DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-80 & 81

DIST. 4 REGION

W.P. No. 205-63-01

CONT. No.

W. O. No.

STR. SITE No.

HWY. No.

LOCATION OAKVILLE CREEK BRIDGE

SLOPE EROSION - WEST END

No OF PAGES - ~

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

3687

FILE

MINUTES OF MEETING

RE: Erosion, West End, Oakville Creek Bridge
W.P. 205-~~63~~-01, Site 10
63

DATE: May 17, 1977, 9:00 A.M.

LOCATION: Structural Section M.T.C.,
3501 Dufferin Street

PRESENT: A. Sulavella)
B. Ly)
D. Riseboro) M.T.C.
C. Farrell)

1. B. Ly reviewed the proposed drainage improvement details and agreed that the proposals will largely eliminate erosion caused by the present 24" C.S.P. but noted that erosion will continue due to surface run off from the slopes.

2. The rock anchor lengths should be increased in length from 6 ft. to 10 ft.

3. An elbow should be provided at the end of the 24" C.S.P. to direct water into the ditch lines.

4. D. Riseboro will check with Remote Sensing to establish whether photography is available at different times for this location. It may be possible to establish rates of erosion from such photography.

5. B. Ly and D. Riseboro will visit the site on May 18, to establish a method of monitoring the slope.

C.F. Farrell,
Sr. Structural Planning Engineer.

CF:gj

c.c. All present

SEND TO: M. Devata.
Soil Mechanics Office
Downsview

FROM: Allan Sulavella DEPT. DATE: May 13/77

SUBJECT: WP 205-63-01 - Erosion - West End - Oakville Creek Bridge.

Attached is the following:

(1) Elevation of ditch liner.
(2) Details of gabions.
(3) Detail of ditch liner achorage into rock.
(4) Portion of D-4.
(5) Gabion S.P.

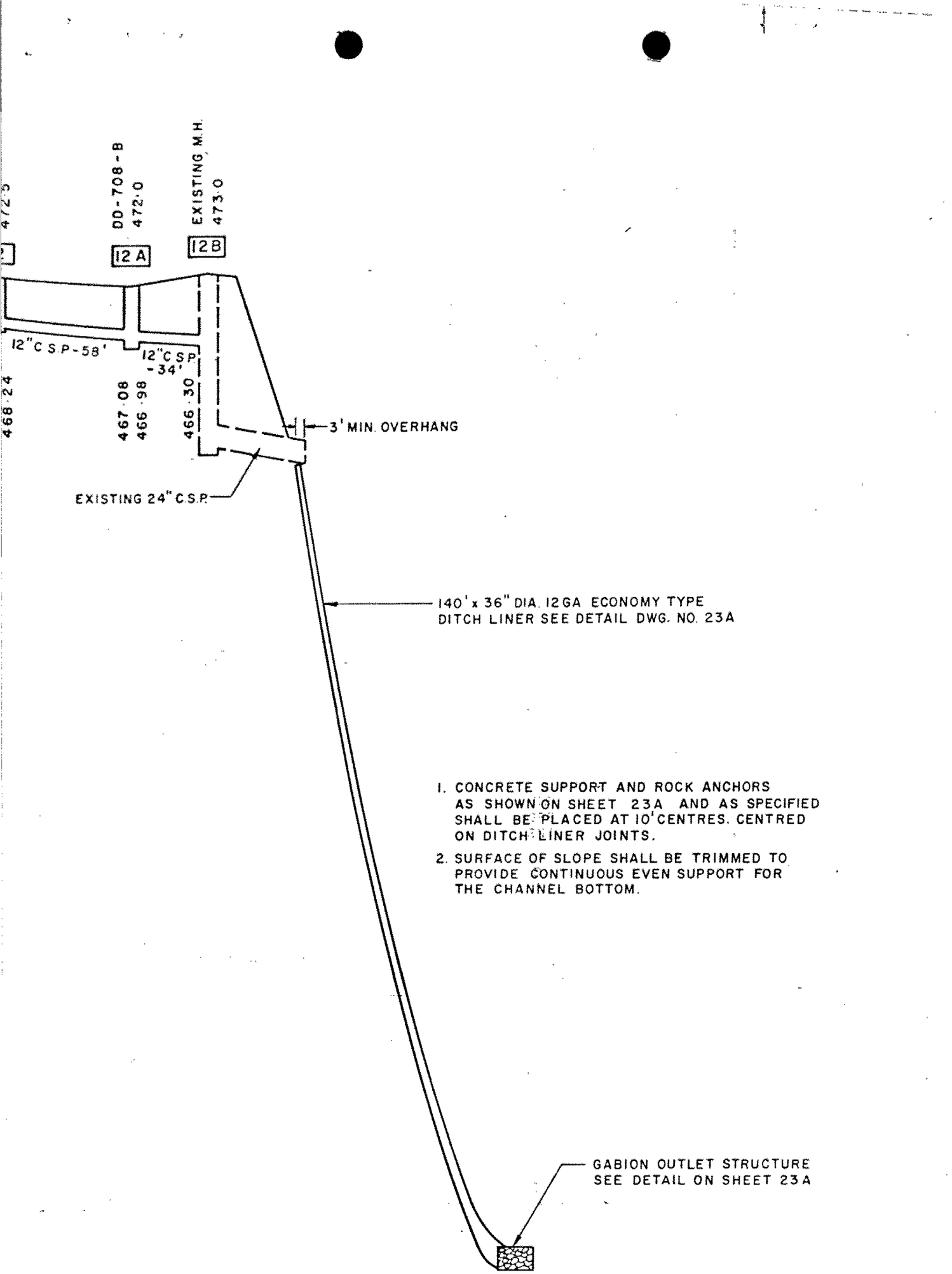
Regional Review held this morning. Completed drawings to be in Head Office by May 20/77. Please contact me if you wish to view drawing or discuss. Chris Farrell also at meeting.

REPLY and you can contact him for details. P. B.

cc: C. Farrell

RECEIVED
MAY 16 1977
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

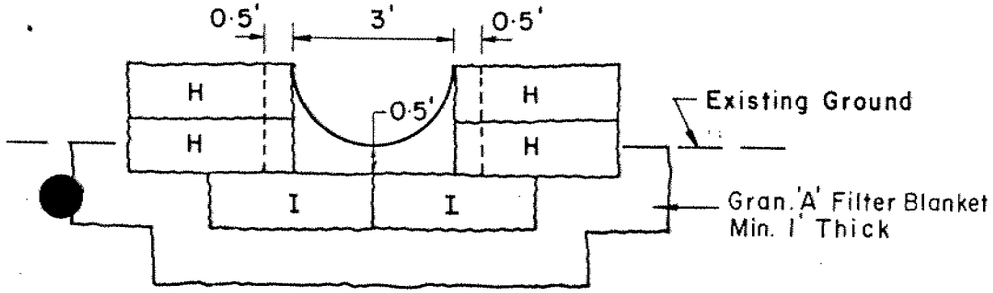
REPLY FROM | REPLY DATE


DD-708-B
472.0
EXISTING M.H.
473.0
12A
12B
12"C.S.P.-58'
12"C.S.P.
-34'
468.24
467.08
466.98
466.30
3' MIN. OVERHANG
EXISTING 24" C.S.P.
140' x 36" DIA. 12GA ECONOMY TYPE
DITCH LINER SEE DETAIL DWG. NO. 23A
1. CONCRETE SUPPORT AND ROCK ANCHORS AS SHOWN ON SHEET 23A AND AS SPECIFIED SHALL BE PLACED AT 10' CENTRES. CENTRED ON DITCH LINER JOINTS.
2. SURFACE OF SLOPE SHALL BE TRIMMED TO PROVIDE CONTINUOUS EVEN SUPPORT FOR THE CHANNEL BOTTOM.
GABION OUTLET STRUCTURE
SEE DETAIL ON SHEET 23A
Ls - 200'
D - 1° 30'
TS
SC
CS
5
6
7
8
9

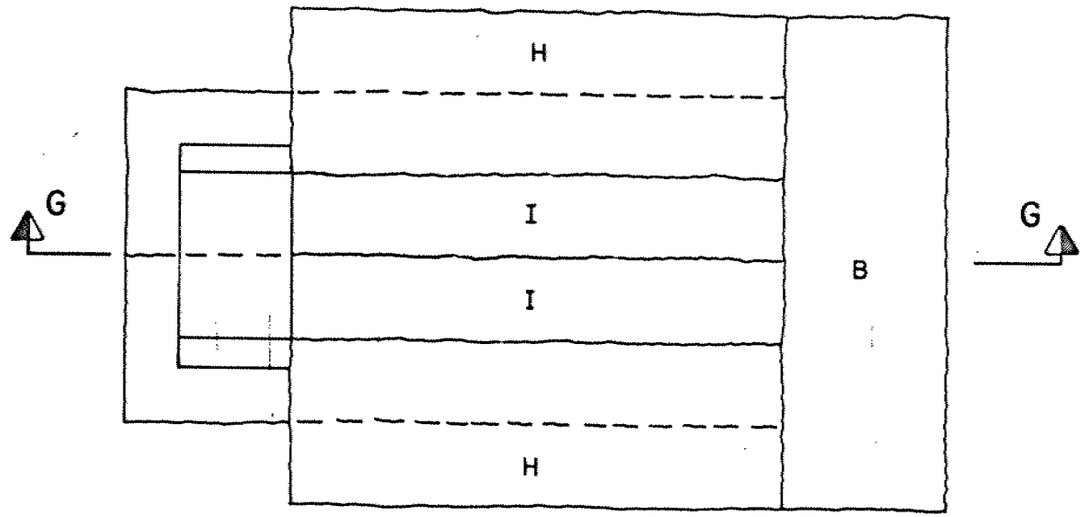
RECONSTRUCTED CONDITION

DETAIL OF GUTTER ENLARGEMENT OUTLET TO EXPANSION JOINT STATION 281+07

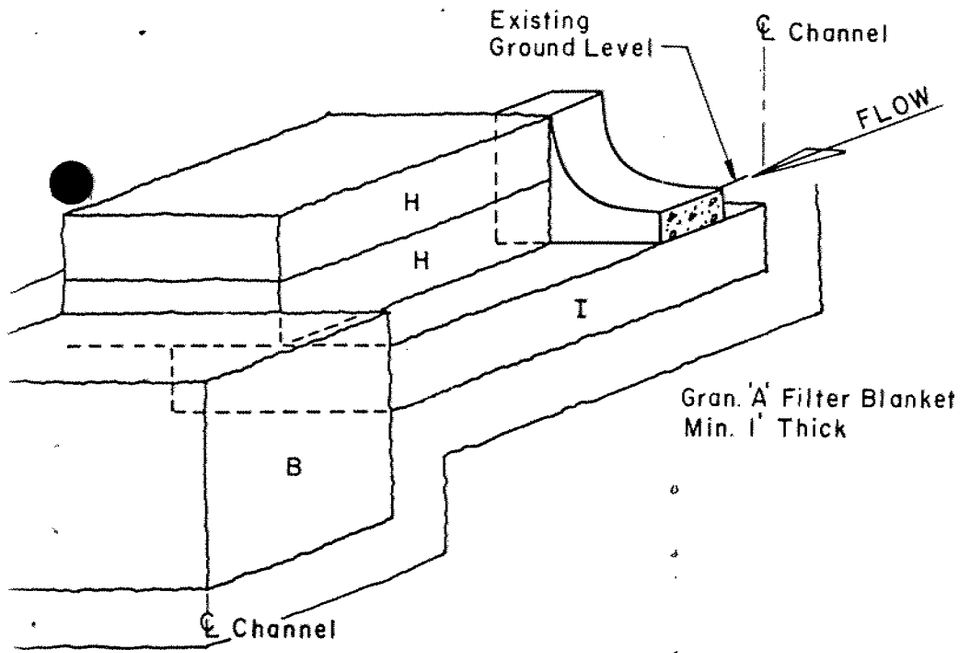
Scale : 3/4" = 1'-0"

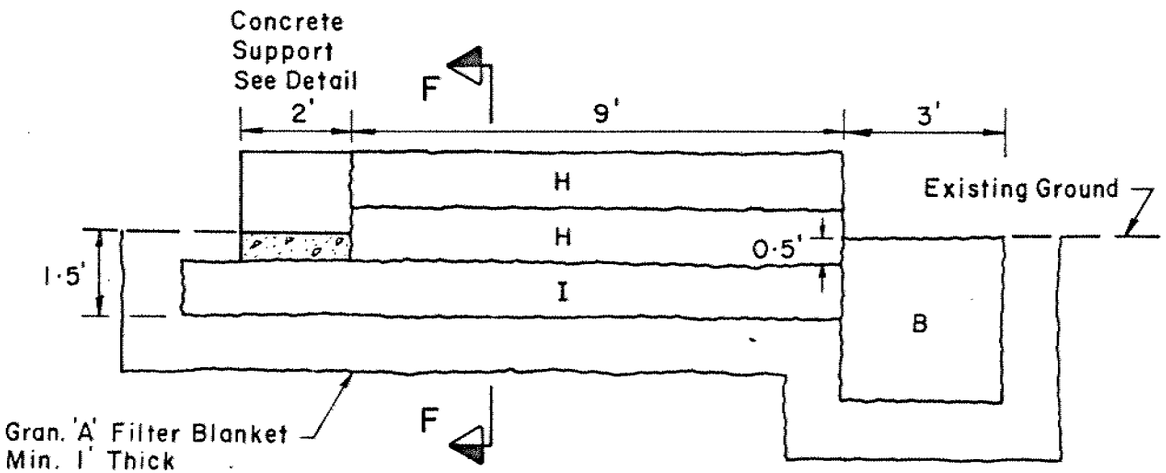


SECTION F - F

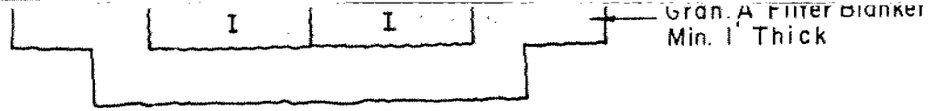


PLAN

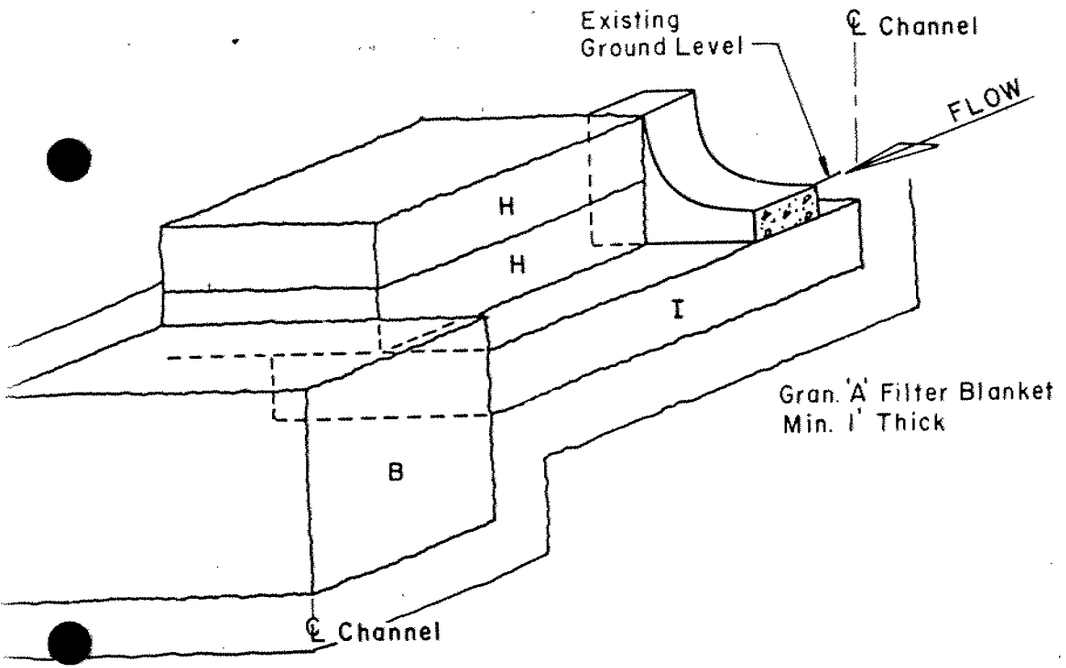




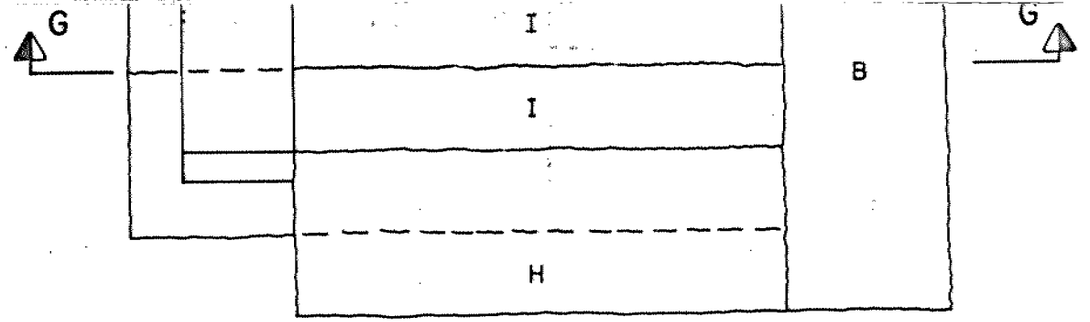
RD GABION DIMENSIONS



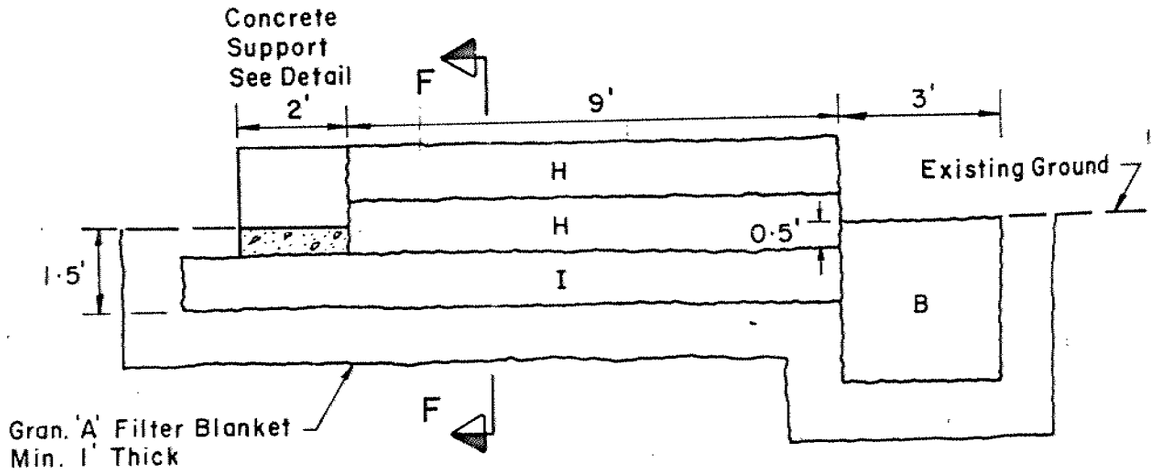
SECTION F - F



STANDARD GABION DIMENSIONS
12' x 3' x 1'
9' x 3' x 1'
9' x 3' x 3'

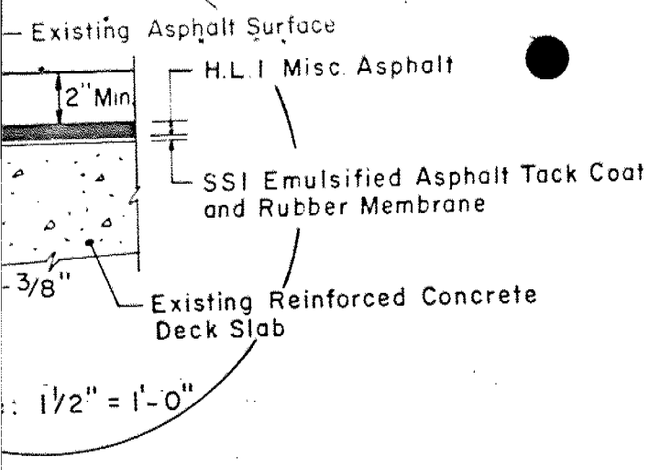


PLAN

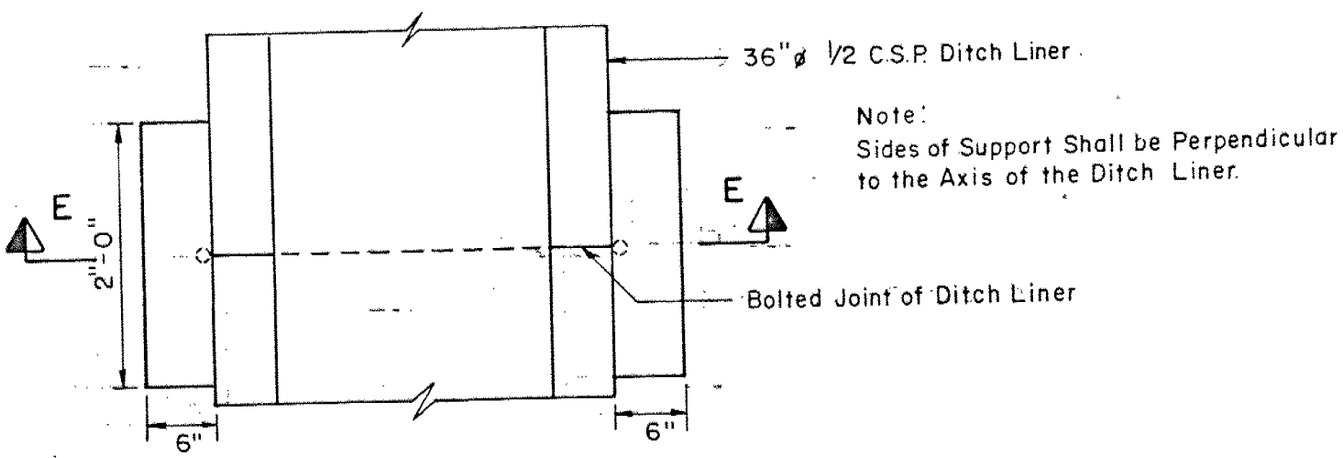


SECTION G - G

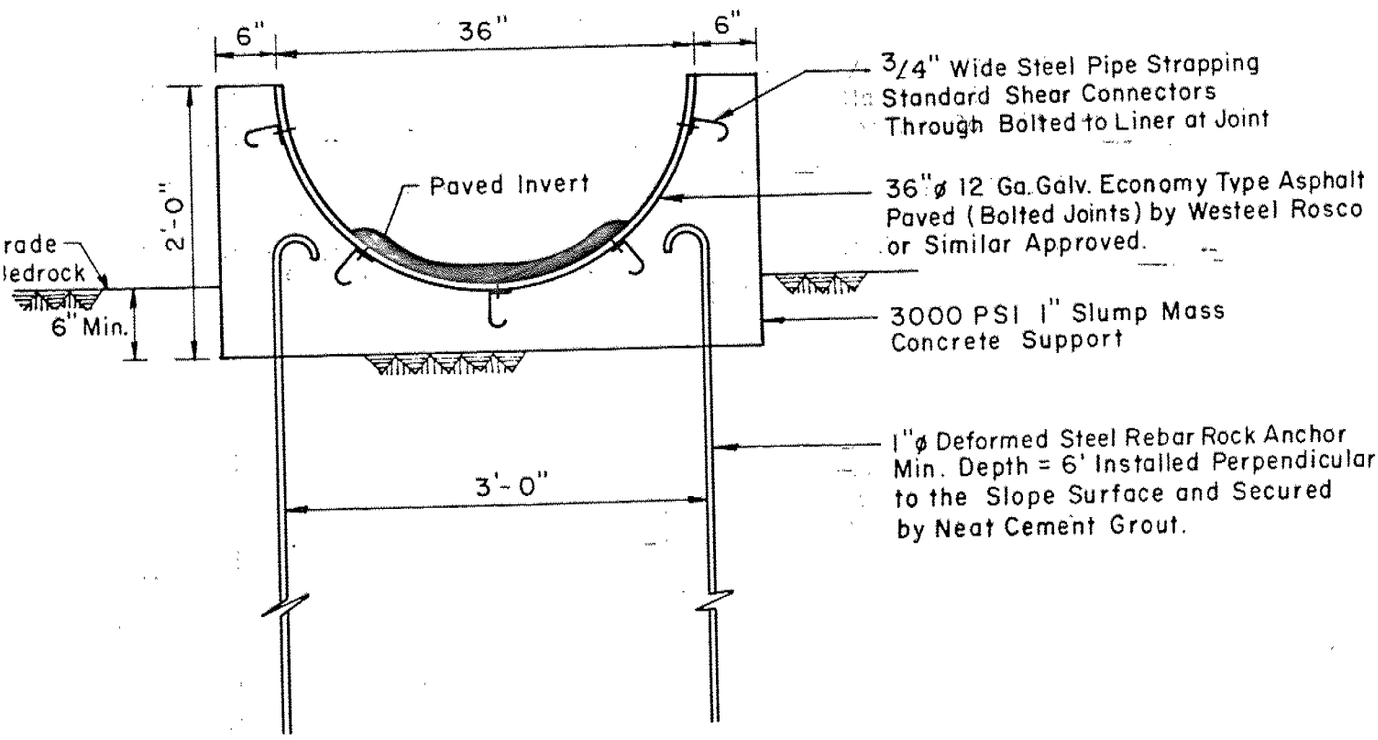
DETAIL OF DITCH LINER OUTLET STRUCTURE



GUTTER ENLARGEMENT END DETAIL STATION 273 + 20 LT. & RT.



PLAN



SECTION E - E
Scale: 3/4" = 1'-0"

DETAIL OF SUPPORT FOR DITCH LINER

OFFERS TO COMPLETE THE WORK SPECIFIED IN THE CONTRACT FOR THE FOLLOWING PRICES

CONTRACT No _____

ITEM	SPEC	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
			BROUGHT FORWARD			
69	601 SP	Duct Bank Encased in Concrete - Two 4" Conduits	lf	498		
		16 MILE CREEK BRIDGE				
70	SP	Bridge Deck Drainage Improvements	lump sum (Insert bid price under "TOTAL" column only)			
71	406	12" C.S.P. Sewer including Excavation, Bedding and Native Backfill	lf	196		
72	406 SP 904	36" C.S.P. Ditch Liner Including Concrete Cradles and Anchors	lf	140		
73	917S SP	Gabion Drop Structure	cu yd	10		

SP - SPECIAL PROVISION

SUB-TOTAL _____

TOTAL TENDER _____

5352 OB-CC-52C 11-76

PROPOSED SPECIAL PROVISION

W.P. No. [illegible] Contract No. ______ District No. 4 Hwy. No. 5 Date MAY 77

Type of work ____________

Location ____________

1.	Initiated by (Give Names, Divisions, District & Jurisdictions, etc.)
2. (a)	This S.P. is new (✓) ☐. This S.P. replaces No. ______ in the Special Provisions Manual. This S.P. modifies the following Specification requirement: MTC Form ____ Section ______ Page(s) ______ Paragraph ________ Remarks as follows:
(b)	Explanation of Intent
3.	Title and Text as follows: Specification No(s). ____________ Item No(s). 75 TITLE GABION DROP STRUCTURES Subtitle ____________ As part of the work to be performed under and at the contract price for the above tender item the Contractor shall excavate for, supply, place and compact the Granular 'A' filter blanket in accordance with the contract drawings.

	Region		Head Office
Detailed by: D.L.C.	Date ______	______	Date ______
Approved by: ______	Date ______	______	Date ______

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. M. Devata
Supervising Engineer
Soils Mechanics Section

From: Planning and Design Office
Central Region

Attention:

Date: 77-05-06

Our File Ref.

In Reply to

Subject:

re: Slope Erosion
West End - Oakville Creek Bridge
W.P. 205-75-01
District 4, Hamilton

On 77-02-22 I received a memorandum from Mr. C. Farrell of the Regional Structural Office advising that a visit had been made with your office to the site. The memorandum contained comments and suggestion for improvements. These were:

(a) extension of the drain pipe to the bottom of the slope, and
(b) possible treatment of the slope with 'Gunite'.

Based on the above recommendations two alternatives were investigated. The cost and general detail is contained in De Leuw Cather's letter dated 77-04-14 which is attached.

Since the cost of the two alternatives was estimated at $35,000. and $59,000. a meeting was held on 77-04-01 with the Structural Office to discuss the subject. At this meeting Mr. Bin Ly of your office was present.

The opinion of the meeting was that the slope should be monitored for a period before a large expenditure could be recommended. Mr. Ly advised that this would take a minimum of three months.

For reasons of project scheduling, this office has had to go ahead and complete the project. We have included in the contract the extension of the drain pipe down the slope. A half-round pipe anchored to the slope will be specified.

Possibly the above is not the total solution. Would your office therefore undertake some study to determine what further work may be necessary and when.

It is unlikely that work on this contract will commence till late summer. It is also considered that any slope improvements need not necessarily be part of this contract. However, a commitment has been made in view that the outfall sewer is being extended to the bottom of the slope. Any further improvement should therefore suit the overall solution.

continued.../2

Could we therefore hear from you in due course.

A. Sulavella

for: J. P. Cullen
Area Manager

JPC/AS/rg

Attached

c.c. G. Burkhardt
D. A. Waller
H. Potts
R. Fitzgibbon
De Leuw Cather

De Leuw Cather

SULAVELLA

MEMORANDUM

TO File

OUR REF: 01-401-31

FROM K. Loughborough

DATE: April 1, 1977

Re: Hwy. 5 - Oakville Creek Bridge
Storm Drainage Improvement

Minutes of meeting held at Structural Office, MTC, 3501 Dufferin St., Downsview at 10:00 a.m., Thursday, March 17th, 1977.

Present: For the Ministry of Transportation & Communications:

A. Sulavella
C. Farrell
B. Ly

For De Leuw Cather, Canada Ltd.:

A. Scott
K. Loughborough

Mr. Loughborough outlined the background for Proposal I and Proposal II for the extension of the 24" dia. c.s.p. on the west slope discussed in a letter from Mr. Scott to Mr. Sulavella dated March 14, 1977. Mr. Loughborough indicated that Proposal I represents only a temporary solution. The Gunite treatment cannot be guaranteed for more than one year since erosion would continue although at a reduced rate, and the rock anchors would loosen eventually. Proposal II, however, represents a permanent solution.

Mr. Farrell noted that the Maintenance Office felt there appeared to be no immediate danger of slope failure at the original west pier but he felt the rate of weathering and erosion would have to be determined. Mr. Ly said this could be monitored over a period of a minimum of a few months and will consider placing monitoring devices on the slope to indicate any erosion.

Mr. Sulavella indicated that stability of the slope was an engineering problem which required appraisal by specialists who can best estimate if and when the original bridge abutment foundations will be near failure. Mr. Loughborough underlined the importance of the memo from Mr. Burkhardt to Mr. Sulavella which discusses the stability of the original west abutment.

If nothing is done, general weathering and erosion from surface and groundwater flow will continue and rate of erosion will increase as the slope steepens. Cost of remedial work will thus increase with time. The advantage of construction of an extension at the same time as the other improvements to Hwy. 5 was pointed

out by Mr. Scott. Mr. Sulavella indicated that construction west of Oakville Creek Bridge will take place in 1977 and east of Oakville Creek Bridge will take place in 1978.

The proposed east end deck drain to down pipe connections design modification was discussed. Sketches were distributed showing the abs pipe connection and expansion joint. Electric heating cables are required to prevent ice build up. The expansion joint axis parallels the direction of bridge deck expansion. The Structural Office will consider the proposal and Mr. Loughborough will provide a ball park construction cost estimate.

Consideration of an addendum will take place at a later date. Mr. Sulavella will contact Mr. Loughborough to arrange a site visit to coincide with a rainstorm. Mr. Loughborough will supply a set of site photographs and a detailed sketch of Proposal II.

K Loughborough

KTL/ts

c.c. Those Present

DeLeuw Gather
CONSULTING ENGINEERS AND PLANNERS

March 14, 1977 Our ref: 01-401-31

Mr. A. Sulavella
Senior Project Manager
Planning and Design Office
Central Region
Ministry of Transportation & Communications
3501 Dufferin Street
Downsview, Ontario
M3K 1N6

Dear Sir:

Re: Erosion at Oakville Bridge
Highway 5, W.P. 205-63-01

In reply to your letter of February 25, 1977, which included recommendations by the Soil Mechanics Office resulting from the prerequisite site examination of the erosion and stability of the west slope, we have made cost estimates for 2 alternative schemes to extend the 24" CSP to the base of the west slope as follows:

Proposal 1: Half C.S.P. Channels Anchored to Slope:

Gunite 2½" thick pneumatically applied mortar treatment with 4" x 4" x 8 ga. reinforcing mesh	$ 13,000
Supply and install 36" dia. 1/2 C.S.P. with 10' long rock anchors (14 sets of 2 at 10' spacing)	8,250
Excavate and place french drain at top of slope	650
Place head wall, energy dissipator and gabion mat at outlet	3,750
Reinstatement	800
	$ 26,450
Contingencies(10%)	2,645
	$ 29,095
Say	$ 29,000

Proposal 1a:

If a soils investigation indicates that the shale slope cannot support the pneumatically applied mortar treatment, the following would be required:

300 grouted anchors 4' [illegible]	and	$ 6,910
Contingencies (10%)		690
	Add	$ 7,600

In view of the comments and recommendations made in a memorandum from G.C. Burkhardt to A. Sulavella dated February 22, 1977, the above alternative represents only a temporary solution. Due to the poor quality of the shale bedrock, Canada Gunite cannot guarantee the durability of a Gunite slope treatment. Canada Gunite indicates that freeze-thaw action will take place even if ground water pressure release outlets are installed, and eventually breakdown the Gunite treatment. Erosion due to general weathering will eventually loosen the rock anchors for both the Gunite blanket and the C.S.P. channel. Hence Proposal 1 is not recommended as a long term solution.

Proposal 1b: Manholes, Drop Pipes and Connecting C.S.P.'s:

Cast in place 5 (4' x 4' x 9" x 2@4') concrete manholes with drop pipes	$ 24,000
Lock in manholes with K-Krete	3,500
Backfill with sand and gravel for insulation against frost	19,000
Supply and install 24" ø C.S.P. at shallow gradient between manholes	1,450
Sod and stake, including top soil	4,200
Headwall and 6' x 10' x 1' gabion mat at outlet	1,250
	$ 53,400
Contingencies (10%)	5,340
	$ 58,740
Say	$ 59,000

This solution is a long term one, assuming ground water flows are low. The excellent energy dissipation will minimize erosion on the floodplain at the base of the slope. Backfill will provide frost protection for the shale slope and the manhole foundations. The reinstated slope will be protected from further general weathering. We therefore, recommend Proposal II.

We have developed a proposal for the preliminary design modification requested by the Bridge Maintenance Office, dealing with the connection from the east end gutter enlargements under the bridge deck across the bridge deck expansion joint to the existing down drain pipes.

We have considered fees incurred as a result of work carried out at your request and to complete the design work not covered by agreement no. 9200-213-74 dated July 8, 1974, and we have itemized estimated fees below.

- project administration and site meeting with Ministry representatives, January 26, 1977	$ 500
- modification requested by the Bridge Maintenance office in connection with the east end gutter enlargements discussed above	600
- developing Proposals I and II discussed above including quantities and cost estimates	700
- design and modification of contract plans for Proposal II above	2,900
- realignment of 4th Line at Highway 5, as outlined in our letter of February 9, 1977	1,800
Total Fees	$ 6,500
- disbursements, largely in connection with survey for design of Proposal II	200
Total additional fees and disbursements	$ 6,700

We will appreciate your consideration of an addendum to allow us to complete the work outlined above.

We look forward to reviewing the preliminary design modification, and two pipe extension alternatives with you.

Yours very truly,

A. Scott, P. Eng.

KTL:ll

c.c. M. Jefferson
K. Loughborough

Ministry of Transportation and Communications

Memorandum

To: Mr. A. Sulavella
Sr. Project Manager
Planning & Design Office
Central Region

From: G.C.E. Burkhardt,
Structural Section
3501 Dufferin St.

Attention:

Date: February 22, 1977

Our File Ref.

In Reply to

Subject:

Re: Oakville Creek Bridge Hwy # 5
Site 10-119 W.P. 205-63-01
District # 4 Hamilton

An inspection of the slopes at the south west corner of the above bridge was made by the undersigned on February 15, 1977 accompanied by Messrs. M. Devata and V. Korlu of the Soil Mechanics Office.

The purpose of the inspection was to observe the shale slopes in view of proposals to modify the drainage scheme at this location.

Mr. M. Devata noted that the slope consists of erodible shale and suggested that any proposed extension to the existing drain pipe should be attached to the slope by rock anchors at least 10 ft. long. Extension of the drain pipe to the bottom of the slope would reduce but not eliminate the weathering of the slope. Erosion in the vicinity of the proposed pipe could be further reduced by treating the slope with 'Gunite' concrete.

No problems are anticipated in the foreseeable future with respect to the stability of the west abutment of the original bridge. This abutment could be used to support any construction equipment required to implement the extension of the drain pipe.

C.F. Farrell

for: G.C.E. Burkhardt,
Head, Structural Section

CF:sg

c.c. M. Devata

~~FILE DIST 6~~

W.P. 205-63-01

De Leuw Cather

CONSULTING ENGINEERS AND PLANNERS

April 6, 1977

Our ref: 01-401

Mr. A. Sulavella
Project Design Engineer
Systems Design Office
Ministry of Transportation & Communications
3501 Dufferin Street
Downsview, Ontario M3K 1N6

Dear Sir:

Re: Hwy. 5 - Oakville Creek Bridge
Storm Drainage Improvement

This letter confirms a telephone conversation between your Mr. Ly and our Mr. Loughborough on Tuesday, April 5, 1977.

He indicated that his statement in our memorandum to our file 01-401 dated April 1, 1977, which reads: "Mr. Ly said this could be monitored over a period of a minimum of a few months and will consider placing monitoring devices on the slope to indicate any erosion", should be changed to read: "Mr. Ly said this could be monitored over a period of a minimum of a few months and the Soil Mechanics Section will assist in monitoring the slope if so required".

We would appreciate your making the requested change on your copy of the memorandum.

Yours very truly,

K Loughborough

K. T. Loughborough, P. Eng.

KTL:ll

c.c. C. Farrell
B. Ly

Bm
↓
File

~~DIST. 6~~

De Leuw Cather

MEMORANDUM

W. P. 205-65-01

TO: File

OUR REF: 01-401-31

FROM: K. Loughborough

DATE: April 1, 1977

Re: Hwy. 5 - Oakville Creek Bridge
Storm Drainage Improvement

Minutes of meeting held at Structural Office, MTC, 3501 Dufferin St., Downsview at 10:00 a.m., Thursday, March 17th, 1977.

Present: For the Ministry of Transportation & Communications:

A. Sulavella
C. Farrell
B. Ly

For De Leuw Cather, Canada Ltd.:

A. Scott
K. Loughborough

Mr. Loughborough outlined the background for Proposal I and Proposal II for the extension of the 24" dia. c.s.p. on the west slope discussed in a letter from Mr. Scott to Mr. Sulavella dated March 14, 1977. Mr. Loughborough indicated that Proposal I represents only a temporary solution. The Gunite treatment cannot be guaranteed for more than one year since erosion would continue although at a reduced rate, and the rock anchors would loosen eventually. Proposal II, however, represents a permanent solution.

Mr. Farrell noted that the Maintenance Office felt there appeared to be no immediate danger of slope failure at the original west pier but he felt the rate of weathering and erosion would have to be determined. Mr. Ly said this ~~could~~ should be monitored over a period of a minimum of a few months and the Soil Mech. Sect. will ~~consider placing~~ assist in monitoring ~~devices on the slope to indicate any erosion~~ the slope if so required.

called DeLeuw Cather on April 5, 1977

Mr. Sulavella indicated that stability of the slope was an engineering problem which required appraisal by specialists who can best estimate if and when the original bridge abutment foundations will be near failure. Mr. Loughborough underlined the importance of the memo from Mr. Burkhardt to Mr. Sulavella which discusses the stability of the original west abutment.

If nothing is done, general weathering and erosion from surface and groundwater flow will continue and rate of erosion will increase as the slope steepens. Cost of remedial work will thus increase with time. The advantage of construction of an extension at the same time as the other improvements to Hwy. 5 was pointed

out by Mr. Scott. Mr. Sulavella indicated that construction west of Oakville Creek Bridge will take place in 1977 and east of Oakville Creek Bridge will take place in 1978.

The proposed east end deck drain to down pipe connections design modification was discussed. Sketches were distributed showing the abs pipe connection and expansion joint. Electric heating cables are required to prevent ice build up. The expansion joint axis parallels the direction of bridge deck expansion. The Structural Office will consider the proposal and Mr. Loughborough will provide a ball park construction cost estimate.

Consideration of an addendum will take place at a later date. Mr. Sulavella will contact Mr. Loughborough to arrange a site visit to coincide with a rainstorm. Mr. Loughborough will supply a set of site photographs and a detailed sketch of Proposal II.

K Loughborough

KTL/ts

c.c. Those Present

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. A. Sulavella
Sr. Project Manager
Planning & Design Office
Central Region

From: G.C.E. Burkhardt,
Structural Section
3501 Dufferin St.

Attention:

Date: February 22, 1977

Our File Ref.

In Reply to

Subject:

Re: Oakville Creek Bridge Hwy # 5
Site 10-119 W.P. 205-63-01
District # 4 Hamilton

An inspection of the slopes at the south west corner of the above bridge was made by the undersigned on February 15, 1977 accompanied by Messrs. M. Devata and V. Korlu of the Soil Mechanics Office.

The purpose of the inspection was to observe the shale slopes in view of proposals to modify the drainage scheme at this location.

Mr. M. Devata noted that the slope consists of erodible shale and suggested that any proposed extension to the existing drain pipe should be attached to the slope by rock anchors at least 10 ft. long. Extension of the drain pipe to the bottom of the slope would reduce but not eliminate the weathering of the slope. Erosion in the vicinity of the proposed pipe could be further reduced by treating the slope with 'Gunite' concrete.

No problems are anticipated in the foreseeable future with respect to the stability of the west abutment of the original bridge. This abutment could be used to support any construction equipment required to implement the extension of the drain pipe.

C.F. Farrell

CF:sg

for: G.C.E. Burkhardt,
Head, Structural Section

c.c. M. Devata

RECEIVED
GEOTECHNICAL OFFICE
FEB 23 1977
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

B2585

RACEY, MacCALLUM AND ASSOCIATES
LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers
AND ASSOCIATED STAFF

MONTREAL VANCOUVER

TORONTO

DONALD C. MacCALLUM, B.ENG., M.E.I.C., P.ENG.
H. JOHN RACEY, B.SC., M.E.I.C., P.ENG.
A. ERIC RANKINE, B.SC., M.E.I.C., A.M.I.ELEC.E., P.ENG.

TORONTO DIVISION
20 CARLTON STREET

REPORT: No. B-500/T-520

Toronto, Ontario.
March 25th, 1957.

Department of Highways of Ontario,
200 Davenport Road,
TORONTO, Ontario.

Attention: Mr. S. McConnie.

RE: FOUNDATION INVESTIGATION FOR THE PROPOSED OAKVILLE CREEK BRIDGE CROSSING HIGHWAY 5, ONTARIO.

Dear Sirs:

Attached hereto is our report describing the results of the bedrock investigation, recently completed at the above noted site. This work consisted of 17 borings carried to a depth of approximately 15 feet into sound bedrock which was of the Queenstone shale formation. This sound rock was encountered at depths ranging from 12 to 30 feet below the present valley floor, and was overlain by very weathered shale and by a surface veneer of red sandy clay of low plasticity.

The principal conclusions of this report are as follows:-

1. The estimated safe bearing pressures that can be applied to the shale are in the order of 15 tons per square foot.

2. Since the sound bedrock will tend to weather quickly upon exposure, particularly during freezing and thawing weather, precautions should be taken to trim its surface to clean sound rock before concrete footings or piers are installed.

3. Although mud-seams were encountered in the sound bedrock, it has been reasoned that they should remain in a stable state when subjected to projected pier loads.

REPORT: No. S-500/T-520 March 25th, 1957.

4. The construction of an alternative earth embankment across the valley appears reasonable although any Queenstone shale bedrock excavated from the walls of the valley should be discarded unless it can be compacted satisfactorily. The lean red clay overlying bedrock at present highway grade, would appear to be a more economical borrow source since it will require less processing. Because of the probable embankment heights involved, a very dense state of compaction will be required. Heavy pneumatic-tired equipment or 5 foot diameter sheeps foot rollers, exerting foot pressures of the order of 300 p.s.i. should accomplish this required state of density in from 4 to 6 coverages per 6 inches of compacted lift, provided the fill moisture content is maintained at or slightly below its plastic limit. The widths of the embankment will be sufficiently wide to permit unrestricted movement of earth moving and compaction equipment, and hence an installed fill cost less than 60 cents per cubic yard should be anticipated.

5. The embankment should be founded directly upon the surface of the weathered shale and, in order to avoid compaction difficulties during possible river flooding, the lower lifts of the embankment should consist of compacted granular material.

6. The foundation requirements for the arch-culvert, associated with this embankment construction, will conform to those specified for the alternative bridge piers. The sound bedrock should adequately resist any horizontal stresses exerted by the arch structure providedprecautions are taken to pour the arch abutments against unweathered rock.

We shall be pleased to discuss any matters associated with the foundation conditions of this site, that may occur to you after the attached report has been reviewed. We thank you for the opportunity to serve you in this regard.

Yours very truly,

RACEY, MacCALLUM AND ASSOCIATES LIMITED.

W. A. Trow, P. Eng.
Divisional Soils Engineer.

WAT/Abel.
Enclosure
In quadruplicate.

Department of Highways of Ontario,
260 Davenport Road,
Toronto, Ontario.

FOUNDATION INVESTIGATION FOR A BRIDGE OVER THE OAKVILLE CREEK, HIGHWAY No. 5, DISTRICT 4, ONTARIO.

Reference: No. S-500/T-520. Racey, MacCallum and Associates Limited.
March 25th, 1957.

C O N T E N T S

E N C L O S U R E S

March 25th, 1957.

FOUNDATION INVESTIGATION FOR A BRIDGE OVER THE OAKVILLE CREEK, HIGHWAY NO. 5, DISTRICT 4, ONTARIO.

This investigation was performed in order to determine the elevation of bedrock and its competence to support the footings of a proposed highway bridge, adjacent to the existing structure. Drilling operations were started on December 7th, 1956 and completed on February 16th, 1957, and consisted of seventeen borings carried out to a depth of approximately 10 feet into sound bedrock.

This report contains a description of subsoil conditions and recommendations regarding the footing depth for the piers of the proposed bridge.

Additional comments with regard to the recently proposed soil embankment and concrete arch crossing for this valley have also been included.

SCOPE OF FIELD INVESTIGATION

The seventeen borings were carried out by means of conventional diamond drill equipment. Three inch casing was used for penetrating through the overlaying soil; core drilling was performed utilising BX bits and a 1-5/8 inch I.D. core barrel. Because water for drilling purposes had to be pumped from Oakville Creek, the only source, which involved a distance of 800 feet from some borings, the rate of drilling was somewhat slower than should be anticipated during summer months when precautions against freezing hose lines are not required.

The locations of the borings are indicated on the sketch in enclosure No. 1. Not all borings could be carried out at the positions requested because of the inaccessibility of some locations. For borings No. 13, 14, 15, 16, 17 and 18, it would have been necessary to build a drilling platform and to hoist the drill on the exact location with a crane. For this reason only one boring was made in the vicinity of numbers 15 and 16. In view of the difficulties avoided by this modification and the apparent uniformity of conditions noted, these alterations in the requested drilling program would appear to be warranted.

SUBSOIL CONDITIONS

The results of the borings are presented in the Engineering data sheets of borings No. 1 to 18. The subsurface profile can be divided into two sections, namely the overburden, and the underlaying rock. Each of these layers will be dealt with separately in the following paragraphs.

March 25th, 1957.

SUBSOIL CONDITION (Cont'd)

The soil layer in the valley has probably been derived by the process of weathering and erosion from the adjacent walls, and has since been reworked by fluvial action as the river cut its path across the valley floor. Apart from the top layer, that contains remnants of vegetation, it consists of a soft sandy clay, mainly reddish in colour. The thickness of this layer varies considerably up to a maximum of 18 feet. Unfortunately the initial requirements for this investigation were to determine the competence of the underlying bedrock for the support of heavy bridge piers, and therefore no detailed attention was given to the properties of the overlying soil.

The soil encountered on the edges of the valley, in borings No. 16, 17 and 18, has the same appearance as the above described materials, but it contains more boulders. This reddish boulder clay probably originates from the Trafalgar or Scarborough moraine, that stretches from Nelson to Scarborough. Because of the presence of the boulders, all samples were obtained using a 2 inch O.D. split spoon. The liquid and plastic limits of the clay constituent were determined and found to be 23% and 15% respectively.

The rock in this area has the appearance of Queenston shale. This shale is mainly reddish in colour, with very few fossils, and some limestone interbeds. The extent of weathering varies considerably over the site, but it shows the same trend for each pair of borings. Although the weathering is quite severe in most cases, no vertical cracks have been encountered. The shale is affected to a greater degree than the limestone interbeds. The levels indicated as mudseams are depths, where the drill did not encounter pressure. Sometimes a quantity of red muck was encountered at corresponding depth in the core barrel, but usually this material was washed out.

The percentage of core recovery, recorded on the data sheets, cannot be regarded as the amount of sound rock minus mudseams. It is more an indication of the quality of the rock encountered. In the soft red shale, the amount of recovery was reduced by breaking up and subsequent grinding of the core. Even with the relatively large size core barrel used, this action was unavoidable.

On the sketch in enclosure No. 1, the elevation of sound bedrock is recorded. In some cases this depth must be considered arbitrary, as the shale that was found sound was still relatively soft.

DISCUSSION OF RESULTS

The soil overlaying bedrock in the valley is soft and must be considered a very poor base for even a light foundation footing. The boulder clay on the edges of the valley, encountered in borings No. 16, 17 and 18, might be competent to support the

March 25th, 1957.

DISCUSSION OF RESULTS (Cont'd)

rather light end abutments, particularly at lower depths in the layer, which contains gravel and some boulders up to 5 inches. Because of the danger of differential settlements it is not advisable, however, to found the abutments on more compressible material than supports the piers. Therefore, a foundation on piles, driven to refusal either into the gravel layer or on the shale seems to be the best solution for this part of the structure. It seems advisable to determine the safe pile load by means of a load test.

For the same reason the upper levels of the very soft and weathered shale cannot be considered a safe base for the bridge piers. The foundation pressure under these structures will be considerable, and even a slight eccentricity would exert a very high pressure at the toe of a footing. Therefore, it will be necessary to excavate to the depth, indicated as sound bedrock elevation in the sketch in enclosure No. 1. The recorded elevations do correlate reasonably for each pair of borings, although a maximum of five feet difference in level was noted at some pier sites.

In order to assist in the decision regarding the permissible bearing value to apply to this Queenston shale bedrock, some analysis of the probable stress history of the rock in this area and the behaviour of mud seams under load would appear to be warranted. The accounting for the presence of mud seams in a rock formation of this great age is rather uncertain, although they could possibly represent the result of some ancient shear zones. It is difficult to conceive, however, that these seams could contain any voids because the overburden pressure on them would be too great and there was no evidence of excess hydrostatic pressures that could be associated with underground seepage or erosion channels. With regard to the pressure on the mud seams, it is reasonable to expect that Oakville Creek has cut its channel through the soft shale in geologically recent times and therefore, the effective pressure, that the seams are stabilized under, is equal to the equivalent weight of rock and overburden extending up to the present highway grade. This weight, at competent footing level, should be of the order of 9 tons per square foot.

Confined layers of clay can be reduced to a state of slow plastic flow when the shearing resistance of the material becomes less than one half of the bearing stress applied to it. Such a condition is quite conceivable under a heavy bridge pier load even allowing for some dissipation of bearing stresses through overlying sound rock. However, if the premise is accepted that large voids in the rock seams do not exist, then a plastic movement and subsequent pier settlement

March 25th, 1957.

DISCUSSION OF RESULTS (Cont'd)

cannot take place, because the plastic material will have no place to move to.

Current practice permits bearing pressures ranging from 10 to 25 tons per square foot on shale bedrock. The latter value is permitted on the Dundas shale formation underlying Metropolitan Toronto, provided mud seams are shown to be absent. In the absence of actual large scale load tests, therefore, a permissible bearing value of the order of 15 tons per square foot would not appear to be unreasonable for this site. Although this Queenston shale is reported to be more resistant to weathering than the Dundas formation, any excavation in it should be quickly covered with concrete and the work should be carried out during dry weather.

COMMENTS ON ALTERNATIVE SOIL EMBANKMENT PROPOSAL

The alternative proposal to a high level bridge is to construct a small arched culvert across Oakville Creek and to fill the remainder of the valley with an earth embankment. The following discussion of the problems involved in this proposal is based on a visual inspection of the soil overlying bedrock on the valley floor.

The matters requiring attention with regard to the proposed embankment arch culvert construction are threefold, namely the foundation of the arch, the base of the embankment and the stability of this earth structure. These problems will be discussed separately in the following paragraphs.

The loading conditions imposed by the footings of the arch structure, could well be more severe than those anticipated under the bridge piers. Therefore, it will be very important to secure a sound base for the support of this type of bridge, and to insure that the weathering of the exposed rock during footing excavation is kept to a minimum. Although the amount of horizontal thrust on these footings will depend on the type of arch to be used, the foundations should be sufficiently confined by the overlying embankment load to take any possible horizontal reaction.

Although no tests were carried out on the soil overlaying bedrock on the valley floor, the soft condition of the clay is an indication that it cannot serve as a base for an embankment of the height required. It would seem advisable therefore, to remove this thin overburden cover and to erect the embankment on the underlaying shale. For the reasons stated previously, the shale should not be exposed longer than necessary. This part of the construction should preferably be carried out during a period of dry weather. Because of the danger of flooding during construction and associated difficulties with clay compaction, it would appear desirable to place the embankment on a compacted granular base carried at least to flood level.

March 25th, 1957.

COMMENTS ON ALTERNATIVE SOIL EMBANKMENT PROPOSAL (Cont'd)

Apart from the base, the stability of the embankment is dependant upon its height, side slopes and the adequacy of compaction of the fill. The height of the embankment, could be reduced by lowering the grade level of the road in this area, which, of course, would involve rock cuts through the valley walls. It should be noted however, that the shale material from the valley boundaries cannot be used as embankment fill without considerable processing to bring it to a finely divided, compactable state. Therefore, it might be more economical to borrow fill material from the overburden along the approaches to the present bridge and to waste any shale excavated. Although the strength versus compacted density relationship for this lean silty clay overburden should be determined before stable side slopes can be estimated, the embankment heights involved will probably require a compacted density approaching the modified Proctor Optimum state. Heavy pneumatic-tired equipment or sheep foot rollers loaded to foot pressures of approximately 300 p.s.i. should obtain this desired state with from four to six complete coverages per 6 inches of compacted thickness. The cost for such work should be somewhat less than 60 cents per yard compacted in place.

CONCLUSIONS

The foregoing observations and comments can be briefly summarized as follows:-

1. The subsoil and rock on the site can be divided into three classifications; the soft sandy clay overburden, the underlying weathered shale, and sound, but soft shale of the parent Queenston formation. The thickness of the two top layers varies considerably over the site.

2. The piers of the proposed bridge will have to be founded on sound bedrock which exists at depths ranging from 12 to 30 feet below the ground surface in the valley floor. The safe bearing pressure on this sound rock is estimated to be of the order of 15 tons per square foot. The mud seams encountered in the shale, are expected to have very little effect on its bearing properties. The shale should not be exposed longer than strictly necessary after excavation, if weathering and softening is to be avoided.

3. The two end abutments of the bridge should be founded on piles, driven to refusal into the boulder clay or to shale bedrock at a depth of approximately 25 to 30 feet below ground surface.

4. The construction of an earth embankment across the valley appears quite feasible although it should not be founded directly on the soft clay overlaying bedrock. This material should be removed and replaced by a granular base up to flood river load. The shale

March 25th, 1957.

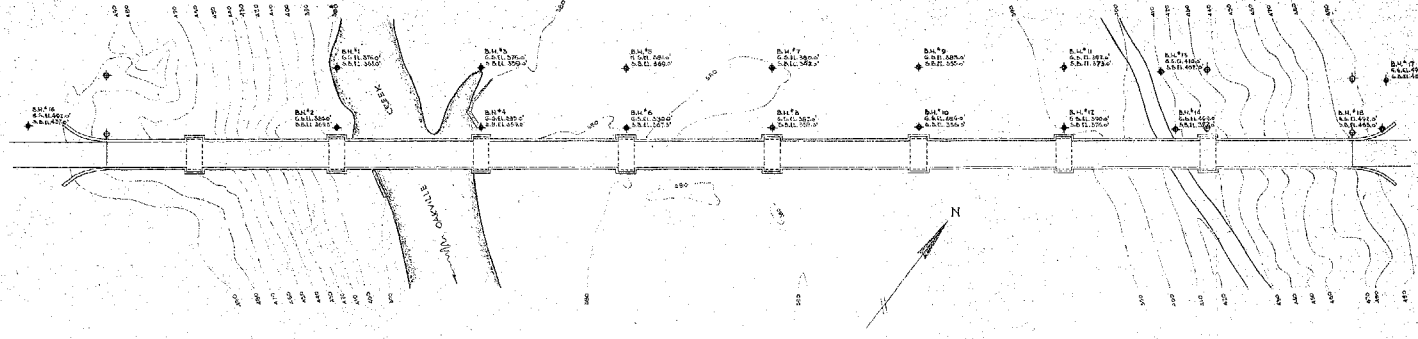
CONCLUSIONS (Cont'd)

from the valley walls cannot be used as fill for the embankment without costly processing. However, the lean red clay overlying bedrock in the approaches to the valley should be satisfactory for this purpose.

5. The foundation for an arch structure across the river should conform to the requirements outlined for safe bearing of the bridge piers.

J. J. Schoustra.

ENCLOSURE No. 1



LEGEND:
- G.S. — GROUND SURFACE
- B.R. — SOUND BEDROCK
- ⊕ — COMPLETED BORING
- ⊖ — PROPOSED LOCATION OF BORING

RACEY MAC CALLUM & ASSOCIATES LIMITED
MONTREAL TORONTO VANCOUVER

BRIDGE OVER OAKVILLE CREEK
HIGHWAY 5, DISTRICT 4, ONTARIO

SKETCH SHOWING LOCATION OF BOREHOLES, GRADE ELEVATIONS AND ELEVATION OF SOUND BEDROCK

DATE: | DRWN BY: J.K. | CHECKED BY:

JOB No. T-520 | SCALE: 1" = 40'

Order No.: S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Kelly
Driller

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 1

Brule
Helper

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 376 Datum: Dept. of Highways of Ontario.

J.S.
Checked by

20. 2. 57.
Day Month Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0376.				Ground Level
2.0374.				Overburden; soft, sandy red-brown clay.
~~3.5372.5~~				Very badly weathered red shale. Fairly sound red-brown and greenish-grey shale and some limestone layers up to 2". Mud-seams at 9 ft. depth.
11.0365.				Reasonably sound red-brown and greenish-grey shale layers and some limestone layers up to 3".
31.0345.				

TABULAR VALUES
Percentage of Core Recovery.

0 20 40 60 80 100

5
10
15
20
25
30
35
40
45

SAMPLING METHOD

1 5/8 inch Diamond drill.

Order No.: S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 2

Driller: Belly

Helper: Brule

Checked by: J.S.

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 385 Datum: Dept. of Highways of Ontario.

Day: 20. Month: 2. Year: 57.

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	385.			Ground Level
2.0	383.			Overburden; soft, sandy red-brown clay.
4.0	381.			Very badly weathered red shale. Fairly sound red-brown and greenish-grey shale layers and some limestone layers up to 3". Mud-seams at 9 ft. and between 11 and 15 ft.
15.5	369.5			Reasonably sound, red-brown and greenish-grey shale layers and some limestone layers up to 3".
31.0	354.			

Tabular Values: Percentage of Core Recovery.

0 20 40 60 80 100

5 10 15 20 25 30 35 40 45

Sampling Method: 1 5/8 inch Diamond drill.

Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Chevrier
Driller

Verzagt
Helper

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 3

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

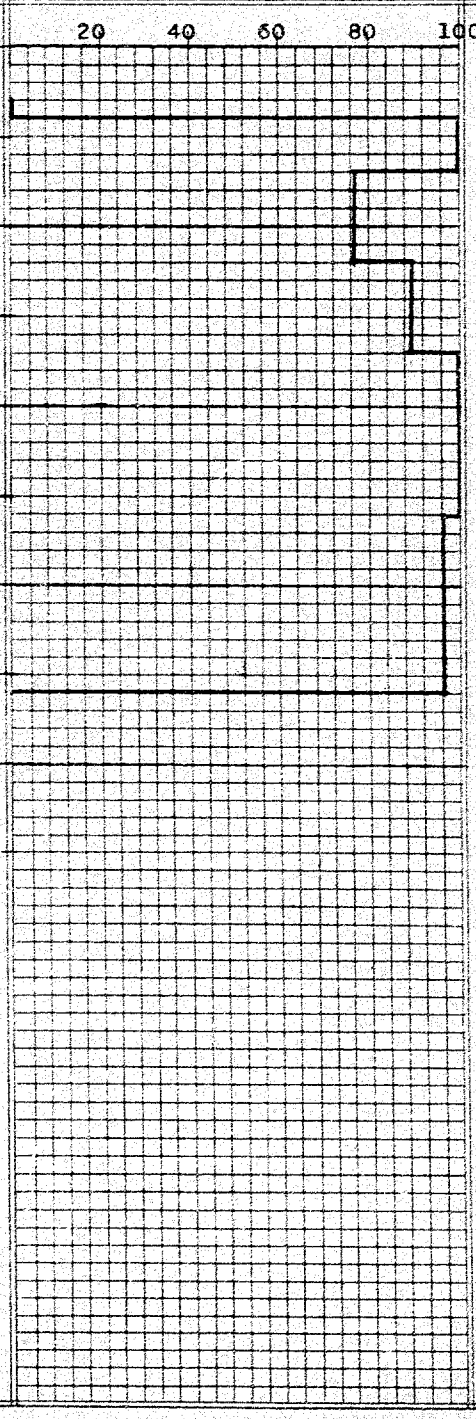
Hole Elevation: 376 Datum: Dept. of Highways of Ontario.

J.S.
Checked by

20. 2. 57.
Day Month Year

DEPTH	EL.	THICK-NESS	SYMBOL	DESCRIPTION
0.0	376.			Ground Level
3.0	373.			Overburden; soft, sandy red-brown clay.
4.0	372.			Very badly weathered red shale. Fairly sound, red-brown and greenish-grey shale layers and some limestone layers up to 2". Mud-seams at 11'6" and 15 ft.
17.0	359.			Reasonably sound, red-brown and greenish-grey shale layers and some limestone layers up to 2".
36.0	340.			

Tabular Values
Percentage of Core Recovery.



Sampling Method: 1 5/8 inch Diamond drill.

Order No. S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Belly
Driller

Brule
Helper

J.S.
Checked by

Hole Begun _____

Hole Ended _____

Engineering Data Sheet for Borehole: 4

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

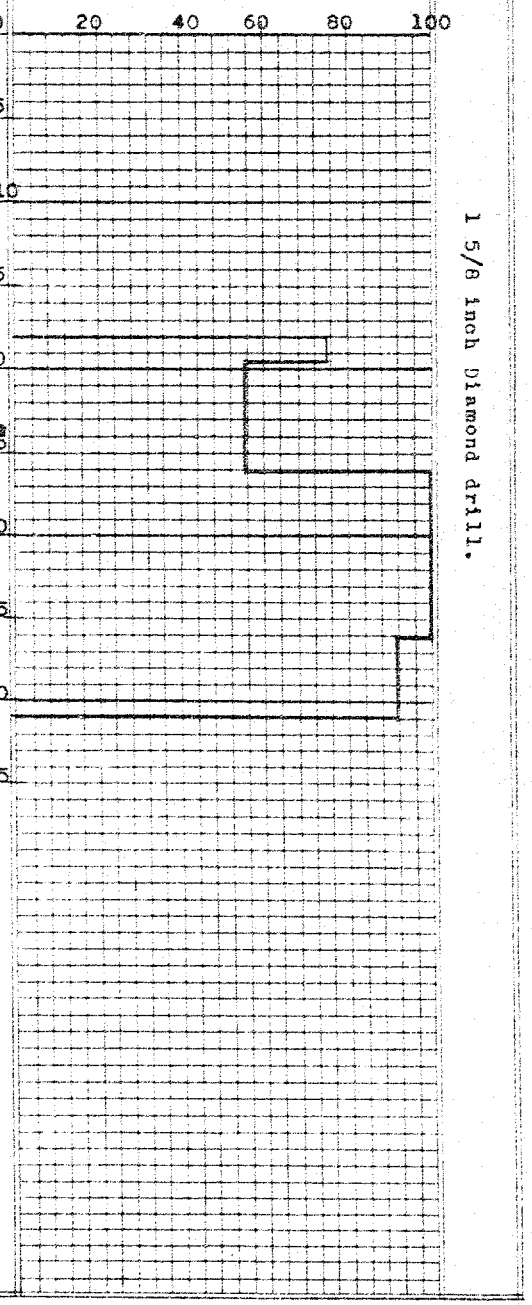
Hole Elevation: 385 Datum: Dept. of Highways of Ontario.

20. Day 2. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	385.			Ground Level
				Overburden; soft, sandy red-brown clay. Some decayed roots in top 2 ft.
18.0	367.			Soft, badly weathered limestone and shale layers.
~~19.5~~	~~365.5~~			Soft, fairly sound, red-brown and greenish-grey shale with limestone interbeds.
26.0	359.			Mud-seams from 19.2-19.6 ft. and from 21-22 ft.
				Reasonably sound, red-brown and greenish-grey shale with limestone. Possible mud-seam at 29.7 ft.
41.0	344.			

TABULAR VALUES
Percentage of Core Recovery.

SAMPLING METHOD



Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Belly
Driller

Hole Begun

Brule
Helper

Hole Ended

Engineering Data Sheet for Borehole: 5

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

J.S.
Checked by

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 381 Datum: Dept. of Highways of Ontario.

20. Day | 2. Month | 57. Year

Depth	El.	Thickness	Symbol	Description
0.0	381.			Ground Level
				Overburden; soft red-brown clay with red shale fragments. Some partly decayed roots in top 2 ft.
6.8	374.2			Reasonably sound red-brown shale with limestone interbeds up to 2". Mud-seam at 11 ft.
12.0	369.			Reasonably sound red-brown and greenish-grey shale with few limestone interbeds. Mud-seam at 15 ft.
35.0	346.			

Tabular Values
Percentage of Core Recovery.

0 20 40 60 80 100

0
5
10
15
20
25
30
35
40
45

Sampling Method

Split Spoon 48 bls/ft.

1 5/8 inch Diamond drill.

Order No.: S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 6

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 380 Datum: Dept. of Highways of Ontario.

Belly — Driller
Brule — Helper
J.S. — Checked by
20. 2. 57. — Day / Month / Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	380.			Ground Level
				Overburden; soft, sandy, red-brown clay with red shale fragments. Some partly decayed roots in top 2 ft.
7.7	372.3			Very soft, badly weathered red-brown shale with limestone interbeds up to 2".
12.7	367.3			Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 3". Probably mud-seam at 19.7 ft.
34.2	345.8			

Tabular Values — Percentage of Core Recovery.

0 20 40 60 80 100

5 10 15 20 25 30 35 40 45

Sampling Method: 1 5/8 inch Diamond drill.

Order No.: S-50-/T-529

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Belly
Driller

Brule
Helper

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 7

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 380 Datum: Dept. of Highways of Ontario.

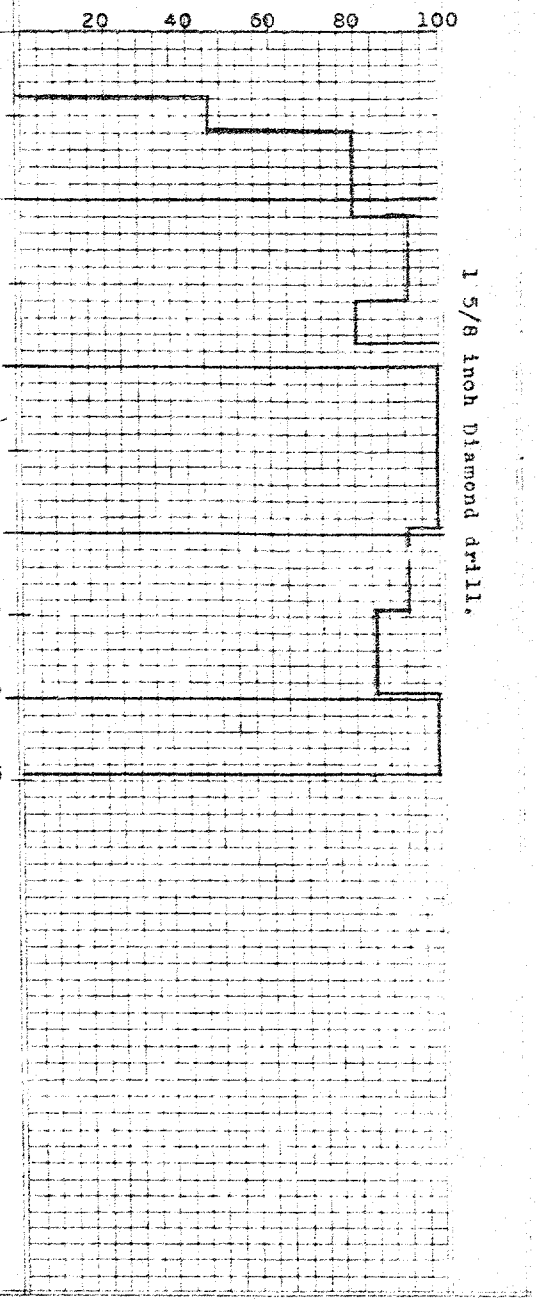
J.S.
Checked by

20. Day 2. Month 57. Year

DEPTH	EL	THICKNESS	SYMBOL	DESCRIPTION
0.0	380.			Ground Level.
		2.0		Overburden; soft, sandy red-brown clay with red shale fragments.
2.0	378.			
		2.0		Very soft, badly weathered red shale.
4.0	376.			
		14.0		Rather weathered, soft red shale.
18.0	362.			
		26.5		Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 2". Mud-seams at 15.7 and 17 ft.
44.5	335.5			

Tabular Values — Percentage of Core Recovery.

Sampling Method



Order No.: 3-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Chevrier
Driller

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 8

Verzagt
Helper

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 382 Datum: Dept. of Highways of Ontario.

J.S.
Checked by

20. Day 2. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	382.			Ground Level
				Overburden; soft, sandy red-brown clay with shale fragments and limestone boulders.
6.0	376.			
				Very soft, badly weathered red-brown shale. Mud-seams noted at 13 ft. and 19. ft.
24.0	358.			
				Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 3".
43.0	339.			

Tabular Values
Percentage of Core Recovery.

0	20	40	60	80	100
5					
10					
15					
20					
25					
30					
35					
40					
45					

SAMPLING METHOD

1 5/8 Diamond drill.

Order No.: S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Linton — Driller

Hole Begun

Hole Ended

Helper

Engineering Data Sheet for Borehole: 9

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 385 Datum: Dept. of Highways of Ontario.

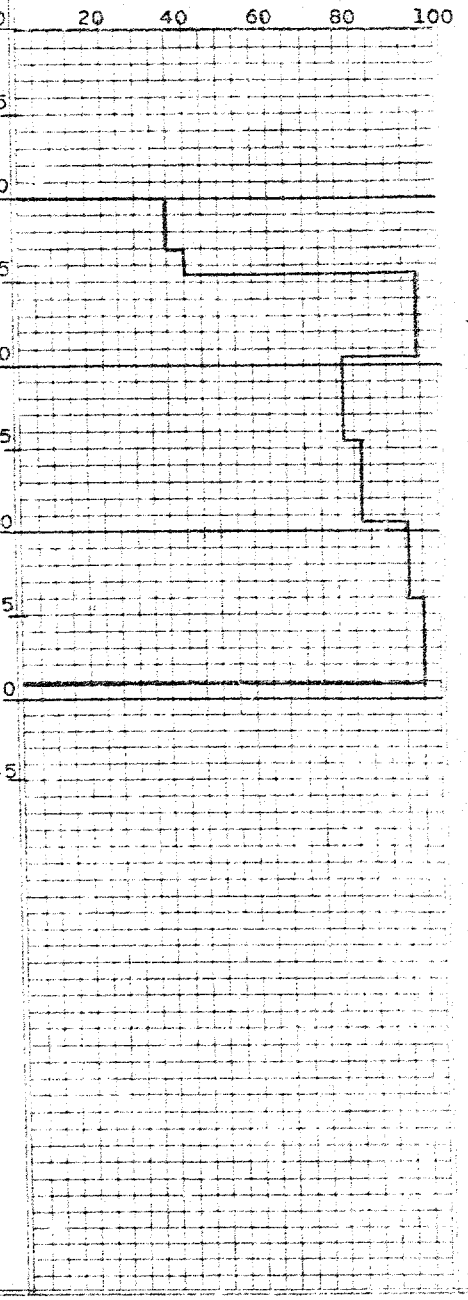
J.S. — Checked by

7. Day 3. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	385.			Ground Level.
				Overburden; soft, red-brown sandy clay and some weathered shale fragments.
10.0	375.			Very badly weathered, red-brown and greenish-grey shale.
14.5	370.5			Mud-seam at 10.5 ft.
				Slightly weathered, red-brown and greenish-grey shale. Mud-seam at 25.5 ft. Some limestone interbeds up to 4".
29.5	355.5			Sound, red-brown and greenish-grey shale.
39.0	346.			

Tabular Values — Percentage of Core Recovery.

Coring Method: 1 5/8 inch Diamond drill.



Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED — Belley, Driller

Hole Begun ____ *Foundation Engineering Division* — Brule, Helper

Hole Ended ____ **Engineering Data Sheet for Borehole:** 10 — J.S., Checked by

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 386 Datum: Dept. of Highways of Ontario. — 7. Day, 3. March, 57. Year

Depth	El.	Thickness	Symbol	Description
0.0	386.			Ground Level
				Overburden; soft, red-brown sandy clay and some soft shale.
10.0	376.			Badly weathered, soft red-brown and greenish-grey shale. Mud-seams noted at 16, 19 and 21 ft.
23.0	363.			Slightly weathered red-brown and greenish-grey shale. Mud-seam at 24 ft.
30.0	356.			Sound, red-brown and greenish-grey shale. Some limestone interbeds up to 2".
43.0	343.			

Tabular Values — Percentage of Core Recovery.

0 20 40 60 80 100

0 5 10 15 20 25 30 35 40 45

Drilling Method: 1 5/8 inch Diamond drill.

Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED — Linton, Driller

Foundation Engineering Division

Hole Begun

White, Helper

Hole Ended

Engineering Data Sheet for Borehole: 11

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 392 Datum: Dept. of Highways of Ontario.

J.S., Checked by

8. Day 3. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	392.			Ground Level
		7.5		Overburden; soft, red-brown sandy clay.
7.5	384.5			
		11.5		Badly weathered, red-brown and greenish-grey shale with limestone interbeds up to 3". Mud-seams at 9 ft, 12 ft and 18 ft.
19.0	373.			
		15.7		Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 3". Mud-seam at 27 ft.
34.7	357.3			

Percentage of Core Recovery. — Tabular Values — Sampling Method

0 20 40 60 80 100

5 10 15 20 25 30 35 40 45

1 5/8 inch diamond drill.

Order No. S-500/T-520

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Chevrier
Driller

Hole Begun

Hole Ended

Stanley
Helper

Engineering Data Sheet for Borehole: 12

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 390 Datum: Dept. of Highways of Ontario.

J.S.
Checked by

7. Day | 3. Month | 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	390.			Ground Level
				Overburden; soft red-brown sandy clay with some weathered shale.
12.5	377.5			
14.0	376.			Badly weathered, red-brown shale.
				Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 5".
46.0	344.			

Tabular Values
Percentage of Core Recovery.

Sampling Method

0 20 40 60 80 100

0
5
10
15
20
25
30
35
40
45

1 5/8 inch Diamond drill

Order No.: S-500/T-53

RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Chevrier
Driller

Stanley
Helper

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 13

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 410 Datum: Dept. of Highways of Ontario.

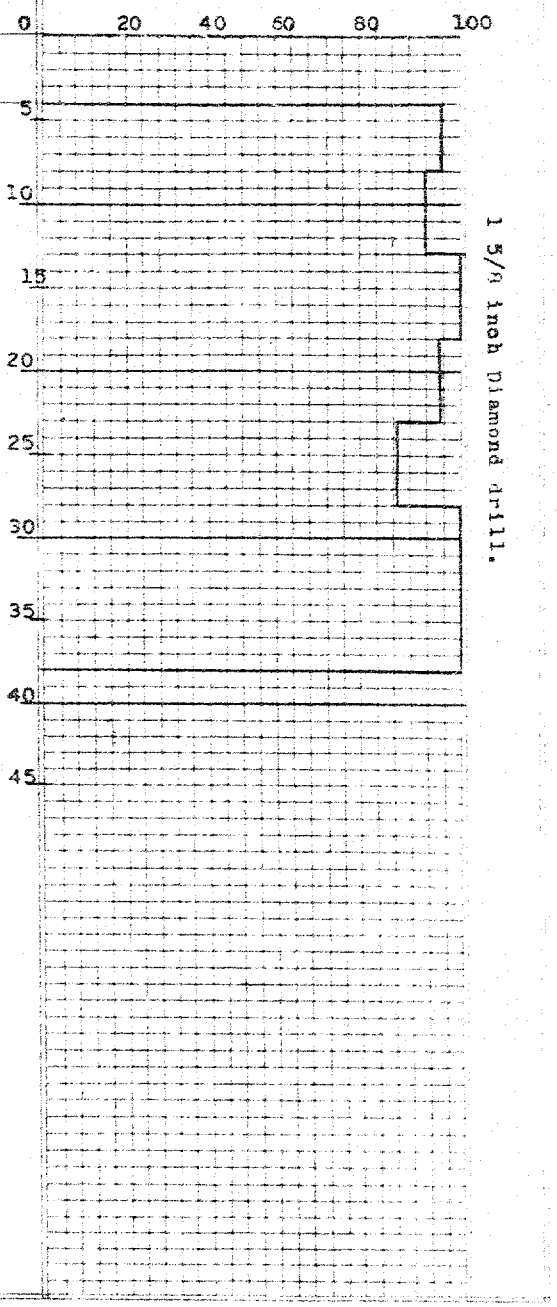
J.S.
Checked by

7. Day 3. Month 57. Year

DEPTH	EL.	THICK. STRA.	SYMBOL	DESCRIPTION
0.0	410.			Ground Level
		4.0		Overburden; soft, red-brown sandy clay.
4.0	406.			
		4.0		Weathered, greenish-grey shale and limestone layers.
8.0	402.			
		30.0		Sound, red-brown and greenish-grey shale with limestone interbeds up to 24". Mud-seams noted at 6 ft. and 25 ft.
38.0	372.			

Tabular Values
Percentage of Core Recovery.

Sampling Method



Order No. S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED Chevrier

Hole Begun — *Foundation Engineering Division* — Stanley

Hole Ended — **Engineering Data Sheet for Borehole:** 14

Job Name: Bridge over Oakville Creek. J.S.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure no. 1.

Hole Elevation: 409 Datum: Dept. of Highways of Ontario. 7. Day 3. Month 57. Year

DEPTH	ELEV.	SYMBOL	DESCRIPTION
0.0	409.		Ground level
			Overburden; soft, sandy red-brown clay with soft shale.
5.0	404.		Very soft red-brown and greenish-grey shale.
12.0	397.		Reasonably sound, red-brown and greenish-grey shale with limestone interbeds up to 2". Mud-seams at 7 ft., 11 ft., 18 ft. and 29 ft.
41.0	368.		

TABULAR VALUES

0 20 40 60 80 100

5 10 15 20 25 30 35 40 45

1 5/8 inch Diamond drill.

Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED — Chevrier, Driller

Hole Begun: — *Foundation Engineering Division* — Stanley, Helper

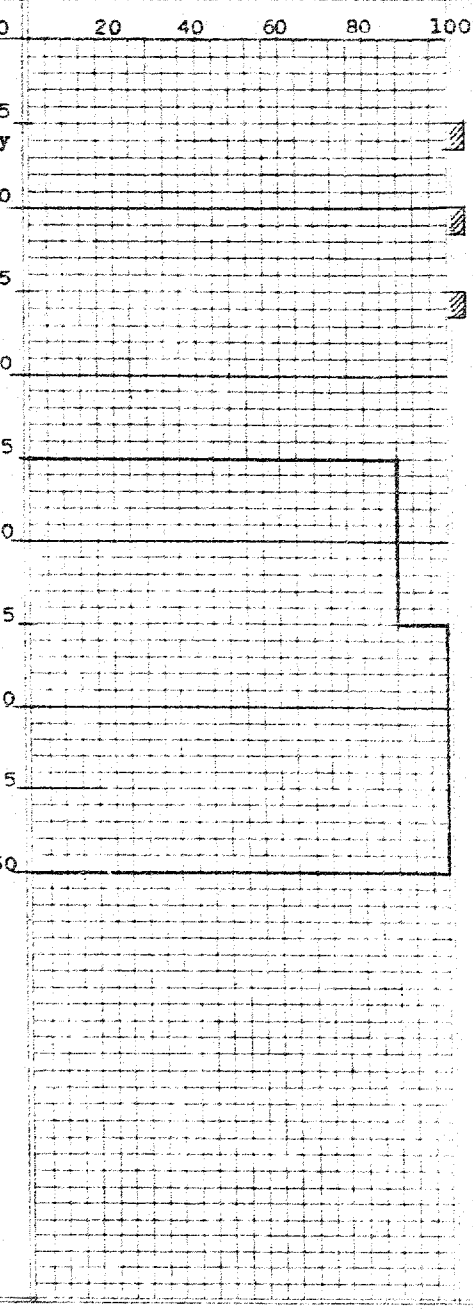
Hole Ended: — **Engineering Data Sheet for Borehole: 16**

Job Name: Bridge over Oakville Creek.
Job Located: Highway 5, District 4, Ontario.
Hole Located: As shown on enclosure No. 1.
Hole Elevation: 492 Datum: Dept. of Highways of Ontario. — J.S., Checked by

8. Day 3. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	492.			Ground level
				Overburden; soft, red-brown sandy clay with numerous stones and boulders. Penetration resistance at 5, 10 and 25 ft. depth resp. 23, 15 and 29 blows/ft.
25.0	467.			Badly weathered red-brown and greenish-grey shale. Limestone interbeds up to 2".
35.0	457.			Sound red-brown shale with limestone interbeds up to 3".
50.0	442.			

Tabular Values — Percentage of Core Recovery.



Sampling Method: Driven split spoon samples. 1 5/8 inch Diamond drill.

Order No. SS-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

Chevrier
Driller

Stanley
Helper

Hole Begun

Hole Ended

Engineering Data Sheet for Borehole: 17

Job Name: Bridge over Oakville Creek.

Job Located: Highway 5, District 4, Ontario.

Hole Located: As shown on enclosure No. 1.

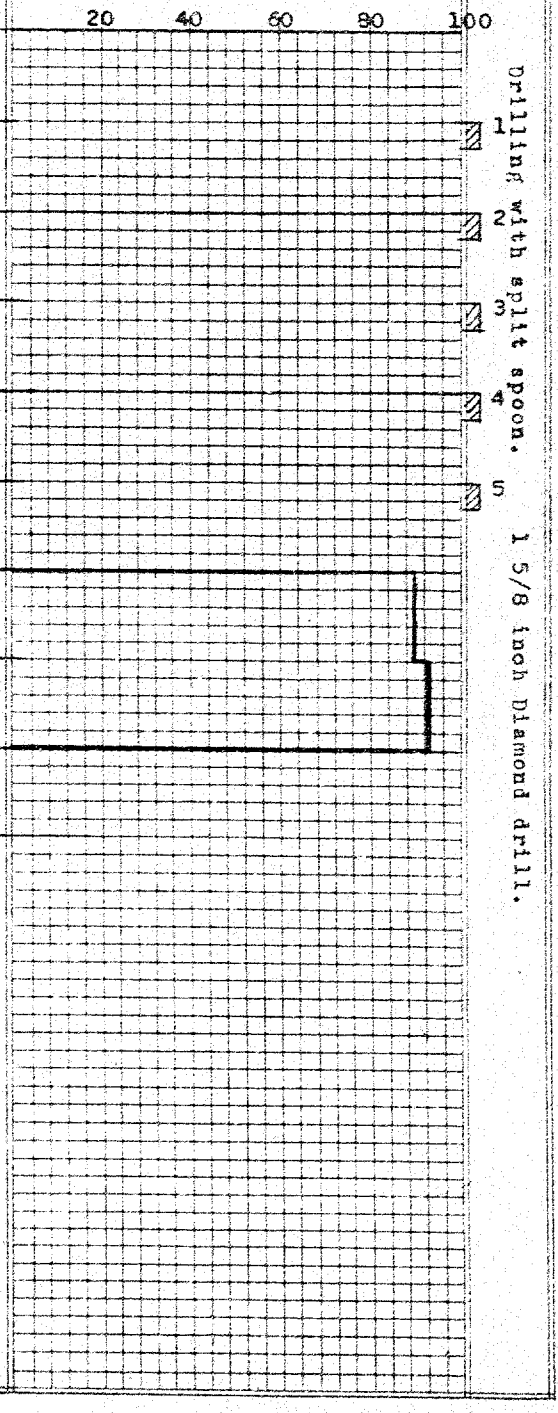
Hole Elevation: 493 Datum: Dept. of Highways of Ontario.

J.S.
Checked by

7. 3. 57.
Day Month Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0.0	493.			Ground Level
				Overburden; soft red-brown sandy clay, with decayed roots in top 6 ft.. Limestone boulders between 20 and 30 ft. depth.
30.0	463.			Reasonably sound red-brown shale with limestone interbeds up to 3".
40.0	453.			

Tabular Values
Percentage of Core Recovery.



Order No.: S-500/T-520 RACEY, MacCALLUM AND ASSOCIATES LIMITED — Chevrier, Driller

Hole Begun

Foundation Engineering Division

Stanley, Helper

Hole Ended

Engineering Data Sheet for Borehole: 18

Job Name: Bridge over Oakville Creek.

Job Located: Highway No. 5, District No. 4, Ontario.

Hole Located: As shown on enclosure No. 1.

Hole Elevation: 492 Datum: Dept. of Highways of Ontario.

J.S., Checked by

8. Day 3. Month 57. Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION	TABULAR VALUES Percentage of Core Recovery.	SAMPLING METHOD
0.0	492.			Ground Level		
				Overburden; soft, red-brown sandy clay, with numerous limestone boulders from 20 ft.		
29.0	463.			Sound, red-brown and greenish-grey shale with limestone interbeds up to 3". Mud-seams at 35 ft.		
65.0	427.					

0 20 40 60 80 100

5 10 15 20 25 30 35 40 45 50 55 60 65

1 5/8 inch Diamond drill.