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CONSULTING GEOTECHNICAL ENGINEERS

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30M3-150-1

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FOUNDATION INSPECTION
CONSTRUCTION OF HIGHWAY 406 BRIDGE
TWELVE MILE CREEK
CITY OF ST. CATHERINES
REGIONAL MUNICIPALITY OF NIAGARA

Our Reference No. R80168
MTC Contract No. 80-44
August, 1980

Prepared For:

Scorpio Engineering Ltd.,
P.O. Box 386,
St. Catherines, Ontario.
L2R 6T7

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(1) copy - Robert Dodds Limited

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1.0 INTRODUCTION

Part of the contract of Scorpio Engineering Limited (henceforth referred to as Contractor) is the construction of the foundations for the abutments and piers of the bridge carrying Highway 406 across Twelve Mile Creek in the City of St. Catherines, Ontario. The Key Plan on Drawing No. 1 illustrates the site location and the extent of the contract. The contract has been let by the Ontario Ministry of Transportation and Communications (henceforth referred to as MTC), Contract Number 80-44, WP Nos: 46-74-13 SB Bridge; 46-74-40 NB Bridge; 46-74-39 Retaining Walls.

The extent of the project that applies to this Contractor is shown on Drawing No. 2, which is a reproduction of Sheet 108 of the tender documents put out by MTC. The proposed footing foundation design is shown on our Drawing No. 3, which is reproduced from Sheet 110 of the contract drawings. Details of the soil conditions encountered in soils borings carried out by MTC are shown on Drawing No. 2, a reproduction of Sheet 108 of the contract drawings.

Robert Dodds Limited, consulting geological and geotechnical engineers, was retained by the Contractor to examine the foundation conditions being encountered in construction

1.0 INTRODUCTION (cont'd)

of the footing for Pier No. 2 on the northbound lane of the bridge.

The method of construction was to drive a sheetpile diversion wall around the exterior of Pier 5 on the southbound lane and Pier 2 on the northbound lane. This provides a working area where the current in the river is relatively still. On Sheet 58 of the contract drawings, river velocity is shown to be an expected maximum of 7.7 fps with the diversion structure in place. Normal water velocity without the diversion in place is shown to be 4.9 fps.

The method of construction of the pier footings requires driving of a sheetpile enclosure or cell within the diversion structure, of approximately 27 ft. by 27 ft. in inside dimension through the reported (by MTC) overlying organic silt and sand and red silt to clayey silt till to approximately elevation 246 ft. The Borehole Logs indicated that at this elevation, in Pier 2 and Pier 5, sound Queenston shale would be encountered. These boreholes were referred to as Boreholes, Nos. 41S and 42S and are reproduced from MTC documents as Drawings, Nos. 4 and 5 in this report.

1.0 INTRODUCTION (cont'd)

The subsurface materials that are of concern in this investigation are the silt to clayey silt till reported by MTC to lie above the red Queenston shale. The descriptions of these strata provided by MTC are reproduced below:

Silt to Clayey Silt

This deposit lies between the silty clay to clayey silt deposit and the underlying bedrock. In thickness it varies from 10 feet under the stream channel to from 25 to 30 feet where no removal by erosion has taken place. It is of glacial origin and consists of silt with lesser quantities of sand, clay and gravel. The origin of the material is primarily the underlying Queenston Shale which gives it a characteristic red colour. The lower portion of the deposit is composed almost entirely of shale fragments which have been compressed together to form a breccia or shale till. As shown on the log sheets, this shale till was on occasion cored and partially recovered employing both NXL and NV3 corebarrels. The deposit is hard to very dense with Standard Penetration 'N' values generally in excess of 100 blows per foot. Atterberg Limit Tests as shown in Figure 2 indicate a low plasticity generally in the silt to clayey silt transition zone. The natural moisture content is below the plastic limit and ranges from 8 to 12 percent.

Queenston Shale

Queenston shale bedrock was encountered under the till layer between elevations 240 and 245. It is red in colour and dips gently toward the south. The shale is generally sound but in places the upper 2 or 3 feet shows some weathering. Periodic limestone beds generally having a thickness of less than 3 inches but occasionally reaching a foot were encountered.

2.0 SITE CONDITIONS

The conditions encountered as reported by the Contractor, together with the conditions observed by the undersigned, at Pier No. 2 of the northbound lane are reported herein. The reported and observed sequence of operations carried out by the Contractor is included.

Sheetpiles for the cell were driven by the Contractor in anticipation of penetrating to approximately elevation 246 ft., whereupon the foundation investigation carried out by MTC indicated that sound shale would be encountered. The borehole log for Borehole 42S located within the cell is reproduced as Drawing No. 4 of this report. The details are also shown on Drawing No. 2. Instead of penetrating what was expected to be a silt to clayey silt till, the sheetpiles encountered refusal at approximately elevation 251 ft. The excavation was dewatered and the Contractor reported that the exposed material appeared to be rock rather than till. The undersigned was requested to attend the site on August 12th, 1980 to inspect the material to determine whether or not it was rock or till. However, on the evening of August 11th, 1980 the cell was flooded and upon arriving at the site on August 12, 1980, it was not possible to examine the material due to the flooding. Attempts to dewater this cell throughout the day were not successful.

2.0 SITE CONDITIONS (cont'd)

Material was placed by clam shell from the shore of the site into the water around the outside of the cell. Attempts were made to dewater on August 13th, 1980. However, a head differential of only 1.5 ft. between the river level and water level in the cofferdam could be obtained. It was noted at this time that the river levels outside the cofferdam dropped by approximately 5 ft. within a space of $\frac{1}{2}$ to 1 hour.

During these operations, the Contractor reported that after the sheetpiles had met practical refusal, the delay of a day allowed further redriving of several feet. The piles were redriven to an average elevation of 248 ft. and more material was placed around the exterior of the cell by dumping through the water, as before. Subsequent dewatering operations were successful and on August 15th, 1980, the exposed material in the base of the cell was examined by the undersigned.

The exposed material at the base of the excavation varied in elevation from approximately 250 ft. to 246 ft. and consisted of massive blocks of rock. Photos, Nos. 2 to 15 inclusive, illustrate the rock conditions encountered. The existence of rock is clearly shown in the bench that was left along the west side of the cell and which

2.0 SITE CONDITIONS (cont'd)

extends for a distance of approximately 15 ft. along the central part of the west cell wall. Vertically, the rock bench extends from approximately elevation 250 ft. at the top to elevation 247 ft., where excavation had stopped. The material is Queenston shale with characteristic thin, grey bands. These bands are approximately 1 to 2 inches in thickness.

The structure of this rock is blocky, indicative of weathering and construction disturbance. Material exposed by hand excavation maintains integrity as illustrated in Photo No. 10. This rock degrades rather quickly with exposure to air as indicated in the Photos, Nos. 11 to 14 inclusive, which show the exposed bench shortly after dewatering and after approximately 5 hours exposure to air.

A test pit was excavated at the location shown on Drawing No. 7. This pit was extended to approximately elevation 243 ft. Throughout the depth of the excavation, the material consisted of rock. The material could be broken up relatively easily with a mechanical spade. The broken up material had no matrix. Photos, Nos. 16 to 19 inclusive, illustrate. The sides of the test pit excavation showed very dry powdery material when the rock was broken by hand.

2.0 SITE CONDITIONS (cont'd)

The spaces between some of the blocks of rock were infilled with the reddish silty clay to clayey silt till. A sample of this till was taken from approximately elevation 251 ft. The characteristics are shown in the form of a gradation curve on Drawing No. 6. The material exhibited a low plasticity to feel and is dense, intact and well graded. Photo No. 20 illustrates.

The apparent location of Borehole 42S was encountered as shown on Drawing No. 7, which is 9 ft. from the south wall and 11 ft. from the west wall of the cell. The Contractor reported that the top of the borehole at approximately elevation 255 ft. was intact. At the time of inspection by the undersigned, excavation had taken place to approximately elevation 249 ft. At that elevation, the sides of the borehole were relatively intact with shale pieces having fallen into the bottom of the borehole. Thin infillings of clay could be felt along the sides below the water which appear to be shale weathered in place. A similar thin seam was encountered in the bedrock bench on the west wall and is shown on Photo No. 15 at the tip of the pencil. Clear water was flowing at a slow rate out of this borehole and is illustrated in Photo No. 21. The measured water temperature was 56°F, whereas the river water temperature was

2.0 SITE CONDITIONS (cont'd)

72° F at the same time. The impact of the borehole upon a piece of the weathered shale taken from the elevation 255 ft. by the Contractor is shown in Photo No. 22.

3.0 DISCUSSION

The bottom of the cell at Pier 2, on the northbound lane of Highway 406, crossing Twelve Mile Creek in the Municipality of St. Catherines, Ontario, encountered rock rather than silt to clayey silt till as indicated on the contract drawings. The depths of the rock inspected by the undersigned varied from approximately elevation 250 ft. to 243 ft. The Contractor reported similar material encountered at elevation 255 ft. This rock is identified as the red Queenston shale common to this area. This shale was laid down in the Upper Ordovician period of the Paleozoic era. The surface has generally been altered by weathering and by glacial action. The Lake Erie-Ontario lobe of the last great glaciers retreated to the east from this area.

Some of the rock is blocky with some silt till infillings in places between the rock openings or fractures.

A sample of this silt till was taken and is distinct from the rock. The classification of till is based upon a definition quoted in "Soil Mechanics in Engineering Practice" by Terzaghi and Peck, 1967, as below:

"Till is an unstratified glacial deposit of clay, sand, gravel and boulders. It covers part of the rock surface in those regions which were glaciated during the ice age."

3.0 DISCUSSION (cont'd)

The rock encountered falls within the definition of rock as per MTC Form 902, September, 1978, as quoted below:

"Rock: Natural beds or massive fragments of the hard, stable cemented parts of the earth's crust (igneous, metamorphic or sedimentary in origin, may or may not be weathered), includes boulders having a volume of 1 cubic yard or greater. "

The apparent location of Borehole 42S was encountered in the excavation of the cell with the collar and sides of the borehole intact from approximately elevation 255 ft. (as reported by the Contractor) to elevation 247 ft. The bottom two feet were observed by the undersigned. Should this portion of the borehole have been in till, it is not expected that the borehole would have maintained its integrity since drilling in June of 1978. The swift current at the river surface, together with the upward flow of water from the borehole, would have caused collapse of the portion of the borehole in till. The borehole is able to maintain its integrity due to the surrounding rock. This water flowing out of the borehole does not appear to originate from 12 Mile Creek as evidenced by differences in clarity and temperature.

The contract documents and the Borehole Logs indicate that sound Queenston shale would be encountered at approximately elevation 246 ft. The test pit in the cell at

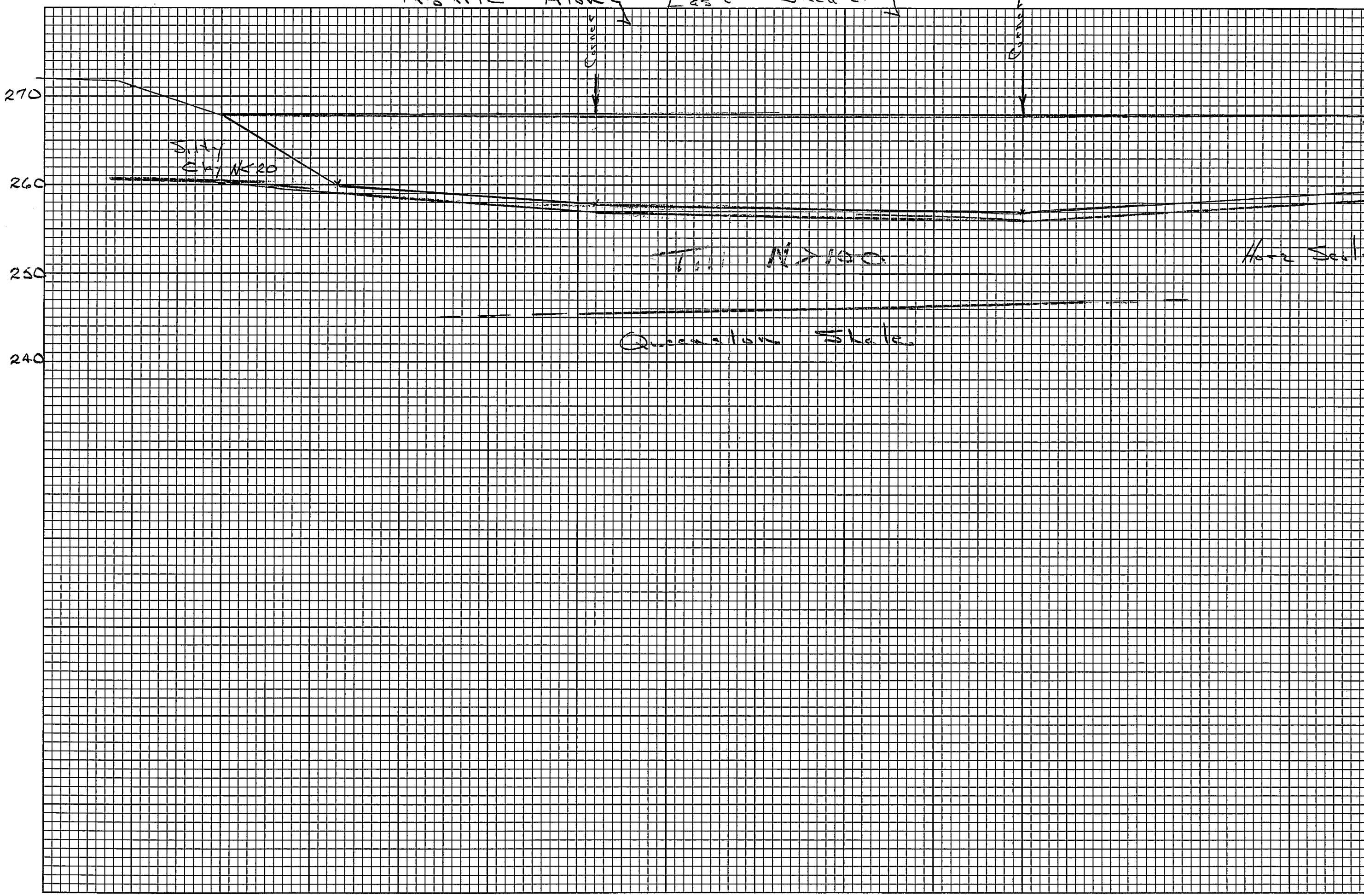
3.0 DISCUSSION (cont'd)

Pier No. 2 in the northbound lane was excavated to approximately elevation 243 ft. without encountering sound Queenston shale. The rock encountered is shale. However, it is relatively soft and easily broken. In addition, the flow of water from the borehole collar would indicate that there are open joints or fractures in the rock.

It is our opinion that footings of piers founded in this material rather than sound Queenston shale may experience detrimental settlements. Construction has indicated that the rock is easily broken up and weathers very quickly when exposed to air. The rock mass has open fractures to allow passage of water and could compress under loading.

Alternate design could be considered, such as steel H piles augered and then driven to refusal at greater depth or cast-in-place concrete piles that obtain their capacity from socketing in underlying sound rock.

Profile Along East Sheeting



Horizontal Scale 1"=20'

The curve shown here as shown on the plans is for minimum requirement for the stability and stability from the purpose of meeting a smooth flow of 12 cubic feet during construction work.

If the construction will be in concrete the sheet pile will be used for the purpose of still provide all data and material to ensure the stability of the wall during the construction of the pile foundation and pier.

Curve shown in wall

Profile Along West Sheeting

47 0780
270
260
250
240

Clayey Silt
Organic
N < 10

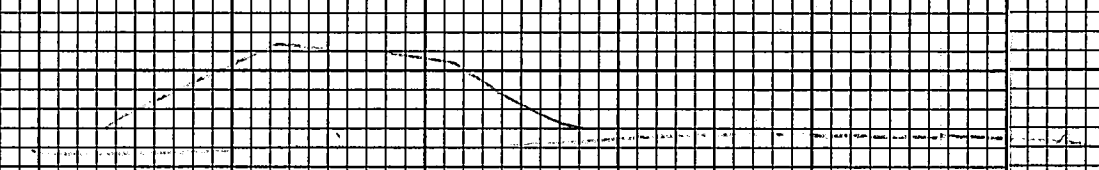
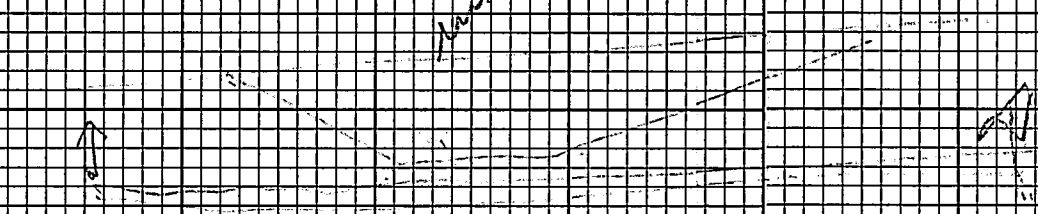
T111 - N > 100

Queenston Shale

Clayey Silt - Organic in places
N < 10

Horizontal Scale 1" = 20'

Horizontal is about 1/20



4.0 SUMMARY

The material inspected by the undersigned in the cellular cofferdam, at Pier No. 2 of the northbound lane of Highway 406, is rock, as per MTC Specification Form 902, rather than soil (till) as described in the foundation investigation by MTC. This opinion is based upon the following:

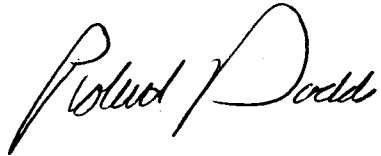
1. The material encountered is hard compared to soil and can be identified as Queenston shale.
2. The soil (till) encountered in parts of the work conforms to the general definition by Terzaghi and Peck (1967) and is distinct from the rock.
3. The rock exhibits layering in places. Till deposits are unstratified.
4. The till generally has a moisture content of 8 to 12% and is workable. The material (rock) encountered was dry when broken and friable.
5. The material (rock) encountered was distinct and blocky with no inclusions of silts, sands or gravels as is the case for tills. The blocky nature is assumed to be due primarily to the effects of construction.
6. The borehole (42S) maintained its integrity which could not normally be expected if the surrounding material was soil (till).
7. The material (rock) encountered had not been reworked or significantly altered from the parent rock (Queenston shale) as would be the case if the material was a till.
8. Sheet piles met refusal at shallow depths of penetration in the material (rock). Much greater depths of penetration would be expected in a till.

4.0 SUMMARY (cont'd)

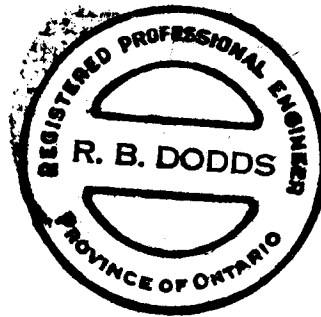
It was noted that the foundation design showed the pier footing founded on sound Queenston shale at approximately elevation 245 ft. The shale encountered within the excavation to elevation 245 ft. should not be considered as sound and alternate foundation designs may be warranted.

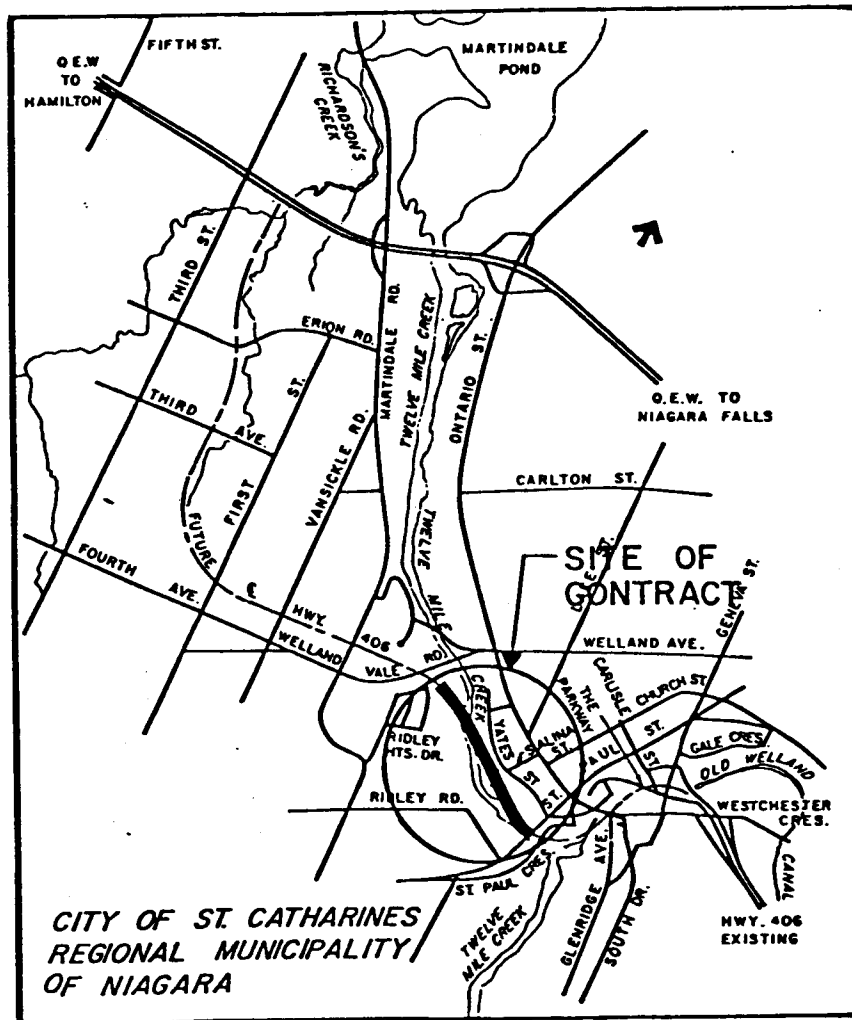
All the foregoing respectfully submitted.

ROBERT DODDS LIMITED,

A handwritten signature in cursive script, appearing to read "Robert B. Dodds".

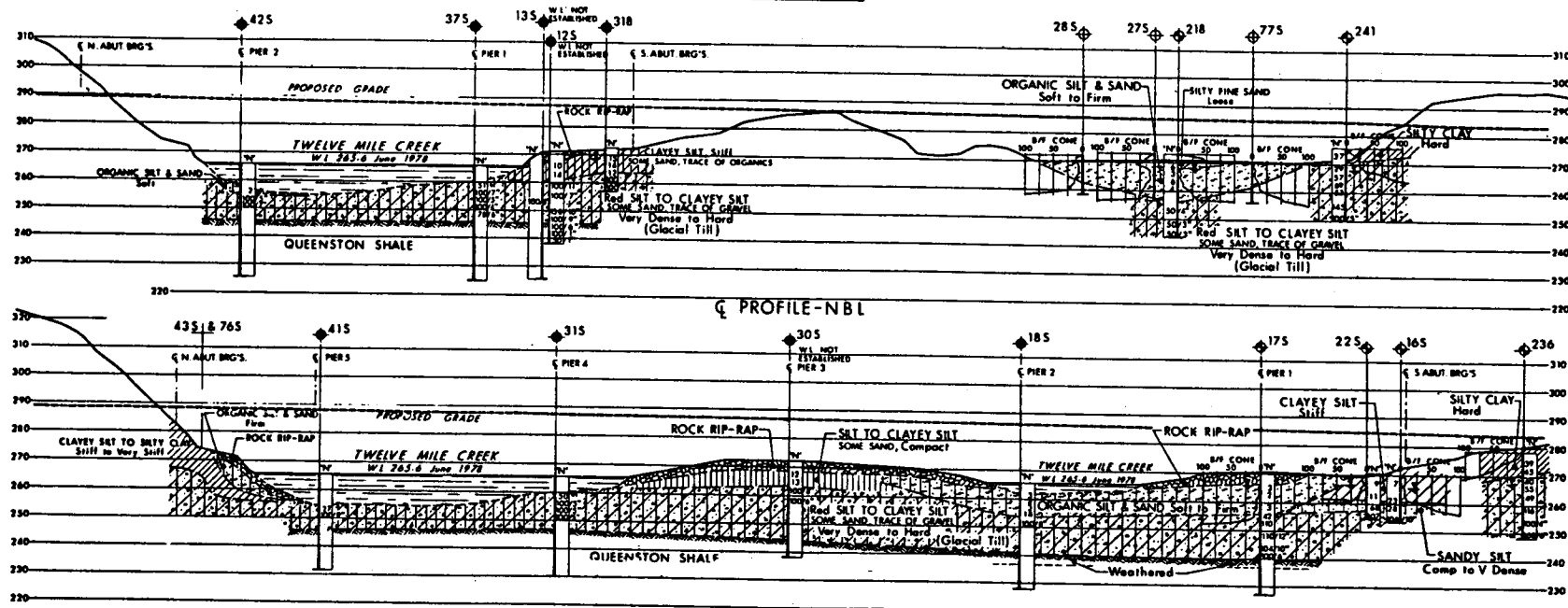
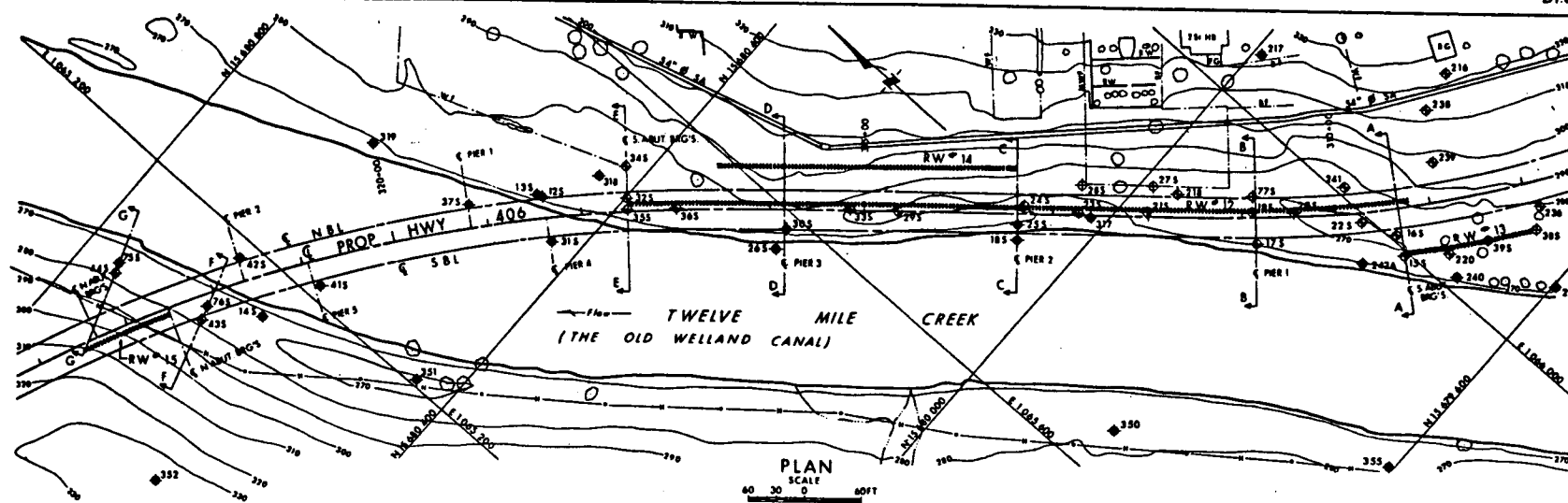
ROBERT B. DODDS, PH.D., P.Eng.





Key Plan
Scale





PROFILE-SBL

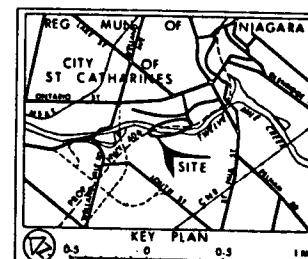
SCALE FOR PROFILES
HOB 60 30 0 60 FT
VERT 20 10 0 20 FT

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

CONT No 80-44
WP No 46-74-40 NB Bridge
46-74-39 Rat Walls
TWELVE MILE CREEK BRIDGES & RETAINING WALLS
(Bridge "SA SBL" & Bridge "SB NBL")
BORE HOLE LOCATIONS & SOIL STRATA



SHEET
108



LEGEND

- ◆ Bore Hole
- ◆ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- W Shows/W (Std Pen Test 350 ft No energy)
- CONE Shows/W (60" Cone, 350 ft No energy)

Wt. at time of investigation
May & June 1978
Wt. for BM 318, Oct 1963
Wt. for BM 218, July 1971
Wt. for BM 236 & 241, Dec 1971
Wt. Not Established in BM 125, 135 & 305

No	ELEVATION	NORTH	EAST
125	270.4	15 480 447	1063 238
135	270.4	15 480 472	1063 439
145	272.4	15 480 407	1063 149
155	271.4	15 479 736	1063 095
165	269.9	15 479 740	1064 005
175	270.8	15 479 584	1063 099
185	268.6	15 479 037	1063 737
195	270.8	15 479 189	1063 973
205	269.6	15 479 656	1063 951
215	270.9	15 479 779	1063 849
225	270.4	15 479 797	1063 991
235	270.4	15 479 797	1063 991
245	270.4	15 480 079	1063 749
255	269.6	15 480 067	1063 749
265	265.6	15 479 746	1063 549
275	273.1	15 479 988	1063 874
285	272.2	15 480 063	1063 823
295	270.0	15 480 179	1063 675
305	273.2	15 480 349	1063 353
315	265.6	15 480 437	1063 219
325	270.9	15 480 398	1063 477
335	271.6	15 480 219	1063 644
345	273.6	15 479 631	1063 572
355	271.7	15 480 389	1063 488
365	273.7	15 480 329	1063 334
375	263.6	15 480 328	1063 387
385	276.2	15 479 623	1064 107
395	274.2	15 479 684	1064 065
405	265.6	15 480 382	1063 213
415	265.6	15 480 663	1063 179
425	272.4	15 480 620	1063 104
435	273.7	15 480 756	1063 079
445	273.7	15 480 756	1063 079
455	273.7	15 480 756	1063 079
465	272.9	15 480 630	1063 118
475	270.9	15 479 002	1063 336
485	274.4	15 479 002	1063 336
495	273.2	15 479 992	1064 053
505	271.0	15 479 992	1064 053
515	273.3	15 479 992	1064 053
525	279.7	15 479 000	1064 179
535	279.7	15 479 000	1064 179
545	279.7	15 479 000	1064 179
555	279.7	15 479 000	1064 179
565	279.7	15 479 000	1064 179
575	279.7	15 479 000	1064 179
585	279.7	15 479 000	1064 179
595	279.7	15 479 000	1064 179
605	279.7	15 479 000	1064 179
615	279.7	15 479 000	1064 179
625	279.7	15 479 000	1064 179
635	279.7	15 479 000	1064 179
645	279.7	15 479 000	1064 179
655	279.7	15 479 000	1064 179
665	279.7	15 479 000	1064 179
675	279.7	15 479 000	1064 179
685	279.7	15 479 000	1064 179
695	279.7	15 479 000	1064 179
705	279.7	15 479 000	1064 179
715	279.7	15 479 000	1064 179
725	279.7	15 479 000	1064 179
735	279.7	15 479 000	1064 179
745	279.7	15 479 000	1064 179
755	279.7	15 479 000	1064 179
765	279.7	15 479 000	1064 179
775	279.7	15 479 000	1064 179
785	279.7	15 479 000	1064 179
795	279.7	15 479 000	1064 179
805	279.7	15 479 000	1064 179
815	279.7	15 479 000	1064 179
825	279.7	15 479 000	1064 179
835	279.7	15 479 000	1064 179
845	279.7	15 479 000	1064 179
855	279.7	15 479 000	1064 179
865	279.7	15 479 000	1064 179
875	279.7	15 479 000	1064 179
885	279.7	15 479 000	1064 179
895	279.7	15 479 000	1064 179
905	279.7	15 479 000	1064 179
915	279.7	15 479 000	1064 179
925	279.7	15 479 000	1064 179
935	279.7	15 479 000	1064 179
945	279.7	15 479 000	1064 179
955	279.7	15 479 000	1064 179
965	279.7	15 479 000	1064 179
975	279.7	15 479 000	1064 179
985	279.7	15 479 000	1064 179
995	279.7	15 479 000	1064 179
1005	279.7	15 479 000	1064 179

DATE: 10/1/78 BY: [Signature]

DESCRIPTION: [Signature]

Geocres No 30M3-150

Sheet No. 108 of 108

DATE: 10/1/78 BY: [Signature]

DESCRIPTION: [Signature]

Geocres No 30M3-150

Sheet No. 108 of 108

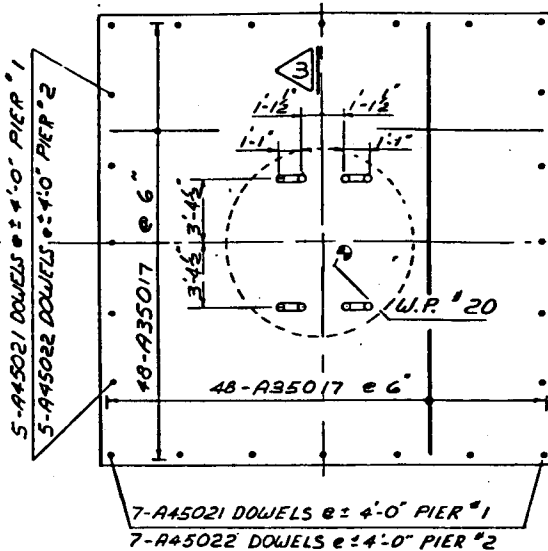
CONT No 80-44
WP No 46-74-40

HWY 406 BRIDGES OVER THE TWELVE
MILE CREEK AND ASSOC. RET. WALLS.
N/B BRIDGE
ABUT. & PIER FOOTINGS

SHEET
110

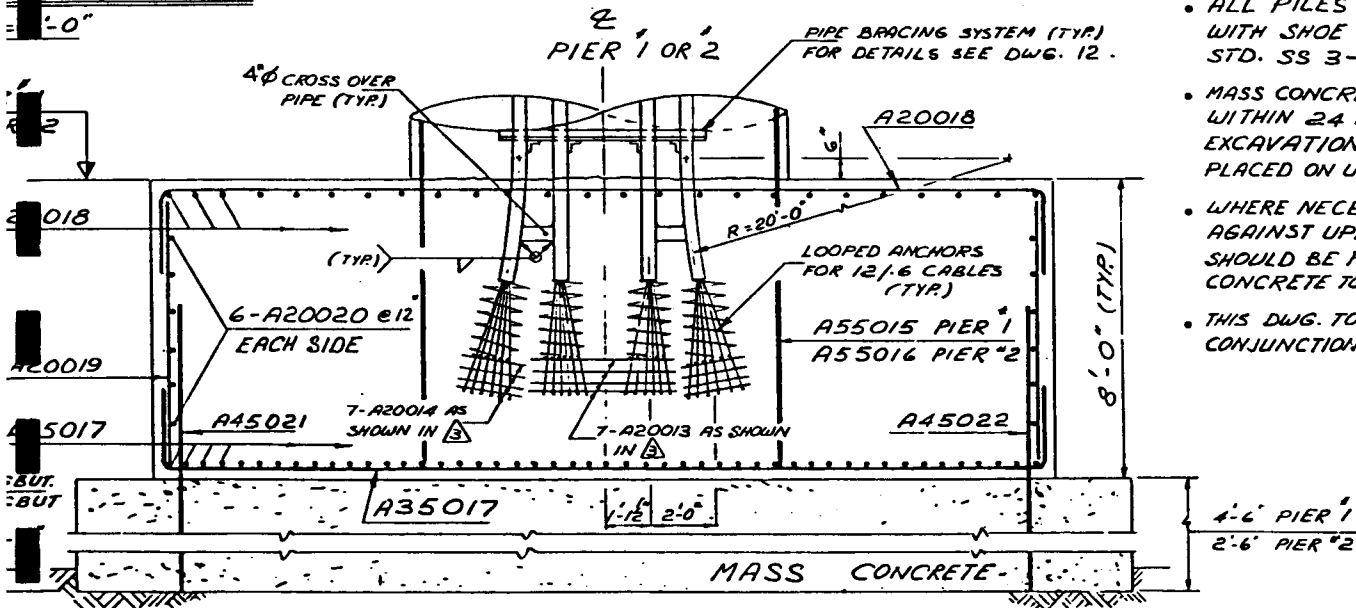
PIER 1 EQUALLY SPACED
PIER 2

PIER 1
PIER 2



BOT. REINF.
(TYP. PIER #1 & #2)

PIER 1 & 2 FTGS



1/8" = 1'-0"

PILE DATA

LOCATION	BATTER	No.	LENGTH
SOUTH ABUTMENT	1:8	5	25'-0"
NORTH ABUTMENT	1:3	18	25'-0"
	1:8	8	30'-0"
	1:3	16	30'-0"

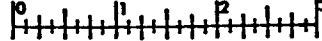
NOTES:

- ALL PILES ARE HP 12 x 74
- PILE SPACING MEASURED AT UNDERSIDE OF FOOTINGS.
- PILES AT ABUTMENTS TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 3-11 USING DESIGN LOAD 100 TONS / PILE.
- ALL PILES TO BE REINFORCED WITH SHOE PLATES AS PER STD. SS 3-1 ON DWG. 49.
- MASS CONCRETE TO BE COMMEIENCED WITHIN 24 HOURS AFTER FOOTING EXCAVATION IS COMPLETED AND PLACED ON UNDISTURBED MATERIAL
- WHERE NECESSARY AS A PRECAUTION AGAINST UPLIFT 2" DIA. PIPES SHOULD BE PLACED IN MASS CONCRETE TO ACT AS RELIEF WELL
- THIS DWG. TO BE READ IN CONJUNCTION WITH DWG. 7, 12 & 31



FOR REDUCED PLAN

USE SCALE BELOW



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	REV	CHECK	J.C.
LOADING	NS 20-44	DATE	REC.

RECORD OF BOREHOLE No 41S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,582; E 1,065,215 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Core COMPILED BY P.S.
DATUM Geodetic DATE June 13, 1978 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
265.6	Water Level																
0.0	Water																
254.6	Channel Bottom						260										
11.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		1	SS	27		250										
246.1			2	SS	100%												
			3	NXL	85%												
				Core	Rec												
19.5	Queenston Shale Limestone Beds		4	NXL	97%		240										RQD - 38%
	23'6" to 23'8"																
	24'7" to 24'10"																
	31'1" to 31'5"																
	33'4" to 34'0"																
231.6			5	NXL	98%												RQD - 63%
				Core	Rec												
			6	NXL	100%												RQD - 87%
				Core	Rec												
34.0	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

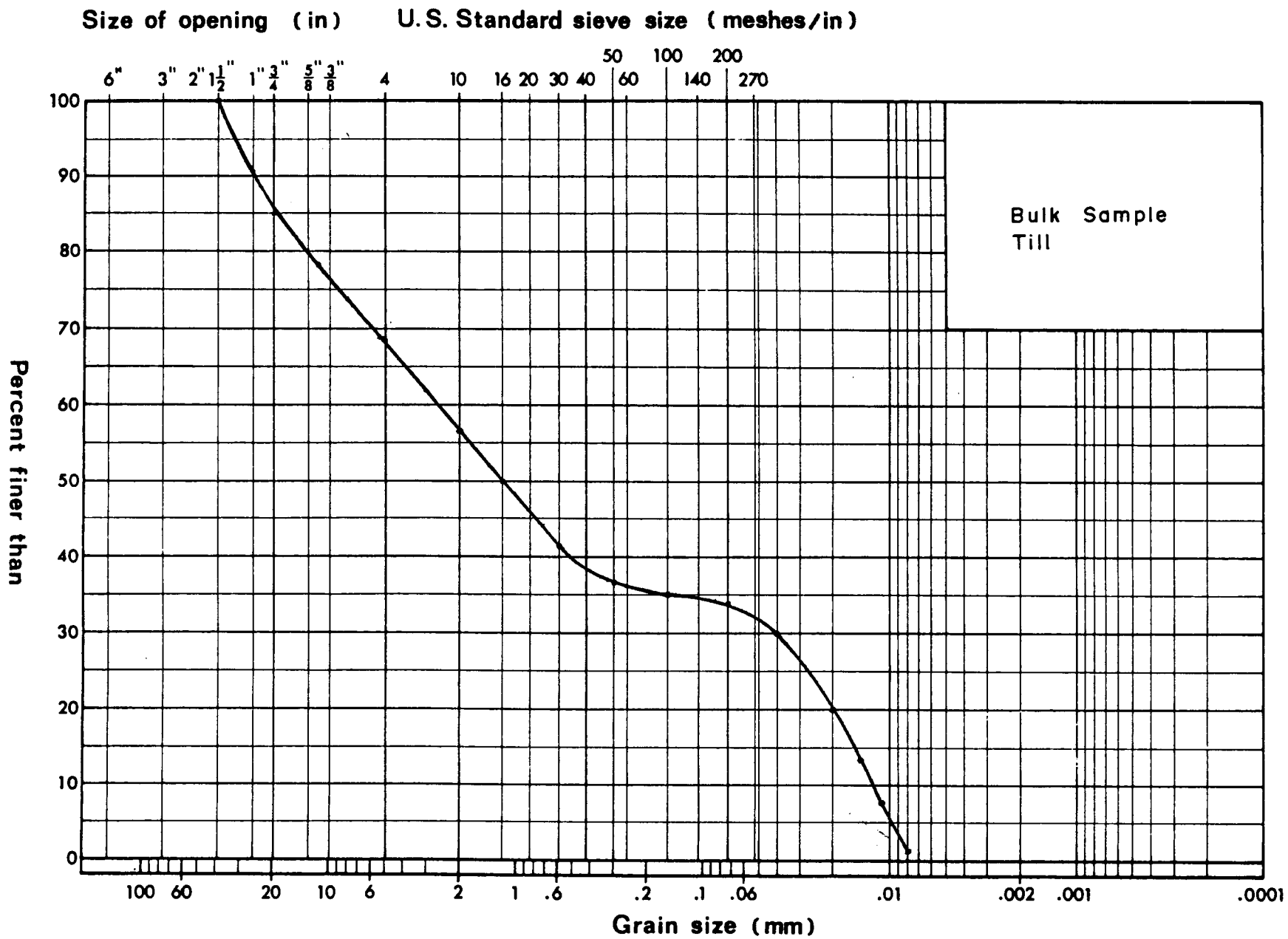
123

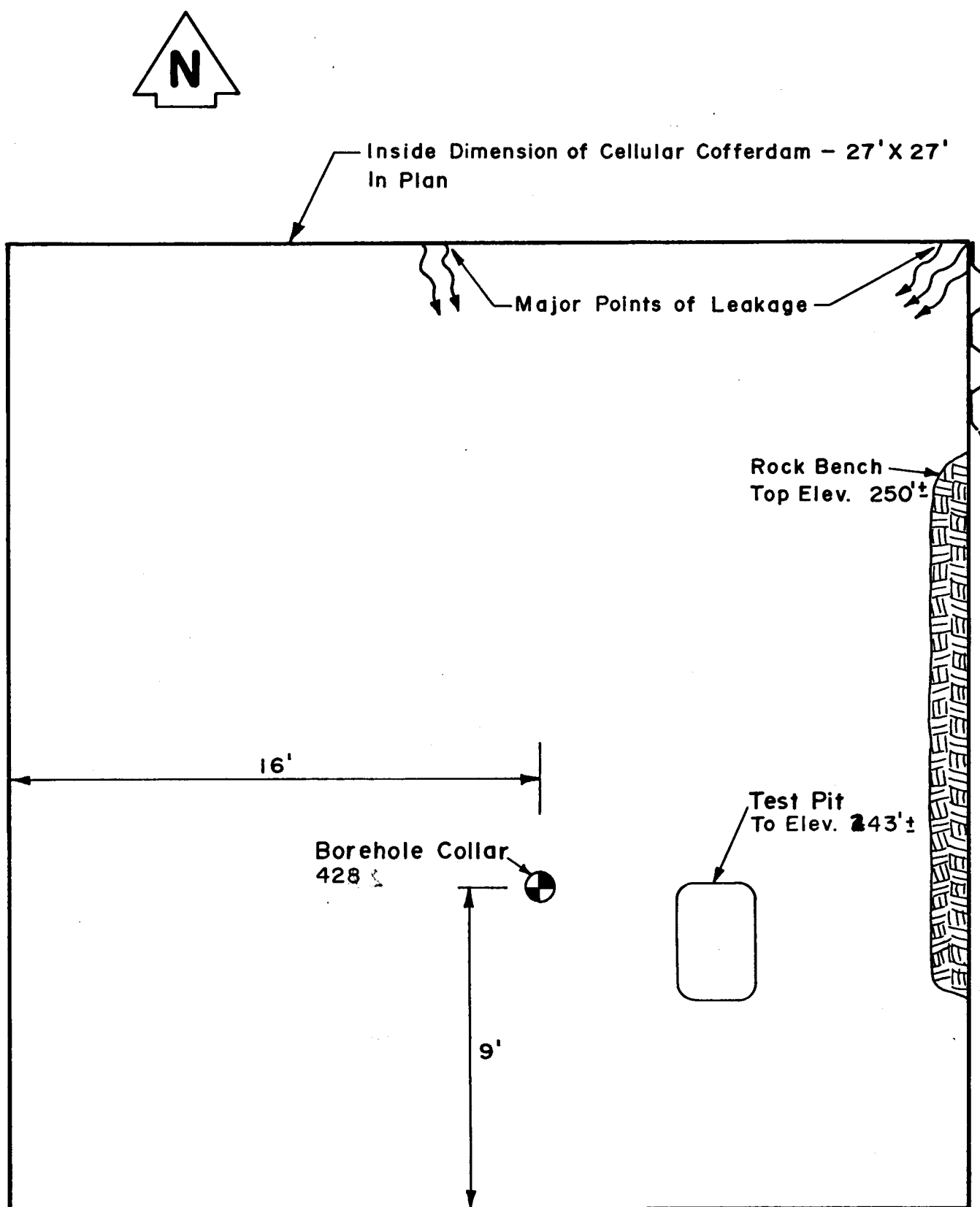
RECORD OF BOREHOLE No 425

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,665; E 1,065,179 ORIGINATED BY J.A.
 DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Core COMPILED BY P.S.
 DATUM Geodetic DATE June 14, 1978 CHECKED BY *GP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT γ					PLASTIC LIMIT W_p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W_L	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
265.6	Water Level																	
0.0	Water																	
257.3	Channel Bottom						260											
8.3	Organic Silt and Sand Soft		1	SS	2													
254.6	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		2	SS	100% 5"													
11.0			3	SS	100% 7"													
245.6			4	NXL RC	45% Rec		250											RQD = 0%
20.0	Queenston Shale		5	NXL RC	80% Rec													RQD = 57%
	Limestone Beds 31'5" to 31'9" 33'0" to 34'2"		6	NXL RC	95% Rec		240											RQD = 68%
			7	NXL RC	100% Rec													RQD = 93%
225.4			8	NXL RC	100% Rec		230											RQD = 93%
40.2	End of Borehole																	

OFFICE REPORT ON SOIL EXPLORATION





CELL PLAN - PIER No. 2



Photo No. 1 - General view of site looking upstream to the south. Cellular cofferdam (cell) inside diversion is at Pier No. 2 of northbound lane.



Photo No. 2 - Base of excavation in cell along west wall looking north. Elevation at approximately 250 feet.



Photo No. 3 - Exposed rock northwest corner of cell.
Base at approximate elevation 248 feet.



Photo No. 4 - Exposed rock northwest corner of cell.
Base at approximate elevation 248 feet.



Photo No. 5 - Exposed rock at northeast corner of cell.
Base at approximately 248 feet.



Photo No. 6 - Exposed rock at bench along east wall of cell.
Top at approximately elevation 250 feet.



Photo No. 7 - Exposed rock at southeast corner of cell.
Base at approximately elevation 248 feet.



Photo No. 8 - Exposed rock at northeast corner of cell.
Base at approximately elevation 248 feet.
Rock bench in foreground.



Photo No. 9 - Till overlying rock along south wall. Top of rock at approximately elevation 251 feet.

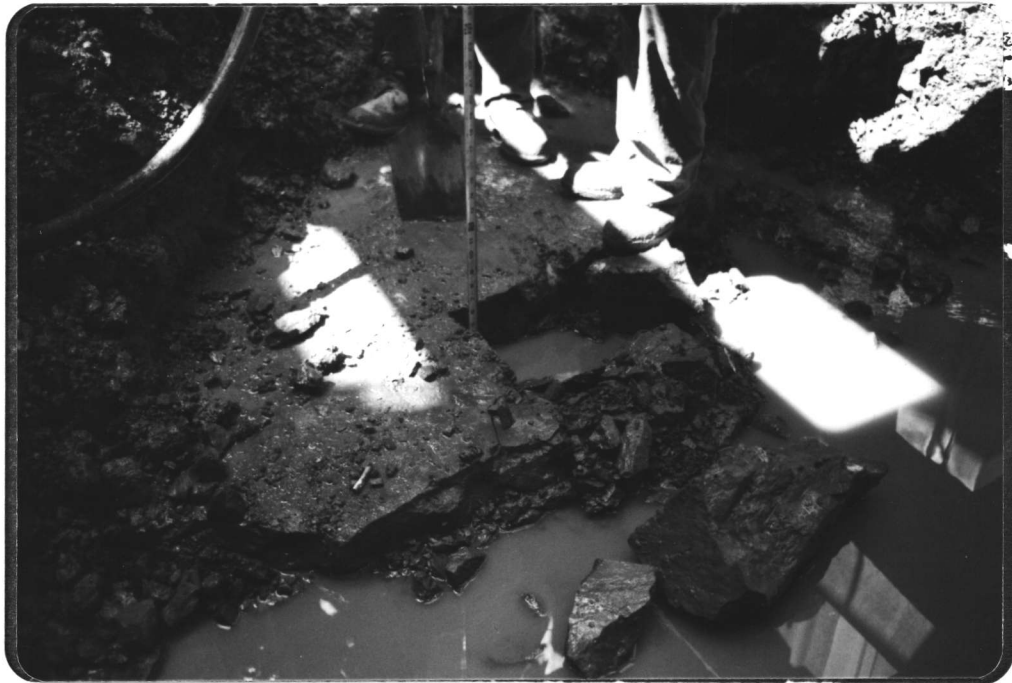


Photo No. 10 - Rock being broken up with mechanical spade at northeast quadrant of cell at approximately elevation 248 feet.



Photo No. 11 - Rock bench along east wall of cell shortly after dewatering. Top at approximately elevation 250 feet.



Photo No. 12 - As per Photo No. 11 showing disintegration after several hours exposure to air.



Photo No. 13 - As per Photos, Nos. 11 and 12, showing progressive disintegration after exposure to air.



Photo No. 14 - As Photos, Nos. 11, 12 & 13, showing progressive disintegration after exposure to air.



Photo No. 15 - Close up of rock bench along east wall to cell showing thin clay seam at pencil tip.



Photo No. 16 - Test pit being excavated by mechanical spade and hand shovelling.



Photo No. 17 - View of test pit excavated to approximately elevation 243 feet.

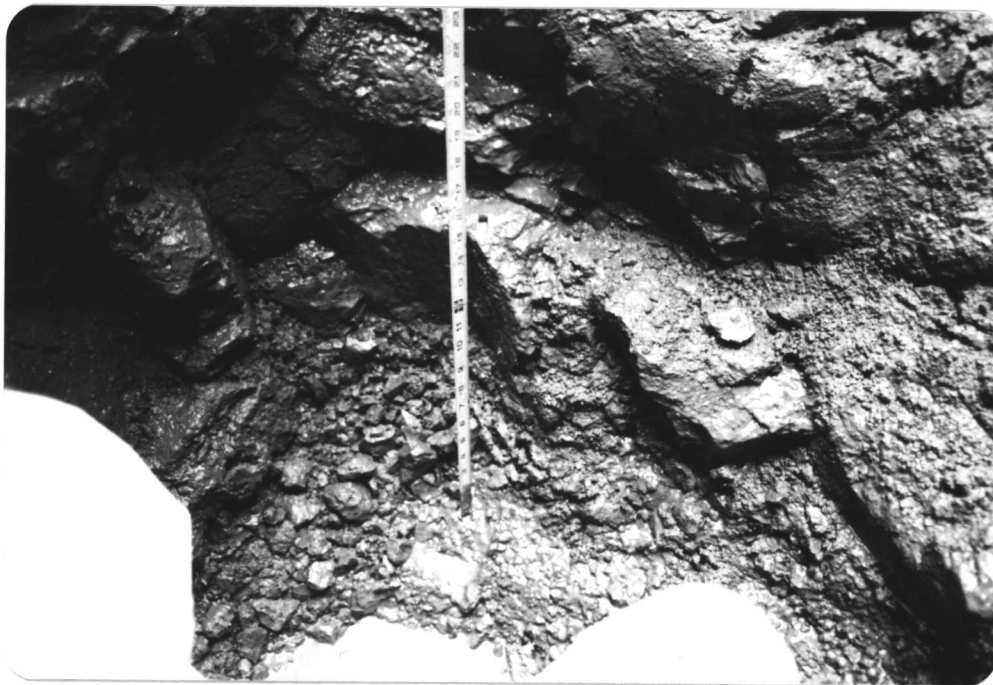


Photo No. 18 - View of north side of test pit from bottom of halfway up. Approximately elevation 246 feet.

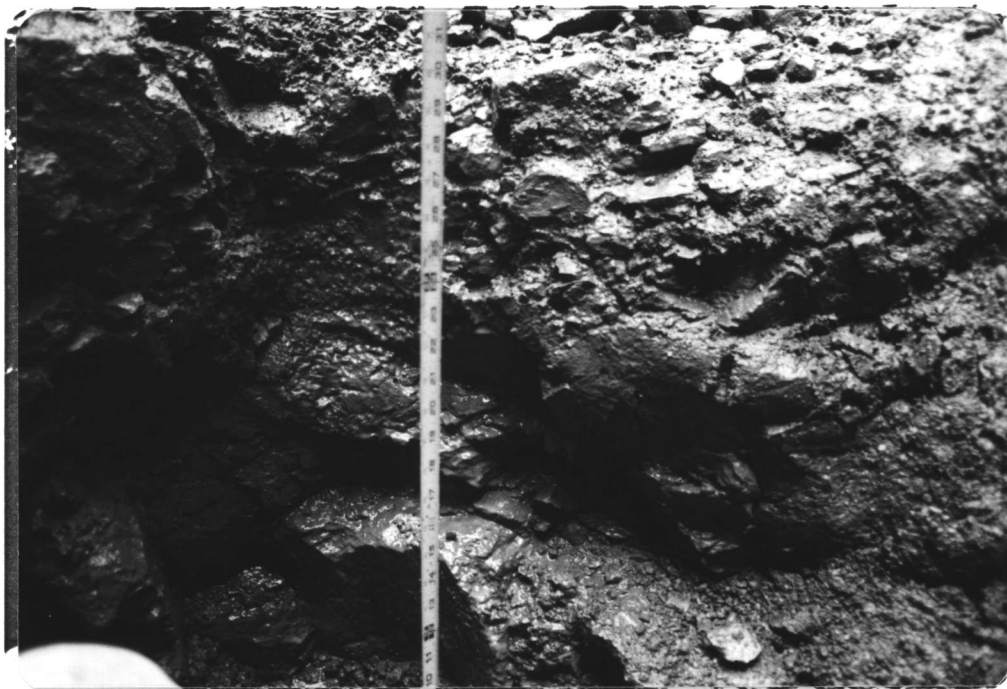


Photo No. 19 - Close-up view of north side of test pit.



Photo No. 20 - Sample of till taken from south wall
above elevation 251 feet.



42 S
Photo No. 21 - Collar of borehole (presumably Borehole, No. 41S) at approximately elevation 248 feet. Note clear water flowing from borehole.



Photo No. 22 - Rock fragment taken by contractor at approximately elevation 255 feet showing borehole edge.