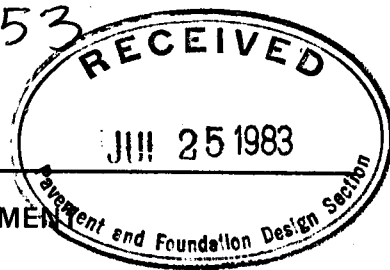




Ontario

Ministry of
Transportation and
Communications

GEODES No:
30M3-53



MEMORANDUM TO CONSULTANT'S AGREEMENT

between the Ministry and:

Golder Associates
(Eastern Canada) Limited
3151 Wharton Way
Mississauga, Ontario
L4X 2B6

Memorandum Number: 1 Agreement Number: 4242-9082-267
Agreement Date: 1983-02-11
Agreement Description: Geotechnical Investigation to determine
causes of and remedies for water seepage
at Thorold Tunnel, Hwy. 58
District 4, Hamilton

Pursuant to Section 1.9 of the above agreement, you are to
perform the following services.

Carry out additional fieldwork and office work including
field inspections during canal drawdown as outlined in
Golder's letter of 1983-03-30.

This work shall be completed by 1983-07-11, for the
fee of \$10,500.00, calculated on a time basis as described under

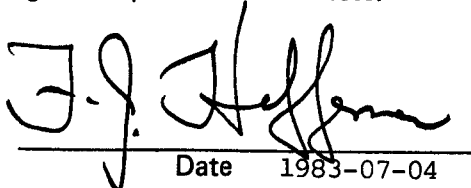
Article 3 of the agreement.

Invoices in respect of this work shall be submitted to K.G. Selby, P. Eng.
Senior Foundations Engineer, M.T.C. 3rd Floor, Central Building
1201 Wilson Avenue, Downsview, Ontario, M3M 1J8

Please acknowledge receipt of this memorandum by signing, affixing seal,
and returning the original and one copy to D.W. Fry, Administrative Officer
Hwy. Design Office, West Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Golder Associates
(Eastern Canada) Limited

agrees to provide the services.


Date 1983-07-04


Executive Director / Date 1983-06-22

memorandum



To: Mr. Jim Lougheed
Maintenance Section
District #4 (Hamilton)

Date: 83 03 22

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Inspection of Rock Slot
South of West Service Building
Thorold Tunnel, Hwy. 58
District #4, Hamilton

Attached are two copies of the report by Acres following their inspection, at our request, of the Rock Slot at Thorold Tunnel. As you will note they conclude that the slot is in satisfactory condition and that therefore no remedial action is required. With regard to their comments on Page 10 regarding flow into the west sump our records show that for 1982 the pumping time (and hence the quantity pumped) was 12300 hours which is less by about 12 percent than the average for the previous 5 years which was about 14000 hours. There appears to be no evidence that the situation is worsening..

K. G. Selby

K.G. Selby, P.Eng.
Senior Foundations Engineer

KGS:syc

memorandum



To: Mr. F. G. Allen
Executive Director
Highway Engineering Division
Central Building

Date: 1982 08 04

From: Engineering Materials Office
Room 313, Central Building

Re: Consultant Assignment for Foundation Investigation,
Thorold Tunnel - Water Seepage Problem
Hwy. 58, District 4, Hamilton

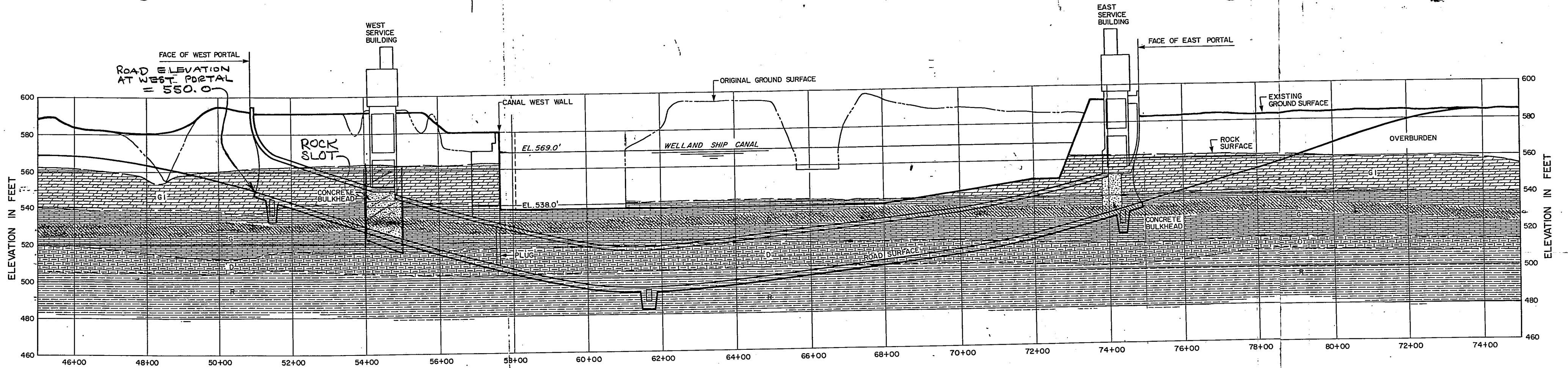
Central Region have requested that an investigation be conducted under the direction of the Pavement and Foundation Design Section to determine the condition of the bentonite seal in the "Rock Slot" at the Thorold Tunnel and the remedial measures necessary to restore the integrity of the seal. Also, they have requested that the subsurface conditions and the structural design of the tunnel be reviewed in order to determine the effects on the tunnel of proposed construction activities (including some blasting) to be undertaken by The St. Lawrence Seaway Authority next winter. The services to be provided are of a complex nature and since Acres Consulting Services, Niagara Falls, are the original geotechnical consultants and structural designers of the tunnel it is recommended that this firm be awarded an assignment to carry out the necessary work.

The total estimated fee for the work is \$10,000 all of which will be expended during this current fiscal year. Please consider this assignment at your earliest convenience.

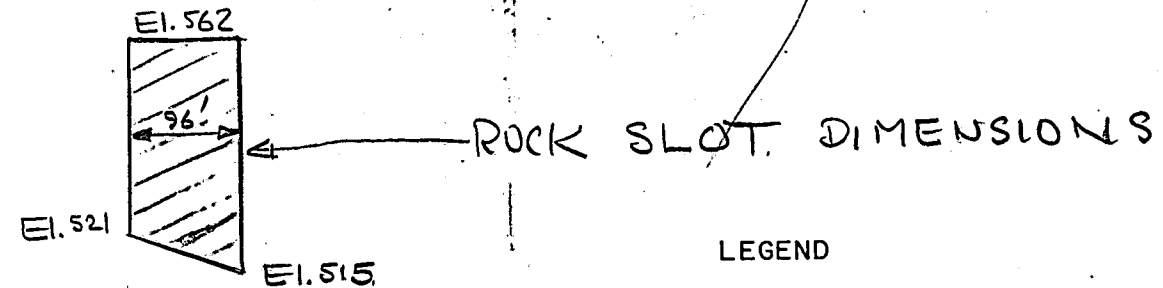
A handwritten signature in dark ink, appearing to read "D. R. Brohm", written in a cursive style.

D. R. Brohm
Manager
Engineering Materials Office

DRB/KGS/jb
cc: K.G. Selby



GEOLOGICAL PROFILE ALONG TUNNEL CENTRE LINE



STA 54+08

STA 55+04

LEGEND

MIDDLE SILURIAN PERIOD BEDROCK

- | | | |
|--------------------|--|--------------------------------------------------------------------------------------------|
| YOUNGEST | | GOAT ISLAND MEMBER
(DOLOMITE WITH SOME DOLOMITIC LIMESTONE) |
| LOCKPORT FORMATION | | GASPORT MEMBER
(DOLOMITIC LIMESTONE WITH SHALE) |
| | | DECEW MEMBER
(DOLOMITE WITH SOME DOLOMITIC LIMESTONE) |
| OLDEST | | ROCHESTER FORMATION
(CALCAREOUS SHALE WITH THIN LIMESTONE BEDS) |
| | | SHALY LIMESTONE LAYER IN GASPORT MEMBER
PROVIDING INITIAL LOAD ON WEST SERVICE BUILDING |

NOTES

1. GEOLOGICAL BOUNDARIES ARE INTERPRETED AS BEING THOSE EXISTING ALONG THE CENTRE LINE.
2. AVERAGE DIP OF BEDDING PLANES 35 FT./MILE TO THE SOUTH.

ACRES

DEPARTMENT OF TRANSPORTATION
AND COMMUNICATIONS
THOROLD TUNNEL STRUCTURAL INVESTIGATIONS

TUNNEL AREA
GEOLOGICAL PROFILE

memorandum



To: Mr. V. Mitranic
Senior Project Manager
Planning & Design
Central (5000 Yonge St.) Region

Date: 83 01 12

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Thorold Tunnel Improvements
W.P. 70-77-04

This is in reply to your memo of 82 12 17 regarding the status of the floor seepage investigation in the Thorold Tunnel.

We are in the process of requesting proposals from two geotechnical consultants, one of which will be awarded the assignment.

At the present time, the Seaway have lowered the canal level by about 10 m in order to carry out construction work. Refilling will commence about March 1st. The seepage investigation will be timed so as to cover the low level and high level water conditions in the canal therefore, we expect that fieldwork will commence on or before 83 02 01 and will be completed by 83 03 15. A final report should be available by 83 04 01.

A handwritten signature in cursive script, appearing to read "K. G. Selby".

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS:syc

cc: G.C.E. Burkhardt
C. Robertson
R. Fitzgibbon

memorandum



To: G.C.E. Burkhardt
Head, Structural Office
Central (5000 Yonge St.) Region
Attn: M. Bendayan

Date: 82 10 01

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: St. Lawrence Seaway Authority
Contract 12-1826 - Extension of Approach
Wall, Lock 7 (1982), Welland Canal,
Seaway, Western Region

Attached for your information and use is a copy of a report by Acres Consulting Services Ltd., following their review, at our request, of drawings and specifications for the above-mentioned contract. Also attached is a copy of a letter from R.W. Poe, Civil Engineer, The Seaway, Transport Canada, together with Addendum No. 2 of Contract 12-1826 which shows compliance with Acres' recommendations. It will be necessary of course for the Ministry to further liaise with the Seaway and/or their contractor to ensure adequate monitoring. Please advise if we can be of any further assistance in this matter.

K.G. Selby

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS:syc

cc: C. Robertson

Atts.



October 26, 1982
P6641.00

Ministry of Transportation
and Communications
1182 North Shore Blvd East
District Office
Burlington, Ontario
L7R 3Z9

Attention: Mr. J. Nation

Gentlemen:

Report Entitled "Thorold Tunnel -
Effect on Tunnel Structure of
Constructing an Extension to the
Upper East Approach Wall, Lock 7"

Further to your telephone request of October 26, 1982, we are
pleased to submit herewith one additional copy of the subject
report for your on-site files at the Thorold Tunnel.

Yours very truly,

T. J. Bradshaw
Deputy Head,
Geotechnical Department

TJB:mjg
Encl

cc - K. G. Selby ✓

ACRES CONSULTING SERVICES LIMITED
5259 Dorchester Road, P.O. Box 1001, Niagara Falls, Ontario L2E 6W1
Telephone 416-354-3831 Telex 061-5107
Cables ACRES CAN NFS

Toronto, Burlington, Calgary, Halifax, Niagara Falls, St. John's, Vancouver, Winnipeg





The St. Lawrence Seaway
Transport Canada

La Voie maritime du Saint-Laurent
Transports Canada

File: 12-1826-1-1

Western Region
P.O. Box 370
St. Catharines, Ontario
L2R 6V8

September 21, 1982

Mr. K. G. Selby
Senior Foundations Engineer
Engineering Material Office
Ministry of Transportation
and Communication of Ontario
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Reference: Contract 1826 - Extension to Approach Wall, Lock 7

Dear Sir:

Please find attached a copy of Addendum No. 2 for Contract 1826 with revisions reflecting the recommendations in the report submitted by Acres Consulting Services on the construction of the new wall over the Thorold Tunnel.

If you have any questions please give me a call.

Yours very truly,

R. W. Poe
Civil Engineer

RWP/mb
Attach.



Canada

ADDENDUM NO. 2

CONTRACT NO. 12-1826 - Extension of Approach Wall, Lock 7 (1982), Welland Canal, Seaway, Western Region

This Addendum modifies and forms part of the Contract Documents for this work, as follows:

SPECIFICATIONS

Section 1 - General

Subsection 1.05 - Use of explosives

Add the following paragraph to 1.05.13

"The peak particle velocity at the tunnel structure adjacent to the approach wall site shall not exceed twenty-five millimetres per second (25 mm/s)."

Add the following to 1.05.14 first paragraph line four after "blasting"

"to carry out a preblast survey of the tunnel structure and"

Subsection 1.06 - Water levels

Add the following paragraph

"Following the flooding of the reach on February 28, 1983 the water level will be maintained at elevation 172.9 plus or minus zero decimal one metres (± 0.1 m) until the opening of navigation at which time the level will be raised to the minimum operating level of 173.68 metres."

Section 3 - Demolition

Subsection 3.06 - Disposal

Line two delete the following

"as shown on the drawings and"

Section 4 - Excavation

Subsection 4.03 - Earth excavation

Add the following paragraph

"Silt material excavated from the canal bottom shall be transported in water tight boxes."

Subsection 4.04 - Bedrock excavation

Add the following to 4.04.6

"however blasting shall not be used for the excavation of the foundations for piers 2 and 3".

Subsection 4.05 - Disposal

Delete lines two and three and add the following to the sentence.

"in the designated disposal area which is located east of lock 7, northwest of the intersection of Peter Street and Davis Road. The Contractor shall build a containment area which will require the following additional work:

- .1 Removal of brush from the lower southerly portion of the designated area along Peter street.
- .2 Strip and stockpile the topsoil from the disposal area including the areas where the dykes will be placed and spread this topsoil on the disposal area at the completion of the contract.
- .3 Construct a containment dyke to a height of two to two decimal five metres (2 to 2.5 m) on the south, west and east sides of the area, as directed by the Engineer. In-situ clay from the stripped area, excavated to a maximum depth of one metre (1 m) shall be used to construct the dyke. The clay shall be placed in layers not exceeding two hundred millimetres (200 mm) maximum thickness and shall be compacted to achieve 98 percent of standard Proctor density as determined by ASTM standard D698 method 'A'.
- .4 No material larger than one hundred millimetres (100 mm) shall be disposed of within the top three hundred millimetres (300 mm) of the final disposal surface, and the disposal area shall be graded to provide good drainage.
- .5 Ditching shall be done along the northerly boundary of the disposal area and from there, southerly to Ten Mile Creek to restore the drainage pattern. The shaping, ditching and topsoiling shall all be done as directed by the Engineer.

This disposal area is for the following materials only:

- .1 Common excavation including silt material from the canal bottom
- .2 Rock excavation
- .3 Demolished concrete
- .4 Rockfill

Materials other than listed (debris etc.) shall be disposed of elsewhere by the Contractor and the Authority shall be saved harmless from all claims that may arise from such disposal.

The Contractor shall cooperate with others who will be using this disposal area."

Subsection 4.06 - Measurement for payment

Add to Item No. 6 - Excavation .3 Bedrock, the following

- "1 Piers 2 and 3
- .2 Remaining bedrock"

Add before the last paragraph the following:

"Item No. 6A - Dyke Construction for the Disposal Area

Dyke construction for the disposal area will be measured for payment by the cubic metre (m^3) for the number of cubic metres (m^3) of material actually placed and compacted as specified in the dyke.

Volumes will be calculated by the average end area method in the dyke.

Item No. 6B - Preparation of the Disposal Area

Preparation of the disposal area will be measured for payment on a lump sum basis.

The price tendered for this item shall include the removal of brush, topsoil stripping and stockpiling, drainage, final grading and replacement of topsoil.

Section 6 - Reinforcing Steel and Grouted Anchors

Subsection 6.04 - Measurement for payment

Add the following paragraph just before the last paragraph

"The price tendered for the 'No. 55M Anchors' shall include the supply of all labour, equipment and materials required to carry out anchor pull tests on two of these 55M anchors designated by the Engineer in order to prove the grouting procedure. Should the anchor pull tests fail the Contractor shall test additional anchors until the grouting procedure meets the pull test requirements."

DRAWINGS

Drawing 3568-1

Delete the disposal area from the drawing.

UNIT PRICE TABLE

The unit price table in the tender form is changed to the attached new unit price table.



The St. Lawrence Seaway
Transport Canada

La Voie maritime du Saint-Laurent
Transports Canada

File: 12-1826-1-1

Western Region
P.O. Box 370
St. Catharines, Ontario
L2R 6V8

September 21, 1982

Mr. K. G. Selby
Senior Foundations Engineer
Engineering Material Office
Ministry of Transportation
and Communication of Ontario
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Reference: Contract 1826 - Extension to Approach Wall, Lock 7

Dear Sir:

Please find attached a copy of Addendum No. 2 for Contract 1826 with revisions reflecting the recommendations in the report submitted by Acres Consulting Services on the construction of the new wall over the Thorold Tunnel.

If you have any questions please give me a call.

Yours very truly,

R. W. Poe
Civil Engineer

RWP/mb
Attach.

Canada



ADDENDUM NO. 2

CONTRACT NO. 12-1826 - Extension of Approach Wall, Lock 7 (1982), Welland Canal, Seaway, Western Region

This Addendum modifies and forms part of the Contract Documents for this work, as follows:

SPECIFICATIONS

Section 1 - General

Subsection 1.05 - Use of explosives

Add the following paragraph to 1.05.13

"The peak particle velocity at the tunnel structure adjacent to the approach wall site shall not exceed twenty-five millimetres per second (25 mm/s)."

Add the following to 1.05.14 first paragraph line four after "blasting"
"to carry out a preblast survey of the tunnel structure and"

Subsection 1.06 - Water levels

Add the following paragraph

"Following the flooding of the reach on February 28, 1983 the water level will be maintained at elevation 172.9 plus or minus zero decimal one metres (± 0.1 m) until the opening of navigation at which time the level will be raised to the minimum operating level of 173.68 metres."

Section 3 - Demolition

Subsection 3.06 - Disposal

Line two delete the following

"as shown on the drawings and"

Section 4 - Excavation

Subsection 4.03 - Earth excavation

Add the following paragraph

"Silt material excavated from the canal bottom shall be transported in water tight boxes."

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Add the following to 4.04.6

"however blasting shall not be used for the excavation of the foundations for piers 2 and 3".

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Delete lines two and three and add the following to the sentence.

"in the designated disposal area which is located east of lock 7, northwest of the intersection of Peter Street and Davis Road. The Contractor shall build a containment area which will require the following additional work:

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- .2 Rock excavation
- .3 Demolished concrete
- .4 Rockfill

Materials other than listed (debris etc.) shall be disposed of elsewhere by the Contractor and the Authority shall be saved harmless from all claims that may arise from such disposal.

The Contractor shall cooperate with others who will be using this disposal area."

Subsection 4.06 - Measurement for payment

Add to Item No. 6 - Excavation .3 Bedrock, the following

- ".1 Piers 2 and 3
- .2 Remaining bedrock"

Add before the last paragraph the following:

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Dyke construction for the disposal area will be measured for payment by the cubic metre (m^3) for the number of cubic metres (m^3) of material actually placed and compacted as specified in the dyke.

Volumes will be calculated by the average end area method in the dyke.

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Preparation of the disposal area will be measured for payment on a lump sum basis.

The price tendered for this item shall include the removal of brush, topsoil stripping and stockpiling, drainage, final grading and replacement of topsoil.

Section 6 - Reinforcing Steel and Grouted Anchors

Subsection 6.04 - Measurement for payment

Add the following paragraph just before the last paragraph

"The price tendered for the 'No. 55M Anchors' shall include the supply of all labour, equipment and materials required to carry out anchor pull tests on two of these 55M anchors designated by the Engineer in order to prove the grouting procedure.

Should the anchor pull tests fail the Contractor shall test additional anchors until the grouting procedure meets the pull test requirements."

DRAWINGS

Drawing 3568-1

Delete the disposal area from the drawing.

UNIT PRICE TABLE

The unit price table in the tender form is changed to the attached new unit price table.



Ontario

Ministry of
Transportation and
Communications

K. Selby
SEP 03 1982
Highway Engineering Division
Central Building, Room 234,
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

August 16, 1982

Acres Consulting Services Ltd.
5259 Dorchester Road
P.O. Box 1001
Niagara Falls, Ontario
L2E 6W1



Gentlemen:

The Ministry wishes to engage your firm to carry out the work and provide the professional services all as described in Schedule A attached, and in accordance with the terms described in Schedule B attached.

The provision of the services may be commenced on the 16th day of August, 1982, and shall be completed on or before the 30th day of September, 1982.

Payments for the provision of the services shall be in accordance with Item 3 of Schedule A. Payroll costs are as defined in Item 1 of Schedule B. Payment will be made within thirty days of our receipt of your invoice. Invoices are to be mailed to K.G. Selby, Senior Foundation Engineer, M.T.C., 3rd Floor, Central Building, 1201 Wilson Avenue, Downsview, Ontario M3M 1J8 and are to indicate the number of this agreement being 4242-9082-124.

Payment for the services provided at the rates defined in Item 3 of Schedule A and for the total estimated fee including disbursements as per Item 4 of Schedule A shall constitute payment in full and no other payment will be made for any reason whatsoever.

If you fail to provide the services to the satisfaction of the Ministry, the Ministry may cancel this agreement by giving you one week's notice in writing. You shall not be entitled to payment for any services rendered after the termination date.

If the above terms are satisfactory to you, kindly indicate by signing, affixing the company seal and returning the original of this letter at the place indicated. The copy is for your records.

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS

Executive Director
Highway Engineering Division

agrees to provide the services on the
terms set out herein.

ACRES CONSULTING SERVICES LIMITED

Per:

David Sampson

Per:

[Signature]

SCHEDULE A

1. Description of the work:

Maintenance and repair of 'Rock Slot' at the Thorold Tunnel, Hwy. 58, District 4, Hamilton.

2. Description of the services to be provided:

- (a) Inspect the 'Rock Slot' at the Thorold Tunnel, determine the condition and efficiency of the bentonite seal and prepare a report detailing findings and containing recommendations for remedial action. Provide six copies of report to M.T.C.
- (b) Review the drawings and specifications prepared by Seaway Transport Canada for works in the canal. Prepare a report to M.T.C. regarding the effect of construction activities on the tunnel and recommend any constraints which should be imposed.

3. Basis of payment shall be on a time basis and shall be the sum of:

- a) Principals, Executives \$75/hour
- b) Consultant's staff except Principals and/or Executives Basic hourly rate of pay + 25.7% x 2.5 on first \$5,000.00 of payroll cost and x 2.0 on the remainder.

4. a) Estimated Fee \$10,000.00

b) Disbursements _____

Total \$10,000.00

5. Name of Principal and his/her estimated time to be spent in the provision of services as well as the hourly rate to be billed to the Ministry.

N/A or Name: R.G. Tanner

Hours to be spent: 10

Hourly rate: \$75.00

The amount to be included in the above estimate.

SCHEDULE B

DEFINITIONS

1. Payroll Costs

"Payroll cost" means salaries plus provision for fringe benefits amounting to 25.7% of salaries paid by the Consultant to staff employed directly in carrying out the services for which the fee is payable.

2. Records and Audit

- 2.1 For the purpose of determining fees calculated on a time basis, the Consultant shall keep a detailed record of the hours worked by, and salaries paid to, his staff employed in providing the services.
- 2.2 The Ministry may inspect and audit the books, payrolls, accounts and records of the Consultant at any time with respect to any item which the Ministry is required to pay, either directly or indirectly, as a result of this agreement.
- 2.3 The Consultant, when requested by the Ministry, shall provide copies of receipts in respect to any disbursement for which the Consultant claims payment under this agreement.



Ontario

Ministry of
Transportation and
Communications

Pavement & Foundation Design Section
Room 315, Central Bldg.
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

September 10, 1982

Mr. R.W. Poe, P. Eng.
Civil Engineer
The Seaway Transport Canada
Maintenance Complex
508 Glendale Ave.
St. Catharines, Ontario
L2R 6V8

Dear Sir:

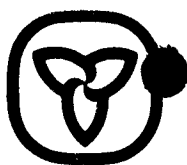
Further to our telephone conversation of September 9, 1982,
I am enclosing two copies of the review by our Consultant
Acres, of the work you intend to carry out in the Welland
Canal adjacent to the Thorold Tunnel. Please advise the
undersigned of any comments you may have regarding the
constraints which are recommended by Acres.

Yours truly,

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS:syc

Encls.



Ontario

Ministry of
Transportation and
Communications

Pavement & Foundation Design Section
Room 315, Central Bldg.
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

September 10, 1982

Mr. R.W. Poe, P. Eng.
Civil Engineer
The Seaway Transport Canada
Maintenance Complex
508 Glendale Ave.
St. Catharines, Ontario
L2R 6V8

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Yours truly,

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS:syc

Encls.



Ontario

Ministry of
Transportation and
Communications

Pavement & Foundation Design Section
Room 315, Central Bldg.
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

September 10, 1982

Mr. R.W. Poe, P. Eng.
Civil Engineer
The Seaway Transport Canada
Maintenance Complex
508 Glendale Ave.
St. Catharines, Ontario
L2R 6V8

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constraints which are recommended by Acres.

Yours truly,

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS:syc

Encls.



September 8, 1982
P6641.00

Ministry of Transportation
and Communications
Highway Engineering Division
Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. K. G. Selby
Senior Foundation Engineer

Gentlemen:

Re: Agreement No. 4242-9082-124
Report on SLSA Proposed Works
Adjacent to Thorold Tunnel

We are enclosing herewith six copies of our report on the subject matter. The proposed SLSA works have been reviewed in the light of their potential effects on the Thorold Tunnel. Our report discusses these factors and makes recommendations regarding constraints which we feel should be placed on the contractor's operations.

If you have any questions regarding our report we would be pleased to discuss them with you at your convenience.

Yours very truly,

TJB:mjg
Encl

for R. G. Tanner
Project Manager

ACRES CONSULTING SERVICES LIMITED
5259 Dorchester Road, P.O. Box 1001, Niagara Falls, Ontario L2E 6W1
Telephone 416-354-3831 Telex 061-5107
Cables ACRES CAN NFS

Toronto, Burlington, Calgary, Halifax, Niagara Falls, St. John's, Vancouver, Winnipeg

TABLE OF CONTENTS

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LIST OF REFERENCES

PLATES

LIST OF PLATES

<u>Number</u>	<u>Title</u>
1	Existing Conditions at Tunnel Station 61+03±(Ft) - Looking East
2	Conditions at Tunnel Station 61+03±(Ft) After Proposed New Construction - Looking East

1 - INTRODUCTION

In July 1982, the Ministry of Transportation and Communications (MTC) contacted Acres Consulting Services Limited (Acres) regarding construction works which the St. Lawrence Seaway Authority (SLSA) proposed to undertake in the vicinity of the Thorold Tunnel between December 1982 and March 1983. This work involves an extension to the Upper East Approach Wall at Lock 7, a portion of which will be located over the tunnel and will replace the existing Bailey Bridge and sheet pile cells located over the tunnel at the site of the new wall.

Acres was requested to review the proposed SLSA works and to advise on the effects that the construction of this wall will have on the tunnel.

Verbal authorization to proceed with the study was given to Acres by Mr. K. G. Selby of the MTC on August 17, 1982. It was subsequently confirmed by Agreement No. 4242-9082-124 as detailed in a letter dated August 16, 1982.

2 - BACKGROUND INFORMATION PROVIDED

During meetings with Mr. Selby on August 13 and 17, 1982 the following SLSA documents related to the proposed works were turned over to Acres.

- Preliminary full size prints of drawings 3568-1, 3, 4, 5, 6, 7, 8 and 9.
- A complete set of 28 reduced drawings for SLSA Contract No. 12-1826 together with 7 other drawings of structures presently existing in the area.
- A complete set of specifications for SLSA Contract No. 12-1826.

3 - EFFECT OF PROPOSED WORKS ON THE TUNNEL

3.1 - General

The drawings and specifications for the proposed new approach wall were reviewed together with drawings, reports and design and construction documents related to the tunnel. As a result, the following factors were identified as requiring study.

- The loads applied to the tunnel and surrounding bedrock in comparison with the site conditions and tunnel design criteria.
- A consideration of the amount of additional load which can be applied to the tunnel by materials disposed of above the tunnel roof.
- The effect of blasting on the grouting which was performed in the tunnel construction joints for waterproofing purposes.
- The effect of blasting on rock squeeze and subsequent pressures on the tunnel.
- The effect of the new wall construction on the tunnel bentonite panel waterproofing system.

Each of these items is described in detail in the following sections.

3.2 - New Loading Conditions

3.2.1 - New Rock Loading Conditions

The existing Bailey Bridge and its foundations on the east bank of the canal, as shown on SLSA drawing 3568-4, are to be demolished and be replaced by a new approach wall which will span over the existing tunnel rock cut. The new configuration is shown on SLSA drawing 3568-3.

The implications of demolishing the existing structure and constructing the new approach wall have been considered with respect to maintaining the service-ability and structural integrity of the existing tunnel.

Calculations of gravity loads from the existing Bailey Bridge and proposed new approach wall indicate that although the total load per pier for the new structure will be higher than that from the existing Bailey Bridge, the average gravity load per unit width of pier is about the same for each case, as shown on Plates 1 and 2. The vertical prestressing of the anchor rods adds a load of 691 t per pier for the new structure. This will make the average stress under the new pier approximately 1.5 times higher than the existing. The effect of this additional vertical loading on rock squeeze and bench stability is thought to be minor.

Values of ship impact loads are not available from information shown on the drawings. However, calculations for energy absorption based on velocity of approach of 2 m/sec show that a lateral load of the order of 5,000 kN could be generated by a large ore carrier striking the wall. This, in turn, would generate a load of about 2,000 kN along the length of the wall due to friction.

It is unknown if provision has been made in the design of the wall for longitudinal loads. A cursory inspection of the drawings suggests that the load path for a longitudinal load, as calculated, would likely be along the deck, to be distributed in some manner throughout the length of the structure to the bedrock.

3.2.2 - Disposal of Material Over the Existing Tunnel

SLSA drawing 3568-1 indicates a disposal area over the tunnel to the east of the new wall. The tunnel at this location was designed for a total uniformly distributed dead plus live load of 250 kN/m^2 which corresponds to the full canal water load. On this basis, any material left on the tunnel roof above canal grade, after the canal is filled, would result in an overstressing condition.

3.3 - Effects of Blasting

The SLSA documents indicate that blasting procedures may be used to prepare foundations for some of the new wall footings, remove portions of the existing canal walls and also to demolish the abutments of and ramps to the existing Bailey Bridge. Of concern is the potential effect that such blasting could have on rock squeeze and the grout waterproofing system in the tunnel construction joints. These two factors are discussed below.

3.3.1 - Effect of Blasting on Waterproofing Grout

To minimize any seepage through the tunnel construction joints, such areas were grouted using a chrome lignin based grout. On curing, this material is reported to have various properties depending on whether it is wet or dry. If dry, it can be brittle but if wet or moist it may be flexible. Since this material probably exists in very thin films in the construction joints, there is a possibility that these films may be cracked and damaged as a result of blast vibrations. Because of this, and based on blasting experience^{4*}, it is recommended that the blasting operations be controlled to limit the peak particle velocity to a value less than 25 mm/sec at the point in the tunnel closest to the blast.

3.3.2 - Effect of Blasting on Rock Squeeze

In the Acres studies reported in 1972 - 1974¹, rock squeeze was confirmed to have imposed significant loads on the west and east service buildings to the extent that it was necessary to construct a relieving slot on the south side of the west service building. In addition, some minor cracking of the tunnel was observed at the only other location where the space between the tunnel walls and the rock face was filled with concrete, i.e., at the west canal bank (Station 57+50 ft approximately) which is approximately 105 m from the location of the SLSA works..

* Numbers refer to items in List of References

Although the nature of rock squeeze is still debatable, it is most likely that it results from slippage of various layers of rock relative to underlying layers under the influence of horizontal stress. It is a time-dependent phenomenon². The only known reference to illustrate the effect of blasting on rock squeeze appears to be the movement records at the Canadian Niagara Power Company Wheel Pit in Niagara Falls when the two power tunnels were excavated for the Sir Adam Beck power station between 1951 and 1953. Observations provided by Ontario Hydro show that in the same general time as the blasting for the tunnels, the observed movement of the walls in the wheel pit showed a sudden increase.

From the time of construction in 1905 to 1953 a movement of about 28 mm occurred, whereas between 1953 and 1955 an additional 8.5 mm occurred which amounts to a 5 times increase in the rate of movement. After 1955, the rate of movement appeared to return to that which existed prior to 1953. As reported by Lee and Lo³, the power tunnels were excavated approximately 150 m away from the wheel pit at the closest point.

From the experience at the wheel pit, it is apparent that blasting may have a significant effect on the amount and rate of development of rock squeeze. No information is available regarding the vibration limits on the blasting in the power tunnels although it seems unlikely that the construction control would allow particle velocities to occur in excess of 50 mm to 100 mm/sec at a distance of 60 m since the tunnels pass at about that depth below residential areas in Niagara Falls. Based on the above assumption, it appears likely

that if the seaway construction resulted in particle velocities of 50 mm/sec or more at any of the three concrete bulkhead locations at the Thorold Tunnel, then a significant increase in the rock squeeze could occur. The west and east service buildings are located 180 m and 400 m respectively from the site of the blasting but the west canal bank is only 105 m from the blasting. If the particle velocity is limited to a maximum of 25 mm/sec, as recommended in Section 3.3.1, the particle velocity, as measured at the west canal bank, should be quite low making it unlikely that the rock squeeze problem will be aggravated.

3.4 - Effect of New Wall Construction on Tunnel Waterproofing

Based on tests performed by Acres in 1972 it was determined that as long as the existing backfill protection above the existing tunnel remains undisturbed, it will provide sufficient confinement and protection for the bentonite waterproofing so that the bentonite will not tend to swell or otherwise lose its effectiveness during the demolition and new construction phases of the proposed project. Proper precautions during blasting are, of course, necessary and are discussed above.

4 - CONCLUSIONS

- (a) The static loads imposed by the new canal wall on the bedrock and tunnel structure should not cause any problem with regard to the performance or integrity of the tunnel. The nature and magnitudes of horizontal loads imposed along the canal wall are not known nor are the methods by which they are resisted. If they are sufficiently large that the footings on the rock benches could be moved in a north-south direction, there is a possibility of movements in the rock fill over the tunnel which could result in damage to the tunnel bentonite waterproofing. Such potential for damage is, however, considered to be remote.
- (b) Materials piled over the tunnel above existing canal grade will result in overstressing the tunnel structure on refilling the canal to operating level.
- (c) The vibrations generated by blasting operations during construction of the new canal wall must be carefully controlled to avoid damage to the grout waterproofing and also additional damage as a result of accelerated rock squeeze.
- (d) Construction operations associated with the new canal wall construction are not anticipated to have an adverse affect on the main tunnel bentonite waterproofing.

5 - RECOMMENDATIONS

- (a) It is recommended that the SLSA be requested to advise if horizontal loads of significant magnitude, i.e., greater than 1,000 kN or 100 t, are expected to be transmitted to the base of the wall footings. If such is the case, it is conceivable that the ledge of rock might be in danger of failing by sliding depending on the magnitude of the load.
- (b) Materials such as rock fill or gravel may be stored above canal level over the tunnel to a depth of 3 to 4 m on a temporary basis while the canal is dewatered but it is recommended that to avoid tunnel overstressing, materials not be disposed of over the tunnel on long term basis when the canal water is at operating level.
- (c) The contractor's blasting operations should be carefully monitored using seismograph equipment and they should be carried out in such a manner as to limit the maximum particle velocities to less than 25 mm/sec in the tunnel structure adjacent to the wall site. In addition, seismograph recordings should be taken either on the bedrock floor of the canal adjacent to the west canal wall or inside the tunnel adjacent to the bulkhead to determine the magnitude of the particle velocities at this location.

It is also recommended that the tunnel be subjected to a thorough inspection prior to the blasting operations, noting such features as seepage through the walls and construction joints together with the current situation regarding wall cracks at all bulkhead locations. With

regard to the instrumentation installed at the east and west service buildings, it is recommended that a set of readings be taken before and after the blasting operations to assess whether any significant changes in conditions occur.

Concerning the wall footings on the rock bench, consideration could possibly be given to constructing these footings on the bedrock surface rather than 1 m below the surface. This would avoid blasting so close to the tunnel and would also result in a greater thickness of limestone between the footing and the weaker, squeezing shale zone in the Gasport Formation. Alternatively, it could be specified that drilling and blasting methods will not be permitted for these two footing excavations.

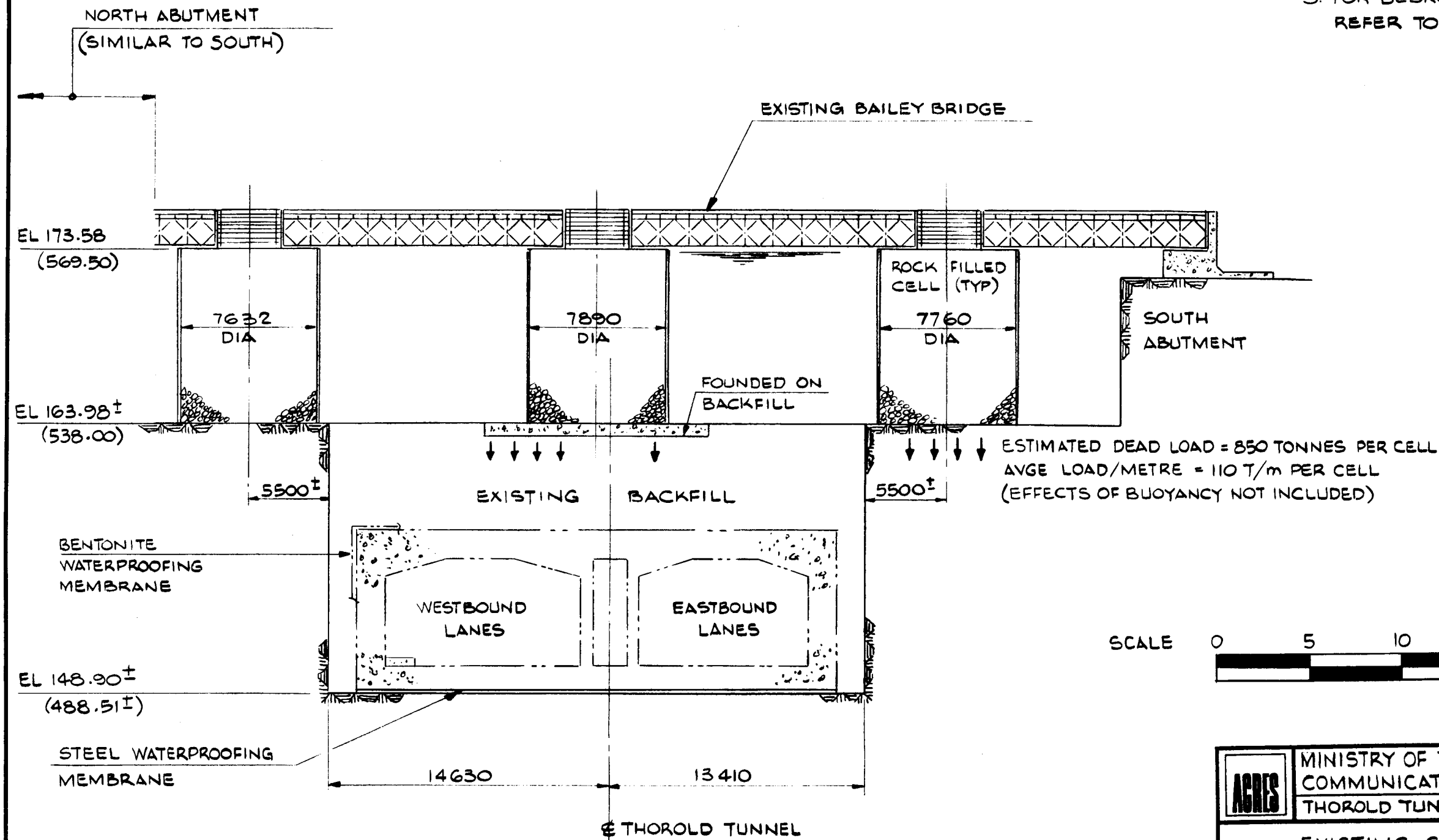
LIST OF REFERENCES

- ¹ Reports to the Ministry of Transportation and Communications, Ontario by Acres Consulting Services Limited entitled
 - Investigations to Determine the Cause of Cracking in the Structure, March 1972.
 - Supplementary Report No. 1 - West Service Building, May 1972.
 - Supplementary Report No. 2 - East Service Building, December 1972.
 - Supplementary Report No. 3 - West Service Building - Review of Observed Structural Behavior, 1971 to 1972.
 - West Service Building - Review of Observed Structural Behavior from August 1971 to September 1974, November 1974.
- ² C.F.P. Bowen, F. I. Hewson, D. H. MacDonald, R. G. Tanner. "Rock Squeeze at Thorold Tunnel", Canadian Geotechnical Journal. Vol 13, No. 2, 1976, pp 111 - 126.
- ³ C. F. Lee and K. Y. Lo. "Rock Squeeze Study of Two Deep Excavations at Niagara Falls", Proceedings of a Specialty Conference on Rock Engineering for Foundations and Slopes. University of Colorado, Boulder, August 15 - 18, 1976, New York: ASCE, 1976. Vol 1, pp 116 - 140.
- ⁴ John F. Wiss. "Construction Vibrations: State-of-the-Art". ASCE Journal of the Geotechnical Engineering Division. Vol 107, No. 6T2, February, 1981, pp 167 - 181.

PLATES

NOTES

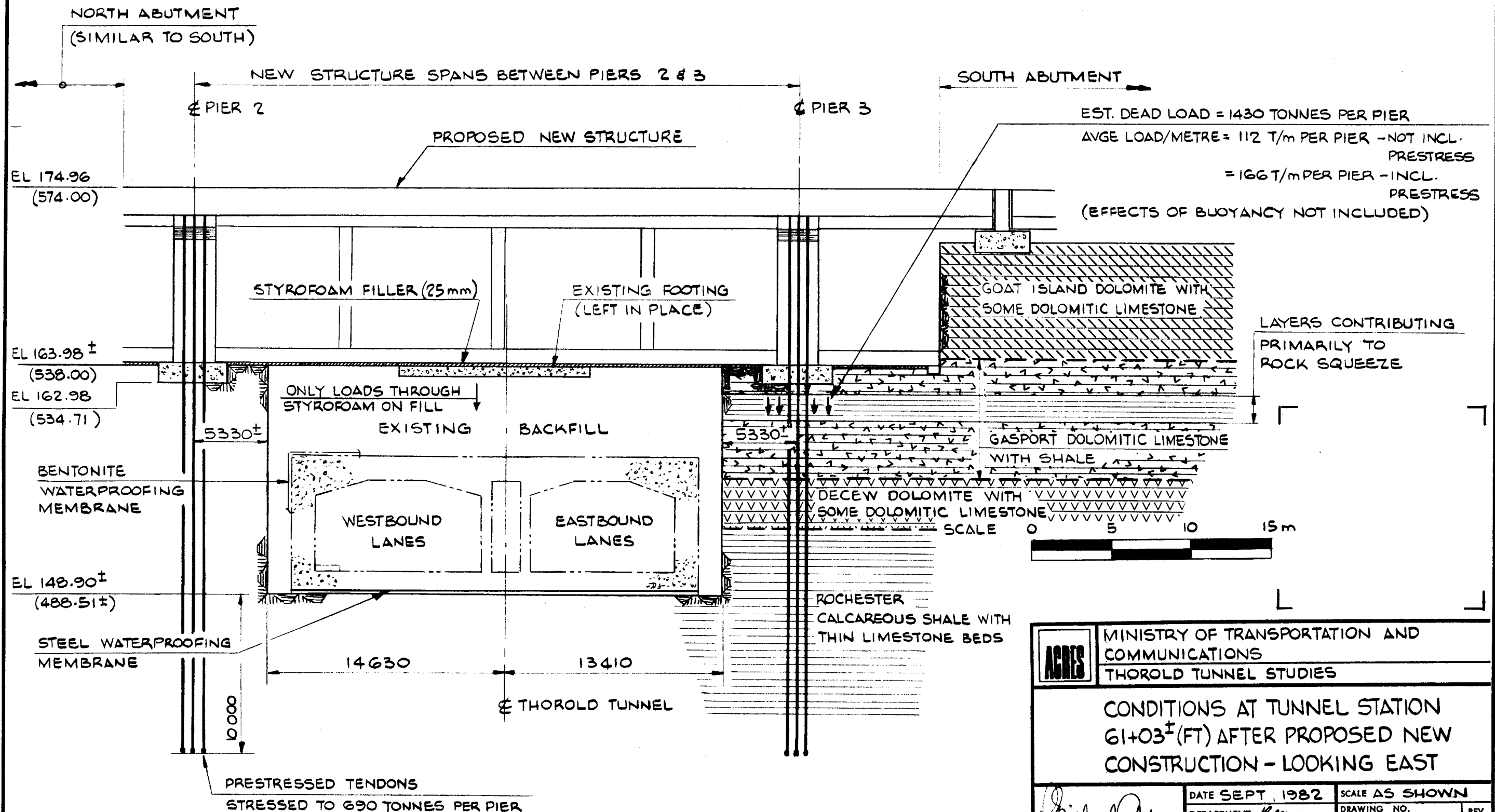
1. INFORMATION TAKEN FROM TUNNEL "AS BUILT" DRAWINGS No. 1195-SB-031, D-5578-205 AND D-5578-225.
2. ELEVATIONS SHOWN IN METRES FOLLOWED BY THE IMPERIAL EQUIVALENT IN BRACKETS (FEET)
3. FOR BEDROCK STRATIGRAPHY REFER TO PLATE 2.



ACRES	MINISTRY OF TRANSPORTATION AND COMMUNICATIONS	
	THOROLD TUNNEL STUDIES	
EXISTING CONDITIONS AT TUNNEL STATION 61+03 ± (FT) LOOKING EAST		
DATE SEPT, 1982 DEPARTMENT PROJECT	SCALE AS SHOWN	
	DRAWING NO.	REV.
ACRES	PLATE 1	OF

NOTES

1. INFORMATION ON PROPOSED CONSTRUCTION TAKEN FROM SLISA DWGS FOR CONTRACT 12-1826
2. ELEVATIONS SHOWN IN METRES FOLLOWED BY THE IMPERIAL EQUIVALENT IN BRACKETS (FEET)



ACRES	MINISTRY OF TRANSPORTATION AND COMMUNICATIONS	
	THOROLD TUNNEL STUDIES	
CONDITIONS AT TUNNEL STATION 61+03± (FT) AFTER PROPOSED NEW CONSTRUCTION - LOOKING EAST		
 ACRES	DATE SEPT. 1982	SCALE AS SHOWN
	DEPARTMENT <i>km</i>	DRAWING NO. PLATE 2
PROJECT <i>903</i>	SHEET OF	REV.





Ontario

Ministry of
Transportation and
Communications

Highway Engineering Division,
Central Bldg., Room 234,
1201 Wilson Avenue,
Downsview, Ontario
M3M 1J8

August 16th 1982

Acres Consulting Services Ltd.
5259 Dordchester Road,
P.O. Box 1001, Niagara Falls
Ontario, L2E6W1

The Ministry wishes to engage your firm to carry out the work and provide the professional services all as described in Schedule A attached, and in accordance with the terms described in Schedule B attached.

The provision of the services may be commenced on the 16th day of August, 1982, and shall be completed on or before the 30th day of September, 1982.

Payments for the provision of the services shall be in accordance with Item 3 of Schedule A. Payroll costs are as defined in Item 1 of Schedule B. Payment will be made within thirty days of our receipt of your invoice. Invoices are to be mailed to R.G. Selby Senior Foundation Engineer, M. T. C., 3rd floor, Central Building, 1201 Wilson Avenue, Downsview, Ontario, M3M 1J8 and are to indicate the number of this agreement being 4242-9082-

Payment for the services provided at the rates defined in Item 3 of Schedule A and for the total estimated fee including disbursements as per Item 4 of Schedule A shall constitute payment in full and no other payment will be made for any reason whatsoever.

If you fail to provide the services to the satisfaction of the Ministry, the Ministry may cancel this agreement by giving you one week's notice in writing. You shall not be entitled to payment for any services rendered after the termination date.

If the above terms are satisfactory to you, kindly indicate by signing, affixing the company seal and returning the original of this letter at the place indicated. The copy is for your records.

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS

F. G. Allen,
Executive Director,
Highway Engineering Division

agrees to provide the services on the
terms set out herein.

Per: _____

SCHEDULE A

1. Description of the work:

Maintenance and repair of 'Rock Slot'
at the Thorold Tunnel, Hwy. 58
District 4, Hamilton.

2. Description of the services to be provided:

- (a) Inspect the 'Rock Slot' at the Thorold Tunnel, determine the condition and efficiency of the bentonite seal and prepare a report detailing findings and containing recommendations for remedial action. Provide 6 copies of report to M.T.C.
- (b) Review the drawings and specifications prepared by Seaway Transport Canada for works in the Canal. Prepare a report to the M.T.C. regarding the effect of construction activities on the tunnel and recommend any constraints which should be imposed.
3. Basis of payment shall be on a time basis and shall be the sum of:

- a) Principals, Executives
- b) Consultant's staff except
Principals and/or Executives

\$ 75 /hour

Basic hourly rate of pay
+ 25.7% x 2.5 on first
\$5,000.00 of payroll cost
and x 2.0 on the remainder.

4. a) Estimated Fee \$10,000.00

b) Disbursements _____

Total \$10,000.00

5. Name of Principal and his/her estimated time to be spent in the provision of services as well as the hourly rate to be billed to the Ministry.

/ N/A ☐ or Name: R. G. Tanner

Hours to be spent: 10

Hourly rate: \$75.00

The amount to be included in the above estimate.

SCHEDULE A

1. Description of the work:

Maintenance and repair of 'Rock Slot'
at the Thorold Tunnel, Hwy. 58
District 4, Hamilton.

2. Description of the services to be provided:

- (a) Inspect the 'Rock Slot' at the Thorold Tunnel, determine the condition and efficiency of the bentonite seal and prepare a report detailing findings and containing recommendations for remedial action. Provide 6 copies of report to M.T.C.
- (b) Review the drawings and specifications prepared by Seaway Transport Canada for works in the Canal. Prepare a report to the M.T.C. regarding the effect of construction activities on the tunnel and recommend any constraints which should be imposed.
3. Basis of payment shall be on a time basis and shall be the sum of:

- a) Principals, Executives
- b) Consultant's staff except Principals and/or Executives

\$ 60 /hour

Basic hourly rate of pay
+ 25.7% x 2.5 on first
\$5,000.00 of payroll cost
and x 2.0 on the remainder.

4. a) Estimated Fee \$10,000.00
- b) Disbursements _____
- Total \$10,000.00

5. Name of Principal and his/her estimated time to be spent in the provision of services as well as the hourly rate to be billed to the Ministry.

N/A ☐

or Name: R. G. Tanner

Hours to be spent: 10

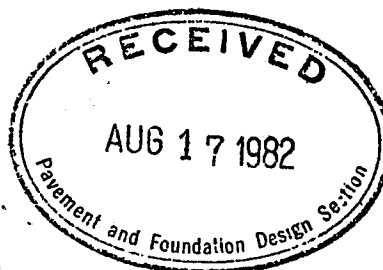
Hourly rate: \$60.00

The amount to be included in the above estimate.



August 17, 1982
W1243.13

Ministry of Transportation
and Communications
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8



Attention: Mr. K. G. Selby
Supervising Foundation Engineer

Gentlemen: Studies Related to Thorold Tunnel

We are pleased to confirm our proposal to undertake the following work related to the Thorold Tunnel.

- (a) Inspect the bedrock slot located south of the west service building and make recommendations regarding any required remedial works.
- (b) Review the drawings and specifications prepared by Seaway Transport Canada for works on the east side of the shipping canal and advise on their effect on the tunnel and any constraints which should be imposed.

It is estimated that the total cost of these two work items is approximately \$10,000, broken down in accordance with the attached form entitled "Project Cost and Performance Report".

On a separate sheet, please find a list of all persons who may have an input to these studies together with hourly salary rates for each. Also included is the name of the Executive Engineer and the extent of his involvement in the project.

We trust that this is the information you require to formalize the agreement. However, should there be any questions regarding these matters please contact the undersigned.

Yours very truly,

T. J. Bradshaw
Deputy Head,
Geotechnical Department

TJB:mjg

cc - R. Tanner
D. Sampson

ACRES CONSULTING SERVICES LIMITED
5259 Dorchester Road, P.O. Box 1001, Niagara Falls, Ontario L2E 6W1
Telephone 416-354-3831 Telex 061-5107
Cables ACRES CAN NFS

Toronto, Burlington, Calgary, Halifax, Niagara Falls, St. John's, Vancouver, Winnipeg

PROJECT COST & PERFORMANCE REPORT

IN-HOUSE & CONSULTANT ASSIGNMENTS

August 17, 1982

W P _____ Hwy 58 Dist 4 Site _____ Region _____

Location Thorold Tunnel

		CONSULTANT: Acres Consulting Services Limited				IN-HOUSE OR CONSULTANT'S ACTUAL
COST FACTORS		ORIGINAL ESTIMATE (IN-HOUSE)	ESTIMATE FOR CONSULTANT SERVICES	CONSULTANT'S ORIGINAL ESTIMATE	CONSULTANT'S REVISED ESTIMATE	
MAN DAYS	FIELD SUPERVISION			3		
	OFFICE ENGINEERING			14		
	DRAFTING & CLERICAL			4		
	TOTAL			21		
SALARY COSTS	FIELD SUPERVISION			1,000		
	OFFICE ENGINEERING			7,400		
	DRAFTING & CLERICAL			950		
	SUB-TOTAL			9,350		
OPERATING COSTS	TRANSPORTATION & COMMUNICATION			150		
	DRILLING SERVICES (Including Mobilization)			n/a		
	SUPPLIES & EQUIPMENT			300		
	LABORATORY TESTS			n/a		
	DISBURSEMENTS (Xerox, Computer etc)			200		
	SUB-TOTAL			650		
TOTAL COST				10,000		
TOTAL METRES				n/a		
COST / m						

Comments: This estimate includes slot inspection and review of Seaway Transport Canada proposed construction work.

THOROLD TUNNEL STUDIES
LIST OF STAFF AND RATES

August 17, 1982

<u>Executive Engineer</u>	<u>Estimated Time Involvement (Hours)</u>
R. G. Tanner (EN 12)	10

<u>Other Staff</u>	<u>Salary Rate (\$/hr)</u>
<u>Engineers</u>	
H. Eichenbaum (EN 12)	28.62
A. H. Tawil (EN 11)	26.54
T. J. Bradshaw (EN 11)	26.11
R. A. MacCrimmon (EN 10)	21.92
D.R.D. Peggs (EN 10)	24.81
<u>Technicians</u>	
H. E. McRae (EN 08)	14.13
<u>Draftsmen</u>	
R. F. Keldson (DR 08)	13.70
<u>Secretaries</u>	
P. L. Croteau (SS 06)	8.94
M. J. Gibbs (SS 06)	8.86

JJB

PROJECT COST & PERFORMANCE REPORT

IN-HOUSE & CONSULTANT ASSIGNMENTS

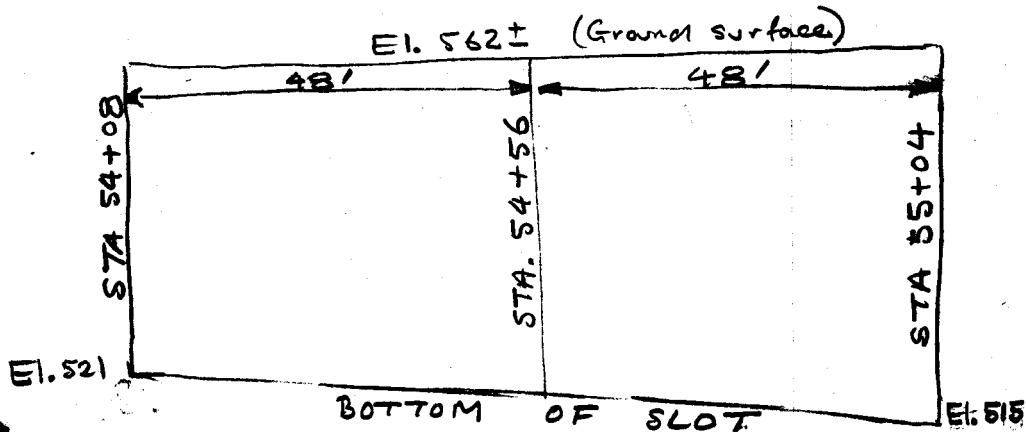
W P Nil. Hwy 58 Dist 4 Site _____ Region Central

Location Thorold Tunnel.

		CONSULTANT:				IN-HOUSE OR CONSULTANT'S ACTUAL
COST FACTORS		ORIGINAL ESTIMATE (IN-HOUSE)	ESTIMATE FOR CONSULTANT SERVICES	CONSULTANT'S ORIGINAL ESTIMATE	CONSULTANT'S REVISED ESTIMATE	
MAN DAYS	FIELD SUPERVISION			3		
	OFFICE ENGINEERING			14		
	DRAFTING & CLERICAL			4		
	TOTAL			21		
SALARY COSTS	FIELD SUPERVISION			1000		
	OFFICE ENGINEERING			7400		
	DRAFTING & CLERICAL			950		
	SUB-TOTAL			9350		
OPERATING COSTS	TRANSPORTATION & COMMUNICATION			150		
	DRILLING SERVICES (Including Mobilization)			—		
	SUPPLIES & EQUIPMENT			300		
	LABORATORY TESTS			—		
	DISBURSEMENTS (Xerox, Computer etc)			200		
	SUB-TOTAL			650		
TOTAL COST				10,000		
TOTAL METRES						
COST / m						

Comments: Acres were verbally authorised to
proceed with work 82-08-16 Regularly

THOROLD TUNNEL
ROCK SLOT



memorandum



To: Mr. F. G. Allen
Executive Director
Highway Engineering Division
Central Building

Date: 1982 08 04

From: Engineering Materials Office
Room 313, Central Building

Re: Consultant Assignment for Foundation Investigation,
Thorold Tunnel - Water Seepage Problem
Hwy. 58, District 4, Hamilton

Central Region have requested that an investigation be conducted under the direction of the Pavement and Foundation Design Section to determine the condition of the bentonite seal in the "Rock Slot" at the Thorold Tunnel and the remedial measures necessary to restore the integrity of the seal. Also, they have requested that the subsurface conditions and the structural design of the tunnel be reviewed in order to determine the effects on the tunnel of proposed construction activities (including some blasting) to be undertaken by The St. Lawrence Seaway Authority next winter. The services to be provided are of a complex nature and since Acres Consulting Services, Niagara Falls, are the original geotechnical consultants and structural designers of the tunnel it is recommended that this firm be awarded an assignment to carry out the necessary work.

The total estimated fee for the work is \$10,000 all of which will be expended during this current fiscal year. Please consider this assignment at your earliest convenience.

A handwritten signature in dark ink, appearing to read "DRB Brohm", written over a light background.

D. R. Brohm
Manager
Engineering Materials Office

DRB/KGS/jb
cc: K.G. Selby

memorandum



Ontario

224 7542

To: Mr. K. Selby
Pavement & Foundation Design
Central Bldg., Downsview

Date: 82 06 17


Thorold Tunnel
Water Level Readings

Enclosed please find copy of readings February 1/80 to June 11/82.

Please note that there are some new pumps requested and the information will be recorded on the sheets at the time of installation.

We will endeavour to send reports every six months in future.

JFL:lo
Encl.
c.c.
G. Green


J. F. Loughheed
Services Supervisor



WATER LEVEL READINGS

Pg 1

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
FEB 1/80	Min. 12 Sec. 13	Min. 8 Sec. 38	4	F. BARNFIELD
FEB 8/80	Min. 12 Sec. 35	Min. 9 Sec. 55	4	P. Boyuk.
FEB 15/80	Min. 13 Sec. 27	Min. 19 Sec. 59	3	R. Book.
FEB 22/80	Min. 13 Sec. 7	Min. 8 Sec. 15	4	J. BRISSON
FEB 29/80	Min. 13 Sec. 54	Min. 11 Sec. 31	3	J. BRISSON
MAR 7/80	Min. 12 Sec. 54	Min. 7 Sec. 56	4	G. GREEN
MAR 14/80	Min. 13 Sec. 7	Min. 8 Sec. 42	4	R. Book
MAR 21/80	Min. 9 Sec. 51	Min. 13 Sec. 03	4	G. GREEN
MAR 28/80	Min. 11 Sec. 16	Min. 9 Sec. 16	4	G. GREEN
April 3/80	Min. 11 Sec. 13	Min. 6 Sec. 8	4	R. Book.
April 10/80	Min. 11 Sec. 13	Min. 8 Sec. 23	4	R. Book
April 18/80	Min. 12 Sec. 28	Min. 8 Sec. 50	4	G. Dohm
April 28/80	Min. 11 Sec. 20	Min. 8 Sec. 50	4	F. Barnfield
MAY 9/80	Min. 11 Sec. 10	Min. 8 Sec. 25	4	R. BOOK
MAY 16/80	Min. 11 Sec. 53	Min. 12 Sec. 40	3	R. BOOK
MAY 23/80	Min. 11 Sec. 37	Min. 13 Sec. 04	3	R. BOOK
MAY 30/80	Min. 10 Sec. 59	Min. 14 Sec. 48	3	R. BOOK
JUNE 6/80	Min. 10 Sec. 50	Min. 14 Sec. 15	3	D. SWIBB
June 13/80	Min. 10-27 sec Sec.	Min. 13-8 sec Sec.	3	R. Book.
JUNE 20/80	Min. 10 Sec. 40	Min. 15 Sec. 48	3	D. SWIBB
June 26/80	Min. 11 Sec. 51	Min. 14 Sec. 47	3	D. SWIBB
July 4/80	Min. 10 Sec. 10	Min. 15 Sec. 25	3	J. BRISSON
July 11/80	Min. 10 Sec. 20	Min. 15 Sec. 55	3	J. BRISSON
July 18/80	Min. 10 Sec. 04	Min. 16 Sec. 28	3	J. BRISSON
July 25/80	Min. 10 Sec. 03	Min. 21 Sec. 17	3	C.R. Book.

WATER LEVEL READINGS

WEST SUMP

Pg 2

DATE 1980	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
AUGUST 1	Min. 10 Sec. 20	Min. 15 Sec. 50	3	J. BRISSON
AUG. 8/80	Min. 11 Sec. 2	Min. 16 Sec. 7	3	R. BOOK
AUG. 15/80	Min. 9 Sec. 37.6	Min. 11 Sec. 46.9	4	D. SWIBB
AUG. 22/80	Min. 9 Sec. 18.0	Min. 12 Sec. 42.0	4	R. BOOK
AUG 29/80	Min. 10 Sec. 49.0	Min. 11 Sec. 38.0	4	G. W. GREEN
SEPT 5/80	Min. 9.10 Sec. 53.0	Min. 11 Sec. 32.0	4	G. W. GREEN
SEPT 12/80	Min. 10 Sec. 12	Min. 10 Sec. 43	4	D. SWIBB
SEPT 19/80	Min. 10 Sec. 35	Min. 11 Sec. 42	4	R. BOOK
SEPT 26/80	Min. 10 Sec. 2	Min. 9 Sec. 57	4	R. BOOK
OCT 3/80	Min. 9 Sec. 50	Min. 12 Sec. 17	4	R. BOOK
OCT 7/80	Min. 10 Sec. 2	Min. 11 Sec. 55	4	R. BOOK
OCT 10/80	Min. 10 Sec. 10	Min. 12 Sec. 30	4	R. BOOK
OCT. 17/80	Min. 10 Sec. 02.3	Min. 13 Sec. 54.4	4	D. SWIBB
80/10/24	Min. 9 Sec. 57	Min. 16 Sec. 56	BEFORE 4	R. BOOK
80/10/24	Min. 9 Sec. 57	Min. 14 Sec. 33	AFTER 4	R. BOOK
80/11/07	Min. 10 Sec. 42	Min. 11 Sec. 10	BEFORE 4	R. BOOK
80/11/07	Min. 10 Sec. 42	Min. 11 Sec. 8	AFTER CLEANING 4	R. BOOK
80/11/14	Min. 10 Sec. 46	Min. 9 Sec. 14	BEFORE 4	R. BOOK
80/11/14	Min. 10 Sec. 46	Min. 10 Sec. 2	AFTER CLEANING 4	R. BOOK
80/11/21	Min. 10 Sec. 05	Min. 10 Sec. 44	BEFORE CLEANING 4	D. SWIBB
80/11/21	Min. 10 Sec. 20	Min. 10 Sec. 49	AFTER CLEANING 4	D. SWIBB
80/11/28	Min. 10 Sec. 54.1	Min. 11 Sec. 09.0	BEFORE CLEANING 4	D. SWIBB
80/11/28	Min. 10 Sec. 56.2	Min. 10 Sec. 58.2	AFTER CLEANING 4	D. SWIBB
80/12/5	Min. 10 Sec. 19.4	Min. 10 Sec. 28.5	BEFORE CLEANING 4	D. SWIBB
80/12/5	Min. 10 Sec. 26.3	Min. 10 Sec. 27.9	AFTER CLEANING 4	D. SWIBB

AUG 15 - OCT 10, ABOVE INFORMATION TO, J. LOUGHEED

WATER LEVEL READINGS

NORMAL CANAL LEVEL
173.13 AT THOROLD

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
	Min. WITH	Min. 11	4 Pumps	
80/10/31	Sec. DEBRI	Sec. 4	1, 2, 6, 9	
80/10/31	Min. 11	Min. 11	SOME	R. Book
	Sec. 36	Sec. 6	WITH DEBRI	
	Min. 10	Min. 10	4 Pumps	R. Book
	Sec. 41	Sec. 18	WITHOUT DEBRI	
80/12/12	Min. 10	Min. 10	4 PUMP	R. Book
	Sec. 44	Sec. 21	With Debris	
80/12/19	Min. 11	Min. 11	4 Pumps	
	Sec. 20	Sec. 36	Without Debris	
	Min. 11	Min. 11	4 Pump	
	Sec. 18	Sec. 58	WITH DEBRI	
80/12/24	Min. 17	Min. 9		
	Sec. 30	Sec. 31		
	Min. 10	Min. 10	WITHOUT	
	Sec. 45	Sec. 35	DEBRI	R. Book
80/12/31	Min. 10	Min. 10	WITH	
	Sec. 44	Sec. 32	DEBRI	R. Book
	Min. 11	Min. 10	WITHOUT	
	Sec. 04	Sec. 30	DEBRI 4-Pumps	R. Book
81/1/9	Min. 12	Min. 9	With	
WATER LEVEL 172.25	Sec. 30	Sec. 45	Debris 4 Pumps	
TEMP - 9 FLURRIES	Min. 12	Min. 9	Without	
WATER LEVEL 172.25	Sec. 28	Sec. 40	Debris 4 Pumps	
TEMP - 4 FLURRIES	Min. 12	Min. 9	WITH DEBRI	
81/1/16	Sec. 51	Sec. 10	4 PUMPS	
	Min. 12	Min. 9	WITHOUT DEBRI	
	Sec. 49	Sec. 8	4 PUMPS	
Water level 172.25	Min. 12' 30"	Min. 8	With Debris	
Temp +4 Cloudy	Sec. 30	Sec. 59	4 Pumps	
January 23/81	Min. 12	Min. 8	Without	
	Sec. 30	Sec. 57	Debris 4 Pumps	
81/1/30	Min. 13	Min. 9	BEFORE CLEANING	
	Sec. 22	Sec. 24	4 PUMPS	
WATER LEVEL 172.25	Min. 13	Min. 9	AFTER CLEANING	
TEMP - 3°C CLEAR	Sec. 42	Sec. 20	4 Pumps	
81/02/06	Min. 12	Min. 9	Before	
Temp - 3 Clear	Sec. 37	Sec. 13	Cleaning Tanks	
81/02/06	Min. 12	Min. 9	After	
Temp - 3 Clear	Sec. 37	Sec. 12	Cleaning tank	
81/02/13	Min. 12	Min. 9	Before	
Temp - 7 Clear	Sec. 08	Sec. 16	Cleaning	
81/02/13	Min. 12	Min. 9	After	
Temp - 7 Clear	Sec. 07	Sec. 08	Cleaning	
WATER LEVEL 172.25	Min. 11 MIN	Min. 10	BEFORE	
TEMP + 8 FOG	Sec. 24	Sec. 50	CLEANING	D. BOYUK
81/02/20	Min. 11	Min. 10	AFTER	
	Sec. 40	Sec. 50	4 - Pumps	D. BOYUK
81/02/27	Min. 9	Min. 12		
	Sec. 03	Sec. 13	4 Pumps	F. BARNEFIELD

WATER LEVEL READINGS

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
1981 March 6 Sunny and Clear	Min. 12 Sec. 3.5	Min. 9 Sec. 10	Dirty Tank 12.6.9	Y. A. Doh
March 7 Sunny and Clear	Min. 12 Sec. 3.3	Min. 9 Sec. 7	Clean Tank 12.6.9	Y. A. Doh
March 13 1981 Cloudy Light Snow	Min. 12 Sec. 4.3	Min. 9 Sec. 12	Dirty Tank 12.6.9	Y. A. Doh
March 13 1981 Cloudy Light Snow	Min. 12 Sec. 4.2	Min. 9 Sec. 10	Clean Tank 12.6.9	Y. A. Doh
March 20 1981 Cloudy light snow	Min. 10 Sec. 3.6	Min. 8 Sec. 4.7	Dirty Tank Pumps 12.6.9	Y. A. Doh
March 20 1981 Cloudy light snow	Min. 12 Sec. 3.6	Min. 8 Sec. 4.3	Clean Tank Pumps 12.6.9	Y. A. Doh
MARCH 27/81 SUNNY SKIES	Min. 10 Sec. 2.9	Min. 9 Sec. 3.5	WITH DEBRIS 173.13m	WATER RESUMED TO REG. LEVEL CR.
MARCH 27/81	Min. 10 Sec. 4.0	Min. 9 Sec. 3.0	WITHOUT DEBRIS 173.13m	Y. A. Book
APRIL 3/81	Min. 10 Sec. 4.3	Min. 9 Sec. 4.0	WITH DEBRIS 173.13m	WITH 4 Pumps.
APRIL 3/81	Min. 10 Sec. 3.9	Min. 9 Sec. 4.0	WITHOUT DEBRIS	Y. A. Book
April 10/81 (Clear and Dry)	Min. 10 Sec. 3.5	Min. 16 Sec. 1.7	With Debris Pumps 12.3	Y. A. Doh
April 10/81 (Clear and Dry)	Min. 10 Sec. 3.3	Min. 16 Sec. 0.8	Without Debris Pumps 12.3	Y. A. Doh
April 23/81 Light Rain	Min. 11 Sec. 2	Min. 16 Sec. 1.5	With Debris Pumps 12.3	Y. A. Doh
April 23/81 Light Rain	Min. 11 Sec. 2	Min. 16 Sec. 2	Without Debris Pump 12.3	Y. A. Doh
May 1/81 Clear and Dry	Min. 11 Sec. 12	Min. 17 Sec. 1.5	With Debris Pumps 12.3	Y. A. Doh
May 1/81 Clear and Dry	Min. 11 Sec. 12	Min. 15 Sec. 5.5	Without Debris Pumps 12.3	Y. A. Doh
May 8/81 Clear and Dry	Min. 10 Sec. 3.4	Min. 9 Sec. 7	With Debris 4 Pumps	Y. A. Book
May 8/81 Clear and Dry	Min. 10 Sec. 3.6	Min. 9 Sec. 8	WITHOUT DEBRIS 4 Pumps	Y. A. Book
May 15/81 Light Rain	Min. 10 Sec. 4.7	Min. 9 Sec. 7	With Debris 4 Pumps	Y. A. Doh
May 15/81 Light Rain	Min. 10 Sec. 4.8	Min. 9 Sec. 6	Without Debris 4 Pumps	Y. A. Doh
May 22/81 Clean and Dry	Min. 10 Sec. 4.3	Min. 9 Sec. 16	With Debris 4 Pumps	Y. A. Doh
May 22/81 Clean and Dry	Min. 10 Sec. 4.3	Min. 9 Sec. 15	Without Debris 4 Pumps	Y. A. Doh
May 29/81 Cloudy + WET.	Min. 10 Sec. 3.0	Min. 9 Sec. 3.0	With Debris 4 Pumps	Y. A. Book
May 29/81 Cloudy + WET.	Min. 10 Sec. 3.3	Min. 9 Sec. 10	Without 4 Pumps	Y. A. Book
	Min. Sec.	Min. Sec.	continued	→

WATER LEVEL READINGS

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
June 4/81 Heavy Rains Do to high level Tank was cleaned	Min. - Sec. -	Min. - Sec. -	Readings were not taken with Debris because tank was cleaned	June 4/81
June 5/81	Min. 9	Min. 9	1-2-3-9 Pumps	Ed Dohn
Clear - Dry	Sec. 58	Sec. 22	Clean Tank	
JUNE 12/81	Min. 15	Min. 9	4 - Pumps WITH	Ed Dohn
CLOUDY + DRY	Sec. 3	Sec. 24	DEBRIS	
JUNE 12/81	Min. 10	Min. 9	WITHOUT	Ed Dohn
CLOUDY + DRY	Sec. 14	Sec. 15	DEBRIS 1,2,3+9	
June 14/81	Min. 10	Min. 10	4 Pumps	Ed Dohn
Clear and dry	Sec. 12	Sec. 0	with Debris	
June 19/81	Min. 10	Min. 9	4 Pumps	Ed Dohn
Clear and dry	Sec. 13	Sec. 36	without Debris	
JUNE 26/81	Min. 10	Min. 9	WITH DEBRIS	Ed Dohn
Clear + DRY	Sec. 17	Sec. 33	4 Pumps 123,9	
JUNE 26/81	Min. 9	Min. 9	WITHOUT DEBRIS	Ed Dohn
Clear + DRY	Sec. 45	Sec. 57	4 Pumps 123+9	
JULY 3/81	Min. 10	Min. 9	WITH DEBRIS	Ed Dohn
Clear + DRY	Sec. 0	Sec. 45	1,2,3+9	
JULY 3/81	Min. 10	Min. 9	WITHOUT DEBRIS	Ed Dohn
Clear + DRY	Sec. 2	Sec. 35	1,2,3+9	
JULY 10/81	Min. 10	Min. 10	WITH DEBRIS	Ed Dohn
Clear + DRY	Sec. 35	Sec. 2	1,2,3+9	
JULY 10/81 (same)	Min. 9	Min. 10	WITHOUT DEBRIS	Ed Dohn
	Sec. 25	Sec. 37	1,2,3+9	
JULY 17/81 Hot & Dry	Min. -	Min. -	WITHOUT DEBRIS	Ed Dohn
	Sec. -	Sec. -	NOT TAKEN	
JULY 17/81 Hot & Dry	Min. 9	Min. 9	WITH DEBRIS	Ed Dohn
	Sec. 05	Sec. 24	123+9	
JULY 24/81	Min. 8	Min. 11	With Debris	Ed Dohn
Sunny and Dry	Sec. 50	Sec. 15	1,2,3,9	
JULY 24/81	Min. 8	Min. 11	Without Debris	Ed Dohn
Sunny and Dry	Sec. 50	Sec. 8	123,9	
AUG 5/81	Min. 9	Min. -	TEST	Ed Dohn
DRY	Sec. 8	Sec. -		
AUG 7/81	Min. 9	Min. 8	With Debris	Ed Dohn
Sunny and Dry	Sec. 18	Sec. 35	Pumps 1,2,3,9	
AUG 7/81	Min. 9	Min. 8	Without Debris	Ed Dohn
Sunny and Dry	Sec. 18	Sec. 35	Pumps 1-2-3-9	
AUG 14/81	Min. 9	Min. 8	WITH DEBRIS	Ed Dohn
CLOUDY + DRY	Sec. 10	Sec. 35	1,2,3+9	
8/108/14	Min. 8	Min. 8	WITHOUT DEBRIS	Ed Dohn
	Sec. 20	Sec. 38	1,2,3,9	
8/121/08	Min. 9	Min. 8	With Debris	Ed Dohn
Sunny and Dry	Sec. 10	Sec. 45	Pumps 123,9	
8/108/21	Min. 9	Min. 8	Without Debris	Ed Dohn
Sunny and Dry	Sec. 10	Sec. 38	pump 1,2,3,9	
8/108/28	Min. 9	Min. 8	with Debris	Ed Dohn
Light - Rain	Sec. 25	Sec. 38	pumps 123,9	
8/108/28	Min. 9	Min. 8	Without Debris	Ed Dohn
Light - Rain	Sec. 25	Sec. 32	pumps 123,9	

(*) AS FILL TIME RUNS IN 10 MIN AREA - I WOULD PRESUME THIS TIME IS IN ERROR
NOT NOTICED PREVIOUSLY - (Any other Tunnel Surveys)

WATER LEVEL READINGS

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
8/109/04	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	CR Book
8/109/04	Sec. 25	Sec. 33	WITHOUT DEBRI	CR Book
8/109/11	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	CR Book
8/109/11	Sec. 20	Sec. 22	WITHOUT DEBRI	CR Book
8/109/11	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	CR Book
8/109/18	Sec. 35	Sec. 19	WITHOUT DEBRI	CR Book
8/109/18	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/109/18	Sec. 42	Sec. 47	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/109/18	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/109/25	Sec. 43	Sec. 25	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/109/25	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/109/25	Sec. 43	Sec. 25	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/02	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/02	Sec. 47	Sec. 47	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/02	Min. 9	Min. 8	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/09	Sec. 47	Sec. 27	WITHOUT DEBRI	Ed. Dohn
8/110/09	Min. 9	Min. 7	WITH DEBRI	Ed. Dohn
8/110/09	Sec. 55	Sec. 49	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/09	Min. 9	Min. 7	WITHOUT DEBRI	Ed. Dohn
8/110/16	Sec. 59	Sec. 49	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/16	Min. 9	Min. 7	WITHOUT DEBRI	Ed. Dohn
8/110/16	Sec. 49	Sec. 57	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/16	Min. 9	Min. 7	WITHOUT DEBRI	Ed. Dohn
8/110/23	Sec. 49	Sec. 56	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/110/23	Min. 10	Min. 8	WITHOUT DEBRI	R. Hammond
8/110/23	Sec. 51	Sec. 0	4 pumps 1, 2, 3, & 4 WITH DEBRI	R. Hammond
8/110/23	Min. 10	Min. 8	WITHOUT DEBRI	R. Hammond
8/111/06	Sec. 50	Sec. 48	4 Pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/111/06	Min. 9	Min. 8	WITHOUT DEBRI	Ed. Dohn
8/111/06	Sec. 59	Sec. 03	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/111/06	Min. 9	Min. 8	WITHOUT DEBRI	Ed. Dohn
8/111/13	Sec. 59	Sec. 54	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/111/13	Min. 10	Min. 8	WITHOUT DEBRI	CR Book
8/111/13	Sec. 15	Sec. 44	4 Pumps 1, 2, 3, & 4 WITH DEBRI	CR Book
8/111/13	Min. 10	Min. 8	WITHOUT DEBRI	CR Book
8/111/20	Sec. 11	Sec. 47	4 pumps 1, 2, 3, & 4 WITH DEBRI	CR Book
8/111/20	Min. 9	Min. 8	WITHOUT DEBRI	R. Hammond
8/111/20	Sec. 33	Sec. 32	4 Pumps 1, 2, 3, & 4 WITH DEBRI	R. Hammond
8/111/20	Min. 9	Min. 8	WITHOUT DEBRI	R. Hammond
8/111/27	Sec. 43	Sec. 20	4 Pumps 1, 2, 3, & 4 WITH DEBRI	R. Hammond
8/111/27	Min. 10	Min. 7	WITHOUT DEBRI	Ed. Dohn
8/111/27	Sec. 08	Sec. 57	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/111/27	Min. 10	Min. 7	WITHOUT DEBRI	Ed. Dohn
8/111/27	Sec. 08	Sec. 51	4 pumps 1, 2, 3, & 4 WITH DEBRI	Ed. Dohn
8/111/27	Min.	Min.	→	→
8/111/27	Sec.	Sec.	→	→

WATER LEVEL READINGS

WEST SUMP

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
Clear Dec 5/1981	Min. 10 Sec. 10	Min. 8 Sec. 2	With Debris Pumps 12, 3, 9.	G. A. Dohn
Clear Dec 5/1981	Min. 10 Sec. 10	Min. 7 Sec. 56	Without Debris Pumps 12, 3, 9.	G. A. Dohn
DEC 11/1981	Min. 10 Sec. 20	Min. 8 Sec. 16	Clear Dec 11 Pumps 12, 3, 9	G. A. Dohn
CLEAR DEC 11/1981	Min. 9 Sec. 15	Min. 7 Sec. 57	Without Debris 12, 3, 9	G. A. Dohn
DEC 16/1981	Min. 10 Sec. 7	Min. 8 Sec. 0	With Debris 12, 3, 9	G. A. Dohn
DEC 18/1981	Min. 10 Sec. 0	Min. 7 Sec. 50	Without Debris 12, 3, 9	G. A. Dohn
Dec 24/1981	Min. 10 Sec. 12	Min. 8 Sec. 13	With Debris 12, 3 and 9	G. A. Dohn
Clear Dec 24/1981	Min. 10 Sec. 3	Min. 8 Sec. 10	Without Debris Pumps 12, 3, 9	G. A. Dohn
Clear Dec 31, 1981	Min. 10 Sec. 44	Min. 8 Sec. 57	With debris Pumps 12, 3, 9	M. Burrows
Dec 31, 1981	Min. 10 Sec. 30	Min. 7 Sec. 56	Without debris pumps 12, 3, 9	M. Burrows
Jan 8/82	Min. 12 Sec. 10	Min. 7 Sec. 55	Debris 4	KJ
Jan 8/82	Min. 12 Sec. 10	Min. 6 Sec. 45	Debris 4	KJ
JAN 15/82	Min. 12 Sec. 26	Min. 7 Sec. 15	WITH DEBRIS 4	Proch
JAN 15/82.	Min. 12 Sec. 32	Min. 7 Sec. 30	WITH OUT DEBRIS 4	Proch.
Jan 22	Min. 12 Sec. 20	Min. 7 Sec. 13	Debris 4	KJ
Jan 22	Min. 12 Sec. 40	Min. 7 Sec. 6	less Debris 4	KJ
Jan 29	Min. 12 Sec. 10	Min. 7 Sec. 5	Debris 4	KJ
Jan 29	Min. 12 Sec. 25	Min. 7 Sec. 15	less Debris 4	KJ
Feb 5	Min. 13 Sec. 0	Min. 7 Sec. 15	Debris 4	KJ
Feb 5	Min. 12 Sec. 57	Min. 7 Sec. 14	less Debris 4	KJ
FEB 11/82	Min. 14 Sec. 53	Min. 7 Sec. 55	WITH DEBRIS 4	Proch
FEB 11/82.	Min. 13 Sec. 20	Min. 7 Sec. 30	LESS DEBRIS 4	Proch
CLOUDY FEB 19/82	Min. 12 Sec. 30	Min. 7 Sec. 25	DEBRIS 4	R. Boyatzis
CLOUDY FEB 19/82	Min. 12 Sec. 35	Min. 7 Sec. 25	CLEAN 4	R. Boyatzis
	Min. Sec.	Min. Sec.		

STATE WEATHER - IS CLEAR, RAIN, CLOUDY ETC
ON SIDE WHEN ENTERING

[Signature]

WATER LEVEL READINGS

WEST SUMP

? #3 PUMP OUT #6 BACKUP IN ITS PLACE #2 BACK IN RIGHT SPOT (REPAIRED)

DATE	LOW TO HIGH	HIGH TO LOW	NUMBER OF PUMPS USED	TAKEN BY
Feb 26/82	Min. 12	Min. 7	1-2-3-9 Pumps	
Clear - Sunny	Sec. 35	Sec. 35	Dirty Tank.	H.A. Doh
Feb 26/82	Min. 12	Min. 7	1-2-3-9 Pumps	
Clear Sunny	Sec. 33	Sec. 32	Clean Tank	H.A. Doh
march 5/82	Min. 12	Min. 7		
Sunny	Sec. 29	Sec. 25	DIRTY TANK	R. Hammond
march 5/82	Min. 12	Min. 7		
Sunny	Sec. 25	Sec. 27	CLEAN TANK	R. Hammond
march 12/82	Min. 12	Min. 7	1-2-3-9	
CLOUDY	Sec. 6	Sec. 25	DIRTY TANK	J. Proctor
march 12/82	Min. 12	Min. 7	1 2 3 9	
CLOUDY	Sec. 22	Sec. 15	CLEAN TANK	J. Proctor
Mar. 19/82	Min. 12	Min. 7		
CLOUDY	Sec. 20	Sec. 30	4 Belina	K/P
Mar 19/82	Min. 12	Min. 7		
CLOUDY	Sec. 30	Sec. 25	4 Belina	K/P
* Mar 26/82	Min. 10	Min. 8		
CLEAR	Sec. 24	Sec. 22	4 clean	K/P
Apr 2/82	Min. 10	Min. 8		
CLEAR	Sec. 32	Sec. 25	4 clean	K/P
Clear - Sunny	Min. 11	Min. 7	1-6-3-9 Pumps	J. Proctor
April 8/82	Sec. 0	Sec. 54	Clean Tanks	
Clear - Sunny	Min. 10	Min. 7	1-6-3-9 Pumps	H.A. Doh
April 16/82	Sec. 55	Sec. 55	Clean Tanks	
Clear - Sunny	Min. 10	Min. 7	4 Pumps	M. Walker
April 23/82	Sec. 53	Sec. 50	1-6-3-9	
Clear - Sunny	Min. 11	Min. 7	4 Pumps	R. Hammond
APR 30/82	Sec. 13	Sec. 50	1-6-3-9 CLEAN	
OVERCAST	Min. 11	Min. 7	1-6-3-9 Pumps	J. Proctor
MAY 7 1982	Sec. 56	Sec. 52	TANK CLEAN	
Clear - Sunny	Min. 11	Min. 7	1-2-6-9	L. Frigault
May 14/82	Sec. 46	Sec. 16	TANK CLEAN	
CLEAR	Min. 11	Min. 7	1 2 6 9	
May 20	Sec. 27	Sec. 38		
Sunny	Min. 11	Min. 7	1, 2, 6, 9	R. Hammond
May 28	Sec. 15	Sec. 38	Clean	
CLOUDY	Min. 10	Min. 7	1, 2, 6, 9	J. Proctor
JUNE 3 82	Sec. 55	Sec. 33	TANK CLEAN	
SUNNY CLEAR	Min. 11	Min. 7	1, 2, 6, 9	L. Frigault
JUNE 11/82	Sec. 15	Sec. 31	TANK CLEAN	
	Min.	Min.		
	Sec.	Sec.		
	Min.	Min.		
	Sec.	Sec.		
	Min.	Min.		
	Sec.	Sec.		
	Min.	Min.		
	Sec.	Sec.		

* Canal Level increased (approx 3') to top

★ WATER LEVEL READINGS BEGAN TO BE TAKEN FROM MCC. WEST VIA INDICATOR LIGHTS INSTALLED ON MCC PANEL COVER.

☐ #2 PUMP OUT #6 BACK UP IN ITS PLACE.

#2 Pump From Welland in #1 SPOT

memorandum



To: Mr. G.M. Sinclair
Reg. Maintenance Engineer
Central (5000 Yonge St.) Region

Date: 82 06 23

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Thorold Tunnel - Water Seepage

This is in reply to your memo of 82 06 18 regarding further investigative work in connection with the water inflow to the west sump of the Thorold Tunnel and the condition of the bentonite seal in the 'rock slot'. We agree that we should now proceed as you have outlined in your previous memo of 80 03 13 and we will be contacting Acres in this regard shortly. Consultant fees and any other costs incurred by the Pavement and Foundation Design Section for investigative work will come from our own budget. Terms of reference will be discussed fully with the Region before any work is assigned.

A handwritten signature in cursive script, appearing to read "K. G. Selby".

K.G. Selby, Eng.
Senior Foundations Engineer

KGS:syc

cc: C.R. Robertson
G.C. Burkhardt
R.D. Gunter

memorandum



To: Mr. K. G. Selby,
Senior Foundations Engineer,
Pavement & Foundations Design Section,
Engineering Materials Office.

Date: 82 06 18

Thorold Tunnel - Water Seepage

Jim Loughheed has just advised me that you did not receive my memo of 80 03 13, which was a follow-up to your report of 80 02 22. Attached are copies of both.

I did not follow-up on this memo, simply assuming that you would be taking the requested action, as I understood from your report that you were prepared to do so. It appears that subsequently the matter was forgotten.

Subsequently, on 80 12 09, another meeting was held at 5000 Yonge Street to discuss a number of items relative to the tunnel seepage. Attached is a copy of my report on that meeting. Point 5) in that report again refers to the bentonite seal, and notes that we came to a somewhat different conclusion.

Regardless of this, I believe we should proceed as outlined in my memo to you dated 80 03 13. Please let me know if you are in agreement with this approach and if you are prepared to proceed accordingly.

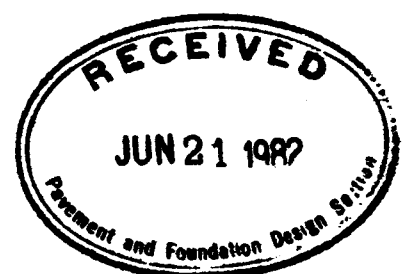
Depending on the cost, there may be some budgetary problems in doing any work in 1982/83, but this decision could be made later. If you expect the Region to cover consultant fees, please let me know what you think is involved before making any commitments in this regard.

A handwritten signature in cursive script, appearing to read "G. M. Sinclair".

G. M. Sinclair,
Reg. Maintenance Engr.,
Central Region.

GMS/js
Encl.

cc: C. R. Robertson
G. C. Burkhardt
R. D. Gunter
File 5808-1



5808-1
Jml

K. G. Selby
Senior Foundations Engineer
Pavement & Foundation Design Section
Central Bldg., Downsview

80 03 13

Thorold Tunnel-Water Seepage

This is further to your report dated 80-02-22 which included your recommendations for future action.

We agree with your recommendations, subject to the following comments:

- 1) Acres should investigate the problem of the bentonite seal. This investigation should include the design of necessary repairs in a form suitable for obtaining tenders. It is not anticipated that the District could undertake the repairs with their own forces.
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It would be appreciated if you would prepare terms of reference for the Consultant and liaise with them. We would, of course, like to be kept advised of any significant developments. The District, in particular, should be involved fully so that they will be aware of progress.

G. M. Sinclair
Reg. Maintenance Engr.
Central Region

GMS:ms

c.c.: C. R. Robertson
G. Burkhardt
D. Gunter

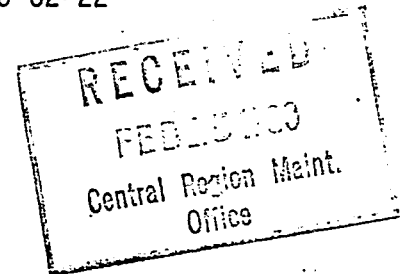
memorandum



To: Mr. H.M. Sinclair
Regional Maintenance Engineer
Central Region

Date: 1980-02-22

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview



Re: Thorold Tunnel - Water Seepage Investigation
District #4 (Hamilton)

At our meeting on 1980-01-21 regarding the seepage problem at the Thorold Tunnel we outlined to you, in some detail, the results of the various investigations and reviews which we had carried out following our receipt from you of the report by Acres Consulting Services Ltd. entitled 'Report on Remedial Works Pavement Slab - West Portal Eastbound Lanes'. This memo confirms the conclusions and recommendations made by us during the meeting and which are summarized as follows:-

Problem

E.B.L.s at West Portal were 'flooded' with water seeping out between joints of concrete slabs. 'Flooded' area extended to a distance of 35 ft. west of the Portal. The water flowed into the surface water interception drain at the mouth of the tunnel and thence into the sumps.

Questions to be Resolved

Where did this water come from and how long has it been coming? Can it be prevented or reduced? What is it costing us now? Is it essential to stop it or reduce it?

Facts and Observations

- 1) The water was first observed by J. Loughhead in Oct., 1977 flowing into M.H. 119 through cracks in the grate housing. The water level, in consequence, did not rise as high as the top of the slabs.
- 2) Repairs to the M.H. 119 grate housing were carried out in July, 1978 at which time three 1½ inch dia. pipes (about 2 ft. long each) were placed at the level of underside of pavement discharging into the M.H. 119. This appeared to have solved the problem.
- 3) In June of 1979 flooding as described above occurred and Acres were hired by the Regional Maintenance to assist in solving the flooding problem. The remedial work consisted of removing the pavement and installing perforated pipes surrounded by pea gravel and a graded filter material and then restoring the pavement. This dried the area up effectively.

It was noticed by J. Loughhead that initially the three 1½ inch pipes referred to in 2) were observed to be plugged up and that when they were cleaned out the water on top of the pavement drained away rapidly and never came above the pavement surface again. Voids below the pavement slabs were attributed to material washing through the 3 small 1½ inch pipes and they were later removed during the repairs.

- 4) From Jan. 15th to March 6th 1979 the canal was lowered by 21 ft. to el. 549 (Note: grade of west portal is el. 550). During this period pumping time was reduced by more than 50 percent. From Jan. 3rd to Jan. 16th 1969 the canal was lowered by 23 ft. to el. 547. Pumping time, in this period, was reduced by more than 75 percent of normal.
- 5) A plot of total pumping time in hours per year versus time shows that a gradual increase from about 8500 in 1969 to about 14000 in 1976 has occurred - an increase of about 65%. Since 1975; however, the pumping time has remained more or less constant.
- 6) A considerable increase in pumping hours occurred between 1972 and 1974 (during which time the pressure relief slot was constructed) from 10,800 hrs. in 1972 to 13,400 hrs. in 1974. It cannot be construed that the slot construction contributed definitely to the increase but the possibility is there.
- 7) During Acres activities at the site in 1979 they observed that the bentonite seal in the 'slot' was about 4 ft. below its original level at the two inspection manholes. Thus a possible leakage path exists in the rock between el. 562 and el. 558.
- 8) Present pumping costs (for 1980) are as follows:

Hydro	\$24,500	per year
Maintenance-Labour	\$10,000	Per year
Maintenance-Parts	\$10,000	Per year
TOTAL		<u>\$44,500</u> Per year

The above are directly proportional to the annual pumping hours therefore, reductions in pumping time would result in direct savings to the Ministry. For instance, a reduction back to the 1970 condition (i.e. from 14000 to 10,000 hours) would result in a saving of about \$13,000 annually.

- 9) Ministry expenditure for remedial measures to solve the flooding problem was \$58,166.00 of which \$11,400 went to Acres for engineering and supervision.
- 10) Acres recommended a further study by them to attempt to find out where the water is coming from. If successful they will recommend methods of reducing flow. Their estimate for their services is \$38,000. It should be noted that they did not come to any definite conclusions as a result of their work in July 1979.

Conclusions

- a) Pumping is affected significantly by canal level (see 4) above) therefore it is safe to conclude that the main source of the water is the canal. ✓
- b) The flooding problem was due in the main to inadequate subsurface drainage. This has been taken care of and probably will not occur again. (See 1), 2), and 3)). ✓
- c) The bentonite seal in the 'slot' has apparently been washing away since the level of the seal has dropped 4 feet. This could be a cause of some leakage and should therefore be thoroughly investigated and repaired. Acres were the original designers of this seal and should be retained for this purpose. ✓
- d) Apart from c) the present situation, which appears to have stabilized since 1975 (see 5)), is not causing any problems for the M.T.C. The pumping capacity is well in excess of pumping needs at present by a ratio of about 2:1 even when 1 pump is being serviced (4 pumps - 1½ required). The cost of these pumps amounts to \$44,500 per year and since water flow is not likely to be reduced to less than the pre 1973 level if the slot is the cause and is sealed, maximum savings would not exceed about \$13,000 annually. ✓

However, if the main source of water can be found and sealed savings would probably amount to about \$30,000 annually. It is really not possible to estimate what it would cost to find this source and if found what it would cost to seal it. ✓

- e) It would be of advantage to have a means by which flow conditions in the vicinity of the west portal could be readily monitored, and read by the Maintenance staff at the tunnel. Piezometers could be installed for this purpose. ?

Recommendations

- (1) Acres should be retained to further look into the problem of the missing bentonite seal in the slot to determine what repairs are necessary. These repairs should be carried out as soon as possible. ✓
- (2) Acres should be requested to provide a cost estimate for a scheme utilizing piezometers which could be monitored regularly by Maintenance staff. The purpose of the scheme would be to try to locate the zone or zones where seepage is increasing. *how much would it cost to fix?*
- (3) Future records of pumping time should be recorded on the same date (say 1st) each month so that proper comparisons can be made. In the past it has happened that readings have been delayed several days making comparisons with the same month in different years difficult. Records of sump inflow times should also be kept at regular intervals (say every two weeks). The suspected cause of any major deviations from the norm of the above readings should be ascertained as soon as possible and duly recorded. *being done*

In connection with the foregoing we would be pleased to assist in providing terms of reference for Acres, also to carry out the necessary liaison with them.

We would also be pleased to provide any further advice in connection with the seepage problem which you might require.

K. G. Selby

K.G. Selby
Senior Foundations
Engineer

KGS:ea

cc: W. Lin
G. Burkhardt
R.D. Gunter

memorandum



To: FILE

Date: 81 01 15

5808-1

Thorold Tunnel Meeting
Central Region, 5000 Yonge Street
- 80 12 09 -

This meeting was called to review the latest data concerning water seepage at the Tunnel and concerns that there should, perhaps, be more warning devices in the event that the pumps stop for any reason. In attendance were:

H. G. Potts	-	Hamilton District
J. F. Lougheed	-	" "
G. Green	-	" "
G. C. Burkhardt	-	Structural Section, Central Region
M. Almer	-	" " " "
D. R. Brohm	-	Maintenance Branch, Head Office
K. G. Selby	-	Pavt. & Fdn. Design Section, H.O.
G. M. Sinclair	-	Reg. Maintenance Engr., Central Region

Discussion included the following points:

- 1) Water inflow to west sump -- after much discussion, the consensus is that there is no significant change in the rate of inflow of water. The increase indicated by the graph prepared by Jim Lougheed is part of a regular annual cycle. Ken Selby also pointed out that the record of pumping hours confirms that there has been no increase in the last four years. It was noted that Mr. Green, who has worked at the Tunnel since it was opened, feels that there has been an increase. The decision was to continue to have the District monitor the sump fill-up time regularly to identify any new trends.
- 2) District will also arrange to have the pump hour-meters checked to ensure that our pumping time is recorded accurately.
- 3) District will arrange to monitor canal water levels at the time the sump fill-up time is being checked.
- 4) District was again asked to make notes of any unusual precipitation conditions prior to checking sump fill-up times.

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It was agreed in subsequent discussions that the District will look into the question of how this might be accomplished, and report to me. If necessary, we may have to retain a consultant (presumably Acres) to assist us in this regard.

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- 7) All the pumps at Thorold and the remainder at East Main are approaching this same situation. Mr. Green has learned from discussions with suppliers that in four to five years we will not be able to get parts for them either. A total replacement program is therefore required.
- 8) In subsequent discussions, it was agreed that the District would consider various alternatives and schedules for pump replacements, and make a proposal to me. It would be helpful if this proposal includes some approximate cost figures and it is understood that these figures will be approximate only.
- 9) Jim Loughheed also raised a concern about the hauling of waste and/or dangerous materials through the Tunnels, particularly Thorold. The suggestion is that such materials should not be permitted to go through the Tunnels due to the special problems a mishap would create. A spill would very quickly go through our pumps and be discharged into the canal. Mr. Smith has agreed to look into this matter as any action would require legislation and enforcement.
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- ...

It has been determined that the batteries could not operate the lane-control signals for any length of time so we would require standby diesel or gasoline-powered equipment to accomplish this. The District have obtained some cost figures and find that a four kilowatt power plant could be bought and installed for about \$6,000.00 and this would have some surplus capacity which might be useful in situations where we have no power.

It has now been agreed in principle that installation of a standby generator should proceed. The District should consider the details involved and submit a D4 for approval when these details are resolved.

- 11) Another suggestion was made that we should install an automatic warning system which would be wired into the OPP office. This would advise them of power failure at the Tunnel. If their priorities at that time permitted, they could proceed to physically close the Tunnel.

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After discussion with Mr. Smith and review with the District, it is evident that there is no total agreement on the need or desirability of instituting either of these options. If the District wishes to pursue any significant changes in staffing arrangements, etc., a proposal could be considered at a later date.



G. M. Sinclair,
Reg. Maintenance Engr.,
Central Region.

GMS/js

cc: Attendees
T. G. Smith

82 06 01

TO: K. Selby
Sr. Foundation Eng.
Pavement & Foundation Design Section
Central Building

FROM: J. F. Lougheed
Services Supervisor
District #4, Hamilton

memorandum



To: K. G. Selby
Senior Foundations Engineer
Pavement & Foundation Design Section
Central Bldg., Downsview

Date: 80 03 13

Thorold Tunnel-Water Seepage

This is further to your report dated 80-02-22 which included your recommendations for future action.

We agree with your recommendations, subject to the following comments:

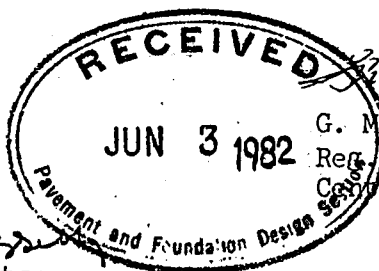
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NOTE:- THIS MEMO WAS
NEVER RECEIVED
BY K. G. SELBY
UNTIL THIS COPY
WAS SENT BY
J. LOUCHEED
ON 82-06-01

GMS:ms

c.c.: C. R. Robertson
G. Burkhardt
D. Gunter



G. M. Sinclair
Reg. Maintenance Engr.
Central Region

RECEIVED

MAR 14 1980



Action Memo

Time

Date

2 03 23

To **H.K. Selby**

From **Dirk Almer**

Telephone No./City

Message Taken By

<input type="checkbox"/> Phoned On Hold	<input type="checkbox"/> Please Call Returned Your Call	<input type="checkbox"/> Will Call Back	<input type="checkbox"/> Waiting in Person	<input type="checkbox"/> Will Return
		<input type="checkbox"/> Wishes Appointment	<input type="checkbox"/> Was Here	

<input type="checkbox"/> File	<input type="checkbox"/> Draft Reply For My Signature	<input type="checkbox"/> Provide More Details	<input type="checkbox"/> For Your Information
<input type="checkbox"/> Type Draft	<input type="checkbox"/> For Your Approval and Signature	<input type="checkbox"/> Keep Me Informed	<input type="checkbox"/> Per Discussion
<input type="checkbox"/> Type Final	<input type="checkbox"/> Circulate and Return	<input type="checkbox"/> Appropriate Action	<input type="checkbox"/> Per Your Request
<input type="checkbox"/> Make Copies	<input type="checkbox"/> Return With Comments	<input type="checkbox"/> Note and See Me	<input type="checkbox"/> Returned With Thanks
<input type="checkbox"/> Please Answer	<input type="checkbox"/> Investigate and Report	<input type="checkbox"/> Note and Return	<input type="checkbox"/>

Comments:

Please advise of any suggestion. **Dirk**

memorandum



To: Mr.G.C.Burkhardt
Head, Structural Section
Central Region
5000 Yonge Street

Date: 82 03 18



Welland Canal (Thorold Tunnel)

This is to notify you that we have received information from the St. Lawrence Seaway Authority advising that the Welland Canal will be drained in the area above the tunnel and if there is any exploratory work or any investigation which has to be done then this would be an appropriate time to do it, as this will be the last chance of having the canal drained for a considerable length of time.

The dates will be approximately from the end of December 1982 to the middle of February 1983.

Would you please inform any other departments which may be interested.

JDN:lo

J D Nation
J. D. Nation
Supvr. Traffic & Mtce. Services

memorandum



To: K. G. Selby
Senior Foundations Engineer
Pavement & Foundation Design Section
Central Bldg., Downsview

Date: 80 03 13

D.E.	COPIES ISSUED
D.A.O.	COPIES REQUIRED
CONST.	NOTE & FILE
MAINT	DISCUSS WITH ME
MAN.	FILE ANSWER
FE'S.	NOTE & RETURN
E.O.S.	
SAFETY	
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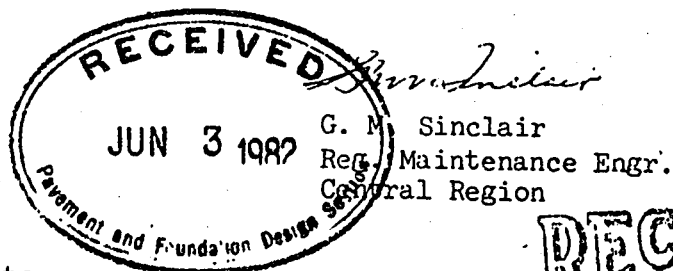
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c.c.: C. R. Robertson
G. Burkhardt
D. Gunter

RECEIVED

MAR 14 1980

Ministry of
Transport & Communications

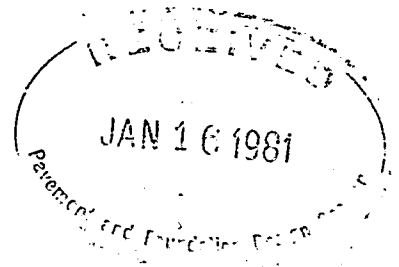
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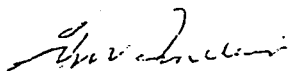
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Reg. Maintenance Engr.,
Central Region.

GMS/js

cc: Attendees
T. G. Smith

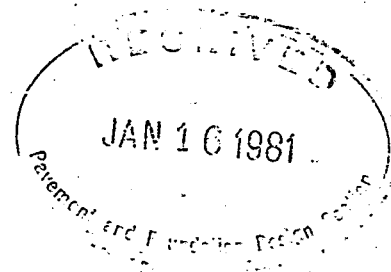
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Date: 81 01 15

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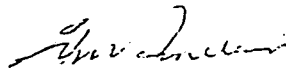
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Reg. Maintenance Engr.,
Central Region.

GMS/js

cc: Attendees
T. G. Smith

memorandum



To: Mr. A. E. Argue,
Director,
Maintenance Branch.

Date: 80 11 19

Thorold Tunnel

Attached is a copy of a report from Hamilton District . which deals with some current issues relative to the tunnel. Some of these issues are relatively simple and can be settled without too much difficulty.

However, you will note that the recent trend in the amount of pumping required appears to be significant. I am therefore asking that offices identified arrange to be represented at a meeting:

- Tuesday December 9, 1980
- 9:00 a.m.
- Boardroom 'D'
- 3rd Floor, 5000 Yonge Street

One of the possibilities for consideration is to attempt to locate the source(s) of the seepage so that some measures might be considered to eliminate or reduce it.

A handwritten signature in cursive script, appearing to read "G. M. Sinclair".

G. M. Sinclair,
Reg. Maintenance Engr.,
Central Region.

GMS/js
Encl.

cc: C. R. Robertson
P. D. Billings
G. C. Burkhardt
R. D. Gunter
A. G. Stermac ✓

memorandum



To: Mr. G. M. Sinclair
Regional Maintenance Engineer
Central Region
5000 Yonge Street

Date: 80 10 31

5808-1

Thorold Tunnel

Further to our meeting at the tunnel, I am enclosing a report from Steve re standby power. This is a small amount of money compared to the investment of the structure and I would suggest we proceed with the installation.

The smaller unit is ample for the existing connected load. I would suggest the larger unit as this would give us additional power which would enable us to provide additional emergency lighting in critical areas such as the sump pump areas which we may have to work in.

Also enclosed is a report from Steel Inspection & Testing Ltd. Hamilton for the discharge pipes. The pipes appear to be satisfactory.

In regard to the existing pumps, it would appear that we are coming to the end of time as some parts are not available at present and I understand the time limit for the supplier to supply parts is nearly over.

I would recommend that we obtain a designer to review the existing system with the intent to install an additional discharge pipe from the west sump, as the quantity of water cannot be handled by the mid-sump and, therefore, if any problem arises with the west sump discharge manifold, we cannot get rid of the water that would overflow into the mid-sump.

This creates a problem to install a new pump valve if required and, at this stage, we have not examined in detail the possibility of additional pumps.

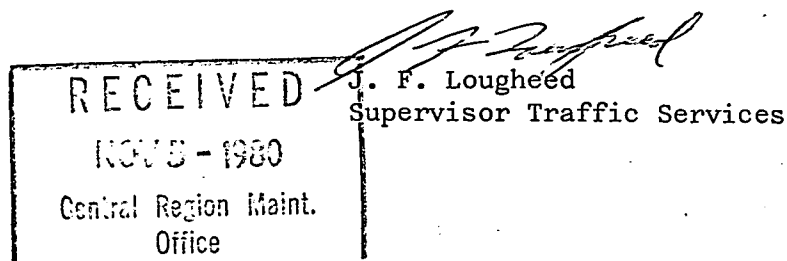
Enclosed is a chart showing the time for sumps to fill up and also for total pump time. It would appear that the water flow is on the increase.

In regard to the security system by Bomar, I would recommend that this also be installed as an additional backup alarm for high water or loss of power. These two functions are the main concern.

We are attempting to provide a service with one less man than we had in 1979 which leaves Welland unattended. With the maintenance required at Welland, sometimes we are shorthanded.

On 80 10 29, George Green went to Welland to do a minor job. On arriving, it was found the sumps had to be cleaned. Rather than spend extra travelling time to make a second trip back, he stayed and cleaned the screens. This extended the length of time which Thorold was left unattended from two hours to four, with only the instructions for the Burlington dispatcher to answer the emergency phone. There is no other system at the present time.

JFL:lo
c.c. S. Fernick
J. F. Lougheed





Memorandum

To: Mr. J. Loughheed
Supvr. Traffic Services
Burlington, Ontario

From: S. Fernick
Supvr. Elect. & Tunnel Crews
Winona, Ontario

Attention:

Date: 1980-10-23

Our File Ref.

In Reply to

Subject:

STANDEY POWER FOR LANE CONTROL SIGNALS
THOROLD TUNNEL

The cost for the above is approximately \$4,200.00 for a 2.5 K.W. power plant that would handle the connected load. A 4 K.W. unit would be \$6,000.00, this would give us extra capacity if required.

The above estimate includes material and labour with an automatic transfer switch using the present circuits for the lane control signal.

I would like to point out that our present circuitry is not water-proof and if the water in the centre of the tunnel was to rise 10' - 12' we would probably lose our circuits. To avoid this we would have to consider a system separate of the existing one.

S. Fernick
Supvr. Elect. & Tunnel Crews

SF:vs

STEEL INSPECTION & TESTING LTD.

REPORT NO.

P.O. Box 4446, Station D
Hamilton, Ontario L8V 4L8

ULTRASONIC EXAMINATION REPORT

Phone: (416) 385-2185

PART NAME <u>DISCHARGE PIPES</u>		PIECE/SERIAL NO. <u>SEE RESULTS</u>	
CUSTOMER <u>M.T.C. THOROLD.</u> <u>ONTARIO.</u>		DWG. NO. <u>N/A</u>	
S.I.T. INSPECTOR(S) PRINT <u>JEFFREY E. FOSTER</u>		NO. OF PARTS <u>THREE</u>	
UT EXAMINATION OF <u>U/T THICKNESS INSPECTION OF ELBOWS</u>		SURFACE COND. <u>WIRE BRUSH</u>	
BEFORE P.W.H.T. <input type="checkbox"/>		PROCEDURE(S) NO. <u>A.S.T.M. E164</u> REV. <u>---</u>	
AFTER INTER P.W.H.T. <input type="checkbox"/>		INSTRUMENT TYPE <u>SONIC D-METER</u> SER NO. <u>---</u>	
AFTER FINAL P.W.H.T. <input type="checkbox"/>		COUPLANT <u>GLYCERINE</u>	
AFTER HYDROSTATIC TEST <input type="checkbox"/>		SENSITIVITY <u>N/A</u>	
IN SERVICE <input checked="" type="checkbox"/>		TIME BASE SCALE <u>300"</u> REJECT <u>---</u>	
CALIBRATION BLOCK(S) <u>SONIC D-METER</u>		AC or TV <u>---</u> db	
TRANSDUCERS		ANGLE <u>0°</u>	SIZE <u>1/4" dia</u>
		SERIAL NO. <u>066127</u>	FREQUENCY <u>5.0 MHz</u>
EXAMINATION RESULTS			
<u>PUMP #1: TOP ELBOW - ⑧ .295" ⑨ .310" ⑩ .310"</u>			
<u>MIDDLE " - ⑤ THRU ⑦ .270"</u>			
<u>BOTTOM " - ① .290" ② .285" ③ .275" ④ .270"</u>			
<u>PUMP #2: TOP ELBOW - ⑦ .305" ⑧ .310" ⑨ .305"</u>			
<u>MIDDLE " - ④ THRU ⑥ .300"</u>			
<u>BOTTOM " - ① .250" ② ③ .260"</u>			
<u>PUMP #3: TOP ELBOW - ⑦ .270" ⑧ .275" ⑨ .285"</u>			
<u>MIDDLE " - ④ THRU ⑥ .285"</u>			
<u>BOTTOM " - ① .285" ② .290" ③ .285"</u>			
<u>PUMP #4: ① THRU ③ .275" - MAIN DISCHARGE ① THRU ⑤ .375"</u>			
SEE ATTACHED DRAWINGS <input type="checkbox"/> SKETCH(ES) <input type="checkbox"/> SUPPLEMENTAL SHEET(S) <input type="checkbox"/>			
SIGNATURES		REPRESENTING	INSPECTION STATUS
OPERATOR(S) <u>Jeffrey E. Foster</u> C.G.S.B. <input checked="" type="checkbox"/> A.S.N.T. <input checked="" type="checkbox"/>		S.I.T. LTD.	SEE RESULTS
EVALUATOR <u>Jeffrey E. Foster</u> C.G.S.B. <input checked="" type="checkbox"/> A.S.N.T. <input checked="" type="checkbox"/>		S.I.T. LTD.	---
AUTHORIZED INSP. <input type="checkbox"/>			
CUSTOMER <input type="checkbox"/>			
OTHER			
OTHER			

NOTE. ALL ADDITIONAL SHEETS MUST SHOW THE ABOVE REPORT NO.

PAGE 1 OF ...1... PAGES.

STEEL INSPECTION & TESTING LTD.

P.O. Box 4446, Stn. D
Hamilton, Ontario L8V 4L8

Phone: (416) 385-21

Purchase Order No. _____

Week Ending 25TH OCTOBER 1980

Client to be Invoiced M.T. COMM.

Description or Serial No. of
Units Inspected

THOROLD BRIDGE

THOROLD DNT.

SE. REF. TT.

Inspection Performed at THOROLD TUNNEL

No. of Inspectors on Job: ONE (1)

DATE	DAY PREPARATION	TRAVEL TIME TO JOB	A.M. IN	A.M. OUT	P.M. IN	P.M. OUT	TRAVEL TIME TO PLANT	PROCESSING INTERPRETATION ETC.	TOTAL MILEAGE	TO HO
Mon.										
Tues.										
Wed.										
Thurs. <u>OCT 23/80</u>		<u>1HR</u>	<u>10.00</u>			<u>NOON</u>	<u>1:00</u>	<u>ULTRASONIC</u>	<u>100-115</u>	<u>4</u>
Fri.										
Sat.										

DATE	TYPE OF FILM	SIZE OF FILM	ORIGINAL WORK AMOUNT OF FILM	REPAIR WORK AMOUNT OF FILM	TOTAL AMOUNT OF FILM
Mon.					
Tues.					
Wed.					
Thurs.					
Fri.					
Sat.					

Type of Inspection ULTRASONIC

I AM IN FULL AGREEMENT WITH ABOVE DETAILS

Remarks: SEE REPORT

Customer's Representative [Signature]

S. I. T. INSPECTOR [Signature]

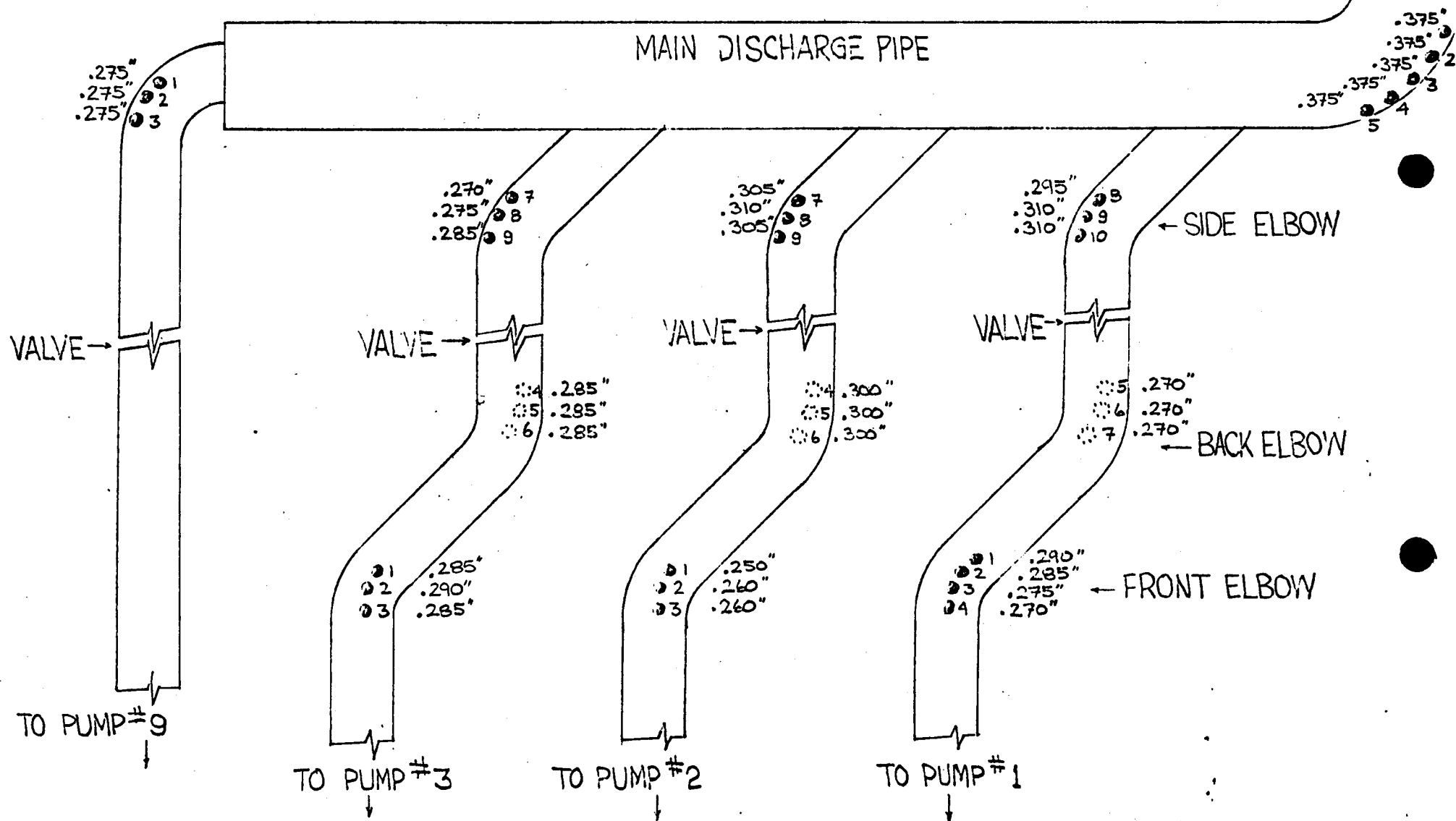
Report No. _____

NOTE: Inspector must fill out both sections in full before asking Customer for signature.

(PLEASE PRINT)

OFFICE COPY

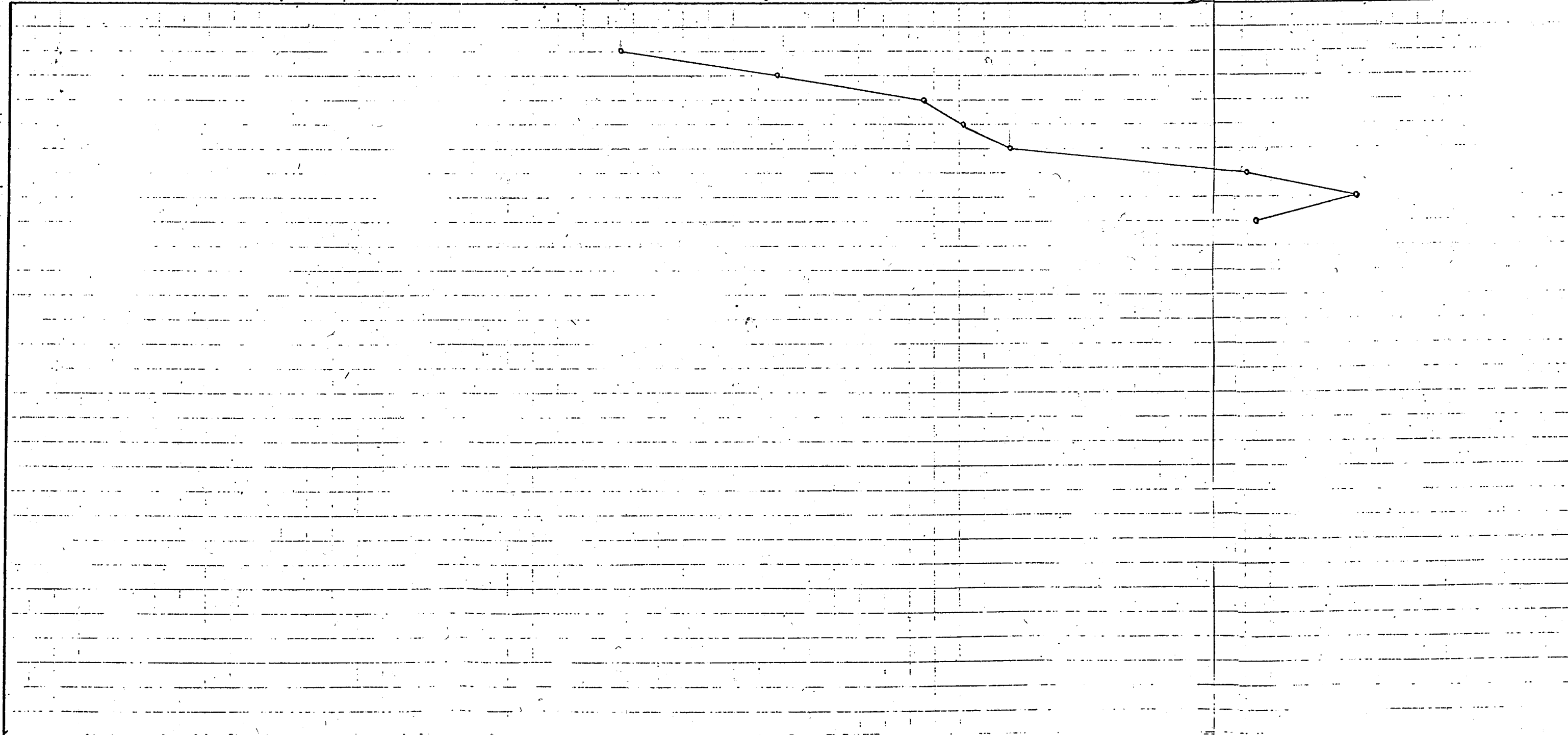
ULTRA SONIC READINGS ON DISCHARGE PIPES IN WEST SUMP
OF THOROLD TUNNEL TAKEN 80/10/23 BY STEEL INSPECTION &
TESTING LTD., HAMILTON, ONTARIO.



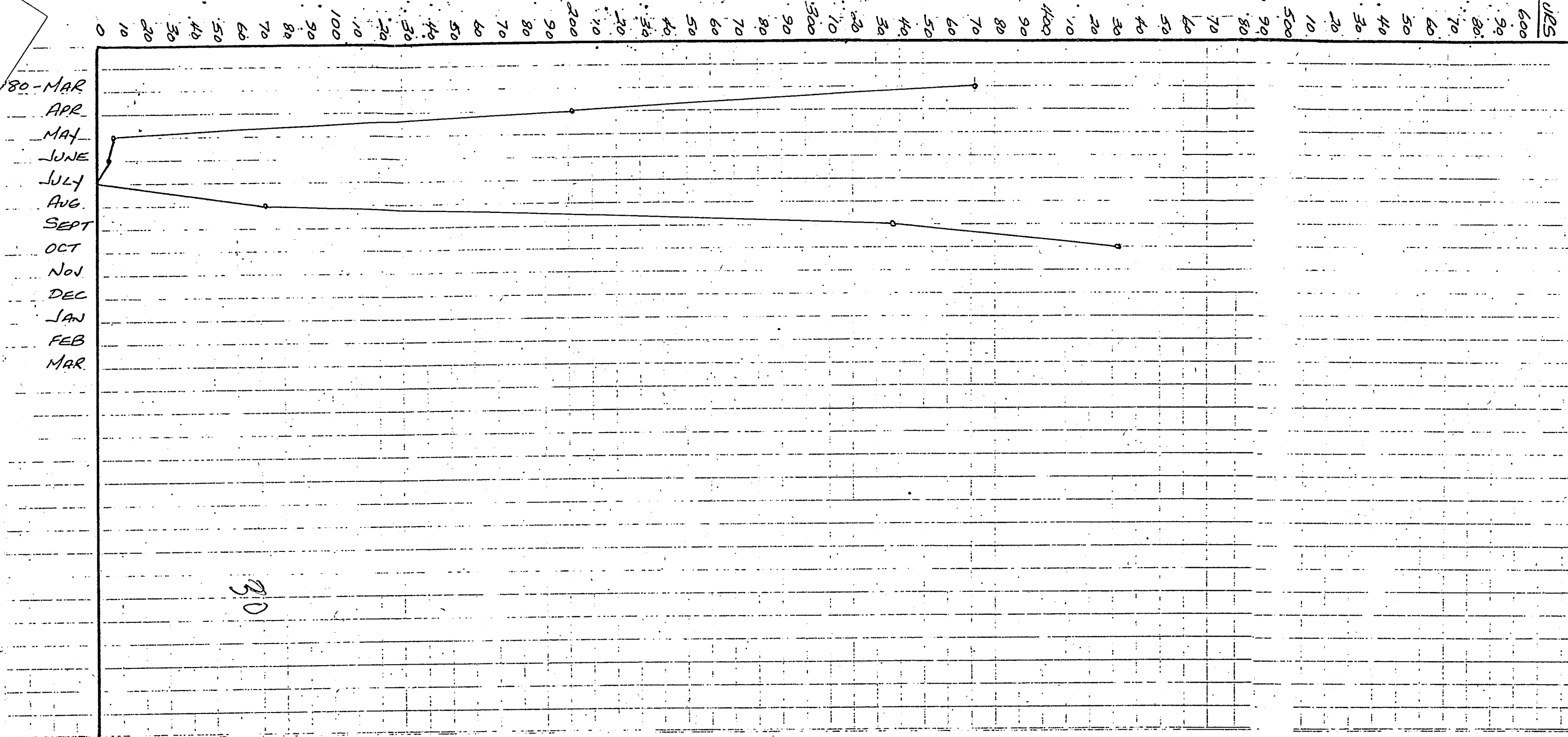
1400 OLD 1 JUNNEL
PUMP HOUR READINGS - WEST PUMP #1

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1980-MAR
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JULY
AUG
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OCT
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DEC
JAN
FEB
MAR



LOOKOLD IUNNEL
PUMP HOUL READINGS -
WST PUMP #2



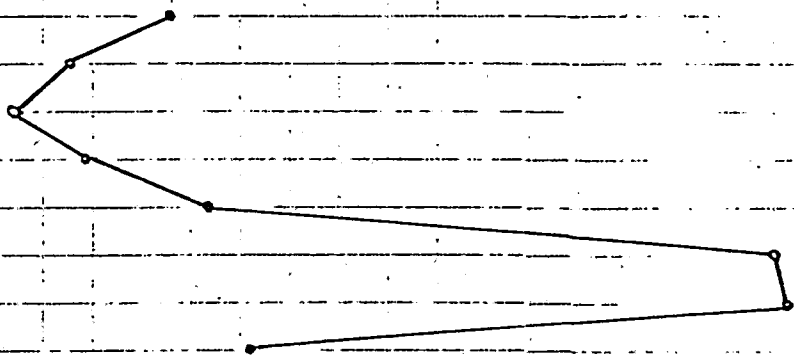
20

THOROLD TUNNEL
PUMP HOUR READINGS

WEST PUMP #3

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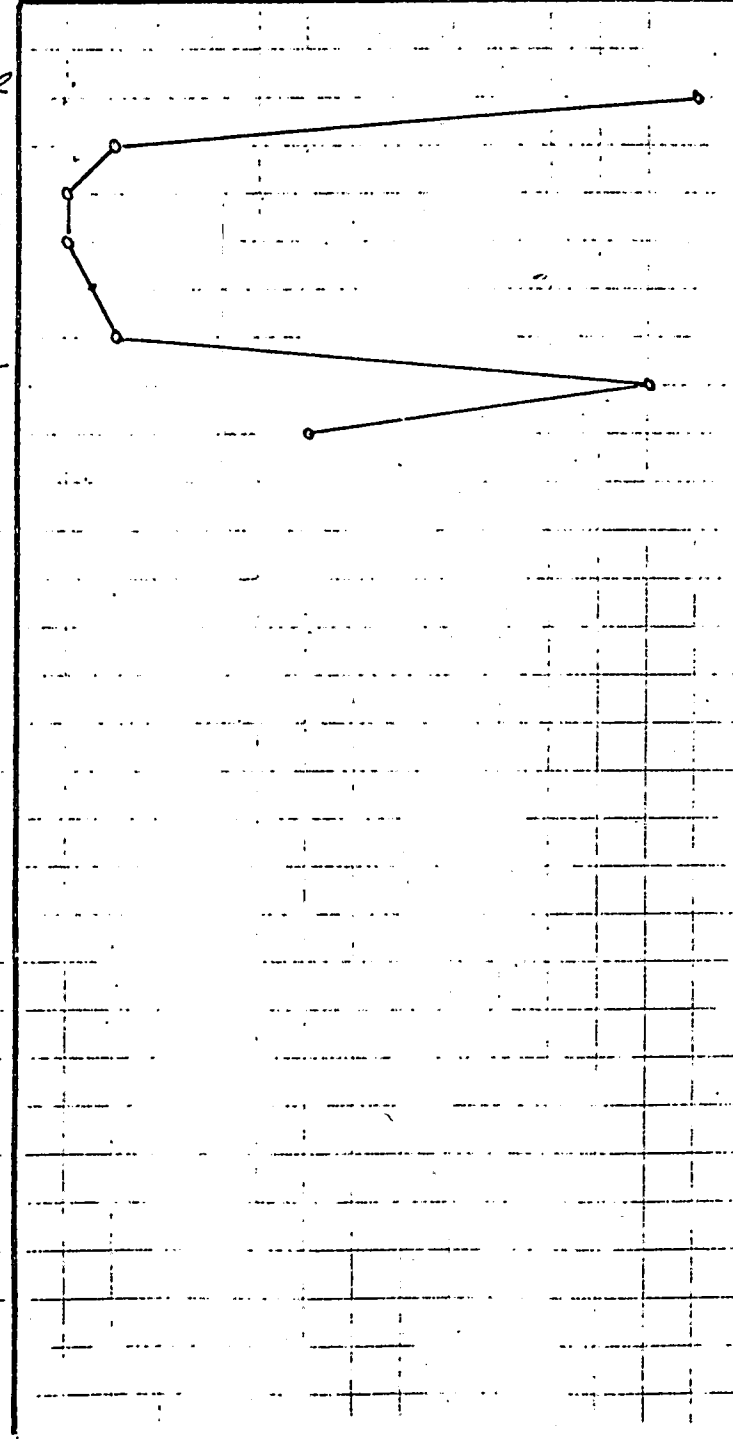


TH COLD TUNNEL
PUMP HOUR READINGS-

WEST PUMP #9

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
PUMPS

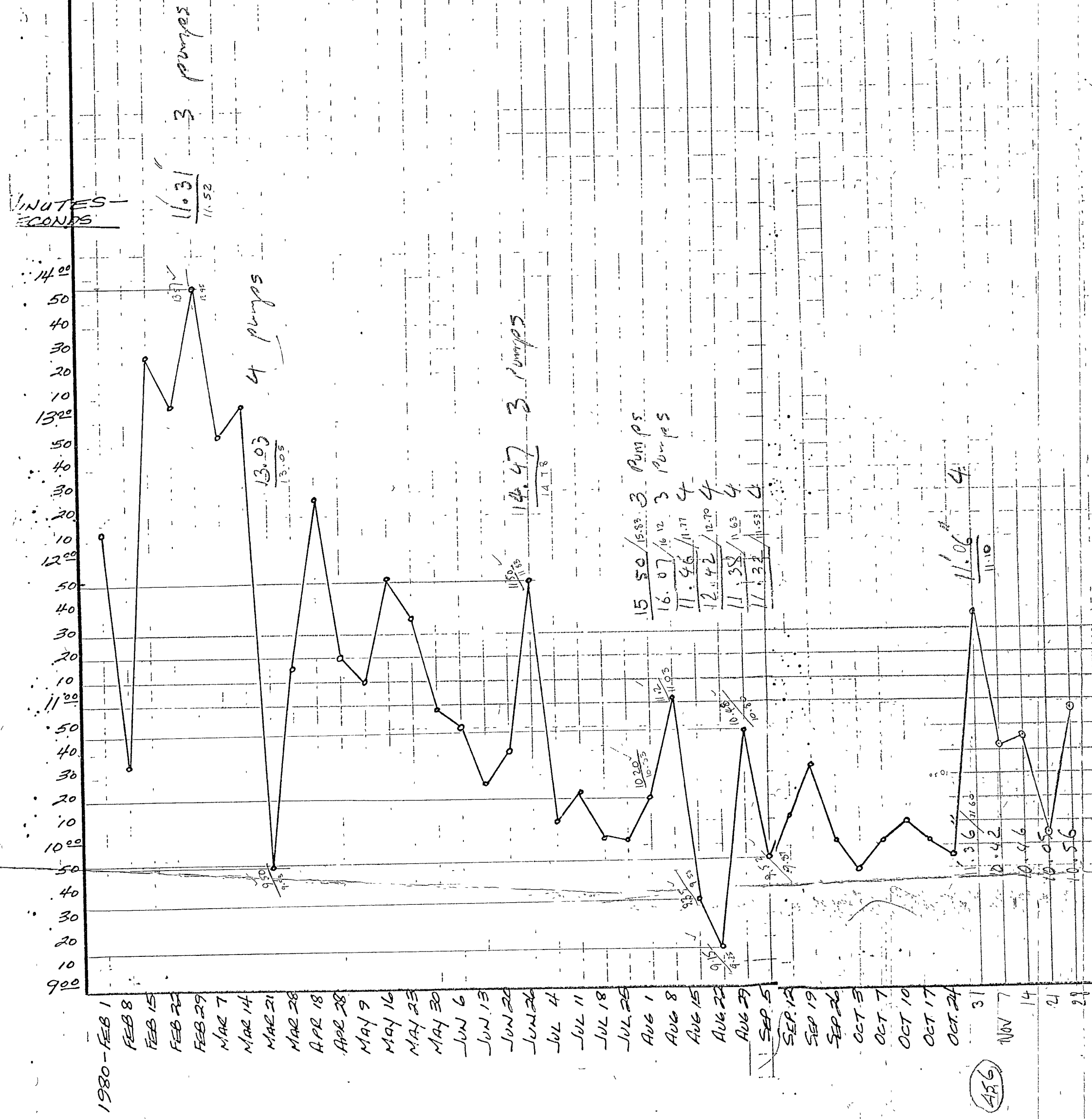
1980-MAR
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FEB
MAR.



1 HOKED TUNNEL PUMP HOUR READINGS - WEST PUMP

LOW-HIGH READINGS

173.6





Memorandum

To: Mr. G. M. Sinclair
Regional Maintenance Engineer
Central Region
3501 Dufferin Street

From: J. F. Lougheed
Supervisor Traffic Services
District #4, Hamilton

Attention:

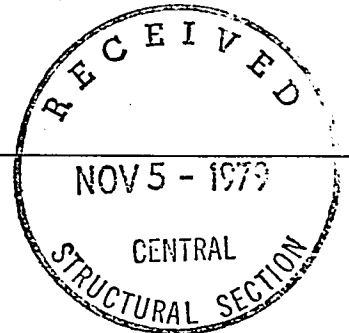
Date: 79 10 29

Our File Ref.

In Reply to

Subject:

Thorold Tunnel
Water Seepage Investigation
Acres Report October 23/79



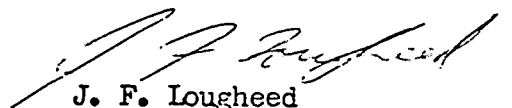
In discussion with the Welland Canal Maintenance Section, I have been advised that the water level is proposed to be lowered two to four feet for the winter season.

According to an announcement in "The Standard", the official closing date has been delayed from December 15, 1979 to December 18, 1979 for this season.

Whether this minimum lowering of water levels would have any bearing or not, I would suggest that whoever is investigating should be aware of it.

JFL:lo

c.c.
Services File


J. F. Lougheed
Supervisor Traffic Services



October 23, 1979
W5574.40

Ministry of Transportation
and Communications
1182 North Shore Blvd East
P.O. Box 5020
Burlington, Ontario
L7R 3Z9

Attention: Mr. C. R. Robertson
District Engineer

Dear Mr. Robertson:

Thorold Tunnel
Proposed Seepage
Investigation

As recommended in the Acres report submitted to the Ministry on September 14 and discussed at the meeting on September 24, we are proposing a program of investigations to assess the prime source of seepage at the west portal of the tunnel.

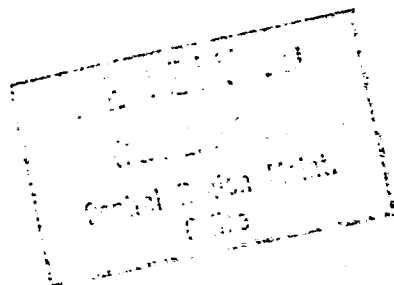
Indications are that the seepage is probably caused by the head of water in the canal causing subsurface flows by a number of possible routes to the tunnel west pump sump. The objective of the investigation program will be to pinpoint the route or routes followed by the major part of the seepage and to assess the likelihood of significant increases in the flow leading to, or due to, failures in the seepage control systems.

It is proposed that the program be carried out in stages to enable portions of the work to be carried out as convenient to the MTC. The proposed program is as follows.

1. - Establish general groundwater levels between the seepage cut off at the west service building and the west portal by means of piezometers and other observations. This will require installation of piezometers in 7 drill holes, 4 to the south of tunnel, 1 over the structure, and 2 to the north. The boreholes will be extended down into the bedrock and rock fill below the tunnel roof level. Piezometers will be installed in the boreholes so as to obtain groundwater levels in either overburden, bedrock or rock fill, depending on the location. Measurements

ACRES CONSULTING SERVICES LIMITED
5259 Dorchester Road, P.O. Box 1001, Niagara Falls, Canada L2E 6W1
Telephone 416-354-3631 Cables ACRESCAN Niagara Falls
Telex 061-5107 ACRES NFS

Toronto, Burlington, Calgary, Halifax, Niagara Falls, Vancouver, Winnipeg



would be made of water levels in the manholes over the relief slot adjacent to the south side of the west service building and in the canal for correlation with piezometer readings.

- 2 - Establish general groundwater levels west of the portal to the south side of the tunnel. This would entail installing piezometers in 3 or 4 drill holes. Permission may have to be obtained to drill on property not owned by the MTC.
- 3 - While the piezometers are being installed and monitored, observations and measurements will be made of known outlets for seepage flow such as in the pump sumps and the manholes at the west portal to plot variations accurately and to see if any direct correlation to piezometers can be established.
- 4 - Take water level measurements over a 2-month period. Assess the water level and other observations and compare them to previous data obtained during and after tunnel construction. Determine if more field observations and measurements are required. Consideration will be given to alternative requirements such as chemical analyses, pressure tests through wall of tunnel, dye tracing, deeper piezometers, etc.
- 5 - Possibly install additional piezometers in areas of greatest probability of leakage to supplement the data already obtained.
- 6 - Initiate tracer studies using dyes to check the most likely paths for water seepage as a result of the assessment of piezometric levels.
- 7 - Depending on the most likely route of water, it may be necessary to excavate test pits to check on erosion conditions and/or location of route of seepage.
- 8 - Assess results to date and prepare projection of rate of increase in water seepage and potential for major increase in flow due to erosion or failure.
- 9 - Reinstate the clay-bentonite in the slot as recommended in the report.
- 10 - Carry out remedial works if necessary to control the amount of seepage. These may comprise additional seepage control to direct seepage into the pumping system or measures to reduce or control the amount of seepage by grouting or other method.

The program cannot be fully defined at the start as at any-time progress and future requirements will be dependent on the observations and results in previous stages. In view of this it is suggested that detailed programs and budgets be established only for stages 1 to 4 inclusive at the start. At the completion of stage 4 a further budget could be established, for any later work, if needed.

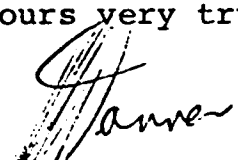
Our estimate of cost for stages 1 to 4 inclusive are as follows.

Stage	Time Required (Weeks)	Engineering Services (\$)	Disbursements (\$)	Total (\$)
1 - Groundwater levels east of portal	3	6,000	12,000 Drilling) 500 Other)	18,500
2 - Groundwater levels west of portal	1.5	2,500	3,000 Drilling) 300 Other)	5,800
3 - Flow measure- ments	(During 1 & 2) +1	2,500	200	2,700
4 - Observations, assessment of water condi- tions, and preparation of program	3	10,500	500	11,000
TOTAL	8.5	21,500	16,500	38,000

The disbursements for Stages 1 and 2 include the cost of drilling and installation of piezometers.

In our opinion it is important that an investigation as proposed be carried out to ensure that a recurrence of the 1979 seepage problems can be avoided. In this regard we confirm that Acres will be willing to assist the MTC in the investigations in any capacity considered appropriate.

Yours very truly,


R. G. Tanner
Project Manager

RGT:mjg

cc - M. Sinclair ✓

MINUTES OF MEETING
Held at MTC offices in
Burlington, Ontario on
September 24, 1979

October 23, 1979
W5574.40

PRESENT:

P. Weber) MTC
M. Sinclair)
G. Burkhardt)
J. Lougheed)

T. Bradshaw) ACS
R. Tanner)

PURPOSE: To discuss report on seepage control of Thorold
Tunnel.

1 - COMMENTS

It should be noted that the conclusion regarding the pressure relief slot on page 1 could be misinterpreted to imply that the erosion of the slot filling material had been confirmed.

2 - PROGRAM OF INVESTIGATIONS

Acres will propose an investigation program together with an estimate of cost. The program will be in stages so that the MTC can assess which parts of the program they wish to have carried out. The submission should be in the form of a short letter. It will be adequate if it describes how much is needed to develop a more comprehensive program. The proposal should be sent to C. Robertson with a copy to M. Sinclair.

RGT:mjg

Reported by


R. G. Tanner

memorandum



To: Mr. H.M. Sinclair
Regional Maintenance Engineer
Central Region

Date: 1980-02-22

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview

Re: Thorold Tunnel - Water Seepage Investigation
District #4 (Hamilton)

At our meeting on 1980-01-21 regarding the seepage problem at the Thorold Tunnel we outlined to you, in some detail, the results of the various investigations and reviews which we had carried out following our receipt from you of the report by Acres Consulting Services Ltd. entitled 'Report on Remedial Works Pavement Slab - West Portal Eastbound Lanes'. This memo confirms the conclusions and recommendations made by us during the meeting and which are summarized as follows:-

Problem

E.B.L.s at West Portal were 'flooded' with water seeping out between joints of concrete slabs. 'Flooded' area extended to a distance of 35 ft. west of the Portal. The water flowed into the surface water interception drain at the mouth of the tunnel and thence into the sumps.

Questions to be Resolved

Where did this water come from and how long has it been coming? Can it be prevented or reduced? What is it costing us now? Is it essential to stop it or reduce it?

Facts and Observations

- 1) The water was first observed by J. Loughhead in Oct., 1977 flowing into M.H. 119 through cracks in the grate housing. The water level, in consequence, did not rise as high as the top of the slabs.
- 2) Repairs to the M.H. 119 grate housing were carried out in July, 1978 at which time three 1½ inch dia. pipes (about 2 ft. long each) were placed at the level of underside of pavement discharging into the M.H. 119. This appeared to have solved the problem.
- 3) In June of 1979 flooding as described above occurred and Acres were hired by the Regional Maintenance to assist in solving the flooding problem. The remedial work consisted of removing the pavement and installing perforated pipes surrounded by pea gravel and a graded filter material and then restoring the pavement. This dried the area up effectively.

It was noticed by J. Loughhead that initially the three 1½ inch pipes referred to in 2) were observed to be plugged up and that when they were cleaned out the water on top of the pavement drained away rapidly and never came above the pavement surface again. Voids below the pavement slabs were attributed to material washing through the 3 small 1½ inch pipes and they were later removed during the repairs.

- 4) From Jan. 15th to March 6th 1979 the canal was lowered by 21 ft. to el. 549 (Note: grade of west portal is el. 550). During this period pumping time was reduced by more than 50 percent. From Jan. 3rd to Jan. 16th 1969 the canal was lowered by 23 ft. to el. 547. Pumping time, in this period, was reduced by more than 75 percent of normal.
- 5) A plot of total pumping time in hours per year versus time shows that a gradual increase from about 8500 in 1969 to about 14000 in 1976 has occurred - an increase of about 65%. Since 1975, however, the pumping time has remained more or less constant.
- 6) A considerable increase in pumping hours occurred between 1972 and 1974 (during which time the pressure relief slot was constructed) from 10,800 hrs. in 1972 to 13,400 hrs. in 1974. It cannot be construed that the slot construction contributed definitely to the increase but the possibility is there.
- 7) During Acres activities at the site in 1979 they observed that the bentonite seal in the 'slot' was about 4 ft. below its original level at the two inspection manholes. Thus a possible leakage path exists in the rock between el. 562 and el. 558. (Canal level = 569.0)
- 8) Present pumping costs (for 1980) are as follows:

Hydro	\$24,500	per year
Maintenance-Labour	\$10,000	Per year
Maintenance-Parts	\$10,000	Per year
TOTAL		<u>\$44,500</u> Per year

The above are directly proportional to the annual pumping hours therefore, reductions in pumping time would result in direct savings to the Ministry. For instance, a reduction back to the 1970 condition (i.e. from 14000 to 10,000 hours) would result in a saving of about \$13,000 annually.

- 9) Ministry expenditure for remedial measures to solve the flooding problem was \$58,166.00 of which \$11,400 went to Acres for engineering and supervision.
- 10) Acres recommended a further study by them to attempt to find out where the water is coming from. If successful they will recommend methods of reducing flow. Their estimate for their services is \$38,000. It should be noted that they did not come to any definite conclusions as a result of their work in July 1979.

Conclusions

- a) Pumping is affected significantly by canal level (see 4) above) therefore it is safe to conclude that the main source of the water is the canal.
- b) The flooding problem was due in the main to inadequate subsurface drainage. This has been taken care of and probably will not occur again. (See 1), 2), and 3)).
- c) The bentonite seal in the 'slot' has apparently been washing away since the level of the seal has dropped 4 feet. This could be a cause of some leakage and should therefore be thoroughly investigated and repaired. Acres were the original designers of this seal and should be retained for this purpose.
- d) Apart from c) the present situation, which appears to have stabilized since 1975 (see 5)), is not causing any problems for the M.T.C. The pumping capacity is well in excess of pumping needs at present by a ratio of about 2:1 even when 1 pump is being serviced (4 pumps - 1½ required). The cost of these pumps amounts to \$44,500 per year and since water flow is not likely to be reduced to less than the pre 1973 level if the slot is the cause and is sealed, maximum savings would not exceed about \$13,000 annually.

However, if the main source of water can be found and sealed savings would probably amount to about \$30,000 annually. It is really not possible to estimate what it would cost to find this source and if found what it would cost to seal it.

- e) It would be of advantage to have a means by which flow conditions in the vicinity of the west portal could be readily monitored, and read by the Maintenance staff at the tunnel. Piezometers could be installed for this purpose.

Recommendations

- (1) Acres should be retained to further look into the problem of the missing bentonite seal in the slot to determine what repairs are necessary. These repairs should be carried out as soon as possible.
- (2) Acres should be requested to provide a cost estimate for a scheme utilizing piezometers which could be monitored regularly by Maintenance staff. The purpose of the scheme would be to try to locate the zone or zones where seepage is increasing.
- (3) Future records of pumping time should be recorded on the same date (say 1st) each month so that proper comparisons can be made. In the past it has happened that readings have been delayed several days making comparisons with the same month in different years difficult. Records of sump inflow times should also be kept at regular intervals (say every two weeks). The suspected cause of any major deviations from the norm of the above readings should be ascertained as soon as possible and duly recorded.

In connection with the foregoing we would be pleased to assist in providing terms of reference for Acres, also to carry out the necessary liaison with them.

We would also be pleased to provide any further advice in connection with the seepage problem which you might require.

K. G. Selby

K.G. Selby
Senior Foundations
Engineer

KGS:ea

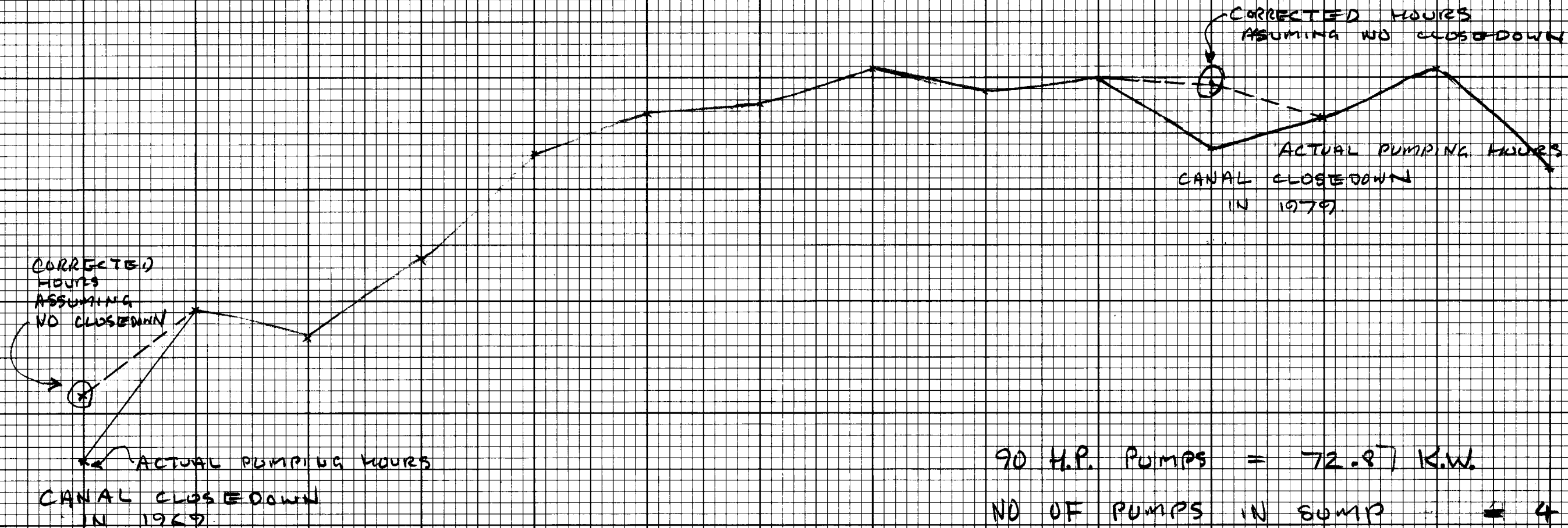
cc: W. Lin
G. Burkhardt
R.D. Gunter
J.F. Longnead

PUMPING HOURS - WEST SUMP
K&E 10 X 10 TO THE INCH 10 X 15 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

MORULD TUNNEL WEST SUMP PUMPING HOURS NEARUS TIME IN YEARS

18000
16000
14000
12000
10000
8000
6000
4000
2000

AVERAGE DAILY PUMPING HOURS → 38.9 37.8 38.4 35.1 36.3 38.9



90 H.P. PUMPS = 72.87 K.W.

NO OF PUMPS IN SUMP = 4

AVERAGE PUMPING HOURS / DAY FOR LAST 4 YEARS (1976-79) = 38

HYDRO REQUIREMENTS / HOUR = \$1.75
(= 72.87 x 2.4c)

MAINTENANCE COSTS LABOUR = \$10,000 / YEAR

MAINTENANCE COSTS PARTS = \$10,000 / YEAR

TOTAL HYDRO COSTS 14000 x 1.75 = \$24,500 / YEAR

TOTAL / YEAR = \$44,500

1968 DEC. 1969 DEC. 1970 1971 1972 DEC. 1973 1974 DEC. 1975 1976 1977 1978 1979 1980 1981 80-01-08
TIME IN YEARS K.E. Smith