

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30MB-90

DIST. 6 REGION

W.P. No. 138-87-00

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 400/407 IC

LOCATION ADVANCE STRUCTURES

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Steeles Ave O/E

N-E corner
from north



N-E corner

from south

Note PVC duct sheared
off.



N-W corner

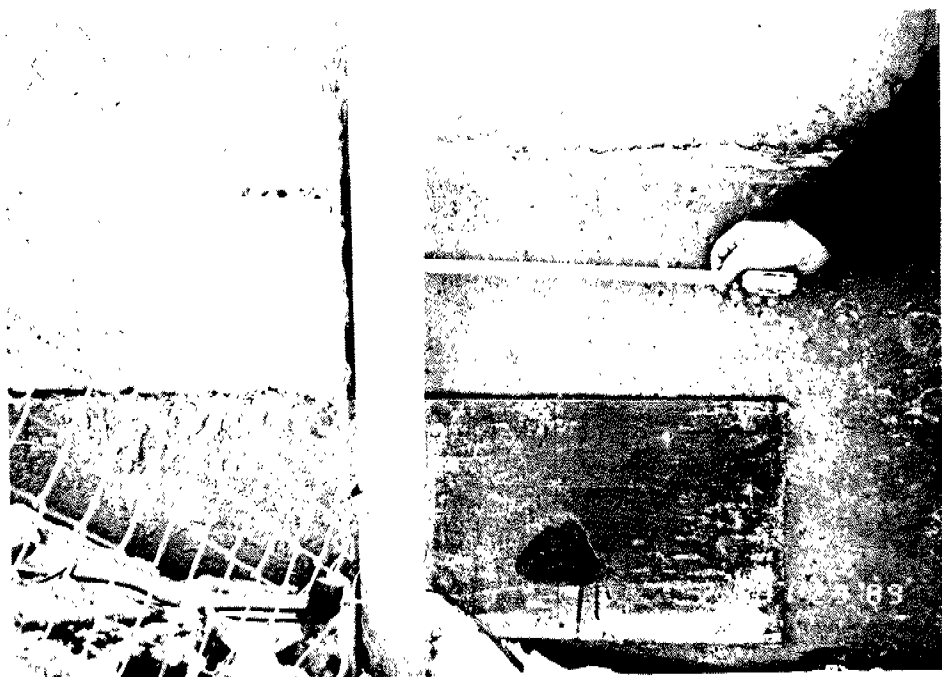
Steeles Ave O/E



N-W corner
Steeles Ave O/E
end of barrier transition



washed granular
at bottom of slope



S-E corner
Steeles Ave O/E

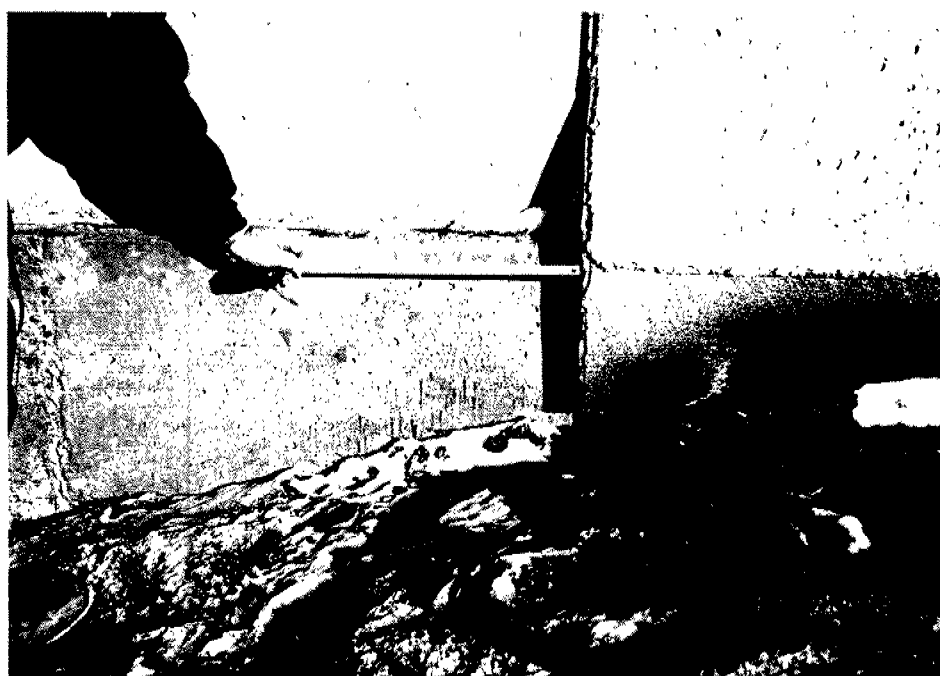
Note, additional conc.
poured under
barrier wall

7



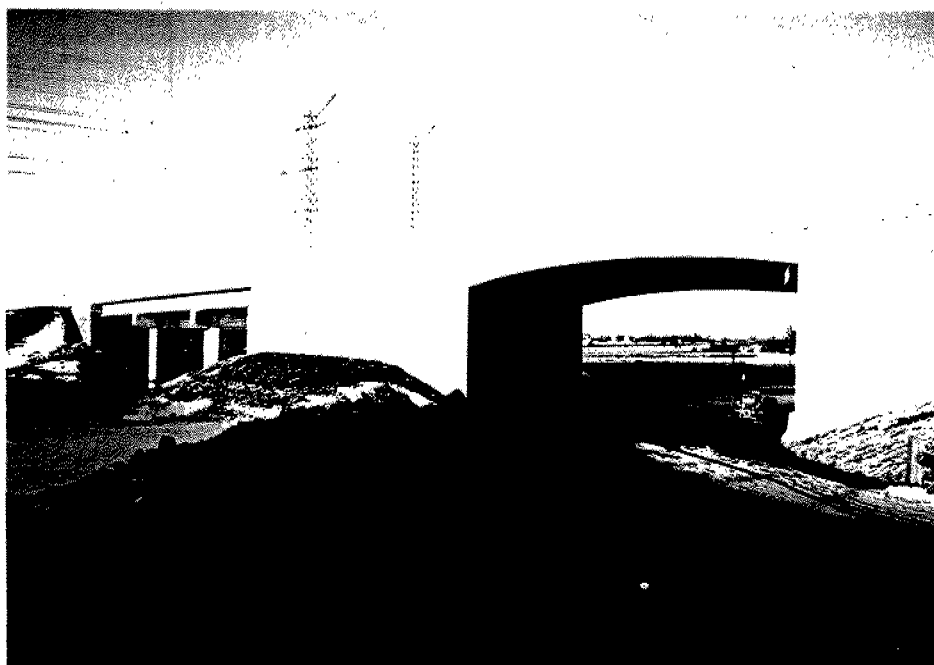
Conc. poured
under barrier
wall

8



S-W corner
Steeles Ave O/E
Note, slope lower
than on design
dwg.

9



General view
Ramp bridge &
CNR O/H

10



S-W corner

Detour over Ramp
to Steeles Ave

Evidence of settlement

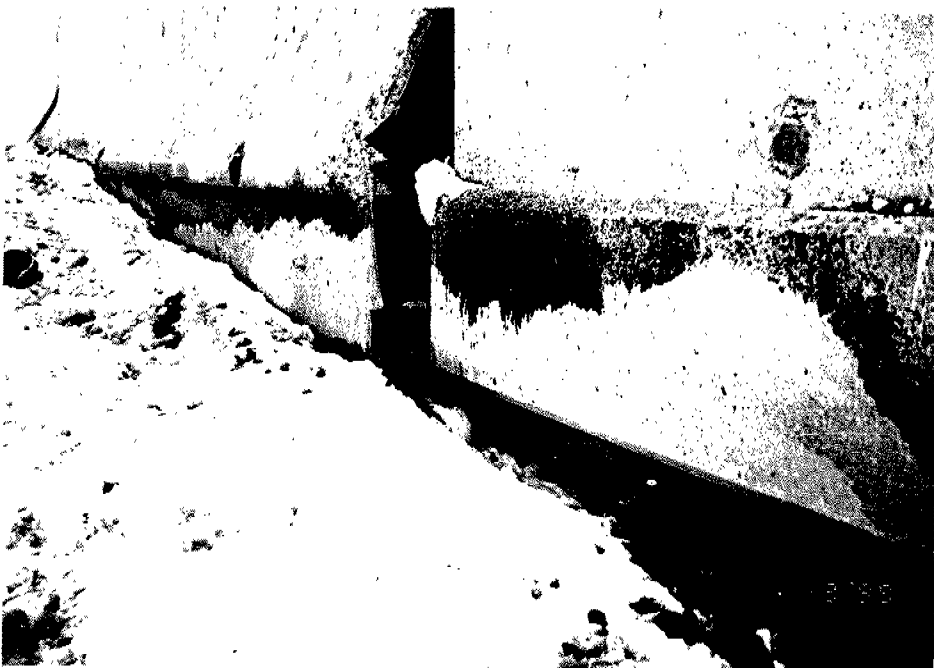
11



S-W corner

Note top of barrier

12



S-E corner

Ramp bridge

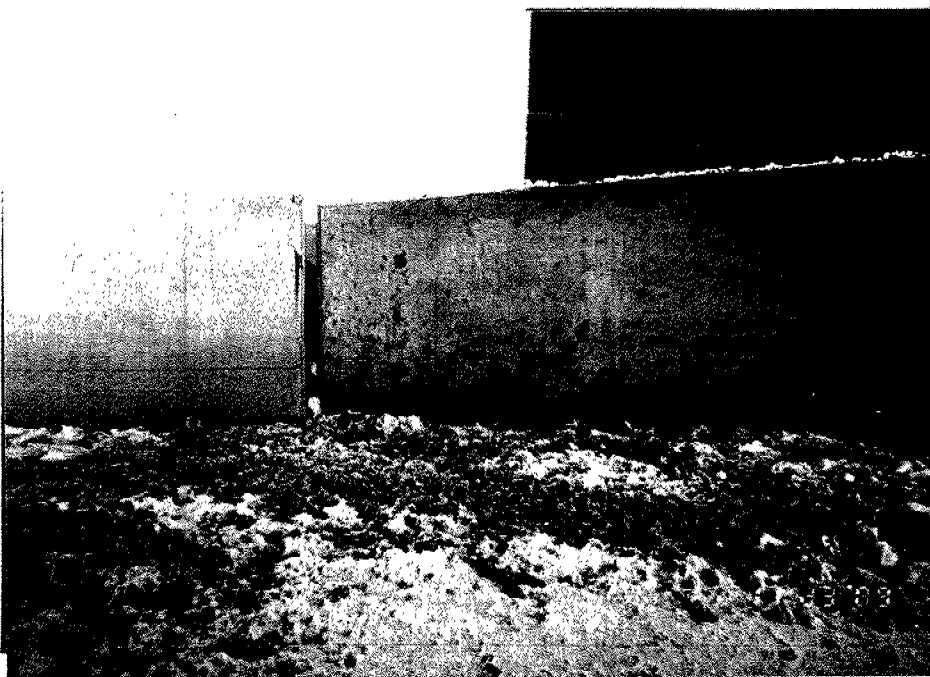
Pg 5

13



Ramp bridge
S-E corner

14



S-E Ramp bridge
Settlement at end
of barrier transition

15



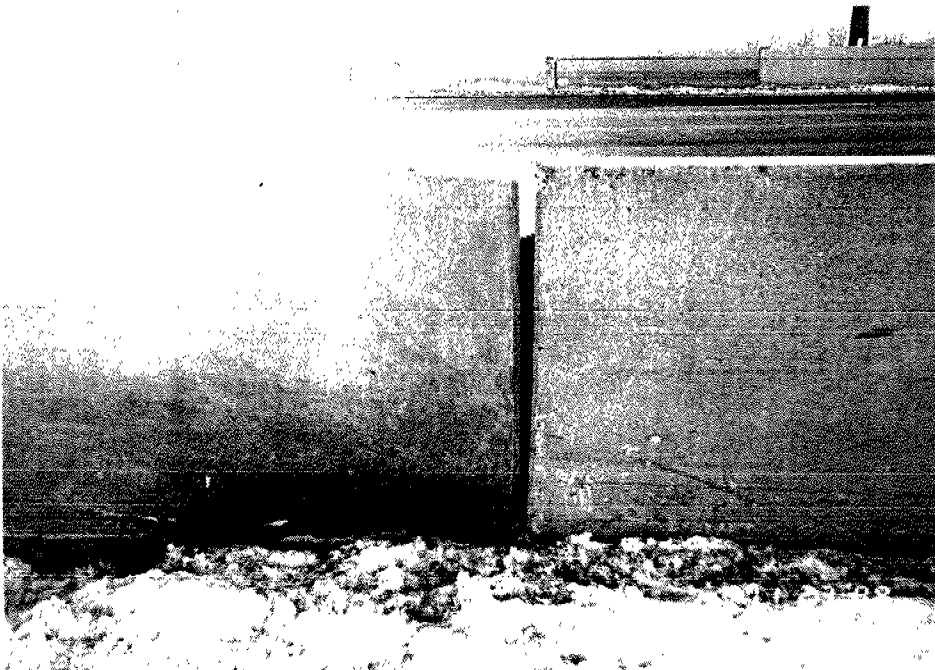
N-E, CNR O/H

g6



N-E, CNR O/H

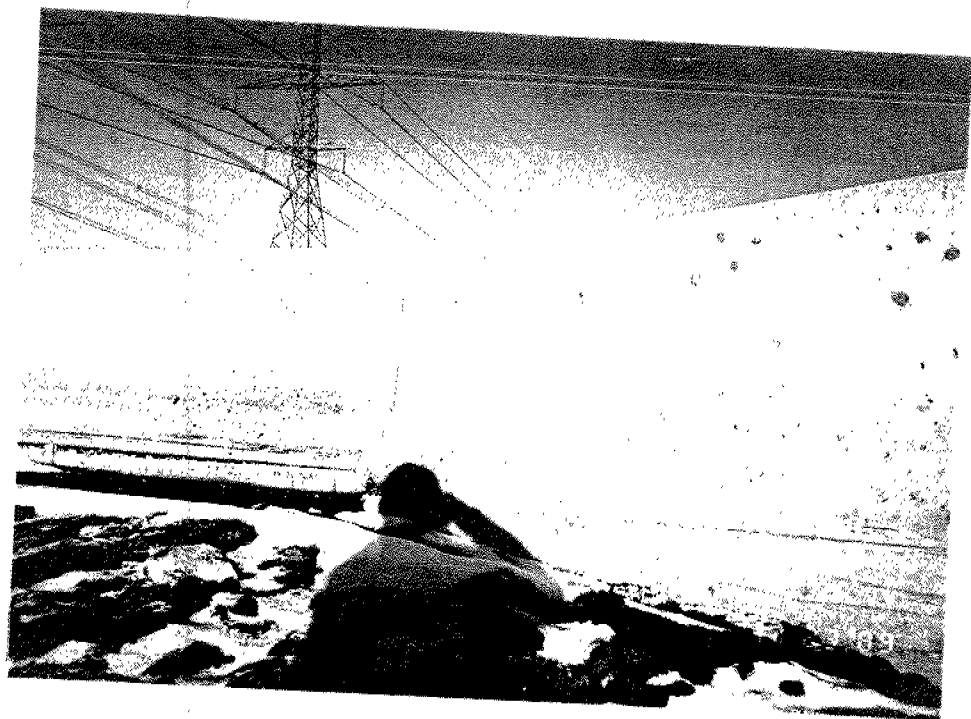
Asphalt patch
to make up
settlement?



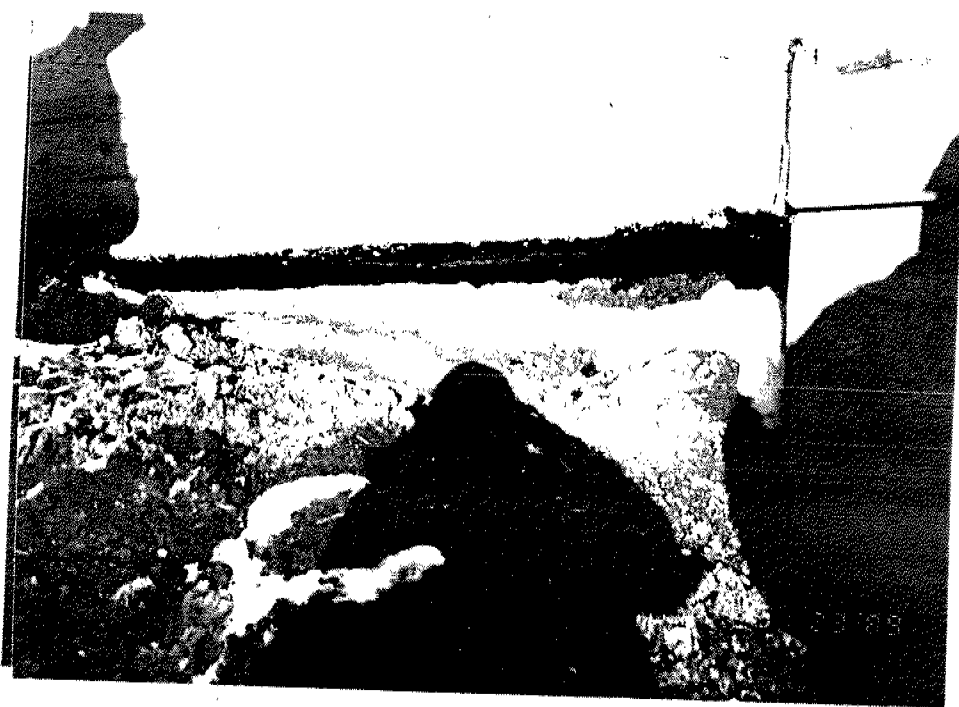
Settlement at end
of barrier transition



N-W CNR O/H



N-W CNR O/H
at junction of
barrier transution &
Hwy barrier



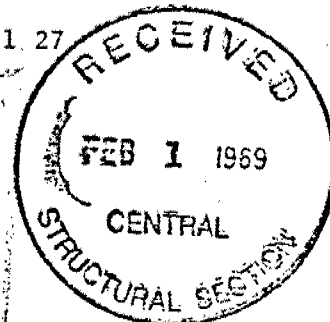
N-W
CNR O/H.

To: John Lam
Structural Section
Central Region

Date: 1989 01 27

From: Foundation Design Section
Room 315, Central Building

RE: ODSD 918.01



The approaches for the structures you are concerned about have all been designed recently. The backfill to the structures would therefore have been governed by DD 3501, 3502, 3503 or the up-dated equivalent. The purpose of these standards is to insure differential settlements adjacent to the structure will be minimized. The approach slabs will also minimize differential settlements.

For these reasons we do not expect enough differential settlement to damage dowel anchorage systems used to connect the concrete barrier to the structure. However the performance of the embankment is also dependent on other variables such as compaction control and we cannot guarantee that no differential settlement will occur.

If there is concern, consideration could be given to connecting the barriers with a metal sleeve instead of using dowels.

Pamela Marks, P. Eng.
Foundation Engineer

PM/mmj

c. c. BILL LANKINEN

IN RESPONSE TO YOUR MEMO
DATED 89-01-23 REGARDING
CONCRETE BARRIER ANCHORAGES
TO STRUCTURES,

C.C. Lankinen
P. Marks
L. Jeffries

J. Lamb, P. Eng.
K. Hutchinson, P. Eng.

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST No 6
CONT No 88-79
WP No 88-78-28



STEELES AVENUE OVERPASS
RAMP 400S - 407 E.W.
GENERAL ARRANGEMENT

SHEET
158



UMA Engineering Ltd.
Engineers & Planners

GENERAL NOTES

CLASS OF CONCRETE

MASS CONCRETE	30 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25
ABUTMENTS, WINGWALLS, RETAINING WALLS	70 ± 20
OUTSIDE FACE	80 ± 20
INSIDE FACE	70 ± 20
PIER	80 ± 20
DECK	
TOP	70 ± 20
BOTTOM	50 ± 10
REMAINDER	70 ± 20

REINFORCING STEEL

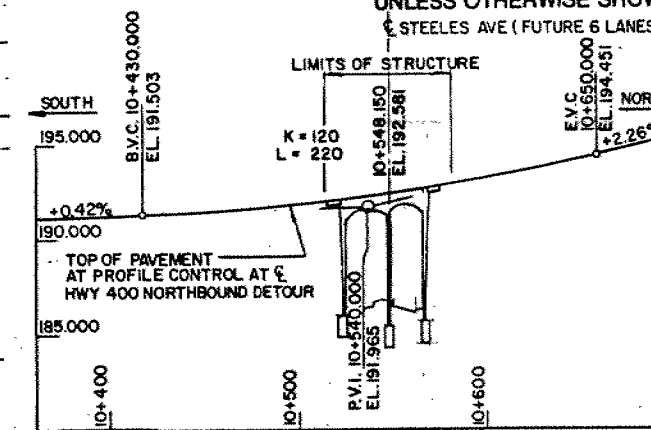
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.

CONSTRUCTION NOTES

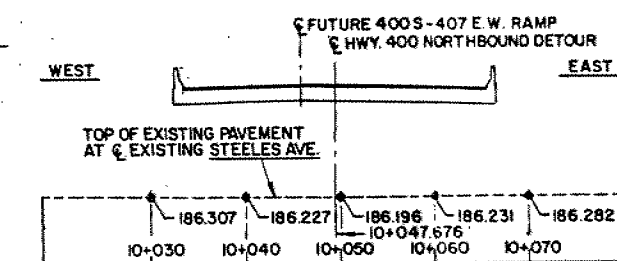
BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 500 MM.

LIST OF DRAWINGS

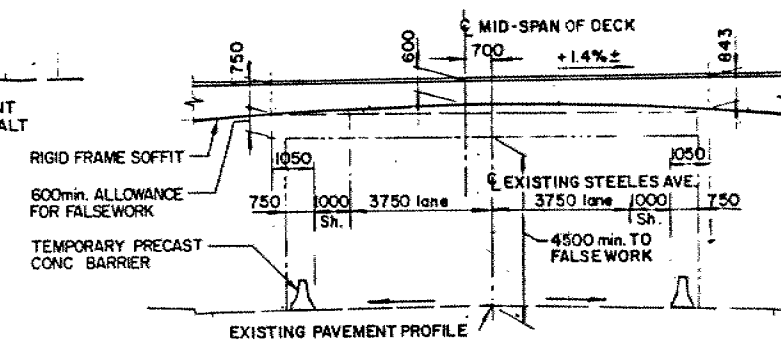
- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- SETTING OUT PLAN
- FOOTING LAYOUT
- NORTH WEST RETAINING WALL ROADWAY PROTECTION
- SOUTH ABUTMENT AND RETAINING WALL FOOTING REINFORCING
- NORTH ABUTMENT AND RETAINING WALL FOOTING REINFORCING
- PIER FOOTING, PIER STEM DETAILS AND REINFORCING
- SOUTH ABUTMENT DETAILS AND REINFORCING
- SOUTH ABUTMENT WINGWALL DETAILS AND REINFORCING
- SOUTH WEST RETAINING WALL DETAILS AND REINFORCING
- NORTH ABUTMENT DETAILS AND REINFORCING
- NORTH ABUTMENT WINGWALL DETAILS AND REINFORCING
- NORTH WEST RETAINING WALL DETAILS AND REINFORCING
- DECK LAYOUT AND SCREED ELEVATIONS
- DECK REINFORCING I
- DECK REINFORCING II
- DECK REINFORCING III
- BARRIER WALL
- 6000 mm APPROACH SLAB
- AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
- BRIDGE DATE AND SITE NO. DATA
- ELECTRICAL EMBEDDED WORK
- QUANTITIES - STRUCTURES



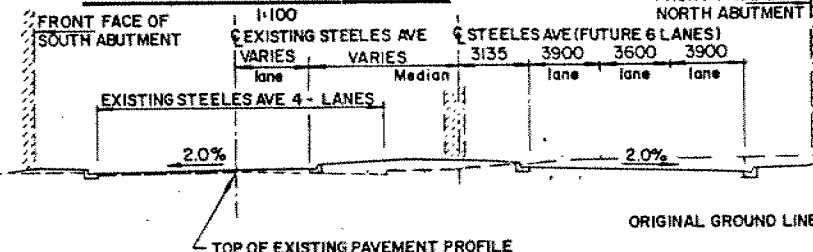
PROFILE - HWY. 400 NORTHBOUND DETOUR



PROFILE - STEELES AVE.



FALSEWORK CLEARANCES



CROSS-SECTION UNDER HWY. 400 DETOUR AT STEELES AVE.

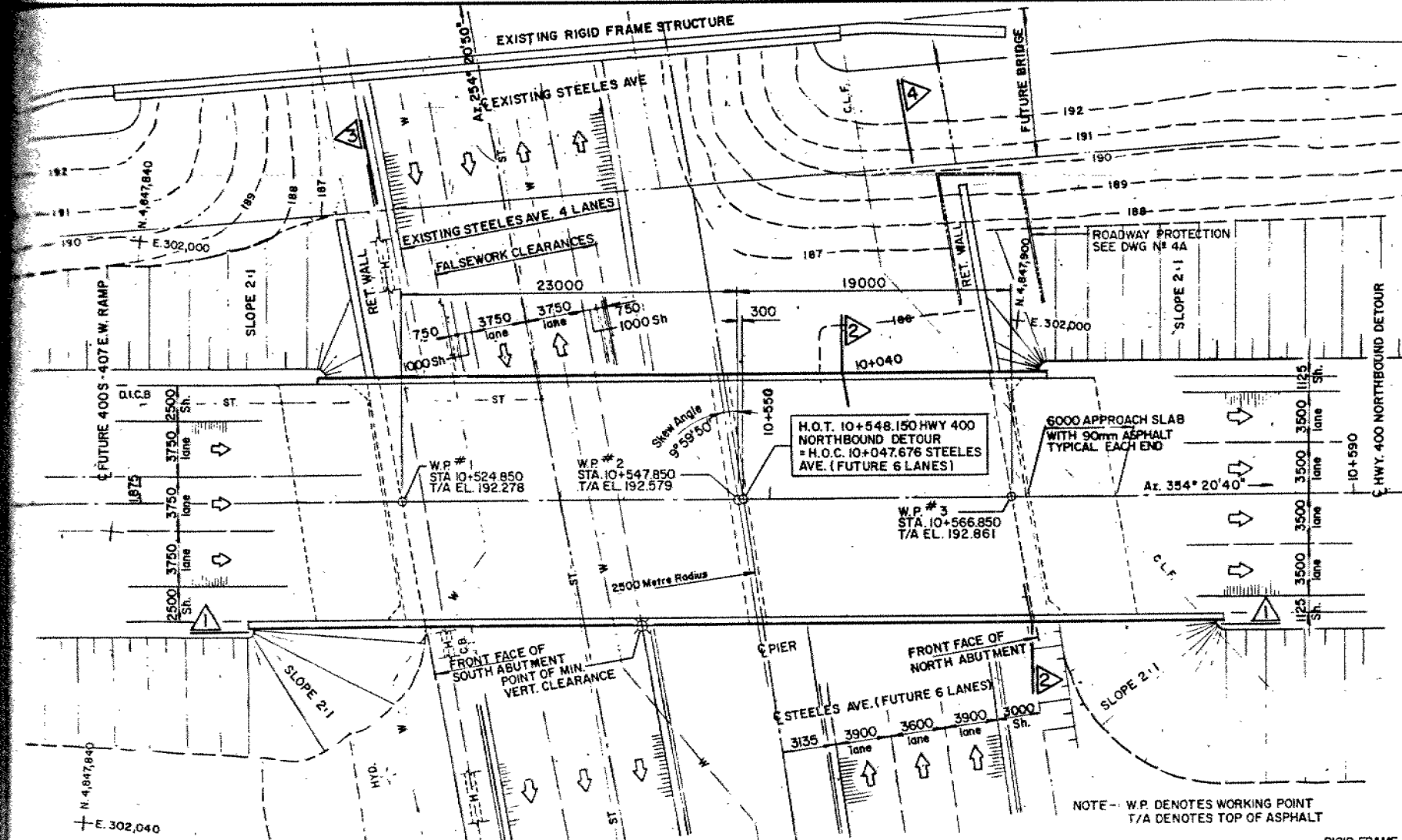
APPLICABLE STANDARD DRAWINGS

- DD - 3502 MIN. GRANULAR BACKFILL REQUIREMENTS
- DD - 3504 RETAINING WALLS BACKFILL
- OPSD - 508.02 WATERPROOFING
- DD - 3201 MAX. LOADING CONSTRUCTION EQUIPMENT
- OPSD - 918-01 CONNECTION TO NEW STRUCTURES

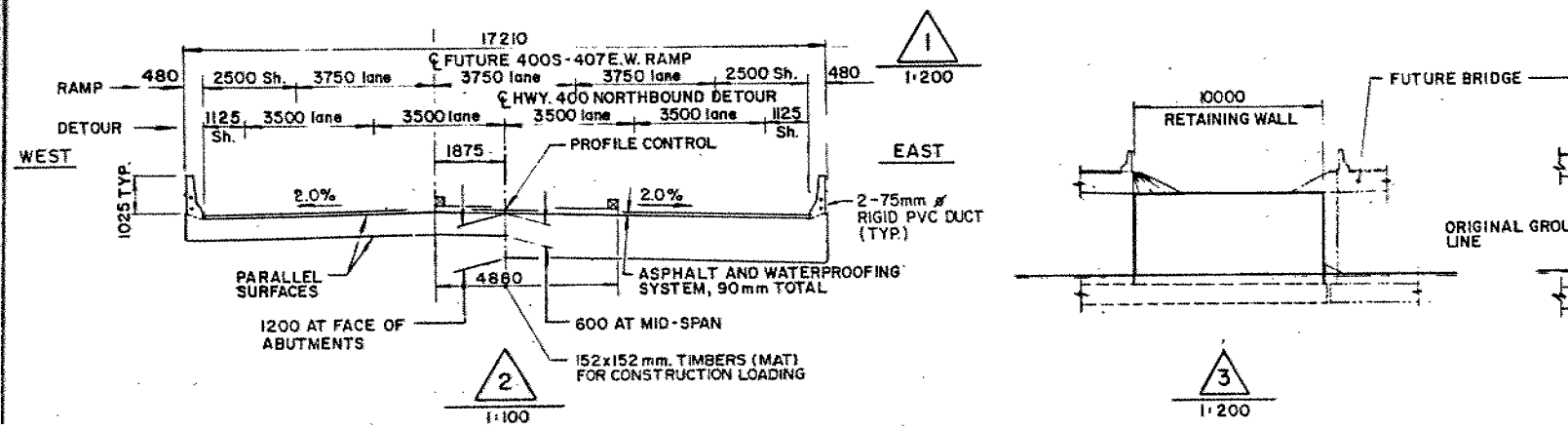
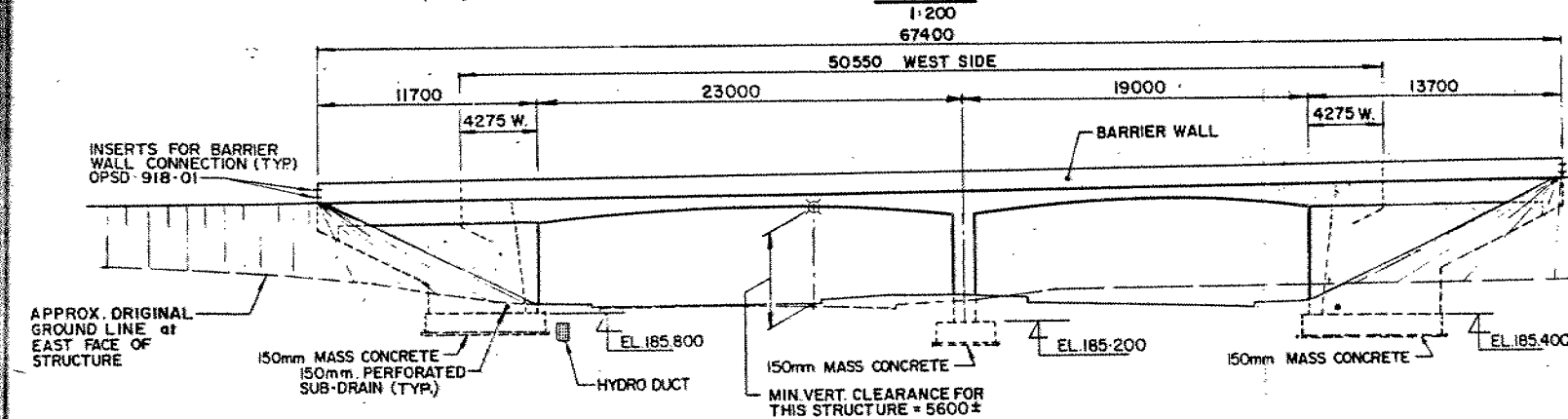


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION



PLAN



PLAN

memorandum



To: Mr. G. C. E. Burkhardt
Head, Structural Section
Central Region

Date: 1989 03 03

Attn: J. Lam, Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Reinforced Earth Wall Details
W.P. 138-87
Hwy. 400/407, District #6, Toronto

Further to your memo dated February 27, 1989, our comments are as follows:

- 1) Concerning the number of panels per levelling pad -

Reference is made to our memo to you dated February 8, 1989, in which we recommended that a cost analysis of 1, 2 and 3 - panel stepping should be carried out. We have reviewed the R. E. letter to Bob Jeffries and in our opinion a more formal cost-benefit analysis to support their choice of 3 - panel steps would be appropriate. Obviously it is to their advantage to recommend larger wall areas.

- 2) Concerning the requirements for granular backfill behind the R. E. volume -

As indicated in our February 8, 1989 memo, R. E. can accommodate native backfill in this zone but they require the parameters of this material. We concur with the proposed taper to minimize differential settlement.

If there are any questions, please advise.

D. H. Dundas
D. H. Dundas, P. Eng.
Sr. Foundation Engineer

DHD/ms

MINISTRY OF TRANSPORTATION

M E M O R A N D U M

TO: See List Below

DATE: 1989-02-27

FROM: Structural Section
Central Region

RE: Reinforced Earth Wall Details
Highway 400/407, District 6

This memo summarized some of the outstanding details for the design of the 400/407 Reinforced Earth Retaining Walls. The memo also make recommendation to the design details as per discussions with appropriate sections and offices. These outstanding details are as follows:

RECO WALL PANELS CONNECTING TO ABUTMENT

Three options were investigated. The option with RECO panels located behind the abutment protrusion of 200mmx120mm is selected. See detail 'A'.

ACTION REQUIRED: This is confirmed in a meeting with G. AlBazi and B. Farago of Structural Office.
Structural Office and Structural Consultants to detail abutment corner to suit.

ELECTRICAL DUCT BANKS IN BETWEEN TIE STRIPS OF RECO WALLS

Normally two and maximum three electrical ducts encased in concrete will be installed between tie strips. For three ducts, the standard duct bank size is 250mm high x 550mm wide. These duct banks should be located at a clear distance of 1000mm from the RECO wall panels vertically and in between the strips. See Detail 'B'.

ACTION REQUIRED: RECO has confirmed that the detail is acceptable.

ADVANCED STRUCTURE APPROACH FILL AT RECO WALL LOCATION

For RECO walls with barrier walls on top, the concrete barrier wall is tie back with 7000mm long reinforcing strip. This strip, at the connection point, is 190mm below top of finish grade. However, for advanced structures, this strips will be exposed because the approach fill is finish at 515mm below final grade. As a result, MTO recommended the barrier wall connection be revised as follows:

- barrier wall tie strip to be located 750mm below final grade.
- additional tie strips to be used if required.

See Detail 'C'.

ACTION REQUIRED: RECO is responsible for revising the detail to suit.
RECO is responsible for designing the number of tie strips at the new location to take collision load.

GRANULAR BACKFILL

At the ends of the tie strips, native backfill is used, the differential settlement between granular A and native backfill should be minimized by a layer of tapered granular backfill from the frost line as per DD - 3504. See Detail 'D' & 'E'

ACTION REQUIRED: Structural Section has contacted Foundation Design Section and confirmed the above detail acceptable.
Road Consultants to detail backfill requirements on each structure. RECO and Foundation Design Section to review.

NUMBER OF RECO WALL PANELS PER LEVELLING PADS

RECO has recommended three wall panels per levelling pad, for practical and economical reasons. Foundation Design Section commented that two wall panels per levelling pads may eliminate some buried RECO wall panels and may result in more cost effective.

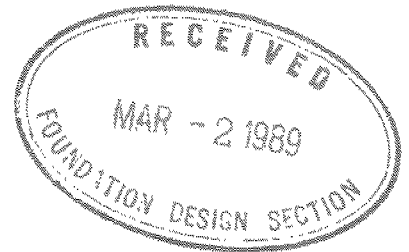
ACTION REQUIRED: RECO has responded to Foundation Design Section regarding the above issue. Foundation Design Section to confirm.

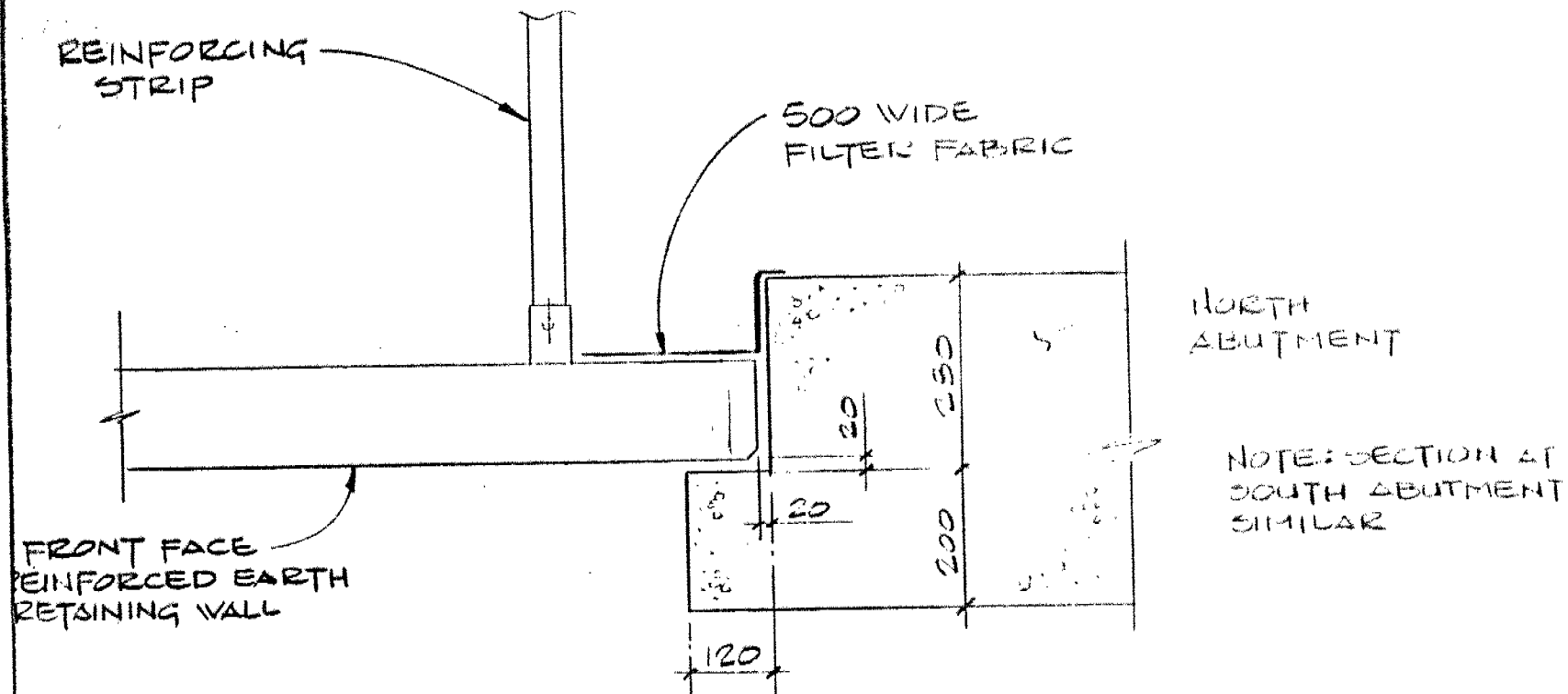
Kindly take appropriate action. In addition, any opinion and/or recommendation to the above proposed details would be appropriated and should be brought to the attention of the undersigned at 224-7425.

John Lam

J. K. Lam
Senior Structural Engineer
for:
G.C.E. Burkhardt
Head. Structural Section

cc: R. MacDonell, RECO
D. Dundas, Foundation Design Section
B. Farago, Structural Office
G. Al-Bazi, Structural Office
J. Klowak, P & D
W. Lankinen, P & D
R. Jeffries, Structural Section
E. Lisinski, D.S. Lea
N. Garland, R.V. Anderson
B. Ellis, A.P.D.
B. Friesen, DelCan (Ottawa)





SECTION (2)

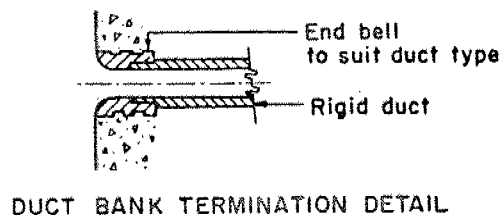
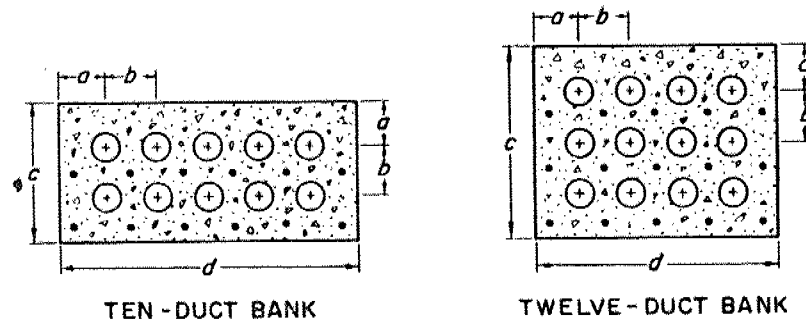
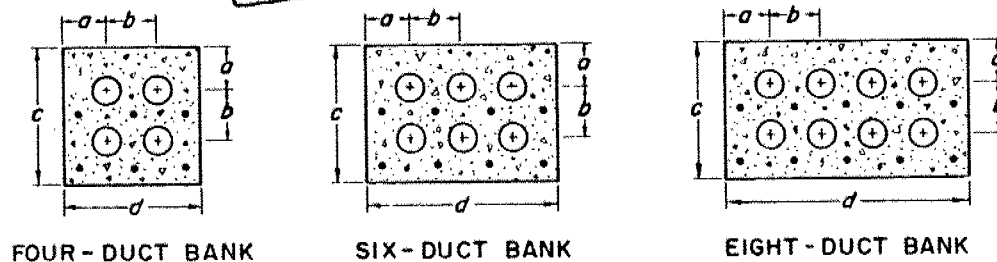
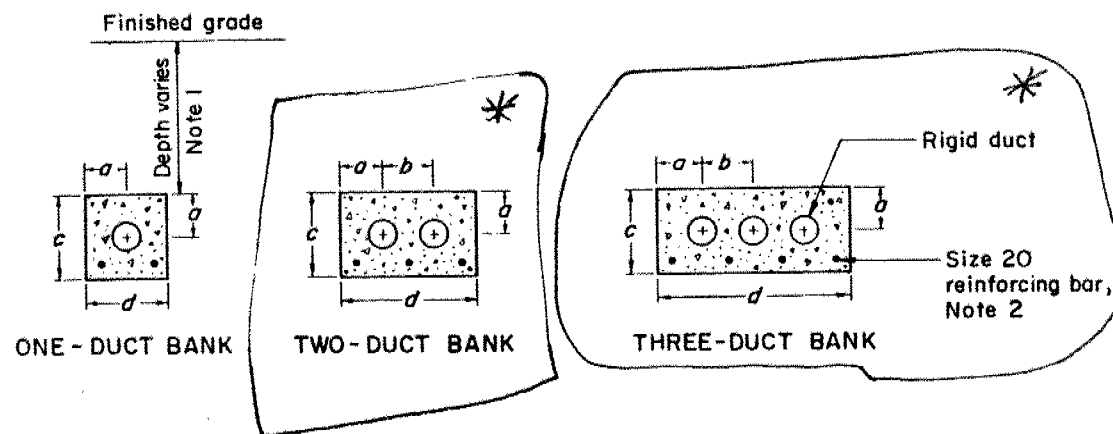
1:10

DETAIL 'A'

Reinforced Earth Company Ltd.
198 Attwell Drive, Suite 201
Rexdale, Ontario M9W 6M8
(416) 674-1818

Reinforced Earth Company Ltd.
198 Attwell Drive, Suite 501
Rexdale, Ontario M9W 6M5
(416) 674-1818

G.I.P. CONCRETE TRAFFIC BARRIER (NOT BY RECO)
 515
 7000 LONG REINFORCING STRIP
 750
 230
 RELOCATE STRIPS TO SUIT
 DETAIL 'C'
 APPROACH FILL FINISH AT 515 mm BELOW FINAL GRADE.
 DETAIL 'B'
 REINFORCED EARTH VOLUME
 1000
 DUCT BANKS ENCASED IN CONCRETE (SEE OPSP-2100.06)
 REINFORCING STRIPS
 1200
 150 Ø PERF. DRAIN FILTER FABRIC WRAPPED OUTLETS AS DIRECTED BY THE ENGINEER
 6010
 SECTION 1
 1:50



No of Duct Banks	TYPICAL DIMENSIONS FOR DUCT BANKS (mm)							
	75 mm dia ducts				100 mm dia ducts			
	a	b	c	d	a	b	c	d
1	125	-	250	250	135	-	270	270
2	125	150	250	400	135	170	270	440
3	125	150	250	550	135	170	270	610
4	125	150	400	400	135	170	440	440
6	125	150	400	550	135	170	440	610
8	125	150	400	700	135	170	440	780
10	125	150	400	850	135	170	440	950
12	125	150	550	700	135	170	610	780

NOTES:

- 1 The top elevation of the concrete encasement shall be a depth of 1.0 m. In rock or high water table areas, the top of the duct bank may be placed at subgrade elevation or as otherwise directed by the engineer.
- 2 The reinforcing bars along the sides and bottom of the duct bank, shall be concealed with a minimum of 25 mm concrete cover.
- A All dimensions are in millimetres or metres unless otherwise shown.

FOR DETAIL - 'B' INFO.

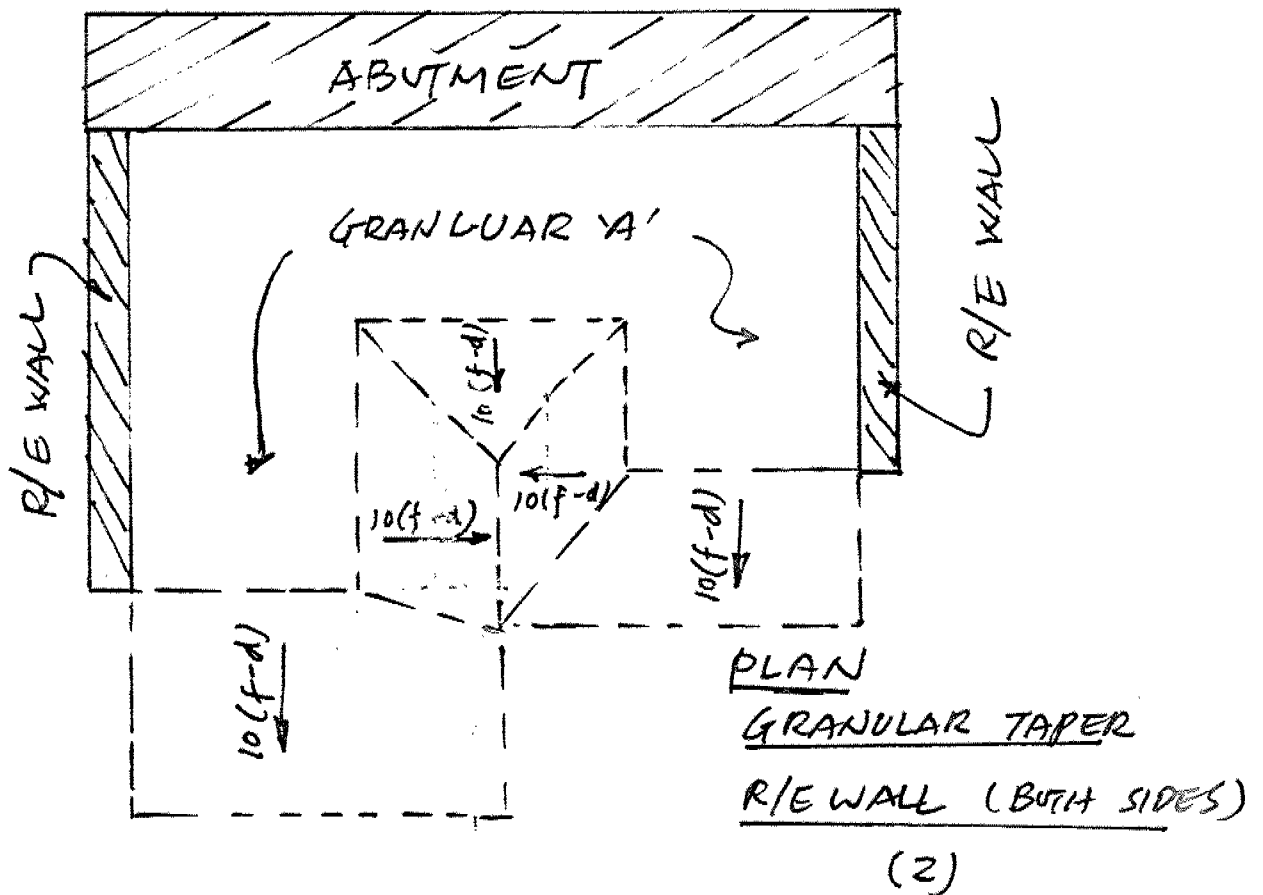
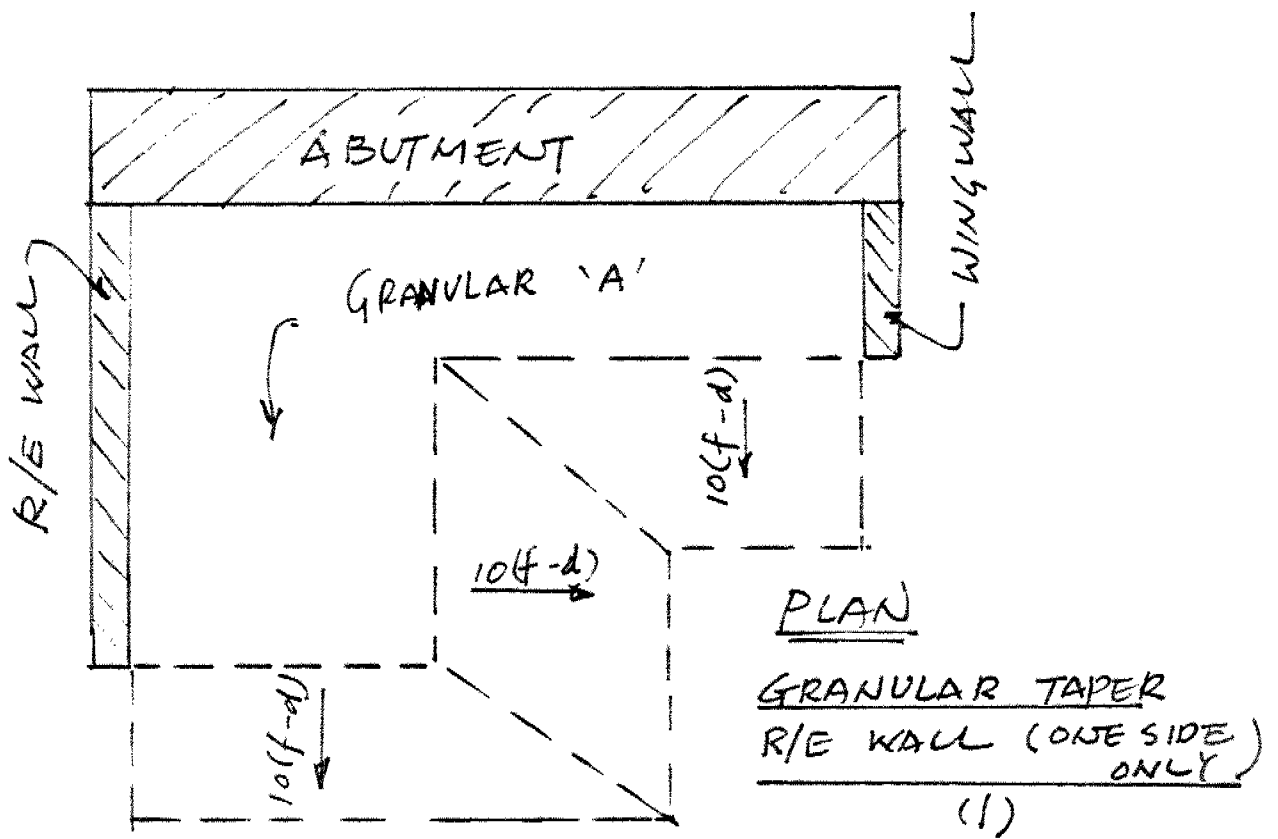
ONTARIO PROVINCIAL STANDARD DRAWING

DUCT BANKS
ENCASED IN CONCRETE

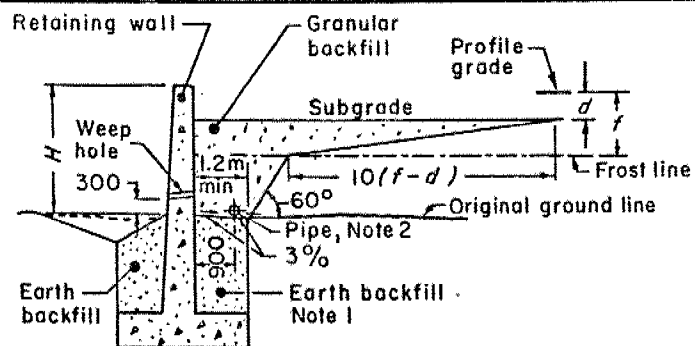
Date 1985 04 15 Rev

Date

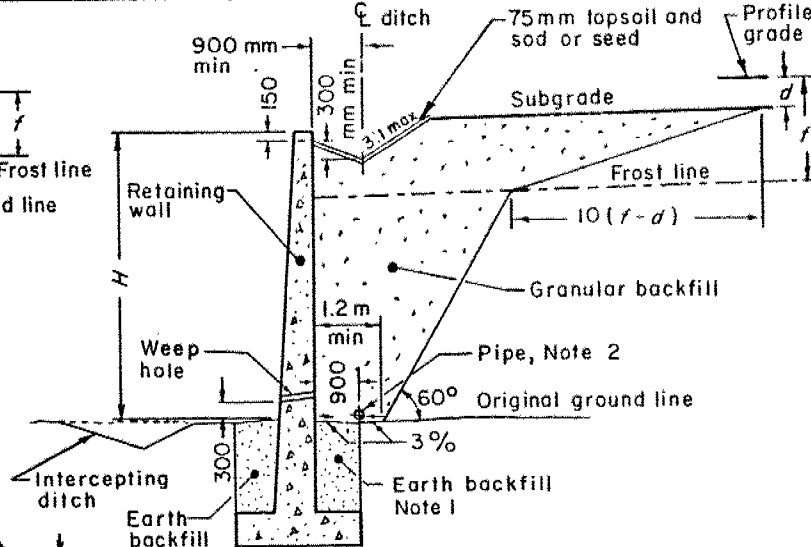
OPSD - 2100.06



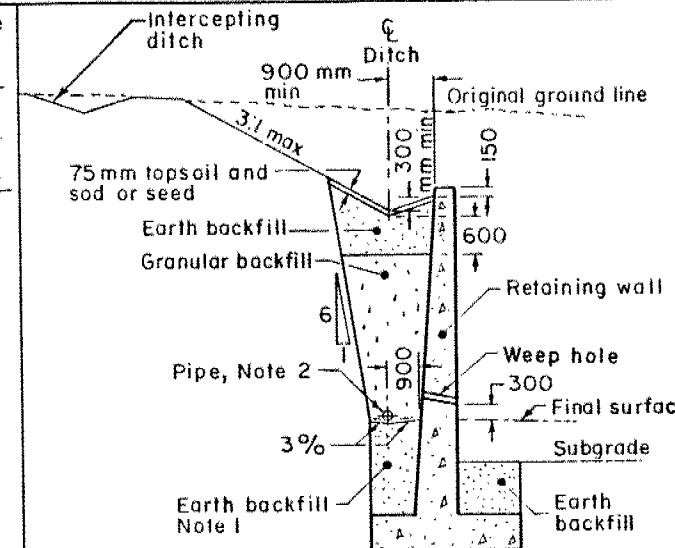
DETAIL 'D'



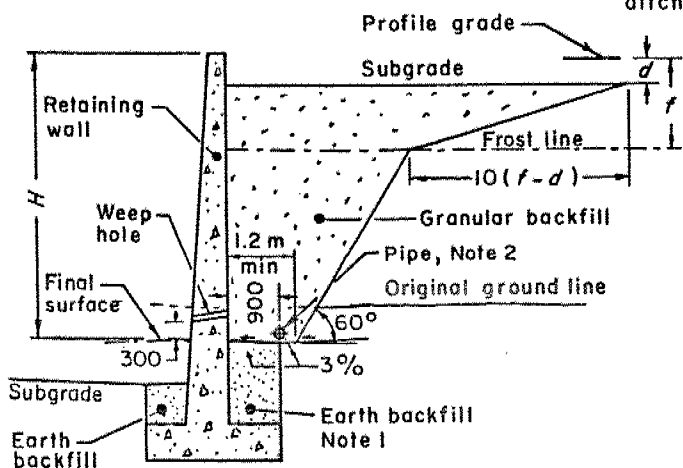
CANTILEVER WALL
H 3.65 m or less



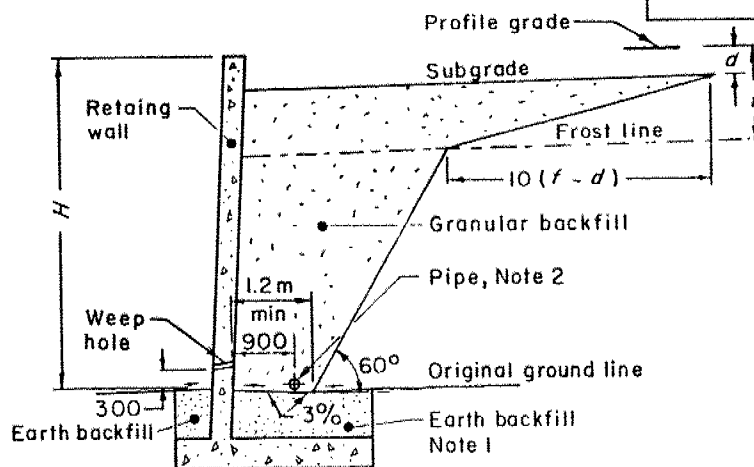
CANTILEVER WALL
Restricted R O W



CANTILEVER WALL
CUT TREATMENT



CANTILEVER WALL
H more than 3.65 m



COUNTERFORT WALL

NOTES:

- 1 Earth backfill behind wall to be to original ground line or final surface in front of wall, whichever is lower.
- 2 Subdrain shall be as specified, provision shall be made to carry pipe through counterfort wall.
- A All dimensions are in millimetres or metres unless otherwise specified.

FILL TREATMENT
Shoulder over Retaining wall backfill

LEGEND:

d = Depth of granular material
 f = Depth of frost penetration
 H = Height of wall.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

No DD-3504

RETAINING WALLS
BACKFILL

Date 1981 06 01 Rev

Gillanders
Manager Highway Standards Office

DETAIL 'E'

memorandum



To: G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1989 02 08

Atten: J. Lam, Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Reinforced Earth Retaining Walls

Ramp 407 E, W to 400 S over Steeles Avenue (Structure 1)
W.P. 138-87-02, Site 37-1169

Hwy. 400 over CNR (Structure 5)
W.P. 138-87-06 & 07

Ramp 400 N to 407 EW over Ramp EW to S (Structure 13)
W.P. 142-87-03, Site 37-1177

Ramp to EW over Ramp 407 EW to 400 N (Structure 14)
W.P. 142-87-02, Site 37-1178

Ramp S EW (Hwy 7) over Ramp 407 E & W to 400N (Structure 22)
W.P. 142-87-02, Site 37-1184

Highway 407/400 Interchange, Advanced Structures
Group W.P. 138-87-00, District 6

Further to your memo dated 89 01 31, we have reviewed the Reinforced Earth Retaining Wall drawings for the above noted structures.

Our comments are as follows:

- 1) The proposed 3-panel stepping sequence results in up to 2 panels being buried in some situations. Consideration should be given to revising the stepping in order to minimize the required Reinforced Earth volume. We recommend that a cost analysis, of 1, 2 and 3-panel stepping should be carried out. Also the possibility of using precast levelling pads should be considered in order to eliminate delays due to concrete curing.
- 2) Concerning the specifications for backfill under Design Parameters in the notes on the drawings:

In our discussion with RE, we understand that their requirement for backfill is only for the wedge behind the reinforced earth volume which extends at approximately 45° - ~~45~~⁶⁰ from the base of the RE volume to the surface. This should be clarified in the notes. Also RE specifies $\phi = 30^\circ$, $\gamma = 19 \text{ kN/m}^3$ as an assumption for their design in lieu of more detailed information. Their design can be revised to accommodate backfills with different properties. This should also be clarified in the notes.

If the source of fill for these projects is known, RE should be advised so that the parameters can be determined and reflected in their design.

If there are any questions, please advise.

DHD/mmj

c.c. - G. Al-Bazi

D. H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundation Engineer

memorandum



Tel: 235-3731

To: G.C.E. Burkhardt
Head
Structural Section
Central Region

Date: 1988 09 20

Attn: J.K. Lam

From: Foundation Design Section
Room 315, Central Building

RE: Earth Reinforcement Retaining Walls
Hwy. 400/407 IC, Advanced Structures
W.P. 138-87-00, Dist. 6

As requested in point 4 of your memo dated 88 08 24, we have reviewed the geotechnical implications of utilizing earth reinforcement concepts for retaining walls at approach structures to the Hwy. 400/407 IC.

In our opinion these sites are geotechnically suited to this type of wall. However, the selected design should be submitted to this office for review so that the overall stability of the design can be verified.

The Reinforced Earth Company Ltd. and Geo-Crete Products Ltd. both market proprietary retaining walls utilizing earth reinforcement concepts and we recommend that the least expensive proposal should be adopted.

If there are any questions, please advise.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundations Engineer

DHD/mj

c.c. - R. Dorton
K. Bassi
J. Klowak



MINISTRY OF TRANSPORTATION
MEMORANDUM

TO: Dave Dundas
Senior Foundation Engineer
Foundation Design Section

DATE: 1988-08-24

FROM: Structural Section, Central Region

Re: Reinforced Earth Retaining Wall Options
Highway 407/400 Interchange, Advanced Structures
W.P. 138-87-00, District 6

On August 18 and 19, 1988, several meetings were held between the Structural Office and the Structural Section regarding the feasibility and cost effectiveness of using Reinforced Earth retaining wall system as alternative retaining wall structures for the W.P. 138-87-00, 407/400 Interchange - approach structures project.

In summary, the following were discussed and recommended:

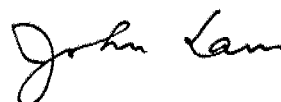
- 1 For aesthetic purposes, only one type of the reinforced earth retaining wall system should be used throughout the entire 407/400 Interchange.
- 2 The choice of using reinforced earth retaining wall system should be based on cost effectiveness.
- 3 Retaining walls for structures #1, #5, #20, #13, #14 and #22 have been identified as ones that may result in cost saving if reinforced earth retaining wall system is used.
- 4 Except for structure #20, the final 'Foundation Investigation and Design Reports' for structures #1, #5, #13, #14 and #22 have not recommended reinforced earth retaining wall system as an alternative. As discussed with Mr. M. Devata, would you please investigate the possibility of using reinforced earth retaining walls as an option for the above notes structures.
- 5 Currently, both Geotechnical Section and the Road Consultant - D.S. Lea have been contacted to review fill materials and balance cut and fill respectively.
- 6 Structural consultants responsible for detail design of the structures #13, #14, #20 and #22 have been notified to stop designing the retaining walls until the reinforced earth wall issues have been resolved.

- 7 Bill Lankinen of Planning and Design has been notified of the possible delay of the project pending on the progress of the reinforced earth walls issue.

The present schedule calls for the following completion dates:

Structures #1, #13, #20	- December 2, 1988
Structure #5	- January 20, 1989
Structures #14, #22	- March 20, 1989

As the detailed design of the structures has started, your immediate attention of the above noted matter would be greatly appreciated.



J.K. Lam
Senior Structural Engineer
for:
G.C.E. Burkhardt
Head, Structural Section

c.c. R. Dorton, Structural Office
M. Devata, Foundation Design Section
W. Lankinen, Planning and Design
J. Klowak, Planning and Design
K. Bassi, Structural Office
G. Al-Bazi, Structural Office
B. Farago, Structural Office

memorandum



To: G. Cautillo
Head
Geotechnical Section
Central Region

Date: 1988 08 26

Atten: P. Ksenych

From: Foundation Design Section
Room 315 Central building

RE: Slope Stability
Advance Structures, Steeles Ave. to Hwy. 7
W.P. 138-87-00
Hwy. 400/407 IC, Dist. 6, Toronto

Further to your memo of 88 06 28, following are our recommendations for the approach fills which are greater than 4.5 m in height.

In this case, refer to the generalized slope stability recommendations (attached) for fills and transitions assuming a critical fill height of 8 m.

D. A. Dundas
D.H. Dundas, P. Eng.
Sr. Foundation Engineer

DHD/mj

Attach.

GENERAL SLOPE STABILITY RECOMMENDATIONS
(for surficial satability concerns)

CUTS

- for cuts less than the critical depth, the slopes should be 2H:1V, treated with a 0.6 m thick granular blanket and a toe drain
- for cuts at or more than the critical depth, the slopes should be at 2H:1V, incorporating a 2 m wide bench, and treated with 0.6 m thick granular blankets and bench and toe drains
- in cuts, the bench should slope towards the bench drain

FILLS

- for fills less than the critical height, the slopes should be 2H:1V
- for fills at or more than the critical height, the slopes should be at 2H:1V incorporation a 2 m wide berm
- in fills the berm should slope towards the toe of slope

TRANSITIONS

- berms/benches may be run out as quickly as is feasible in the area beyond which they are required for stability
- regarding the location of benches/berms along the slope, in cuts there should be no uninterrupted slope greater than the critical depth while in fills there should be no uninterrupted slope greater than the critical height
- regarding the transition between cuts and fills, there should be no uninterrupted slope higher than the critical fill height.

M E M O R A N D U M

Geotechnical Section, Central Region

Telephone: 224-7410

To: Mr. M.S. Devata
Chief Foundation Eng., East
Foundation Design Section
3rd Floor, Central Building

Date: 88-06-28

Attention: D.H. Dundas

Re: Slope Stability ✓
W.P. 138-87-00, Hwy. 400/407 Interchange
Advance Structures, Steeles Ave. to Hwy. 7
District 6, Toronto

In reference to DS-Lea's memo (J.A. Lyle to M. Devata, June 7, 1988) regarding the above, and my subsequent conversation with D. Dundas on June 27th, I request that the Foundation Section review the approach fills beyond the structures which are greater than 4.5 in height and forward recommendations for a stable slope geometry.

At locations where berms are proposed, please provide recommendations for transition runouts.

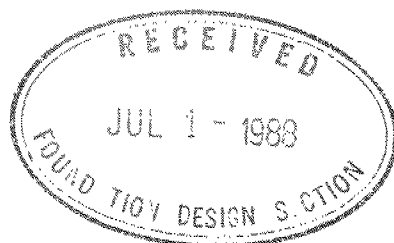
Enclosed for your information is a key plan showing the project structure locations.

Please forward your recommendations by July 15, 1988.

PK/GC/rb
Encl.

P. Ksenych

P. Ksenych
for:
G. Cautillo
Head, Geotechnical Section



DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-90

DIST. 6 REGION

W.P. No. 138-87-00 (C)

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 400/407

LOCATION CULVERT STA 11+484

RAMP 407 W TO 400 S

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

FILE

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 138-87-00-C

DIST 6

HWY 400/407 IC STR SITE

Culvert Station 1 + 484

Ramp 407 W to 400 S

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FOUNDATION INVESTIGATION REPORT
For
Culvert Sta. 1+484
Ramp 407 W to 400 S
W.P. 138-87-00-C, Site N/A
Hwy. 400/407 IC, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation at the above mentioned site carried out during the period 89 04 25 to 89 04 27. This investigation was conducted at the request of the Central Region Structural Office. The fieldwork consisted of 2 sampled boreholes and 2 dynamic cone penetration tests and one piezometer installation. The borings were advanced with hollow stem augers using an auger mounted on a muskeg vehicle. Sampling was performed to a maximum depth of 17.2 m and to El. 176.4 m and the dynamic cone tests to a maximum depth of 3.2 m and to El. 188.8 m. This report applies to the culvert at Sta. 1+484, Ramp W-S and the drainage channel within 50 m of the culvert inlet and outlet.

SITE DESCRIPTION

The site is located about 500 m east of Hwy. 400 on Ramp 407 West to 400 South in the Township of Vaughan, Regional Municipality of York, at the Hwy. 400/407 interchange.

The terrain is flat with scattered brush cover. The land is vacant with a drive-in theatre north of the site and a publishing company south of the site. There are no streams or other forms of surficial drainage near the site currently however, a drainage channel is being excavated.

According to Chapman and Putnam (1984), the site is located on a glacial deposit known as the Peel Plain.

INVESTIGATION PROCEDURES

Sampling was done at 0.8 m to 1.5 m intervals using a split spoon sampler. The split spoon samples provided Standard Penetration (N) values for assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of shear strengths of the cohesive materials.

Borehole elevations and layout was provided by Central Region Surveys and Plans.

Laboratory Tests

Laboratory testing was carried out on representative samples to determine characteristics of the soil.

The laboratory testing consisted of:

- grain size analysis
- natural moisture content determination
- Atterberg Limit determination

SUBSURFACE CONDITIONS

The surficial soil consists of clayey silt to silt, some sand and traces of gravel. It is a glacial till deposit varying in thickness from 7.6 m to 9.4 m. This deposit is underlain by an extensive stratum of clayey silt to silty clay (lacustrine) that exceeds 8.1 m in thickness.

The boundaries of the different deposits together with the field and lab test results are shown on the Record of Borehole sheets No's 89-1 & 89-2 contained in the appendix of this report. The stratigraphical sections are shown on Drawing No. 1388700-C. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below:

Clayey Silt to Silt, some Sand, trace of Gravel, random Silt and Sand pockets, occasional Boulders (Glacial Till)

The surficial soil consists of a glacial till which extends to a relatively level bottom at El. 184.2 m to El. 184.5 m. The total thickness of this layer ranges from 7.6 m to 9.4 m. The glacial till varies in its constituents with the general trend being an increase in silt content with depth. Consequently the plasticity decreases with depth as the till becomes a slightly plastic silt. There is a distinct zone of silt and sand with occasional pockets of gravel between El. 190 m to El. 187 m. This zone is water bearing as evidenced

by a slight boiling action in the augers when this zone was penetrated. This material may slump into the excavation. Below this zone the till is hard with occasional boulders and is difficult to auger. A boulder was encountered in BH 89.2 at El. 186 m. Measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	8-18	10.6
Liquid Limit w _L (%)	12-26	19
Plastic Limit w _p (%)	10-12	11
Plasticity Index I _p (%)	2-14	8
SPT Blows 'N'	21-120/20 cm	60

The average standard penetration test 'N' value is 60 blows/30 cm. The blow count and consistency increases with depth to the silt and, sand zone such that the consistency ranges from very stiff to hard. Below the silt and sand zone the deposit is very dense. The typical plasticity characteristics of the material are shown in Figure 1.

The grain size distribution is fairly uniform within this deposit as shown in Figure 2.

Clayey Silt to Silty Clay, with thin Silt seams (Lacustrine)

This deposit underlies the clayey silt to silt. The depth of this deposit was not determined during this investigation as all the boreholes were terminated in this layer. However, boreholes done on nearby investigations indicate the layer extends to at least El. 170.8 m. This is a lacustrine deposit with numerous thin silt seams. These seams could be water bearing.

Measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	13-22	18
Liquid Limit w _L (%)	36-46	41
Plastic Limit w _p (%)	15-17	16
Plasticity Index I _p (%)	20-29	25
SPT Blows 'N'	36-120/23 cm	85

The average standard penetration test 'N' value is 85 blows/30 cm. The blow count decreases with depth and therefore the consistency decreases with depth. This corresponds to an increase in clay content and plasticity with depth. The typical plasticity characteristics are plotted in Figure 3.

The grain size distribution is shown in Figure 4.

Groundwater

A piezometer was installed in BH 89-2 at El. 181.6 m. The measured water level on 89 05 02 was El. 190.0 m (3.6 m below ground level). This water level is at the top of the silt and sand zone. However, due to ongoing construction activity and the excavation of a drainage channel the water table will probably be dropping below El. 190.0 m prior to construction of the proposed culvert.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a culvert under Ramp 407 W to 400 S at Sta. 1+184. A 1.5 m x 1.8 m concrete rigid frame box type culvert will cross under the ramp on a skew angle with total length of culvert being 89.5 m \pm . The proposed invert elevation at the inlet (east end) is 180.55 m and at the outlet (west end) 180.28 m. The proposed ramp grade is 185.5 m \pm .

Recommendations are provided for the culvert foundations and the requirements for the deep channel slope at the culvert inlets & outlets.

Culvert Foundations

The culvert may be founded on a raft foundation at an elevation within 1.0 m below the proposed invert elevations. The allowable bearing capacities as per the O.H.B.D.C. are as follows:

Factored Bearing Capacity at U.L.S. 375 kPa
Bearing Capacity at S.L.S. Type II 250 kPa

The culvert footing should be constructed in the 'dry'. Although some dewatering problems may occur where granular seams and silt seams intersect the excavation below the water table, it is anticipated that dewatering may be achieved by using sump pumping techniques, incorporating perimeter ditches to prevent disturbance of the foundation soil.

Excavation

The temporary excavation for the installation of the culvert should be maintained at a continuous incline of 1H:1V or flatter, from the ground surface to the base of the excavation. The excavation should proceed in an upstream direction to facilitate drainage.

Water-bearing silt and sand seams may be encountered throughout the excavation or just beneath the level of the excavation. There is a slight possibility that

the presence of these zones may result in surficial instabilities that will require treatment. If disturbances of this material occurs, our office should be contacted for remedial measures.

Bedding

In order to keep compatible with the existing grading design the box culvert can be founded on a granular 'A' pad. The granular 'A' pad should be 560 mm deep. This will then allow drainage of granular blanket which is to be constructed upstream of the culvert inlet.

Drainage Channel Slopes

The following recommendations apply to the drainage channel upstream from the culvert inlet to Sta. 1+706 on Ramp 407 W - 400 N. These recommendations also apply downstream of the culvert outlet to Sta. 1+834 Ramp 407 W - 400 N.

The channel slopes should be maintained at an incline of 2H:1V or flatter, to a maximum height of 6.0 m, and treated with a 600 mm thick granular blanket and a 230 mm \pm gabion mat, both materials extending across the channel and halfway up the cut slopes. The granular blanket should consist of Granular 'A' or Granular 'B', Type II.

Where the cut exceeds 6.0 m in depth, slopes should remain at 2H:1V or flatter and incorporate a 2.0 m to 3.0 m wide bench at approximately mid-height. The lower slope and channel bed should be treated with a 600 mm thick granular blanket overlain with a 230 mm \pm gabion mat. A 1.2 m deep sub-drain is required along the toe of the uppermost slope.

In the downstream direction the Granular 'A' blanket should be tapered out to allow a smooth transition of the subgrade from the granular blanket treatment to the gabion mat treatment. This will ensure that the granular 'A' blanket will have positive drainage.

The slopes should have an interceptor ditch at the top of slope where space permits.

Slope vegetation should be established on the upper slope as soon as possible after completion of the cut in order to control surficial erosion.

Due to the proximity of the sites and the similarity of the material refer to the report for W.P. 164-79-06 concerning further details of the drainage channel slope design (Pages 6 and 7). The design should be kept consistent with this report.

Backfill

Native material may be used as backfill. The depth of frost protection in this area is 1.2 m.

Some settlement is anticipated within the excavation backfill zone, but can be minimized by careful compaction control and by using suitable material.

Culvert Inlet

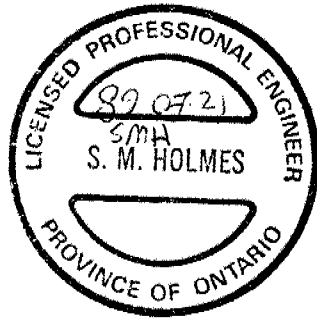
A seal of cohesive material with a minimum thickness of 600 mm is recommended at the culvert inlet. The seal should comply with the requirements outlined in OPSS 1205 'Material Specification for Clay Seal'. It should extend over the backfill to the culvert from the projected high water level down to the channel bed and 1.0 m upstream along the channel bottom. The clay seal will not be required if the wing walls extend beyond the limits of the backfill around the culvert.

Rock Protection

Erosion protection at the culvert inlet and outlet should proceed as addressed in the requirements for slope protection (See report for W.P. 164-79-06) for details) which consist of granular blankets protected by gabion mats.

MISCELLANEOUS

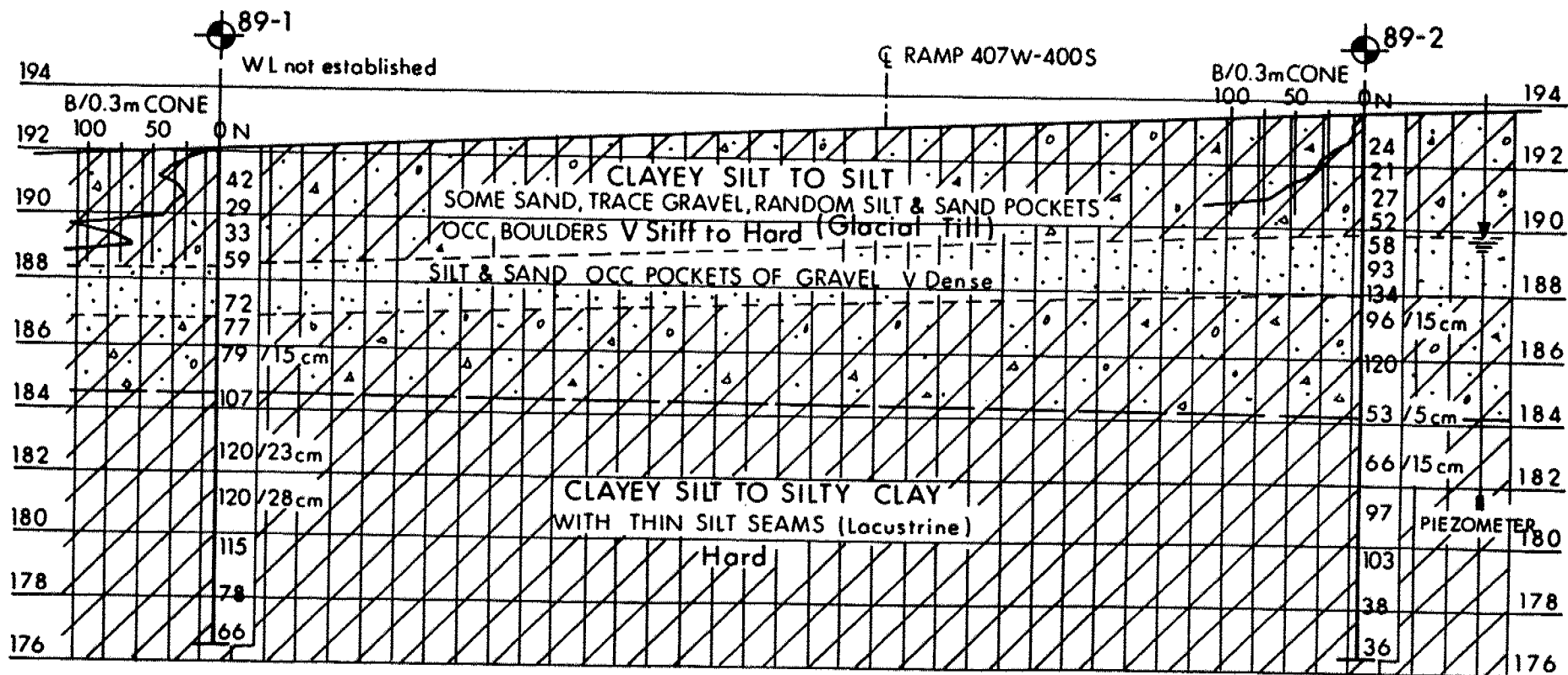
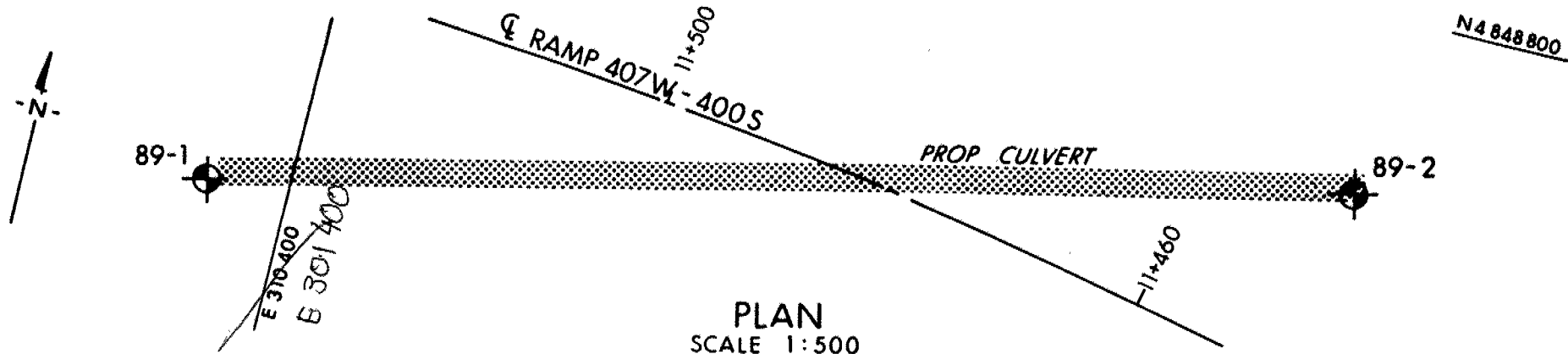
The field work for this project was supervised by Mr. S. Holmes, Foundation Engineer and Mr. F. Pinder, Engineer Trainee. The equipment used was owned and operated by Master Soil Investigations Ltd. This report was prepared by Mr. S. Holmes, Foundation Engineer in conjunction with Mr. D. Dundas, Senior Foundation Engineer, and reviewed by Mr. M. Devata, Chief Foundation Engineer.



S. Holmes, P.Eng.
Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX



DWG No 1388700-C

SCALE 1:500 Horz
1:200 Vert

WP 138-87-00-C
HWY 400 & 407 DIST 6
Geocres No 30M13-90

RECORD OF BOREHOLE No 89-1

METRIC

W P 138-87-00 LOCATION Co-ords. N 4 848 765.5; E 301 393.5 ORIGINATED BY FP
 DIST 6 HWY 400/407 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY AL
 DATUM Geodetic DATE 89 04 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	SHEAR STRENGTH kPa		WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	x LAB VANE	10	20	30		
192.1	Ground Surface													GR SA SI CL							
0.0	Clayey Silt to Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occasional Boulders Very Stiff to Hard		1	SS	42	*	192							2 33 42 23							
			2	SS	29		190							3 38 46 15							
			3	SS	33									55 31 12 2							
			4	SS	59																
	silt and sand occ. pockets of gravel Very Dense Brown Grey		5	SS	-		188														
			6	SS	72																
			7	SS	77																
	(Glacial Till)		8	SS	79	15 cm	186														
184.5			9	SS	107		184							1 5 52 42							
7.6	Clayey Silt to Silty Clay With Thin Silt Seams Hard (Lacustrine)		10	SS	120	23 cm	182														
			11	SS	120	28 cm	180														
			12	SS	115		178														
			13	SS	78																
176.4			14	SS	66									0 0 (100)							
15.7	End of Borehole * Water Level Not Established																				

OFFICE REPORT ON SOIL EXPLORATION

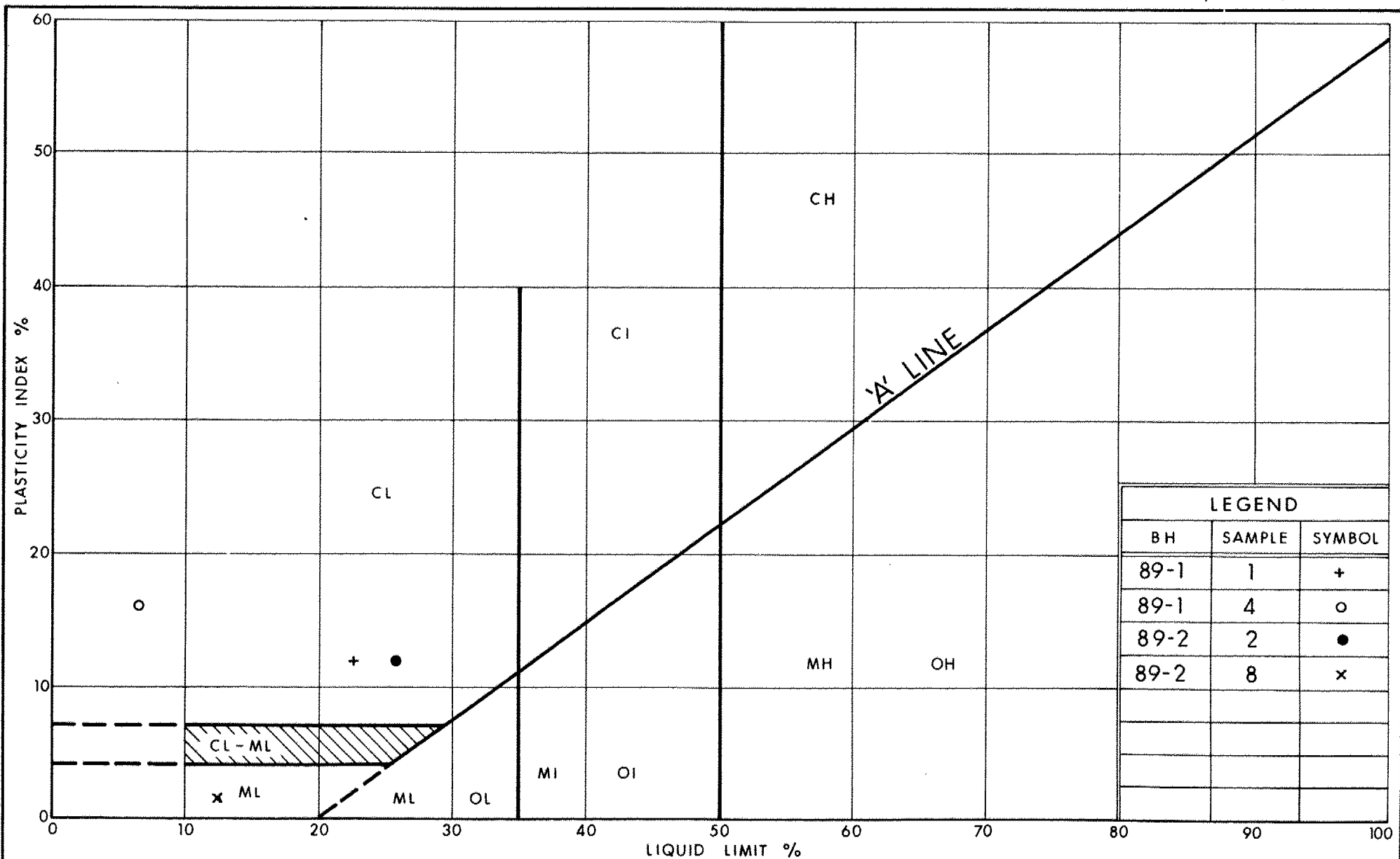
RECORD OF BOREHOLE No 89-2

METRIC

W P 138-87-00 LOCATION Co-ords. N 4 848 785.9; 301 480.7 ORIGINATED BY SH
DIST 6 HWY 400/407 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY AH
DATUM Geodetic DATE 89 04 25 & 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
193.6	Ground Surface												GR SA SI CL
0.0	Clayey Silt to Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occasional Boulders Very Stiff to Hard		1	SS	24								3 25 38 34
			2	SS	21								
			3	SS	27								
			4	SS	52								
	Silt and Sand Occ. Pockets of Gravel Very Dense Brown Grey		5	SS	58								1 14 80 5
			6	SS	93								0 90 (10)
	(Glacial Till)		7	SS	134								4 24 54 18
			8	SS	96/	15 cm							
			9	SS	120								
184.2			10	SS	337	5 cm							
9.4			11	SS	66/	15 cm							
	Clayey Silt to Silty Clay With Thin Silt Seams Hard (Lacustrine)		12	SS	97	piezometer							
			13	SS	103								
			14	SS	38								
176.4			15	SS	36								
17.2	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation

Ontario

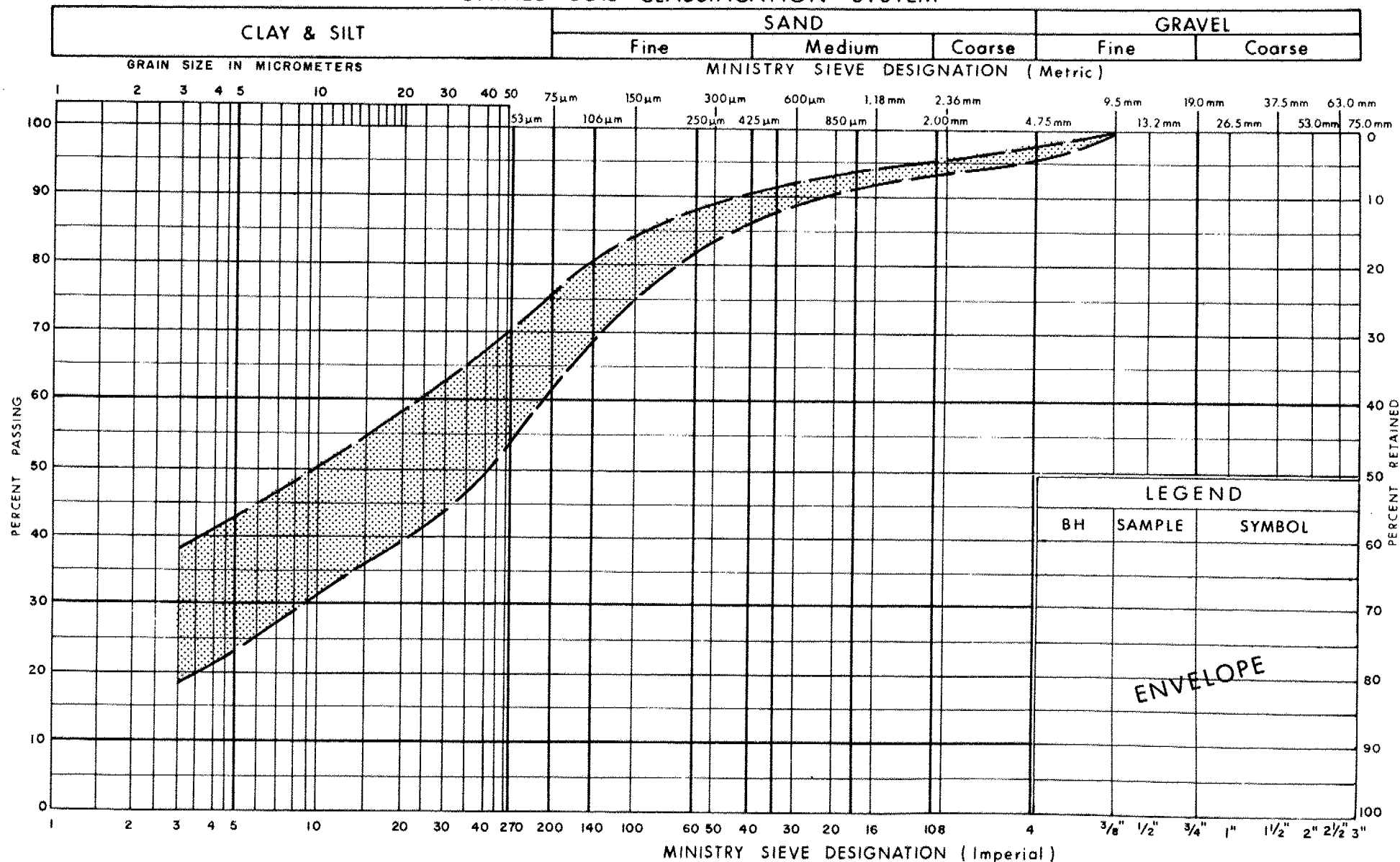
PLASTICITY CHART CLAYEY SILT TO SILT

SOME SAND, TRACE GRAVEL, RANDOM SILT & SAND POCKETS, OCC BOULDERS

FIG No 1

W P 138-87-00-C

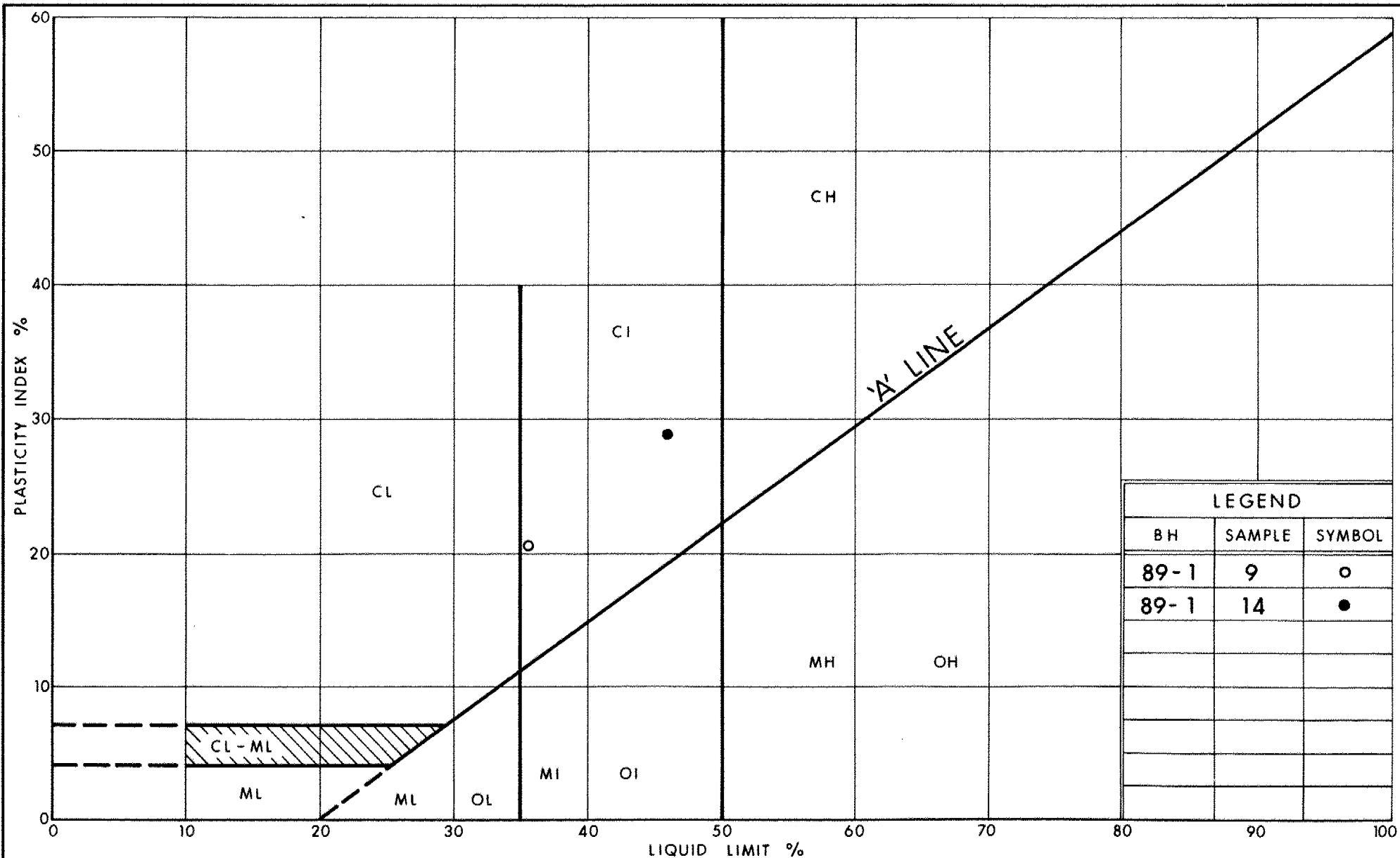
UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILT
SOME SAND, TRACE GRAVEL, RANDOM SILT & SAND POCKETS, OCC BOULDERS.

FIG No 2

W P 138 - 87 - 00 - C



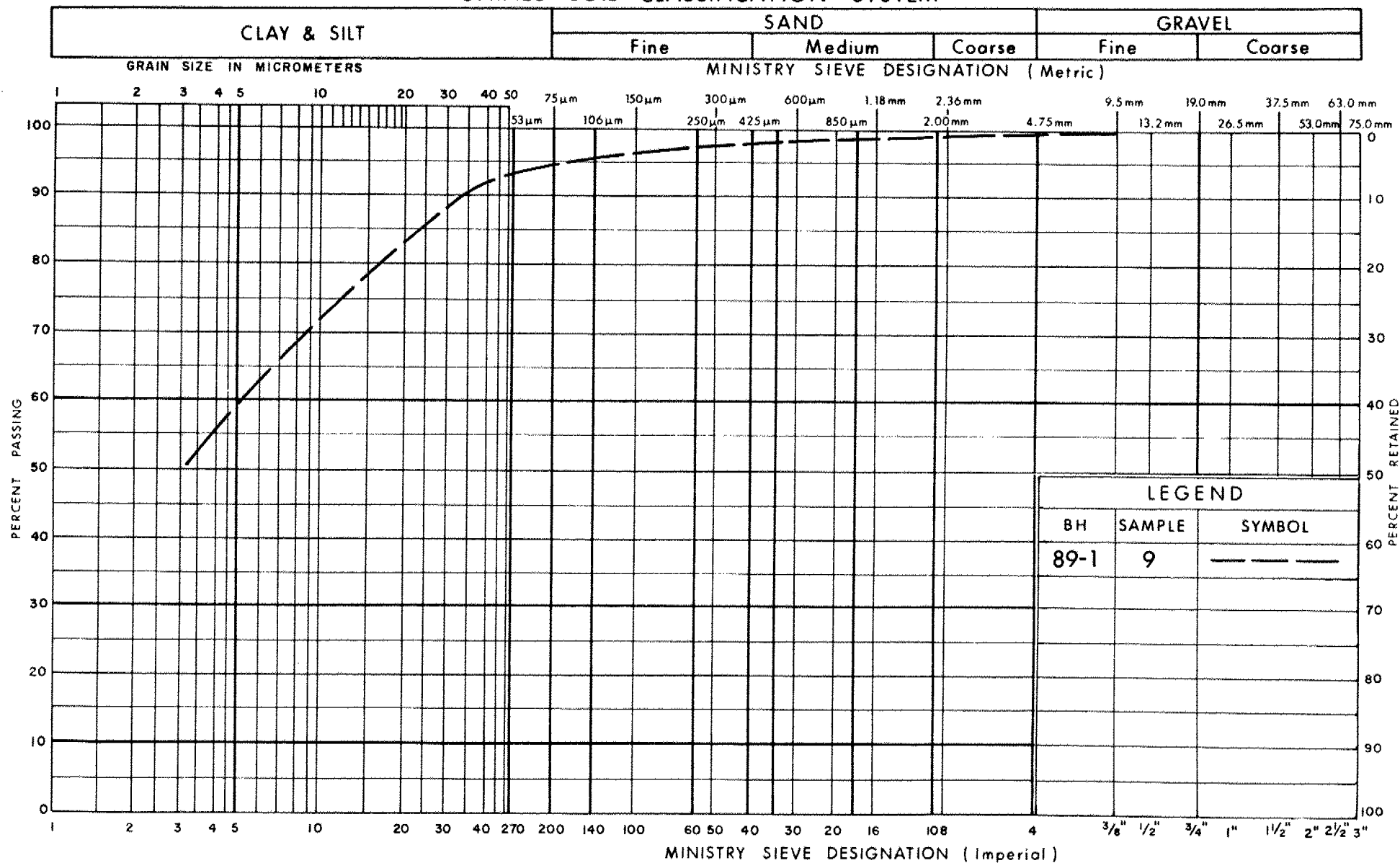
Ministry of
Transportation

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
WITH THIN SILT SEAMS

FIG No 3

W P 138-87-00-C

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
WITH THIN SILT SEAMS

FIG No 4

W P 138-87-00-C