are proposed.

The crossing site is located in a shallow valley approximately 3/4 mile wide and 50 feet deep, incised into

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2.0 SITE AND GEOLOGY - Continued

the fluvial sands and glacial tills which mantle the Mackenzie River valley in this section of the project.

The deepest boring, to a depth of 101 feet, did not encounter bedrock at this site, although shale is encountered at shallow depth several miles to the north along the highway centreline. Bedrock in the area is horizontally bedded shale, sandstone and limestone of the Fort Simpson Formation of Devonian age.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING

A total of seven testholes were drilled at the bridge site along centreline to depths ranging from 15 to 101 feet at the locations shown in Figure 1. Figure 2 shows a centreline section of the valley.

Two testholes were drilled at the abutment locations to depths of 101 and 55 feet and three holes were drilled at pier locations to depths of 51, 71 and 66 feet respectively.

The drilling and sampling at the bridge site was done between January 30 and February 7, 1973 by Kenting Big Indian Drilling of Calgary utilizing a Gardner-Denver 200 "helidrill" mounted on a Foremost 60 tracked vehicle.

Sampling was done using the air recovery percussion method for disturbed samples, 3 inch thin-walled Shelby tubes for undisturbed cohesive soil samples, and the

3.0 FIELD INVESTIGATION AND LABORATORY TESTING - Continued

standard split spoon for granular soil samples. Standard Penetration blow counts were taken with the split spoon sampler.

Samples were logged in the field and classified according to the Unified Soil Classification System as shown in Figure 3. Ice contents were classified according to the N.R.C. Technical Memorandum No. 75 "Guide to the Field Description of Permafrost" as shown in Figure 4.

Moisture contents were obtained for all samples returned to the laboratory and the samples were subjected to routine classification tests including grain size distribution and Atterberg limits. The results of all laboratory and field tests are included in the testhole logs appended to this Report.

4.0 FOUNDATION CONDITIONS

The following boreholes were drilled to investigate the foundation conditions at the bridge abutment and pier locations.

HOLE NUMBER	LOCATION
394-C-B	South Abutment
394-S-C	South Pier
394-S-D	Centre Pier
394-S-E	North Pier
394-S-F	North Abutment

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4.0 FOUNDATION CONDITIONS - Continued

The detailed soil descriptions for these holes are given in the borehole logs appended to this Report.

The boreholes drilled for the three piers showed unfrozen, medium density, silty-sands and gravel to a depth of about 20 feet. Blow counts ranged from 20 to 59 and averaged 30.

This stratum is underlain by approximately 20 feet of dense, dark grey, sandy-silt with minor clay, having W_L = 45 percent, W_p = 20 percent and an average water content of 30 percent. Blow counts from the Standard Penetration test ranged from 22 to 52 and averaged 32 indicating that the silt consistency ranges from very stiff to hard.

Below a depth of about 45 feet, the soil is a clayey-silt with blow counts ranging from 22 to 39 and averaging 32 indicating a very stiff to hard consistency.

No frozen ground was encountered in the three pier testholes.

Testhole 394-C-B, drilled on the south abutment location, showed silty-sand and sandy-silt to a depth of 46 feet. The soil was frozen to a depth of 33 feet. Moisture contents varied from 20 to 30 percent in the lower section of the hole but increased to a maximum of 45 percent in the upper 10 feet of the hole. Blow counts of 46 and 19 were recorded at depths of 35 and 40 feet respectively, in the unfrozen soil, indicating a very stiff to hard consistency.

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4.0 FOUNDATION CONDITIONS - Continued

Testhole 394-S-F, drilled on the north abutment location, showed loose to medium dense silty-sand to a depth of 18 feet. Standard Penetration Test blow counts ranged from 4 to 33. This stratum is underlain by dense sand and gravel to a depth of approximately 60 feet with an average blow count of 44. Dense grey clayey-sandy-silt occurs to a depth of 101 feet. A thaw-consolidation test on a sample from a depth of 16 feet in this hole showed a consolidation of 0.34 percent.

The two testholes drilled on the centreline of the approach embankments some 500 feet back from the river (394-C-G and 394-C-K) showed silty-sand and clayey-silt with moisture contents in excess of 20 percent in the top 20 feet. The soil sampled in these holes was frozen throughout.

5.0 RECOMMENDATIONS AND CONCLUSIONS

The following conclusions and recommendations are made, based upon the results of the investigation program, for the design and construction of the Willow Lake River bridge foundations and approach fills.

5.1 Pier and Abutment Foundation Design

The subsurface investigation program described previously shows the piers to be underlain by unfrozen, medium density, silty-sands and gravels to a depth of 20 feet. Very stiff to hard, unfrozen, sandy and clayey-

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5.1 Pier and Abutment Foundation Design - Continued

silt underlies this stratum with the clay content increasing with depth. Under the abutments, some 20 feet of frozen silty-sand overlies silty sands and gravels. The upper 20 feet of the abutment holes are characterized by relatively high water contents and standard penetration blow counts in 394-S-F of 4 to 7 indicate a loose relative density in at least part of this stratum.

In view of the subsurface conditions under the abutments and of scour considerations, a driven friction pile foundation is recommended for all piers and abutments at this site. The suitable types include pre-cast reinforced concrete, and steel pipe and H piles. Steel H piles are recommended for use at this site in view of their high driving strength, high load capacity and ease of splicing.

It is recommended that all piles used for pier foundations should be driven to a depth of not less than 50 feet or "refusal". As an initial guide, it is recommended that "refusal" be considered to be 240 blows per foot (20 blows per inch) under a hammer rated at 15,000 ft-lb.

Ultimate pile capacity should be established in the field by use of dynamic pile driving formulae. The Janbu formula (Terzaghi and Peck, 1967[1]) is recommended with the use of a factor of safety of 3 to establish an allowable load per pile. Design loading should not exceed 40 tons per pile for a minimum H pile size of HP 10 x 57.

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[1] Terzaghi, K., and Peck, R.B., 1967. Soil Mechanics in Engineering Practice, John Wiley and Sons, 2nd edition, p. 229.

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5.1 Pier and Abutment Foundation Design - Continued

It is recommended that all piles used for abutment foundations should be driven to a depth not less than 60 feet into the existing soil or to "refusal". The recommendations for "refusal", establishment of allowable load per pile, and design loading limits are as outlined previously for the pier foundations.

The abutment foundations may be placed on pile-supported footings located in the embankment. If this procedure is adopted, it is recommended that the abutments be placed on select, well-compacted granular fill. Settlement of the foundation under the weight of the approach embankments would subject the piles supporting the abutments to significant negative skin friction which must be allowed for in the pile design. It is recommended, as an alternative, that the abutment sites be preloaded for a minimum of 2 summer months with the full height of the approach embankment to allow consolidation of the foundation soil, then a portion of the embankment fill be removed to allow pile driving and construction of the bridge abutments.

5.2 Lateral Abutment Loads

The approach fills will have a maximum height of approximately 30 feet and it is recommended that they be constructed of well-compacted granular fill from the approach cuts or the adjacent borrow pits. Thus earth pressures against the concrete abutment and wing walls will be larger than the active case and will approach the earth pressure at-rest case.

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5.2 Lateral Abutment Loads - Continued

It is recommended that the lateral earth pressure design should use a triangular load distribution using a coefficient of earth pressure at-rest (K_o) of 0.40 with due allowance for any surcharges or live loads acting near the wall.

Either the Coulomb or the Rankine method of calculation of earth pressure against the wall can be used. It is recommended that the angle of shearing resistance of the granular fill be taken as 38 degrees and the dry density of the granular fill be taken as 125 pcf. If the Coulomb method of analysis is adopted, the angle of wall friction between the concrete and the granular fill should be taken as 20 degrees.

The use of extensive measures to ensure proper drainage of the backfill behind the abutment is recommended to prevent the development of hydrostatic pressure against the wall. The measures adopted should include the use of perforated steel pipe drains at the base of the wall, weep holes through the wall and the use of select, free-draining granular fill immediately behind the wall.

The use of batter piles to ensure sufficient lateral support against lateral earth pressure is recommended in view of the nature of the upper 20 feet of the abutment foundations.

5.3 Bridge Approach Embankments

The grade presently proposed for the Willow Lake River bridge will result in embankments with a maximum height

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5.3 Bridge Approach Embankments - Continued

of approximately 30 feet. These embankments will overlie the upper silty-sand and sandy-silt deposits which have a relatively high water content.

Some settlement of the embankments will occur and, to allow consolidation to take place prior to abutment construction, it is recommended that the abutments be constructed a minimum of two months prior to bridge construction.

The embankment should be compacted to a minimum density of 98 percent Standard Proctor density utilizing vibrating rollers. The maximum recommended lift thickness is 9 inches.

Data from the project hydrology consultants (Bolter, Parish, Trimble Ltd. of Edmonton) shows that occasional abnormally high water levels will occur due to ice jams on the Mackenzie River. Hence, the approach embankments must be designed for stability against rapid drawdown conditions. If the embankments are constructed from free-draining granular fill containing a minimum of fines, embankment sideslopes as steep as 2.5 horizontal to 1 vertical can be used. If the embankment fill is not free-draining, the maximum recommended embankment sideslopes are 3.5 horizontal to 1 vertical.

It is recommended that the embankment sideslopes be armoured with a minimum thickness of 18 inches of rip-rap having a minimum diameter of 6 inches. Size and thickness of the rip-rap should be increased in those areas of the embankment subject to high velocity water flow. Sufficient cobbles and boulders to

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5.3 Bridge Approach Embankments - Continued

satisfy this requirement, as well as to provide rip-rap protection for the abutments, should be available in the adjacent borrow pits (392-No. 1 and 396-No. 1) at haul distances of approximately 1-1/2 miles.

III EVALUATION OF ADDITIONAL BOREHOLE DATA

With reference to Drawing No. A-1 in Appendix A, the 1976 boreholes have generally confirmed and further defined the subsoil stratigraphy as inferred from the 1973 drilling programme.

The entire crossing site is underlain, at a depth of roughly 40' below stream bed, by an extensive stratum of very stiff to hard, sandy-silt-clay. All test holes terminated in this stratum and standard penetration tests in this material by Acres averaged 32 blows per foot. Hole advance into this zone varied from roughly 15 to 40 feet.

Deposits above the sand-silt-clay to present ground line are highly variable fluvial deposits. An attempt has been made on Drawing No. A-1, to delineate the various stratigraphic zones, however the limits shown thereon should be considered as very broad approximations. The majority of these fluvial deposits have high sand and silt contents, however there are some gravelly zones, and some strata with significant clay content. In general the deposits are in a medium dense or stiff state.

Permafrost was reported to a depth of roughly 30 feet in two holes by Acres (holes B and F), on either side of the

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present stream channel (see Drawing A-1), and confirmed in holes #1 and #2 (1975) by D.P.W. It is expected the stream channel between approximately Stations 980+00 and 988+00 will be entirely free of permafrost. Moisture (ice) contents in the frozen zones generally range between 20 and 30%, and although the sandy subsoil is saturated in the thawed state, there is little ice lensing. Standard penetration tests by Acres in hole F on the north bank are very low for permafrost soils (4 and 7 blows per foot), however subsequent tests by D.P.W. in the same area produced blow counts in excess of 100 blows per foot which are more realistic in the frozen sandy subsoil.

In addition to test drilling, three penetration cones were driven below the stream bed by Public Works Canada. The penetration cones are 2" in diameter and are driven into the subsoil on 1 7/8" diameter rods by a 140 lb. hammer falling 30". The number of blows per foot of penetration is recorded. Results of these tests are plotted on Drawing A-1 in Appendix A. There is no direct correlation between pile driving and cone penetration results, however the penetration cone does provide an indication of relative subsoil density. All 3 plots show a marked increase in driving resistance near a depth of 25 to 30 feet where blow counts

exceed 100 blows per foot.

The leading portion of the penetration cone (i.e. the 2" diameter cone) is left down the hole to facilitate retraction of the extension rods. Although the rods are only 1/8 of an inch smaller in diameter than the cones, no problem was encountered in pulling the rods. Thus there was very little 'drag' or friction on the rods, hence the large majority of driving resistance was point resistance which indicates the deposits below a depth of 25-30' (elev. 220) are very dense.

IV FOUNDATION RECOMMENDATIONS

Acres Consulting Services Ltd. have recommended driven friction pile foundations utilizing steel H-piles. Design loadings of 40 tons per pile (10BP57) with 50 feet of penetration at pier locations, and 60 feet of penetration at abutments have been recommended, with ultimate pile capacities to be established in the field from pile driving data and the Janbu pile driving formula.

This design approach is generally concurred with. The design loadings recommended by Acres would result in an allowable shaft friction in the order of 500 lbs./sq. foot of pile

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area (end-bearing ignored), which is considered to be a reasonable average design value for the length of steel piles recommended by Acres in the variable but moderately dense subsoil at this site.

Either 12" steel H-piles or 12" diameter steel pipe piles have been recommended by Bailey Bridge and Pitts for the pile bents. In the subsoil at Willowlake River, the larger displacement pipe section is considered superior to the H-section for a friction pile design, and for this reason 12" diameter closed-end pipe is recommended.

The pipe piles may be designed on the basis of an average allowable shaft friction of 300 lbs./ft.^{2} for the upper 25 feet of embedded length (i.e. to approximately elevation 230) and a value of 650 lbs./ft.^{2} below that level. In addition end-bearing may be assumed at 15 kips/ft.^{2}. At least 5 feet of embedded pile below stream-bed should be ignored for design purposes for scour protection. Roughly 45' of pile penetration will be required to support a 30 ton design load.

Pile capacities may be checked in the field by pile driving formulae, however it is expected that some pile 'set-up' after driving will occur and a pile load test would provide a much more positive check. A pile load test would normally not be justified for a temporary Bailey Bridge structure,

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however it would be worthwhile at this site as the data obtained could subsequently be utilized for foundation design of the permanent structure. Thus a load test is recommended with the test pile driven to a depth of at least 55 feet (i.e. below elevation 200), in anticipation of heavier pile loadings for the permanent structure. Details for a load test can be provided at a later date.

No driving problems are anticipated at bridge piers. There were no heavy granular strata reported in the drill holes and, although occasional cobbles may be encountered, they should displace easily enough not to seriously affect pile driving.

It is expected that 20 to 30' of permafrost will exist at the abutment locations on both sides of the River. For a temporary Bailey Bridge structure it is recommended the abutments be placed on rock filled timber cribs constructed on existing grade. Placement of approach fills and crib-work on the permafrost soils is not expected to promote thawing below present grade, and although some minor settlement may occur it can be accommodated by periodic shimming of the abutment.

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Pile supported abutments would be expensive as it would be necessary to pre-drill through the frozen zones before driving and gain full pile load support in the non-permafrost soils below a depth of 20-30 feet.

Detailed pile driving records should be maintained during construction including initial pile lengths, cut-offs, tip elevations, hammer data, plus blow counts for every foot of penetration.

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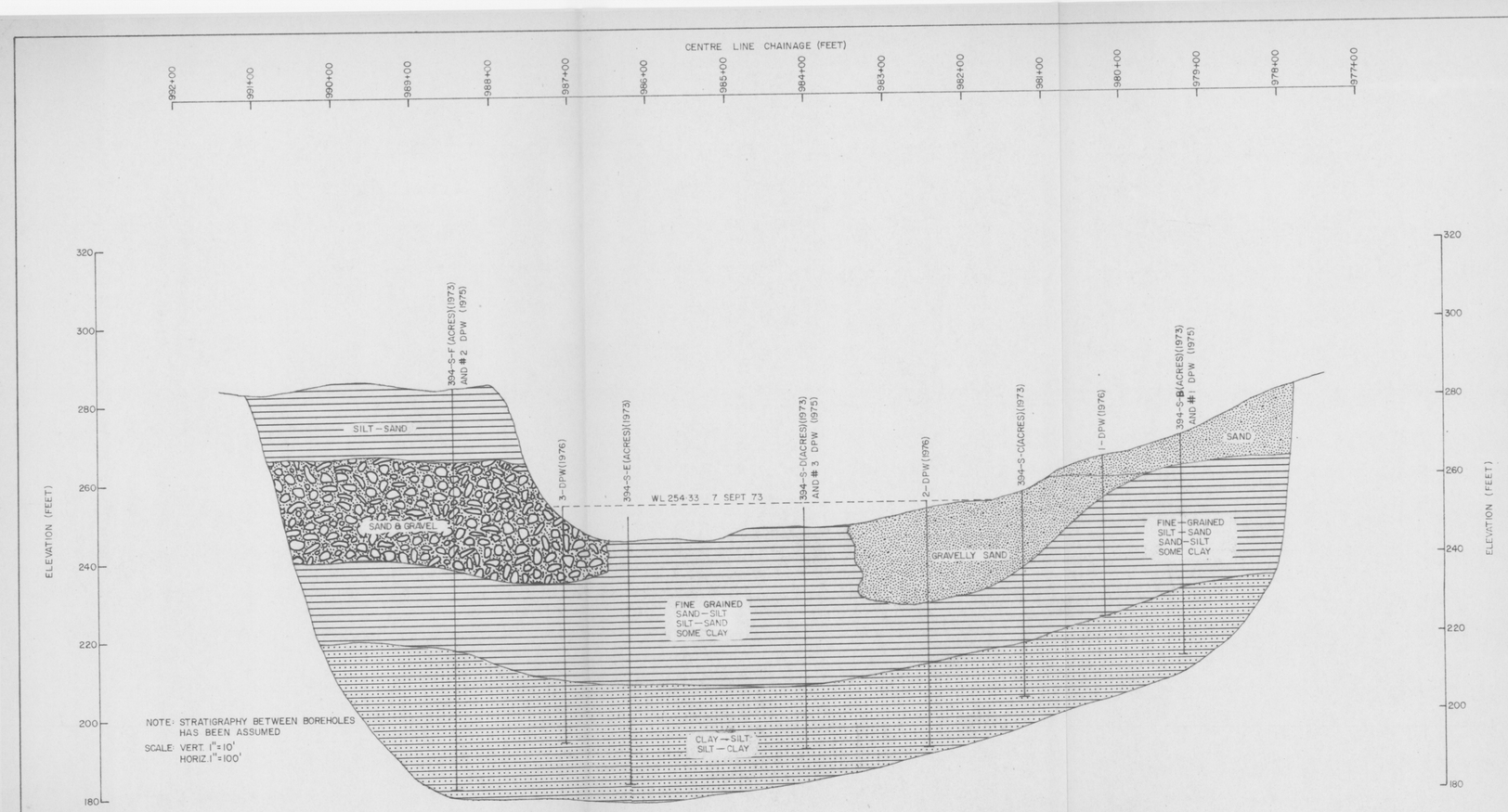
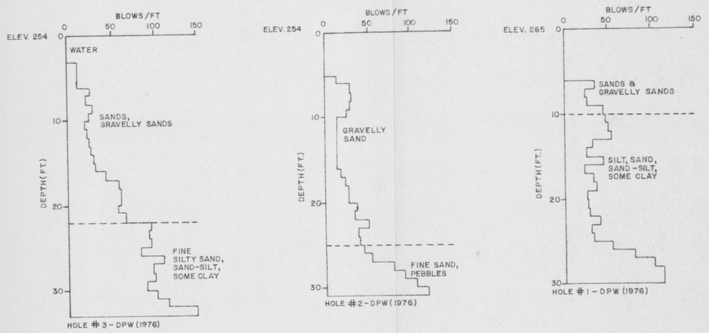


PLOTS OF PENETRATION RESISTANCE



NOTE: 2" DIA. CONE DRIVEN BY 140 Lb. HAMMER FALLING 30"

PUBLIC WORKS CANADA
WESTERN REGION

WILLOWLAKE RIVER CROSSING
℄ PROFILE & STRATIGRAPHY

DWG. NO. A-1

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: WILLOWLAKE RIVER - STATION 979+25

FIELD ENG.	DATE DRILLED. 3/2/75	AIRPHOTO NO.	CHAINAGE.	OFFSET.	TEST HOLE	#1 (1975)
TECH. PRONYCH	RIG. AIR	SURFACE DRAINAGE.	VEGETATION.	ELEV.	MILE	

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
0					CL ML	Clay-Silty Sandy Silt-Sandy Clayey			73	-	27	0	Damp	
3'													Wet	
					ML	Silt-Sandy		V_c-V_r	64	-	36	0	Wet	
10'								1	25	-	51	24	Wet	S.P.T.=130 blows for 10"
					SM	Sand-Silty Gravelly	F		7	-	74	19	Wet	
					SW	Gravelly Fine-Medium		V_s	5	-	86	9	Sat.	S.P.T.= 50 blows for 1"
						Pebbles			8	-	92	0	Wet	
									4	-	94	0	Wet	
30'						Bottom of Hole - 30'								

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

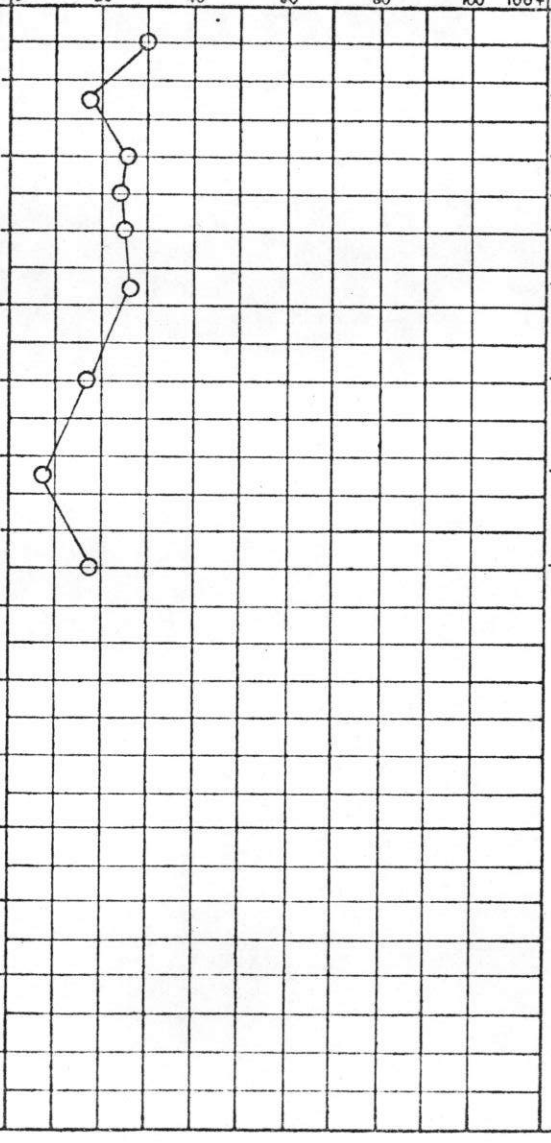
SITE: WILLOWLAKE RIVER - STATION 988+50

FIELD ENG.	DATE DRILLED. 4/2/75	AIRPHOTO NO.	CHAINAGE.	OFFSET.
TECH. Reynolds	RIG. Auger	SURFACE DRAINAGE.	VEGETATION. Spruce	ELEV.

TEST HOLE #2 (1975)

MILE

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0					Pt	Peat		
					CL	Clay-Silty Sandy .5		
4					SM	Sand-Silty Clayey 3'	F	
8								
12								
16								
20					SW	Fine-Coarse Pebbles		
24					SM	Silty Gravelly		
28								
32						Pebbles 31.5		
36						Bottom of Hole - 31.5		
40								
44								
48								
52								
56								



GRAIN-SIZE ANALYSIS						
CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
60	40	0		Sat.	
45	55	0		Moist	
48	52	0		Sat.	
34	66	0		Wet	S.P.T. 67 blows/ ft.
37	63	0		Sat.	
44	56	0		Sat.	
13	80	7		Sat.	S.P.T.=113 blows for 6"
17	67	16		Wet	
16	81	3		Sat.	S.P.T.=100 blows for 4"

DS-14-5-74 a

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: WILLOWLAKE RIVER - STATION 984+00

FIELD ENG.	DATE DRILLED. 3/2/75	AIRPHOTO NO.	CHAINAGE.	OFFSET.
TECH. Reynolds	RIG. B-50	SURFACE DRAINAGE.	VEGETATION.	ELEV.

TEST HOLE #3 (1975)

MILE

REMARKS

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
						ICE		ICE						
4						WATER								
8						SAND-SILTY								
12					SM									
16						GRAVELLY								
20									-11-		73	16	Sat.	
24					SM	SILTY			-13-		87	0	Sat.	Freewater
28									-91-		9	0	Damp	
32						BOTTOM OF HOLE - 30'								
36														
40														
44														
48														
52														
56														

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: WILLOWLAKE RIVER CROSSING SOUTH BANK

FIELD ENG.	DATE DRILLED. 1/3/76	AIRPHOTO NO.	CHAINAGE. 980 + 25	OFFSET.
TECH. CURRIE	RIG. B-50 Auger	SURFACE DRAINAGE.	VEGETATION.	ELEV.

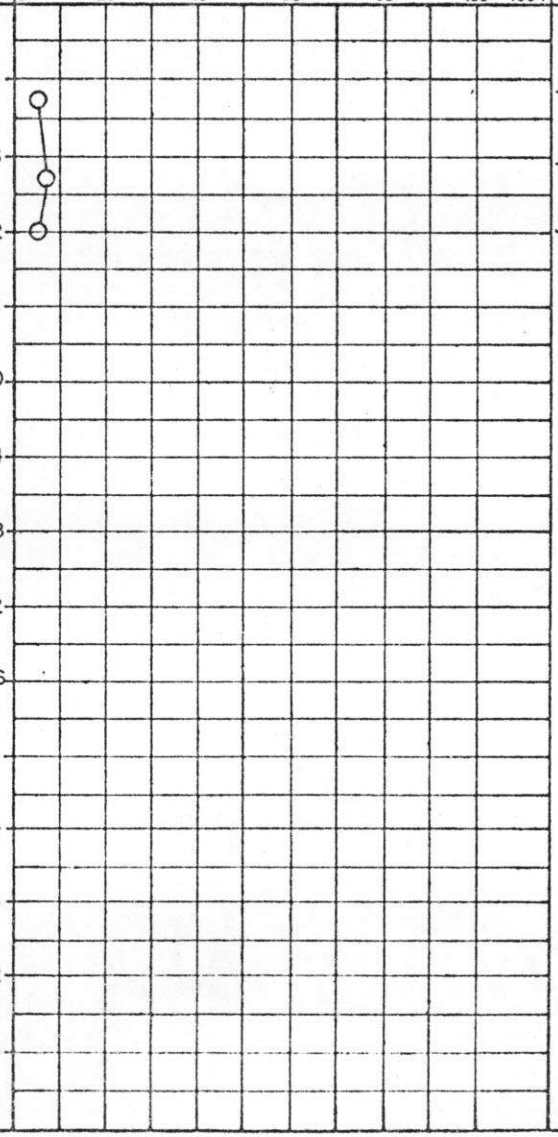
TEST HOLE #1 (1976)

MILE

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
4						Sand-Silty		
						Gravel-Sandy Cobbles — 3' to 4.5'		
8					SW GW	Sand & Gravel Sand-Gravelly Wet @ 10'		
12						— 10' — Saturated (Freewater) 10' - 40'		
16						Sand-Fine Silty		
20					SP	Silt-Sandy		
24					SM	Unable to tell where Soil Strata change		
28								
32								
36								
40						— Bottom of Hole - 40'		
44								
48								
52								
56								

DRY DENSITY (lbs/ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



DEPTH (FEET)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
4	11	7	82		
8	12	63	25		
12	53	46	1		

D3-14-5-74 a

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: WILLOWLAKE RIVER CROSSING MID STREAM

FIELD ENG.	DATE DRILLED. 1/3/76	AIRPHOTO NO.	CHAINAGE. 982 + 50	OFFSET.
TECH. CURRIE	RIG. B-50 Auger	SURFACE DRAINAGE.	VEGETATION.	ELEV.

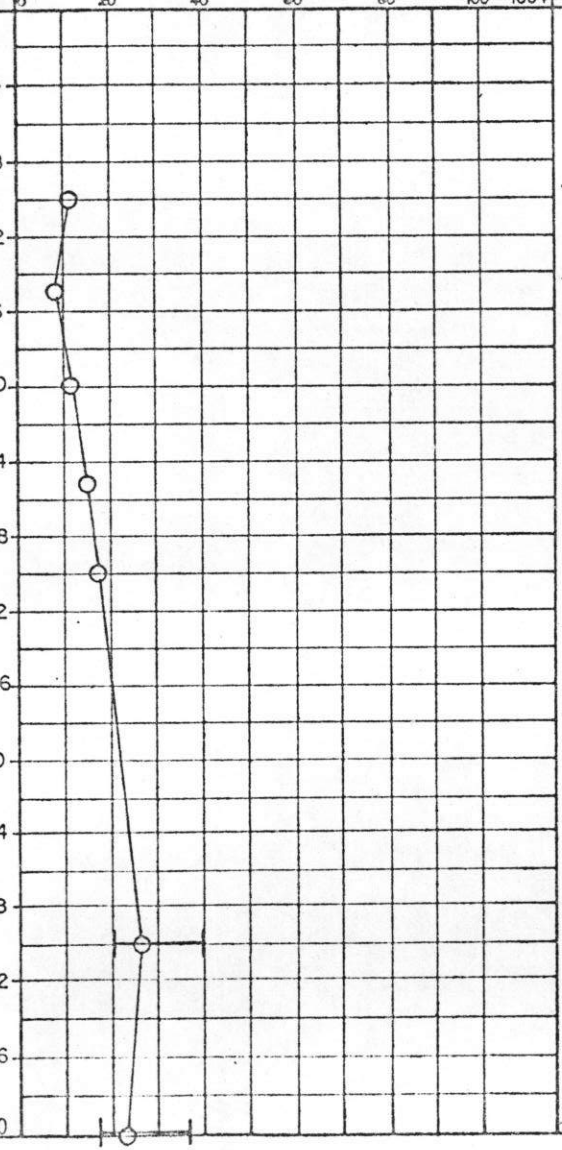
TEST HOLE #2 (1976)

MILE

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
						Ice		Ice
						3'		
4								
8						Sand, Gravelly		
12						Coarse to Medium		
					SP	Freewater to 50'		
16					SW			
20								
						21'		
24					SP	Sand - Silty - Pebbles		
28						- Fine Grained		
32					SW	- Medium Dense		
36								
40								
44								
48								
						48'		
52					Cl	Clay-Silty - Medium Plastic - Stiff		
56								
						60'		

Bottom of Hole - 60'



GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT
CLAY %	SILT %	SAND %	GRAVEL %	
- 2 -		75	23	Sat.
- 2 -		71	27	Sat.
- 4 -		67	29	Sat.
- 4 -		87	9	Wet
- 7 -		84	9	Wet
-97 -		3	0	Wet
- 97 -		3	0	Wet

D3-14-5-74 a

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

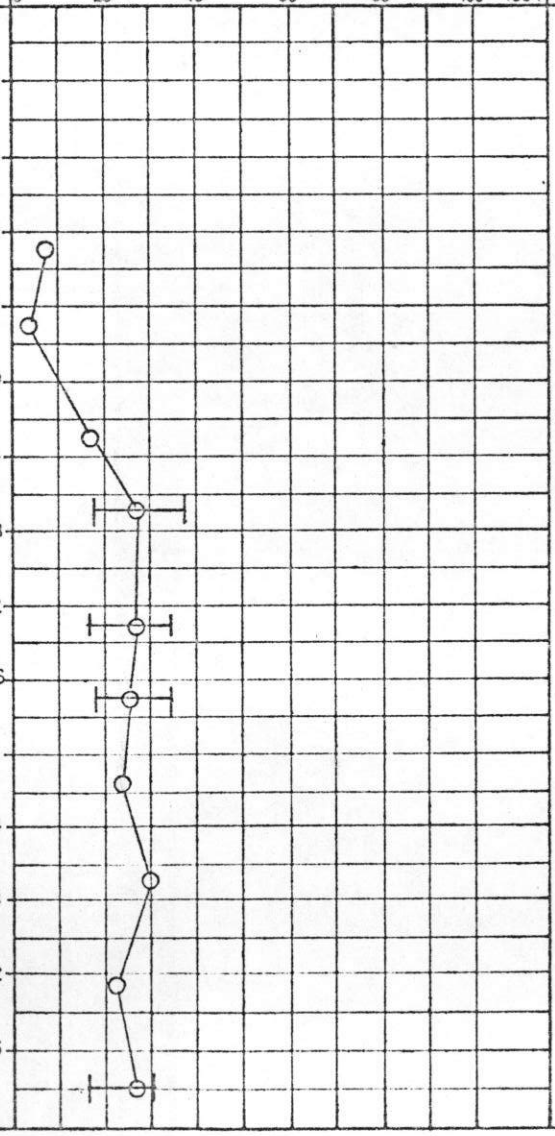
DRILL HOLE REPORT

SITE: WILLOWLAKE RIVER CROSSING
CLOSE TO NORTH BANK

FIELD ENG.	DATE DRILLED. 2/3/76	AIRPHOTO NO.	CHAINAGE. 987 + 50	OFFSET.
TECH. CURRIE	RIG. B-50 Auger	SURFACE DRAINAGE.	VEGETATION.	ELEV.

TEST HOLE #3 (1976)
MILE
REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
						Ice		Ice
4						Sand with Gravel		
8								
12						Gravel-Sandy		
16						-Loose to Medium Dense		
20						Sand-Gravelly		
24						24'		
28					Cl	Clay-Silt Sandy Pebbles		
32					Cl			
36						-Stiff or Dense -Medium Plastic		
40								
44								
48								
52								
56					CL	Clay-Silt Pebbles Low Plastic		
						60' Bottom of Hole - 60'		



GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
- 6 -		39	55	Freewater
- 1 -		17	82	Sat.
- 8 -		54	38	Freewater
-80 -		13	7	Sat.
-82 -		13	5	Sat.
-97 -		3	0	Wet
-96 -		4	0	Sat.
-93 -		7	0	Freewater
-77 -		12	11	Freewater
-96 -		2	2	Wet

DS-14-5-74 a

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 30/1/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 979+25 | OFFSET:
CKD: | TECH: W.R. | RIG: 1 | SURFACE DRAINAGE: GOOD | VEGETATION: D. B. | ELEV: 271

TEST HOLE: MILE 394 | B,C,S C | NUMBER B

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)
PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (P.C.F.)	DRY DENSITY (P.C.F.)	REMARKS
0-8	1	P		50	SM	FINE SILTY SAND WITH A TRACE OF CLAY --BROWN--- GREY		N_{bn}'	6	27	67	0			
8-12	2	P	90	38	ML	SILTY WITH SOME CLAY AND A TRACE OF SAND	F		16	76	8	0			
12-20	3	P	10	38	SP	SAND WITH A TRACE OF SILT AND GRAVEL		V_x							
20-24	4	P		126	SP SP				0	8	91	1			

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 30/1/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 979+25 | OFFSET:
CKD: | TECH: W.R. | RIG: 1 | SURFACE DRAINAGE: GOOD | VEGETATION: D B | ELEV: 271

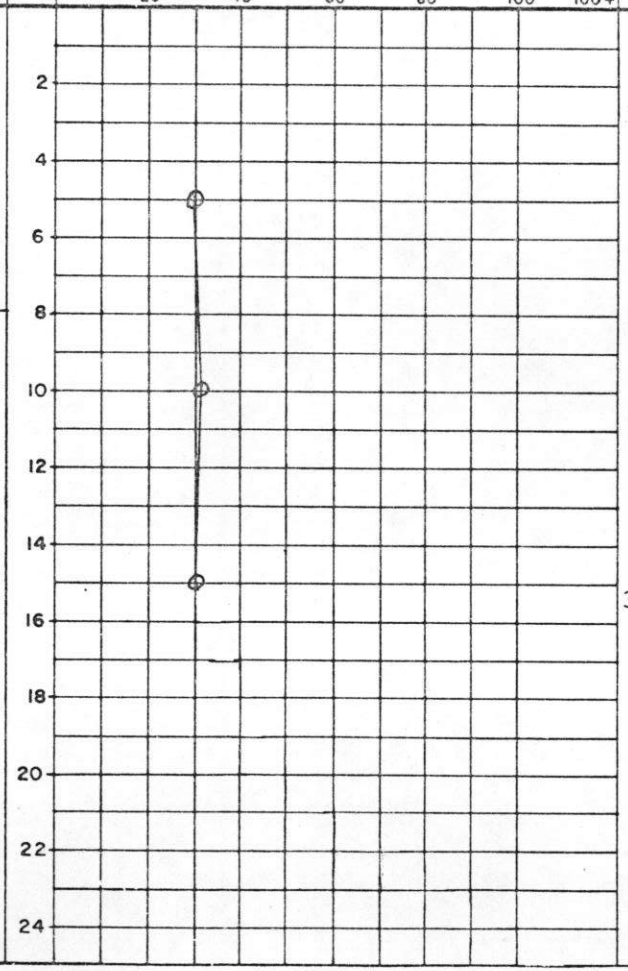
TEST HOLE

MILE	B,C,S	NUMBER
394	C	B

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
25	6	P		112	SM	GREY SAND WITH SOME SILT	F	N_f	0	12	88	0			
30	7	P	90	93	SM				2	22	76	0			
35	8	P		46	SM		UF								
40	9	P		19	ML	GREY SILT WITH SOME FINE SAND AND A TRACE OF CLAY			3	84	13	0			
45	10	T			ML										
50					CL	GREY CLAYEY SILT WITH A TRACE OF SAND									

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+



ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 30/1/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 979+25 | OFFSET:
CKD: | TECH: R.S. | RIG: 1 | SURFACE DRAINAGE: GOOD | VEGETATION: D B | ELEV: 291

TEST HOLE

MILE	B,C,S	NUMBER
394	C	B

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
2							UF	
4								
6					11	END OF DRILLED HOLE AT 55'		
8					20			
10					49			
12					36			
14					45			
16					44			
18					57			
20					65			
22					115			
24					146			
						END OF DYNAMIC PENETRATION TEST AT 65'		

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

GRAIN-SIZE ANALYSIS				WET DENSITY (PCF)	DRY DENSITY (PCF)
CLAY %	SILT %	SAND %	GRAVEL %		

REMARKS

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 5/2/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 981 + 31 | OFFSET:
CKD: | TECH: M.H.R. | RIG: 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: RIVER (NIL) | ELEV: 258

TEST HOLE

MILE	B,C,S	NUMBER
394	S	C

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (P.C.F.)	DRY DENSITY (P.C.F.)
0														
2						GRAVELLY SAND	F	N_{bn}						
4	1								0	3	65	32		
6							UF							
8														
10	2	P		20	GP				0	8	64	28		
12														
14	3	P		59	GP									
16														
18						DARK GREY SANDY SILT WITH A TRACE OF CLAY									
20	4	P		31	ML									
22														
24														

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

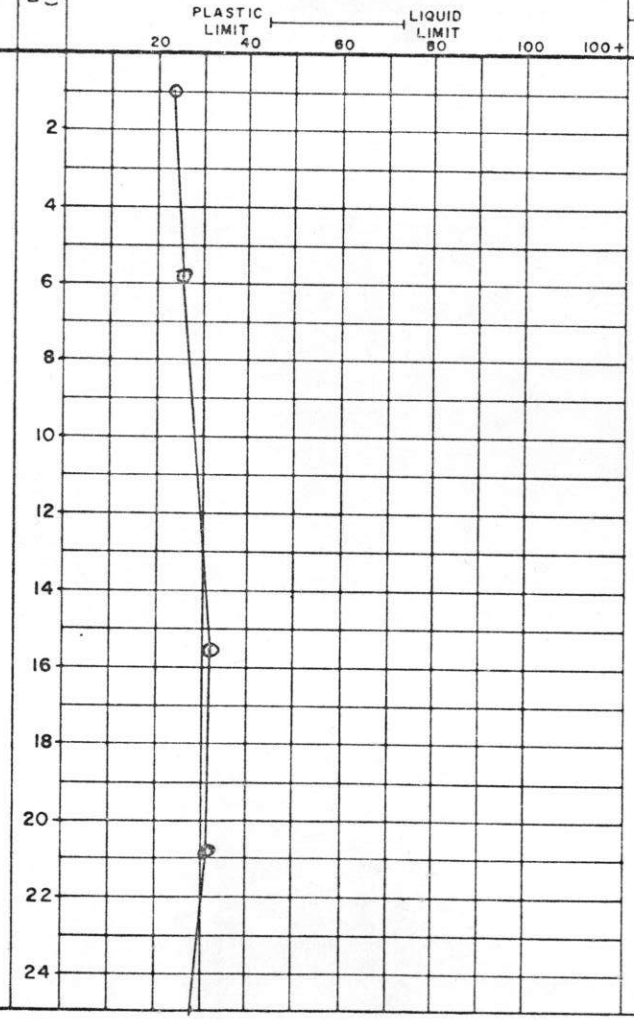
DWN: | FIELD ENG: | DATE DRILLED: 5/2/72 | AIRPHOTO NO: A2271-71 | CHAINAGE: 981 + 31 | OFFSET:
CKD | TECH: R.G. | RIG: 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: RIVER | ELEV: 258

TEST HOLE

MILE	B,C,S	NUMBER
394	S	C

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
25	5	P	70	41	ML			
30	6	P		49	ML			
35	7	P		33	ML		UF	
40	8	P		32	ML			
45	9	P		46	ML			
50								

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)



DEPTH (FEET)	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
10						
16						
20						

REMARKS

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 5/2/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 981 + 31 | OFFSET:
CKD: | TECH: R.G. | RIG: 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: RIVER | ELEV: 258

TEST HOLE

MILE	B,C,S	NUMBER
394	S	C

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
	10	P		41				
2						END OF HOLE AT 51-5'		

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

GRAIN-SIZE ANALYSIS				WET DENSITY (PCF)	DRY DENSITY (PCF)
CLAY %	SILT %	SAND %	GRAVEL %		

REMARKS

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 7/2/7 | AIRPHOTO NO: A 22771-71 | CHAINAGE: 984 + 05 | OFFSET: 27' E

CKD: B.P.S | TECH: R.G. | RIG: No. 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: Nil | ELEV: 256.5

TEST HOLE

MILE	B,C,S	NUMBER
394	S	D

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
2						ICE AND WATER								
3														
4														
6						RIVER BOTTOM ↘								
8														
10														
12														
14														
16														
18						DARK GREY SILT WITH A TRACE OF CLAY AND OF SAND								
20	1	P	90	23	ML		UF		6	84	10	0		
22														
24														

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 7/2/75 | AIRPHOTO NO: A22771-71 | CHAINAGE: 984 + 05 | OFFSET: 27'E

CKD: B.P.S. | TECH: R.G. | RIG: #2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: NIL | ELEV: 256.5

TEST HOLE

MILE	B,C,S	NUMBER
394	S	D

REMARKS

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT ⟷ LIQUID LIMIT
20 40 60 80 100 100+

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
30	2	P		22	ML		UF		4	90	6	0		
40	3	P		35	ML				5	79	16	0		

ACRES CONSULTING SERVICES LIMITED CALGARY, ALBERTA	DRILL HOLE REPORT	DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE HIGHWAY

DWN	FIELD ENG	DATE DRILLED 7/2/7[illegible]	AIRPHOTO NO: A22771-71	CHAINAGE: 984+05	OFFSET: 27' E	TEST HOLE
CKD B.P.S.	TECH R.G.	RIG #2	SURFACE DRAINAGE: ON RIVER	VEGETATION: NIL	ELEV 256.5	MILE 394 / B,C,S S / NUMBER D

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
0															
2															
4															
45						DARK GREY CLAY AND SILT										
6															
8							UF								
50															
	4	P	70	36	CL				48	51	1	0			
12															
14															
16					CL										
18															
60															
	5	P	90	22	CL				43	56	1	0			
22						END OF HOLE AT 61.5'										
24															

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

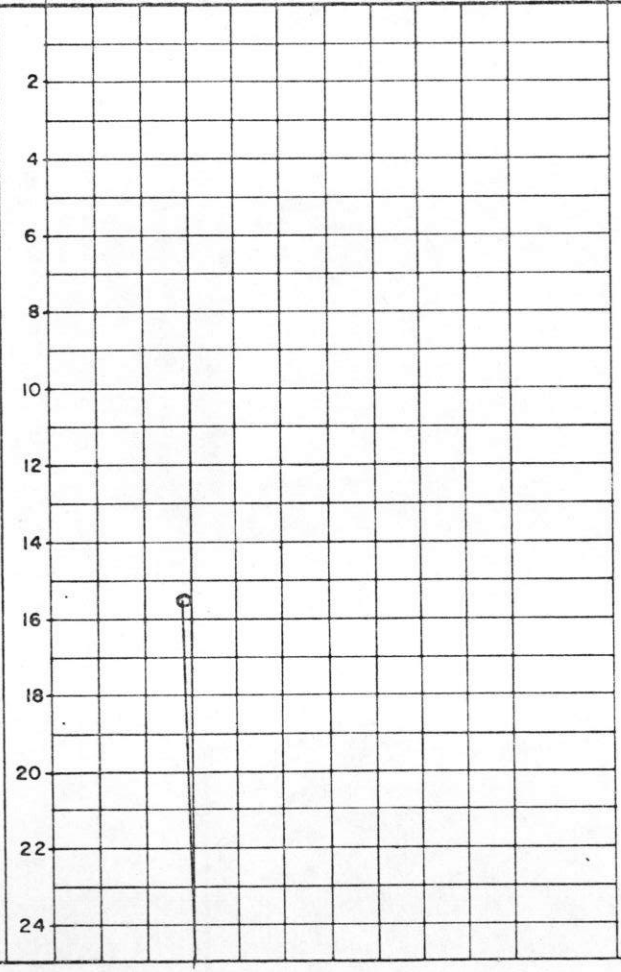
DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 6/2/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 986 + 27 | OFFSET:
CKD: | TECH: M.H.R. | RIG: 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: RIVER (NIL) | ELEV: 256

TEST HOLE: MILE 394 | B,C,S S | NUMBER E

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0						ICE AND WATER		
6						RIVER BOTTOM		
8						GREY SAND WITH A TRACE OF SILT		
16	1	P		30	SP		NF	
22						GREY SANDY SILT WITH SOME CLAY		

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)
PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+



GRAIN-SIZE ANALYSIS	CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
	0	6	94	0		

REMARKS

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

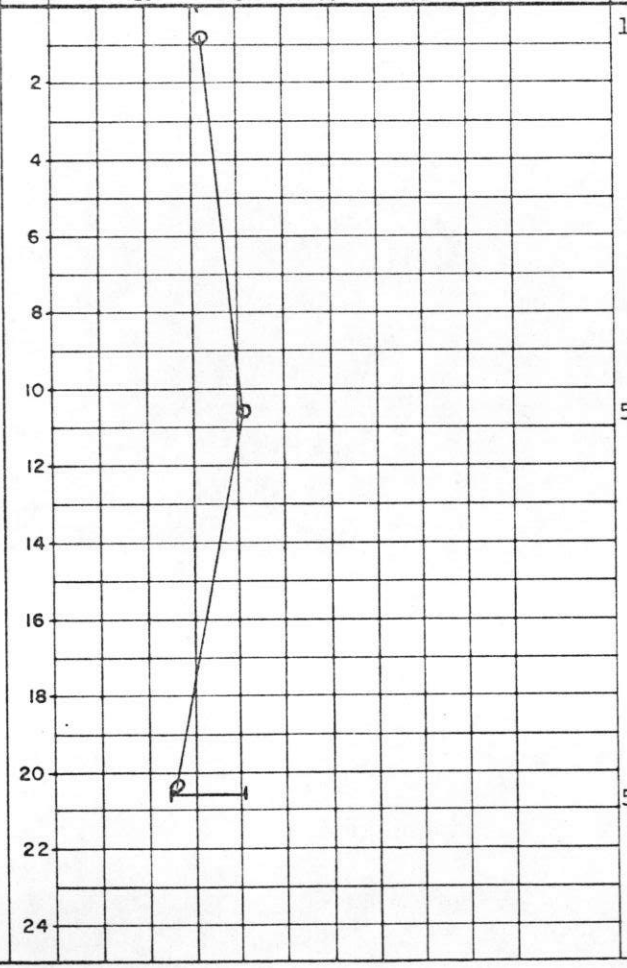
DWN: | FIELD ENG: | DATE DRILLED: 6/2/72 | AIRPHOTO NO: A22771-71 | CHAINAGE: 986 + 27 | OFFSET:
CKD: | TECH: M.H.R. | RIG: 2 | SURFACE DRAINAGE: ON RIVER | VEGETATION: RIVER (NIL) | ELEV: 256

TEST HOLE: MILE 394 | B,C,S: S | NUMBER: E

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
25	2	P		52	CL		UF		16	71	13	0			
35	3	P		32	ML				5	47	48	0			
16						GREY CLAY AND SILT									
45	4	P		31	CL				54	46	0	0			

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+



ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN:	FIELD ENG:	DATE DRILLED:	AIRPHOTO NO: A22771-71	CHAINAGE: 986 + 27	OFFSET:
CKD:	TECH: M.H.R.	RIG: 2	SURFACE DRAINAGE: ON RIVER	VEGETATION: RIVER (NIL)	ELEV: 256

TEST HOLE

MILE	B,C,S	NUMBER
394	S	E

REMARKS

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
50														
52														
4						GREY SILT WITH SOME FINE SAND AND A								
55					ML	TRACE OF CLAY			8	56	36	0		
6							UF							
8														
60	5													
12														
63														
14						GREY SILT AND CLAY								
65														
16	6	P	39		CL				47	52	1	0		
						END OF HOLE AT 66'-5"								
18														
20														
22														
24														

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 6/2/73 | AIRPHOTO NO: A22771-71 | CHAINAGE: 988+25 | OFFSET:
CKD | TECH: R.G. | RIG: 2 | SURFACE DRAINAGE: GOOD | VEGETATION: A G | ELEV: 284

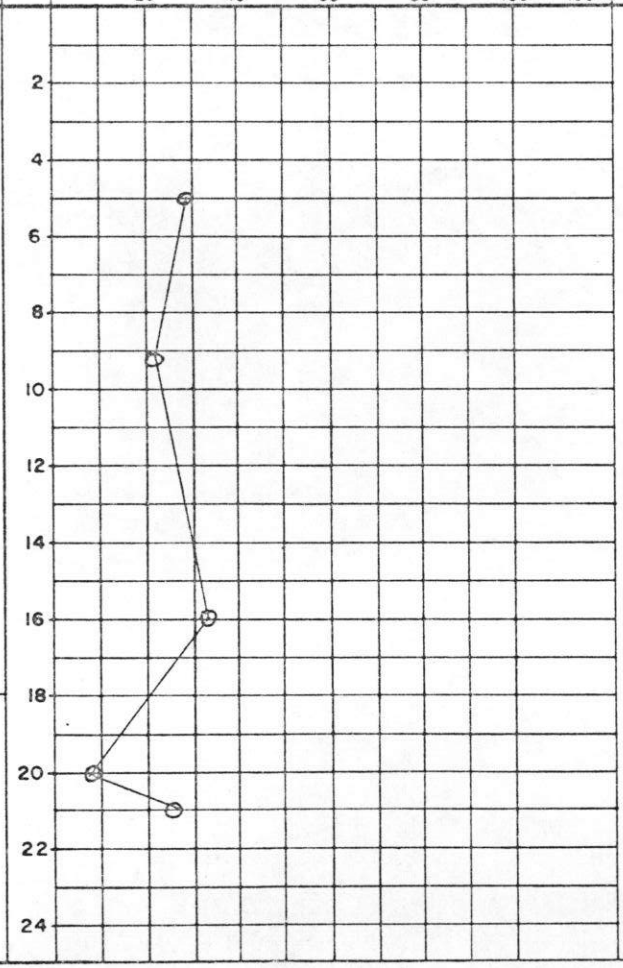
TEST HOLE

MILE	B,C,S	NUMBER
394	S	F

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
4	1	P		33	SC	BROWN SILTY SAND WITH SOME CLAY	F	N_{bn}
10	2	P		4	SC			
16	3	P		7	ML			
20	4	P		37		BROWN SAND WITH SOME GRAVEL AND A TRACE OF SILT		N_f

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+



GRAIN-SIZE ANALYSIS				WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
CLAY %	SILT %	SAND %	GRAVEL %			
12	43	45	0			
13	40	47	0			
0	6	78	16			

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED: 7/2 | AIRPHOTO NO: A22771-73 | CHAINAGE: 998 + 25 | OFFSET:

CKD | TECH: R.G. | RIG: 2 | SURFACE DRAINAGE: GOOD | VEGETATION: A G | ELEV: 284

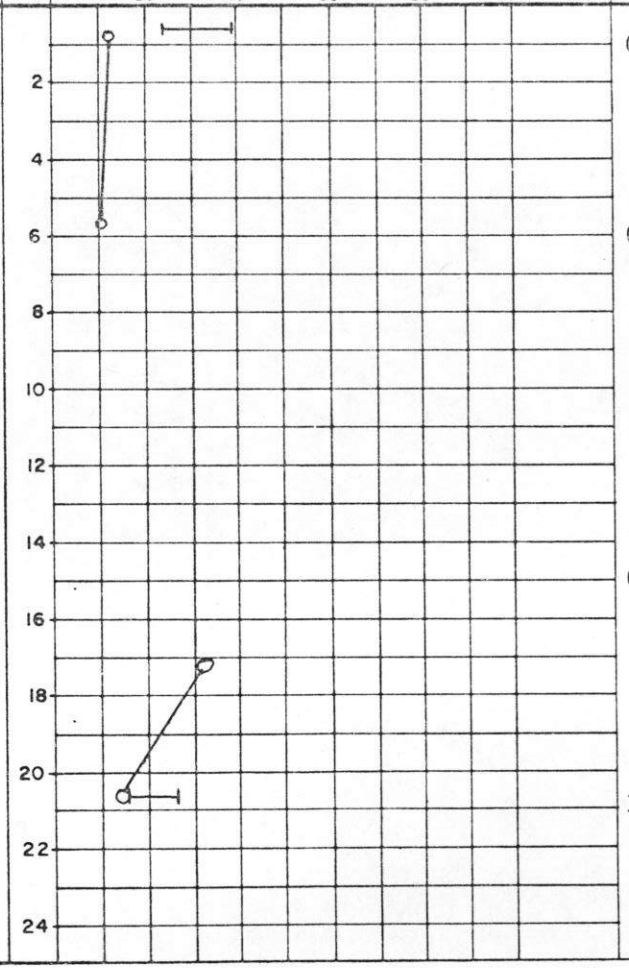
TEST HOLE

MILE	B,C,S	NUMBER
394	S	F

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
25	5	P		43											
2									0	7	56	37			
4					SW	SANDY GRAVEL WITH MINOR SILT	F	N_f							
30	6	P		44											
6									0	8	67	25			
8							UF								
35															
12															
14															
40									0	4	23	73			
16							UF								
18	7														
45	8	P		58	ML				16	36	48	-			
22															
24															
50															

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+



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CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN:	FIELD ENG:	DATE DRILLED 3/2	AIRPHOTO NO: A22771-73	CHAINAGE: 988 + 25	OFFSET:
CKD:	TECH M.H.R.	RIG 2	SURFACE DRAINAGE: GOOD	VEGETATION: A G	ELEV 284

TEST HOLE

MILE	B,C,S	NUMBER
394	S	F

REMARKS

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)
0	9	P		39	ML	SILTY SANDY GRAVEL, MINOR CLAY			22	30	16	32		
4														
5.5	10	T			ML									
8														
9.5	11	P		48	ML		UF		6	87	7	0		
12														
14														
15.5	12				SM	GREY SILTY SAND, MINOR CLAY AND GRAVEL								
18														
19.8									13	37	46	4		
22	13													
24														

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN:	FIELD ENG:	DATE DRILLED: 7/3	AIRPHOTO NO: A22771-73	CHAINAGE: 988 + 25	OFFSET:
CKD:	TECH: M.H.R.	RIG: 2	SURFACE DRAINAGE: GOOD	VEGETATION: A G	ELEV: 284

TEST HOLE

MILE	B,C,S	NUMBER
394	S	F

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
2	14				CL	GREY, CLAYEY, SANDY SILT, MINOR GRAVEL		
4								
6								
8								
10	15				CL			
12								
14								
16								
18								
20					CL			
22								
24								

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT
20 40 60 80 100 100+

DEPTH (FEET)	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
2							
4							
6	20	45	31	4			
8							
10							
12							
14							
16							
18							
20							
22							
24							

ACRES CONSULTING SERVICES LIMITED
CALGARY, ALBERTA

DRILL HOLE REPORT

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DWN: | FIELD ENG: | DATE DRILLED 7/2/73 | AIRPHOTO NO: A22771-73 | CHAINAGE: 988 + 25 | OFFSET:

CKD | TECH: M.H.R. | RIG: 2 | SURFACE DRAINAGE: GOOD | VEGETATION: A G | ELEV: 284

TEST HOLE

MILE	B,C,S	NUMBER
394	S	F

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	WET DENSITY (PCF)	DRY DENSITY (PCF)	REMARKS
100	16	P	-	38	CL				40	58	2	0			
2						END OF HOLE AT 101'-5"									

○ = WATER CONTENT (% OF DRY WEIGHT)
△ = ICE CONTENT (% OF SAMPLE VOLUME)

PLASTIC LIMIT — LIQUID LIMIT

20 40 60 80 100 100+