

562 Notre Dame
Sudbury, Ontario
675-1600

William Trow Associates

Soil Mechanics
Consultants

W. A. Trow
M.Sc. MEIC. P. Eng.
K. Peaker
Ph.D. MEIC. P. Eng.



(Sudbury) Ltd.

Henry R. Krzywicki, M.Eng., P.Eng.
Manager

December 2nd, 1971.

Project: S-1186

Department of Transportation and Communications,
Design Services Branch,
Foundations Office,
DOWNSVIEW, Ontario.

ATTENTION: Mr. M. Devata, P. Eng.

RE: Foundation Investigation
Proposed Crossing at Marten River at Hwy. 64
Township of Sisk
District of Nipissing
W.P. 68-68 (North Bay)

Dear Sirs:

In accordance with your authorization of October 25th,
1971, the foundation investigation for the above mentioned bridge
site has been completed.

Our findings and recommendations arising from the field
work are given in the accompanying report. Should you have any
queries regarding our comments, please do not hesitate to contact
our office.

Yours very truly,

WILLIAM TROW ASSOCIATES (SUD.) LTD.

H.R. Krzywicki, P. Eng.

HRK/mmd
Encls.

Dist: Mr. M. Devata, P. Eng. (11)



FOUNDATION INVESTIGATION
PROPOSED CROSSING AT MARTEN RIVER AT HWY. 64
TOWNSHIP OF SISK
DISTRICT OF NIPISSING
W.P. 68-68 (NORTH BAY)

71-11-138 (L)
Cont 76-80

Prepared for:

Department of Transportation and Communications

WILLIAM TROW ASSOCIATES LIMITED
Toronto, Hamilton, Sudbury
Sarnia & London

Project: S-1186
December 2nd, 1971

562 Notre Dame Avenue
Sudbury, Ontario
(705) 674 - 9681

TABLE OF CONTENTSTEXT

	<u>Page No.</u>
SUMMARY	1
PROJECT AND SITE DESCRIPTION	2
FIELD WORK AND SUBSOIL STRATIGRAPHY	3
FOUNDATIONS	6
(i) FOOTINGS	6
(ii) PILES OR CAISSONS	7
SETTLEMENTS	8
EXCAVATIONS AND DEWATERING	8
EARTH PRESSURES	9
SCOUR PROTECTION	9

DRAWINGS

BOREHOLE LOCATION AND STRATIGRAPHY	Site Plan
BOREHOLE LOGS	Dwgs. 1 to 8, incl.
GRADINGS	Dwgs. 9 to 11, incl.

SUMMARY

The river level at the time of the investigation was elev. 939.6. The maximum depth of water recorded was 14 feet and the flow was measured to be less than 1 foot per minute.

The subsoil consists of 8 feet of organic sand, sand and gravel and cobbles and boulders overlying extremely dense till. The till, generally, is silt but tends to be sandy and gravelly in mid-stream. Frequent cobbles and small boulders were encountered in the till and overlying river bottom material. The bedrock encountered at a depth of 85 to 90 feet was identified as gneiss.

Foundation alternatives range from footings to caissons and combinations of both types. The safe net bearing value of the till for footings is at least 5 tsf. Caissons or piles socketed into the dense till a minimum of 10 feet can be designed for their structural capacity.

Settlement will not be a problem with the very dense, granular foundation soil at the site.

Footing excavations near the river banks can be dewatered by pumping from oversized excavations. Foundations in mid-stream should be excavated without dewatering to avoid disturbing the foundation soil.



The earth pressure against abutments should be calculated using an earth pressure coefficient of 0.35.

The maximum scour depth is estimated to be 6 feet below the river bottom. Scour protection will be required to protect shallow foundations.

The above points are discussed in detail in the following report.

PROJECT AND SITE DESCRIPTION

The proposed bridge replacement is over the Marten River on Highway 64 approximately 0.3 miles South of Highway 11. The river meanders and flows very slowly in a westerly direction at the bridge crossing. The measured velocity at the time of the investigation was less than 1 foot per minute.

The river at the bridge site is about 140 feet wide. The flood plain for the river terminates near the south bank and extends for a considerable distance on the north side of the river. The terrain on the north bank is low, wet and marshy.

At the time of the investigation the river level was recorded at elev. 939.6.

It is understood that the existing timber truss bridge, which is founded on 3 main cribs, will be replaced by a 3 span structure. It has been indicated that consideration is being given to utilizing piles or caissons extending up to the bridge deck.

FIELD WORK AND SUBSOIL STRATIGRAPHY

The field work for the proposed bridge replacement consisted

of 8 conventional diamond drill boreholes made from a raft. Originally, the boreholes were to be taken to bedrock, but the drilling program was altered after the first boreholes (BH. 2) was completed and the results were discussed with the Department. Two borings were taken into the bedrock and the remainder were terminated at depths ranging from 50 to 70 feet below the water table.

The field work was started on October 27th, 1971 and continued until November 25th, 1971. Most of the drilling was carried out with one B.S.S.#1 drill but a second similar drill was used between November 16th and 24th, 1971 to complete the field work within the allotted time.

The water level in the river varied from 939.5 to 939.7 during the foundation investigation which is about the same level as recorded in December 1970. The greatest depth of water encountered at the test locations was about 14 feet.

The subsoil at the proposed bridge crossing was found to consist generally, of about 8 feet of organic sand, sand and gravel, and cobbles and boulders overlying extremely dense till. The till material, which frequently had unit weights in excess of 150 pcf, generally, was a silt till containing frequent cobbles and occasional boulders. However, in the central portion of the riverbed (BH. 2, 3, 6 & 7) the till at the upper

levels was found to be coarser, ranging from sand and gravel till to silty sand till. The silty till often became very sandy below a depth of 40 or 50 feet below the water line and at most locations a stratum of clayey silt till was intersected, but no definite stratigraphy could be established from the field data.

The presence of cobbles and boulders in the extremely dense silt and sand matrix made drilling and sampling very difficult. In all instances the boreholes had to be cased to the full depth by running the casing and cleaning with the core barrel. The boulders encountered in the till varied considerably. Granite and Quartzite predominated but pieces of Limestone and Diorite were also recovered.

The bedrock sampled in BH. 2 and BH. 5, at a depth of 85 to 90 feet below the river level, was identified as Granite Gneiss and Biotite Gneiss. The Granite Gneiss showed a highly contorted mica development and a pronounced separation of mica seams at 45 degrees to the core. Some Slicksides was in evidence and planes of schistosity were observed at 15 degrees to the core. Minor fault planes were observed in both the Granite Gneiss and the Biotite Gneiss.

The subsoil encountered in each borehole is described in detail on the borehole logs (Dwgs. 1 to 8, inclusive). A subsoil stratigraphy,

as interpreted from the borehole data is given on the site plan.

Grain size analyses were made on the upper sand and gravel and the results were plotted on Dwg. 9 to 11, inclusive.

FOUNDATIONS

The foundation alternatives for this project vary from spread footings on the very dense till to caissons socketed into the dense till, or a combination of foundation types.

(i) Footings

In the event that spread footings are decided upon, the recommended safe net bearing value for the till is at least 5 tsf. It is expected that footings can be used for the exterior supports adjacent to the north and south banks of the river. Consideration should be given to moving the exterior bridge piers further into the banks to minimize construction difficulties.

Footings may be used to support the central piers, but excavations in the order of 20 to 24 feet below the river level are envisaged. It is expected that any excavation into the till material will be made without dewatering in order to avoid an unbalanced hydrostatic pressure and possible disturbance of the sandy till. A mass concrete foundation poured

within the confines of a watertight crib or large diameter caissons would permit dewatering for the remainder of construction.

(ii) Piles or Caissons

The alternative to footing foundations would be to utilize drilled-in caissons or piles. The caissons should be drilled within the confines of a heavy gauge open end steel liner, with the liner filled with water to the river level to equalize the hydrostatic pressure. It is recommended that the caissons be drilled a minimum of 10 feet into the till. Prior to placing concrete, using the tremie method, it is recommended that the steel liner be driven to refusal in the very dense till. Refusal may be considered to be 10 blows per inch with a hammer having a driving energy of 30,000 ft./lbs.

The estimated safe capacity of drilled-in piles or caissons will be their structural capacity. It is expected that a 12 inch diameter concrete filled steel lined pile will have a safe capacity of 50 tons and an 18 inch diameter pile will have a safe capacity of 100 tons. If the piles are carried up to the bridge deck, it will be necessary to assess the piles for lateral stability and structural capacity.

Other foundation alternatives include large diameter drilled caissons. With drilled piles or caissons the frequent occurrence of cobbles and small boulders will make drilling difficult.

Driven piles have not been discussed because of the difficult driving through the cobbles and boulders in and overlying the till stratum.

SETTLEMENT

No settlement problems are envisaged with the extremely dense granular till as foundation material. Unless footing beds are disturbed during construction any settlement of the footings will be negligible. Differential settlement problems are not anticipated if both footing and pile foundations are used for the structure.

EXCAVATIONS AND DEWATERING

Excavations in mid-river should be made below the water without dewatering to avoid disturbing the foundation soil, as discussed previously. However, where the till stratum is close to the existing grade, near the river banks, it is expected that open excavation to the till stratum can be made. An oversized excavation with side slopes of about 5 horizontal to 1 vertical is envisaged. If the footings can not be moved away from the

river, it will be necessary to divert the river away from the footing excavation. As the upper sand and gravel is free-draining, high capacity pumps will be required to depress the water level in the footing area.

EARTH PRESSURES

In the event that spill-through abutments are not utilized for the bridge, it will be necessary to design the abutments to withstand earth pressure. The earth pressure, p , at any depth h , below the finished grade can be estimated from the following expression.

$$p = 0.35\gamma h \text{ psf}$$

where p = the earth pressure at any depth.

0.35 = The earth pressure coefficient considered to be applicable for drained granular backfill.

γ = the unit weight of the backfill material adjacent to the abutment; considered to be 130 pcf for drained Class 'B' pit-run gravel.

h = the depth below grade in feet at which the earth pressure is required.

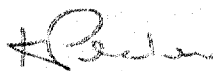
In the above expression, it has been assumed that free-draining backfill is used behind the abutment and that an effective drainage system has been provided to drain the backfill.

SCOUR PROTECTION

At the time of investigation the flow in the river was less than

one foot per minute. The borings in the centre of the river indicate a depth of scour of no more than 6 feet below the river bottom. Providing the foundations are taken into the very dense till, it is expected that cobbles and boulders dumped around the foundations will provide sufficient protection against scour and erosion for shallow foundations.

WILLIAM TROW ASSOCIATES (SUDBURY) LTD.



H.R. Krzywicki, P. Eng.

HRK/mmd

Encls.

Dist: Department of Transportation and Communications,
Design Services Branch,
Foundations Office,
DOWNSVIEW, Ontario.

Attention: Mr. M. Devata, P. Eng. (11)

BOREHOLE LOG

JOB No. S-1186

BOREHOLE No. 1


DRAWING No. 1


PROJECT Bridge Site,


LOCATION Marton River at Highway 64,


STA. 274+46, 21.0' R

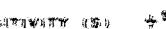
HOLE LOCATION AND DATUM SEE DRAWING NO. 1


2" O.D. SPLIT TUBE 


2" I.D. SHELBY TUBE 


2" DIA. CONE 


PUSHED 

VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 

PLASTIC AND LIQUID LIMIT 

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 

% STRAIN AT FAILURE 

F E R	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FEET	PENETRATION RESISTANCE				NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT			NATURAL UNIT WEIGHT P.C.F.
					250 FT. LB.	450 FT. LB.	650 FT. LB.	850 FT. LB.	5	10	15	
		WATER Nov. 5th, 1971	939.5									
		SAND and GRAVEL-compact to dense, brown, well graded; organic silt at 6 ft. depth, wet; cobbles below 6.8 ft. depth.	937.9									
		SILT TILL-very dense, grey, angular gravel sizes, frequent cobbles and small boulders, moist;	930.5	10								
		Boulders are Granite and Quartzite		20								159.7
				30								154.2
				40								153.9
				50								158.0
				60								No Rec.
				70								No Rec.
				80								No Rec.
				90								No Rec.
				100								No Rec.
		CLAYEY SILT TILL-very dense, grey, gravel sizes, moist.	891.5									
		END OF BOREHOLE	888.4									
		NOTE:										
		1) Borehole advanced with conventional diamond drill. Turning casing and core barrel for full depth to penetrate cobbles and boulders.										
		2) Borehole started Nov. 3rd and completed Nov. 5th, 1971.										



NATURAL MOISTURE X
PLASTIC AND LIQUID LIMIT —○—
UNDRAINED TRIAXIAL AT
OVERBURDEN PRESSURE 15
% STRAIN AT FAILURE 10

William Trow Associates Ltd.






BOREHOLE LOG





JOB No. S-1186

BOREHOLE No. 4

DRAWING No. 1

PROJECT Bridge Site,
 LOCATION Narvon River at Highway 64,
STA. 273+20, 17' R.

2" O.D. SPLIT TUBE 
 2" I.D. SHELBY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S)  + 5

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING NO. 1

F.S.S.	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FEET	PENETRATION RESISTANCE		NATURAL MOISTURE CONTENT AND ATTERBURG LIMITS			NATURAL UNIT WEIGHT P.C.F.
					250 FT. L.R. T.2	2500 FT. L.R. T.2	% DRY WEIGHT	5	10	
		WATER Nov. 11th, 1971	939.7							
			933.6							
		SILT FILL-very dense, grey; slightly cohesive at upper levels, gravel sizes; frequent cobbles; boulders by 18 ft. depth.		10						152.3
										164.7
				20						No Rec.
										No Rec.
				30						No Rec.
										No Rec.
				40						162.2
		Becoming sandy by 40 ft. depth								
				50						153.2
				60						157.7
		END OF BOREHOLE	874.5							
		NOTES:		70						
		1) Borehole advanced with conventional diamond drill. Running casing and core barrel for full depth to penetrate cobbles and boulders.		80						
		2) Borehole started Nov. 12th and completed Nov. 15th, 1971.		90						
				100						






BOREHOLE LOG





JOB No. S-1186

BOREHOLE No. 5

DRAWING No. 5

PROJECT: Bridge Site,
 LOCATION: Marten River at Highway 64,
 STA. 273+13, 17.0' L

2" O.D. SPLIT TUBE 
 2" I.D. SHELBY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING No. 1

F.T.	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	PENETRATION RESISTANCE 300 FT. L.R. BLOWERS FE. 20 40 60 80				NATURAL MOISTURE CONTENT AND ATTERING LIMITS % DRY WEIGHT			NATURAL UNIT WEIGHT P.C.F.
					SHEAR STRENGTH K.S.F.				5	10	15	
		WATER Nov. 18, 1971	939.6									
		COBBLES AND BOULDERS	934.5									
		SILT TILL-very dense, grey, slightly cohesive at upper level, very moist; becoming extremely dense by 15 ft. depth and only moist; frequent gravel and cobble sizes;	929.6	10								146.5
				20								No Rec.
				30								155.9
				40								153.5
		Becoming very sandy by 40 ft. depth; slightly cohesive between 45 and 50 ft. depth.		50								158.9
				60								153.0
				70								No Rec.
		CLAYEY SILT TILL-very dense, grey, frequent gravel sizes, moist.	864.6	80								148.3
				90								146.5
		BIOTITE GNEISS BEDROCK-planes of schistosity at 30° to the vertical; some and minor fault planes evident - 100% Recovery.	854.4									167.4
		END OF BOREHOLE	842.4	100								EX CORE 100% Rec.
		NOTES: 1) Borehole advanced with conventional diamond drill. Running casing and core barrel for full depth to penetrate cobbles and boulders. 2) Borehole started Nov. 16th and completed Nov. 20th, 1971.										





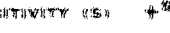
BOREHOLE LOG





JOB No. S-1186

BOREHOLE No. 6

DRAWING No. 6

PROJECT Bridge Site,
 LOCATION Marten River at Highway 69,
STA. 273+50, 17' L.

2" O.D. SPLIT TUBE 
 2" I.D. SHELLEY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING No. 1

F & S SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FEET	PENETRATION RESISTANCE 250 FT. LB. BLOW/FT. 20 40 60 80				NATURAL MOISTURE CONTENT AND ATTERING LIMITS % DRY WEIGHT			NATURAL UNIT WEIGHT P.C.F.
				SHEAR STRENGTH K.S.F.				5	10	15	
	WATER Nov. 21st, 1971	939.6									
			10								
	SILTY SAND-dense, grey, frequent gravel sizes, wet.	925.6									
			20								No Rec.
	SILTY SAND TILL-very dense, grey; frequent gravel sizes, well graded, wet; frequent cobbles and gravel sizes.	919.6									No Rec.
			30								No Rec.
	SILT TILL-very dense, grey; frequent gravel sizes, moist, frequent cobbles; becoming very sandy by 40 ft. depth.	911.6									155.2
			40								145.7
			50								148.1
			60								No Rec.
			70								No Rec.
			80								No Rec.
			90								153.4
			100								152.7
	CLAYEY SILT TILL-very dense, grey, frequent gravel and cobble sizes, moist.	879.6									155.5
			60								No Rec.
			70								No Rec.
			80								156.5
	END OF BOREHOLE	871.2									
			70								
			80								
			90								
			100								

NOTES:

- 1) Borehole advanced with conventional diamond drill. Running casing and core barrel for full depth to penetrate cobbles and boulders.
- 2) Borehole started Nov. 21st and completed Nov. 23rd, 1971.








BOREHOLE LOG





JOB No. 5-1186

BOREHOLE No. 7

DRAWING No. 7

PROJECT Bridge Site,
 LOCATION Marten River at Highway 64,
 STA. 274+00, 17'L.

2" O.D. SPLIT TUBE 
 2" I.D. SHELLEY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT
 OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING No. 1

F & S	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FEET	PENETRATION RESISTANCE		NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT			NATURAL UNIT WEIGHT P.C.F.	
					300 FT. LB. 20	BLOWS/FT. 40 60 80					
		WATER Nov. 24th, 1971	939.6					5	10	15	
				10							
		SAND and GRAVEL-dense, grey, well graded; frequent cobbles and small boulders, wet.	926.8	20							No Rec.
											No Rec.
		SILTY SAND TILL-very dense, grey; frequent gravel sizes and cobbles.	914.6	30				X			167.5
		SILT TILL-very dense, grey, frequent gravel sizes and cobbles.	903.6	40				X			156.0
		Becoming very sandy by 45 ft. depth		50					X		158.2
		CLAYEY SILT TILL-very dense, grey; frequent small gravel sizes and cobbles, moist.	881.6	60					X		144.1
		END OF BOREHOLE	873.1	70						X	142.0
		NOTES:		80							
		1) Borehole advanced with conven-									
		tional diamond drill. Running									
		casing and core barrel for full									
		depth to penetrate cobbles and									
		boulders.									
		2) Borehole started Nov. 24th									
		and completed Nov. 26th, 1971.									
				90							
				100							

NOTES:

- 1) Borehole advanced with conventional diamond drill. Running casing and core barrel for full depth to penetrate cobbles and boulders.
- 2) Borehole started Nov. 24th and completed Nov. 26th, 1971.



William Trow Associates Ltd.

BOREHOLE LOG

JOB No. S-1186

BOREHOLE No. 8

DRAWING No. 8

PROJECT: Bridge Site,
 LOCATION: Marten River at Highway 64,
 STA. 274+35, 18' L.

2" O.D. SPLIT TUBE
 2" I.D. SHELBY TUBE
 2" DIA. CONE
 PUSHED
 VANE TEST AND SENSITIVITY (S)

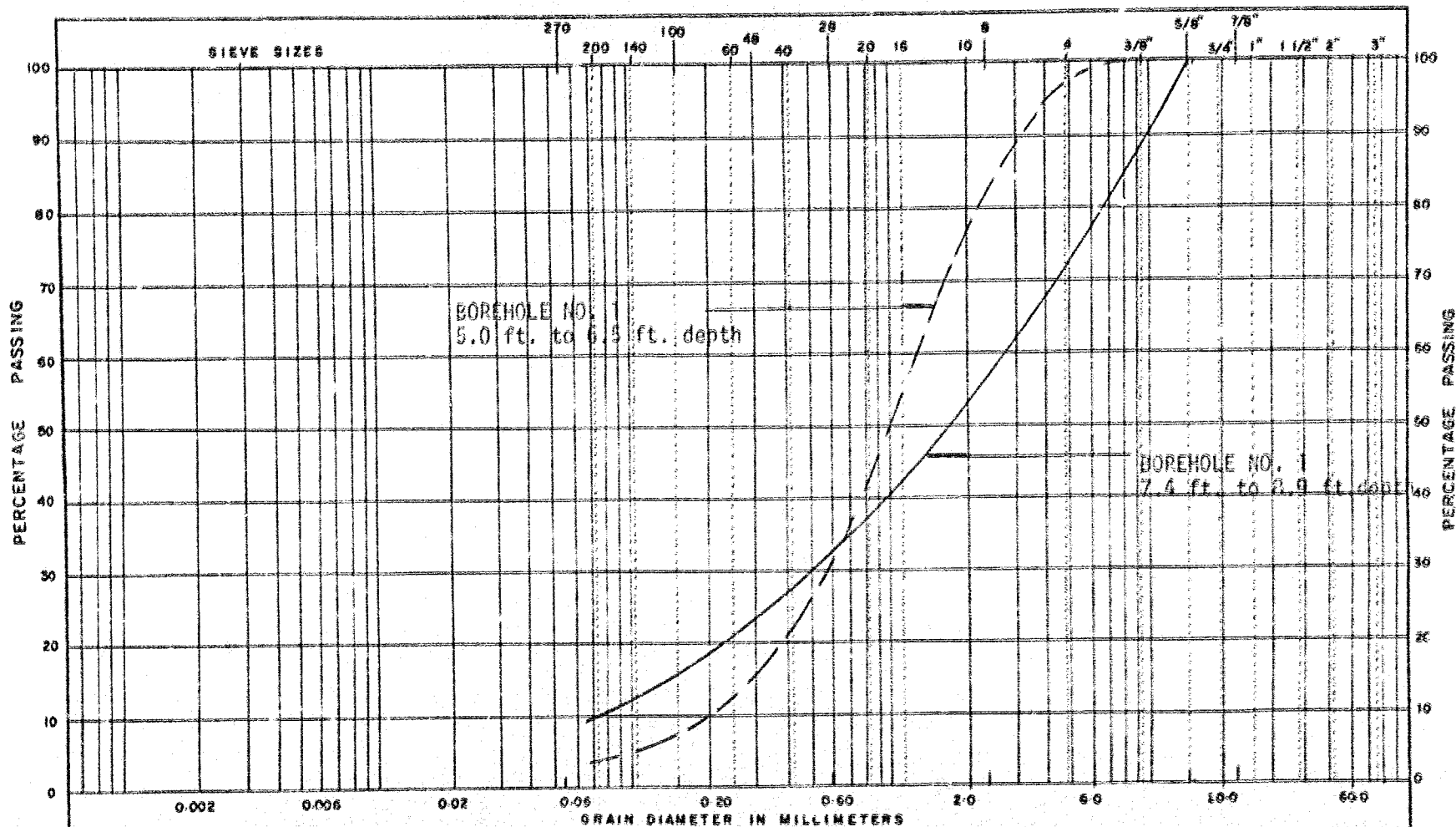
NATURAL MOISTURE
 PLASTIC AND LIQUID LIMIT
 UNDRAINED TRIAXIAL AT
 OVERBURDEN PRESSURE
 % STRAIN AT FAILURE

HOLE LOCATION AND DATUM SEE DRAWING NO. 1

F & G	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FEET	PENETRATION RESISTANCE 300 FT. LB. BLOWS/FT.				NATURAL MOISTURE CONTENT AND ATTEBERG LIMITS % DRY WEIGHT			NATURAL UNIT WEIGHT P.C.F.
					20	40	60	80	5	10	15	
		WATER Nov. 17th, 1971	939.6									
		SAND-loose, brown, organic, wet; becoming sand and gravel by 7 ft. depth; small boulder at 9 ft. depth.	937.7									
		SANDY SILT TILL-very dense, grey; frequent cobbles and gravel sizes, moist.	929.6	10						X		142.7
			924.6							X		146.9
		SILTY SAND TILL-very dense, grey; frequent gravel, cobbles and small boulders, moist.		20								No Rec.
												No Rec.
				30						X		149.4
												No Rec.
				40						X		No Rec.
			897.6									156.2
		CLAYEY SILT TILL-very dense, grey; frequent gravel sizes and cobbles, moist.		50						X		No Rec.
												153.3
				60								146.3
										X		144.6
				70								No Rec.
		END OF BOREHOLE	878.6	60						X		149.1
		NOTES: 1) Borehole advanced with conven- tional diamond drill. Running casing and core barrel for full depth to penetrate cobbles and boulders. 2) Borehole started Nov. 17th and completed Nov. 23rd, 1971.		70								
				80								
				90								
				100								



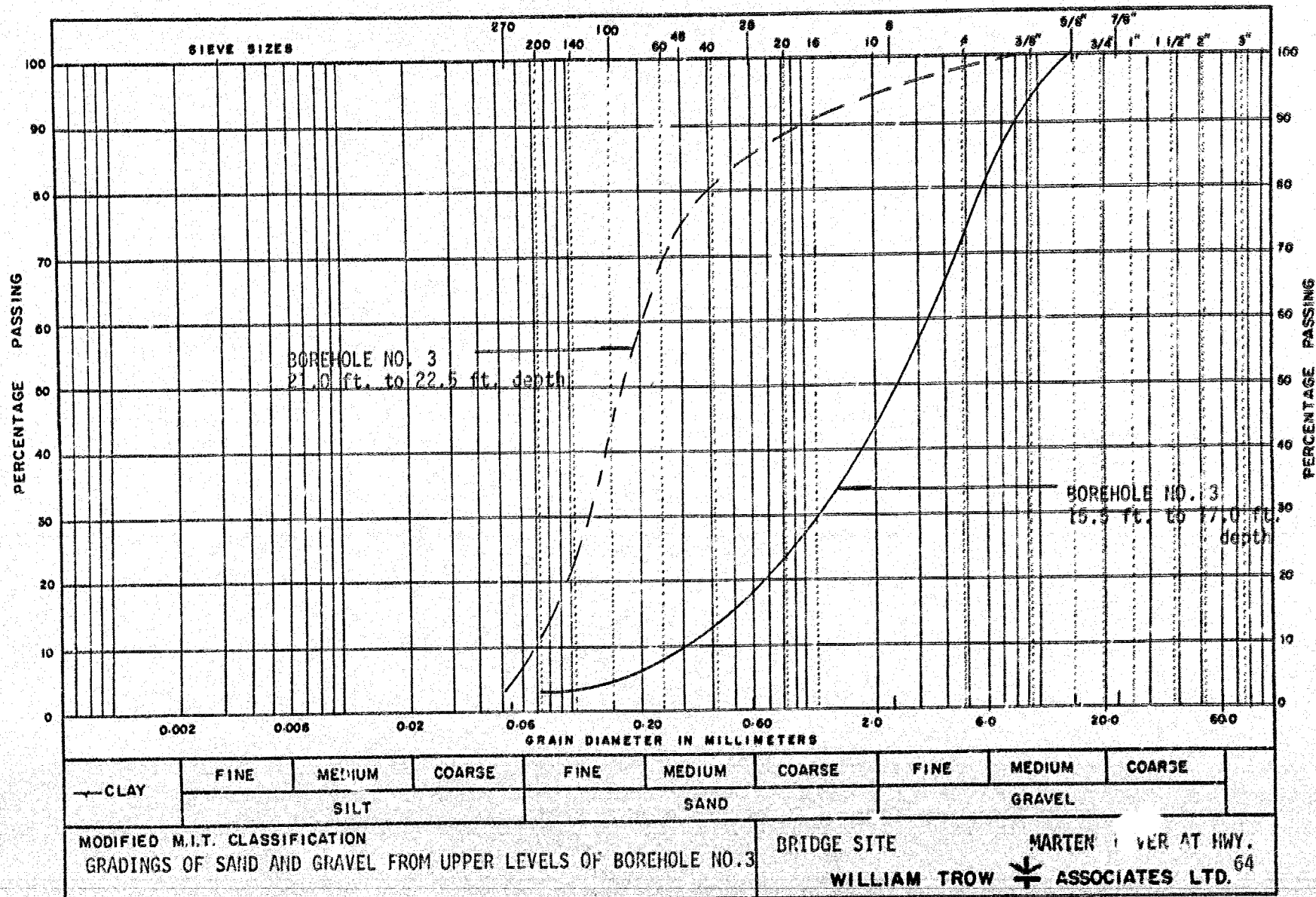
MECHANICAL ANALYSIS



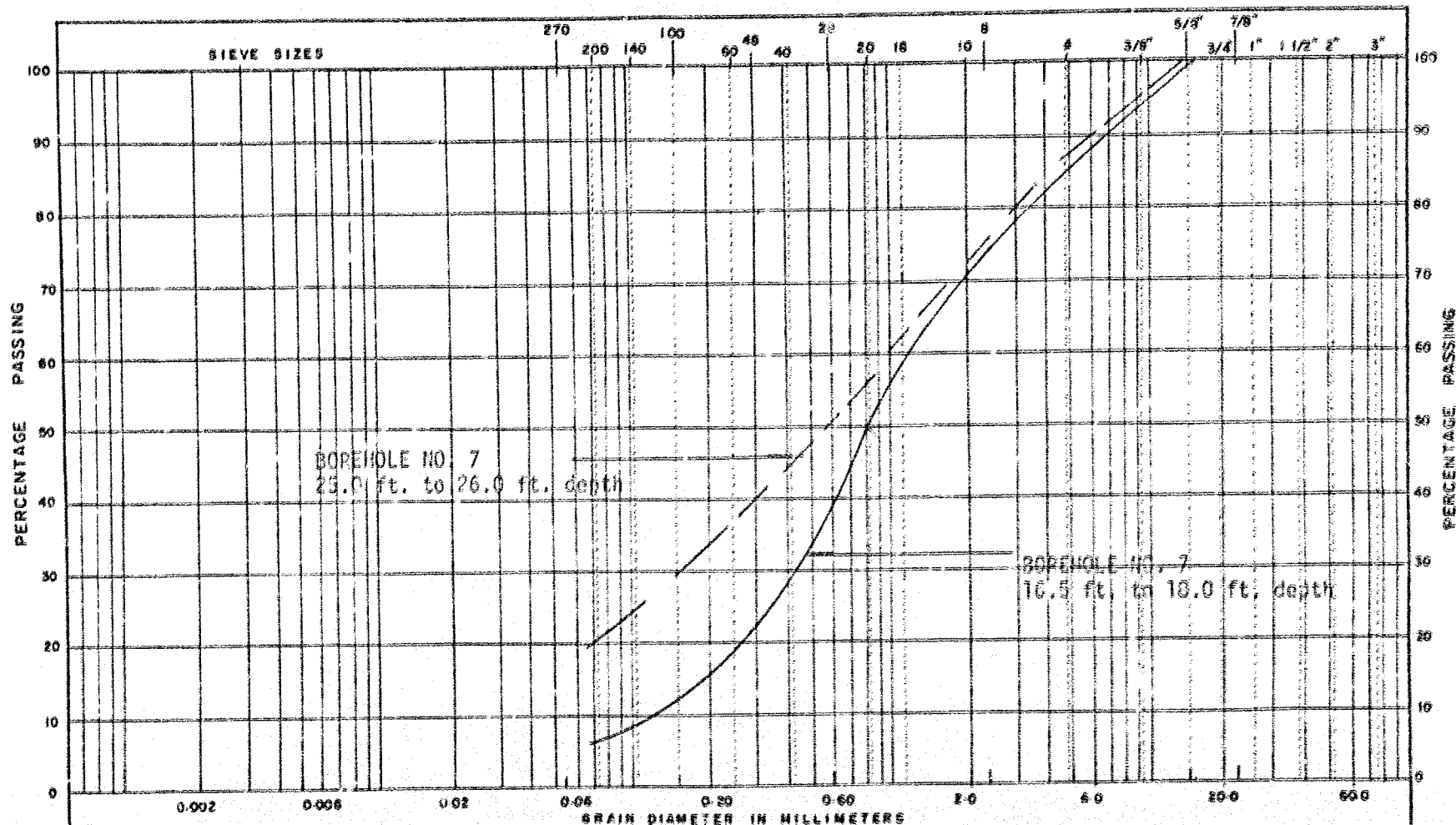
MODIFIED M.I.T. CLASSIFICATION
GRADINGS OF SAND AND GRAVEL FROM UPPER LEVELS OF BOREHOLE NO. 1


BRIDGE SITE MARTEN RIVER AT HWY.
WILLIAM TROW & ASSOCIATES LTD. 64

MECHANICAL ANALYSIS



MECHANICAL ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION GRADING OF UPPER SAND AND GRAVEL AND UNDERLYING SILTY SAND TILL FROM BOREHOLE NO. 7						BRIDGE SITE WILLIAM TROW  MARTEN RIVER AT HWY. ASSOCIATES LTD. 64			




DIARY EXTRACTS
PROPOSED CROSSING
MARTEN RIVER
TWP. OF SISK, DISTRICT OF NIPISSING
W.P. 68-68

October 27th, 1971

Drilling Contractor - Canadian Longyear Limited arrived at site at 7:30 a.m. and started to assemble raft. At 4:00 p.m. raft assembled and drill (50S1) set up on borehole #2 - Contractor went to town of field to pick up some timber required for the raft.

WILLIAM TROW ASSOCIATES (SUDBURY) LTD.


H.R. Krzywicki, P. Eng.

HRK/nmd



DIARY EXTRACTS
PROPOSED CROSSING
MARTEN RIVER
TWP. OF SISK, DISTRICT OF NIPISSING
W.P. 68-68

October 28th, 1971

Drilled and sampled to 21.4 ft. depth below water surface (depth of water 12.9 ft.). Encountered sand and gravel with relatively large boulders (24 in. dia.). Drilling time to-date 18½ hrs.

October 29th, 1971

Drilled and sampled to 38.0 ft. Subsoil appears to be boulders and cobbles in till matrix. Drilling time to-date 28½ hrs.

October 30th, 1971

Drilled and sampled to 59.0 ft. Subsoil generally as previously described to 53 ft. depth. Change to silt till at 53 ft. depth. Partial borehole log enclosed. Drilling time to-date 37 hrs. (28½ drilling hrs.)

HRK/nmd

WILLIAM TROW ASSOCIATES (SUD.) LTD.

HR Krzywicki
HR Krzywicki, P. Eng.

P.S. I just talked to fieldman (Nov. 1, 1971). We are down to 92.2 feet in till with cobbles and 2 feet into what we suspect is bedrock. Till is very dense and contains frequent cobbles. Please review your design proposal in the light of our findings. If we decide to proceed as planned we will require an additional drill on site to meet deadline.

HRK.

562 Notre Dame
Sudbury, Ontario
675-1600

William Trow Associates

Soil Mechanics
Consultants

W. A. Trow
MSc. MEIC. P. Eng.
K. Peaker
PhD. MEIC. P. Eng.



(Sudbury) Ltd.

Henry R. Krzywicki, M.Eng., P.Eng.
Manager

November 1st, 1971.

Project: S-1186

Mr. Murty S. Devata,
Foundation Section,
Material and Testing Office,
Room 107, Lab Bldg.
DOWNVIEW, 464, Ontario.

RE: Geotechnical Services
Proposed Crossing
Marten River,
Twp. of Sisk, District of Nipissing
WP 68-68

Dear Sirs:

Enclosed are the extracts of the field notes for October
28th, 29th and 30th, 1971.

Should you have any queries regarding our comments, please
do not hesitate to contact our office.

Yours very truly,

WILLIAM TROW ASSOCIATES (SUDBURY) LTD.


H.R. Krzywicki, P. Eng.

HRK/mod

Encls.

Marten River Bridge,
W.P. 68-68-01, Site 43-2
1.4 Miles South of Highway 11,
Highway #64, District #13.

The existing timber truss bridge over Marten River, supported on rock filled timber cribs has outlived its functional purpose. The structure is about 172 ft. long and 32 ft. wide. In 1973 Bailey reinforcement was placed over the existing deck to accommodate logging trucks of up to 55 ton weight. The daily traffic count is estimated at 500 vehicles.

The new structure will be built on offset line, thus existing bridge will be used during construction.

The new bridge has one 110 ft. span and is 34 ft. wide, accommodating two lane traffic. Four steel plate girders 4.0 ft. deep and 7 1/2" concrete deck are designed for composite action. The abutments are supported on rock fill. Granite rock fill is available within the right-of-way and will be used for this structure. Therefore, expected settlement will be acceptable.

Bridge soffit elevations provided satisfy navigation requirements for pleasure boating. Bridge span chosen is acceptable for Hydrology requirements.

MEMORANDUM

TO: Mr. J. C. McAllister (2)
Regional Bridge Planning Supervisor
Northern Region
North Bay, Ontario

FROM: Foundations Office
Design Services Branch
Central Bldg., Downsview

ATTENTION:

DATE: December 8, 1971

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Marten River Bridge
at Hwy. 64 (Line 'A')
Twp. of Sisk - Dist. 13 North Bay
W.O. 71-11138 -- W.P. 68-68

Enclosed please find complete foundation investigation report for the above-mentioned project. The report has been prepared by William Trow Associates.

We believe you will find the factual information to the design and construction of the proposed structure and approaches sufficient for your purposes.

AGS:mt
Attach.

A. G. Stermac
A. G. Stermac
Principal Foundation Engineer

cc: Messrs. D. W. Farren
B. R. Davis
A. Rutka
H. McArthur
R. S. Chapman
B. J. Giroux
R. Northwood
G. A. Wrong
B. A. Singh

Foundation Office ✓
Documents.

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

Copy for the information of A. STERMAC

Mr. J. McAllister,
Regional Structural Planning Engineer,
Northern Region, North Bay.

Structural Office,
West Building, DOWNSVIEW.

September 20, 1972

Marten River Bridge,
W.P. #68-68-01, Site #43-2,
Hwy. #64, District #13.

71-11-138

Attached herewith are prints of the Preliminary Bridge
Plan Drawing D-43-2-P1 for the above-mentioned structure.

The estimated cost of the proposed structure is
\$121,000.00 which includes tender, materials, engineering and
sundry construction.

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

CSG:dp
Attach.

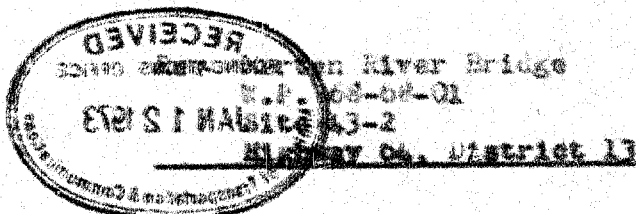
C. S. Grebski,
Structural Design Engineer.

cc. A. McKim,
B. R. Davis,
A. Stermac,
J. Anderson,
R. Murphy

Mr. C.S. Grabaki,
Structural Design Engineer,
West Building.

Structural Maintenance Section
W.E. Birch

January 12, 1973



2-11-14²

In answer to your memo of 12/1/54, re preliminary plan of the subject structure, please advise as follows:

From past history of various bridges (especially limestone) we do not recommend a rock fill design. The existing Marten Lake Bridge (Site 45) on Highway 101 was constructed on this rock fill and has experienced serious settlements caused by unequal settlement.

We have also had to make corrections to the plans for the Bay Bridge on the 1000 Island Expressway, High Falls and over Muskegon River, Highway 11 and the St. Joseph Island truss bridge. All these structures were founded on limestone rock fill.

W.D. Birch,
Structural Maintenance Engineer.

WLB/maz
C.C. A.E. Argue
A. Sternac

30A Jan 73

Copy for the information of A. STERNAC

W. D. Birch,
Structural Maintenance Engineer,
Rm. 324, Central Bldg.

Structural Office,
West Building, DOWNSVIEW.

January 16th, 1973.

Marten River Bridge,
W.P. #68-68-01, Site #43-2,
Hwy. #64, District #13.

In reply to your memorandum regarding the use of limestone rock fill at the approaches, we have been in contact with the Region on this matter.

In their opinion, there is very little limestone in this area and, in all probability, the rock used for fill will be granite which is the predominant type at this site.

We do not expect any problems with the granite rock fill. There will, no doubt, be some settlement of the rock fill, but this should be within tolerable limits. As this is a single span bridge, a small amount of settlement will not be structurally harmful.

The comments and views of the Foundation Section should be obtained on this matter. Perhaps we could get together with Mr. A. Stermac to discuss this. This type of structure is being used more frequently now due to its economy and ease of construction, hence, this question should be resolved.

CSG:dp

C. S. Grebski,
Structural Design Engineer.

cc. A. E. Argue,
A. Stermac. ✓



31 L - 36



ADDITIONAL BOREHOLES
PROPOSED STRUCTURE AT
HIGHWAY NO. 64 AND MARTEN RIVER
NORTH BAY, ONTARIO

71-11-138 (C)
cont 76-80

Prepared for:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

WILLIAM TROW ASSOCIATES LIMITED
Toronto, Hamilton, Sudbury
London, Sarnia

Project: J 7182/S1186
February 14th, 1973

90 Milvan Drive,
Weston, Ontario.
749-1290

THE TROW GROUP

CONSULTING
ENGINEERS



WILLIAM TROW ASSOCIATES LIMITED

Soil Mechanics Consultants
90 Milvan Drive, Weston 486, Ontario
749-1290

W.A. Trow, M.Sc., M.E.I.C., P.Eng.
K. Peaker, Ph.D., M.E.I.C., P.Eng.

Project: J 7182/S1186

February 14th, 1973

Mr. A.G. Stermac,
Principal Foundations Engineer,
Ministry of Transportation and
Communications,
Foundations Office,
Design Services Branch,
Downsview, Ontario.

Attention: Mr. M. Devata, P.Eng.

Additional Boreholes
Proposed Structure at
Highway No. 64 and Marten River
North Bay, Ontario

Dear Sirs,

Since the submission of our foundation report No. S 1186 for the proposed structure at the crossing of Marten River at Highway No. 64, the alignment for Highway No. 64 has been changed from line 'A' to line 'B' which is approximately 50 feet west of line 'A'. This shift in alignment necessitated additional subsoil information.

The request for additional field investigation was given verbally by Mr. M. Devata, Supervising Foundations Engineer on January 15th, 1973. The additional field work to be carried out was specified by the Ministry as follows:

Two borings supplemented with dynamic cone penetration tests had to be done at approximate locations shown on our revised drawing. The borings had to penetrate into the very dense granular glacial till to a depth of 10 feet to 15 feet. If peat was encountered, its depth and extent should be investigated.

The above field investigation was carried out between February 1st and February 6th, 1973. A diamond drill rig adapted for soil sampling purposes was mounted on a raft. The boreholes were advanced by wash boring techniques. Samples in the overburden were obtained by using a two-inch O.D. split-spoon barrel which was hammered into the soil in accordance with the Standard Penetration Test. The same procedure was used to advance the dynamic cone penetration test.

The soil and river level conditions encountered at the boring locations are presented in the self-explanatory borehole logs. The location of the boreholes and elevations of the river level was surveyed in the field by personnel from William Trow Associates Limited, Sudbury Office. The elevations shown on the revised drawing and borehole logs are referenced to a geodetic datum.

Laboratory tests conducted on soil and water samples included grain size distribution, pH and sulphate content.

SUBSOIL CONDITIONS

The predominant stratum encountered at both the borings is a coarse, granular sand and gravel till with frequent granite cobbles and boulders. The thickness of this glacial till was not fully penetrated; it was, however, proved to have a thickness in excess of 28 feet. Standard penetration testing carried out with this deposit gave 'N' values which ranged from 28 blows/foot to in excess of 100 blows/foot. Based on this, it is estimated that the relative density of this material varies from compact to very dense. Typical grain size curves for the samples of this stratum are enclosed in the letter.

At borehole 9, the granular glacial till was overlain by 6.5 feet of loose to compact, brown, silty sand. The upper two inches of this

material were mixed with black fibrous peat. Four feet of soft to firm peat were also encountered at borehole 10 immediately above the granular glacial till.

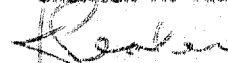
The river level measured on February 1st and February 3rd, 1973, was found to be at elevation 93⁰.35 feet. Chemical tests performed on river water samples gave a pH value of 6.8 and traces of sulphates, i.e. less than 150 ppm.

We hope that the above factual data will be adequate for your design requirements. If you have any queries, please do not hesitate to contact this office.

Yours very truly,

WILLIAM TROW ASSOCIATES LIMITED


Shaheen A. Ahmad, P.Eng.


K.R. Peaker, P.Eng.

SAA:EF
Enc.

Dist: Ministry of Transportation and
Communications,
Att: Mr. M. Devata, P.Eng.,
Supervising Foundations Engineer

(11)

BOREHOLE LOG

JOB No. 7182

BOREHOLE No. 9

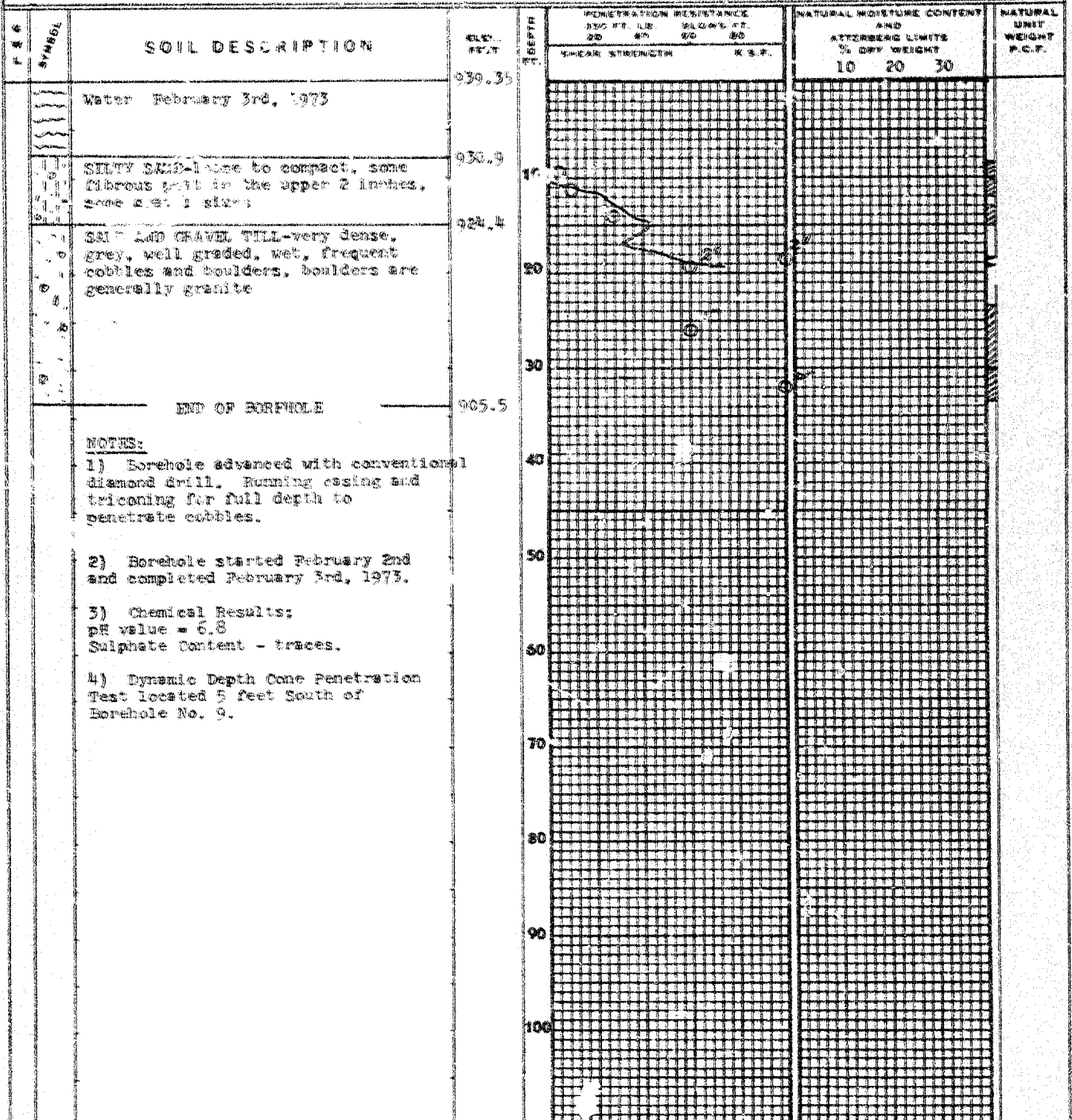
DRAWING No. 1

PROJECT Bridge Site, Marten River at HWY. 64
 LOCATION Sta. 273+26, 26' West of
 Proposed Bridge.

2" O.D. SPLIT TUBE
 2" I.D. EMERY TUBE
 2" DIA. CONE
 PUSHED
 VANE TEST AND SENSITIVITY (SI) +5

NATURAL MOISTURE
 PLASTIC AND LIQUID LIMIT
 UNDRAINED TRIAXIAL AT
 OVERBURDEN PRESSURE
 % STRAIN AT FAILURE

HOLE LOCATION AND DATUM SEE DRAWING NO. 1



BOREHOLE LOG

JOB No. J 7182

BOREHOLE No. 10

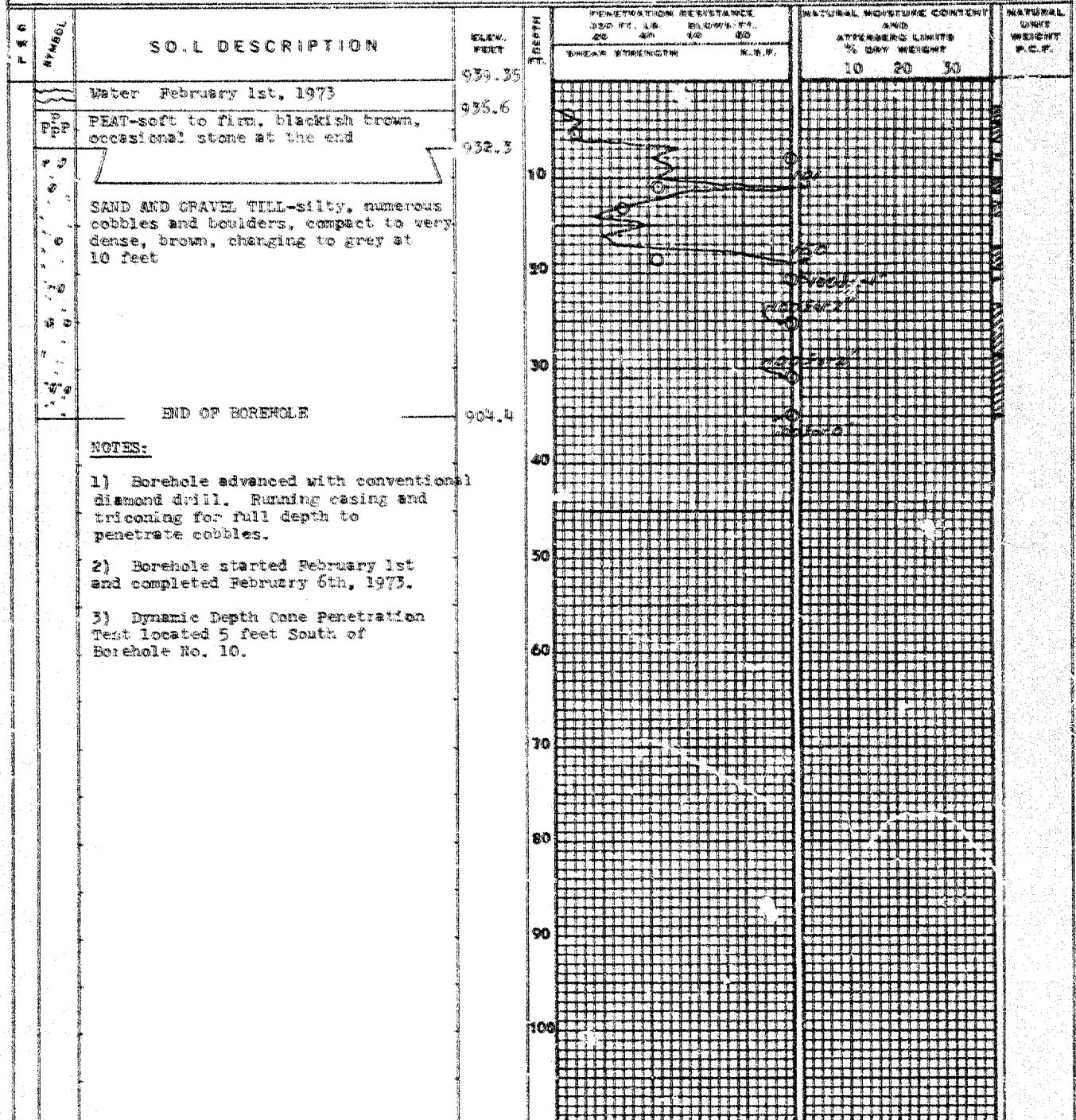
DRAWING No. 2

PROJECT Bridge Site, Marten River at Hwy. 64
 LOCATION Sta. 273+26, 26' West of
Proposed Bridge.

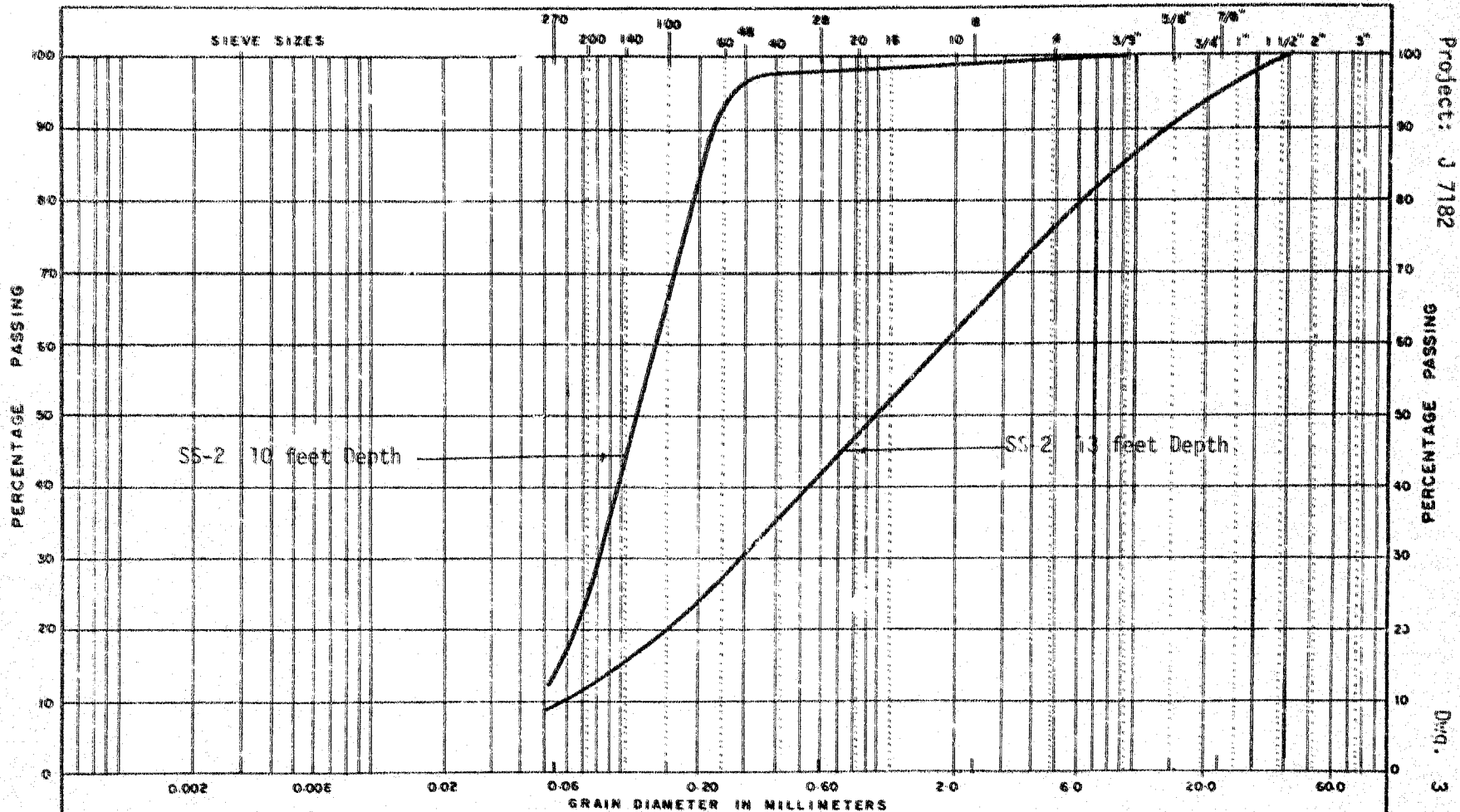
2" O.D. SPLIT TUBE
 2" A.D. SHELLEY TUBE
 2" DIA. CONE
 PUNED
 VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE
 PLASTIC AND LIQUID LIMIT
 UNDRAINED TRIAXIAL AT
 OVERBURDEN PRESSURE
 % STRAIN AT FAILURE

HOLE LOCATION AND DATUM SEE DRAWING No. 1



MECHANICAL ANALYSIS

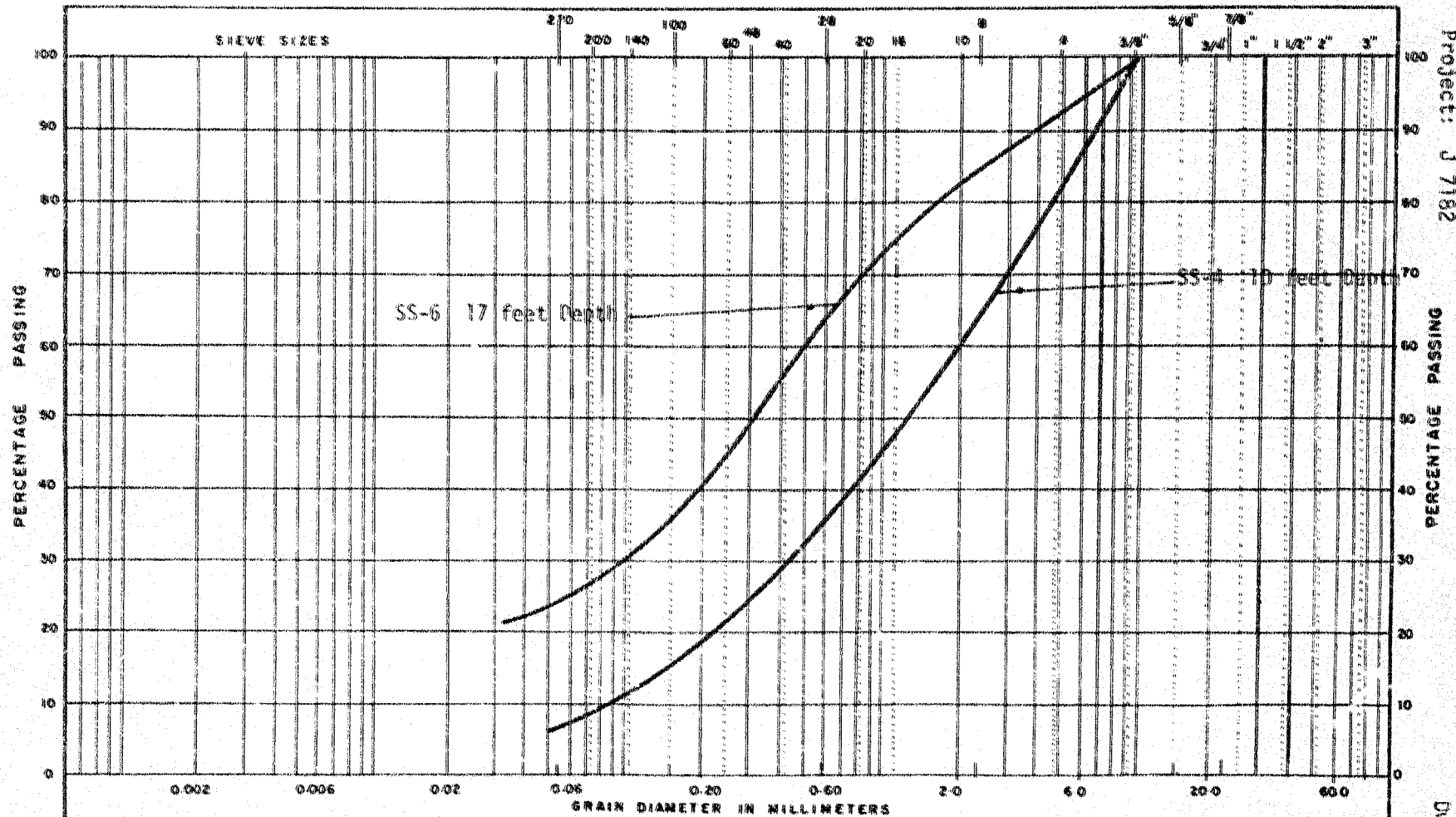


MODIFIED M.I.T. CLASSIFICATION
Typical Soils, Borehole 9

Marten River, Ontario.

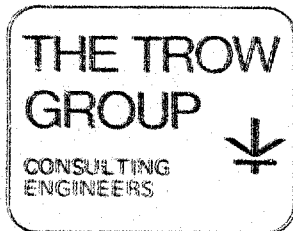
WILLIAM TROW  ASSOCIATES LTD.

MECHANICAL ANALYSIS



DWG. 4

CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION						Marten River, Ontario.			
Sand and Gravel, Borehole 10						WILLIAM TROW & ASSOCIATES LTD.			



WILLIAM TROW ASSOCIATES LIMITED

Soil Mechanics Consultants
90 Milvan Drive, Weston 486, Ontario
749-1290

W.A. Trow, M.Sc., M.E.I.C., P.Eng.
K. Peaker, Ph.D., M.E.I.C., P.Eng.

Project: J 7182

February 23rd, 1973

Mr. A.G. Stermac,
Principal Foundations Engineer,
Ministry of Transportation
and Communications,
Foundations Office,
Design Services Branch,
Downsview, Ontario.

Attention: Mr. M. Devata, P.Eng.

Extent of Peat
Proposed Structure at
Highway No. 64 and Marten River
North Bay, Ontario

Dear Sirs,

Please find enclosed the results of probes conducted to determine the depth of peat in the area of concern. It appears from the results that the peat concentration is in the north bank. The thickness of the peat in this area ranges from 8 inches to 3.5 feet. Only 2 inches to 3 inches of peat were found in the southern banks of the river.

Should you have any queries, please do not hesitate to contact this office.

Yours very truly,

WILLIAM TROW ASSOCIATES LIMITED

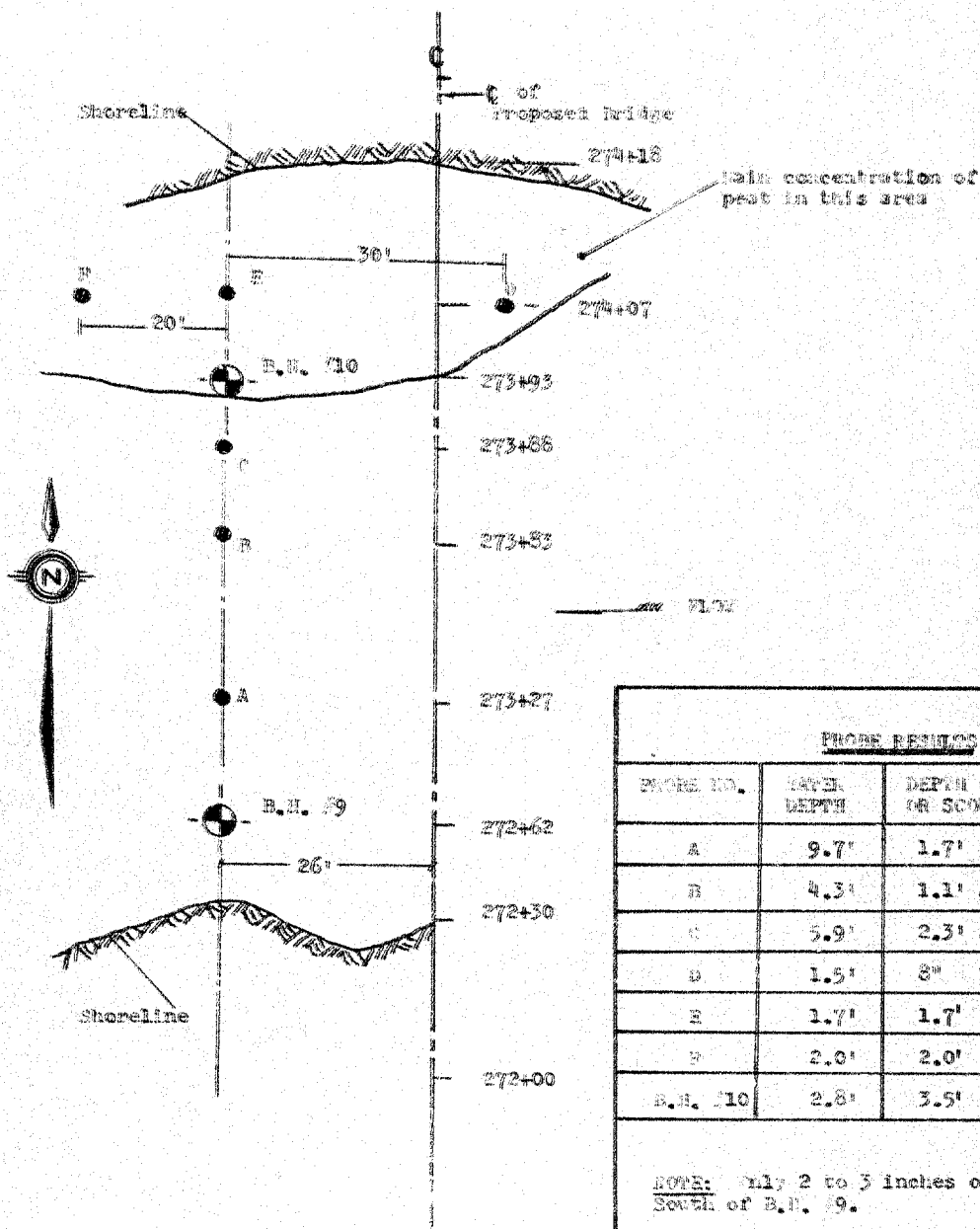
Shahen Ahmad
Shahen A. Ahmad, P.Eng.

K.R. Peaker
K.R. Peaker, P.Eng.

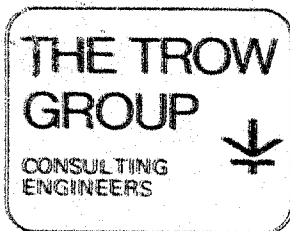
SAA:EF

Enc.

Dist: Ministry of Transportation
and Communications (11)
Att: Mr. M. Devata, P.Eng.



NOTES



WILLIAM TROW ASSOCIATES LIMITED

Soil Mechanics Consultants
90 Milham Drive, Weston 486, Ontario
749-1290

W.A. Trow, M.Sc., M.E.I.C., P.Eng.
K. Peaker, Ph.D., M.E.I.C., P.Eng.

February 28th, 1973.

Project: J 7182

Mr. A.G. Stermac,
Principal Foundation Engineer,
Ministry of Transportation and Communications,
Foundations Office,
Design Services Branch,
Downsview, Ontario.

Attention: Mr. M. Devata, P. Eng.

Revision of Dwg. 1
Proposed Structure at
Highway No. 64 and Marten River
North Bay, Ontario

Dear Sirs:

Please find enclosed the revised Dwg. 1. We apologize for any inconvenience caused by this delay.

Yours very truly,

WILLIAM TROW ASSOCIATES LIMITED

Shaheen Ahmad
Shaheen A. Ahmad, P. Eng.

SAA:dej
Dist: Ministry of Transportation
and Communications
Attn: Mr. M. Devata, P. Eng.

(11)

✓ WP 68-68-1
T

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. J. C. McAllister, (2)
Regional Structural Planning Supervisor,
Northern Region,
North Bay, Ontario.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE:

March 6, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT: Additional Boreholes for Proposed
Marten River Bridge at Hwy. #64 (Line 'B'),
Twp. of Sisk - District #13 (North Bay)
W.O. 71-11138 (C), W.P. 68-68, Site #43-2

Since the submission of foundation investigation report prepared by soil consultants, William Trow & Associates, the alignment for Hwy. #64 has been changed from Line 'A' to Line 'B' which is approximately 50 ft. west of Line 'A'. This shift in alignment necessitated additional subsoil information.

Enclosed please find additional foundation investigation report for the above-mentioned project and this should be read in conjunction with the original foundation investigation report prepared by the soil consultant. It should be noted that the peat encountered in the vicinity of the north bank should be completely subexcavated prior to the placement of approach fills.

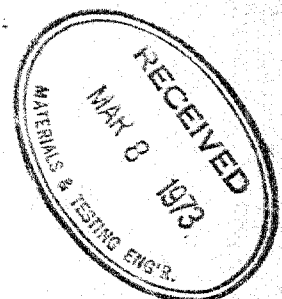
Should you have any queries, please do not hesitate to contact this Office.

MD/ao
Attch.

cc: E. J. Orr
B. R. Davis
A. Rutka
H. McArthur
G. E. French
B. J. Giroux
J. E. Gruspier
G. A. Wrong
B. A. Singh

Foundations Files
Documents

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: J. McAllister,
Reg. Structural Planning Supervisor,
NORTHERN REGION, North Bay.

FROM: Structural Office,
West Building,
Downsview.

ATTENTION:

DATE:

May 22nd, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT:

Marten River Bridge,
W.P.68-68-01, Site 43-2,
Highway 64, District 13.
(REDESIGN)

71-11136 (c)
~~72-11-148~~

n.D

Attached herewith are prints of the revised Preliminary Bridge Plan Drawing D-43-2-P2 for the above-mentioned structure.

The revised estimated cost of the proposed structure is \$110,000 which includes tender, materials, engineering, and sundry construction.

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



C.S. Grebski,
Structural Design Engineer.

CSG:do
Attach.

cc. B. R. Davis,
W. D. Birch,
A. E. McKim,
A. Stermac (2),
J. Anderson,
R. Murphy,
M. Stoyanoff,

20 Comments
On Drawings
7/12 June/73



DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 312-364

DIST. 13 REGION NORTHERN

W.P. No. 68-68-01

CONT. No. 76-80

W. O. No. 71-11138

STR. SITE No. 43-002

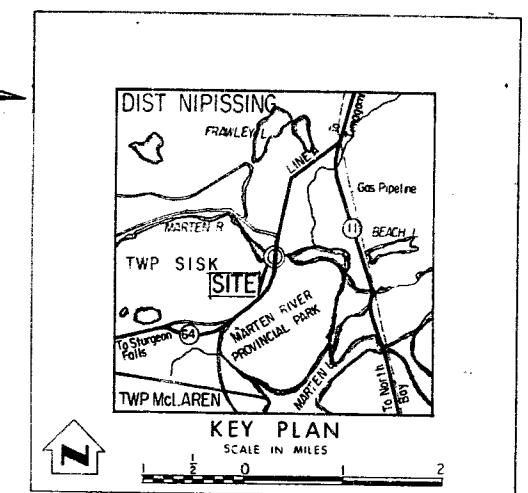
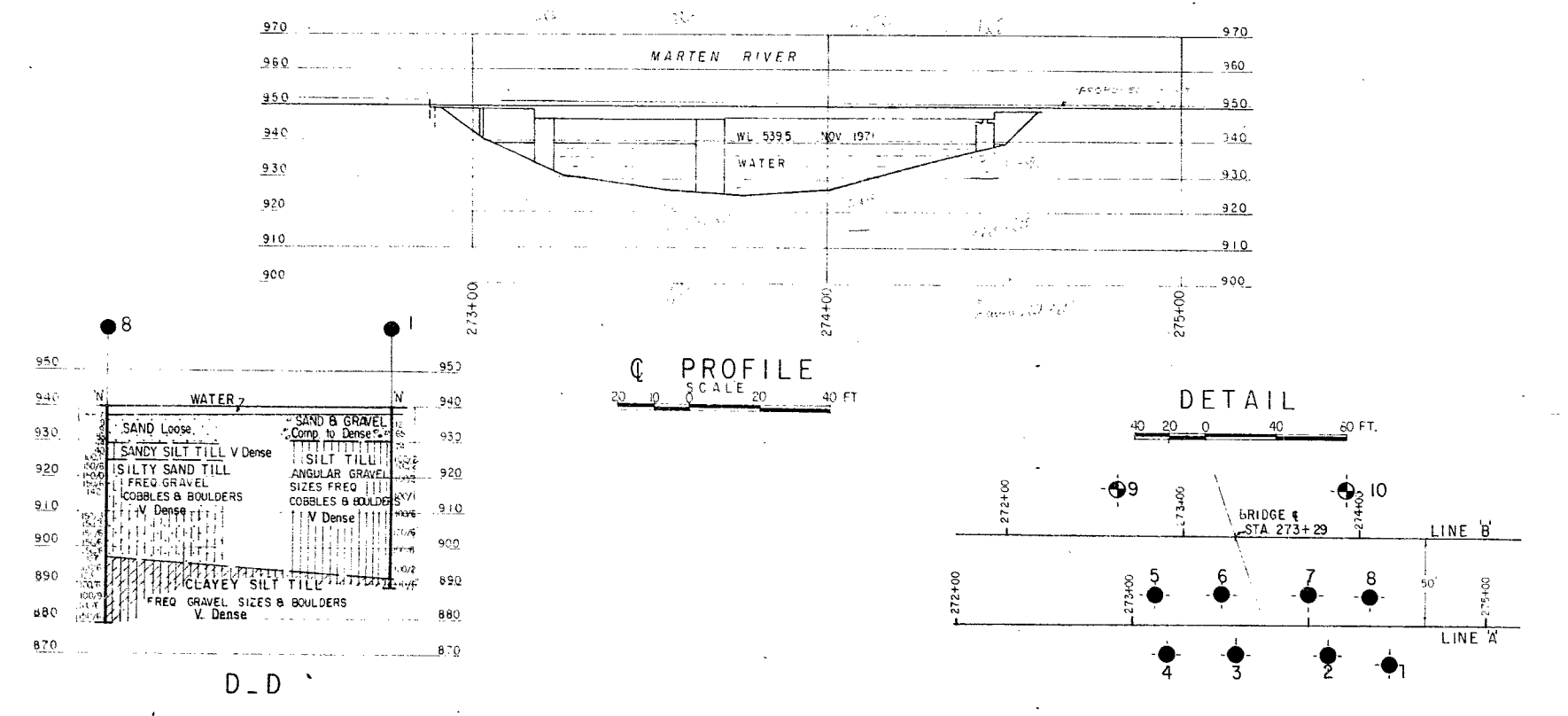
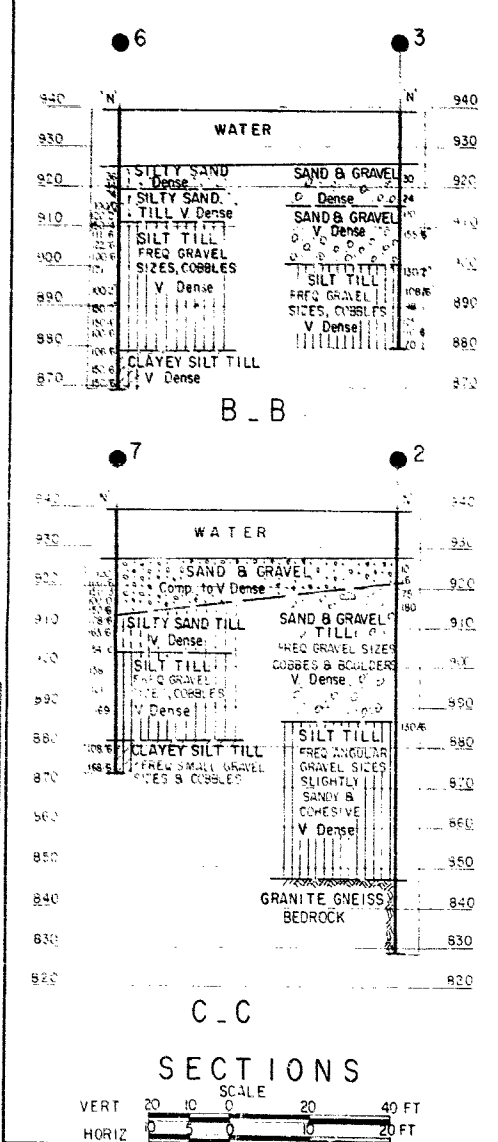
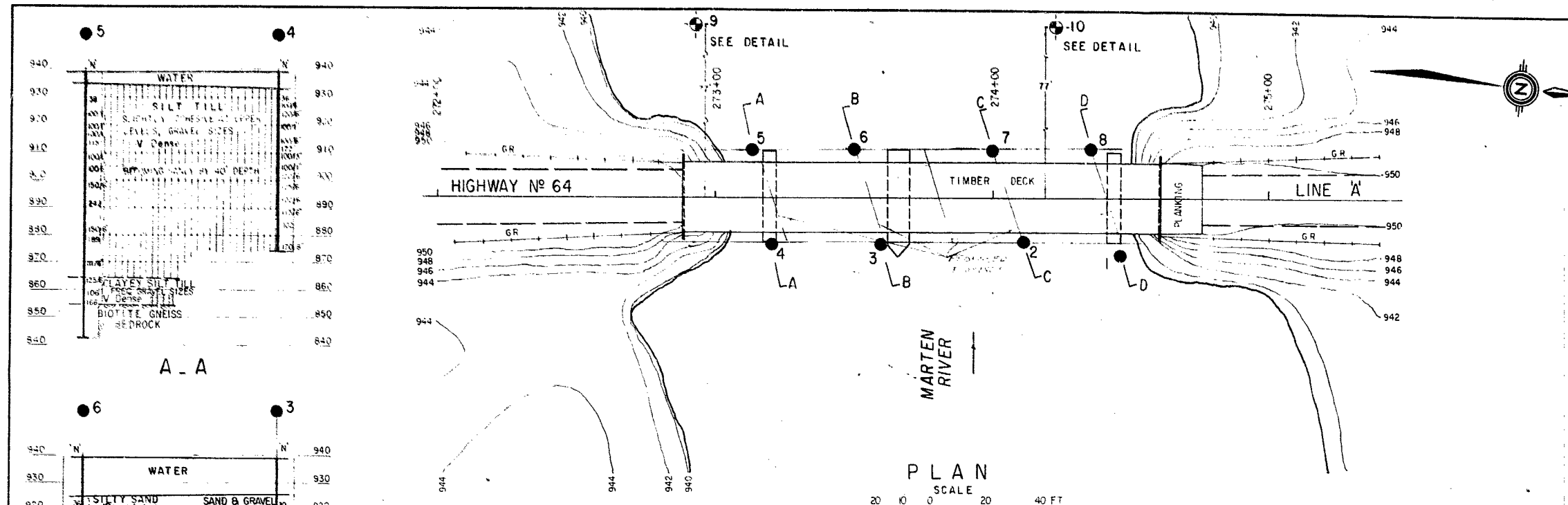
HWY. No. 64

LOCATION X-ING AT MARTEN RIVER

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 3

REMARKS: Documents to be included before

completion



LEGEND			
●	Bore Hole		
⊕	Cone Penetration Test		
⊗	Bore Hole & Cone Test		
—	Water Levels established at time of field investigation NOV 1971		

NO	ELEVATION	STATION	OFFSET
1	939.5	274+46	210' RT
2	939.5	274+11	166' RT
3	939.5	273+59	170' RT
4	939.7	273+20	170' RT
5	939.6	273+13	170' LT
6	939.6	273+50	170' LT
7	939.6	274+00	170' LT
8	939.6	274+35	150' LT
9	939.3	273+00	170' LT
10	939.3	274+00	170' LT

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

REVISIONS		FEB 1978 HOLE & CONE 9 & 10 ADDED	
DATE	BY	DESCRIPTION	

WILLIAM TROW ASSOCIATES LIMITED
 DEPARTMENT OF TRANSPORTATION AND COMMUNICATION
 DESIGN SERVICES BRANCH - FOUNDATION OFFICE

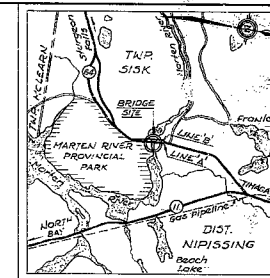
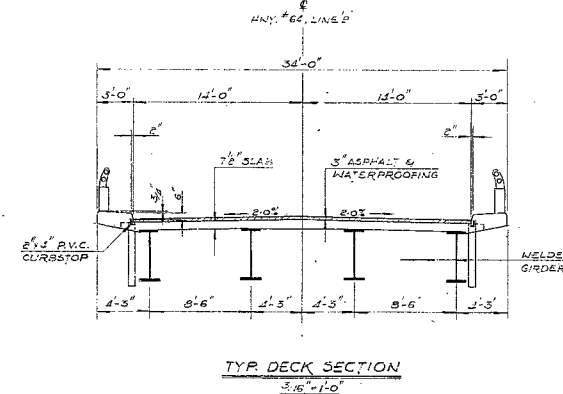
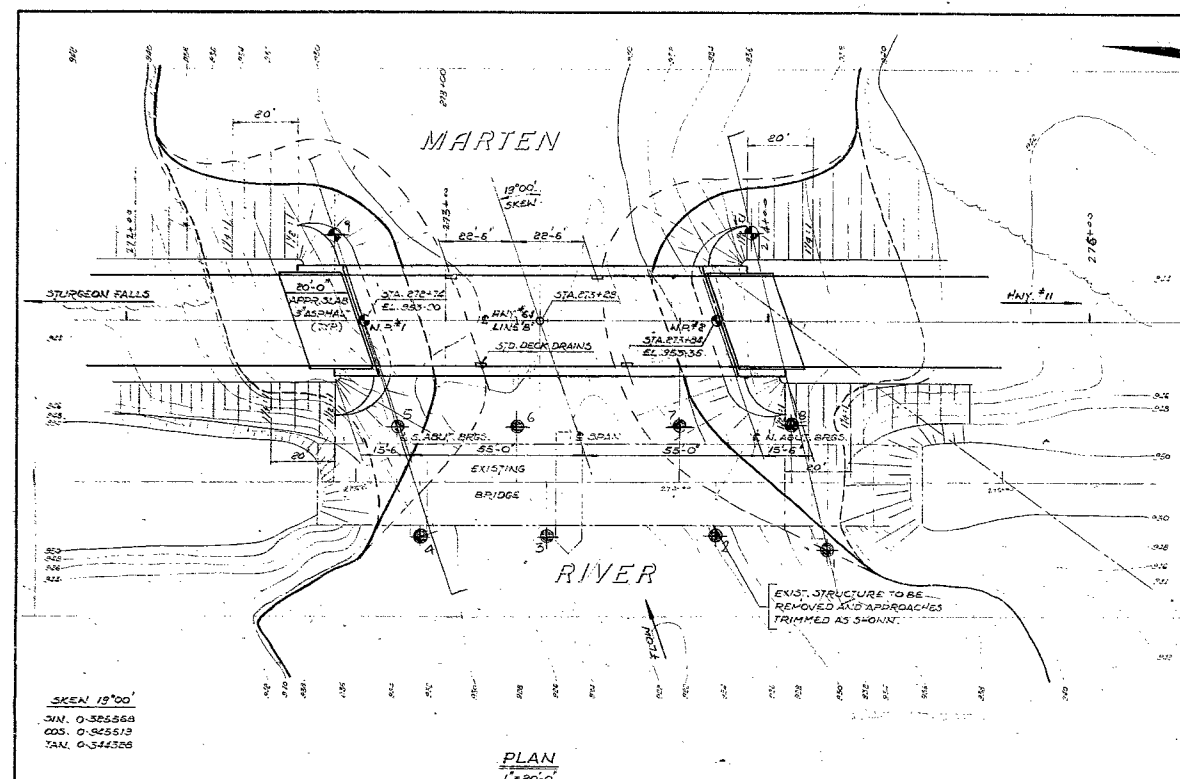
MARTEN RIVER 31L-36
 GEOCREP No.

HIGHWAY NO. 64 LINE 'A' REV'N DIST NO. 13
 DIST. NIPISSING
 TWP. SISK LOT. CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD HK	CHECKED	WP NO. 68-68-01	DRAWING NO.
DRAWN EFK	CHECKED	JOB NO.	S-1186/7182
DATE DEC 1971	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	CONT NO.		

PRINCIPAL FOUNDATION ENGINEER



NOTES:

CLASS OF CONCRETE
DECK, CURBS OVER DECK & PARAPET WALLS - 4000 P.S.I.
REMAINDER - 3000 P.S.I.
CLEAR COVER TO REINFORCING STEEL
FOOTINGS & ABUTMENTS - 3"
DECK - TOP - 2", BOTTOM - 1"
CURBS - 2"
AND/OR AS NOTED ON DRAWINGS
CONSTRUCTION NOTES
THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$.
NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

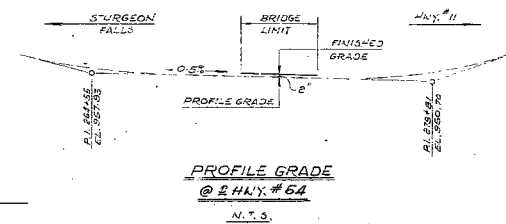
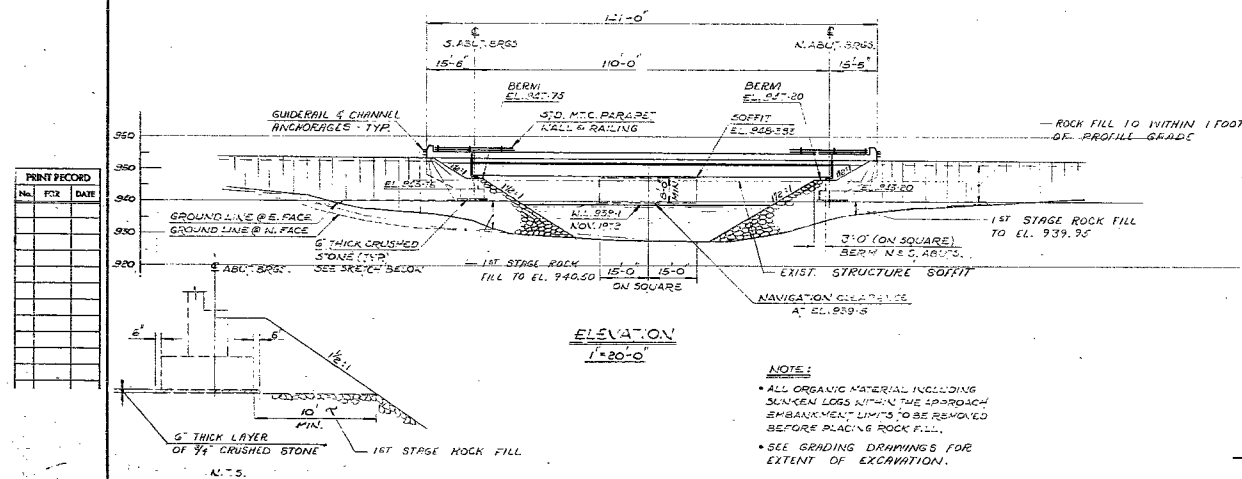
LIST OF DRAWINGS

- 43-2-1 GENERAL LAYOUT
- 43-2-2 BORE HOLE LOCATIONS & SOIL STRATA
- 43-2-3 FOOTING LAYOUT & REINFORCING
- 43-2-4 ABUTMENT DETAILS & REINFORCING
- 43-2-5 STRUCTURAL STEEL I
- 43-2-6 STRUCTURAL STEEL II
- 43-2-7 DECK DETAILS & REINFORCING
- 43-2-8 PARAPET WALL DETAILS
- 43-2-9 STANDARD STEEL PARAPET RAIL
- 43-2-10 APPROACH SLABS
- 43-2-11 STANDARD DETAILS I
- 43-2-12 STANDARD DETAILS II
- 43-2-13 AS CONSTRUCTED ELEV. & DIM.

CONCRETE QUANTITIES:

CONCRETE IN ABUTMENTS AND WING WALLS - 80 CY. YD.
CONCRETE IN DECK - 100 CY. YD.
CONCRETE IN PARAPET WALLS - 18 CY. YD.
CONCRETE IN APPROACH SLABS - 38 CY. YD.

STRUCTURAL STEEL - 57 TONS

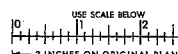


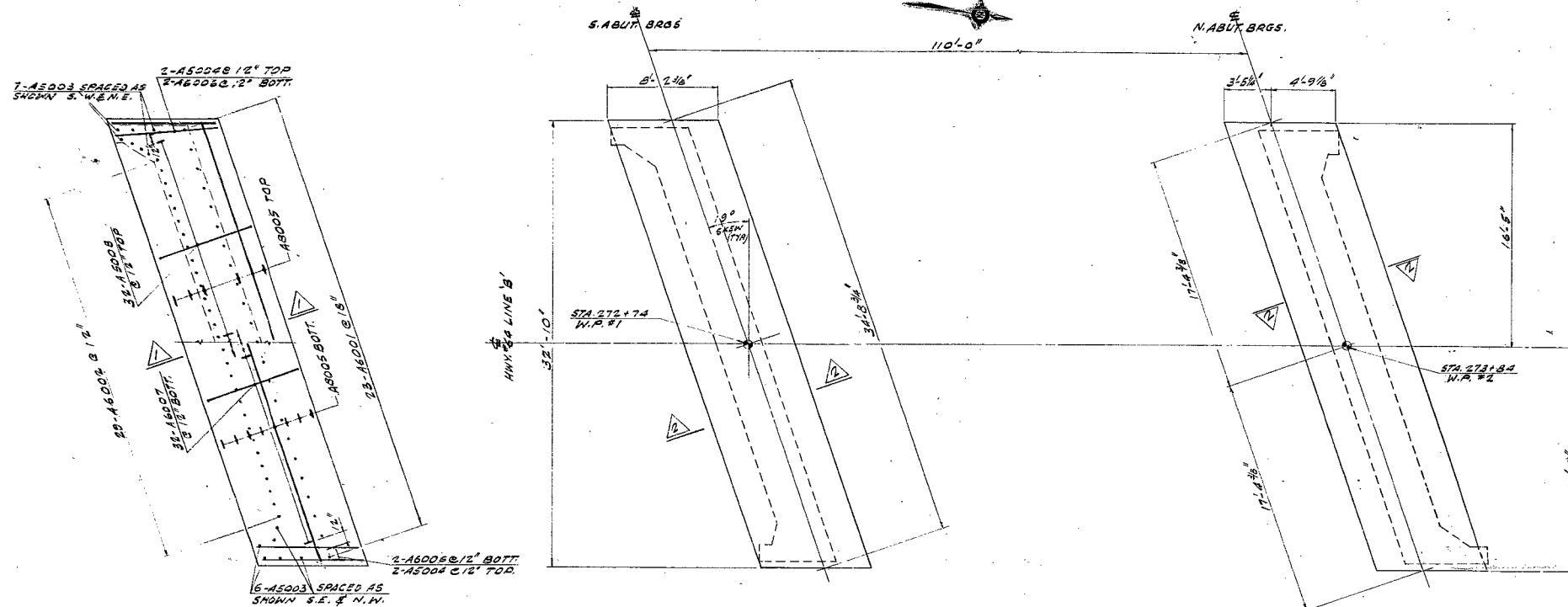
314-36
GEODESIC No.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO			
MARTEN RIVER BRIDGE			
KING'S HIGHWAY No. 64		DIST. No. 15	
DIST. NIPISSING		LOT	
TWP. SISK		CON.	
GENERAL LAYOUT			
APPROVED	DESIGNED	CHECKED	CONTRACT No.
DATE	DATE	DATE	W.P. No.
JULY '73	JULY '73	JULY '73	68-65-01
SITE No. 43-2			SHEET 1

FOR REDUCED PLAN

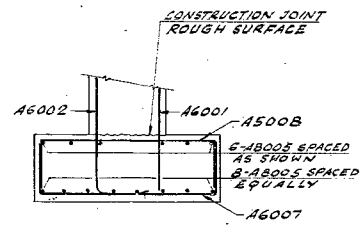




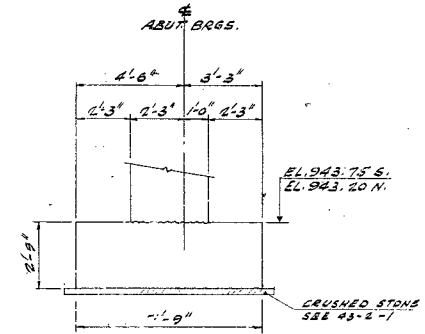
PLAN
SCALE: 1/4" = 1'-0"

NOTE:
SOUTH ABUTMENT SHOWN
REINFORCING IN NORTH
ABUTMENT SIMILAR
EXCEPT OPPOSITE HAND.

FOOTING LAYOUT
SCALE: 1/4" = 1'-0"



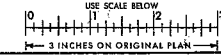
REINFORCING
SCALE: 1/4" = 1'-0"



DIMENSIONS
SCALE: 1/4" = 1'-0"



FOR REDUCED PLAN
USE SCALE BELOW



31436 GEOGRAPHIC No.	
REVISIONS	DATE BY DESCRIPTION
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO	
MARTEN RIVER BRIDGE	
KING'S HIGHWAY No. 64	DIST. No. 13
DIST. NIPISSING	LOT CON.
FOOTING LAYOUT & REINFORCING	
APPROVED <i>[Signature]</i>	CONTRACT No.
DESIGN <i>[Signature]</i>	W.P. No. 68-68-01
DRAWING <i>[Signature]</i>	CHECK <i>[Signature]</i>
DATE 7/24/73	LOADING 425 20-44
SITE No. 43-2 SHEET 3	