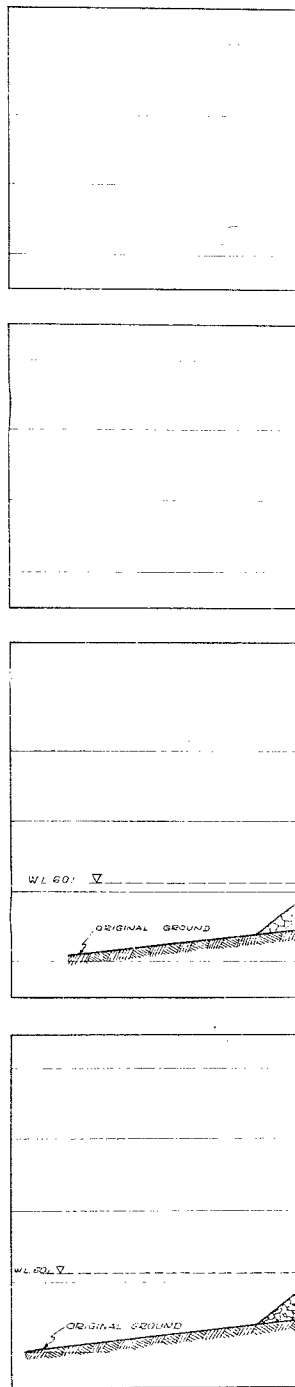
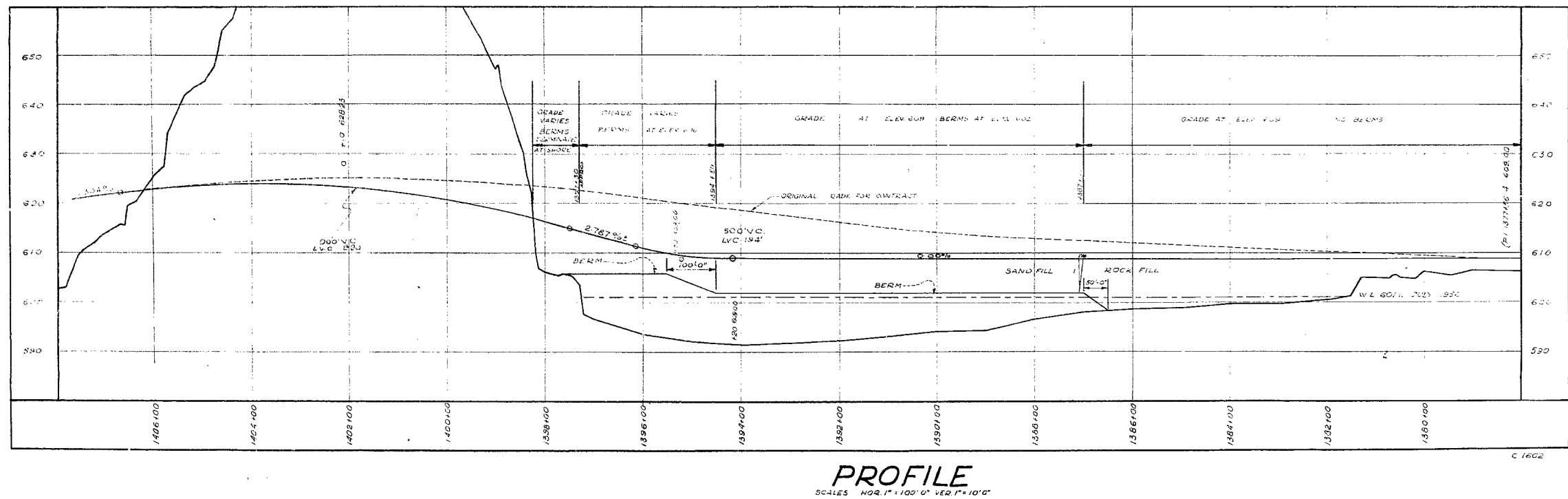
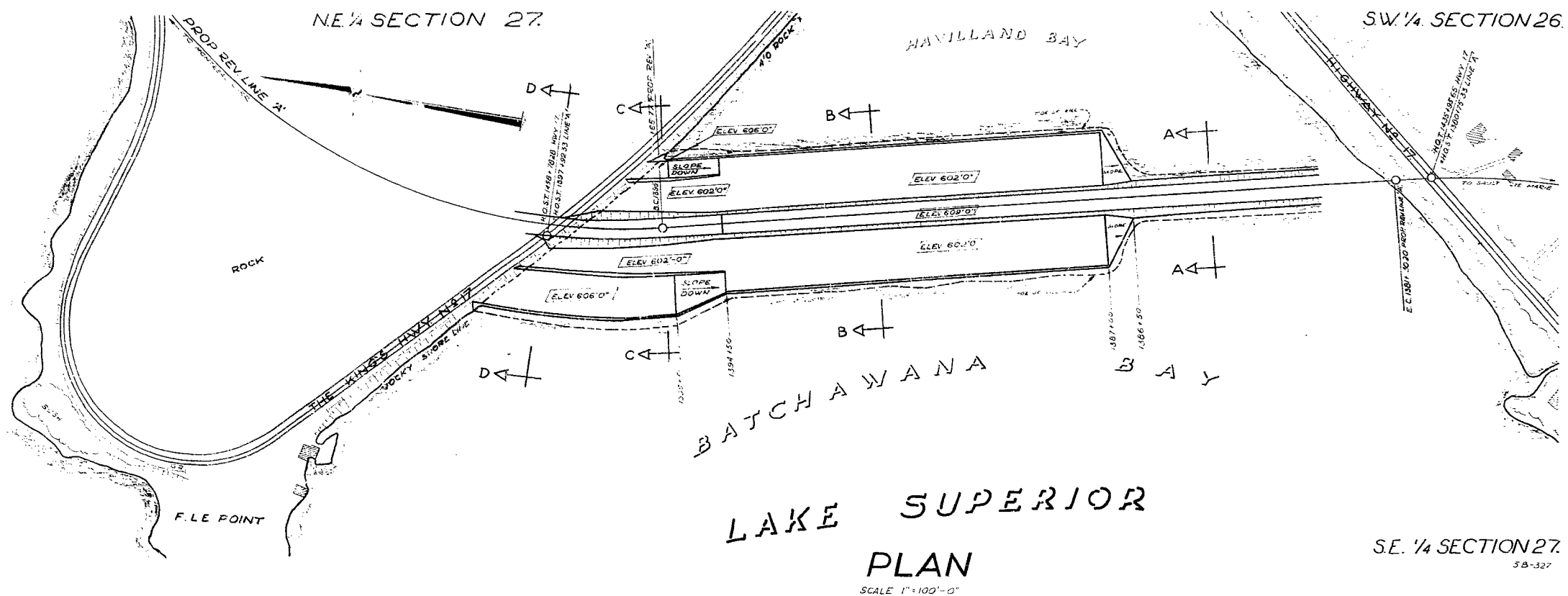
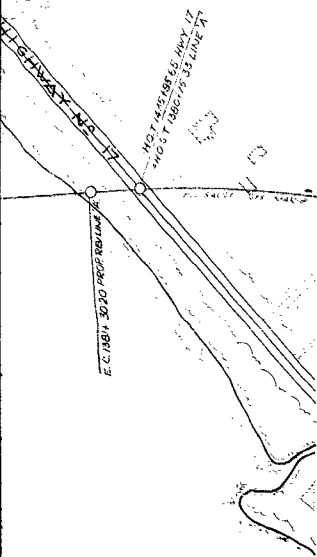


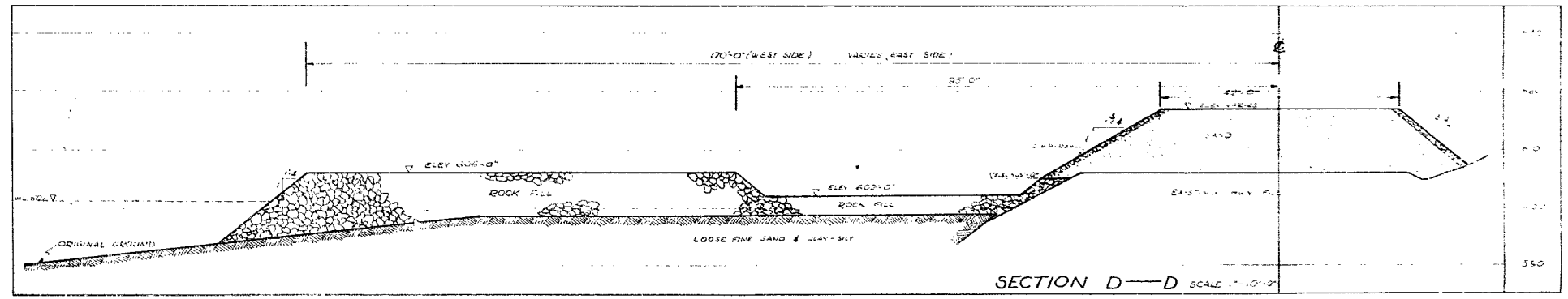
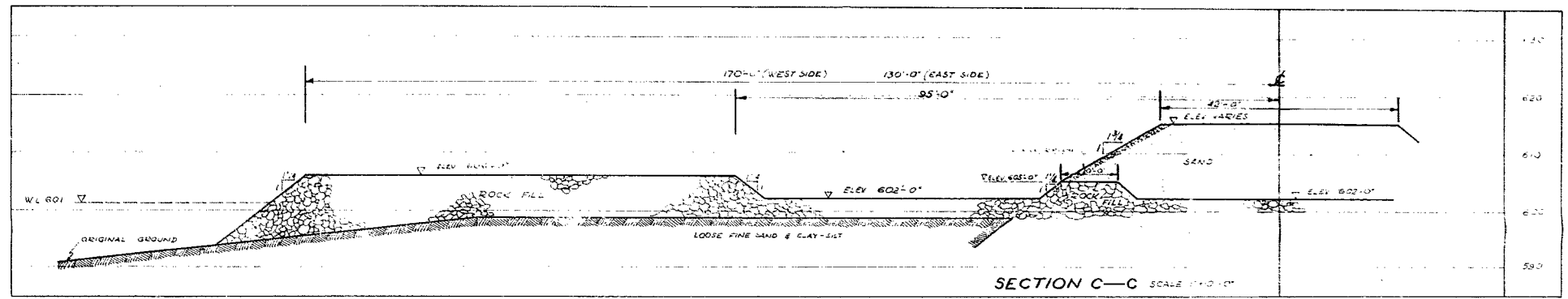
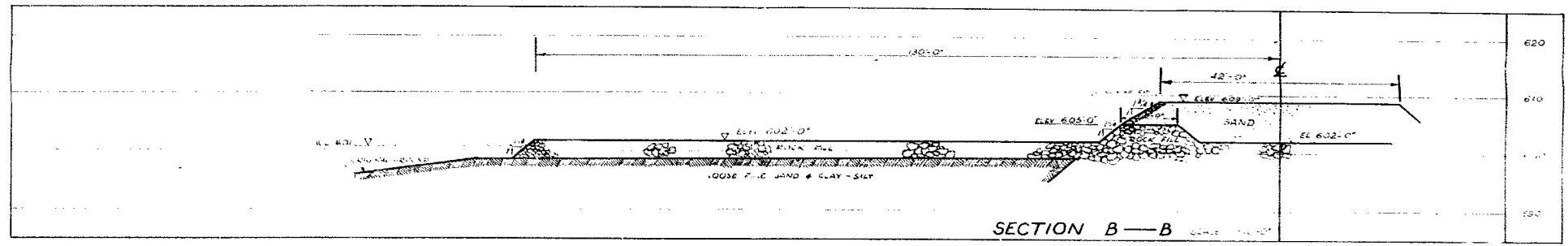
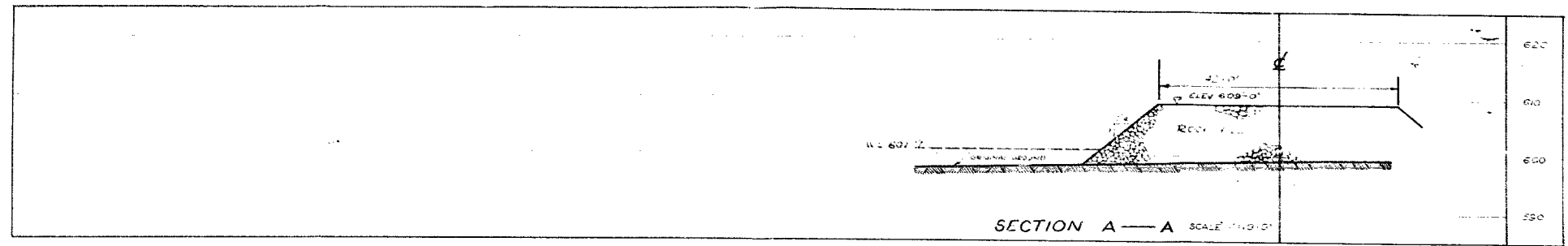
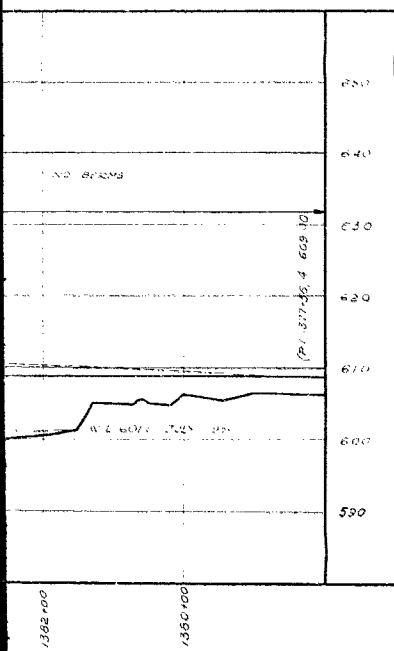
#59-F-106
HWY #17 T.C.H.
HAVILLAND BAY
CAUSEWAY



SW 1/4 SECTION 26.



SE 1/4 SECTION 27.
SB-327



NOTES: 1. ALL DIMENSIONS ARE IN FEET AND INCHES. 2. ALL DIMENSIONS ARE TO THE CENTERLINE OF THE ROAD. 3. ALL DIMENSIONS ARE TO THE CENTERLINE OF THE ROAD.

DEPARTMENT OF HIGHWAYS ONTARIO
T.C.H. 17, HAVILLAND BAY CAUSEWAY
DETAILS OF REVISED SECTION
DRAWN BY: [Signature]
CHECKED BY: [Signature]
DATE: 27 NOV 1988
F-59-106A

Mr. F.P. Collins,
Dist. Engineer -
Materials Research.

August 23, 1960.

Cont. 58-613, Naviland
Bay Causeway, Highway 17 T.O.H.

Attention: Mr. N. Bernhardt.

It has been brought to our attention, your concern over possible future failures on the Causeway due to the filtering of the sand fill through the rock base. Numerous local settlements have occurred since the spring of 1960 and it is possible that others will occur. However, it would be impractical to recommend a treatment which would insure that future failures do not occur. Thus, any local settlements can only be treated as they occur.

In addition, one fact should be considered with respect to paving this section. Due to the condition of the clay under the embankment, distortion of the grade caused by settlement must be anticipated. Therefore, it might be practical to place only one lift of asphalt base course as an interim treatment.

ack/hl
c.c. H.A. Fregaskes
J.V. Cash
G. Hunter (P)
L. Goderman ✓
T. Saint (P)
Files.

G.A. Wrong,
Principal Soils Eng.

R. F. Kissick

Per: R.F. Kissick,
Project Soils Eng.

92-58-613

Mr. D. P. Collins,
District Engineer,
Sault Ste. Marie, Ont.

December 1, 1959.

Re: Havilland Bay Causeway -

Materials & Research Section.

Hwy.17 (TCH) -- Cont.58-613.

Enclosed please find detailed drawing indicating the sections and types of fill material to be used for the completion of the above noted Causeway. Also attached, is a memorandum prepared by Dr. H. G. Golder, emphasizing the most important points with respect to basis of design, material requirements, and comments on the sections chosen.

You will note in this memorandum that our estimate of quantities is 20,000 cu. yds. of sand, and 20,000 cu. yds. of rock fill. I understand from Mr. Tregaskes, that you have negotiated a contract based on a required rock quantity of 25,000 cu. yds. This will, without a doubt, be the upper limit of the quantity required. We are not able to state a firm figure of rock quantity required because of the unknown estimate of volume that will sink into the clay below the berm sections. Our figures are based on an estimated sinkage of 2 feet.

I would like to bring to your attention the fact that the Causeway section has been designed accepting a safety factor of 1.2. We expect that there will, perhaps, be some over-stressing of this clay subsoil with some slight movements evidenced on the surfaces of the fill being placed. We feel that it would be economically out of the question to design a safety factor to ensure that this situation does not occur. We would like you to instruct your field personnel on the job to pay particular attention to movements they observe and to report these immediately to the Materials and Research Section.

I have agreed with Mr. L. Beaudre to mail these drawings to you for your study and, in the event that there are any points which are not immediately clear to you, we will, at your request, visit your office and discuss the details with you. A more detailed report will be prepared and forwarded to you for construction purposes.

LGS/MCS
Encls. (2)

cc: Messrs.

H. A. Tregaskes (2)

H. D. McKillan

L. Sadie

L. G. Golder
L. G. Golderman,

PRINCIPAL SOILS & FOUNDATIONS ENGINEER

District Use (4) Foundation Section
Gen. Files.

HAVILLAND BAY CAUSEWAY
Highway 17 (TCH) - Contract 58-613

TECHNICAL NOTE ON CONSTRUCTION OF CAUSEWAY

Purpose of Note:

The purpose of this note is to record the agreement reached on the grade to be used in the construction of the causeway, and the cross-sections and materials at each chainage. The principles of the method adopted to increase stability are explained and the way in which these affect the method of construction is stated. A comprehensive report on the whole investigation will be issued later.

The grade chosen was selected after a comparison with another grade using the existing floor level of the rock cut. In spite of the cost of blasting the comparatively thin layer of rock in the floor, the chosen grade proved much cheaper than the alternative.

Method of Increasing Stability:

The failure in the causeway was due to the fact that the weight of the fill created shear stresses in the underlying clay which were greater than the shear strength of the clay. The stresses can be reduced by reducing the weight of the fill. This can be done by lowering the fill and by using

cont'd. /2 ...

Method of Increasing Stability: (cont'd.) ...

lighter material. The shear stresses can also be reduced by using flatter slopes for the sides of the fill, or by balancing part of the weight by berms or counterweights. All the above methods have been used in the design of the new sections.

The elevation of the finished grade has been reduced to 609 over the greater portion of the fill. The remainder has been reduced to below 615 by lowering the cut in the rock. The details of the new grade are given below.

Much of the new fill will be of sand which is lighter than rock. It is also cheaper. The slopes of the sand fill will be flatter than the rock slopes, $1\frac{3}{4}/1$ instead of $1\frac{1}{4}/1$. Where the sand occurs in a position at which it could be eroded by wave action it is protected by a toe of rock.

The movements which have already occurred in the clay under the weight of the fill over chainages 1387 to 1397 have raised the bottom of the lake and formed natural berms. These can be made use of to balance the weight of the new fill but they must be protected from erosion by a blanket of rock. Over the higher sections, however, these berms will not be sufficient and further berms must be built. As it is an advantage to have these as heavy as possible they will be formed of rock. This will also make them safe from erosion. These berms will not extend continuously from the fill since their action is greater the farther (within limits) they are away from the centre

Method of Increasing Stability: (cont'd.) ...

line of the fill. The lower area between the berms and the fill will be protected by a rock blanket.

Some of the rock tipped will undoubtedly sink into the top of the clay. How much this will be is not known. Probably the figure will be between 2 and 3 feet. However, if the rock is so tipped that the clay is not displaced ahead of it in a wave, the effect will be that the surface of the rock and clay mixture will rise and its combined weight will still be useful. The method of doing this is described below.

Level of Centre-line:

The new grade at the centre-line is shown in the attached drawing. This line approaches from the South at elevation 609 which is maintained over a level section to chainage 1394+23. From this point a 500 ft. vertical curve connects to a rising grade of 2.787% to chainage 1397+50 where the elevation is 615.13. From here a second vertical curve of 900 ft. radius passes through the cut in the rock where the grade is lowered some six feet below the original elevation. This curve joins the existing grade at chainage 1406+70 at elevation 622.23.

cont'd. /4 ...

Cross-sections:

There are four different cross-sections in the length of the causeway and these are shown in the drawing, and are described below.

Section A-A.

This section runs from chainage 1381+30 to 1386+50. The grade elevation is constant at 609. The existing section is stable in this length and there has been no movement of the lake bottom. Consequently it is not necessary to take any remedial measures other than reducing the grade to 609 where it is higher than this or to make it up to this elevation where necessary.

Section B-B.

This section runs from chainage 1387 to 1394+50. The grade elevation is constant at 609. The existing rock fill in this area has already been spread to an elevation of approximately 602 and now covers the existing clay berms to a depth of about 2 feet. These berms will be extended to a distance of 130 ft. from the centre line of the causeway on both sides and will be protected by a rock toe. New rock fill will be required for this. The causeway fill above elevation 602 will be of sand with a rock toe on each side to elevation 605 to protect the sand against erosion.

Cross-sections: (cont'd.) ...

Section C-C.

Over this section the grade elevation rises from 609 to 615. The chainages are from 1395+50 to approximately 1397+30. In this section also the existing rock fill has been spread to an elevation of approximately 602 over the existing clay berms. Here, however, the berms must be much bigger as shown in the drawing. The blanket of rock covering the existing berms will be extended at elevation 602 and new berms will be constructed of rock fill to elevation 606 extending from 95 ft. to 170 ft. from the centre line on the West side and 95 ft. to 130 ft. on the East side.

The new causeway fill will be of sand with rock toes.

Section D-D.

This section joins the end of the causeway and the cut in the rock and is partly over land. The chainages are 1397+30 to approximately 1398+30. The fill is of sand with side slopes of 1 3/4/1. No special problems arise.

Transition Sections.

The transitions from one section to another will be done gradually both as regards height and width of berms, over the lengths given below.

Section A-A to Section B-B -	transition over chainages	1386+50 to 1387.
Section B-B to Section C-C -	" " "	1394+50 to 1395+50.

cont'd. /6 ...

Plan:

A plan of the causeway showing the lengths and positions of the different sections and transitions listed on the foregoing pages, is shown in the drawing.

Materials and Quantities:

Sand.

The sand used in the fill must be clean and free from clay and organic matter. It should be larger than 'fine sand', preferably medium sand and above (i.e., > 0.2 mm). Suitable sand exists in a borrow pit within one mile of the South end of the causeway. The quantity of sand required in the fill is estimated at about 20,000 cu. yds.

Rock.

The rock will presumably come from an extension of the existing rock cut at the North end of the causeway.

The grade has been lowered some 6 feet in the bottom of the cut. Excavation will be carried out to 12" below grade level and drilling will presumably be taken down to about 2 feet below grade level. The amount of rock which will be obtained from the floor of the cut will be about 4,400 cu. yds. The total quantity of rock required will be about 20,000 cu. yds.

The rock from the cut is measured in the solid. The volume required should allow for bulking of the rock when excavated. This will be about 30%. Thus, solid rock required will be 16,000 cu. yds. of which 4,400 cu. yds. will come from the floor of the cut.

cont'd. /7 ...

Construction Procedure:

The order of construction is important in the case of section C-C above.

The blanket of rock some two feet thick over the existing berm should be built first. (This may have already been constructed.) This is best done with fairly light equipment (e.g. D 4s or equivalent). This blanket need not be thick enough to support a heavy weight. Its purpose is to protect the clay beneath it. At this stage the general level will be 602.

The outside berms should next be built to elevation 606. These should be built by end tipping from the North end, access being obtained by a transverse construction road at chainage 1396+00, of sufficient thickness to support the plant used. After this, the causeway fill itself can be built up. In this way the amount of soft clay displaced will be a minimum.

No tipping must be done when the water is frozen, unless precautions are taken to blow the ice before tipping.

As the materials used will be such that stability problems will be confined to the clay beneath them, no special measures will be needed to compact the sand or rock. The compaction caused by construction traffic will be adequate.

H. Q. Golder, P.Eng.

26th. November, 1959.