Dr. MacPhail

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FILE CM4-S13-R2	DIVISION OF MECHANICAL ENGINEERING	PAGE 1 OF 4
PREPARED BY H.A.N.	OTTAWA, CANADA	COPY NO. 1
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	SECTION Hydraulics Laboratory	

SECURITY CLASSIFICATION CONFIDENTIAL

SUBJECT CORNWALL ISLAND MODEL - STUDY FOR THE EFFECTS OF CONSTRUCTION DELAYS IN THE CORNWALL NORTH CHANNEL FOR THE 1 JULY 1958 CONDITION

PREPARED BY H. A. Neu

ISSUED TO Internal.

CORNWALL ISLAND MODEL - STUDY FOR THE EFFECTS OF CONSTRUCTION DELAYS IN THE CORNWALL NORTH CHANNEL FOR THE 1 JULY 1958 CONDITION

INTRODUCTION

On 1 July 1958, ships of 14 ft. draft are scheduled to use the Seaway route through the South Channel of Cornwall Island. Excavation and dredging by the U.S. Corps of Engineers for navigation has to be balanced by compensating cuts in the Cornwall North Channel to establish natural flow distribution. Model tests reported in HY-19 indicated that the completed regulating channel in the North Channel established natural balance of flow for 270,000 c.f.s. For 310,000 c.f.s., the distribution changed, compared with nature, by +2 percent and for 180,000 c.f.s. by -1½ percent to the North Channel.

Since work in the regulating channel does not seem to proceed as expected, the Seaway Authority requested, in a letter dated November 29, 1957, tests to evaluate the effects of this construction delay and to develop remedial measures.

Tests were requested for a cofferdam with the upstream dam in three different locations, each about 1000 ft. farther upstream than the previous one. With each cofferdam, spur dykes were to be tested at the entrance to Polly's Gut in order to restore natural flow distribution. However, this proved impracticable. The St. Lawrence Seaway Authority cancelled the tests for the two upstream dam positions and substituted instead a dam along the regulating channel, leaving both ends of the channel open. The tests were confirmed by letter on December 19, 1957.

MODEL PROCEDURE

In all tests "1 July 1958A Revised" conditions were installed in Cornwall South Channel as outlined in revised Seaway drawing 9393.

With each cofferdam in the North Channel spur dykes were tested in Polly's Gut. In order to evaluate their hydraulic value, discharge distributions, water elevations, velocities and flow directions at critical areas were measured. The discharge used was 270,000 c.f.s. only; Massena diversion with 27,300 c.f.s. was in operation and Lake St. Francis was controlled as in nature.

RESULTS

(a) Cofferdam as specified in Item 1 of letter of November 29, 1957.

The cofferdam (Fig. 1) changed the natural distribution of "1 July 1958A" condition by about 8½ percent to the South Channel. The increase of flow from 7½ percent, as reported in HY-16, to 8½ percent to the South Channel, was due to improvements in "1 July 1958A" condition. In order to restore natural flow a spur dyke was tested at various locations. The most effective location was at the funnel-shaped sleeve of Polly's Gut entrance. The length of the dyke required to restore natural flow was 675 feet with an offshore height of 45 to 50 feet. The relationship between length of dyke and flow distribution is shown on graph in Figure 1. The drop in water level at the offshore end of dyke was more than 7 feet, the velocities about 23 ft./sec. Flow directions before and after installing the dyke are plotted in Figures 2 and 3. The water surface elevations in the vicinity of the Gut entrance were 3½ feet above those when no cofferdam and no dyke were installed in the North Channel.

(b) Open cofferdam along regulating channel, as outlined in letter of December 19, 1957.

At the beginning of the test, it was found that the specified length of dam would give the water very little opportunity to use the completed regulating channel. In agreement with the Seaway observer, it was decided to shorten the dam by 250 ft. at its upstream end. The discharge distribution still remained 4½ percent in favour of the South Channel. A spur dyke, 475 feet long, was required to restore natural flow distribution. (Graph in Figure 4). The water surface was 1½ ft. higher than during balanced condition of "1 July 1958A".

Throughout the test it was obvious that with the longitudinal dam the upstream section only restricted the flow in the North Channel. The most practical solution, therefore, would be to shorten the dam from upstream until natural distribution is established. In the tests, the dam was shortened by increments of 250 feet. In graph on Figure 5, the relationship between decreasing length of dam and change of discharge to the South Channel is plotted. A dam 1800 feet long, i.e. 500 feet shorter than the specified one, and 250 feet shorter than the previous one, would send only 1¼ percent more water to the South Channel.

DISCUSSION

The cofferdams tested, were located in the flow control section of the North Channel. They changed the discharge distribution substantially in favour of the South Channel. In order to restore natural flow for the "Jan. 1958" cofferdam, a 3½ ft. rise in water elevation at the Polly's Gut entrance was required. The spur dyke, as tested in the model, can hardly be applied to prototype conditions because three-quarters of the natural Gut Channel would have to be blocked off. The condition created cannot be predicted in detail, but erosion and scour would gravely endanger the river regime of the entire Cornwall area. Besides this, no fill materials exist which could stand water velocities of 23 ft./sec. in depths down to 50 ft.. For the open cofferdam along the regulating channel conditions are similar but not quite as serious. Therefore, in our opinion, spur dykes should not be used. For the longitudinal cofferdam, we suggest that construction should be speeded up so that for 1 July 1958 at least 500 feet of the upstream end of the cofferdam will be removed. The remaining unbalance in flow would then be only 1¼ percent, which is too small to be measured in the prototype.

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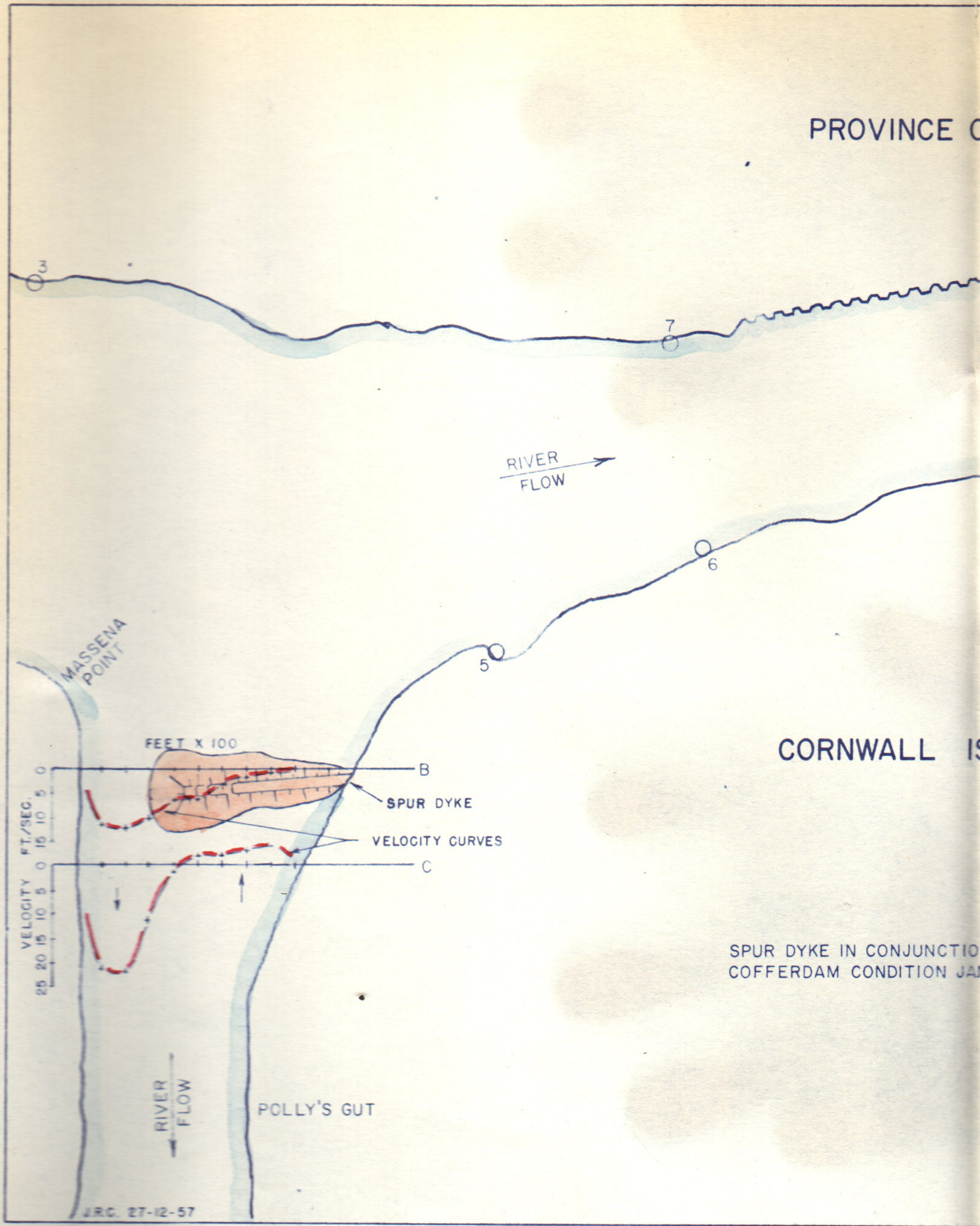
PROVINCE O
3
7
RIVER FLOW
6
5
MASSENA POINT
CORNWALL IS
FEET X 100
B
SPUR DYKE
VELOCITY FT./SEC.
0 5 10 15
VELOCITY CURVES
C
0 5 10 15 20 25
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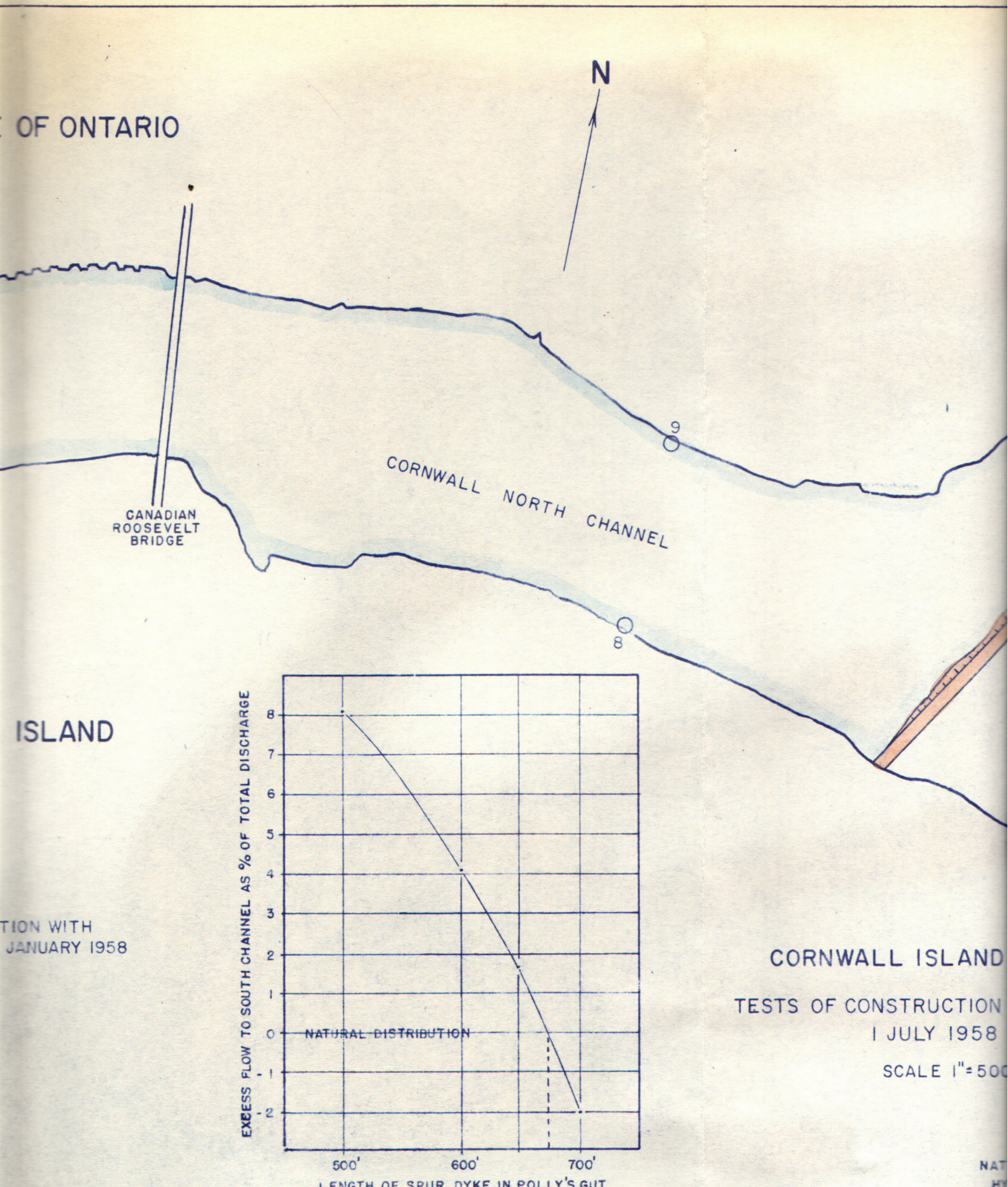
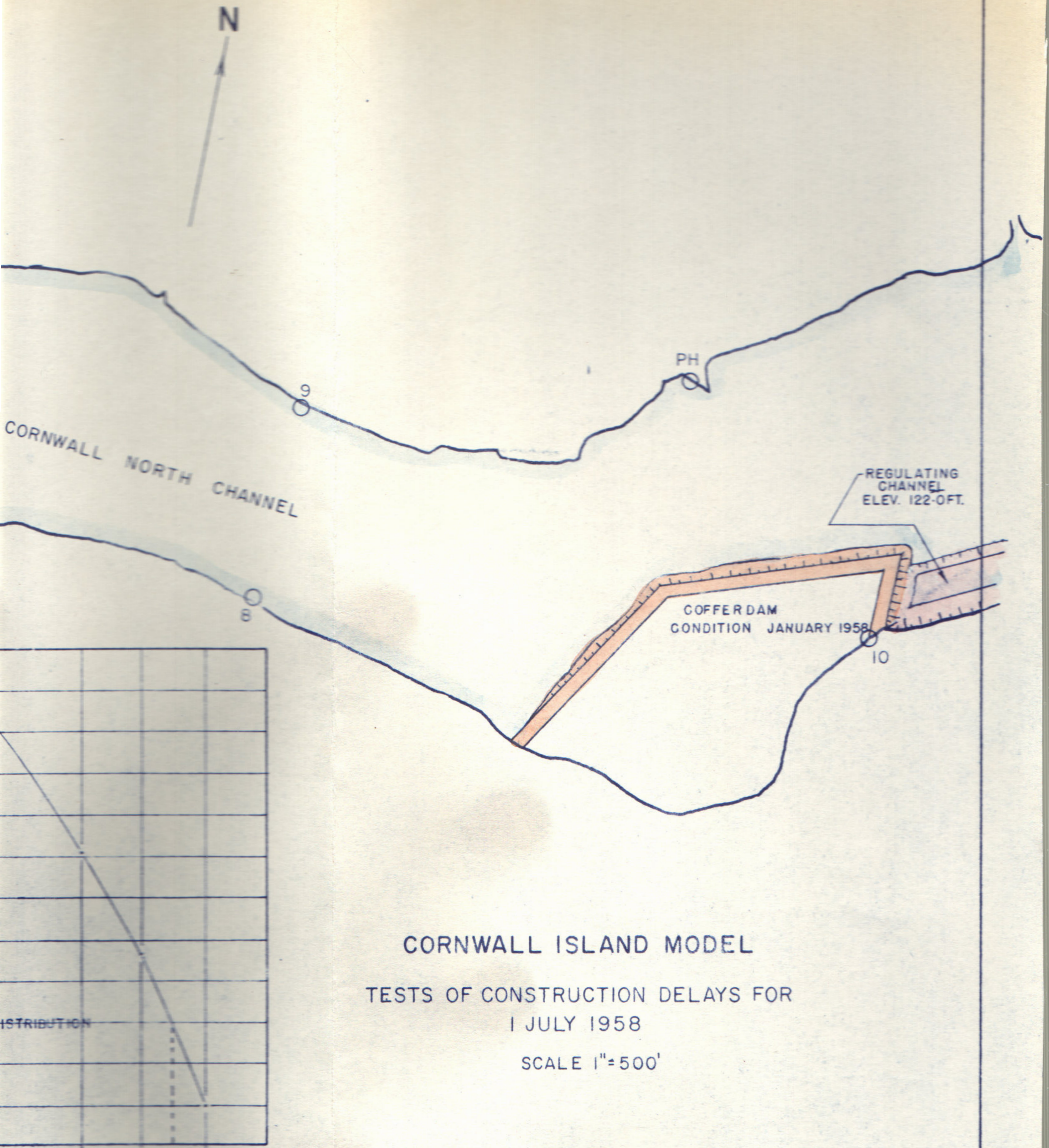
RIVER FLOW
POLLY'S GUT
J.R.C. 27-12-57



OF ONTARIO
N
CANADIAN ROOSEVELT BRIDGE
CORNWALL NORTH CHANNEL
9
8
ISLAND
TION WITH
JANUARY 1958
EXCESS FLOW TO SOUTH CHANNEL AS % OF TOTAL DISCHARGE
8
7
6
5
4
3
2
1
0
-1
-2
NATURAL DISTRIBUTION
500'
600'
700'
LENGTH OF SPUR DYKE IN POLLY'S GUT
CORNWALL ISLAND
TESTS OF CONSTRUCTION
1 JULY 1958
SCALE 1"=50
NAT
HY

FIG. 1



CORNWALL ISLAND MODEL

TESTS OF CONSTRUCTION DELAYS FOR
1 JULY 1958

SCALE 1" = 500'

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FIG. 2

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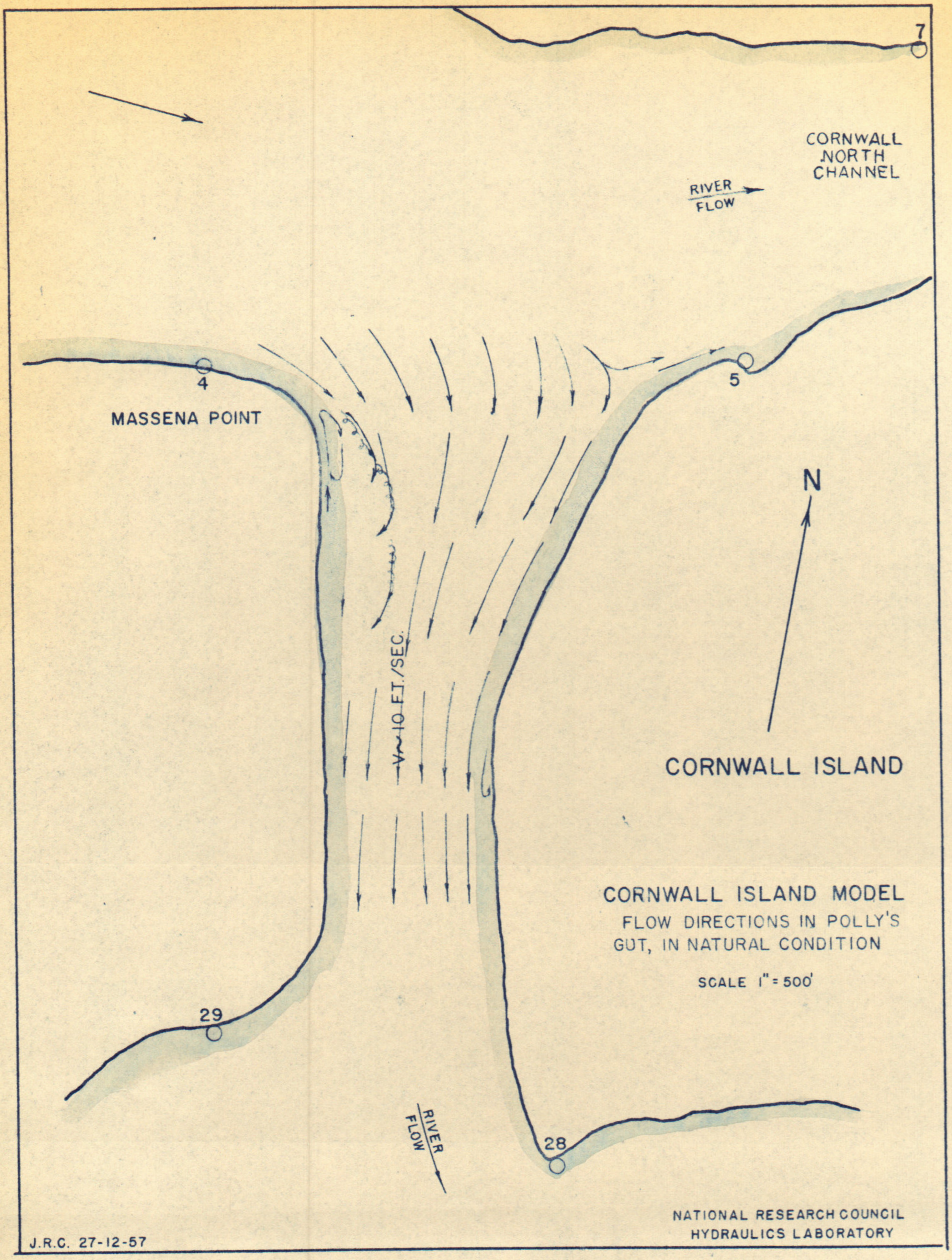

CORNWALL ISLAND MODEL

FLOW DIRECTIONS IN POLLY'S GUT, IN NATURAL CONDITION

SCALE 1" = 500'

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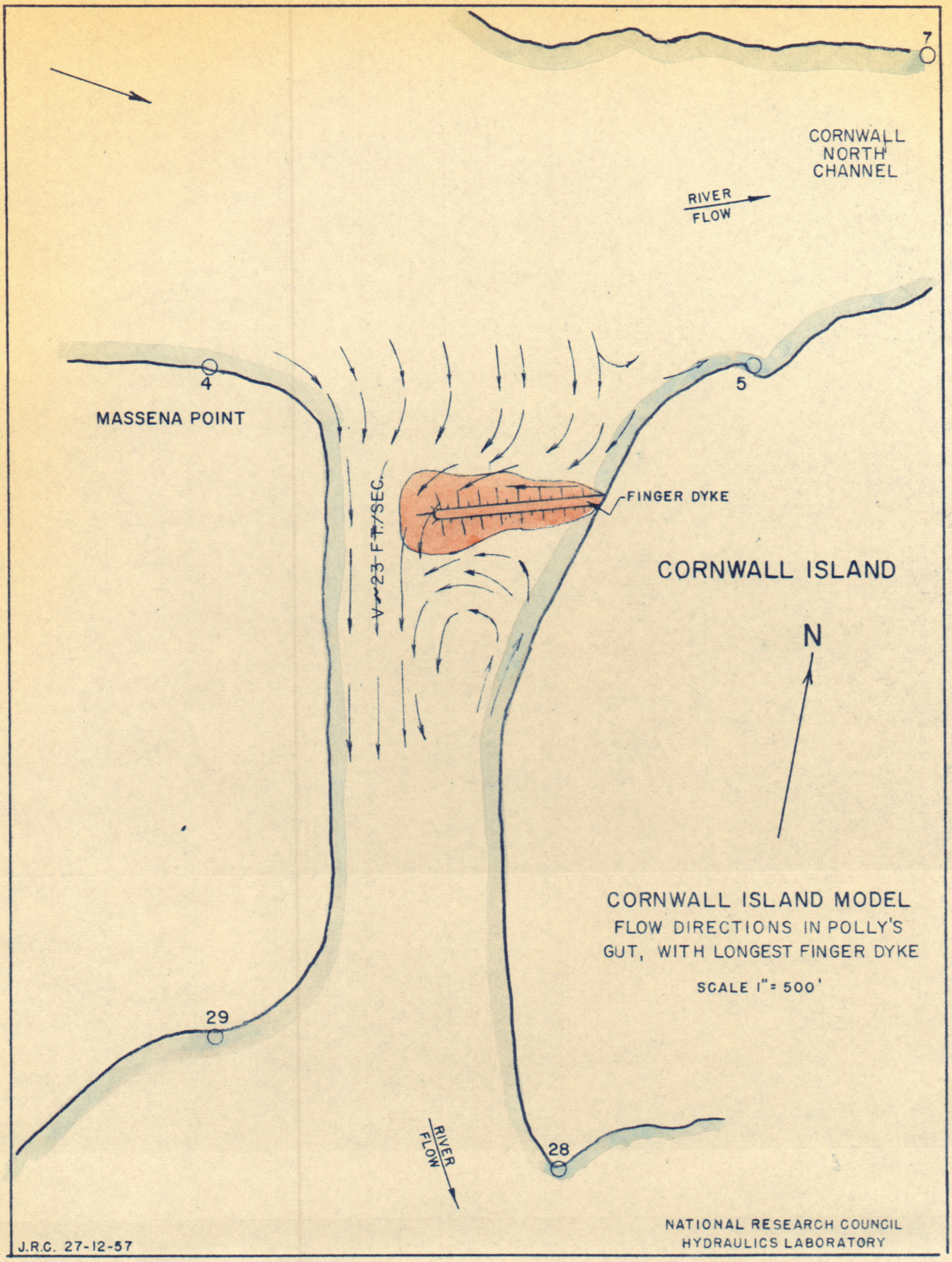

CORNWALL ISLAND MODEL
FLOW DIRECTIONS IN POLLY'S GUT, WITH LONGEST FINGER DYKE
SCALE 1" = 500'

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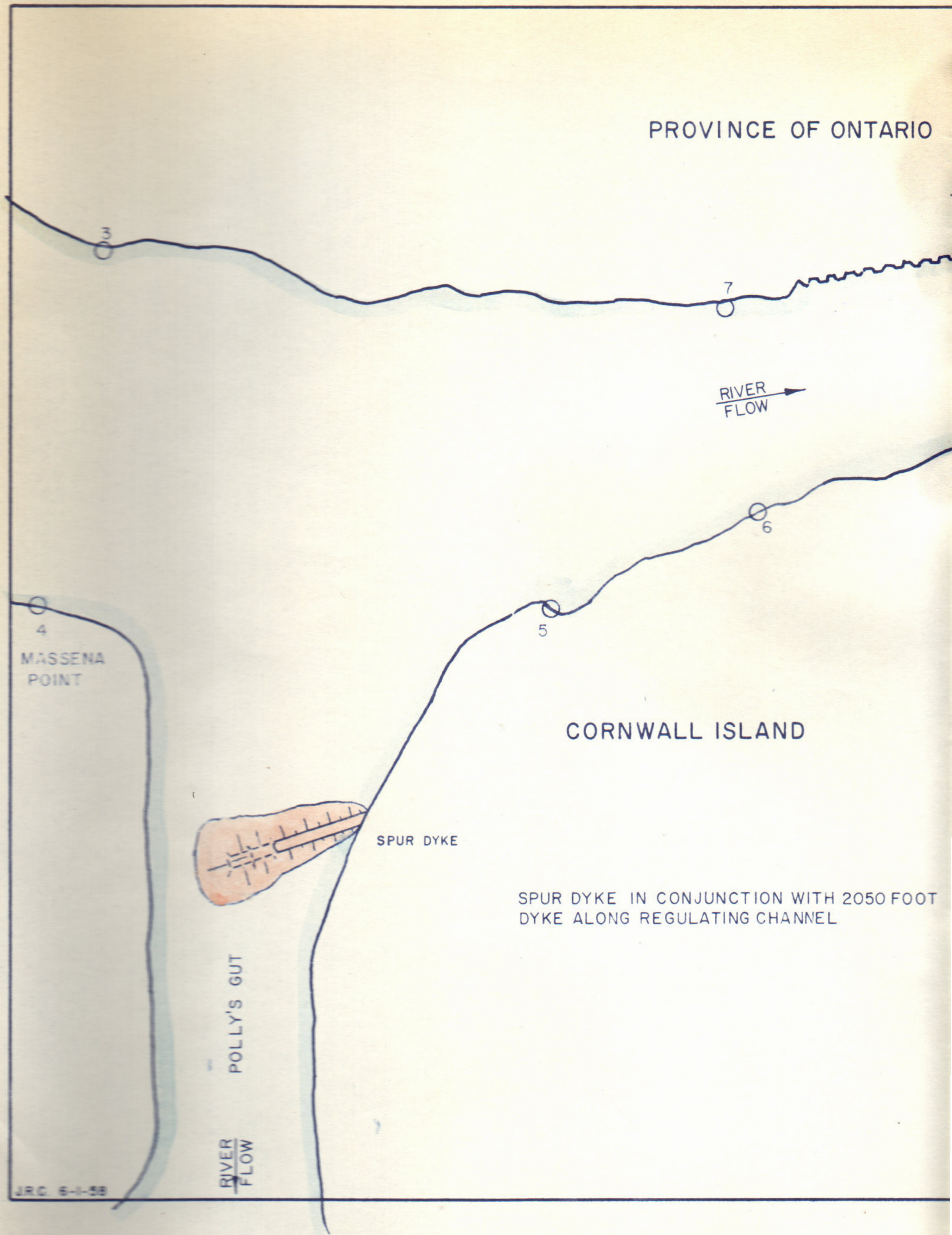
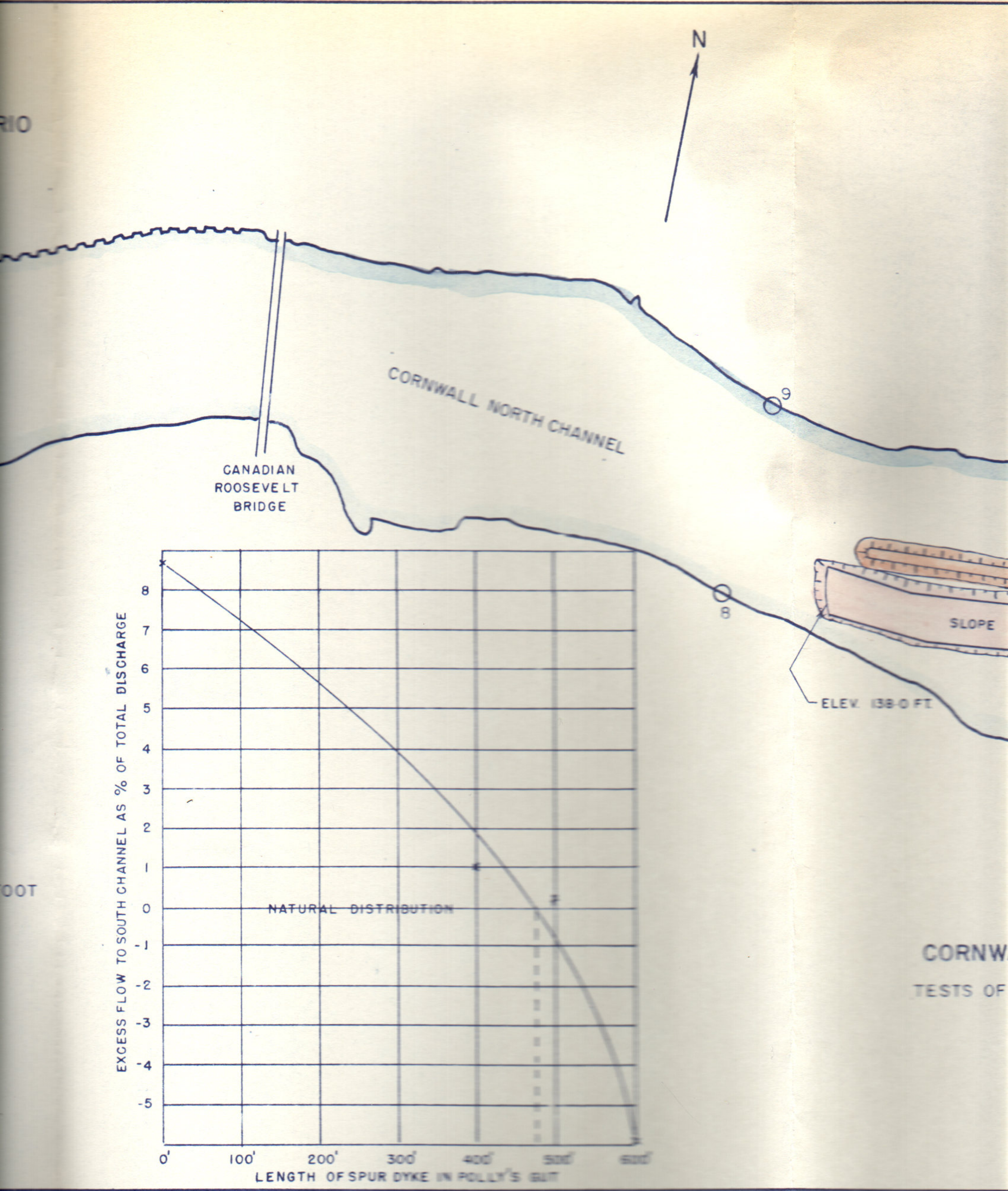

PROVINCE OF ONTARIO
3
7
RIVER FLOW
6
4
5
MASSENA POINT
CORNWALL ISLAND
SPUR DYKE
SPUR DYKE IN CONJUNCTION WITH 2050 FOOT
DYKE ALONG REGULATING CHANNEL
POLLY'S GUT
RIVER FLOW
J.R.C. 6-1-58

HY-22



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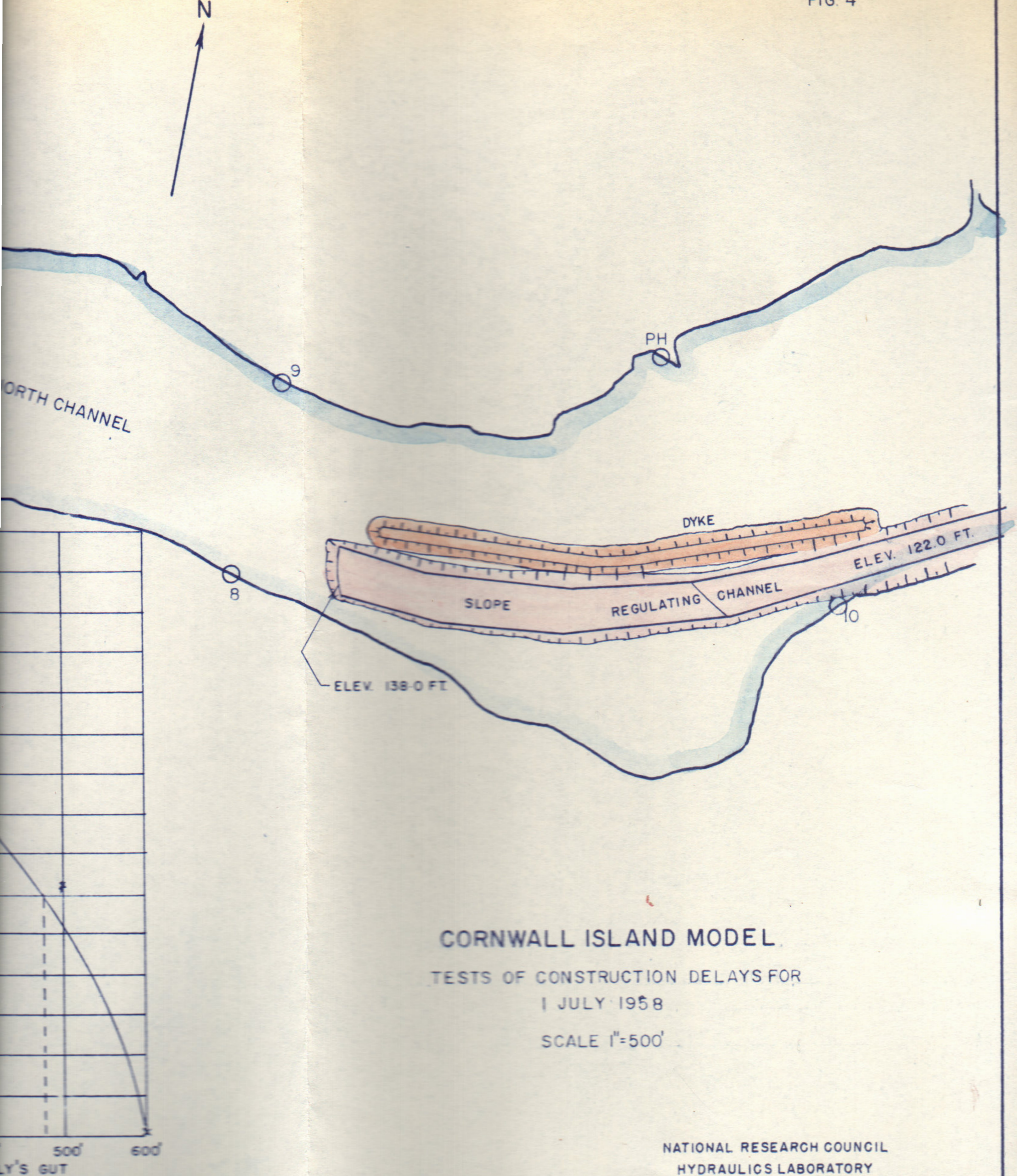
N
CORNWALL NORTH CHANNEL
9
CANADIAN
ROOSEVELT
BRIDGE
8
SLOPE
ELEV. 138.0 FT.
OOT
CORNWA
TESTS OF
EXCESS FLOW TO SOUTH CHANNEL AS % OF TOTAL DISCHARGE
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
NATURAL DISTRIBUTION
0'
100'
200'
300'
400'
500'
600'
LENGTH OF SPUR DYKE IN POLLY'S GUT

FIG. 4



CORNWALL ISLAND MODEL

TESTS OF CONSTRUCTION DELAYS FOR
1 JULY 1958

SCALE 1"=500'

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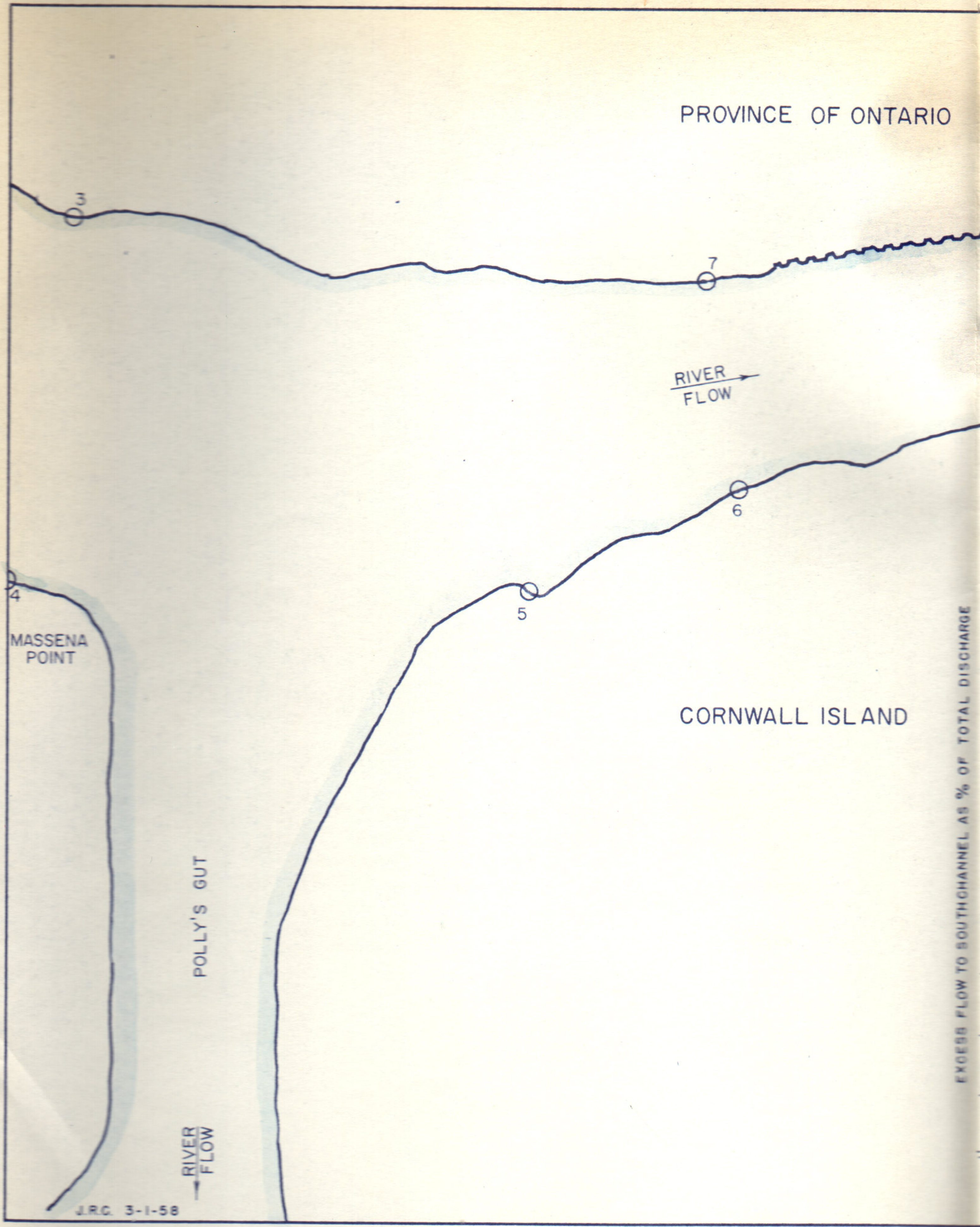


EXCESS FLOW TO SOUTHCHANNEL AS % OF TOTAL DISCHARGE

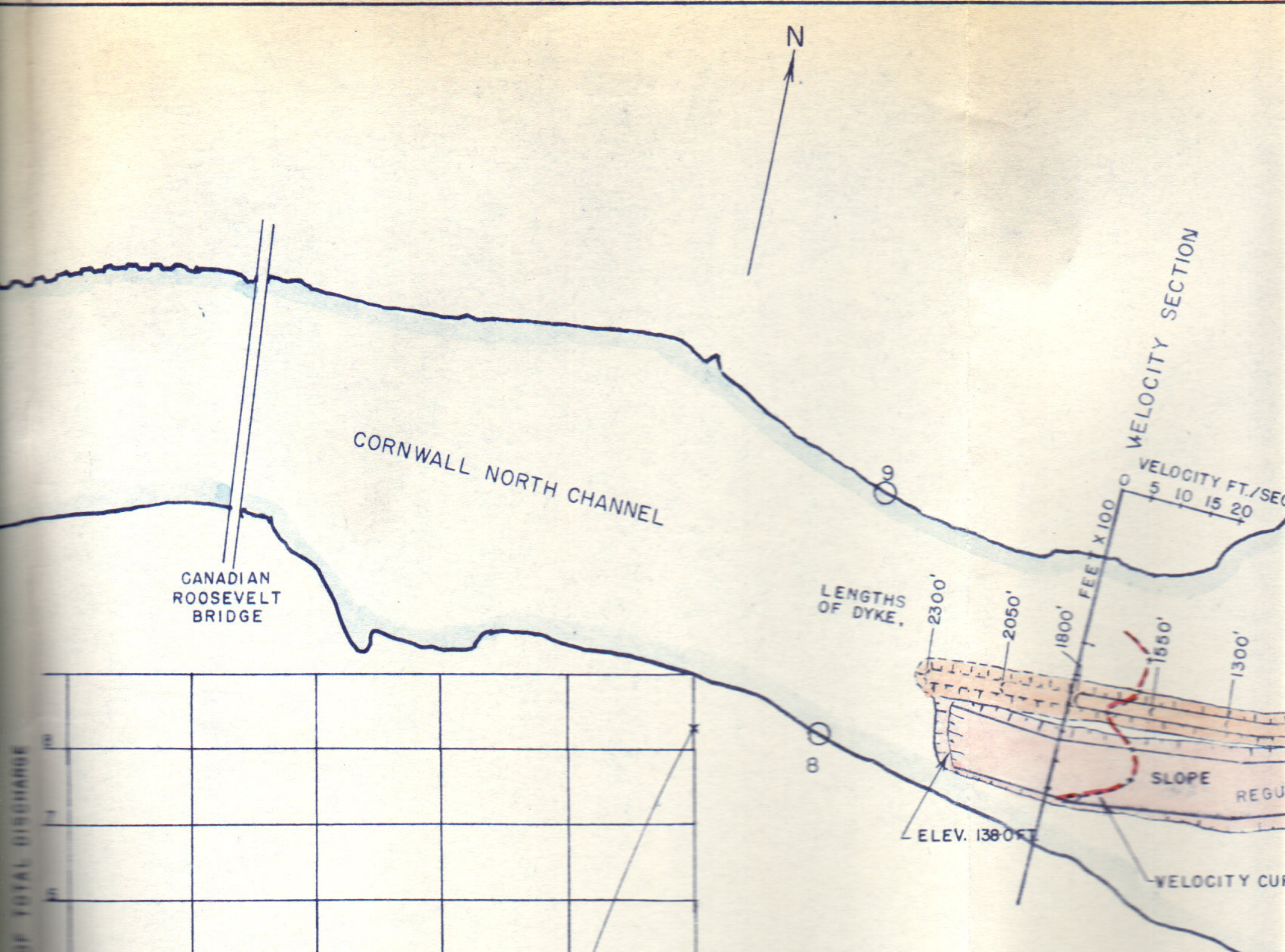
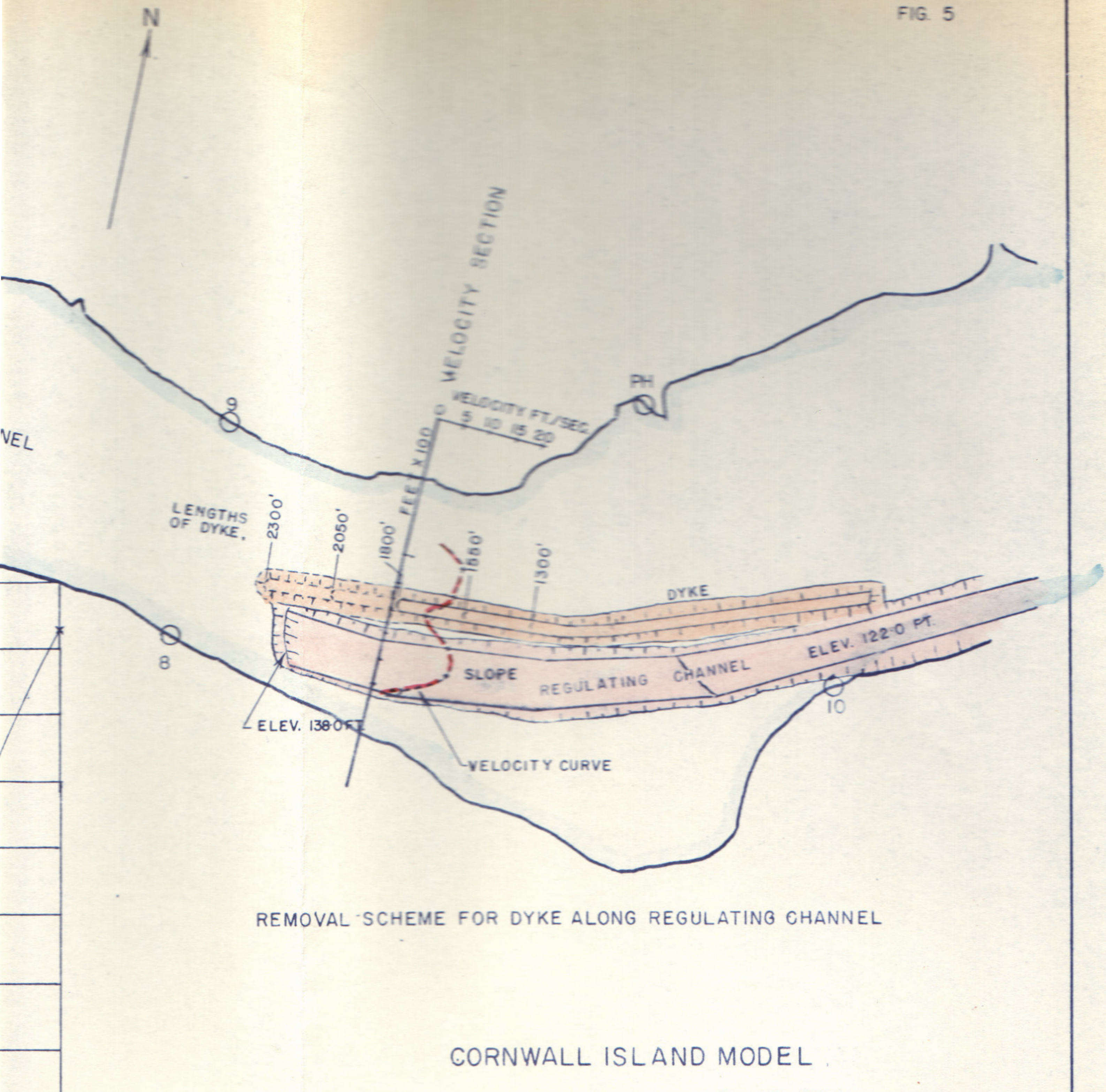

N
CORNWALL NORTH CHANNEL
CANADIAN
ROOSEVELT
BRIDGE
VELOCITY SECTION
VELOCITY FT./SEC
0 5 10 15 20
FEET X 100
LENGTHS
OF DYKE.
2300'
2050'
1800'
1550'
1300'
9
8
SLOPE
REGU
ELEV. 138 0 FT.
VELOCITY CUR
REMOVAL SCHEME FOR DYKE A
CORNWALL
TESTS FOR CONS
SC
NATURAL DISTRIBUTION
1300'
1550'
1800'
2050'
2300'
LENGTH OF DYKE ALONG REGULATING CHANNEL IN NORTH CHANNEL

FIG. 5



REMOVAL-SCHEME FOR DYKE ALONG REGULATING CHANNEL

CORNWALL ISLAND MODEL

TESTS FOR CONSTRUCTION DELAYS FOR
1 JULY 1958

SCALE 1" = 500'

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