

#67-F-201

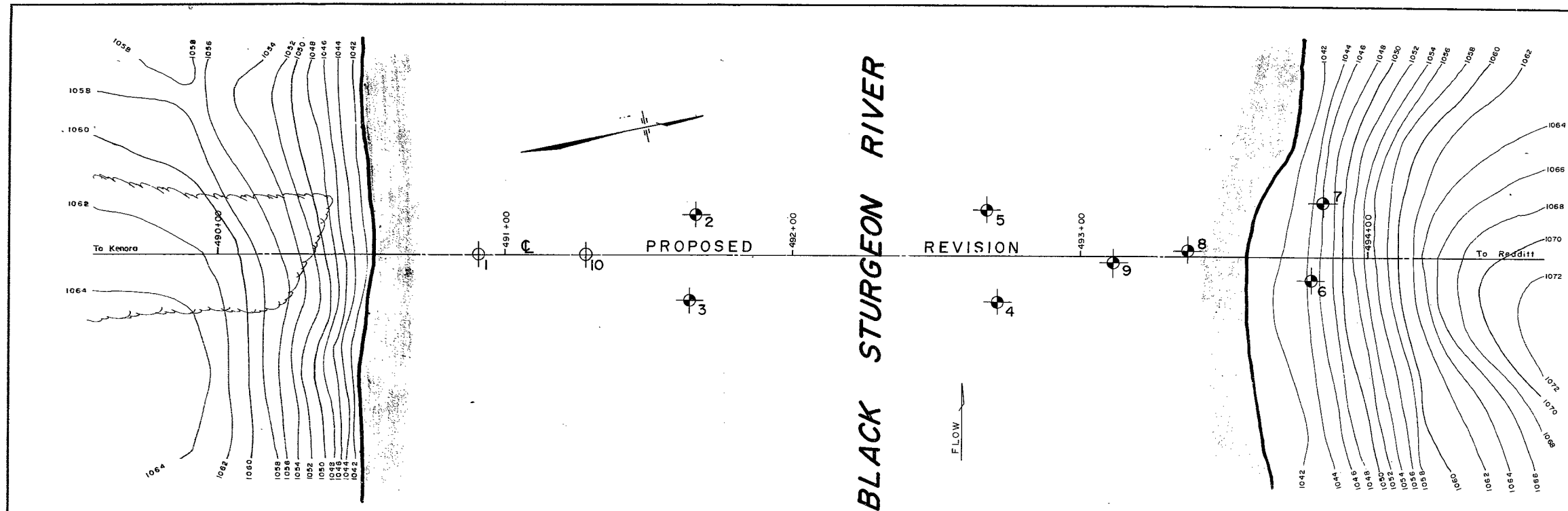
W.P. #158-66

HWY #128

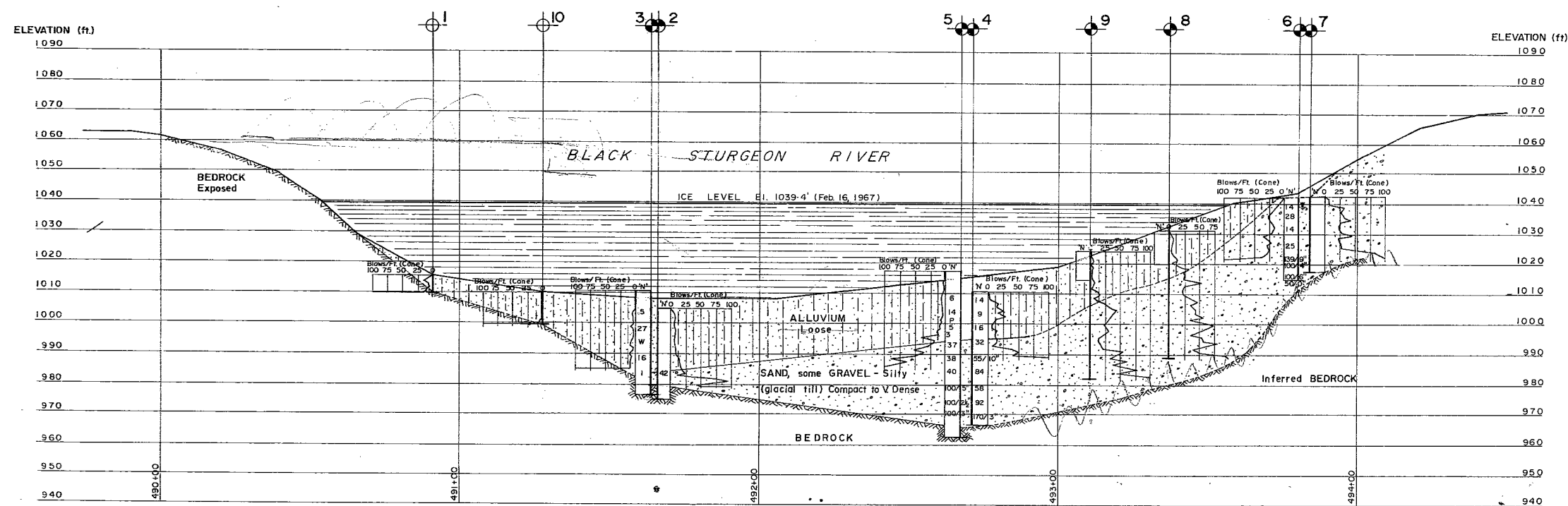
MOON BRIDGE

OVER BLACK

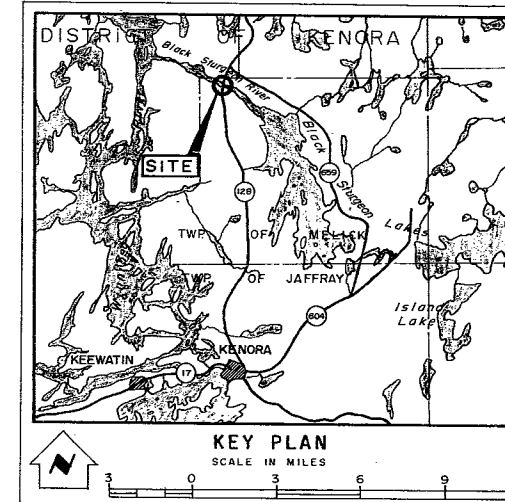
STURGEON RIVER



PLAN
SCALE IN FEET
20 10 0 20 40



PROFILE
SCALE IN FEET
20 10 0 20 40

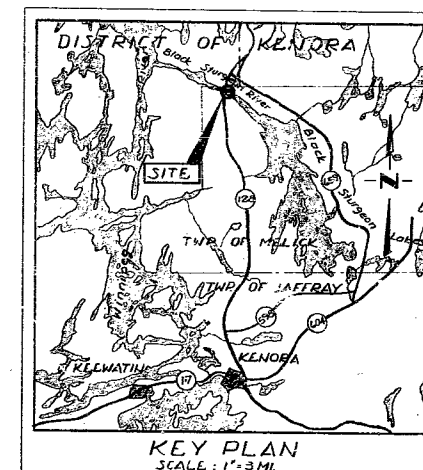
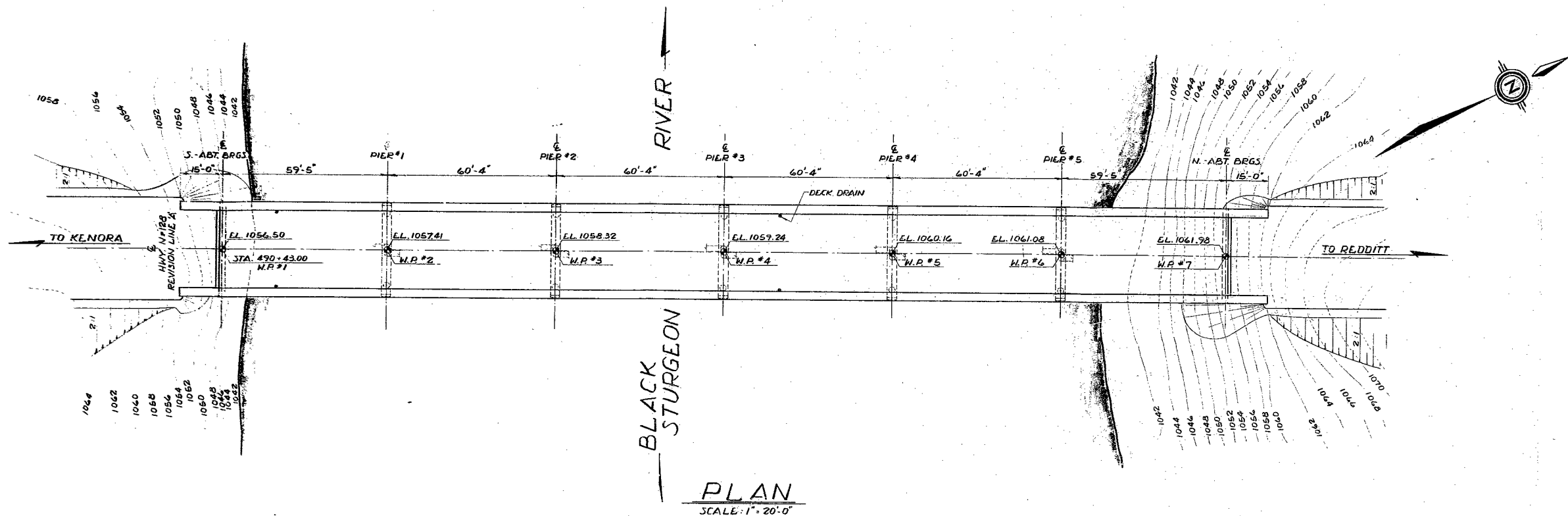


LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. (Feb. 16, 1967)		
B.M. 1048-28' GEODETIC DATA N. & W. in top of O'4 Pine Stp. 16' Lt. of Sta. 490+43 Rev. L.			
NO.	ELEVATION	STATION	OFFSET
1	1039.4	490+91	CL
2	1039.4	491+66	14' LT.
3	1039.4	491+64	16' RT.
4	1039.4	492+71	16' RT.
5	1039.4	492+67	16' LT.
6	1042.7	493+80	8' RT.
7	1042.8	493+84	19' LT.
8	1039.4	493+37	2' LT.
9	1039.4	493+11	2' RT.
10	1039.4	491+28	CL

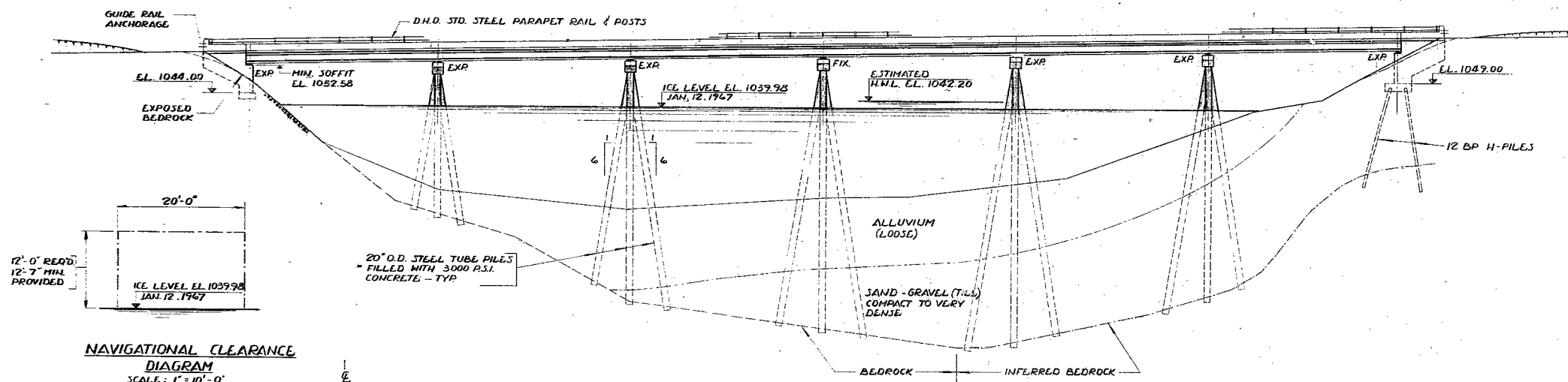
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS	DATE	BY	DESCRIPTION

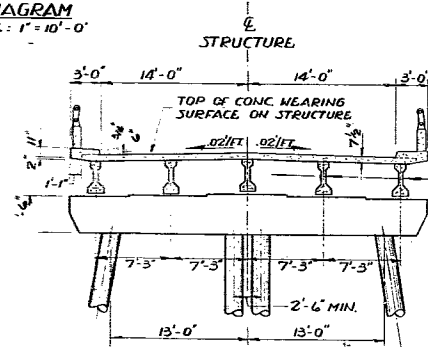
DOMINION SOIL INVESTIGATION LIMITED			
DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
BLACK STURGEON RIVER			
KING'S HIGHWAY NO.	128	DIST. NO.	20
DIST.	KENORA	TWP.	MELICK
LOT	13 & 14	CON.	VI
BOREHOLE LOCATIONS & SOIL STRATA			
SUBM'D. L. R.	CHECKED	W.P. NO. 158-66	DRAWING NO.
DRAWN D. M.	CHECKED	JOB NO. 7-2-2	7-2-2/16
DATE	MAR. 17, 1967	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.		



REFERENCE BENCH MARK
BENCH MARK E.L. 1048.28 GEODETIC DATUM
NORTH-WEST IN TOP OF 0.4" PINE STP
16' LEFT OF STA. 490+43, REV. LINE 'A'

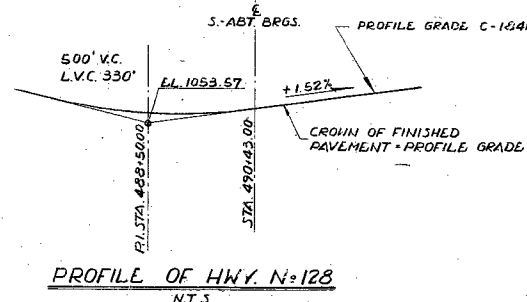


NAVIGATIONAL CLEARANCE
DIAGRAM
SCALE: 1" = 10'-0"



FOUNDATION NOTES

- PILES FOR PIERS #1 & #2 TO BE DRIVEN TO BEDROCK AND ANCHORED THERE IN BY MEANS OF DONUTS CORE DRILLED INTO THE BEDROCK.
- PILES FOR PIERS #3, #4, #5 & NORTH ABUTMENT SHOULD BE DRIVEN TO A SATISFACTORY SET IN THE GLACIAL TILL.
- SOUTH ABUTMENT TO BE PLACED DIRECTLY INTO EXPOSED BEDROCK.
- FOR PIERS #1 & #2 IT MAY BE NECESSARY HOLD PILES IN POSITION BY MEANS OF TEMPORARY BRACING UNTIL THE PIER CAP HAS BEEN CONSTRUCTED.



REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

MOON BRIDGE
OVER BLACK STURGEON RIVER
2.9 MILES N. OF SFC HWY. N-598
KING'S HIGHWAY No. 128 (LINE 'A') DIST. No. 20
DIST. KENORA
TWP. MELICK LOT 14 CON. 27

— PRELIMINARY PLAN —

APPROVED	BRIDGE ENGINEER	SITE No. 415-7	W.P. No. 158-66
DESIGN A.M.	CHECK	CONTRACT	
DRAWING A.A.	CHECK A.M.	CONTRACT	
DATE JUNE/67	LOADING HS 20-44	CONTRACT	
		CONTRACT	
		CONTRACT	

Mr. C. S. Grebski,
Bridge Design Engineer,
Bridge Division,
Admin. Bldg.

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

June 27, 1967

Moan Bridge over Black Sturgeon River,
8.9 Miles North of Sec. Hwy. #598,
Site 415-7, W.P. 158-66, Hwy. #128,
-- District #20 (Kenora) --

We have reviewed the Preliminary Bridge Plan
Dwg. D-6212-P1, for the above mentioned structure, and
submit the following comments:

- 1) The probable bedrock profile should not be shown on the final design drawings, since no attempt was made to determine the bedrock elevation north of B.N.'s #4 and #5.
- 2) The tube piles for Piers 3, 4 and 5, should be driven open ended into the dense sand and gravel stratum to the required tip elevation. During construction, the pile driving should be controlled by the use of the Hiley Formula according to current D.H.O. Standards DD 1218 and DD 1219. All the loose alluvium material should be washed out prior to placing the concrete in the tube piles.
- 3) Since the material underlying the alluvium deposit is very dense, the final drawing should call for the piles to be driven by a D-22 hammer.

MD/MdeP

cc: Messrs. S. McCombie
F. De Visser

Foundations Files
Gen. Files

M. Devata
M. Devata,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Sternac,
PRINCIPAL FOUNDATION ENGR.

Department of Highways Ontario

Copy for the information of

Mr. A. Stermac, Principal Foundation Engineer,
Room 107, Lab. Building

Mr. F. DeVlaser,
Reg. Bridge Location Engineer,
P.O. Box 1170,
Port Arthur, Ontario

Bridge Division,
Downsview, Ontario

June 21, 1967

Noon Bridge over Black Sturgeon River
5.9 Miles N. of Sec. Hwy. No. 598
W.P. 158-66, Site No. 418-7
Highway 128, District No. 20

Attached herewith are prints of the Preliminary Bridge
Plan Drawing D-6212-P1 for the above-mentioned structure.

The estimated cost of the proposed structure is \$250,000.
This cost includes tender, materials, engineering and sundry
construction.

Any comments or revisions you may have should be submitted
within three weeks.

CSG:rd

C.S. Grebaki,
Bridge Design Engineer

Attach.

c.c. S. McCombie
A. Stermac
R. Forrest
E. Cross

Copy for the information of

Mr. A.G. Stermac, Principal Foundation Engineer,
Room 107, Lab. Building

MEMO TO FILE

Bridge Division,
Downsview, Ontario

June 8, 1967

**Moon Bridge over Black Sturgeon River
8.9 Miles N. of Sec. Hwy. #598
Site 41S-7, W.P. 158-66
Highway 128, District No. 20**

A meeting was held at 2 P.M. on Thursday, June 8, 1967, at the Foundation Office.

Present were:

Mr. A.G. Stermac, Principal Foundation Engineer
Mr. A. Witecki, Bridge Project Engineer
Mr. K.G. Bassi, Regional Bridge Project Engineer N.W.

At this meeting it was agreed that:

1. As the proposed design will not necessitate any additional fill at the North Bank, there is no need for a 20' berm as called for in the memo accompanying the Foundation Report.
2. As the material underlying the alluvium is very dense, the final drawings should call for the piles to be driven by a D22 hammer.
3. The tube piles for Piers 1 and 2 should be driven open-ended to refusal, and washed out prior to drilling a 4"Ø dowel hole in the bedrock by means of a diamond drill. A 3" to 4"Ø dowel can then be placed in the dowel hole before placing concrete in the tube piles to anchor the piles to the bedrock.
4. Steel H-Piles should be called for at the North Abutment.


K.G. Bassi,
Regional Bridge Project Engineer

KGB:rd

c.c. A.G. Stermac
F. DeVissser
A. Witecki

with 158-66

Mr. E. E. Davis,
Bridge Engineer,
Bridge Division,
Main. Bldg.

Foundation Section,
Materials & Testing Div.,
Room 187, Lab. Bldg.

March 21, 1947

Attention: Mr. E. E. Davis

MAR 21 1947

FOUNDATION INVESTIGATION REPORT FOR C.E.O.
BY: DOMINION SOIL INVESTIGATION LIMITED --
Proposed Moon Bridge over the Black Sturgeon River,
R.F. 158-66, Highway 128, District 20 (Hanson).

Attached, please find the foundation investigation report for the above mentioned structure, prepared and submitted by the consultant, Dominion Soil Investigation Ltd.

We have reviewed the report and herewith submit our comments for your consideration:

The factual information is, in our opinion, adequate. We think that there is not enough evidence available to infer the bed-rock to the north of B.H.'s 4 and 5. It is quite possible that the rock surface continues on the same slope as between B.H.'s 2 and 4, and does not climb in the northerly direction. Therefore, we would suggest that no attention be given to the inferred rock surface beyond B.H.'s 4 and 5 on Drawing 7-2-2/16.

The recommendations pertaining to the foundations of the two piers and the south abutment are straightforward and need no comment. Regarding the north abutment, we would suggest that a 20-ft. long berm be built in front of the abutment. The top of the berm should be at or slightly below elevation 1050, depending on the details of the bridge design. The berm should be placed first - i.e., before the driving of piles and abutment construction. It is believed that the berm will provide the necessary stability and will also enable the construction of the abutment footing at a higher level, thus eliminating the need for dewatering. The details of this proposal should be worked out during the course of bridge and approach designs.

For any questions pertaining to the foundations of the above structure you wish to discuss, please feel free to call on our Office.

cc: Mr.

attach.

cc: Messrs. E. E. Davis (2)
E. A. Ferguson
D. J. Farren
E. J. Harrell
G. W. Sinclair
P. de Visser
P. Norman
S. A. Singh

A. E. Stearns
A. E. Stearns
SENIOR FOUNDATION ENGINEER

Foundations Files
Gen. Files

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

Box. 401 & Leslie St.,
Scarborough, Ontario.

January 31, 1967

Materials and Testing Division

Consolidation Well Investigation Ltd.,
77 Grosvenor Blvd.,
Scarborough, Ontario.

Attention: Mr. J. Sleszynski

Re: Letter of Authority -- Foundation Investigation
-- on Bridge over Black Sturgeon River,
6.3 Miles N. of Sec. Hwy. 528 - S.R. 158-65,
Hwy. 124 -- District No. 20 (Kenora). REF. 7-2-2

Dear Sir:

Please consider this your authority to carry out the
necessary foundation investigation at the above mentioned
crossing.

The plans will be given to your Engineer in Port William
by Mr. F. De Visser, Regional Bridge Location Engineer,
777 Memorial Ave., Port Arthur, Ontario, Tel. No. 345-2143 (Area
Code 307). Mr. De Visser will also outline what additional
information might be required.

We understand that you have a fully equipped drill and
crew presently working in Kenora and, therefore, no major
mobilization cost is to be incurred by the Department. You are,
however, requested to send from Toronto, a fully qualified
engineer to be in charge of the investigation. We also under-
stand that you have established that it is financially more
favourable to the Department for your Engineer to drive from
Toronto rather than fly to the Lakeshore and rent a car there.

This applies if the investigation lasts more than a week.
Since we are advised by Mr. De Visser, that the investigation is
certain to last longer, you may proceed with the suggested
arrangement.

Should your Engineer at the site require any additional
information during the investigation, he should contact Mr. De Visser.

cont'd. /2 ...

Dominion Soil Investigation Ltd.,

Attn: Mr. I. Lissakowsky

January 31, 1967

Mr. F. Norman, Regional Materials Engineer, is also being advised that your organization is carrying out this investigation and, should you wish to contact him, you are free to do so.

You are requested to start the field work not later than February 6, 1967, and submit eleven (11) copies of your final report to the Foundation Section by not later than March 17, 1967.

Previous requirements as to preliminary borehole information and laboratory testing program, should be followed.

Since the drawing accompanying the foundation report, showing the location of borings, the inferred subsoil conditions, etc., is to become a contract drawing, you are requested to prepare it in accordance with the C.E.O. Standards. To enable you to do this, we are supplying you with a sample drawing with all the necessary explanations, together with linen sheet for your drawing. You are also requested to provide us with a Cronaflex copy of the drawing.

Charges for the work will be in accordance with your schedule of Rates, effective August 1, 1966, and the invoice should be addressed to the attention of the undersigned.

We are attaching Purchase Order A-08822, covering the purchase of any new material required for this work, in order that you may use this as a basis for exemption from the Federal Tax for such purchases. The Exemption Certificate is printed thereon.

Yours very truly,

QR

A. Bulka

MATERIALS & TESTING ENGINEER

AGG/ais:
Attach.

cc: Messrs. G. McCombie
H. A. Murrell
F. Le Visser
G. E. Sinclair
F. Norman
H. Tonings
Mrs. I. Steinberg
H. Szymanski (2)
A. Crowley
Foundations Files
Gen. Files

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

ONTARIO
DEPARTMENT OF HIGHWAYS
MATERIALS AND TESTING DIVISION - FOUNDATION SECTION
DOWNSVIEW, ONTARIO.

PROPOSED
MOON BRIDGE
OVER THE
BLACK STURGEON RIVER
SITE 41S-7, W.P. 158-66
HIGHWAY 128, DISTRICT 20

FOUNDATION CONDITIONS

SUBMITTED BY:

DOMINION SOIL INVESTIGATION LIMITED
77 CROCKFORD BOULEVARD
SCARBOROUGH, ONTARIO.

OUR REF. NO; 7-2-2

MARCH, 1967.

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0. INTRODUCTION

Authorization was received from Mr. A. Rutka, P.Eng., Materials and Testing Engineer, to conduct a soil investigation for the proposed Moon Bridge north of Kenora, Ontario. The present one-lane bridge west of the proposed realignment is no longer capable of handling the volume of traffic on Highway No. 128. The new bridge will consist of three, approximately equal spans and will have two abutments on the shores and two piers in the river. The road grade will be about 20 ft. above the river level.

The purpose of our work was to reveal the soil profile below the site, to determine the engineering properties of each type of soil encountered and to advise on the design and construction of foundations and approach embankments of the new bridge.

This report presents our findings and recommendations.

1. SUMMARY

The soil profile along the proposed Moon bridge is quite variable. The south shore is exposed bedrock which dips steeply into the river and forms a channel below it. Two types of overburden were encountered in the riverbed: a loose, layered alluvium underlain by compact to very dense glacial till. The maximum thickness of the alluvium is about 20 ft., whereas that of the till is between 30 and 40 ft. This glacial till comprises the north shore where the bedrock is about 30 ft. below the ground surface.

As a consequence of the above non-uniformity of soil profile, the foundation conditions are also variable at every pier and abutment. For convenience, they will be summarised below:

SOUTH ABUTMENT	-	spread foundations, bearing on the bedrock
SOUTH PIER	-	end bearing piles driven to refusal at the bedrock surface
NORTH PIER	-	end bearing piles driven to a satisfactory set in the very dense glacial till
NORTH ABUTMENT	-	short, end bearing piles driven to a satisfactory set in the very dense glacial till.

The feasibility of a spill-through type abutment, in which the horizontal earth pressure is resisted by a rock-fill, was ruled out because the loose alluvium would become unstable under any applied load. All horizontal thrust should be balanced by the abutment structure itself.

2. THE SITE

The site is located ten miles north of Kenora where Highway No. 128 crosses the Black Sturgeon River. The latter is a slowly flowing wide stream draining the Black Sturgeon Lakes westward into the Winnipeg River. At the proposed crossing the river flows in an approximately 300 ft. wide channel between steeply rising banks which are quite different. The south bank is exposed bedrock, dipping steeply into the river and the rock is bare except for scattered trees and bushes which were capable of surviving on the meagre soil which accumulated in cavities. The north side of the river is built up of sand, cobbles and boulders. White birch predominates which also indicates well drained, granular soils. This physiography, together with a knowledge of the geology of the area points to certain tentative conclusions regarding the subsurface stratigraphy: it is probable, that as the glaciers retreated towards the north, granular wash-material was laid down along the north shore, whereas the bedrock along the south side was stripped bare of mos. of the overburden. In more recent geological times, the present river occupied the existing channel and deposited sediments. The flow of the water being slow, the alluvium is expected to be mainly fine grained and loose.

3. SUBSURFACE CONDITIONS

Two types of overburden were encountered above the bedrock: a recent alluvium and a glacial till deposit. These, together with the bedrock, will be treated in more detail in the following paragraphs.

For a better visualisation of the subsurface profile, we refer to enclosure no. 16 on which the sequence of these strata is illustrated.

31. Alluvium

A predominantly granular alluvial deposit of maximum 25 ft. thickness comprises the riverbed. It is a very heterogeneous, layered deposit, with occasional organic content. The following types of materials were encountered:

- A) Uniform fine sand - with some medium sand and 7.5 to 35% silt (for grain size distribution see enclosure no. 12). The grains are subrounded to subangular.
- B) Silt - with some (15%) fine sand (for grain size distribution see enclosure no. 12).
- C) Highly plastic clay - with some (17%) fine sand. The grain size distribution of the material is presented on enclosure no. 13 and the following are the index properties:

Natural moisture content	63.5%
Liquid limit	50.4%
Plastic limit	20.1%
Plasticity index	30.3%
Liquidity index	1.4
Natural unit weight	99 pcf
Assumed specific gravity	2.75
Void ratio	1.85

(The activity of approximately 1.0 indicates the probable clay mineral to be illite).

- D) Clay of intermediate plasticity - with the following index properties:
- | | |
|--------------------------|--------|
| Natural moisture content | 38.20% |
| Liquid limit | 36.40% |
| Plastic limit | 16.50% |
| Plasticity index | 19.90% |
| Liquidity index | 1.1 |
- E) Medium to coarse sand and fine gravel. Grains subrounded to subangular.

Fine sand (material "A") and silt (material "B") are the principal soil types and are approximately equally represented. The thickness of the individual layers varied between 3/4" and 8" in the samples. The layers of medium to coarse sand and fine gravel (material "E") were irregular and thin (not more than 2" thick). Clay layers (materials "C" and "D") of a maximum thickness of 6" were only occasionally encountered and there was no field evidence indicating that these were continuous. It is, therefore, most likely that the clay is embedded in the granular layers only in the form of lenses.

From the preceding, it appears that the engineering properties of the alluvium are determined by those of the fine sand or silt materials. Since the recovery of undisturbed specimens from this submerged cohesionless soil was not possible, the evaluation of the apparent angle of friction was based only on "secondary" phenomena, such as penetration resistances, the slope of the riverbed and the

appearance of samples.

Terzaghi and Peck state that the apparent angle of friction of loose, fine sands (uniform, round grains, in a submerged state) may be as low as 27 degrees; whereas that of saturated silts may be 20 degrees with measured minima of 17 degrees. The observations in the field and laboratory consistently pointed to the very loose state of the alluvium in the upper 10 to 15 ft. thick zone, therefore, the question is narrowed down to the decision whether the properties of the silt or fine sand should govern.

We recommend 20 degrees as a characteristic friction angle of the upper portion of the alluvium because

- i. large number of silt layers was detected;
- ii. the natural slope (based on the D.H.O. sounding results) between stations 493 + 00 and north edge of water is also about 20 degrees. It is believed that the slope of the riverbed at this section probably indicates the natural angle of repose of the alluvium because the sediment deposited by the water will come to rest at the bottom as dictated by its inherent frictional properties;
- iii. finally, although there are layers of coarser materials - fine, medium and coarse sand and fine gravel - the presence of the very soft clay layers adversely affects the shearing resistance of the deposit.

32. Glacial Till: silty sand, some gravel

This material was encountered in the southern two-thirds of the river channel and on the south shore. Typical gradation curves are presented on enclosure no. 14. From these, the composition of

the till is as follows:

Gravel (fine)	2 to 36%
Sand (well graded)	51 to 53%
Fines (non-plastic silt)	47 to 11%
Clay size	maximum 7.5%

The shape of grains is subangular to angular.

The profile of the till between the north pier and north abutment was inferred from the dynamic cone penetration tests and the penetration resistances indicated that the deposit is in a compact state near its top, changing to dense and very dense with depth. The angle of shearing resistance (ϕ) can be assumed to range between 37 degrees and 43 degrees and the cohesion intercept to be zero ($C = 0$).

The permeability of the material is medium to low, depending on the silt content. The coefficient of permeability is estimated to be between 10^{-3} to 10^{-5} cm/sec (appr. equal to 2×10^{-3} to 2×10^{-5} ft/min).

The degree of saturation is low (damp to moist) above the water level, complete (moist to wet) below it.

The compressibility of the soil is estimated to be small.

33. Bedrock

The bedrock surface forms a channel below the river which was probably the bed of a primary water course before the last glacial period. The rock material itself, which comprises acid intrusives such as granite, syenite and rhyolite, originates from

the Precambrian era. The appearance of rock is granitic, medium grained and massive, with frequent intrusions. The predominant colour is grey, but white, green and pink are also well represented on account of the aforementioned intrusions. The average percentage of core recovered is fairly high (67.5%) which indicates a competent formation.

Based on published information the unconfined compressive strength of these types of rocks ranges between 25 and 40 kips per square inch, except at weaker intrusions where it may drop to 10 to 25 kips per square inch (ref. no. 6). Since the bedrock below the site is confined, even the maximum value (40 kips per square inch) is considered to be conservative.

34. Groundwater Conditions

The groundwater level in the boreholes located on the north shore corresponded to the water level in the river. A rise in the water level and seepage towards the river can be expected after rainy periods.

4. DISCUSSION

41. Foundations for Abutments and Piers

411. South Abutment

The bedrock is exposed along the south shore, therefore the foundations for the south abutment could be placed directly into the bedrock. The rock contour drops steeply towards the river, hence blasting and rock excavation will be needed to provide a flat bearing surface. The finished foundation grade should be free of fractured rock material.

The safe bearing capacity of igneous massive granitic rocks is in the order of 100 kips per square foot, and it is believed that only a fraction of this will be utilised in the design to avoid disproportionately small footings.

The earth pressure from the fill behind the abutment will have to be resisted by a retaining wall (see section 42), therefore, the reaction will have a horizontal component also. The width of the footing should be designed in such a manner that it provides a sufficient factor of safety against over-turning and sliding. These criteria will likely determine the depth of bedrock excavation. The coefficient of friction between concrete and rock should be taken as 0.6.

Since it is probable that the excavated bedrock surface will be below the river water level, provisions for dewatering will have to be made.

This could consist of the construction of a coffer-dam which would keep river water out of the foundation area.

The settlement under the anticipated load will be negligibly small.

412. Piers

Since the bed of loose alluvium is below water and its thickness excessive, piling will be the most economical foundation method. Piles should be driven to refusal in the bedrock (= el. 980 ft.) at the south pier and to a satisfactory set in the glacial till at the north pier location (the use of the Hiley formula is recommended). It is estimated that the latter will occur between elevations 970 and 975 ft. at the north pier location, and driving to the bedrock surface will not be practicable.

The load carrying capacity of the piles will be determined by their structural properties. Steel H-bearing piles appear to be the most suitable, because of their high strength, ease of handling and because some driving difficulties through the overburden are anticipated at the northern pier. However, the use of timber piles is not ruled out, but in case they are used they should be provided with a driving shoe to avoid damage to the tip, furthermore, if they extended above river level, the timber should be treated. When resistance against forces applied at right angles to the piles is computed, the restraining effect of alluvium at the piers should be disregarded. The surrounding soil below a depth of 10 ft. from the river bottom will be sufficient to prevent lateral buckling but the

horizontal thrust should be resisted by battered piles.

Settlements will be negligible at both piers.

413. North Abutment

For the north abutment, piled foundations appear to be the most economical because the surface of a very dense bearing stratum is at a considerable depth and below groundwater level. Steel H-bearing piles or untreated timber piles appear to be suitable and they are expected to reach refusal or satisfactory set between elevations 1015 and 1020 ft. The use of the Hiley formula is recommended and timber piles should be provided with driving shoe to avoid damage to the tip.

The excavation for the pile cap should be made under water and one feasible method of dewatering would be in a similar manner as suggested for the south abutment.

The horizontal component of the earth pressure acting on the abutment should be resisted by battered piles, and because of the sloping surface of hard strata they may be somewhat longer than the vertical ones.

42. Approach Fill behind the Abutments

It is understood that the proposed grade will be between 15 and 20 ft. above the water level. Therefore, approach fills have to be constructed on both sides which will be supported either by a retaining wall-type abutment, or by rock fill in a spill-through type abutment.

In the latter event, the rock fill would be supported by the soil strata in the riverbed. Because loose, alluvial deposits would support the toe of the rock fill, the stability of the subsoil was analysed with the aid of the Swedish slip-circle method and with the following assumptions:

Alluvium: Apparent angle of friction: 20 degrees; cohesion: 0;
unit weight: 100 pcf above water.

Rock fill: Apparent angle of friction: 50 degrees; unit
weight: 120 pcf above water; side slope: 1 vertical
on $1\frac{1}{2}$ horizontal.

The results of the analysis are shown on enclosure no. 15. From these, it appears that the factor of safety against slip failure is between 0.6 and 0.8, and to achieve a factor of safety of 1, an angle of shearing resistance between 25 and 32 degrees would be required depending on the location of the slip surface. Considering that a factor of safety of 1 is still insufficient, even higher values would be required to achieve a safe design. (For instance, the alluvium should have an angle of shearing resistance between 35 and 43 degrees to support the rockfill with a safety factor of 1.5).

Since it is unlikely that the alluvium - even after consolidation - could develop the required shearing resistance, it is concluded that the loose subsoil is not capable of supporting the rock fill, and most probably, toe failure would occur.

The conditions are similar near the south abutment, furthermore, an excessive amount of rockfill would be required to achieve sufficient

support. Safe design could be achieved only by flattening the slope of the rockfill, in which case the quantity of the latter would increase considerably and the cross section of the river could become too narrow for hydrological requirements.

From the preceding treatise, we concluded that the construction of an open, spill-through abutment is not feasible, and we recommend that the horizontal earth pressure of the approaches should be resisted by the abutment structure.



DOMINION SOIL INVESTIGATION LIMITED

L. S. Rolko

L.S. Rolko, P.Eng., A.M. ASCE.

LSR/me

5. APPENDIX

51. Location and Elevation of Boreholes

The site was identified using plan No. 2-B-688, Rev. Jan. 1967 and the borings were located with the aid of a preliminary, un-numbered plan, both provided by Mr. F. DeVisser, P.Eng., Regional Bridge Location Engineer in Port Arthur, Ontario. The proposed grades were taken from a preliminary profile prepared by the Regional Office of the Ontario Department of Highways.

All elevations are geodetic.

52. Field and Laboratory Work

The site exploration was commenced on February 3, and finished on February 16, 1967. Extremely cold weather - temperatures frequently dropped as low as -40F degrees - and the thick snow cover on the ground hindered the progress of the work.

Eight boreholes and ten dynamic cone penetration tests were put down at the locations shown on enclosure no. 16. The holes were advanced by a washboring rig. Representative samples were taken at frequent intervals of depth with a 2-inch outside diameter split barrel (= split spoon), which was driven into the subsoil with a 140 lb. hammer dropping 30 inches. This energy was used in the dynamic cone penetration test also, in which a cone (2" Ø, 60 deg. apex) attached to the end of 1 5/8-inch diameter drilling rods is driven into the soil without casing. From driving the split spoon, the Standard Penetration Resistances (= 'N' values) were derived, which indicate the density of the substrata at the

sample locations, whereas the dynamic cone penetration test results produced a continuous record of subsoil density.

A thin-walled, 2-inch diameter steel tube (Shelby tube) was used to obtain relatively undisturbed samples from the soft and loose alluvium.

Since the presence of coarse sand and fine gravel layers frequently made the advancement of the thin-walled sampler rather difficult and caused denting of the cutting edge, samples were also taken with a "SIDE SAMPLER" (abbreviated as Si.Sa. on the borehole logs). This device consists of a 2-inch outside diameter, approximately 3/16-inch thick pipe of about 2 ft. length with an approximately 8-inch long and 1/2-inch wide opening along its axis. A removable cone-tip at the end of the sampler facilitates its advancement. At the required sampling depth the side sampler is rotated, whereupon material enters through the opening. Although the recovered soil material is disturbed, this method of sampling is very suitable in loose alluvial deposits.

The shear strength of the alluvium was measured with a four bladed, 2-inch diameter by 4-inch long vane, with a coring thickness of 1/8-inch. Since the results were inconsistent (although highly representative of the nature of soil encountered), the tests were discontinued.

The underlying bedrock was explored by removing the snow cover (south shore) and by about 13 ft. of diamond drilling. AXT size (1 1/8-inch diameter) core was recovered and the rate of

recovery varied between 50 and 84%; with a weighted average of 67.5%. This percentage is considered to be characteristic of the type of rock encountered.

All samples and rock cores were thoroughly examined and classified in our laboratory. Representative samples were subjected to classification tests (grain size analysis and plasticity tests) and the results of these are shown on the enclosures. In addition to the above, the natural water content of five soil specimens and the unit weight of the very soft clay alluvium were also determined. For results, we refer to the data sheets.

The soil samples are available for inspection for three months. Thereafter they will be disposed of unless otherwise instructed.

53. References and Relevant Standards

1. The Unified Soil Classification System by A.A. Wagner.
(ASTM Procedures for Testing Soils, 1964, p. 208).
2. CSA Standard No. A119.1-1960: Code for Split Barrel Sampling of Soils.
3. CSA Standard No. A119.2-1960: Code for Thin Walled Tube Sampling of Soils.
4. CSA Standard No. A119.3-1962: Dynamic-Cone Soil Penetration Test.
5. Terzaghi and Peck: Soil Mechanics in Engineering Practice.
John Wiley & Sons Inc., New York, 1948.
6. Krymine and Judd: Principles of Engineering Geology and Geotechnics. McGraw-Hill, Toronto, 1957.
7. Canadian Geotechnical Journal.
Vol. 1, No. 1, September 1963. Nomenclature.

enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
$\phi > 8"$	$3" - 3\frac{3}{4}"$	COARSE	FINE	COARSE	MEDIUM	FINE	0.074	0.002	$>$	NO SIZE LIMIT		
U.S. Standard Sieve Size :		No. 4		No. 10		No. 40		No. 200				

SAMPLE TYPES.

AS Auger sample	RC Rock core	TP Piston, thin walled tube sample
CS Sample from casing	% Recovery	TW Open, thin walled tube sample
ChS Chunk sample	SS Split spoon sample	WS Wash sample

SAMPLER ADVANCED BY static weight : w
 " pressure : p
 " tapping : t

OBSERVATIONS
 MADE WHILE
 CORING

Steady pressure
 No pressure
 Intermittent pressure

Washwater returns
 Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SYMBOL :



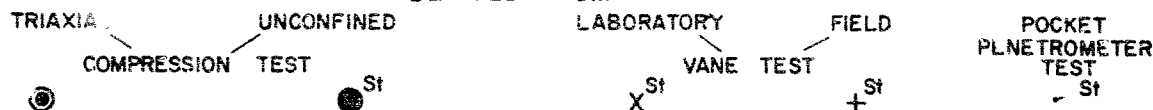
322

SOIL PROPERTIES.

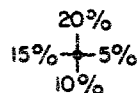
W % Water content	γ_s Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength
PL % Plastic limit	RD Relative density	ϕ Angle of int. friction
PI % Plasticity index	C_v Coeff. of consolidation	C' Cohesion
LI Liquidity index	m_v Coeff. of volume compressibility	ϕ' Angle of int. friction

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



Strain at failure is represented by direction of stem



$$St : \text{sensitivity} = \frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$$

SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq.ft.
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000

CONE TEST 1 (Sta. 490+91, C) GEOTECHNICAL DATA SHEET FOR ~~BOREHOLE~~

OUR REFERENCE NO. 7 - 2 2
 Your Ref No WP 158 - 66
 CLIENT D. H. O

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER
 LOCATION HWY No 128, N of KENORA
 DATUM ELEVATION GEODETIC

METHOD OF BORING CONE PENETRATION TEST (DYNAMIC)
 DIAMETER OF BOREHOLE ———
 DATE FEB. 17, 1967
 ENCLOSURE NO 2

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	No. of Advancement of Sampler	2.0	4.0	6.0	8.0	100	WP	W	WL	
1039.4	0	ICE LEVEL													
1030	10	RIVER WATER													
1020	20														
1010	24.0	ALLUVIUM loose													
	30	END OF CONE TEST													
1000	40														

GEOTECHNICAL DATA SHEET FOR BOREHOLE 2 (Sta. 491+66, 14' Lt.)

YOUR REFERENCE NO. 7 - 2 - 2
Your Ref. No. WP 158-66
Client: D.H.O.

PROJECT: PROPOSED BRIDGE over BLACK STURGEON RIVER
LOCATION: HWY. No. 128, N. of KENORA
DATUM ELEVATION: GEODETIC

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 3"
DATE: FEB. 11 - 12, 1967

ENCLOSURE NO. 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot				CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	Advance- ment of Sample	2.0	4.0	6.0	8.0	100	W _p	W	W _L	
1039.4	0	ICE LEVEL													
1030	10	RIVER WATER													
1020	20														
1010	30														
34.9		ALLUVIUM		1	TW	P									
1000	40	(layers of fine sand, silt, occasional layers of very soft clay and medium to coarse sand and fine gravel) loose		2	TW	P									
990	50			3	W.S.	—									
55.0		SAND some GRAVEL silty (glacial till) dense to v. dense		4	S.S.	42									
980	60			5	W.S.	—									
64.7		BED ROCK		6	R.C.	68%									
970	70	END OF BOREHOLE													

GRADATION

G.S.	S.A.	FINES
— per cent —		

0	65	35
FINES: ML		
(-2 μ size: 6%)		

GEOTECHNICAL DATA SHEET FOR BOREHOLE 3 (Sta. 491+64, 16' Rt.)

7 7 7
Your Ref No WP 158 GG

• 1997 • (1) 14 (2)

PROPOSED BRIDGE over BLACK STURGEON RIVER

HWY N^o 128, N of KENORA

ALYSSA L. S. ALBANI GEODETIC

WASH DC 25 JUL 68 1000Z

$$f_1 \wedge f_2 \in \mathcal{F} \quad \text{if and only if} \quad f_1 \in \mathcal{F} \text{ and } f_2 \in \mathcal{F} \quad \square$$

100 FEB 9 - 11, 1967

1970-1971

ELEVATION FEET	DEPTH FEET	LOCATION AND DESCRIPTION	SAMPLES			PENETRATION RESISTANCE BLows per foot					WATER CONTENT PERCENT			REMARKS
			SAND	SILT	CLAY	20	40	60	80	100	WL	WP	LI	
1039.4	0	ICE LEVEL												
1030	10	RIVER WATER												
1020	20													
1010	28.5	ALLUVIUM				CONE SINKS UNDER WEIGHT OF RODS AND HAMMER								
	30	(layer of fine sand, silty, and some layers of very soft clay and of medium to coarse sand and fine gravel)	1	SS	sinks									
			2	SS	5									
1000	40		2A	WS										
			3	SS	27									
			4	WS										
			5	SS	W									
990	50	loose	6	WS										
			7	SS	16									
			8	WS										
			9	SS	1									
980	57.9	SAND some GRAVEL silty, v. dense (g.l.)	10	RC										
	60	BEDROCK	11	RC	84%									
			12	RC	90%									
	63.6	END OF BOREHOLE												
970	70													

GRADATION

GR	SA	FINES
0	93	7

— per cent —

FINES, ML

Si, Sa denotes "side sampler"

GEOTECHNICAL DATA SHEET FOR BOREHOLE 4 (Sta. 492+71, 16' Rt.)

OUR REFERENCE NO. 7-2-2

Your Ref. No. W.P. 158-66

CLIENT D.H.O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY No 128, N of KENORA

DATUM ELEVATION GEODETIC

METHOD OF BORING WASH BORING

DIAMETER OF BOREHOLE 3"

ENCLOSURE NO. 5

DATE FEB 7-9, 1967

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	Advance- ment of Sampler	2.0	4.0	6.0	8.0	100	WP	W	WL	
1039.4	0	ICE LEVEL													
1030	10	RIVER WATER													
1020	20														
1010	29.0	ALLUVIUM (layers of fine sand, silt, occasional layers of very soft clay and of medium to coarse sand and fine gravel)		1	Si. Sa. sinks										
				2	S.S.	14									
				3	S.S.	9									
1000	40	loose		4	S.S.	16									
				5	S.S.	32									
990	50	SAND, some GRAVEL silty (glacial till)		6	S.S.	55/10									
				6A	W.S.	—									
				7	S.S.	84									
980	60	very dense		7A	W.S.	—									
				8	S.S.	58									
				8A	W.S.	—									
				9	S.S.	92									
970	70			9A	W.S.	—									
				10	S.S.	10/3									
73.2	80	END OF BOREHOLE		11	R.C. 9%	—									
960															

Si. Sa.
denotes
"side sampler"

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 5. (Sta.492+67, 16' Lt.)

OUR REFERENCE NO. 7 2 - 2
Your Ref. No. W.P. 158-66

CLIENT D. H. O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY No 128, N of KENORA

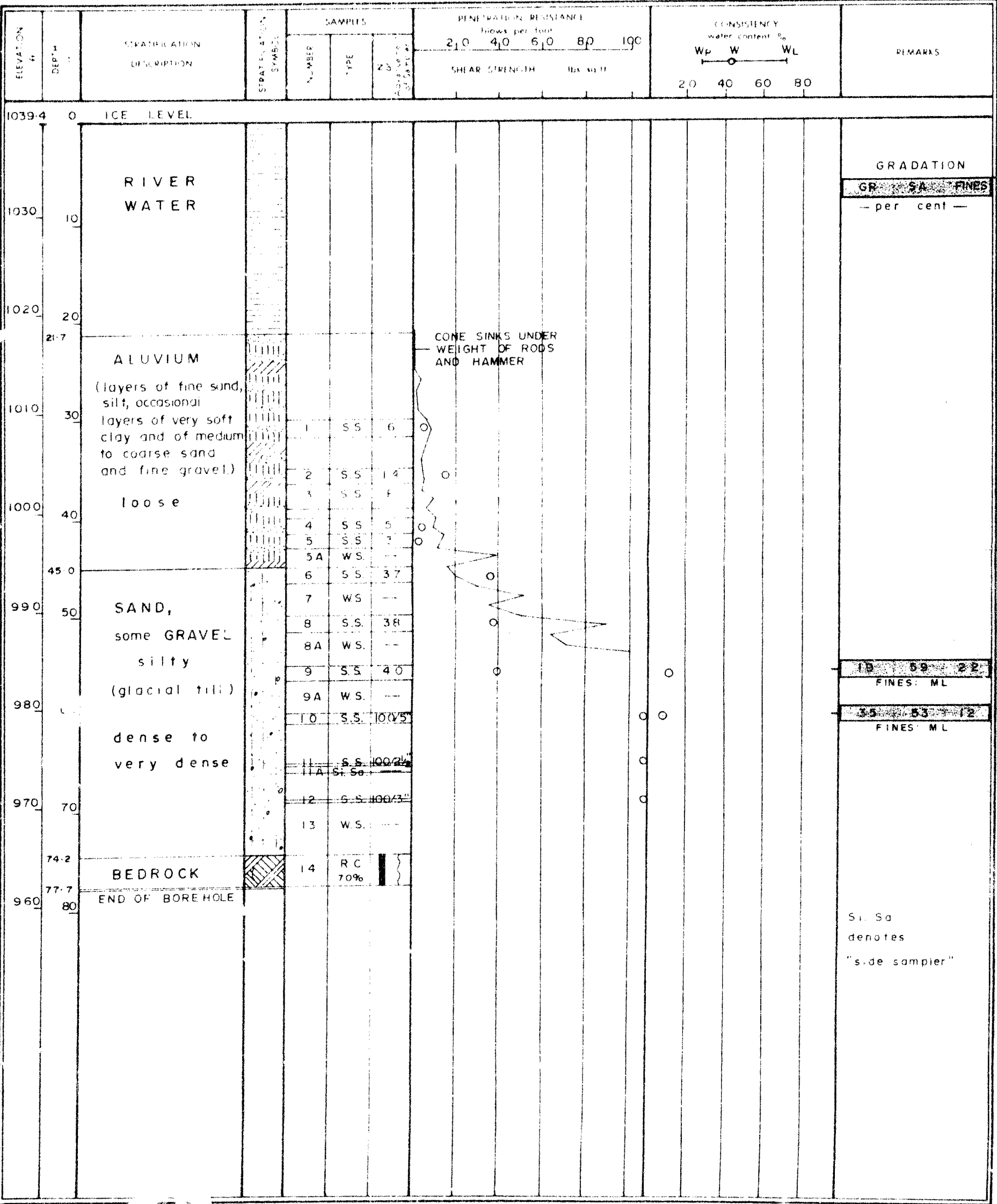
DATUM ELEVATION GEODETIC

METHOD OF BORING WASHBORING

DIAMETER OF BOREHOLE 3"

DATE FEB. 4 - 7, 1967

ENCLOSURE NO. 6



GEOTECHNICAL DATA SHEET FOR BOREHOLE . 6 . (Sta. 493+80, 8' Rt.)

PROJECT NO. 7-2-2
Your Ref. No. W.P. 158-66

CLIENT D.H.O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY No 128, N of KENORA

DATUM ELEVATION GEODETIC

METHOD OF BORING WASHBORING

DIAMETER OF BOREHOLE 3"

DATE FEB. 13-14, 1967

ENCLOSURE NO. 7

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot				CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	Adjustment of Sample	2.0	4.0	6.0	8.0	100	WP	W	WL	
1042.7	0	GROUND SURFACE													
1040		SAND, some GRAVEL silty (glacial till) compact very dense		1	S.S.	14									WL: El 1039.9' Feb. 14, 1967 GRADATION GR SA FINES — per cent — 3 72 25 FINES ML 11 42 47 FINES: ML (-20 size 7.5%)
	2			S.S.	28										
1030	10			3	S.S.	14									
				4	S.S.	25									
1020	20			5	S.S.	139/9"									
				6	S.S.	100/4"									
				7	S.S.	100/6"									
				8	S.S.	50/6"									
1010	30	END OF BOREHOLE													
	40														

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 7 . (Sta. 493+84, 19' Lt.)

OUR REFERENCE NO. 7-2-2
Your Ref. No. W.P. 158-66
CLIENT D. H. O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER
LOCATION HWY No 128, N of KENORA
DATUM ELEVATION GEODETIC

METHOD OF BORING WASHBORING
DIAMETER OF BOREHOLE 3"
DATE FEB. 14-15, 1967

ENCLOSURE NO. 8

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	Adjustment of Sample	2.0	4.0	6.0	8.0	10.0	Wp	W	WL	
1042.8	0	GROUND SURFACE													
1040		SAND, some GRAVEL silty (glacial till)													
1030	10														
	20	compact very dense													
1020				2	S.S. R.C. W.S.										
	25.0	END OF BOREHOLE													
1010	30														
	40														

NOTE: CORE
BARREL NOT
CAPABLE OF
PENETRATING
BELOW 25 FT.
ALL DIAMONDS
POLISHED SMOOTH.

BX SIZE CASING
COULD NOT BE
DRIVEN BELOW
23 FT. NO
PENETRATION
FOR 500 BLOWS
WITH 300 LB.
HAMMER.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 8 (Sta. 493+37, 2' Lt.)

OUR REFERENCE NO. 7-2-2
Your Ref No. W. P. 158-6.6

CLIENT D. H. O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY No 128, N. of KENORA

DATUM ELEVATION GEODETIC

METHOD OF BORING WASHBORING

DIAMETER OF BOREHOLE 3"

DATE FEB. 15 - 16, 1967

ENCLOSURE NO. 9

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	No. of Advances of Sampler	2.0	4.0	6.0	8.0	100	Wp	W	WL	
1039.4	0	ICE LEVEL													
		RIVER WATER													
1030	8.0	ALLUVIUM (layers of fine sand, silt, occasional layers of very soft clay and of medium to coarse sand and fine gravel.) loose		1	Si Sa	--									
	10			2	Si Sa	--									
				3	Si Sa	--									
				4	Si Sa	--									
1020	20	END OF BORE HOLE		5	Si Sa	--									
	25														
1010	30	(probably GLACIAL TILL)													
1000	40														
990	50														
	50.9	END OF CONE TEST													
980	60														

Si Sa.
denotes
"side sampler"

GEOTECHNICAL DATA SHEET FOR BOREHOLE . . 9 . . (Sta. 493+11, 2' Rt.)

OUR REFERENCE NO. 7-2-2
Your Ref. No. WP 158-66

CLIENT D. H. O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY No 128, N. of KENORA

DATUM ELEVATION GEODETIC

METHOD OF BORING WASH BORING
DIAMETER OF BOREHOLE 3"

DATE FEB 16, 1967

ENCLOSURE NO. 10

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	Advancement of Sample	2.0	4.0	6.0	8.0	10.0	Wp	W	WL		
1039.4	0	ICE LEVEL														
1030	10	RIVER WATER														
1020	20	ALLUVIUM (layers of fine sand, silt, occasional layers of very soft clay and of medium to coarse sand and fine gravel) loose		1	Si. Sa	tapped										
				2	Si. Sa	tapped										
				3	Si. Sa	tapped										
				4	Si. Sa	pushed										
				5	Si. Sa	tapped										
1010	30	END OF BOREHOLE														
1000	40	(probably GLACIAL TILL)														
990	50															
980	60	END OF CONE TEST														
	70															

Soil Samples
have bad odour indicating organic content

BH. 9A LOCATED 3' SOUTH OF B.H. 9

 SAMPLES FROM BH. 9A

1	T.W.	P	A
2	T.W.	P	A
3	T.W.	P	
4	T.W.	P	

 GRADATION

G.R.	SA	FINES
- per cent -		
0	16	84
FINES: CH (-2 μ size 30%)		
0	15	85
FINES: ML (-2 μ size 6%)		

 BH 9A SA.1A

 BH 9A SA.2A

CONE TEST 10 (Sta. 491+28, C) GEOTECHNICAL DATA SHEET FOR BOREHOLE

OUR REFERENCE NO. 7 2 2

Your Ref. No. WP 158-66

CLIENT D.H.O.

PROJECT PROPOSED BRIDGE over BLACK STURGEON RIVER

LOCATION HWY. No 128, N. of KENORA

DATUM ELEVATION GEODETIC

METHOD OF BORING CONE PENETRATION TEST (DYNAMIC)

DIAMETER OF BOREHOLE

DATE FEB 17, 1967

ENCLOSURE NO.

11

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	Advancement of Sampler	20	40	60	80	100	Wp	W	WL	
1039.4	0	ICE LEVEL													
1030	10	RIVER WATER													
1020	20														
1010	30	ALLUVIUM loose													
1000	40	END OF CONE TEST													
990	50														

VERTICAL SCALE: 1 IN. TO 10 FT

DOMINION SOIL INVESTIGATION LIMITED

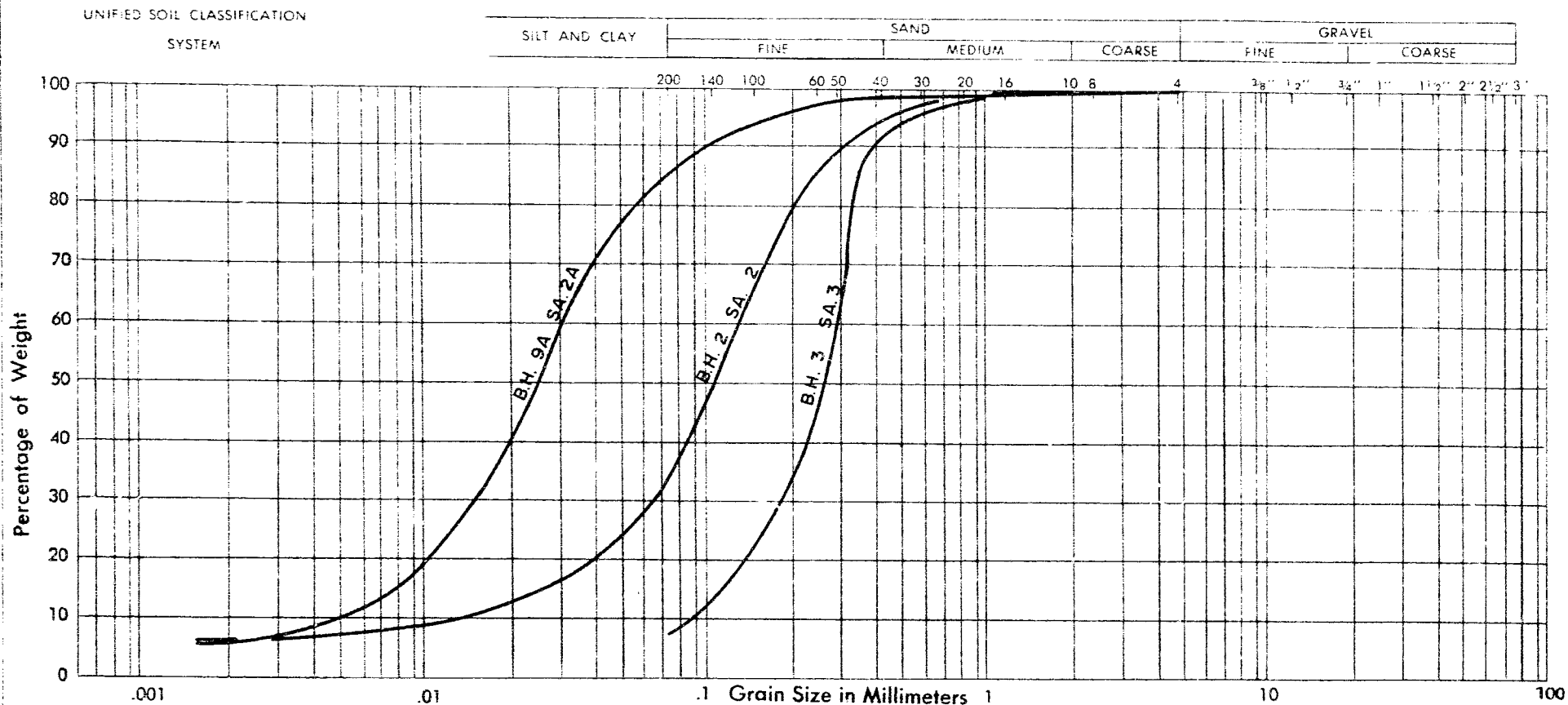
MADE D. A. M. CHD

Roller

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 7-2-2



PROJECT: MOON BRIDGE
 LOCATION: KENORA, ONTARIO
 BOREHOLE NO.: 2, 3, 9A
 SAMPLE NO.: 2, 3, 2A
 DEPTH OF SAMPLE: 40', 40', 20'
 ELEVATION OF SAMPLE: 1000'±, 1000'±, 1019'±

COEFFICIENT OF UNIFORMITY B.H. 3 3.3
 COEFFICIENT OF CURVATURE S.A. 3 >1

PLASTIC PROPERTIES:

LIQUID LIMIT % =
 PLASTIC LIMIT % = fines
 PLASTICITY INDEX % = non-plastic
 MOISTURE CONTENT % =
 ACTIVITY =

Classification of Sample and Group Symbol:

SILTY fine SAND	fine SAND some SILT	SILT, with some fine SAND
B.H. 2 SA. 2 (SM)	B.H. 3 SA. 3 (SP-SM)	B.H. 9A SA. 2A (ML)
"A"	"A"	"B"

Material
Type

Enclosure No. 12

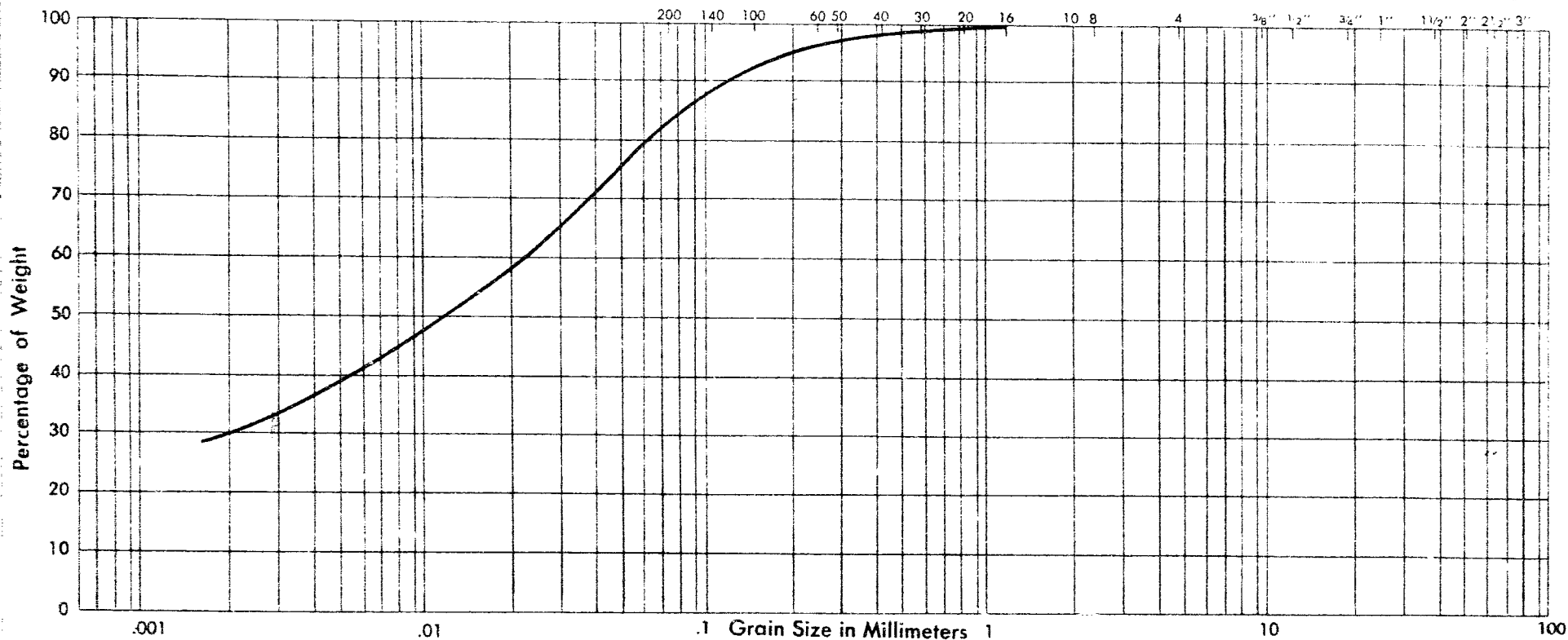
DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 7-2-2

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



PROJECT: MOON BRIDGE
LOCATION: KENORA, ONTARIO
BOREHOLE NO.: 9 A
SAMPLE NO.: 1 A
DEPTH OF SAMPLE: 15.5'
ELEVATION OF SAMPLE: 1024' ±

COEFFICIENT OF UNIFORMITY
COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:
ALLUVIUM
(highly plastic) CLAY

CH

PLASTIC PROPERTIES:

LIQUID LIMIT	% =	50.4
PLASTIC LIMIT	% =	20.1
PLASTICITY INDEX	% =	30.3
MOISTURE CONTENT	% =	63.5
ACTIVITY	=	~1.0
UNIT WEIGHT	=	99.0 p.c.f.

Enclosure No. 13

Material "C"
Type

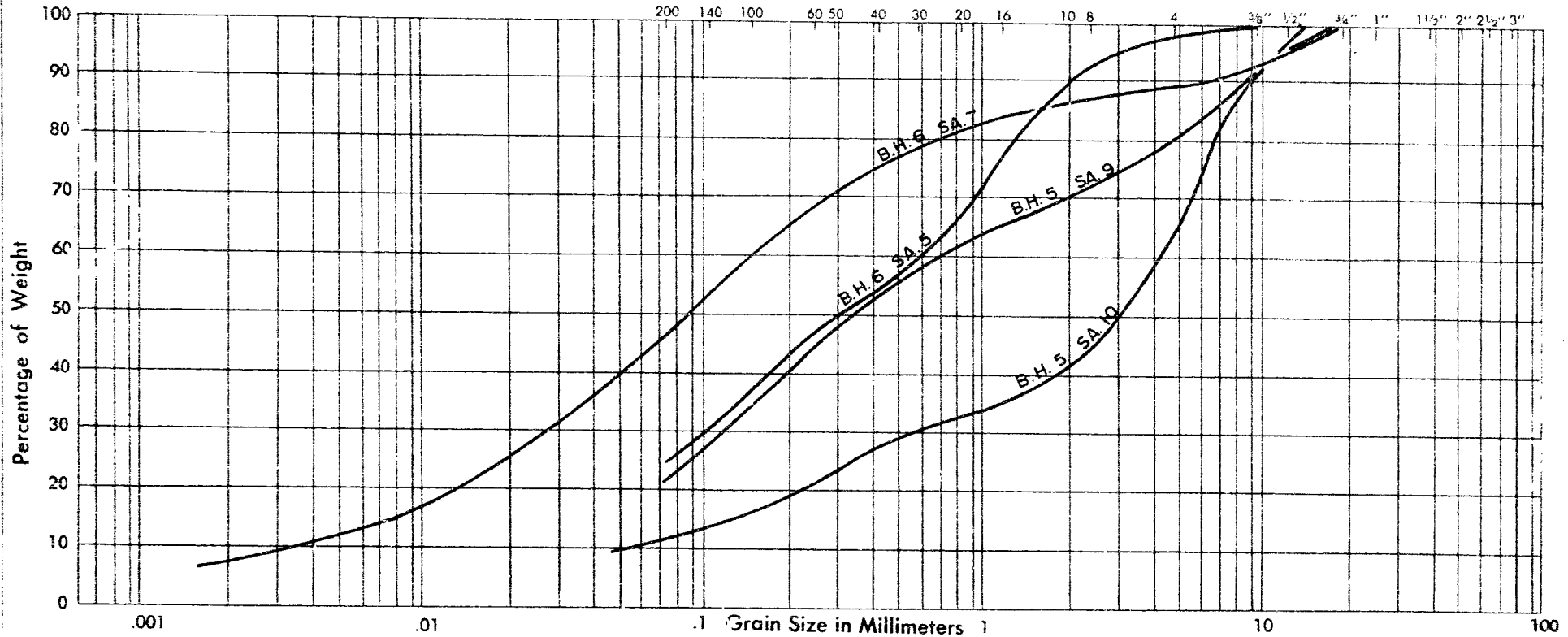
DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 7-2-2

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



PROJECT: MOON BRIDGE
LOCATION: KENORA, ONTARIO
BOREHOLE NO.: 5 5 6 6
SAMPLE NO.: 9 10 5 7
DEPTH OF SAMPLE: 55' 60' 20' 26'
ELEVATION OF SAMPLE: 984'± 979'± 1022'± 1016'±

COEFFICIENT OF UNIFORMITY B.H. 5 > 80
COEFFICIENT OF CURVATURE S.A. 10 > 1 (SW - SM)

Classification of Sample and Group Symbol:
SAND some GRAVEL,,
Silty SM

(GLACIAL TILL)

PLASTIC PROPERTIES:

LIQUID LIMIT	%	=	
PLASTIC LIMIT	%	=	fines
PLASTICITY INDEX	%	=	non
MOISTURE CONTENT	%	=	plastic
ACTIVITY	=		

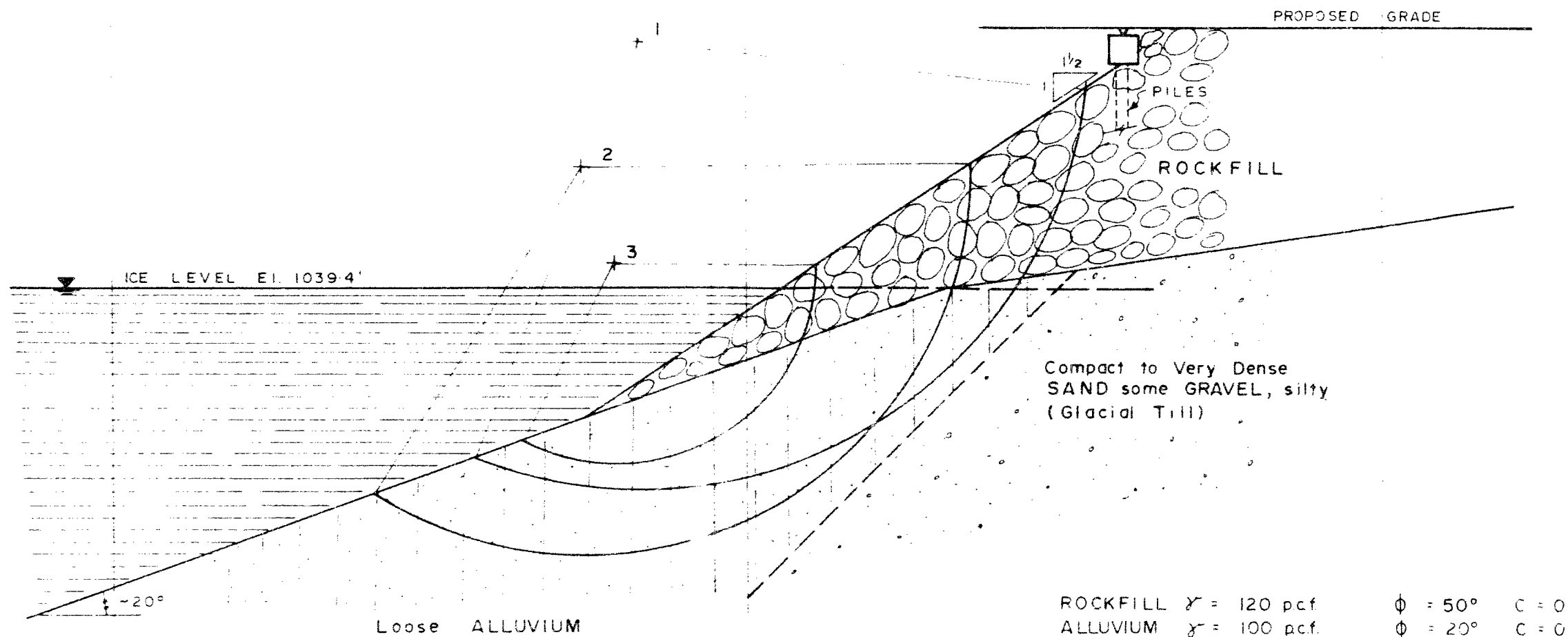
Enclosure No. 14

STA. 493+00

CIRCLE No.	$\phi = 20^\circ$	$F_s = 1$
1	$F_s = 0.59$	$\phi_{REQ} = 31.4^\circ$
2	$F_s = 0.70$	$\phi_{REQ} = 27.3^\circ$
3	$F_s = 0.79$	$\phi_{REQ} = 24.7^\circ$

STA. 493+50

STA. 494+00



STABILITY ANALYSIS OF ROCKFILL

SCALE: 1" = 10 Feet

Department of Highways Ontario

Copy for the information of

Mr. A. G. Stermac, Principal Foundation Eng., Room 107, Lab. Bldg.

Mr. P. D. Billings,
District Engineer,
KENORA, Ontario.

A. E. McKim,
Bridge Office,
Downsview, Ontario.

Mr. J. A. McKillop
Dist. Construction Engineer.

January 2nd, 1969.

Contract 68-163, Moon Bridge over
Black Sturgeon River, Highway 128,
District 20.

W.P. 158-66-142
W.P. 158-66-142/67

We are returning approved as noted 4 prints of the contractor's proposed alternative method of anchoring the piles for Piers "A" and "B" into the rock. The only change we have made in his proposal is to ask that all loose material be removed from the top of the tremie before concreting the piles.

In inspecting the installation of these piles we ask that your staff pay particular attention to the following points.

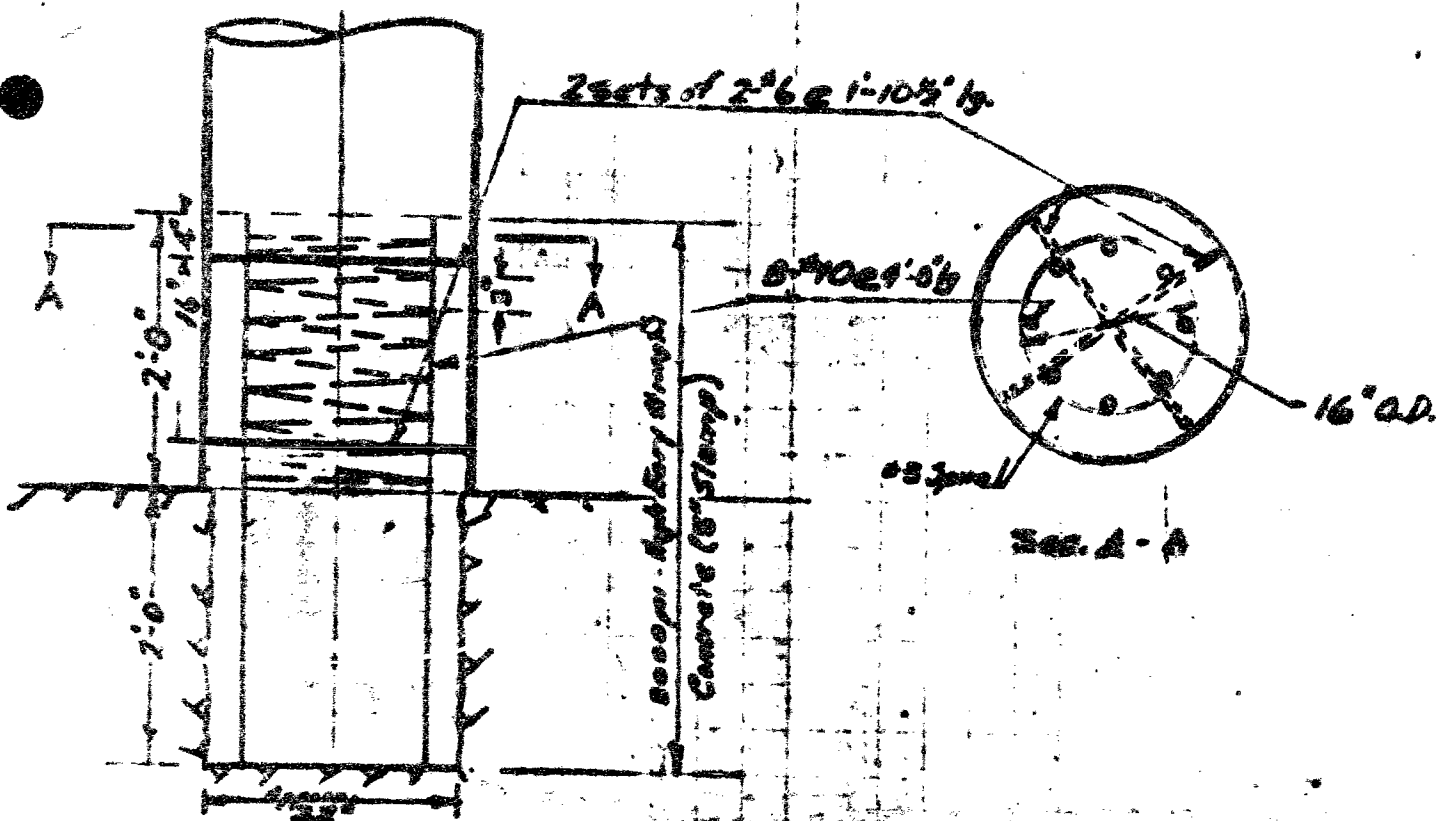
- 1) Ensure that pile is driven to bedrock.
- 2) Ensure that socket extends 2'-0" into rock.
- 3) Ensure that tremie does not extend more than 2'-0" into pile, or if it does, that the cages are extended in order that the cages extend to the bottom of the socket.

We would appreciate it if you could let us know when this work is being done as we would like to have an observer there for a short period.

AEMCK/co


A. E. McKim,
BRIDGE CONTROL ENGINEER.

c.c. A.G. Stermac



INSTALLATION PROCEDURE

- 1) Churn Drill socket
- 2) Clean out socket.
- 3) Place High Early Concrete with Tremi Bucket
- 4) Install Reinforcing Cage -
- 5) After 24 hrs pump out remaining part of pipe and fill with concrete. (3000 psi.)

As noted
APPROVED Jan 2/69 PURSUANT TO SECTION

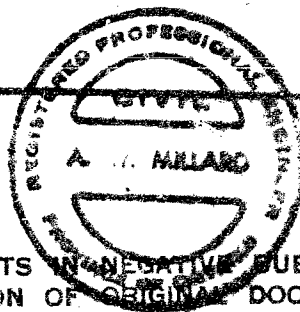
106.4 OF THE GENERAL CONDITIONS OF PROPOSED ALTERNATIVE P.R.

D.W.O. CONTRACT NO. 68-163

ANCHORS

PIERS A & B ONLY

DEFECTS IN NEGATIVES DUE TO
CONDITION OF ORIGINAL DOCUMENT



BRIDGE CONSTRUCTION LIAISON ENGINEER

W. P. 158-66

Nov. 1, 1967

Black Sturgeon River; Hwy 192, District 20

Note:

B. Davis asked P. Bassi to investigate the economics of a combination consisting of a causeway and one span bridge.

It would appear that all the alluvium could be displaced in the course of dumping rock for the causeway. The height of the embankment could thus reach 10 ft ~~in~~. Since rock is not available within the immediate vicinity, an approximate price of \$ 3.50 would have to be paid for a cubic yard.

Based on the above the multi-span bridge is the more economic solution.

Afternoon

P.S. This was discussed at the meeting

Nov. 1, 1967 in the Transportation Section

DEPARTMENT OF HIGHWAYS ONTARIO

Form

SB-OS-62

67-6700

ACTION SLIP

DATE

MAR. 19/69.

TO

PRINCIPAL FDN. ENGR

PIAT & RESEARCH DOWNSVIEW

FROM

KENDRA

☐NOTE AND
FILE☐PREPARE REPLY FOR
MY SIGNATURE☐NOTE AND
RETURN TO ME☐TAKE APPROPRIATE
ACTION☐RETURN WITH MORE
DETAILS☐PER YOUR
REQUEST☐NOTE
AND SEE ME☐FOR YOUR
SIGNATURE☐PLEASE
ANSWER☐FOR YOUR
INFORMATION☐FOR YOUR
APPROVAL☐INVESTIGATE AND
REPORT☐RETURN WITH YOUR
COMMENTS☐

COMMENTS

IN 0 158-66-1 & 2

RE. CONJ. 68 163

HIDDEN DR. W. R. BLICK

STURGEON RIVER Hwy. 128

TO CALL TENDERS FOR BLACK STURGEON BRIDGE



Leo Bernier, M.P.P. (Kenora) announced today that the Department of Highways will call tenders for construction of a 390 foot bridge structure over the Black Sturgeon River-Highway 128 (Kenora-Redditt). Included with the bridge structure will be the reconstruction and alignment of the bridge approaches.

Tenders will close December 11th with work commencing as soon as conditions permit, completion is established to be approximately October, 1969.

This prestressed beam structure 390 feet in length, will have a 30 foot travel width.

In making the announcement, Mr. Bernier noted that the pre-

sent structure was in such poor condition that the school bus was not permitted to travel it with students aboard. He felt certain that all the residents of Redditt and Kenora would be pleased with the news of the commencement of this urgently needed structure which is estimated to cost in the neighborhood of \$365,000.

Local Kenora Newspaper.
Nov 12/68.

DISTRICT NO. 22 CONTRACT NO. 68-163 STRUCTURE Moon Bridge over Elbow River
CONTRACTOR Geo. Armstrong & Co. Ltd. DESIGN LOAD OF PILE 165 Tons
Drummond St. Montreal, Canada WEIGHT 7,000 lb HEIGHT OF FALL OR ENERGY 4'
HAMMER DETAILS: TYPE Drop Hammer WEIGHT OF ANVIL OR CAP 500 lbs
TYPE OF ANVIL OR CAP Steel PILE DETAILS 3" dia. 24 1/2' long 24" x 24" x 24" Pile @ 125 lbs per foot
PILE NO. 1 LOCATION Drummond St. DATE DRIVEN Feb 13 / 69

TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.
30	1			26	75		51			76	
	2			27	76		52			77	
	3			28	77		53			78	
	4			29	78		54			79	
	5			30	79		55			80	
	6			31	80		56			81	
	7			32	81		57			82	
	8			33	82		58			83	
	9			34	83		59			84	
	10			35	84		60			85	
	11			36	85		61			86	
	12			37	86		62			87	
	13			38	87		63			88	
	14			39	88		64			89	
	15			40	89		65			90	
	16			41	90		66			91	
	17			42	91		67			92	
	18			43	92		68			93	
	19			44	93		69			94	
	20			45	94		70			95	
	21			46	95		71			96	
	22			47	96		72			97	
	23			48	97		73			98	
	24			49	98		74			99	
	25			50	99		75			100	

DETAILS FOR FINAL SIX INCHES OF PENETRATION	1	2	3	4	5	6
BLOWS PER INCH	8	14	11	12	12	10
MEASURED REBOUND IN INCHES	12	12	12	11	13	13
FINAL LENGTH OF PILE	FINAL CUT OFF ELEVATION					

SIGNED [Signature]
NAME (PRINT) John J. [unclear]
DATE March 10, 1964

ATTACH SKETCH OF PILE NUMBERING SYSTEM

BRIDGE CONSTRUCTION - PILE DRIVING RECORD

DISTRICT NO. 20 CONTRACT NO. 68-163 STRUCTURE Munn Bridge over Black Sturgeon
CONTRACTOR Geo. Armstrong & Co. LTD DESIGN LOAD OF PILE 165 Tons
HAMMER DETAILS: TYPE Drop Hammer WEIGHT 2000 lb HEIGHT OF FALL OR ENERGY 4'
TYPE OF ANVIL OR CAP Cast Iron WEIGHT OF ANVIL OR CAP 500 lbs
PILE DETAILS 24" O.D. Tube Pile @ 125 lbs per foot
PILE NO. 16 LOCATION Pier "D" DATE DRIVEN Feb 13 / 69

TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.
40	1	13		26	13		51			76	
	2	7		27	14		52			77	
	3	4		28			53			78	
	4	4	70+20	29	15		54			79	
	5	2		30			55			80	
	6	10		31	21		56			81	
	7	10		32	11		57			82	
	8	2		33	15		58			83	
	9	2		34	12		59			84	
	10			35	14		60			85	
	11	10		36	20		61			86	
40+30	12	6		37	23		62			87	
	13	9		38	20		63			88	
	14	7		39	24		64			89	
	15	4		40	20		65			90	
	16			41	21		66			91	
	17	5		42	26		67			92	
	18	5		43	23		68			93	
	19	1		44	23		69			94	
	20	5		45	17		70			95	
	21	10		46			71			96	
	22	7		47			72			97	
	23	10		48			73			98	
	24	5		49			74			99	
	25	7		50			75			100	

DETAILS FOR FINAL SIX INCHES OF PENETRATION	1	2	3	4	5	6
BLOWS PER INCH	10	12	13	14	15	17
MEASURED REBOUND IN INCHES	1	1	1	1	1	1
FINAL LENGTH OF PILE	83.2'					
FINAL CUT OFF ELEVATION	1054.62					

REPORT TO BE SENT TO: - PRINCIPAL FOUNDATION ENGINEER
MATERIALS & RESEARCH DIVISION
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS
TORONTO, ONTARIO

SIGNED [Signature]
NAME (PRINT) L. A. Lamoreaux
DATE Feb 10 / 69
ATTACH SKETCH OF PILE NUMBERING SYSTEM

BRIDGE CONSTRUCTION - PILE DRIVING RECORD

DISTRICT NO. 20 CONTRACT NO. 68-163 STRUCTURE Moon Bridge over Black Sturgeon
CONTRACTOR See Appendix A, P. 1 DESIGN LOAD OF PILE 165 Tons
HAMMER DETAILS: TYPE Drop Hammer WEIGHT 3000 lb HEIGHT OF FALL OR ENERGY 4'
TYPE OF ANVIL OR CAP Steel WEIGHT OF ANVIL OR CAP 500 lbs
PILE DETAILS Galvanneal Pile 1/2 24" O.D. Tube Pile — 125 lbs per foot
PILE NO. 19 LOCATION Pier "E" DATE DRIVEN Feb 7/69

TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.
40	1	3		26	33		51			76	
	2	3		27	32		52			77	
	3	3		28	30		53			78	
	4	3		29	28		54			79	
	5	3		30	26		55			80	
	6	3		31	24	Complete Refusal	56			81	
	7	3		32	22		57			82	
	8	3		33	20		58			83	
	9	3		34	18		59			84	
	10	3		35	16		60			85	
	11	3		36	14		61			86	
	12	3		37	12		62			87	
	13	3		38	10		63			88	
	14	3		39	8		64			89	
	15	3		40	6		65			90	
	16	3		41	4		66			91	
	17	3		42	2		67			92	
	18	3		43	0		68			93	
	19	3		44	0		69			94	
	20	3		45	0		70			95	
	21	3		46	0		71			96	
	22	3		47	0		72			97	
	23	3		48	0		73			98	
	24	3		49	0		74			99	
	25	3		50	0		75			100	

DETAILS FOR FINAL SIX INCHES OF PENETRATION	1	2	3	4	5	6
BLOWS PER INCH						
MEASURED REBOUND IN INCHES						
FINAL LENGTH OF PILE	50'			FINAL CUT OFF ELEVATION 1024.94		

REPORT TO BE SENT TO: - PRINCIPAL FOUNDATION ENGINEER
MATERIALS & RESEARCH DIVISION
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS
TORONTO, ONTARIO

SIGNED [Signature]
NAME (PRINT) L.A. Lamoureux
DATE March 10/69

ATTACH SKETCH OF PILE NUMBERING SYSTEM

10 Blows 1/2"
Complete Refusal

BRIDGE CONSTRUCTION - PILE DRIVING RECORD

DISTRICT NO. 20 CONTRACT NO. 65-163 STRUCTURE Abutment over North Sturgeon River
 CONTRACTOR Geo. Armstrong & Co. Ltd. DESIGN LOAD OF PILE 70 Tons
Pile driven by Frank Landolt Ltd.
 HAMMER DETAILS: TYPE Drop Hammer WEIGHT 4000 lb HEIGHT OF FALL OR ENERGY 6'
 TYPE OF ANVIL OR CAP 54" I WEIGHT OF ANVIL OR CAP 500 lbs
 PILE DETAILS Barlow Pile 1/2" x 11" x 41 P.Y.s
 PILE NO. 23 LOCATION North Abutment DATE DRIVEN Jan 30/69

TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.
20	1	1		26			51			76	
	2	10		27			52			77	
	3	9		28			53			78	
	4	11		29			54			79	
	5	9		30			55			80	
	6	9		31			56			81	
	7	7		32			57			82	
	8	7		33			58			83	
	9	7		34			59			84	
	10	6		35			60			85	
	11	6		36			61			86	
	12	5		37			62			87	
	13	5		38			63			88	
	14	5		39			64			89	
	15	5		40			65			90	
	16	4		41			66			91	
	17	4		42			67			92	
	18	4		43			68			93	
	19			44			69			94	
	20			45			70			95	
	21			46			71			96	
	22			47			72			97	
	23			48			73			98	
	24			49			74			99	
	25			50			75			100	

DETAILS FOR FINAL SIX INCHES OF PENETRATION	1	2	3	4	5	6
BLOWS PER INCH	5	7	1	10	15	20
MEASURED REBOUND IN INCHES	0.5	0.5	0.5	0.5	0.5	0.5
FINAL LENGTH OF PILE	30			FINAL CUT OFF ELEVATION		
				1047.50		

REPORT TO BE SENT TO: - PRINCIPAL FOUNDATION ENGINEER
 MATERIALS & RESEARCH DIVISION
 DEPARTMENT OF HIGHWAYS
 PARLIAMENT BUILDINGS
 TORONTO, ONTARIO

SIGNED [Signature]
 NAME (PRINT) D. A. Lawrence
 DATE March 10/69

ATTACH SKETCH OF PILE NUMBERING SYSTEM