#60-F-81

W.P. #142-60

Hwy. #61 E.

PIGEON R. BR.

STUART LOCATION

PIGEON RIVER

60-F-81

23-61-54

Mr. A. M. Toye,

Bridge Engineer

Mr. A. Stermac

September 20, 1960.

Re: Additional Fdn. Investigation
International Bridge-Pidgeon
River Hwy. #61, S.P. 142-60.

Attention: Mr. S. McCombie

The original foundation investigation at the above site was carried out by Dominion Soil Investigation Ltd. It has been pointed out in the covering letter that because of the soft material on the east bank, large and non-uniform settlements can be expected. Such settlements are not permissible and two possible corrective measures have been suggested. The second suggestion i.e., the extension of the structure has been adopted by the designer M. M. Dillen & Co. Ltd., as it is seen on the drawing No. 3-4648-2.

In order to provide information on the stratification and properties of the soil at the new abutment location, two additional boreholes were put down by this Section. The locations of these borings are shown on the attached drawing. The extended subsoil profile A-A is also shown on this drawing.

A surface layer of very loose and soft material of only about 5 feet depth was found in both boreholes. Underlying this material is sand and sandy clay which with depth becomes clay of intermediate plasticity. Below this layer, a layer of sand overlying bedrock was found. The stratification in both boreholes is similar but the bedrock elevations are different. Bedrock was encountered in BH 1 at elev. 562.0 while in BH 2 it was already at elev. 580.5. This indicates a sloping of the bedrock in the northern direction.

The proposed excavation of the soft surface layer as indicated on the above mentioned drawing No. 3-4648-2 should be carried out. The properties of the underlying strata are such that there is no stability problem for the limited approach fill. The settlements will be small and therefore tolerable.

The borings were done between August 24th and 29th, 1960, under the supervision of Mr. Frank Norman.

Cont'd /2

We believe that with this additional information you have all the necessary data for the completion of your design work. However, should there be any other question in connection with the above job that you would like to discuss please feel free to call on our office.

L. G. Soderman
Principal Foundation Engineer

Per: A. Sterman
Foundation Office Engineer

Attach
AS/tt
c.c. Foundation Section
General File

Mr. A. M. Hayo,
Bridge Engineer.
Materials & Research Section.

March 17, 1960.
FOUNDATION INVESTIGATION - by
Dominion Soil Investigation, Ltd

Attention: Mr. S. McCombe.

Re: Pigeon River Bridge,
Hwy. 61 - Line 'B'
Short Location
Thunder Bay District
W.P. 142-60 - Dist.19.

The detailed foundation report prepared by Dominion Soil Investigation, Ltd., has been reviewed by the Foundation Section. Comments arising from the review of this report, are as follows:-

(1) West Abutment - (American side)

The fill at this location is in place. The placing of spread footings directly on the fill is not recommended. Steel 'H' piles, driven through the fill to refusal, will provide the most positive type of foundation. These 'H' piles will reach refusal at approx. elevation 568 in the vicinity of Borehole 11 - (North side), and at approx. elevation 584 to 580 in the vicinity of Borehole 12 (South side).

(2) Pier Locations -

The proposed piers should be supported on steel 'H' piles. These steel 'H' piles will meet refusal to driving at elevations varying from 580 to 565. The refusal elevations have been determined from the borehole logs and may vary by even greater limits than those suggested. A 14" section at 73#/ft. is recommended because of difficult driving through the stoney material.

cont'd. /2 ...

(2) Pier Locations - (cont'd.) ...

Sheet piling will provide protection from river ice, as well as scour, and will also provide forming for the pile caps. The sheet piling should be driven to penetrate approx. 5 to 7 feet into the clay layer or to refusal, as in the case of Boreholes 7 & 8.

(3) East Abutment -

The foundation report states that there will be no problems associated with the stability of the approach fill. This is not the case. If failure does not occur during construction of the proposed fill, the large differential movements, caused by the high stress in the subsoil, will be objectionable.

Two possible corrective measures are available: The first is excavation of the organic clay silt from beneath the proposed embankment. This will involve an excavation to approximately 10 feet in depth, most of which will be under water. The second corrective measure would be to extend the structure. If the structure is lengthened approx. one span length, or 60 feet, no problems with the approach fill will result.

The foundation for the East abutment will be similar to the west abutment - i.e., steel 'H' piles, driven through the fill to refusal. Scour protection in the form of rip-rap, will be required for both the North and South abutments.

If we can be of further assistance in connection with the foundations for this structure, please contact the Foundation Section.

[illegible]
Attach.

cc: Messrs. A. M. Toye (1)
C. O. Ramsay (1)
O. M. Hunter (1)
J. B. Garland (1)
L. Powell (1)
State of Minnesota (3)
Foundations Office (1)
Gen. Files (1)

L. G. Somerman,
[illegible]
or:

[illegible]

Department of Highways, Ontario
Materials and Research Section
Downsview, Ontario.

REPORT ON
FOUNDATION INVESTIGATION
PIGEON RIVER BRIDGE
STUART LOCATION - HIGHWAY NO. 61
LINE "B"
PIGEON RIVER, ONTARIO.
W.P. 142-60.

Submitted by:-

Dominion Soil Investigation Ltd.,
88 Eglinton Avenue East,
Toronto 12 - Ontario.

February 23, 1960.

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Engineering Data Sheets

APPENDIX II
Laboratory Test Results

Pocket Of Back Cover

HUdson 7-3633

88 Eglinton Ave East
Suite 312

DOMINION SOIL INVESTIGATION LTD.

SOIL MECHANICS • FOUNDATION ENGINEERING

TORONTO 12, ONTARIO

FOUNDATION INVESTIGATION
PIGEON RIVER BRIDGE
STUART LOCATION, HIGHWAY NO. 61
W.P. 142-60

1. INTRODUCTION:

A complete foundation investigation for the proposed new bridge over Pigeon River on Ontario and U.S. Highway No. 61 was authorised by the Ontario Department of Highways, Materials and Research Section.

This report presents the results of the field investigation, the results of laboratory tests, and subsequent analysis of foundation conditions related to the design and construction of the proposed bridge and its approaches.

2. LOCATION OF SITE:

The location of site is shown in Enclosure No. 1 at the back of the report. Briefly, the proposed bridge is about 1½ miles south-east of the Ontario Provincial Police Detachment buildings at Middle Falls. The bridge over the Pigeon River joins Highway No. 61 on the Minnesota, U.S.A., side with the same Highway No. 61 on the Ontario, Canada, side. This general area is known locally as Stuart Location which is within Pardee Township in Thunder Bay District.

The international boundary line is at station 2582 + 83.5 on survey line 'B'.

3. DESCRIPTION OF SITE AND PIGEON RIVER:

At Stuart Location Pigeon River makes a partial 'U' turn. The proposed highway crosses the river at the lower part of the 'U' (see plan on Enclosure 1). The west bank on the U.S. side has a steep slope rising about 22 ft. above ice surface and levels off. It is predominantly a stiff brown clay. Small trees and shrubs line the banks.

3. Continued:

On the Canadian side, at the east bank, a 2-3 ft. alluvial mound has been built up by spring floods. Beyond it for a distance of about 100-150 ft. is a flood plain having a general elevation of 603±. The deposits in the flood plain are alluvial silt, sand and organic silt. North of the crossing the flood plain is several hundred feet wide. A steep bank beyond the flood plain rises to elevation 630± forming a flat plateau. This plateau is also a stiff clay with some rock ridges (see Inferred Geology below).

The trees along the east bank lean toward the river. Many have been undermined by the progressive erosion of the river bank. The main stream channel is presently near the west bank. In recent times the centre of the river has been filled with multi-layered silts, sands, gravel and organics. Maximum depth of river deposits is about 10 ft. This deposit is very loose and will scour easily. A loose fine organic sandy silt has been deposited at river bed adjacent to the east bank.

Large boulders and stones line the East bank from a point about 80 ft. downstream from the crossing. They are part of a diabase rock ridge intersecting the crossing at a slight angle with Line "B". The river cuts across several diabase ridges. High Falls, about ½ mile upstream had a drop of 90 ft. originally, and Middle Falls, about 2 miles upstream, has a drop of 20-25 ft. Pigeon River flows into Pigeon Bay, Lake Superior, which is about 1 mile downstream from the site.

Ice thickness during the investigation was between 6" and 12". The thickness varied depending on the intensity of the current. In several locations, particularly where the water is shallow and turbulent, there was no ice formation. Upstream from the proposed crossing the river is much wider and the flood plain area is large. When the ice moves in the spring, it will likely break up into large sheets.

4. INFERRED GEOLOGY OF THE AREA:

The area around Stuart Location may be described as rolling topography with a succession of broad valleys running south-west and north-east between outcropping rock. Bedrock is of the Late Precambrian era. The outcropping rock forming the tabular upland is primarily sills of diabase with related rocks. These rocks are very susceptible to erosion by atmospheric agencies and streams.

Within the broad valleys the underlying bedrock is part of the Animikie series, the lowest group of strata in the Late Precambrian. It has been subdivided into three separate formations by T. L. Tanton. * At the site the rock is part of the Rove formation which is composed in part of shale, greywacke and fragmental volcanic rock. The geological formations for the area are shown on Enclosure No. 2 at the back of the report.

*Memoir 167, Geological Survey of Canada.
Port Arthur, Fort William and Thunder Cape Map Area.

4. Continued:

A soft greenish-grey rock with texture of silt or fine grained sandstone, was encountered in those boreholes within the valley. The rock contains tiny flakes of mica and chlorite in a medium crystalline mass. Most of the rocks in the Animikie series contain iron formations. The Rove formation has a thickness of about 130 ft. while the entire Animikie series is approximately 2,000 ft. thick.

The lowlands marked by broad valleys contain thick deposits of granular soil and clay placed during Pleistocene times. These valleys were probably deepened by glacial erosion and subsequently ground morraine, lacustrine and fluviolacustrine beds were laid down on which the surface of the lowlands has been developed. They slope gently from elevation 850± to present Lake Superior water level. The lowlands have been trenched and gullied by streams since the level of glacial Lake Algonquin and its succeeding stage dropped to the level of Lake Superior.

It may be observed from the map showing the geological formations that the bridge site is immediately north of a diabase sill ridge. This ridge is only about 25 ft. south of centreline at the west bank and about 80 ft. south at the east bank. A very dense bouldery till overlies bedrock. It is presumably the late Wisconsin drift. Coarse gravel, sand, stones and silt predominate with some boulders up to several feet in diameter. Boulders and stones of granitic gneiss, chert and conglomerate were noted but most of the stones are rounded diabase rock fragments irregularly distributed in the till sheet. The till slopes to the North-West perpendicular to the proposed bridge centreline.

The reddish-brown clay is a lake-bed or delta deposit formed in post-glacial times together with the deposition of old Lake Algonquin. The red color of the clay is derived from the ferroginous rocks of the late Precambrian that were being eroded and decomposed at a higher elevation. Varves found in the clay at elevation 600-610 were formed during intermediate stages of deposition during a period of no fluctuation in Lake Superior.

5. DRILLING PROGRAMME:

Field work was carried out during the period of December 3 to 19, 1959. The drilling was done by a crew from Boyles Bros. in Port Arthur.

Drilling was started at borehole 1 on the Canadian side. A dynamic cone penetration test was made at all boreholes but borehole 13 and at points necessary to correlate strata. Refusal was met when the cone struck the bouldery till stratum. Insitu vane shear tests were conducted in the clay stratum. Towards the bottom of the clay stratum, numerous coarse sand and gravel sizes mixed in the clay gave erratic and unreliable results.

5. Continued:

Both 2" and 3" thin-walled tube samples were recovered. Numerous split spoon samples that were taken were sealed for moisture content determination.

The most time-consuming operation was penetrating the bouldery till and drilling through rock and bedrock. When the till was reached, an impregnated AX casing shoe was inserted inside the BX casing. An AXT core bit was used to recover the rock core samples. Rocks from the core barrel were logged as recovered, and representative specimens are stored in a core box. In some boreholes, it was necessary to drill the AX casing to solid rock.

A BX casing with shoe was used to drill through the fill material at the east approach (borehole 13). In addition to being frozen, it contained numerous boulders.

6. LABORATORY TESTS:

The samples recovered were examined and tests on selected samples were performed following a discussion of the investigation with a D.E.O. representative. All tests were made by the Materials and Research Section.

Seven consolidation tests of the clay and alluvial soil samples were made. The results are shown in Appendix II, Laboratory Test Results, at the back of the report. The results of consolidation tests on samples 4 and 5 of borehole 2 are not considered reliable. The samples were probably disturbed. Unconfined compression and triaxial shear test results are summarized in the same Appendix along with other test results.

Generally the laboratory test results were consistent. Unconfined compressive strength test results compared favourably with insitu vane shear results. In some cases the shear strengths determined by laboratory tests were higher than those obtained from vane shear tests.

7. SOIL DESCRIPTION:

The location of boreholes and subsurface sections are shown on Enclosure A found in the pocket at the back of the report. The subsoil is classified under seven distinct geological formations. Boundaries of strata between boreholes are approximate only, based on geological interpretation.

(a) Very Loose Alluvium:

Within the flood plain at the east bank is a 10 ft. alluvial deposit. It is composed of clayey silt near the surface then changes to a dark grey organic silt. Numerous organic fibres are mixed in the silt-sand deposit.

Water content is about 33% and the unit weight between 116 and 119.5 pcf. The organic content is about 15%. Triaxial quick

7. (a) Continued:

tests gave shear strength results of 375-550 psf. One consolidation test on a sample from a depth of 5'-0 gave a compression index of 0.32 and the coefficient of consolidation, which is almost constant for the range of loads applied, is 0.04 in. 2 minute.

(b) Loose gravel and coarse sand:

Below the alluvium is a 1.5-2.5 ft. layer of grey well-graded gravel and coarse sand. This stratum was encountered in most of the boreholes immediately above the clay stratum. In some cases clay was mixed in the granular soil.

(c) Stiff Reddish-brown clay:

A thick layer of stiff reddish-brown clay covers the site with the exception of one area in the vicinity of borehole 8. The clay layer was encountered at elev. 617 at the west bank and it terminated at elev. 584 and 570. On the South side of the centreline, the river has eroded the clay to a thickness of only 4-6 ft. in the main channel. Along a line 25 ft. south of the centerline, the clay-till contact is generally between elevations 580 and 586. However, along a line 25 ft. north of the centerline, the same contact is between elevations 567 and 573.

The wet unit weight of the clay ranges from 104 to 129 pcf with the majority being in the range of 116-120 pcf. Natural water contents average about 32%, the plastic limit about 21%, and the liquid limit between 34% and 50% with some layers as high as 62.6%.

Vane shear strengths are in the range of 1000 psf at the top of the stratum to 2200 psf at the bottom. The increase in shear strength would indicate that the clay has a Cv/p ration of about 0.5 below the dessicated top crust. Shear strengths obtained from unconfined compression tests agreed favorably with vane tests except when the clay was varved or contained numerous coarse sand and gravel particles. The sensitivity of the clay from insitu vane tests is commonly between 3 and 5 but some results were as high as 9.5. Remoulded shear strength was measured after 10 complete rotations of the vane.

The compressive indexes for the clay determined by consolidation tests are as follows:-

Borehole	Sample	Elevation	Compression Index	
13	1	608	0.74)	West Bank
13	2	597	0.58)	
5	4	590	0.405)	River Bed.
10	2	585	0.37)	

7. (c) Continued:

Results of two other tests, borehole 4 samples 4 & 5, are not considered reliable since the e-log p curve suggests that the samples were much disturbed. Preconsolidation pressure determined by the Casagrande construction suggests that the preloading pressure was in the range of 2.4-2.8 tons per sq. ft.

(d) Very dense bouldery till:

A very dense till containing numerous diabase stones and boulders in a matrix of sand, silt and gravel underlies the clay. It was necessary to drill with diamond bits or impregnated shoes through this till. Split spoon sampling was attempted but no recovery was possible.

(e) Bedrock:

A sharp demarkation between broken rock or boulders and bedrock was difficult to establish. Within the valley portion of the site, bedrock is a soft greenish-grey greywacke. It was fractured and fissured at the top. On the south side of the centerline, large diabase boulders and fractured diabase rock was encountered. Greywacke was reached at the boreholes near the east bank.

8. DISCUSSION:

(a) Embankment Stability:

i) West approach:
The embankment was constructed to grade before the investigation was carried out. There is no evidence of instability of the approach or the adjacent banks. Slope of the natural banks is much steeper than the fillslope.

A cursory stability analysis of the existing fill slope was made. The results indicate that the factor of safety is in excess of 1.5.

ii) East approach:
It was assumed that clay fill material similar to that found in the area would be used in the embankment. It was further assumed that the fill would be placed directly on the alluvium having slopes of 2 on 1. Using an estimated value for cohesion in the clay fill of 300 psf and excluding frictional resistance, the factor of safety is in the order of 1.3 to 1.5 for a slide confined to the alluvium. If the fill is constructed over a period of about 1 week or more to proposed grade (elev. 623), the factor of safety would increase slightly with time and would therefore be sufficiently stable. Close field control is suggested to ensure that the minimum insitu shear strength of the fill is at least 300 psf or more, due to cohesion or the equivalent in frictional resistance as required in a stability analysis. The factor of safety for a deep-seated slide within the clay stratum is over 1.5.

8. ii) Continued:

Total settlement of the fill is predicted to be in the order of 1.6 to 2.0 ft. with grade at elev. 623. Settlement due to consolidation of the alluvial stratum alone is about 1.5 ft. Most of the predicted settlement will take place within 2-3 months but a small percentage will continue over a period of 1½ years.

(b) West abutment:

A shallow depth abutment supported in the stiff clay is one possibility for the West abutment. The safe bearing capacity for spread footings placed between elevations 615 and 610 is only 3000 psf. Assuming that the footing width is about 6.0 ft., and the dead load pressure is limited to 2000 psf the predicted settlement is in the order of 3 to 4 inches. This, of course, would require remedial measures to the approach span to correct for the settlement.

An alternative is a pile-supported small abutment with the bearing piles driven to the very dense bouldery till.

The ultimate capacity of a friction pile based on weighted vane shear strength values is about 3.5 kips per foot of embedded depth in the clay. Settlement of the entire pile group would however, still be excessive for a pile less than 25 ft. in length.

(c) River Piers:

Two major considerations enter into the design and construction of the piers. The first is the choice of foundation. Safe bearing capacity of the clay is less than 2000 psf for spread footings established in it. There is the added problem of excessive settlement and particularly differential settlement of the pier in a direction perpendicular to the bridge centerline. The clay stratum is considerably deeper on the upstream than on the downstream side of the bridge.

The second consideration is the depth of scouring. On the upstream side, the river has eroded the clay to as low as elev. 581.7 at borehole 6. The riverbed deposits laid subsequently to erosion are very loose and are susceptible to scouring.

It may be desirable to use a combination of mass concrete and bearing pile foundations. The mass concrete foundation would rest directly on the bouldery till on the downstream side of the centerline and as the depth to till became excessive, bearing piles would be used. Although a direct evaluation of the safe bearing capacity of the bouldery till could not be made, a safe bearing pressure of 6000 psf may be assumed. Heavy scour protection is suggested. This may take the form of steel sheet piling around the pier footings or thick rip-rap protection for footing embedded in the clay stratum or a combination of the two.

8. (d) East abutment:

As outlined under river piers above, the clay or the overlying alluvium is not suitable for supporting spread footing foundations. A pile-supported abutment is required. In view of the high total settlement due to the weight of the approach fill (when placed directly on the alluvium), it is advisable to place the fill about 2-3 months prior to construction of the abutment. This will have the beneficial effect of most of the settlement being completed before the abutment is in place and thus avoiding the probability of negative skin friction and adhesion from the alluvium and fill material overstressing the bearing piles.

Either a spill-through abutment or a shallow depth pile-supported abutment may be used. The latter may prove more practical and economical. However, this is left to the structural engineer's discretion. Bearing piles, regardless of type, are not expected to penetrate very far into the very dense bouldery till.

Stone rip-rap protection on the slope and the upstream side of the approach fill is required. At the toe of the slope where fine silt and sand is deposited, heavy rip-rap protection is required.

9. CONCLUSIONS AND RECOMMENDATIONS:

The borings revealed that a very dense bouldery till overlies bedrock and broken rock. Elevation at top of the till stratum on the upstream side is 563.2 to 573.3 with a general elevation of 568±. On the downstream side of the centerline the till was encountered between elevations 585.3 and 579.4 with a general elevation of 583-584. A stiff reddish-brown clay covers the till with some alluvial deposits above it in the east flood plain.

The clay has a low bearing capacity and settlement would be excessive under comparatively low bearing pressures. Pile foundations are recommended throughout. Bearing piles will stop on or within the bouldery till stratum. A thick layer of river deposits lines the river bed. Scour protection is necessary for river piers and stone rip-rap or other forms of protection is recommended for the approach fill slopes.

Approach fill at the west abutment (U.S. side) is completed to grade. The embankment is stable. A stability analysis of the east approach embankment revealed that a factor of safety in the range of 1.3 to 1.5 is available when the fill is placed to grade directly on the alluvial deposits. Close field control is suggested to assure that the minimum shear strength of the fill material (supposedly clay) is 300 psf.

It is recommended that the west approach fill be placed about 2-3 months prior to abutment construction. Within that period of time most of the predicted 1.6 to 2.0 ft. of settlement will have taken place.

9. Continued:

This would have the effect of minimizing the probability of negative skin friction developing on the piles ; and the abutment after the abutment is constructed. The bearing piles should be pre-cored through the fill material particularly if construction is started with a consolidation period of 2 months or less.

If the 2-3 month period of consolidation is not desirable, or for other reasons, possibly that the minimum shear strength of the clay fill could not be guaranteed, the alternative is to remove the alluvium to the gravel and sand strata overlying the clay. Settlement due to consolidation of the clay alone is predicted to be in the order of 4 to 7 inches. The variation in predicted settlement is due to the difference in thickness of clay perpendicular to the centerline of the highway.

In all probability sheetpiling cofferdams will be required to construct the river piers. In view of the scour protection necessary, it may be advisable to leave the cofferdam in place for that purpose and they may also act as ice breakers protecting the pier shaft.

DOMINION SOIL INVESTIGATION LTD.

A. Kobelak, P. Eng.

Report No. 59-179.

February 1960.

APPENDIX I

ENGINEERING DATA SHEETS

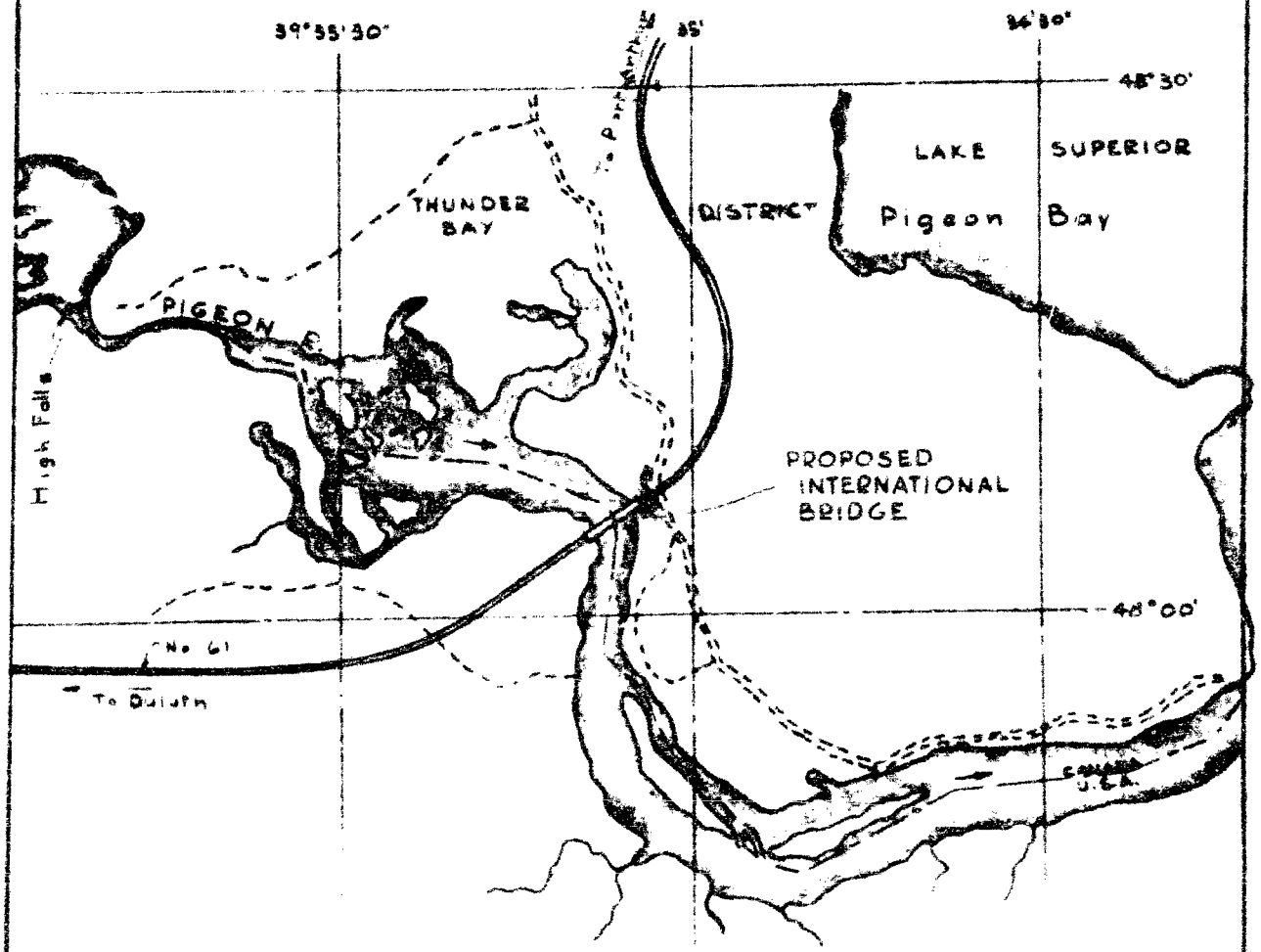
LOCATION OF SITE	Enclosure No. 1.
GEOLOGICAL FORMATIONS	Enclosure No. 2.
BOREHOLE LOGS AND CONE PENETRATIONS	Enclosure No. 3-21 incl.

Order No. 60-109

Enclosure No 1

Prep By G.R.

KEY PLAN



LOCATION OF SITE

Scale:- 1" = 1000'

Dominion Soil Investigation Ltd.

Order No. 59-179

Enclosure No. 2

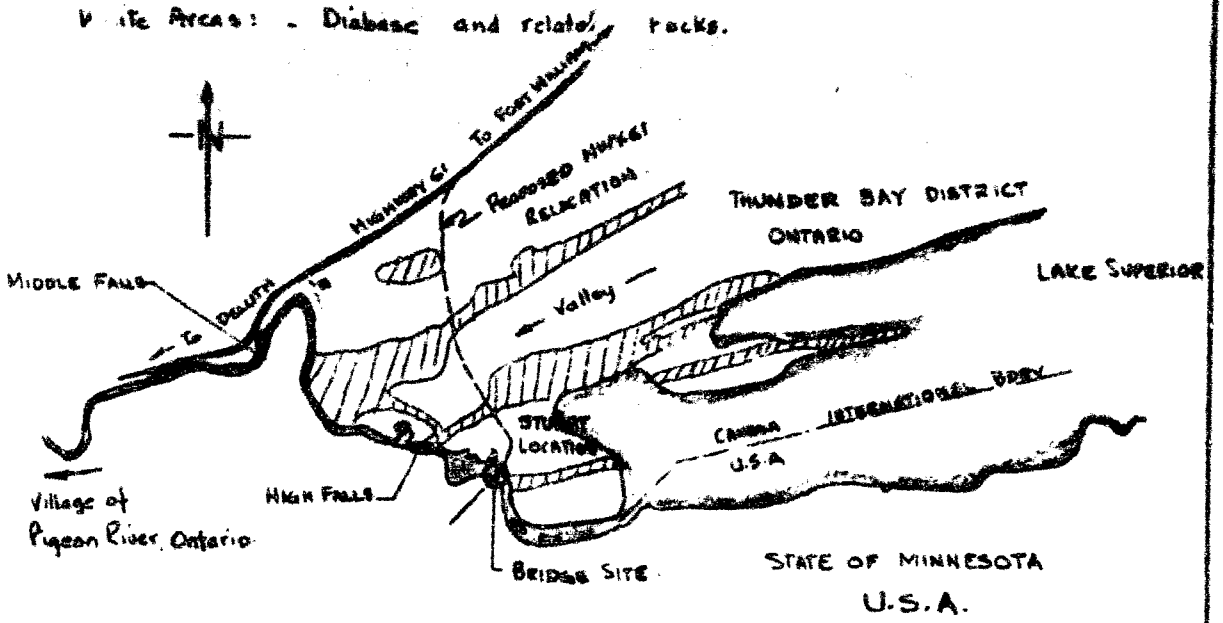
Prep. By AK

LEGEND:

LATE PRECAMBRIAN FORMATION:

Shaded Areas: - Rove formation of the Animikie Series.
Shale, greywacke, fragmental volcanic rocks.

White Areas: - Diabase and related rocks.



GEOLOGICAL FORMATIONS

Scale 1" = 1 mile

Reproduced from Map 355A, Sheet 2 . Memoir 167
Geological Survey of Canada
Fort William . Port Arthur & Thunder Cape Area

Order No. 59-179

Enclosure No. 3

Enclosure No. 3

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 1

Project: Pigeon River Bridge

Location: Stewart Loon. Hwy 61, Line 2

Hole Location: Sta. 258+30, 28' Rt. of ℄

Hole Elevation and Datum: 603.3 Geodetic.

Field Supervisor: [illegible] Prep.: [illegible]

Driller: Boyles Checked: [illegible]

Date: Dec. 3, 1959.

LEGEND: Shear Strength (C): Unconfined compression; Vane test and sensitivity (S). Penetration Resistance (P): 2" Split tube; 2" Dia. Cone; Casing. Sampling Method: 2" Dia. split tube; 2" Shelby tube. Consistency: Natural moisture and Liquidity Index (IL); Liquid limit; Plastic limit.

Description	Elev. feet	Depth feet	Sample	Natural unit wt. P.C.F.	Remarks
Ground surface.	603.3	0.0			
Organic topsoil	602.7				
Loose greyish-brown clayey silt, pockets of fine sand (W.L.)	602.2		SS1		Cone penetration made at Sta. 258+41, 28ft. Rt of Centreline.
Loose dark grey organic silt, with organic fibre. Thin sand layer at 7ft.		5.0	ST2	116	Water rose to 9" below surface when casing was withdrawn. Triaxial Test on ST2 Quick test, [illegible] psf.
Loose D.grey organic silt numerous organic fibre, some sand	593.4	10.0	SS3A, SS3B		
Loose coarse sand changing to Loose grey gravelly coarse sand.	[illegible]				
Stiff reddish-brown clay, occasional coarse sand Pepper - thin silt lenses.		15.0	SS4, ST5	114	
Refusal on stone	588.5				
Very dense stoney till, Diabase stones, occasional green medium crystalized stones.	586.2	20.0			10% core recovery
Very dense bouldery till. 10% core recovery.		25.0			
Broken bedrock or boulders.	573.0		AXT core		95% core recovery.
Soft greenish-grey Greywacke 95% core recovery		30.0			
END OF BOREHOLE	570.3				
		35.0			

Strength and Penetration Resistance: C_s 500, 1000, 1500, 2000 PSF; 0, 20, 40, 60, 80 blows/ft

Consistency: Moisture content, % dry weight: 20, 30, 40, 50, 60

Order No. 59-179 Enclosure No. 3 No. Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 1

Date: Dec. 3, 1959

Project: Pigeon River Bridge
Location: Stewart Locn. Hwy 61, Line B
Hole Location: Sta. 258+38, 28' Rt. of ℄
Hole Elevation and Datum: 603.3 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles Checked:

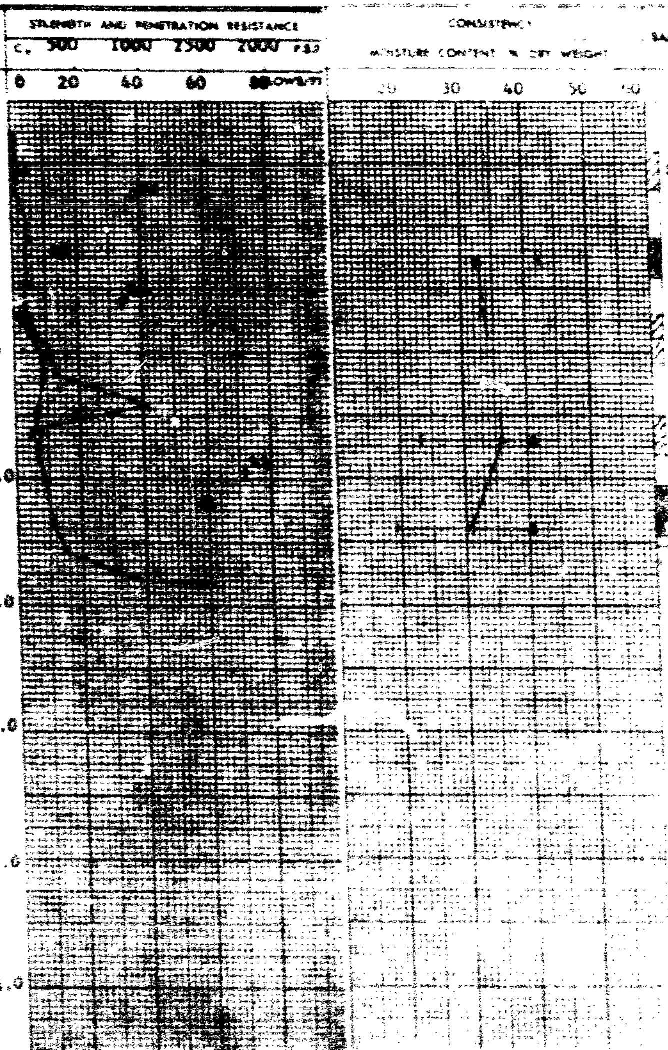
LEGEND
Shear Strength (C)
Unconfined compression
Vane test and sensitivity (S)
Penetration Resistance (P)
2" Split tube
2" Dia. Cone
Casing

Sampling Method
2" Dia. split tube
2" Shelby tube

LEGEND
Consistency
Natural moisture and Liquidity Index (LI)
Liquid limit
Plastic limit

Sampling Method
2" Dia. split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	603.3	0.0
	Organic topsoil	602.7	
	Loose greyish-brown clayey silt, pockets of fine sand (W.L.)	601.2	
	Loose dark grey organic silt, with organic fibre. Thin sand layer at 7ft.		5.0
	Loose D.grey organic silt numerous organic fibre, some sand	593.4	10.0
	Loose coarse sand changing to Loose grey gravel& coarse sand.	591±	
	Stiff reddish-brown clay. occasional coarse sand Paper-thin silt lenses.		15.0
	Refusal on stone	585.5	
	Very dense stoney till, Diabase stones, occasional green medium crystalized stones.	584.2	20.0
	Very dense bouldery till. 10% core recovery		25.0
	Broken bedrock or boulders.	573.8	
	Soft greenish-grey Greywacke 95% core recovery		30.0
	END OF BOREHOLE	570.5	35.0



NATURAL SAMPLE UNIT WT. P.C.F.

REMARKS

Water table ... [illegible]
Sta. ... [illegible]
Water tube ... [illegible]
surface ... [illegible]
withdrawn
Triaxial Test ... [illegible]
Quick test ... [illegible]

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Borehole No. 4

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 2

Date Dec.4,19[illegible]

Project: Pigeon River Bridge

Location: [illegible] Hwy.61 .. Line "B"

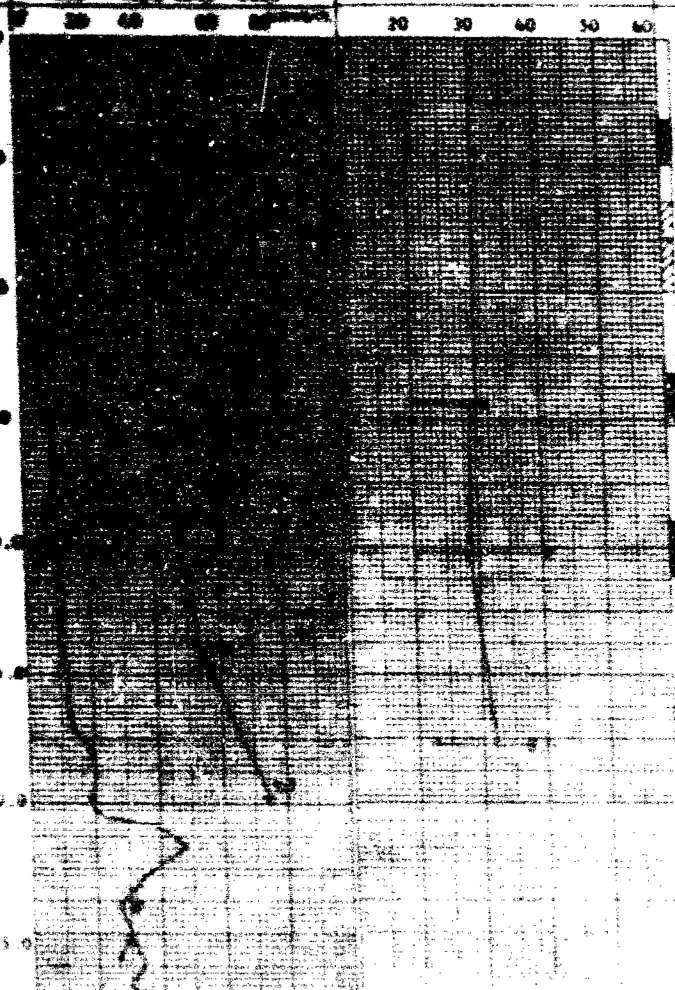
[illegible] Sta.[illegible], [illegible] of ℄

Hole Elevation and Datum: 602.0

Field Supervision: [illegible] Prep.: [illegible]

Driller: [illegible] Checked: [illegible]

STRATA	DESCRIPTION	ELEV.	DEPTH	SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	Ground surface	602.0	0.0			
	Topsoil					
	W.L.	601.?				Dynamic Cone penetration [illegible]
	Loose dark brown clayey silt with sand pockets or layers.					
	Very loose organic silt, D.grey with organic fibres.		5.0	ST1	117	Triaxial Quick Test [illegible] 150 psf
	V.L. loose D.grey organic silt with some fine sand.	597.0		SS2 / TOS1		Organic content [illegible]
	Medium dense gravel & coarse sand.	595.2	10.0	SS3		
		593.4				
	Stiff reddish-brown clay, occasional shale (black) particles.	590.0				
	Firm greyish-brown clay, some black shale particles.		15.0	ST4	118	
	As above - mottled with red clay		20.0	ST5	[illegible]	
		580				
	Stiff reddish-brown clay, occasional small stone below 29 ft.		25.0	ST6	116	
		571.?	30.0			
	Dense black coarse sand and gravel,	570		SS7		
	Very porous		35.0			Wash water rising through cone penetration hole
	Refusal for dynamic cone.	565.?				



Order No. 58-179 Enclosure No. 4 No. Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 2

Project Pigeon River Bridge
Location Stuart Lake. Hwy.16..Line "B"
" Location Sta.1584+40. 21ft.Lt. of ℄
Hole Elevation and Datum 603.0
Field Supervision AK From AK
Driller Boyles. Checked

Date Dec.6,1958

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface	603.0	0.0
	Topsoil		
	± W.L.	601.7	
	Loose dark brown clayey silt thin sand pockets or layers.		
	Very loose organic silt,D.grey with organic fibre.		5.0
	Med. dense D.grey organic silt with some fine sand.	595.0	
	Medium dense gravel & coarse sand.	593.2	10.0
	Stiff reddish-brown clay,numerous small (black) particles.	591.4	
	Firm greyish-brown clay,some black shale particles	590.0	15.0
	As above mottled with red clay		20.0

STRENGTH AND PENETRATION RESISTANCE

C_u 500 1000 1500 2000 PSF

N' 20 40 60 80 blows/ft

CONSISTENCY

NATURAL MOISTURE CONTENT

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Borehole No. 2

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 2 cont'd.

Date: Dec.5, 1959.

Project: Pigeon River Bridge
Location: Stuart Loca. Hwy.61, Line
Hole Location: Sta. 2304+80 ,21 ft. Lt of c
Hole Elevation and Datum: 603.0 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Legend: Shear Strength (S) — Unconfined compression; Vane test and sensitivity (S). Penetration Resistance (N) — 2" split tube; 2" dia. Cone; Casing. Sampling Method — 2" Dia. split tube; 2" Shelby tube.

Borehole No. 5

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 2 cont'd.

Legend: Consistency — Natural moisture and Liquidity Index (LI); Liquid limit; Plastic limit. Sampling Method — 2" Dia. split tube; 2" Shelby tube.

Symbol	Description	Elev. Feet	Depth Feet	Strength and Penetration Resistance (C P.S.F.; Blows/Ft. 20 40 60 80)	Consistency / Moisture Content % Dry Weight	Sample	Natural Unit Wt. P.C.F.	Remarks
		568.0	35.0					
	Dense dark grey med. to coarse sand and fine gravel.							
		563.2	40.0			AX casing		Refusal at 39'-10"
	Very dense grey bouldery till. Stones and boulders are dark grey fine crystalline diabase. Matrix of grey silt and fine sand. Bouldery till or broken bedrock.		45.0			AXT bit		Core recovery about 10%
		554.3	50.0					
	Soft greenish-grey mottled bedrock - Greywacke.					AXT core		Core recovery 85%
		547.0	55.0					
	End of Borehole.		60.0					

Order No. 59-139 Enclosure No. 5 Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 2 cont'd.

Date Dec. 5, 1959.

Project: Pigeon River Bridge
Location: Stuart Locn. Hwy. 61, Line
Hole Location: Sta. 2586+50, 21 ft. Lt of c
Hole Elevation and Datum: 603.0 Geodetic.
Field Supervisor: AE Prep. AE
Driller: Boyles. Checked

Boring
Consistency
Natural moisture and Liquidity index (L.I.)
Liquid limit
Plastic limit
Sampling Method
3" Dia. split tube
3" Shelby tube

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE c P.S.F. 0 20 40 60 80 BLOWS PER FT.	CONSISTENCY MOISTURE CONTENT % DRY WEIGHT	NATURAL SAMPLE UNIT WT P.C.F.	REMARKS
		568.0	35.0				
	Dense dark grey sand to coarse sand and fine gravel.	563.2	40.0				
	Very dense grey bouldery till. Stones and boulders are dark grey fine crystalline diabase. Matrix of grey silt and fine sand		45.0				
	Bouldery till or broken bedrock.	556.3	50.0				
	Soft greenish-grey mottled bedrock - Greywacke		55.0				
	End of Borehole.	547.0					

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Order No. [illegible] Borehole No. 3 Borehole No. [illegible]

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 3

Date: Dec. 7, 1959.

Project: Pigeon River Bridge
Location: Stuart Loon. Twp 6, Line "G"
Hole Location: 603.2 [illegible]
Hole Elevation and Datum: Sta. 2506+93 25' Rt.
Field Supervisor: [illegible] Prep.: [illegible]
Driller: Baylen. Checked:

Symbol	Description	Elev. Feet	Depth Feet	Strength and Penetration Resistance	Consistency / Moisture content % dry weight	Sample	Natural unit wt. P.C.F.	Remarks
	Ground surface.	603.2	0.0					
	V. Loose D. brown peat. W.L.	603.[illegible] / 602.[illegible]						
	Loose brown clayey silt, changing to loose silty sand, some clay.							
	Loose dark grey organic silt, some fine sand.	[illegible]	5.0			ST1 3"		Triaxial quick test
	Med. dense D. grey gravel and coarse sand.	594.[illegible]				ST2 3"		
	— — END OF BOREHOLE.	[illegible]	10.0					
		590.[illegible]						
			15.0					
	Refusal for dynamic cone test at 20.0 ft.	583.2	20.0					

Order No. 56-179

Enclosure No. 6

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 3

Project: Pigeon River Bridge
Location: Stuart Lem. Hwy 61, Line "B"
Hole Location: 683.2 Geodetic.
Hole Elevation and Datum: Sta. 2586+50 25'Rt.
Field Supervisor: AK From: AK
Driller: Boylen Checked:

Date: Dec. 7, 1954

Shear Strength
Unconfined compression
Vane bar and sensitivity
Penetration Resistance
3" Split tube
3" Dia. Cone
Casing

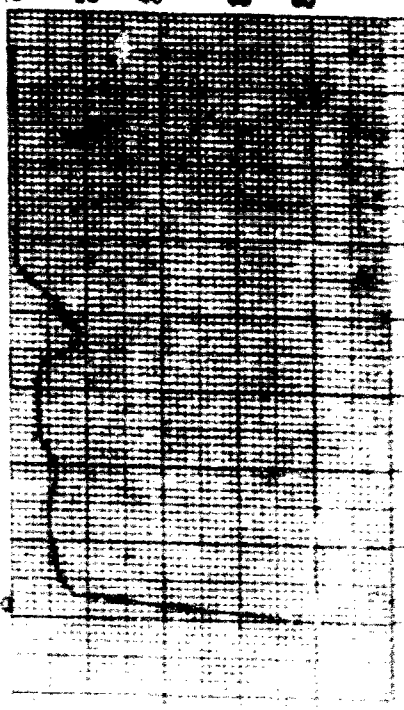
Sampling Method
3" Dia. split tube
3" Shelby tube

DESCRIPTION	ELEV FEET	DEPTH FEET
Ground surface.	683.2	0.0
W.Loose D.brown peat. W.T.	683.0	
	682.0	
Loose brown clayey silt, changing to loose silty sand, some clay.	596?	5.0
Loose dark grey organic silt, some fine sand.	594.6	
Med dense D. grey grave. and coarse sand.		10.0
END OF BOREHOLE.	590.0	
		15.0
Refusal for [illegible] zone	583.2	20.0
test at		

STRENGTH AND PENETRATION RESISTANCE

c, 500 1000 1500 psf

0 20 40 60 80 Cu-t/ft²



Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Order No. 59-179 Enclosure No. 7

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: Cone 5A

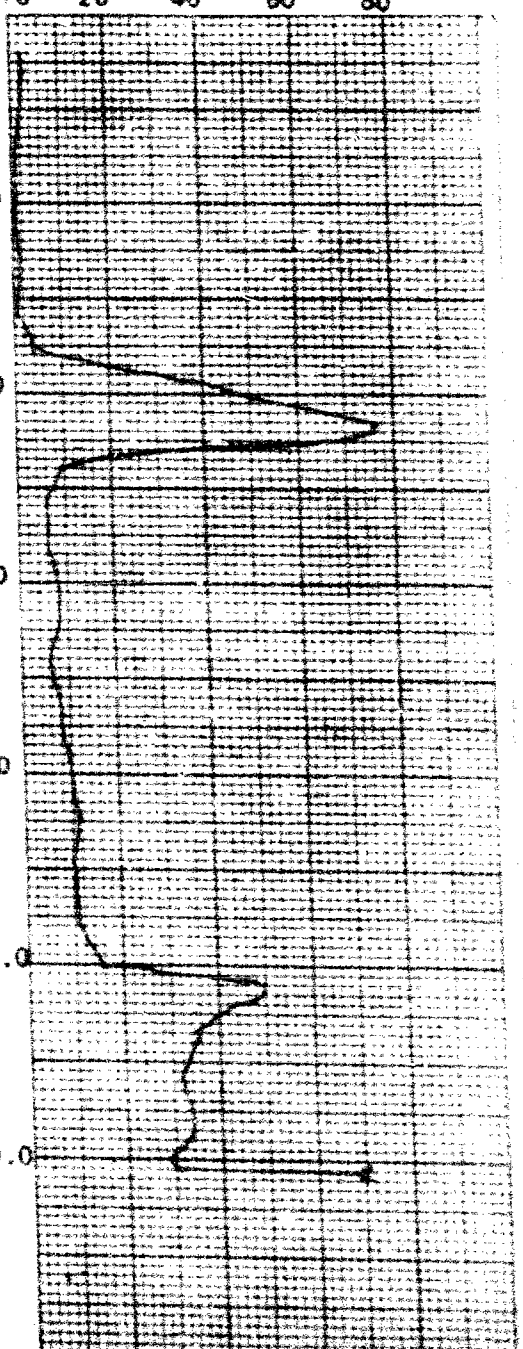
Project: Pigeon River Bridge
Location: Stuart Locn. Hwy.61, Line "B"
Hole Location: Sta. 2584+54 on ℄
Hole Elevation and Datum: 603.1 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Date: Dec. 7, 1959.

LEGEND
Shear Strength (C)
Unconfined compression
Vane test and sensitivity S:
Penetration Resistance P
2" Split tube
2" Dia Cone
Casing
Sampling Method
2" Dia split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	603.1	0.0
	⊥ W.L.	602.5	
	Dynamic Cone Penetration test		
			5.0
		594.4	
			10.0
		591.3±	
			15.0
			20.0
		578.0	25.0
	Hammer bouncing sharply.	573.0	30.0
	Refusal at 30'-2" presumably bedrock or bouldery till.		

STRENGTH AND PENETRATION RESISTANCE
C PSF
0 20 40 60 80 BLOWS/FT



Enclosure No. 5

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 4

Project: [illegible] Bridge
Location: [illegible], Line [illegible]
Hole Location: Sta. [illegible], [illegible]
Hole Elevation and Datum: 601.3 Geodetic.
Field Supervision: [illegible] Prep: [illegible]
Driller: Boyles. Checked: [illegible]

Date: Dec. 7, [illegible]

Sampling Method: 2" Dia. split tube; 2" Shelby tube

Symbol	Description	Elev. (ft)	Depth (ft)	Natural moisture content % dry weight	Sample	Natural unit wt. P.C.F.	Remarks
	Ice surface. Ice 9" thick.	601.3	0.0				
	Water. River bed at cone penetration	596.3					Cone penetration at Sta. [illegible]
	River bed at Borehole 4	596.0					
	Very loose dark grey fine silty sand. (River wash)		5.0		SS1		
	[illegible] gravel & [illegible] sand.	594.7					
	Stiff reddish-brown clay, pockets of grey silt. Clay has high plasticity	593.7	10.0		SS2		
					ST3		[illegible]
	Stiff reddish-brown clay Homogeneous.		15.0				
	Very dense grey bouldery till. Matrix of silt and fine sand.	582.4	20.0				
	Soft greenish-grey Greywacke	577.5					90% core recovery.
		576.3	25.0				Borehole caved-in at 23-24ft. Drilling terminated - AX casing drilling required.

END OF BOREHOLE.

Order No. 58-179 Reference No. A Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 4

Project: Pigeon River Bridge
Location: Shuniah Loca. Twp 61, Line "B"
Hole Location: 85m.2583+85,25ft. Rt. of ℄.
Hole Elevation and Datum: 601.3 Geodetic.
Field Supervision: AE Prep.: AE
Driller: Boylen. Checked:

Date: Dec. 7,

Shear Strength (C)
Unconfined compression
Vane test and results, (S)
Penetration Resistance (P)
3" Split tube
3" Dia. Cone
Casing

Sampling Method
3" Dia. split tube
3" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ice surface.	601.3	0.0
	Ice 5" thick.		
	Water		
	River bed at cone penetration	598.3	
	River bed at Borehole 4	595.6	
	Very loose dark grey fine silty sand. (River wash)	594.7	5.0
	Med.dense gravel & cob 25 mm.	593.7	
	Stiff reddish-brown clay, pockets of grey silt.		10.0
	Clay has high plasticity		
	Stiff reddish-brown clay Homogeneous.		15.0
		582.6	
	Very dense grey bouldery till Matrix of silt and fine sand.		20.0
	Soft greenish-grey Greywacke	577.5	
		575.0	25.0

END OF BOREHOLE

STRENGTH AND PENETRATION RESISTANCE
C 500 1000 1500 2000 PSF
0 20 40 60 80 BLOWS/FT

CONSISTENCY
MOISTURE CONTENT IN DRY WEIGHT
20 30 40 50 PC

NATURAL SAMPLE UNIT WT PCF

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Sampling Method
2" Dia. split tube
2" Shelby tube

Order No. [illegible] Enclosure No. 10 Enclosure No. 10

Dominion Soil Investigation Ltd.

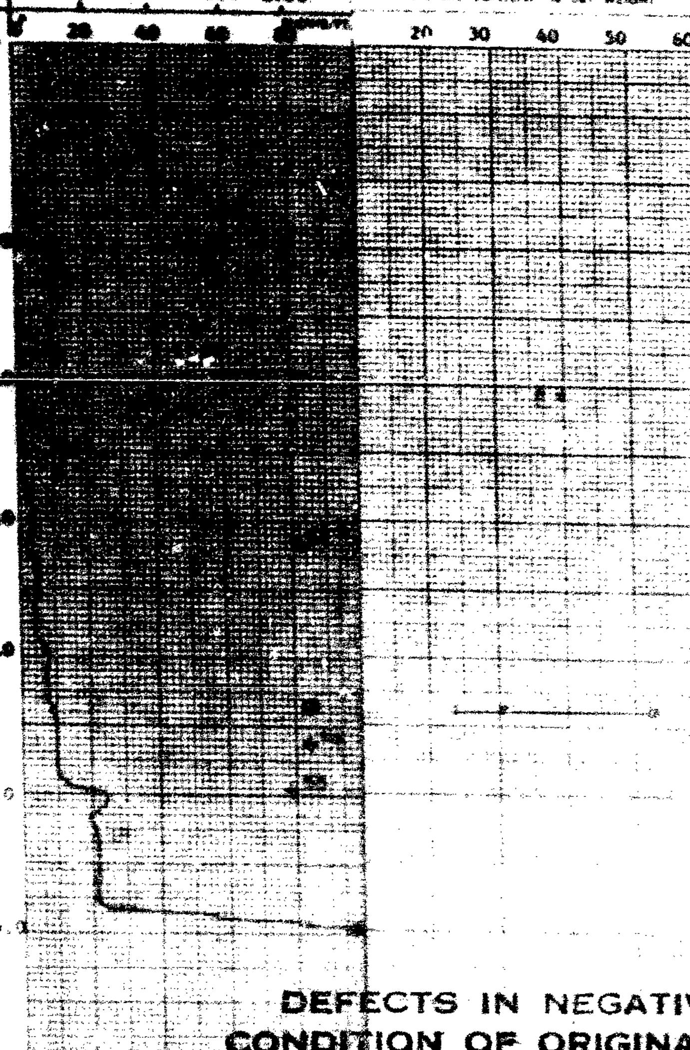
Engineering Data Sheet for Borehole 6

Date: Dec.10,1959.

Project: Pigeon River Bridge
Location: [illegible] Loc. Rep.[illegible], Line "[illegible]"
Hole Location: 2583[illegible].35 [illegible]
Hole Elevation and Datum: 60[illegible].2 Geodetic.
Field Supervisor: [illegible] Plotted: [illegible]
Driller: [illegible] Checked: [illegible]

LEGEND
Consistency
Natural moisture and Liquidity index (LI)
Liquid limit
Plastic limit
Sampling Method: 2" Dia. split tube; 2" Shelby tube

Symbol	Description	Elev. Feet	Depth Feet	Sample	Remarks
	[illegible] surface of Ice.	601.2	0.0		Cone penetration at Sta.2583+[illegible] 25 ft. Rt. of Centreline.
	Water		5.0		
	River bed at [illegible]	593.6			
	Very loose fine to med. sand with some silt, traces of organics.		10.0	SS1	Organic content [illegible] %
	Very loose sand with organic silt. numerous partially decayed wood.	590			
	As above.		15.0	SS2 lost	
	Layers of med. to coarse sand alternating with [illegible] grey sandy silt, organic [illegible]	582.5 / 581.7		SS3	
	Stiff reddish-brown clay, some black shale particles.	580	20.0		
	Stiff fat reddish-brown clay, some sharp black shale sizes.		25.0	ST4	[illegible]
	Large stone struck at 31.8ft. Borehole deflected.	570.[illegible]	30.0		
	Stiff reddish-brown clay and med. to coarse sand mixture	567.0	35.0		
	Refusal for cone and wash bit on stone or boulder.				
	END OF BOREHOLE.				



DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

Code No. 59-120

Enclosure No. 10

Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 5

Project: Pigeon River Bridge
Location: Stuart Lake. Bay.61, Line "B"
Hole Location: 2583425.25 Lat.of E.
Hole Elevation and Datum: 601.2 Geodetic.
Field Supervision: AE Prep.: AE
Driller: Boyles. Checked:

Date: Dec.10,1959.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Surface of Ice.	601.2	0.0
	Water		
	River bed at E.E.6	593.4	
	Very loose fine to med. sand with some silt, traces of organics.	590	10.0
	Very loose sand with organic silt, numerous partially decayed wood.		
	As above.		15.0
	Layers of sand, to coarse sand alternating with D.grey sandy silt, organic fibre, decayed wood.	582.5	
	[illegible]	581.7	
	Stiff reddish-brown clay, some black shale particles.	580	20.0
	Stiff fat reddish-brown clay, some angular black shale sizes		25.0

STRENGTH AND PENETRATION RESISTANCE
C 500 1000 1500 2000 P.S.F.
0 20 40 60 80 BLOWS/FT.

CONSISTENCY
MOISTURE CONTENT % BY WEIGHT
20 30 40 50 60

NATURAL SAMPLE UNIT WT P.C.F.

REMARKS

Large stone struck at [illegible] Borehole deflected.
Stiff reddish-brown clay and med to coarse sand & shale
Refusal for core and wash b[illegible] on stone or boulder

END OF BOREHOLE

Order No. 59-179

Enclosure No. 11

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 7

Project: Pigeon River Bridge
Location: Stuart Locn. Hwy.61, Line "B"
Hole Location: Sta. 2583+25, 20ft. at of ℄
Hole Elevation and Datum: 601.2 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Date: Dec.11, 1959.

LEGEND
Shear Strength (C)
Unconfined compression ⊕
Vane test and sensitivity (S) +S
Penetration Resistance (P)
2" Split tube
2" Dia Cone
Casing
Sampling Method
2" Dia split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ice surface.	601.2	0.0
	River bed.	592.6	5.0
	Very loose organic silt Very loose gravel, fine to coarse sand, traces of silt & clay. Organic content low ± 2.6%		10.0
	River Bed Depostts.	587.7	
	Loose fine sand & organic silt.	586.7	
	Loose med. to coarse sand & gravel Dark grey.	585.4	15.0
	Stiff reddish-brown clay, numerous med. to coarse sand sizes. Moisture content 29.6%	581.7	
	Refusal on 6" stone. Drilled with AX casing Brown clay mixed with sand & gravel	579.4±	20.0
	Dense grey fine to med. sand, some silt, occasional stone.	576±	25.0
	Very dense grey bouldery till Numerous stones, gravel in a sand - silt matrix.	572.5±	
	Broken rock, stones - diabase		30.0
	Soild dark grey diabase rock. occasional fissure.	567±	
	Soild bedrock - Hard dark grey diabase.	564.7	35.0
	END OF BOREHOLE.		

STRENGTH AND PENETRATION RESISTANCE
C PSF
0 20 40 60 80 BLOWS/FT

SS1
SS2
SS2A
+S
AX
AX casing
AXT core

Order No. 59-179

Enclosure No. 12

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 8

Project: Pigeon River Bridge
Location: Stuart Locn. Hwy.61, Line "B"
Hole Location: Sta.2582+65,25ft.Rt of ℄
Hole Elevation and Datum: 601.2 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Date: Dec.11,1959

LEGEND
Shear Strength (C)
Unconfined compression ⊕
Vane test and sensitivity (S) +S
Penetration Resistance (P)
2" Split tube
2" Dia. Cone
Casing
Sampling Method
2" Dia. split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
	Ice surface	601.2	0.0
	Ice 10" thick		
	Water		
	6" layer of organic silt.	590.9	10.0
	Very loose dark grey med.to coarse sand and fine gravel,tr.silt&clay		
	Med.dense coarse sand & gravel.	587.5	
	Medium dense dark grey silt with clay partings,also med.to c. sand. Moisture content [illegible]%	586.4	15.0
	4" stone at 17.8ft. Drilled Ax casing	583.4	
	Med.dense to dense grey fine to med. sand with some silt.		
	Dense to very dense coarse black sand & gravel - shapp& angular particles.	580	20.0
	occasional small stone. (2" to 5" dia.)		
	Not possible to use split spoon sampler.	575	25.0
	Very dense bouldery till. numerous diabase stones.		
	Matrix of fine to med. sand, some silt.	570	30.0
	Broken rock or bedrock	568.5±	
	Bedrock green-grey greywacke.	567.7	
	END OF BOREHOLE.		35.0

STRENGTH AND PENETRATION RESISTANCE
C P.S.F.
P BLOWS/FT
0 20 40 60 80

SS1
SS2
AX casin
AXT core and AX casin

Order No. 59-179

Enclosure No. 13

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: Cone 8A

Project: Pigeon River Bridge
Location: Stuart Locn. Hwy.61, Line "B"
Hole Location: Sta. 2582+60 Oa ℄
Hole Elevation and Datum: 601.2 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Date: Dec.12,1959.

LEGEND
Shear Strength - C
Unconfined compression
Vane test and sensitivity (S) ⊕ +S
Penetration Resistance - P
2" Split tube
2" Dia. Cone
Casing
Sampling Method
2" Dia. split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
	Ice surface.	601.2	0.0
	Dynamic cone penetration test. 2" dia. 60 degree cone.		5.0
	River bed at ℄	591.0	10.0
		588	
		586.7±	15.0
			20.0
		577.7	
		576.0	25.0
	Refusal - presumably stone		

STRENGTH AND PENETRATION RESISTANCE
C PSF
0 20 40 60 80 BLOWS FT

Borehole No. 14

Borehole No. 14

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 9

Date: Dec. 14, 195?.

[illegible] Bridge

Location: [illegible], Line "[illegible]"

Hole location: Sta. [illegible], [illegible] Lt. of [illegible]

Hole Elevation and Datum: 601.2

Field Inspector: [illegible] Prep.: [illegible]

Driller: [illegible] Checked

LEGEND

Unconfined compression

Vane test and sensitivity

Penetration Resistance

2" Split tube

2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube

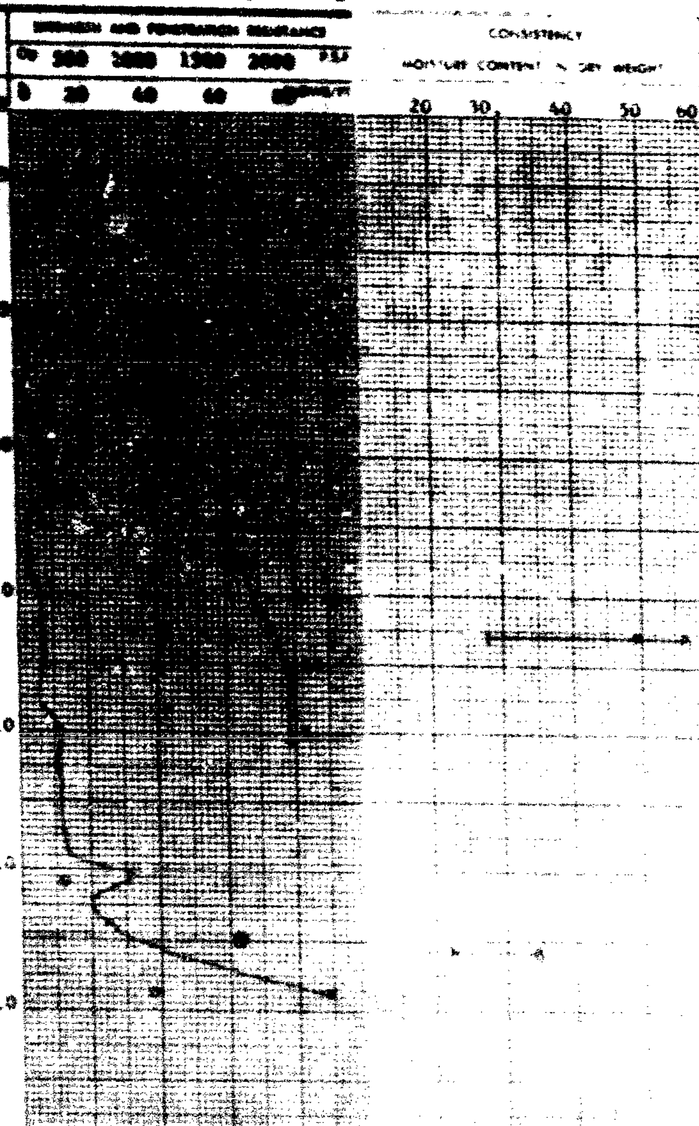
Consistency

Natural moisture and Liquidity Index (LI)

Liquid limit

Plastic limit

Symbol	Description	Elev. Feet	Depth Feet
	[illegible] surface.	601.2	0.0
	[illegible] ice.		
	Water		5.0
	River bed.	591.4	10.0
	[illegible] med. to coarse sand, some silt, fine gravel, [illegible].		
	Loose black coarse sand & gravel. [illegible]	586.2	15.0
	Firm reddish-brown clay	585.8	
	Stiff reddish-brown clay, traces of med. to coarse black sand sizes.		20.0
			25.0
	Stiff reddish-brown clay, some med. to coarse sand particles.		
	Numerous coarse sand & gravel particles mixed in the clay	571.5?	30.0
	[illegible] med. to coarse sand and med. gravel, some stones (3"-4")	567.7	35.0
	END OF BOREHOLE.	566.7	



Remarks

Cone penetration at Sta. 258+65, 20ft [illegible]

STH 129 Sample tapped with Hammer

2 SSS

Loosing wash water in sand.

Order No. 90-179 Enclosure No. 14 Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 9

Dominion Soil Investigation Ltd.

Project: Pigeon River Bridge
Location: Stuart Loom. Hwy.61, Line "B"
Hole Location: Sta. 2582+63, 25ft. Lt. of
Hole Elevation and Datum: 601.2
Field Supervisor: AK Prep.: AK
Driller: Bagley Checked:

Date: Dec.16,195

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
	Ice surface.	601.2	0.0
	18" ice.		
	Water		5.0
	River bed.	591.4	
	Very loose med. to coarse sand, some silt, fine gravel, eggonics.		10.0
	Loose black coarse sand & gravel, sharp and angular.	586.7	
	Firm reddish-brown clay	584.8	15.0
	Stiff reddish-brown clay traces of med. to coarse black sand sizes.		20.0
	Stiff reddish-brown [illegible] and, to coarse sand [illegible]		
	[illegible]		
	Dense and [illegible] sand, gravel, [illegible]		
	END OF [illegible]		

STRENGTH AND PENETRATION RESISTANCE

Qu 500 1000 1500 2000 PSF

0 40 60 80 Blows/ft

Sampling Method
3" Dia. split tube
3" Shelby tube

Borehole No. 15

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Date: Dec.16,1959.

Strata	Description	Elev. (ft)	Depth (ft)	Sample	Natural Unit Wt. P.C.F.	Remarks
	Ice surface 10"ice thickness.	600.6	0.0			
		598.6				
	Approach fill material weathered brown clay,some sand.		5.0			Cone at Sta. 2582+10,25ft. Lt. of centreline.
		590.4				
	Loose coarse sand and gravel.					
		588.4				
	Soft to Firm reddish-brown clay.		10.0	SS1		
				ST2	122	
	Firm reddish-brown clay.		15.0			
	As above - some coarse sand and gravel in thin layers,and pockets of silt.		20.0			
				SS3		
	Stiff clay,layers of coarse sand and gravel.					
		576.0	25.0			
	Stone					
	Stiff reddish-brown clay,numerous coarse sand and gravelsizes.		30.0			
	As above.					
		566.3				
	Sandy till - Very dense		35.0			
	Sand,gravel,diabase stones,some silt.					
	Diabase boulders -broken up.					
		562.0				
	[illegible]-grey rock [illegible]					
		558.6	41.0			Lost part of core during recovery

Order No. 59-179

Enclosure No. 10

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 10

Project: Pidgeon River Bridge
Location: Stuart Lake, Hwy. 61, Lineage
Hole Location: Sta. 2582+02, 25ft. Rt. of
Hole Elevation and Datum: 601.6 Geodetic.
Field Supervision: AE Prep: AE
Drilled: Hayles. Checked:

Date: Dec. 14, 1959.

Sampling Method
3" Dia. split tube
3" Shelby tube
Casing

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Loo surface 10"ins thickness.	601.4	0.0
	Approach fill material weathered brown clay, some sand.	588.6	5.0
	Loose coarse sand and gravel.	583.6	
	Soft to Firm reddish-brown clay.	582.4	10.0
	Firm reddish-brown clay.		15.0
	As above - some coarse sand and gravel in thin layers, and pockets of silt.		20.0
	Stiff clay, layers of coarse sand and gravel.		
	Stone	576.9	25.0
	Stiff reddish-brown clay, bouldery with cobbles sand and gravel, silty		
	As above.		
	Boulders, Very coarse		
	Sand, gravel, cobbles, silt, some clay		
	Cobbles, boulders, silt, sand		
	Metamorphosed precambian grey rock greywacke bedrock		

STRENGTH AND PENETRATION RESISTANCE
Q: 500, 1000, 1500, 2000 P.S.F.
d: 20, 40, 60, 80 BLOWS/FT.

CONSISTENCY
MOISTURE CONTENT % DRY WEIGHT
20, 30, 40, 50, 60

NATURAL SAMPLE UNIT WT. P.C.F.

REMARKS

Dominion Soil Investigation Ltd.
Engineering Data Sheet for Borehole

Borehole No. [illegible]

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole [illegible]

Date: Dec.16,1959.

[illegible]

Symbol	Description	Elev.	Depth
	[illegible] Ice [illegible] thick.	[illegible]	0.0
	Water		
	[illegible] clay [illegible].	[illegible]	
	[illegible]	[illegible]	5.0
	Firm reddish-brown clay, numerous coarse sand particles.		
	Firm reddish-brown clay, some black coarse sand particles.		10.0
	Stiff clay, some coarse sand stones		15.0
	Very dense bouldery till coarse sand and gravel, stones.	588.3	
	Very dense med. to coarse sand, gravel & stones (3" to 6")	579.3	20.0
	END OF BOREHOLE.		

Consistency — Moisture content % dry weight: 20 30 40 50 60

SPT [illegible]

Cas[illegible] load

AX casing

Results

Cone penetration at Sta[illegible]

[illegible]

Order No. [illegible]

Borehole No. 11 ... No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 11

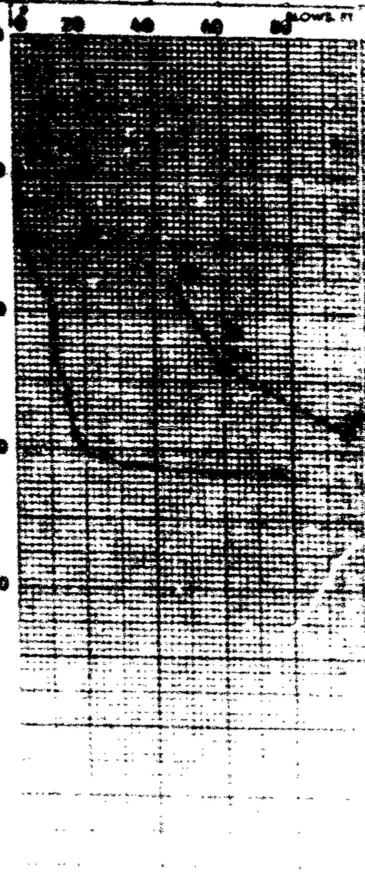
Project: Pigeon River Bridge
Location: Stuart Lake, Hwy. 61, Line "E"
Hole Location: Sta. 2300+00, 20ft. Rt of ℄
Hole Elevation and Datum: 601.3 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked

Date: Dec.16,195

Legend
Shear Strength
Unconfined compression
Vane test and sensitivity
Penetration Resistance
2" Split tube
2" Dia. Cone
Casing
Sampling Method
2" Dia. split tube
3" Shelby tube

Stratum	Description	Elev. Feet	Depth Feet
	Ice surface.	601.3	0.0
	Ice 12" thick.		
	Water		
	Fill material -very soft.	597.7	
	Loose [illegible] sand & gravel	596.8 / 596.3	5.0
	Firm reddish-brown clay, numerous coarse sand particles.		
	Firm reddish-brown clay, some black coarse sand particles.		10.0
	Stiff clay, some coarse sand sized		15.0
	Very dense bouldery till coarse sand and gravel, stones.	585.3	
	Very dense med. to coarse sand, gravel & stones (3" to 8")		20.0
		579.3	

STRENGTH AND PENETRATION RESISTANCE



END OF BOREHOLE

Borehole No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole

Order No. 59-179

Enclosure No. 17

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: Cone 11A

Project: Pigeon River Bridge
Location: Stuart Locn. Hwy.61,Line "B"
Hole Location: Sta. 2582+10, 3ft.Lt. of c
Hole Elevation and Datum: 601.8
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

Date: Dec. 16,1959.

LEGEND
Shear Strength (C)
Unconfined compression
Vane test and sensitivity (S)
Penetration Resistance (P)
2" Split tube
2" Dia. Cone
Casing
Sampling Method
3" Dia. split tube
2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ice Surface.	601.8	0.0
	Dynamic cone penetration test. 2" 60 degree cone.		
	Fill material from West embankment.		5.0
		593.4	
		592.3	10.0
			15.0
			20.0
		576.5	25.0
	Refusal for cone at 25.3ft. Hammer bouncing.		

STRENGTH AND PENETRATION RESISTANCE
C PSF
0 20 40 60 80 BLOWS/FT.

Borehole No. 16

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 12

Date: Dec.17,1959.

[illegible]

LEGEND

Depth	Description	Elev.	Depth (ft.)	Moisture content, % dry weight: 20 / 30 / 40 / 50 / 60	Sample	Natural unit wt. P.C.F.	Remarks
	Elevation of Datum?	[illegible]					
	Fill material - sand-gravel.						Cone penetration at Sta. 2581+4?,25ft. Rt. Of ℄.
	Stiff reddish-brown clay, silty, [illegible] silt, to coarse sand.	[illegible]			SS1		
	Stiff [illegible] brown silty clay [illegible] of white fine silt.				ST?	120	
	Brown clay with coarse sand & gravel.	6??.5 / 6??.3	20.0				
	Stiff reddish-brown clay [illegible] sand to coarse sand and fine gravel [illegible].		25.0		SS?		
	Stiff greyish-brown clay-homogeneous.	5?3.3	30.0		SS?		
	As above, slightly stiffer.	5??.?	35.0				

Order No. 59-129 Borehole No. 2 No. Borehole No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 12

Date: Dec. 17, 1959

Project: Pigeon River Bridge
Location: Hubert Loc. Hwy. 61, Line "B"
Hole Location: Sta. 2388+48, @51t.Rt.of ℄
Hole Elevation and Datum: 621.6 Geodetic.
Field Supervisor: AK Prep.: AK
Driller: Boyles. Checked:

LEGEND
Shear Strength (C)
Unconfined compression
Vane test and sensitivity (S)
Penetration Resistance (P)
2" Split tube
2" Dia. Cone
Casing

Sampling Method
2" Dia. split tube
2" Shelby tube

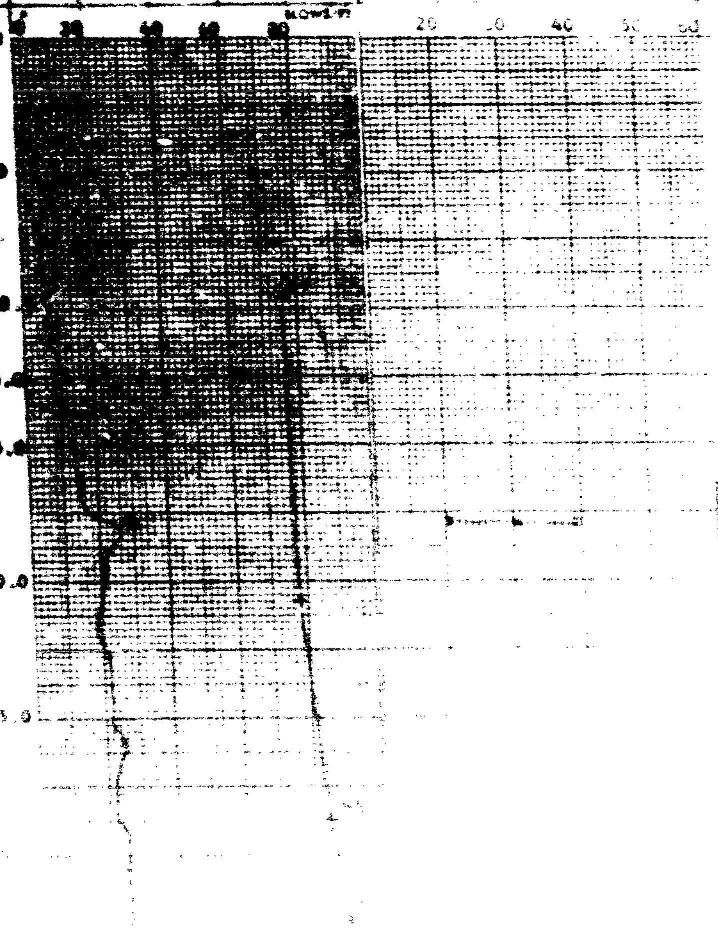
Strata	Description	Elev. Feet	Depth Feet
	Shoulder of Embankment	621.6	0.0
	Fill Material - sand & gravel.		
		616.0	5.0
	Stiff reddish-brown clay, silty, numerous sand, to coarse sand.		10.0
			15.0
			19.0
	Stiff varved brown silty clay varves of white fine silt.		
		602.5	
	Brown clay with numerous sand & gravel	601.5	20.0
	Stiff reddish-brown clay numerous sand, to coarse sand and fine gravel sizes.		
			25.0

Strength and Penetration Resistance: 0 500 1000 1500 2000 P.S.F.; BLOWS/FT 20 40 60 80

Consistency: Moisture Content % 20 30 40 50 60

Natural Sample Unit Wt. P.C.F.

Remarks



Enclosure No. 9

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole [illegible] Sheet 2 of 2

Engineering Data Sheet for Borehole 1 2

Date: Dec. 18, 1959.

[illegible]

Symbol	Description	Elev.	Depth	Remarks
	Stiff greyish-brown clay Homogeneous.	388.6	[illegible]	
	Very dense bouldery till. Boulders, coarse sand & gravel.	[illegible]	[illegible]	AXT core
	Brown greywacke, small granite 9" pink & grey granite. Soft greenish-grey greywacke	[illegible]		
		376.6	[illegible]	
	END OF BOREHOLE.			

Consistency: Moisture content % dry weight — 20 30 40 50 60

Natural sample unit wt. P.C.F.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 12 Sheet 2 of 2

Project: Pigeon River Bridge
Location: Robert Lecm. Hwy.61, Line ~yr.
Hole Location: 8m. 2581+43, 25ft. Rt. of c
Hole Elevation and Datum: 621.6 Geodetic.
Field Supervision: AE Prep.: AE
Drilling: Bayliss. Checked:

Date: Dec. 18,1~6

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
	Stiff greyish-brown clay homogeneous.	586.6	35.0
	Very dense bouldery till. Stones, coarse sand & gravel.	586.2	40.0
	Brown greywacke, small granite 9" pink & grey granite.	580.6	
	Soft greenish-grey greywacke	576.6	45.0
	END OF BOREHOLE.		

STRENGTH AND PENETRATION RESISTANCE
CU 500 1000 1500 2000 P.S.F.
BLOWS/FT 0 20 40 60 80

Dominion Soil Investigation Ltd.
Engineering Data Sheet for Borehole

20 30 40 50 60

Borehole No. 20

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 10, Sheet 1 of 2

Project: Pigeon River Bridge
Location: [illegible] Twp., Sec.31, Line [illegible]
Hole location: Sta. 2360+42, 300ft. Lt. of ℄
Hole Elevation and Datum: 603.2 Geodetic.
Field Supervisor: AK
Driller: Bayliss.
Drafted: AK
Checked:
Date: Dec.18,1959.

Strata	Description	Elev. feet	Depth feet	Remarks
	Surface grade - East approach.	603.2	0.0	
	Roadway approach fill. Sand, gravel, and stones.	600		Refusal for cone penetration at 2.5 and 3.0 ft. Drilled with BX casing [illegible]
	Firm reddish-brown clay, some sand.	597.3	5.0	
			10.0	
		590.0		
	Firm reddish-brown clay, high plasticity.		15.0	ST1 116 Liquid limit [illegible]
	Firm greyish-brown clay, homogeneous.		20.0	
		580.0		
	As above.		25.0	ST
			30.0	
	Stiff greyish-brown clay. Stiffer at 32ft.	570.6		
		568.3	35.0	SS3 105C.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 11

Hole No. 59-130

Enclosure No. 30

Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 13 Sheet 1 of 2

Dominion Soil Investigation Ltd.

Engineering Data sheet for Borehole

Project Pigeon River Bridge
Location Stuart Lines. Hwy.61, Line "g"
Hole Location Sta. 2581+62.22ft.lt. of ℄
Hole Elevation and Datum 623.2 Geodetic.
Field Supervisor AK Prep. AK
Driller Boylen. Checked

Date Dec.18,19

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE C_u 500 1000 1500 2000 PSF; 20 40 60 80 100
	Roadway grade - West approach	623.2	0.0	
	Roadway approach fill Sand,gravel, and stones.	620		
		617.3	5.0	
	Firm reddish-brown clay, some coarse sand.		10.0	
		610.0		
	Firm reddish-brown clay-high plasticity.		15.0	
	Firm greyish-brown clay Homogeneous.		20.0	
		600.0		
	As above		25.0	

Enclosure No. 21

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 13 Sheet 2 of 2

Date: Aug.19,1959.

[illegible]

Description	Elev.	Depth	Sample	Unit wt. P.C.F.	Remarks
Stiff greyish-brown clay	508.2	35.0	ST3 lost		
		40.0	ST4	108	
As above.		45.0			
Stiff greyish-brown clay, traces of coarse sand particles.		50.0			
Stones, some sand & gravel	530.0				
Soft greenish-grey Greywacke	540	55.0	AXT core.		75% core recovery [illegible] core barrel
Broken stone -Diabase	546				
Diabase stones & boulders	548	60.0			[illegible]
	560.0	65.0			

END OF BOREHOLE

Order No.

Enclosure No.

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole 13 Sheet 2 of 2

Project: Pigeon River Bridge
Location: Stuart Lake, Hwy.61, Line "P"
Hole Location: Sta. 2501+42,22ft.Lt. of ℄
Hole Elevation and Datum: 623.2 Geodetic.
Field Supervisor: AK
Prep.: AK
Driller: Bryson.
Checked:

Date: Dec.19,195

LEGEND
Shear Strength
Unconfined compression
Vane test and sensitivity
Penetration Resistance
2" Split tube
2" Dia. Cone
Casing

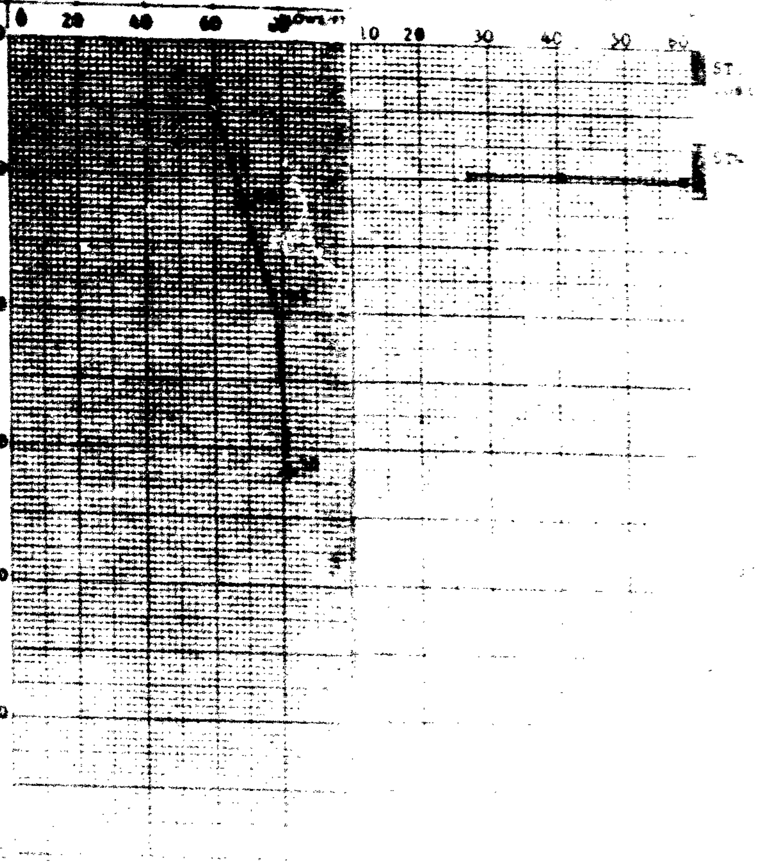
Sampling Method
2" Dia. split tube
2" Shelby tube

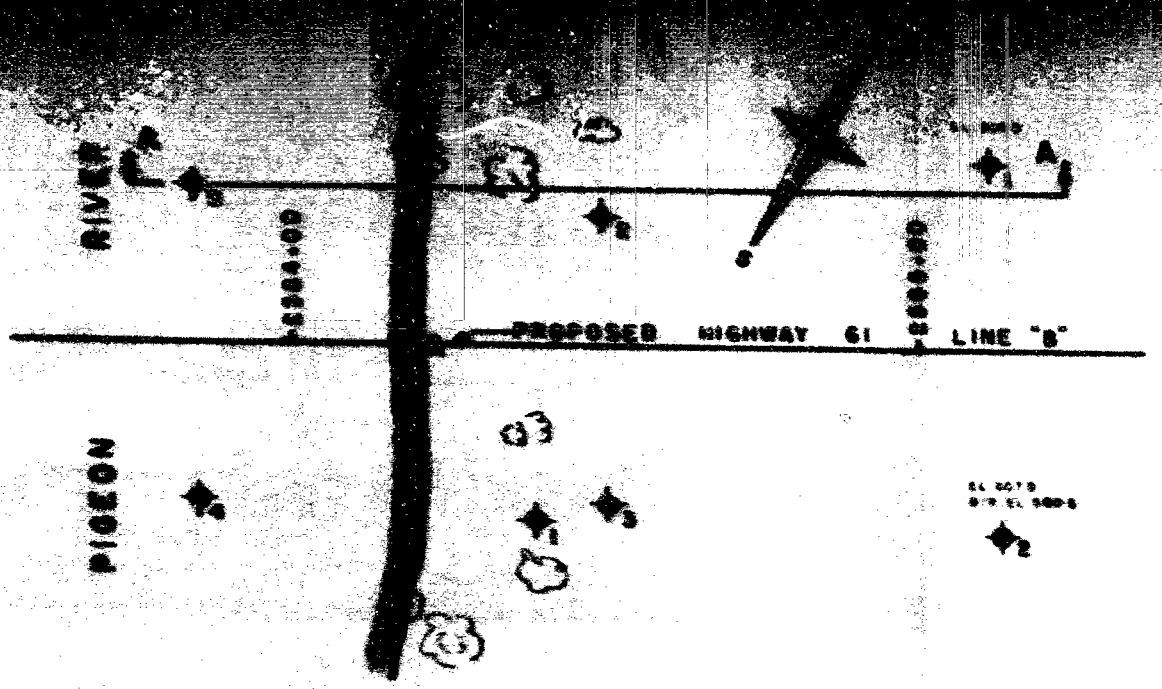
SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
		588.2	35.0
	Stiff greyish-brown clay		
			40.0
	As above.		
			45.0
	Stiff greyish-brown clay, traces of coarse sand particles.		
			50.0
		570.0	
	Stones, some sand & gravel		
		568	55.0
	Soft greenish-grey Greywacke		
		566	
	Broken stone - Diabase		
		565	
	Diabase stones & boulders		
			60.0
		560	
	END OF BOREHOLE		

STRENGTH AND PENETRATION RESISTANCE

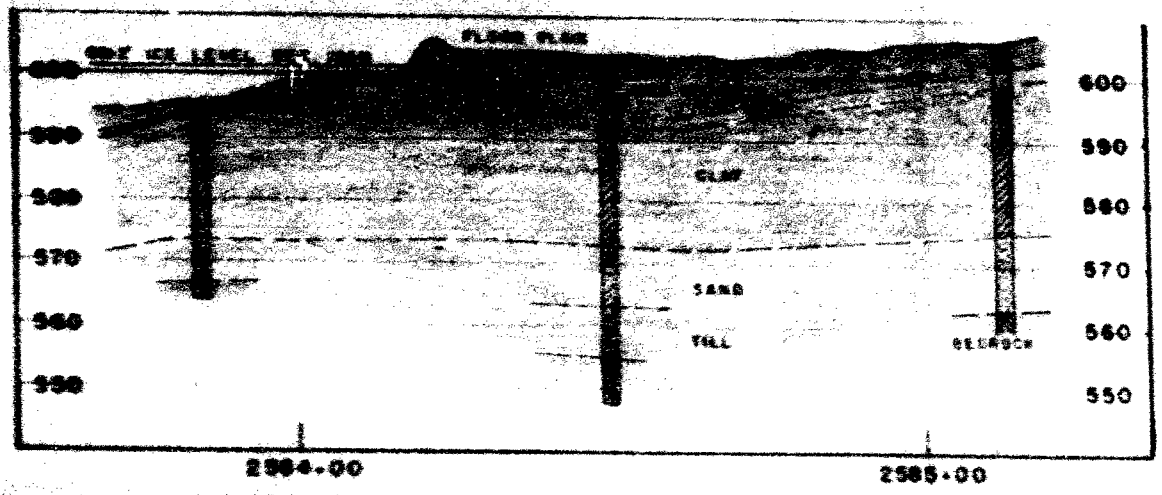
C_u 500 1000 1500 2000 PSF

0 20 40 60 80 Blows/ft





PLAN



PROFILE A-A

LEGEND

- BORE HOLES BY DOMINION SOIL INVEST. LTD.
- BORE & PENETRATION HOLE DEPARTMENT OF HIGHWAYS

ADDITIONAL
FOUNDATION INVESTIGATION
PIGEON RIVER BRIDGE
HIGHWAY 61
STUART LOCATION
THUNDER BAY DISTRICT - W.P. 142-60
SCALE 1"=20'