REPORT
MODEL STUDY OF
MARINA ENTRANCE, HARBOUR TOWN
HILTON HEAD ISLAND
SOUTH CAROLINA

NEA Hydraulic Laboratory
Reykjavík, Iceland

October 1973

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THE NATIONAL ENERGY AUTHORITY

HYDRAULIC LABORATORY

IN REYKJAVIK

Report on a model study of

MARINA ENTRANCE, HARBOUR TOWN

by

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THE SEA PINES PLANTATION COMPANY

HILTON HEAD ISLAND, S.C.

October 1973

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LIST OF SHEETS

B = baffles on North wall
P = parallel walls
R = rubble mound on South wall
25° = South wall turned 25° clockwise

LIST OF PHOTOS

Photo	TEST	North wall	South wall	Direction	Waveheight
1.	A1	Present Entrance		WNW	0.60 m
2.	C1	Present Entrance		W/WSW	0.45 m
3.	A7	300 ft	250 ft parallel	WNW	0.60 m
4.	C2	300 ft	250 ft parallel	W/WSW	0.45 m
5.	A10	250 ft	160 ft, 25°	WNW	0.60 m
6.	A12	250 ft, B	160 ft, 25°	WNW	0.60 m
7.	A13	250 ft, B	160 ft, 25°, R	WNW	0.60 m
8.	C6	250 ft, B	160 ft, 25°	W/WSW	0.45 m
9.	C7	250 ft, B	160 ft, 25°, R	W/WSW	0.45 m
10.	The wave generator				
11.	The wave recording equipments				

B = baffles on North wall
P = parallel walls
R = rubble mound on South wall
25° = South wall turned 25° clockwise

1. INTRODUCTION

The aim of the model study was to investigate how much breakwater walls and energy absorbing slopes would improve the wave characteristics in the entrance and in the harbour basin in the immediate vicinity of the entrance. The model study was performed in a model scale 1 : 45. Sheet No. 1 shows the layout of the marina entrance and the three directions of wave propagation which were tested.

This study was made in continuation of the contract on the Palmas Del Mar model study on cost - plus basis as agreed upon by Dr. P. Bruun.

These projects were performed jointly by The National Energy Authority, Hydraulic Laboratory, and The Icelandic Harbour Authority.

2. MODEL SCALE AND HYDRAULIC SIMILITUDE

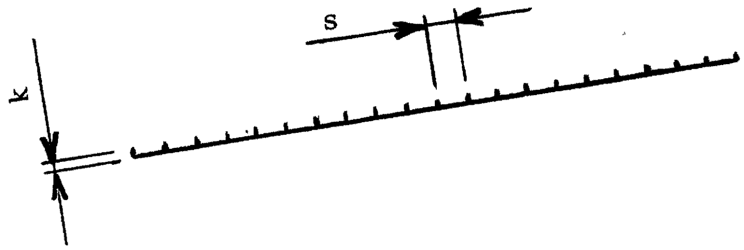
According to the size of the marina entrance and wave characteristic the model scale of 1 : 45 was found suitable.

In hydraulic models on wave action the gravity force is the main force. Other forces, such as fluid friction, surface tension, and like, are neglected. This fact means that Froude´s law is used.
The most important ratios are :

Geometrical scale		= 1 : 45
Velocity scale	$(1:45)^{1/2}$	= 1 : 671
Time scale	$(1:45)^{1/2}$	= 1 : 671
Area scale	$1:45^2$	= 1 : 2020
Volume scale	$1:45^3$	= 1 : 91000

3. MODEL CONSTRUCTION AND EXPERIMENTAL TECHNIQUE

Sheet No. 2 shows the layout of the model. In the test area the bottom of the model was horizontal with water depth of 8 centimeters (cm) or 12 ft in the prototype. The entrance and the walls were made of galvanized iron sheets.



The baffles on the North wall were also made of galvanized iron sheets with s = 5.3 cm and k = 1.3 cm.

On the sea side rubble mounds were made of stones, approximately 3 cm in diameter. The slopes were 1 : 3. The crest was at sea level, width 10 cm. Rubble mound slopes in the entrance were made of stones, approximately 2 cm in diameter. The slopes were 1 : 1.5.

Waves were produced by a pneumatic wave generator. The wave period was checked with a stop watch. The wave heights were measured with two resistance meters and all measurements were registered by a strip chart recorder.

The incident wave height was measured by recording the wave height at ten points over one wave length in the wave direction. From these ten recorded points an average wave height was calculated and used as an incident wave height.

The wave heights in the entrance and in the marina basin were measured in areas as shown in Sheet No. 1. Due to the reflection in the entrance the wave heights were particularly measured in the 6 areas located on a half circle about 100 ft. inside the inner entrance to the marina basin. The measure points were marked with steel sheets on the bottom of the model. In each area the wave height was measured at five points (approx. 12 cm apart) from these five points the average wave height and in few cases the standard deviation was calculated.

4. WAVE CHARACTERISTICS

Tests were run with wave action from WNW and W/WSW. Sensitivity tests were run by wave action 5 degrees W of WNW.

Wave heights corresponded to 0.60 m (2 ft) for WNW and 0.45 m (1.5 ft) for W/WSW. Wave period was 3 sec. for all tests.

Tests were only run for MLW conditions as this is the most dangerous situation for navigation. Differences between MLW and other tide conditions would be small.

5. MODEL TESTS

As the reflection plays an important part in this entrance, some remarks on the reflection by vertical walls follow :

For incident angle (the angle between the direction of wave advance and the wall) greater than approx. 45 degrees the reflection pattern is "normal". The incident and the reflected waves are slightly disturbed near the wall, but the angle of reflection is equal to the angle of incidence and the reflected wave height is only slightly less than the incident wave height.

If the angle of incidence is less than about 35 to 45 degrees the reflection appears to be of the type called Mach-reflection in acoustics. When the angle of incidence is less than about 20 degrees, the wave crest bends, becoming normal to the wall, and no reflected wave appears.

When the angle of incidence is greater than 20 degrees but less than 40 to 45 degrees, three waves are present, the incident wave, a Mach-reflected wave and a Mach-stem wave (the wave portion normal to the wall). The width of the Mach-stem wave depends upon the angle of incidence. The reflected wave height, and the angle of reflection is greater than the angle of incidence. The height of the Mach-stem portion is greater than the incident wave height and is at its maximum at the wall. The Mach-reflected and Mach-stem waves are followed by a through.

Reflection may be decreased by the use of rubble mounds. Wave action may also be decreased by means of "wave traps" in the form of "baffles" which are vertical sheets placed at certain intervals related to the wave length.

To decrease the wave action in the entrance the South wall was tested with and without rubble mound with a slope of 1 : 1.5. The North wall was tested with and without baffles. The design of the baffles was related to wave length of 2.5 sec. waves.

The layouts of the various tests can be classified into the following main groups :

(1) Entrance with only one wall (North).
(2) Entrance with two parellel walls.
(3) Entrance with two walls, the South wall turned 25 degrees clockwise compared to the North wall.

This report includes the results of 32 tests. Sheet No. 3 shows schematic layout of all tests.

6. EXPERIMENTAL RESULTS

Sheets No. 4 to 35 contain the results of the tests showing the calculated average wave height in each area and in some cases the standard deviation. The average wave height in the 6 areas inside the inner entrance was calculated and is shown on the sheets. As these average wave heights give the best overall view when comparing the various tests they are also shown in Sheet No. 3.

Photos 1-2 show the present entrance, test A1 og C1.

7. DISCUSSION AND CONCLUSION

As mentioned earlier the results can be classified into the following main groups :

(1) Entrance with only one wall (North).

(2) Entrance with two parallel walls.

(3) Entrance with two walls, the South wall turned 25 degrees clockwise compared to the North wall.

Re. (1) Economy solution : The solution corresponding to tests A4/B4 including a 140 ft North wall and a rubble mound along the South side of the present entrance is the most favourable. For reasons of navigation, however, the rubble mound on the South side is not desirable. Omitting the rubble mound the North wall has to be at least 300 ft long to reach similar average waves from WNW, test A5.

Re. (2) Entrance with two parallel walls :

The two solution considered, test A7/C2, A8/C3, suffer from reflections in the entrance and are therefore not practical unless comprehensive rubble mounds along the walls are included.

The reflection is clearly demonstrated in photo 3.

Re. (3) Two walls

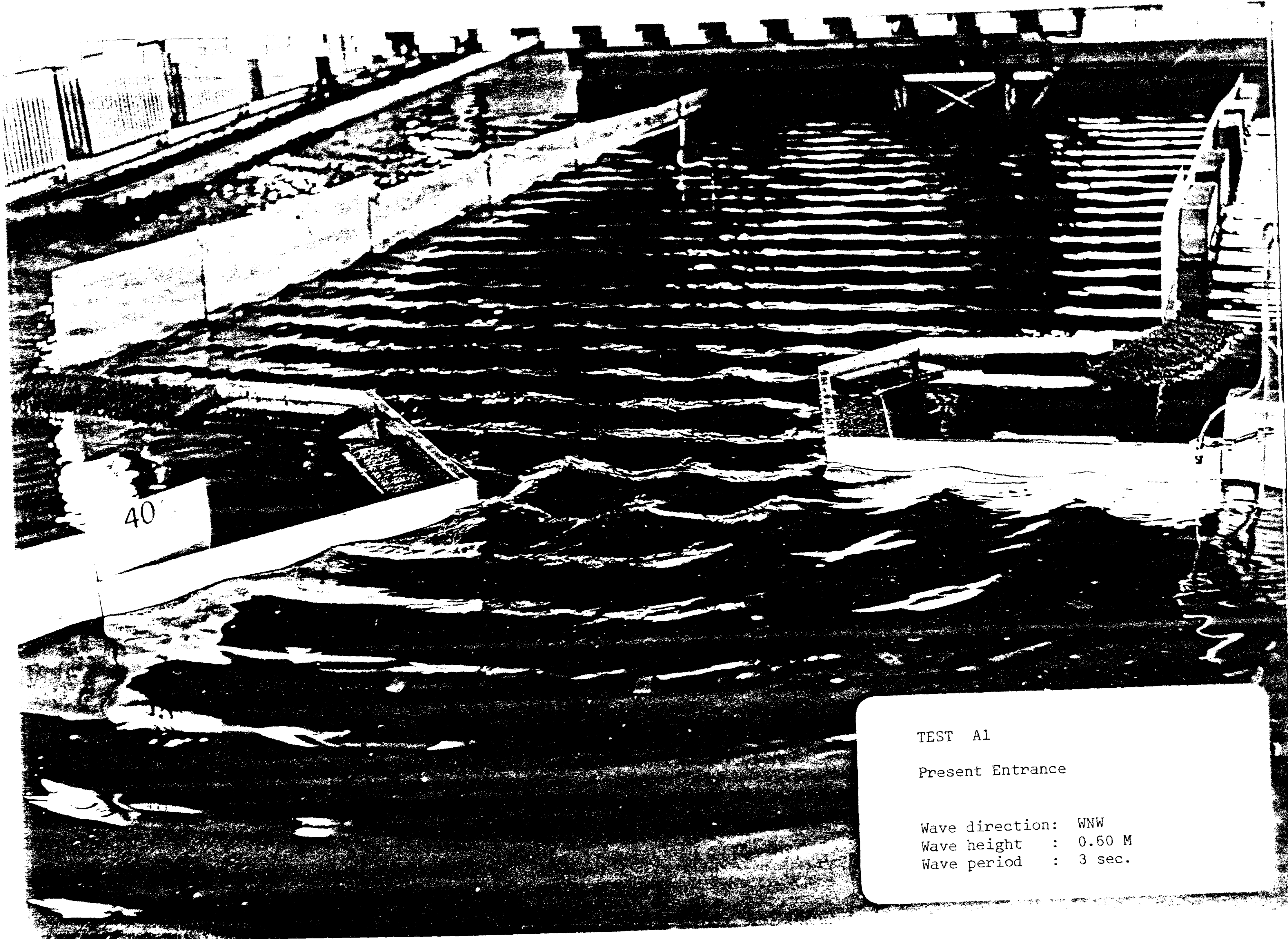
South wall turned 25 degrees clockwise :

It is quite clear that baffles on the North wall and a rubble mound along the South wall are advantageous (compare tests A10/C4 to tests A12/C6 and tests A11/C5 to tests A13/C7).

Photos No. 5-9 demonstrate the effect of the baffles and the rubble mound.

It is evident by comparing tests with the 200 ft and the 250 ft North wall that the North wall shall be at least 250 ft long.

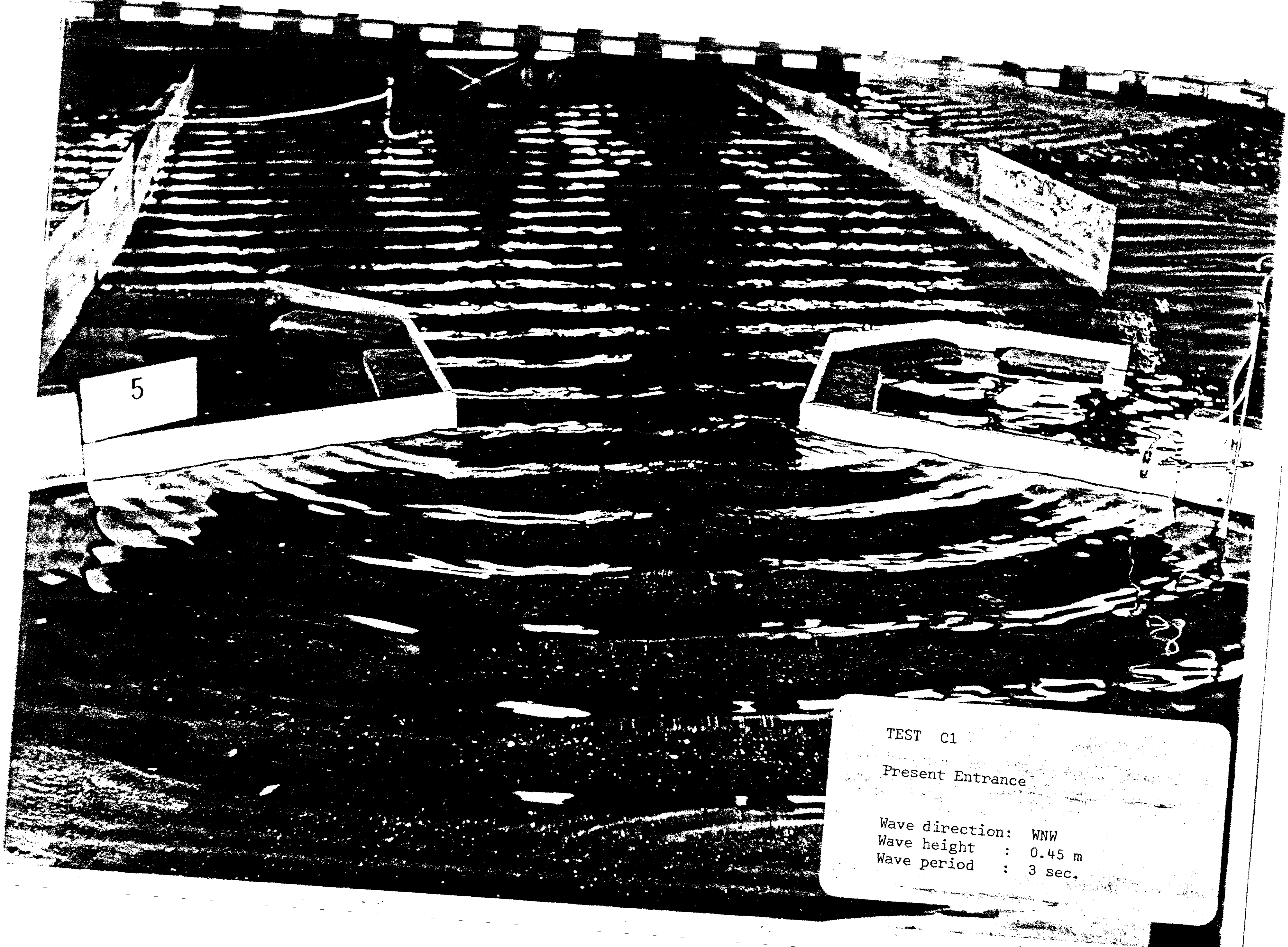
Consequently the layout A13/C7 (sheet No. 26/27) is recommended.



TEST A1

Present Entrance

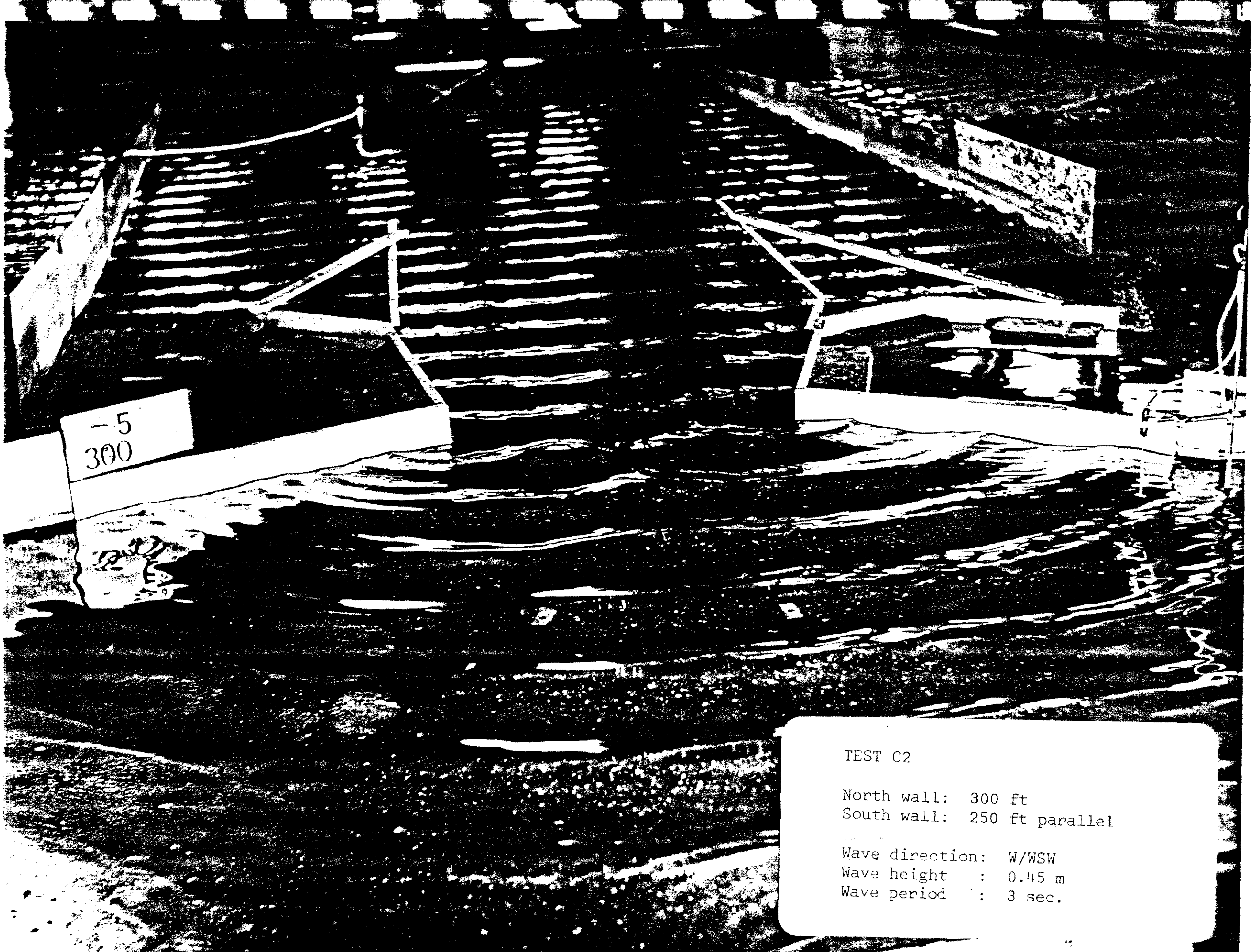
Wave direction: WNW
Wave height : 0.60 M
Wave period : 3 sec.



TEST C1

Present Entrance

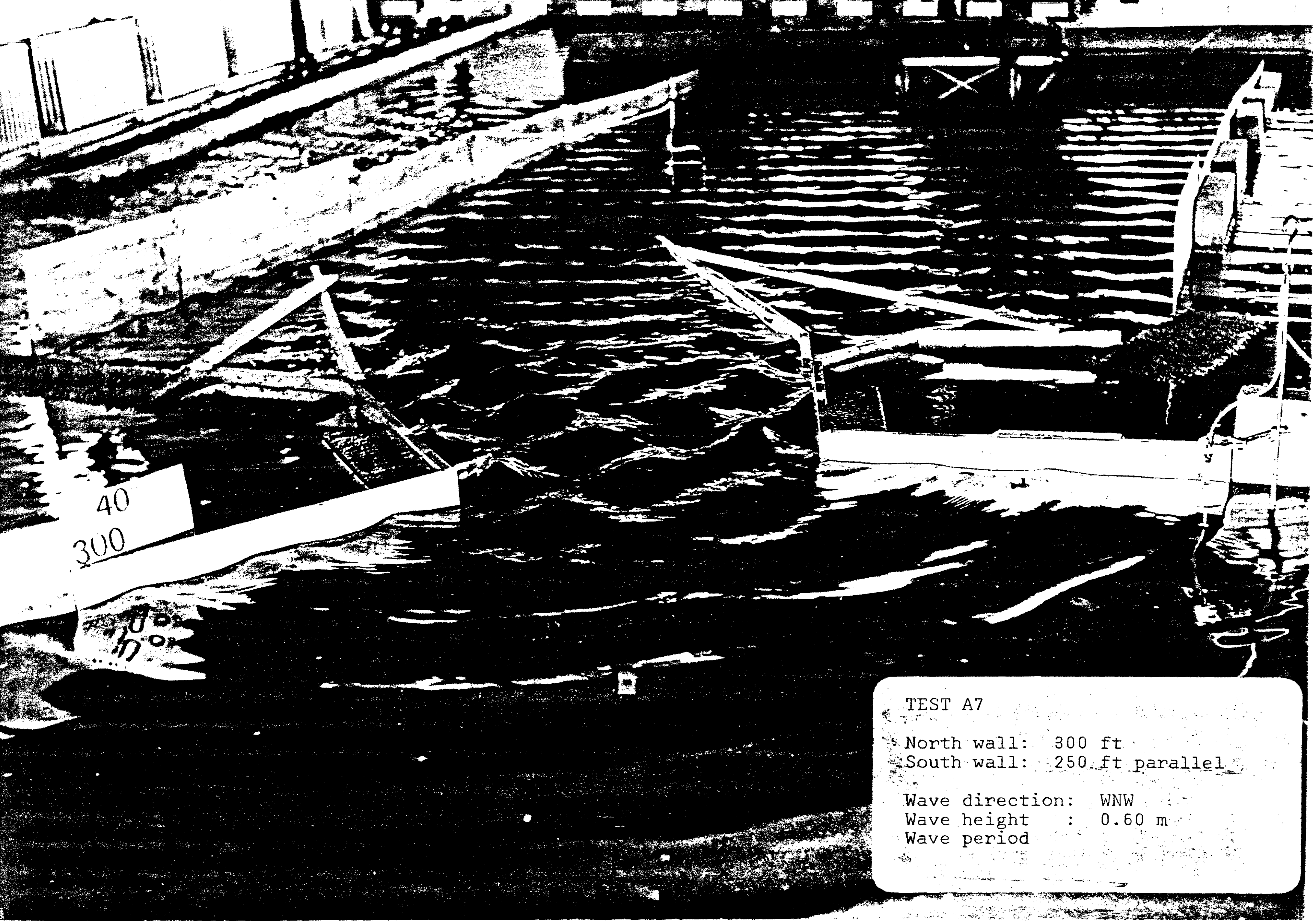
Wave direction: WNW
Wave height : 0.45 m
Wave period : 3 sec.



TEST C2

North wall: 300 ft
South wall: 250 ft parallel

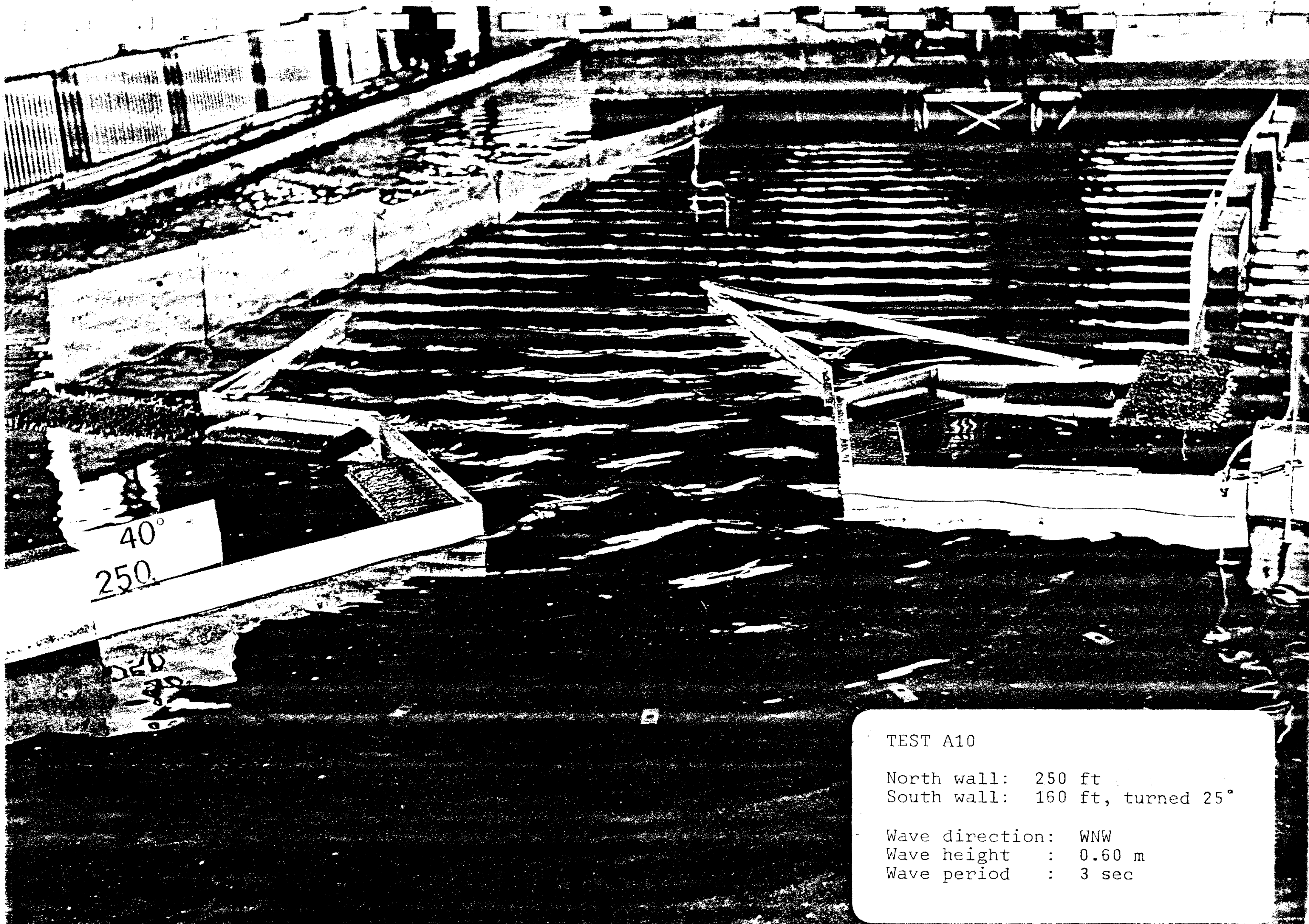
Wave direction: W/WSW
Wave height : 0.45 m
Wave period : 3 sec.



TEST A7

North wall: 300 ft
South wall: 250 ft parallel

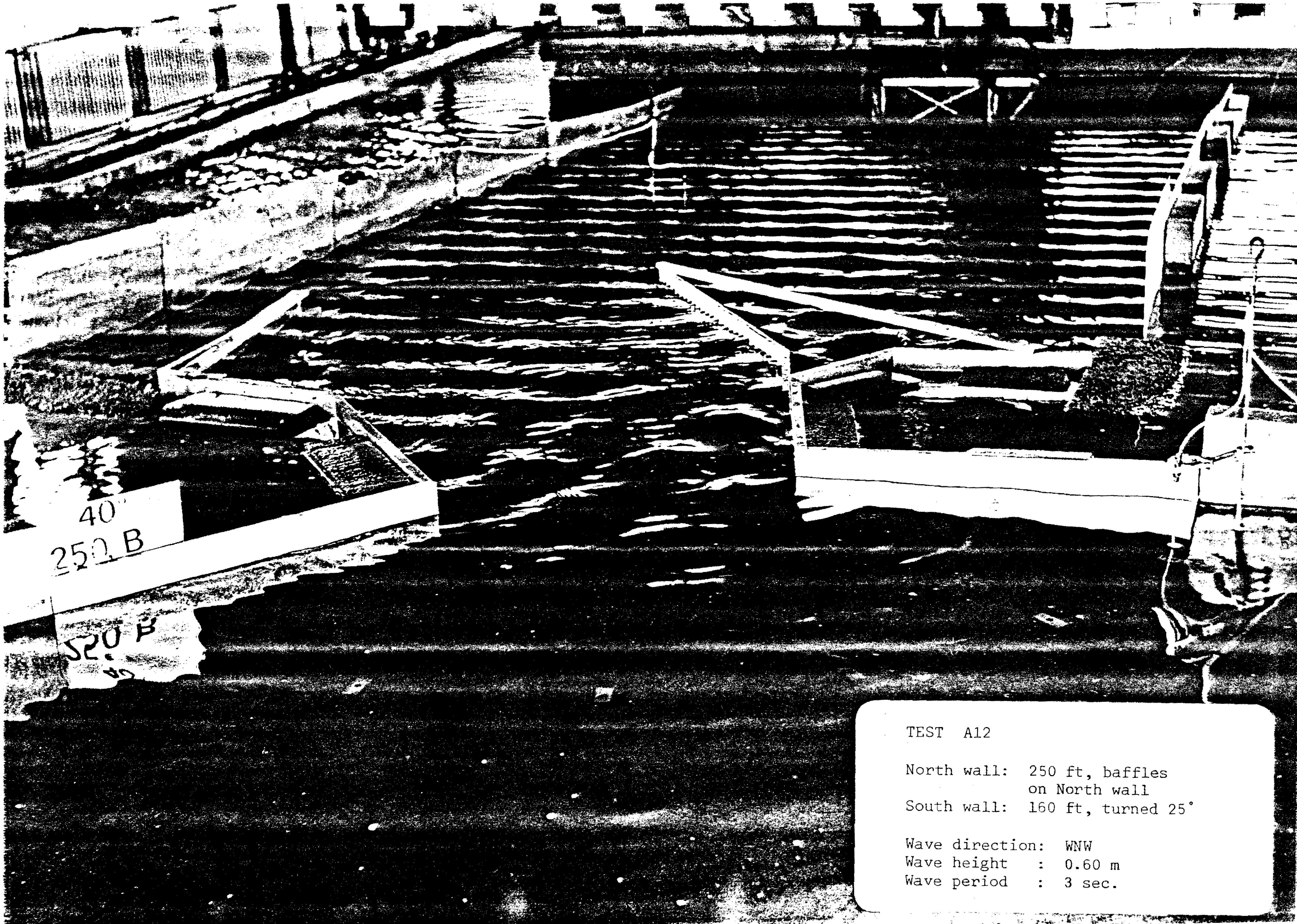
Wave direction: WNW
Wave height : 0.60 m
Wave period



TEST A10

North wall: 250 ft
South wall: 160 ft, turned 25°

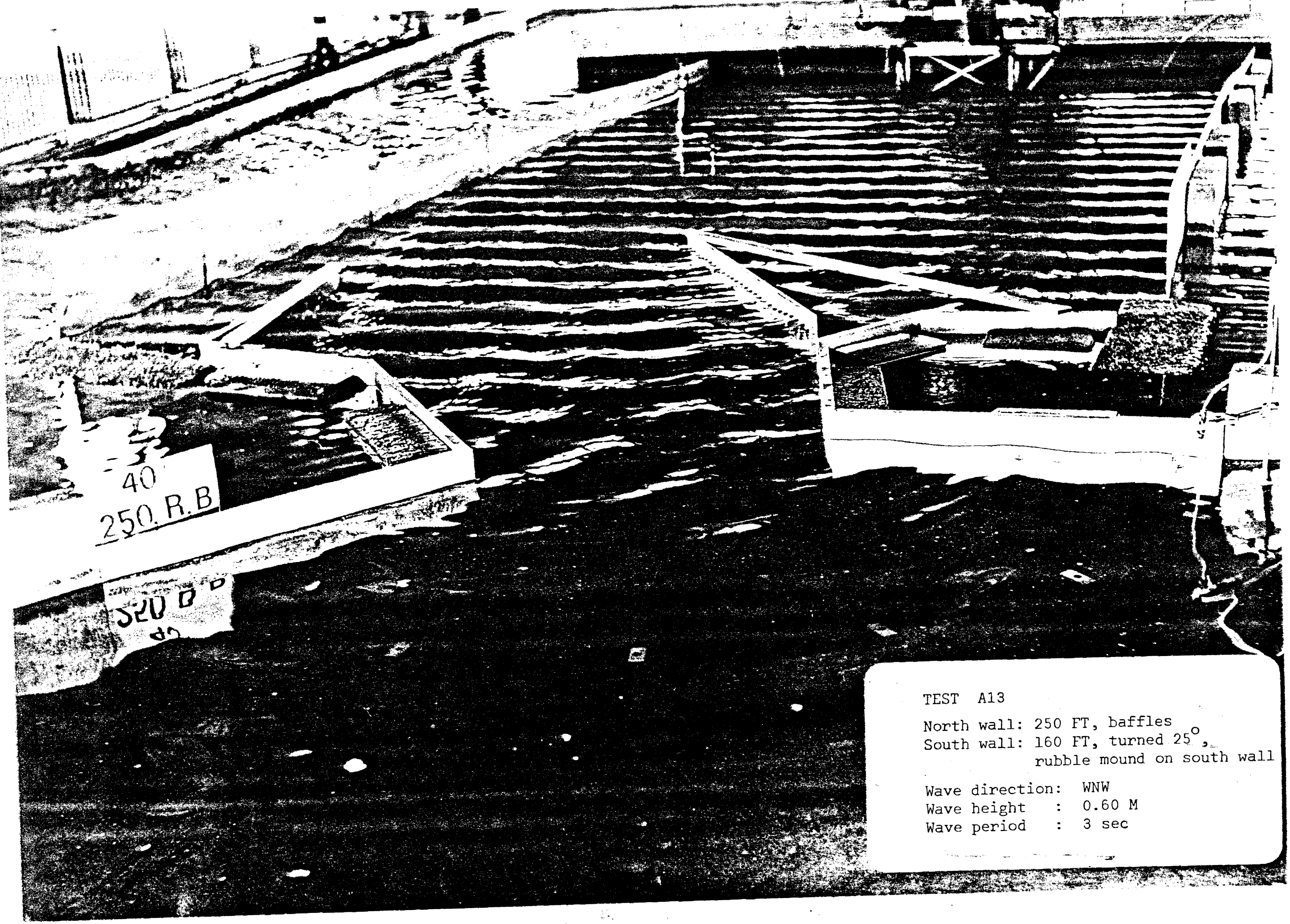
Wave direction: WNW
Wave height : 0.60 m
Wave period : 3 sec



TEST A12

North wall: 250 ft, baffles on North wall
South wall: 160 ft, turned 25°

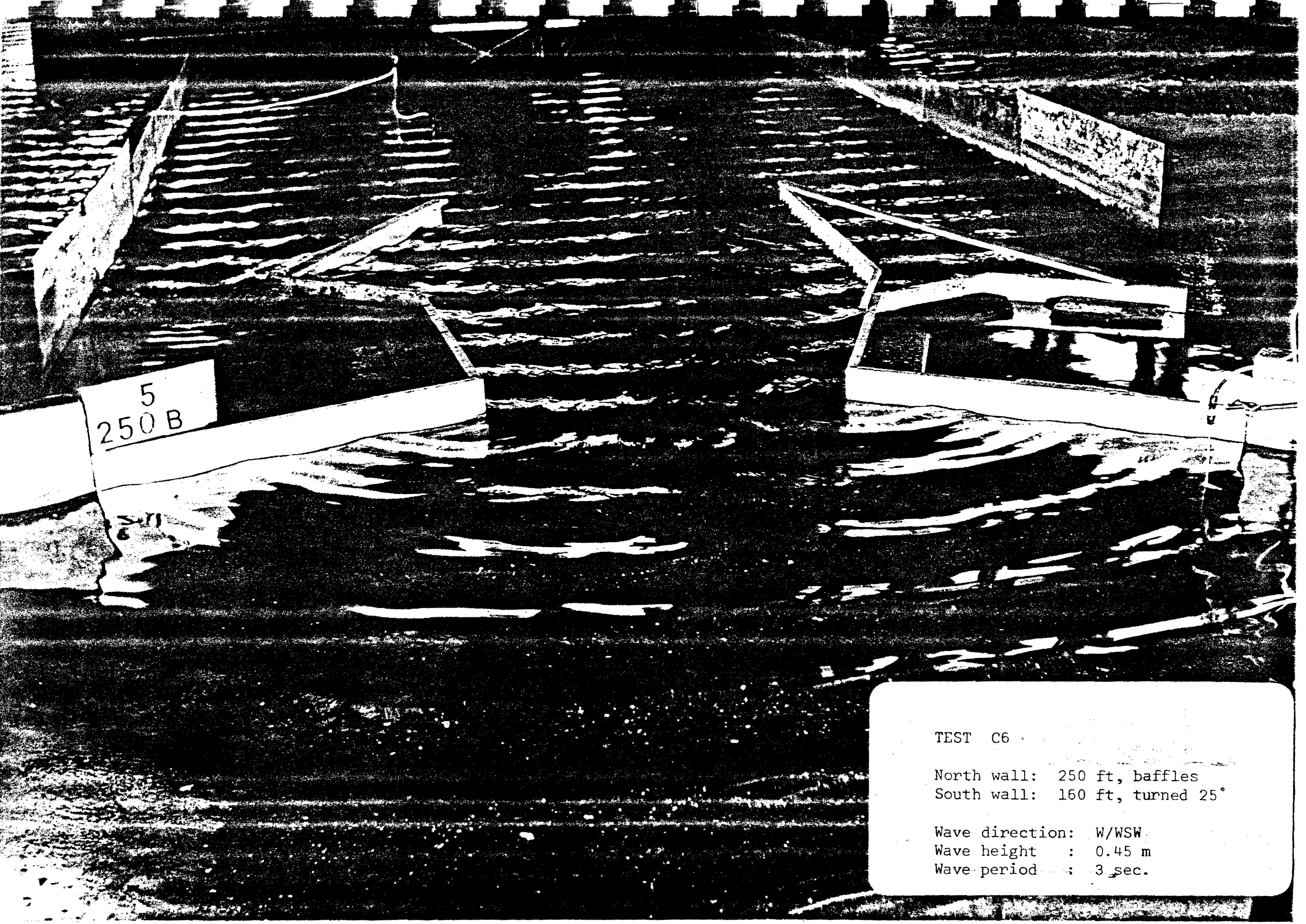
Wave direction: WNW
Wave height : 0.60 m
Wave period : 3 sec.



TEST A13

North wall: 250 FT, baffles
South wall: 160 FT, turned 25°,
rubble mound on south wall

Wave direction: WNW
Wave height : 0.60 M
Wave period : 3 sec



TEST C6

North wall: 250 ft, baffles
South wall: 160 ft, turned 25°

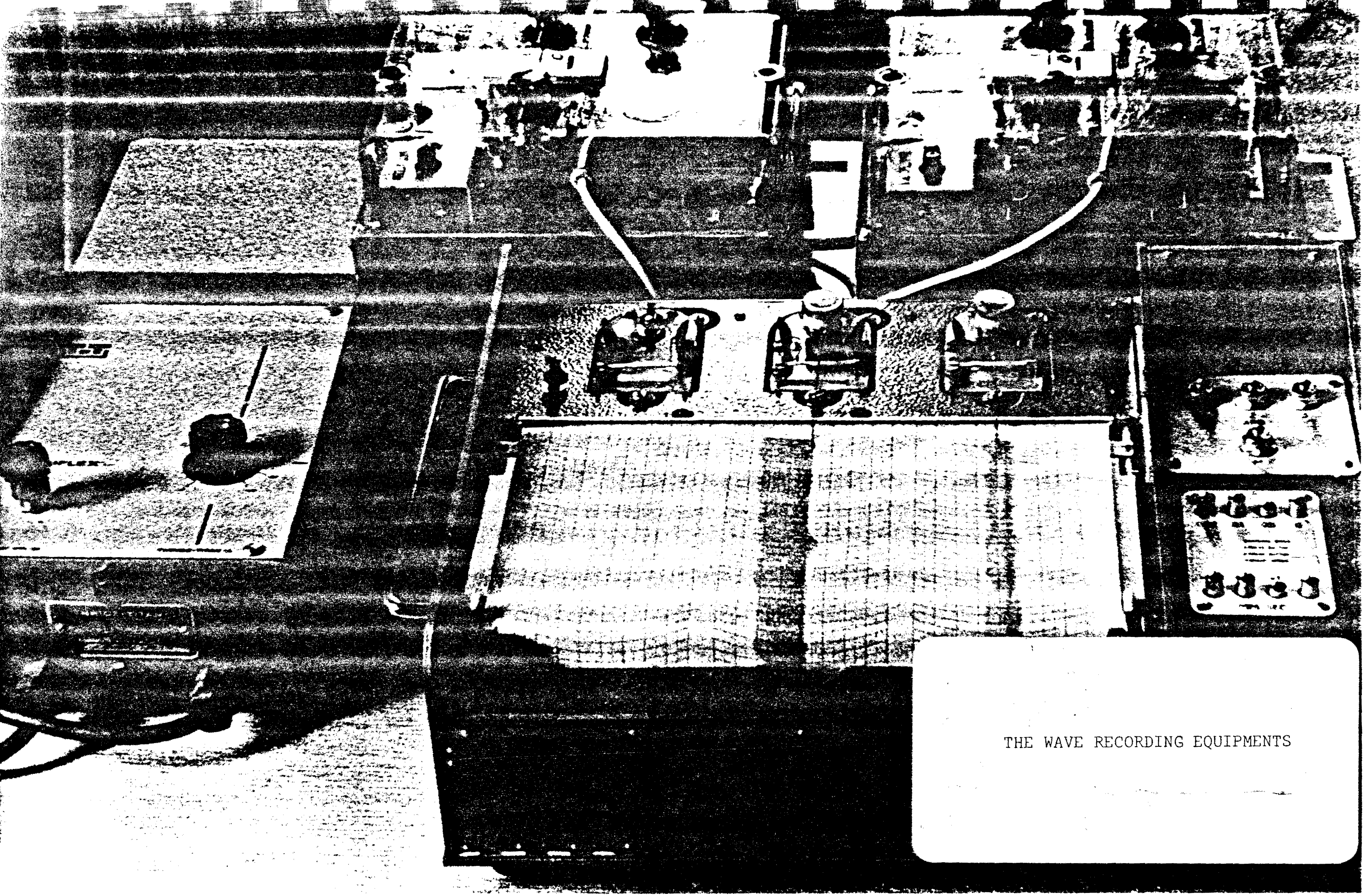
Wave direction: W/WSW
Wave height : 0.45 m
Wave period : 3 sec.

TEST C7

North wall: 250 ft, baffles
South wall: 160 ft, turned 25°
rubble mound on southwall

Wave direction: W/WSW
Wave height : 0.45 m
Wave period : 3 sec.

THE WAVE GENERATOR



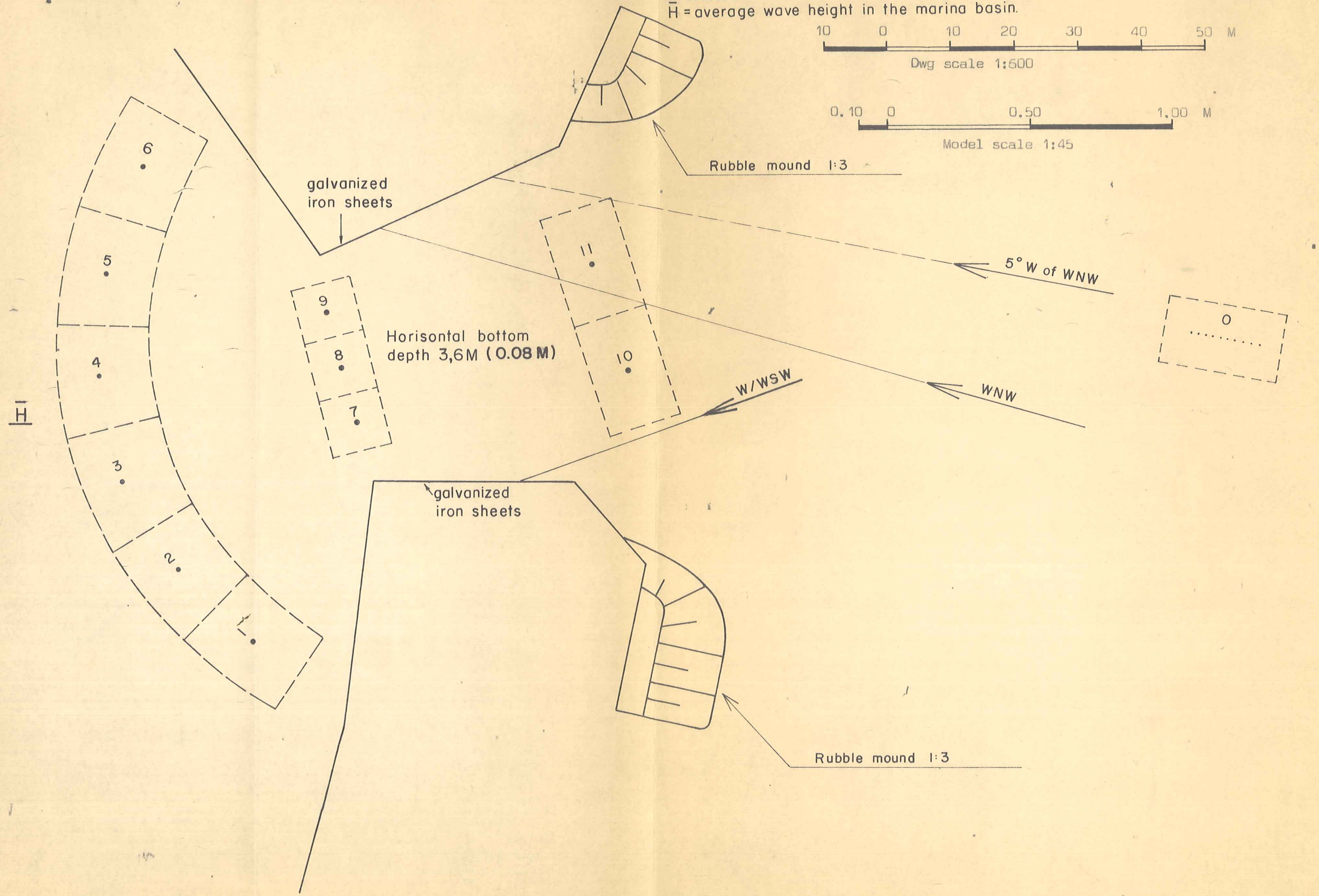
THE WAVE RECORDING EQUIPMENTS

Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:600
South Carolina	Drawn by B.E.
Model Study Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavik, Iceland	Oct. 1973

LAYOUT OF MARINA ENTRANCE

SHEET No. I

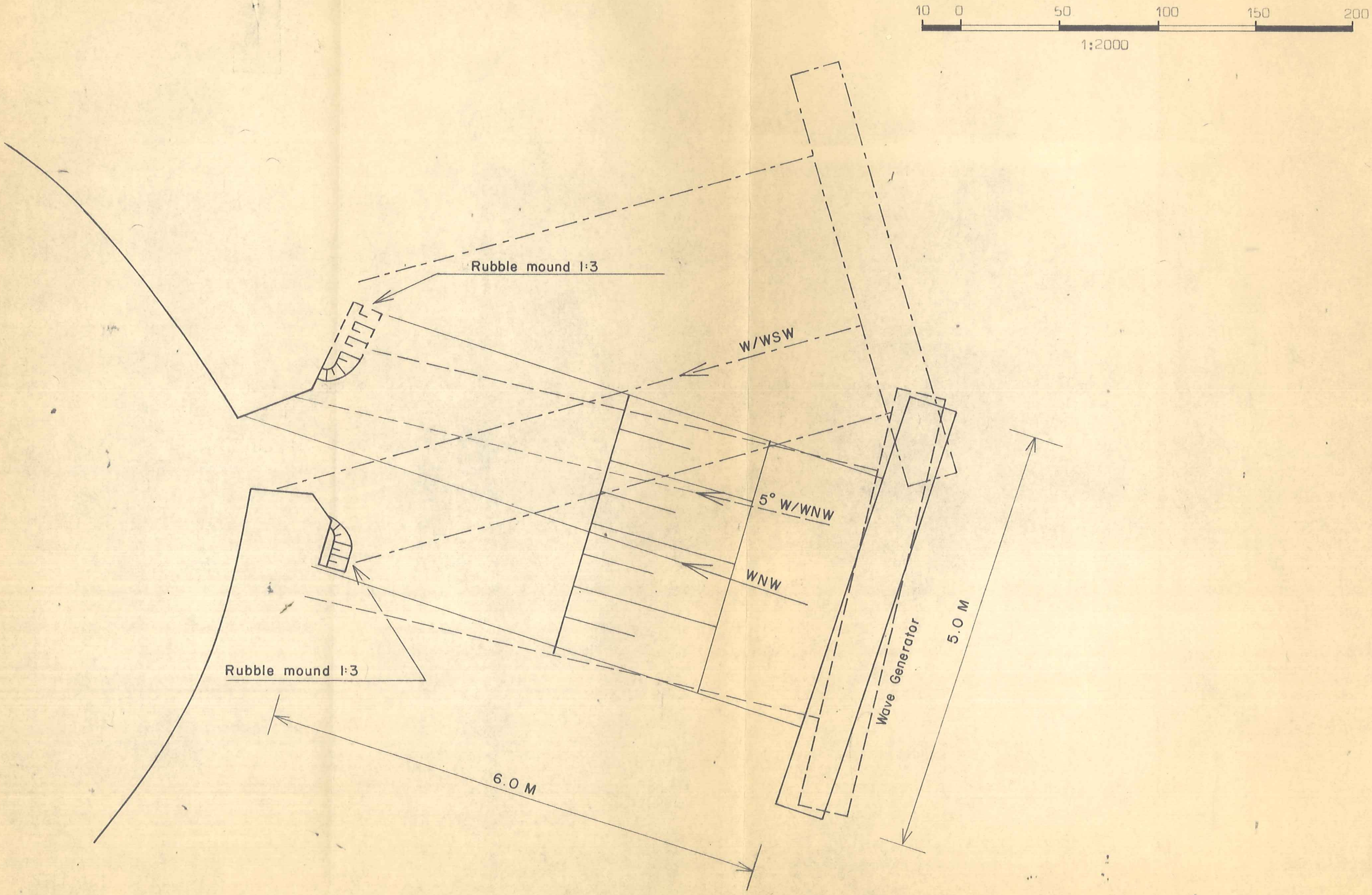
MEASURE AREA
FIVE MEASUREMENTS IN EACH AREA
$\bar{H}$ = average wave height in the marina basin.



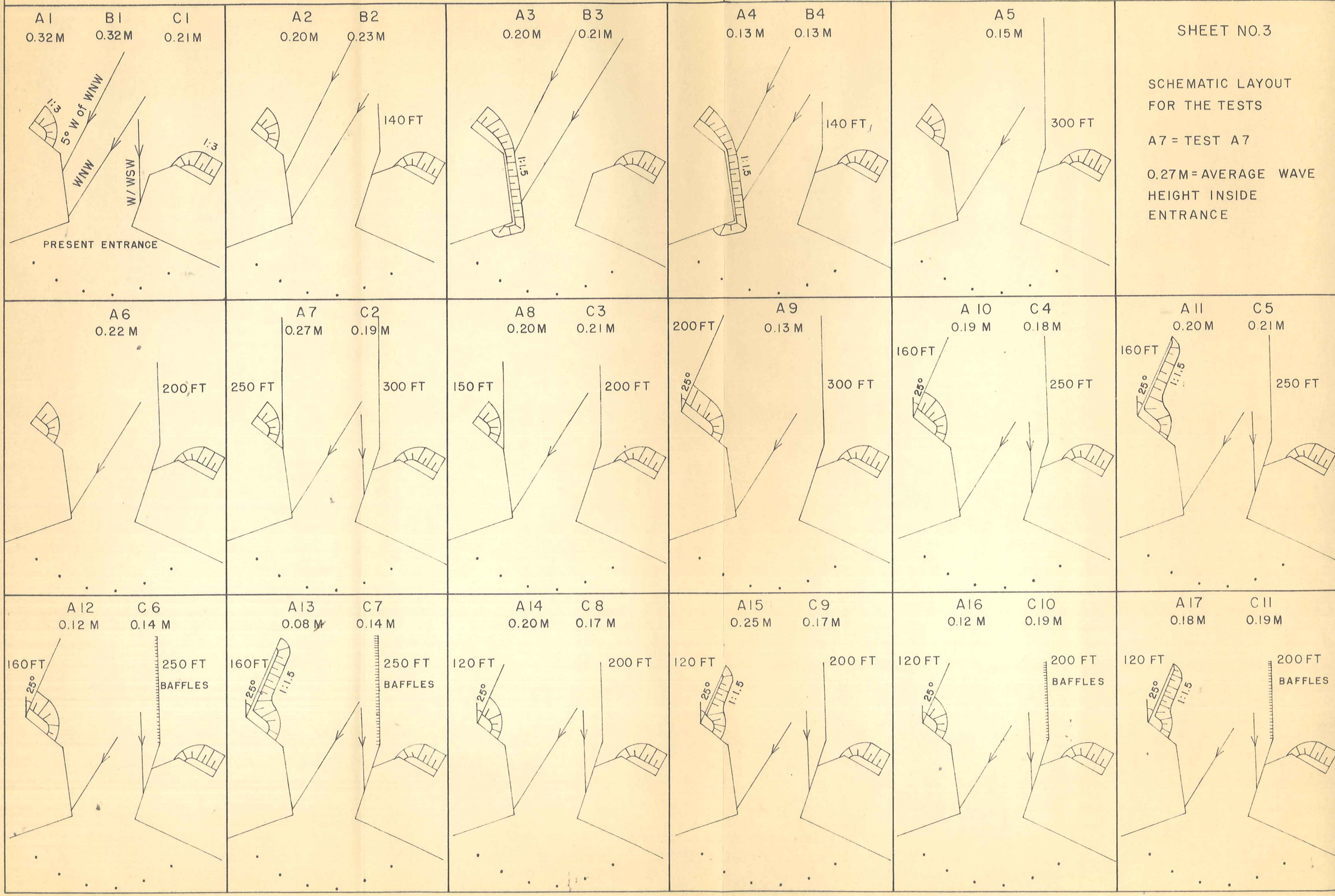
Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study Scale 1:45	Chkd by G.V.
NEA Hydraulic Laboratory, Reykjavik, Iceland	Oct 1973

LAYOUT OF MODEL

SHEET No. 2



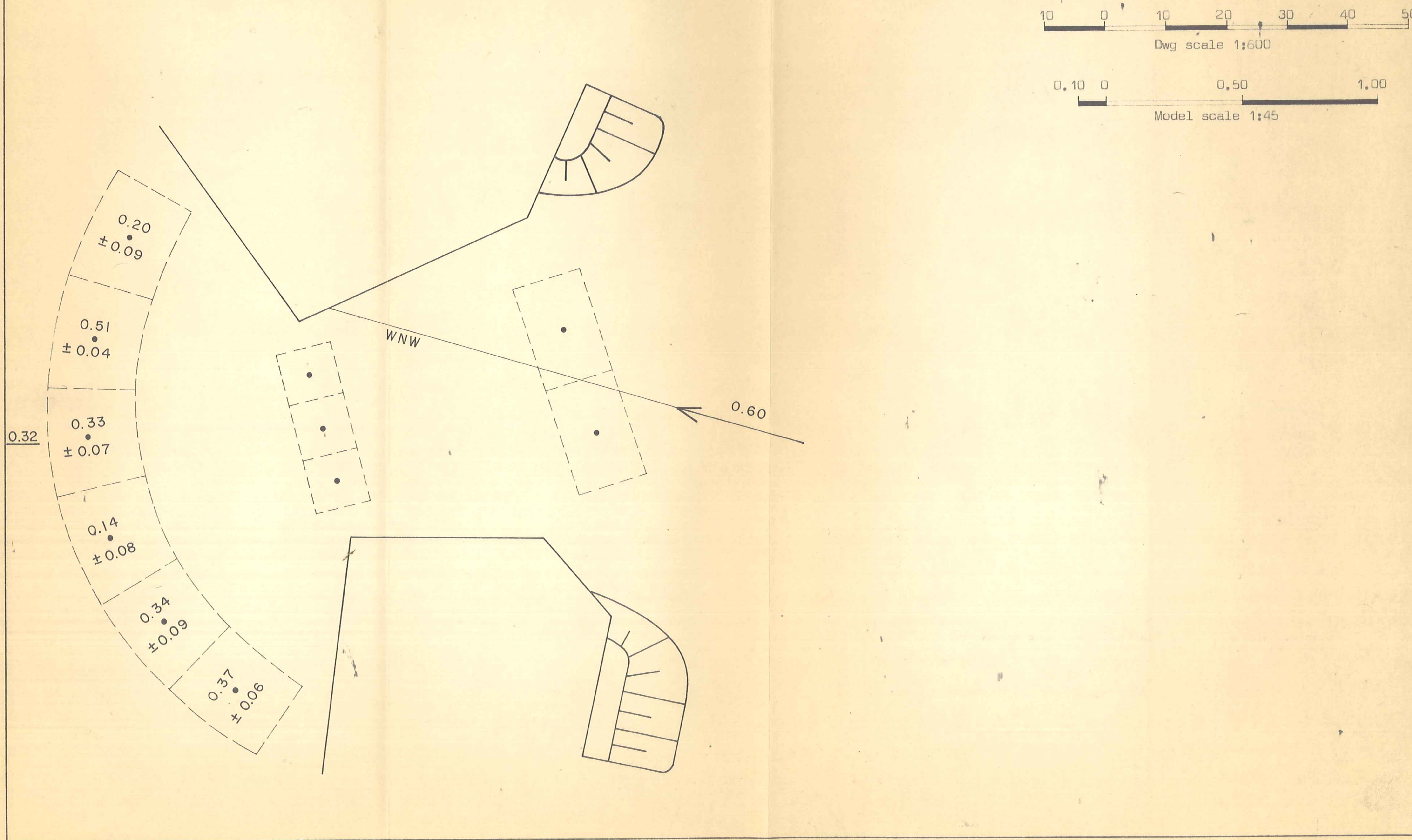
Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study Scale 1:45	Chkd by G.V.
NEA Hydraulic Laboratory, Reykjavik, Iceland	Sept. 1973



Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavik, Iceland	Oct 1973

Wave height 0.60 M
Wave period 3 sec
Wave direction WNW

SHEET No.4
TEST A-1



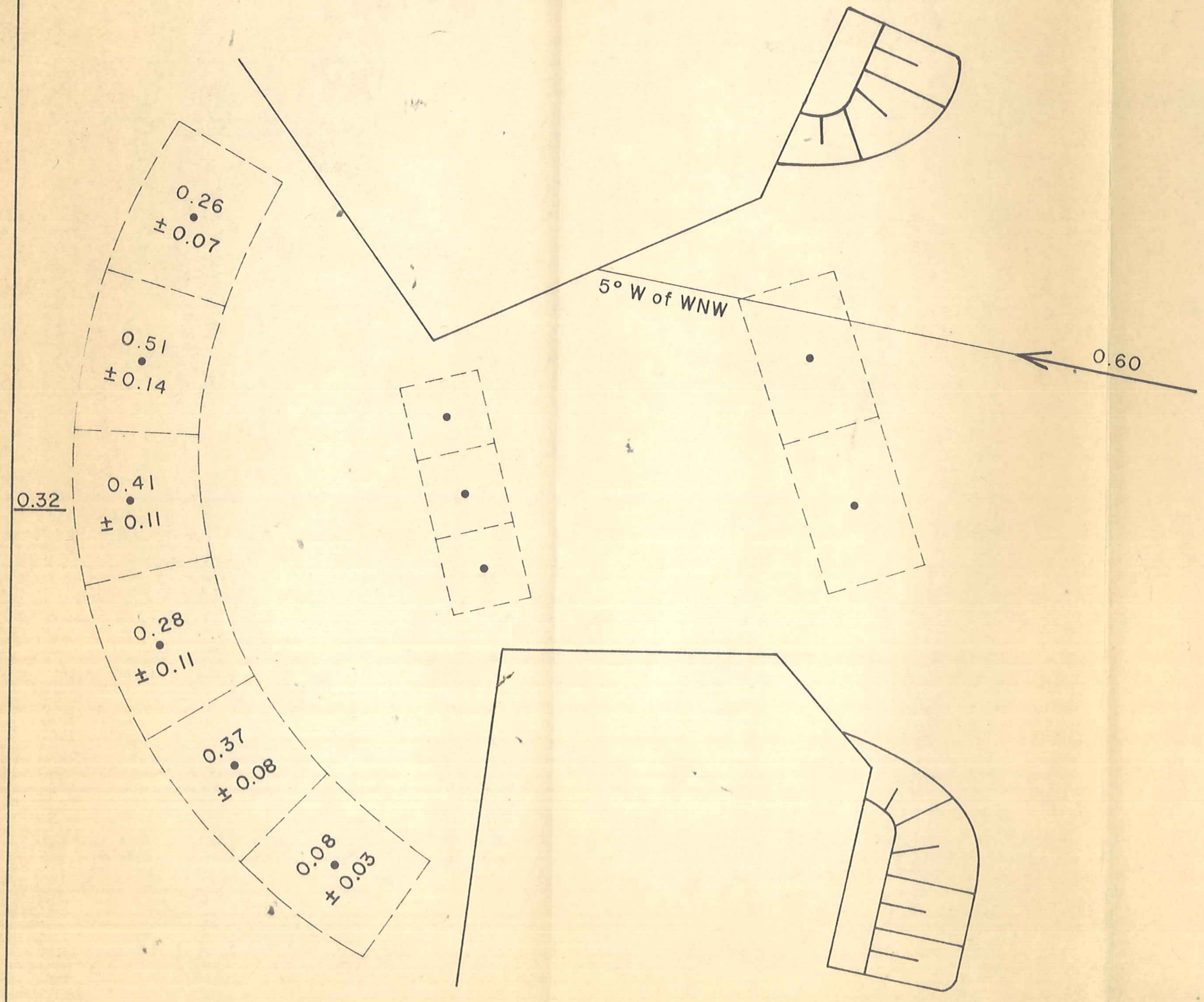
Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction 5° W of WNW

SHEET No. 5
TEST B-I

M 10 0 10 20 30 40 50
Dwg scale 1:600

M 0.10 0 0.50 1.00
Model scale 1:45



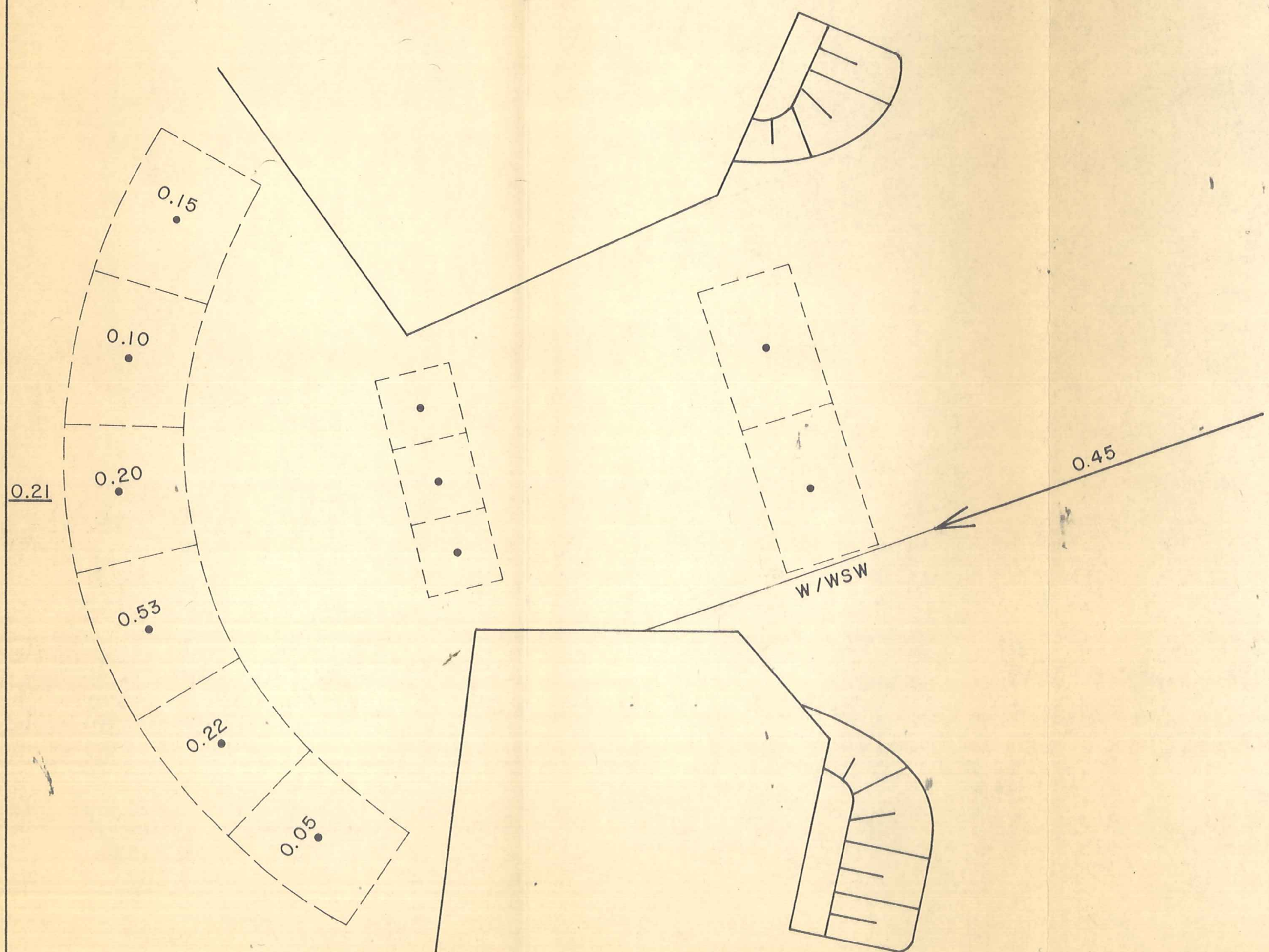
Marina entrance, Harbour, Town, Hilton Head Island, South Carolina	Dwg scale 1:2000
Model study, Scale 1:45	Drawn by B.E.
	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.45 M
Wave Period 3 sec
Wave direction W/WSW

SHEET No. 6'
TEST C-1

Dwg scale 1:600

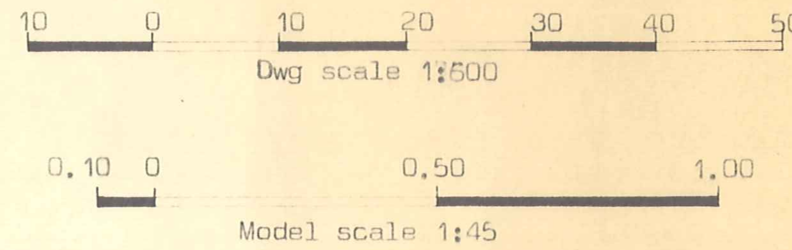
Model scale 1:45

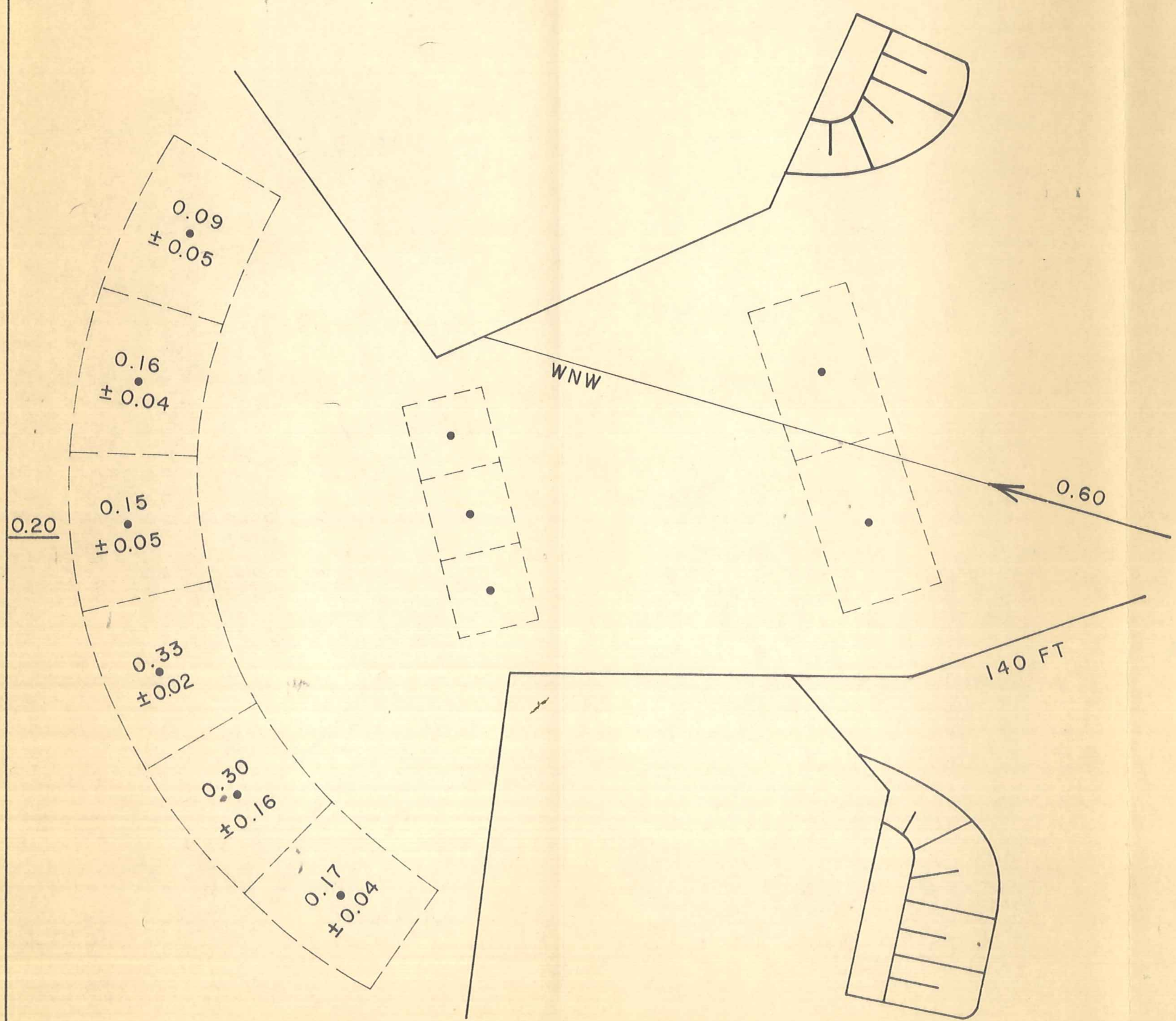


Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave period 3 sec
Wave direction WNW

SHEET No. 7
TEST A – 2

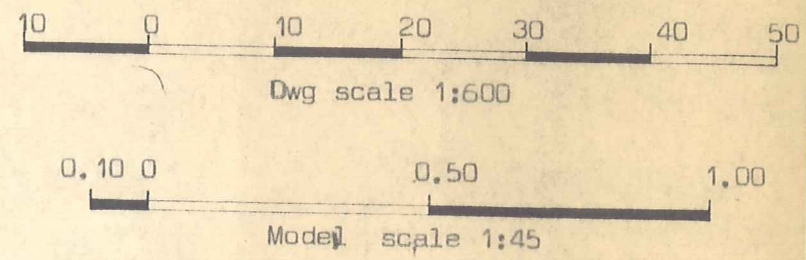


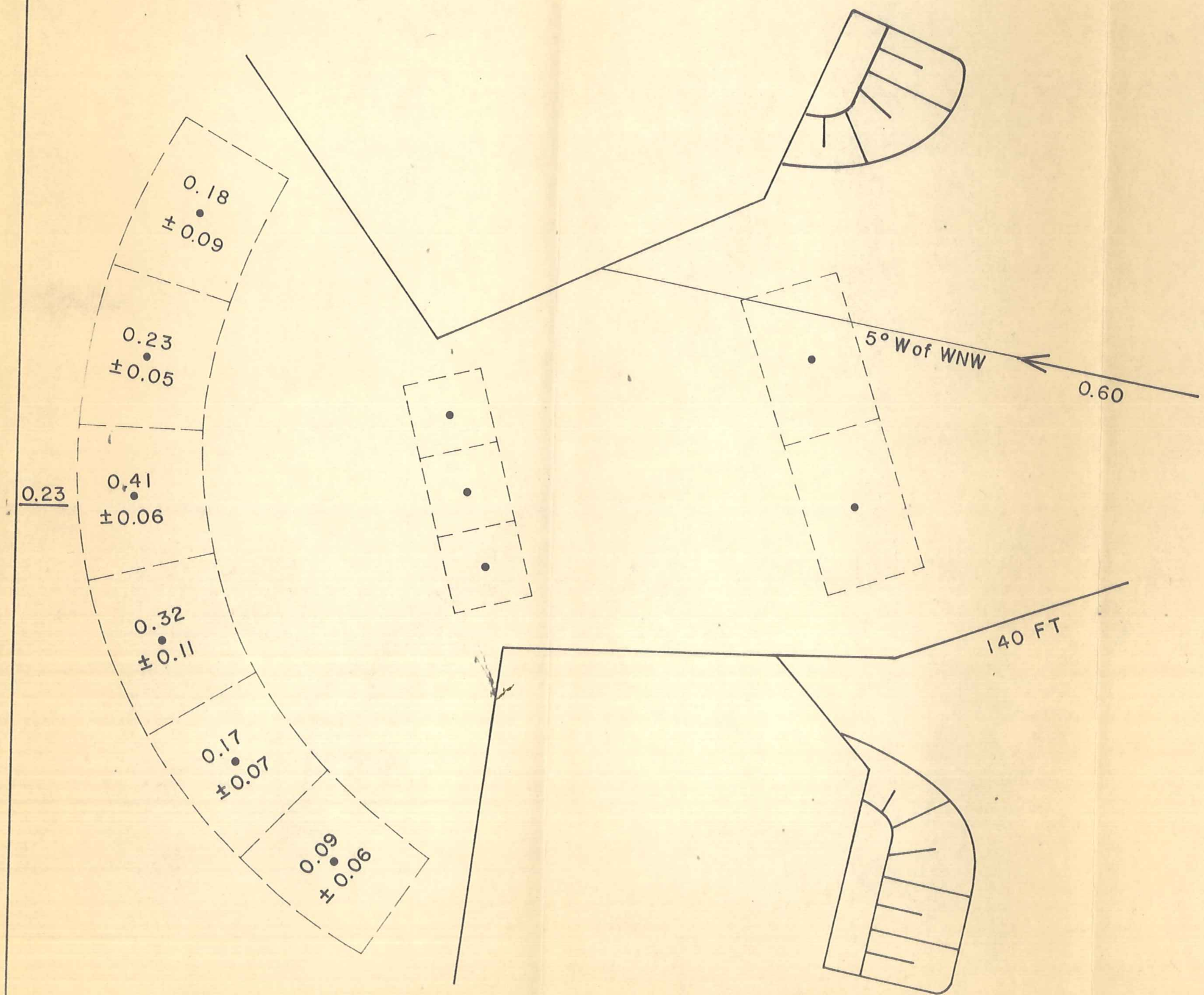


Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavik, Iceland	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction 5° W of WNW

SHEET No. 8
TEST B - 2

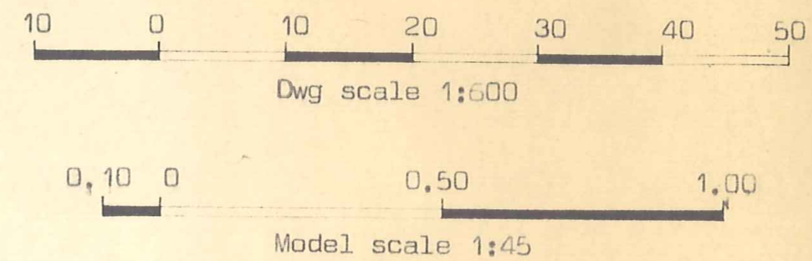


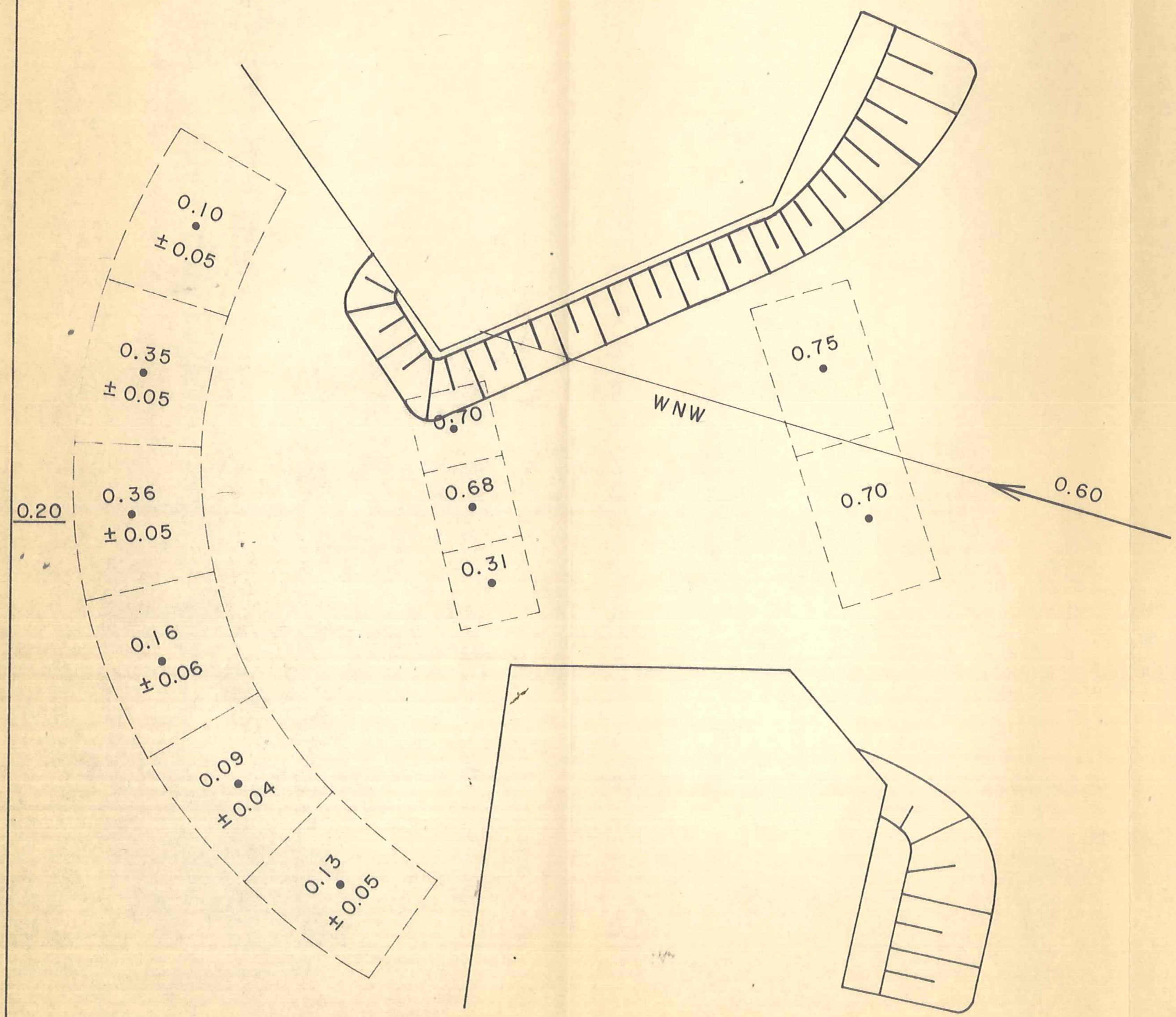


Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 9
TEST A-3





Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction 5° W of WNW

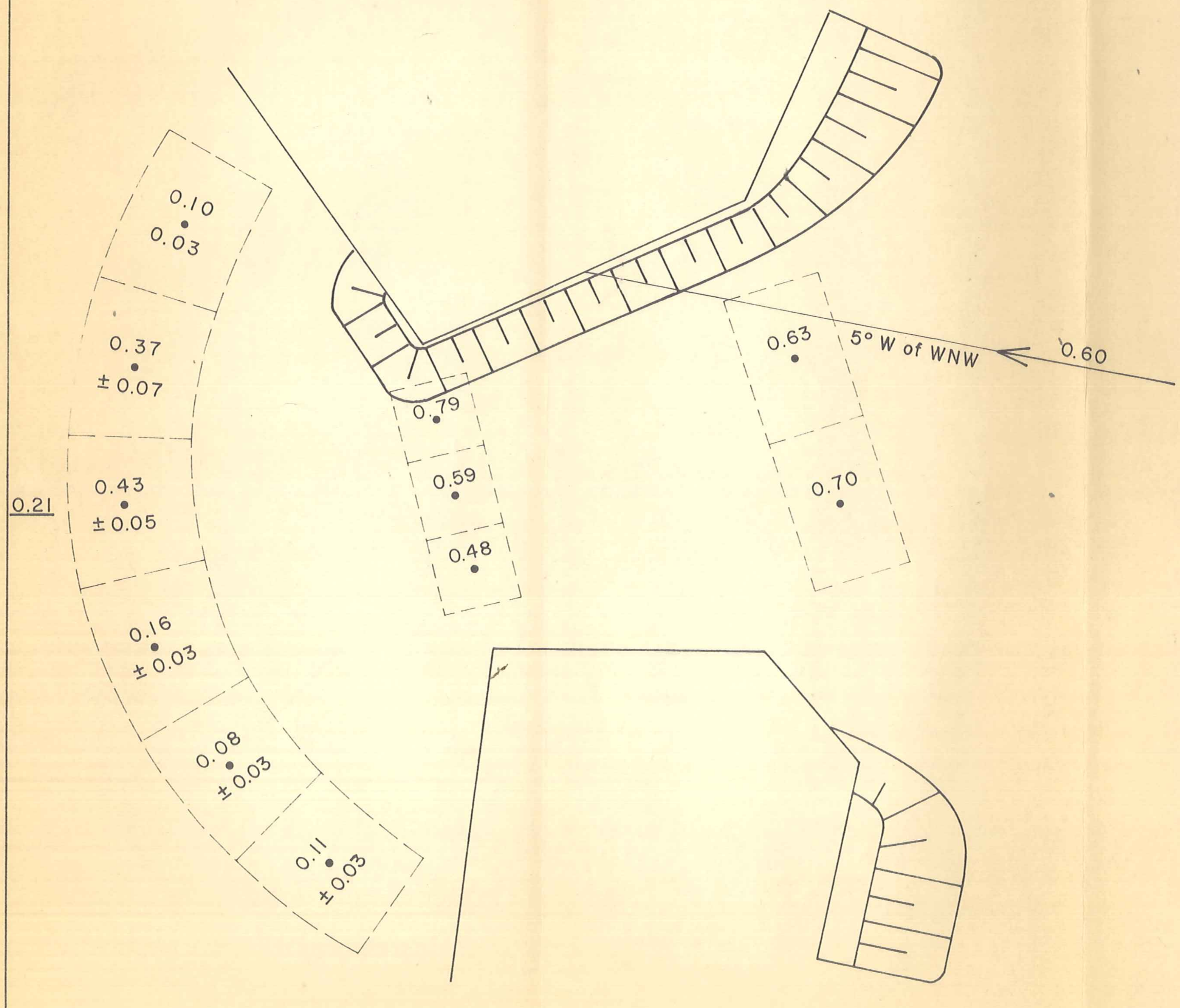
SHEET No. 10
TEST B-3

10 0 10 20 30 40 50

Dwg scale 1:600

0.10 0 0.50 1.00

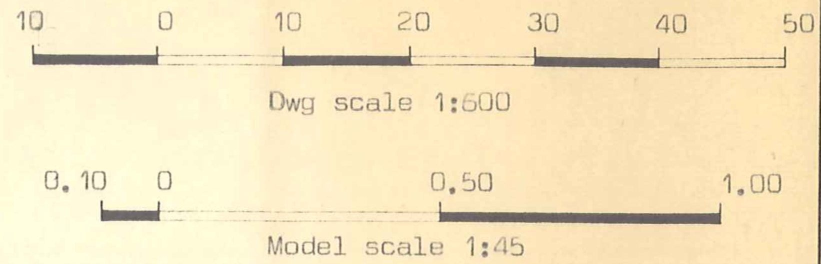
Model scale 1:45

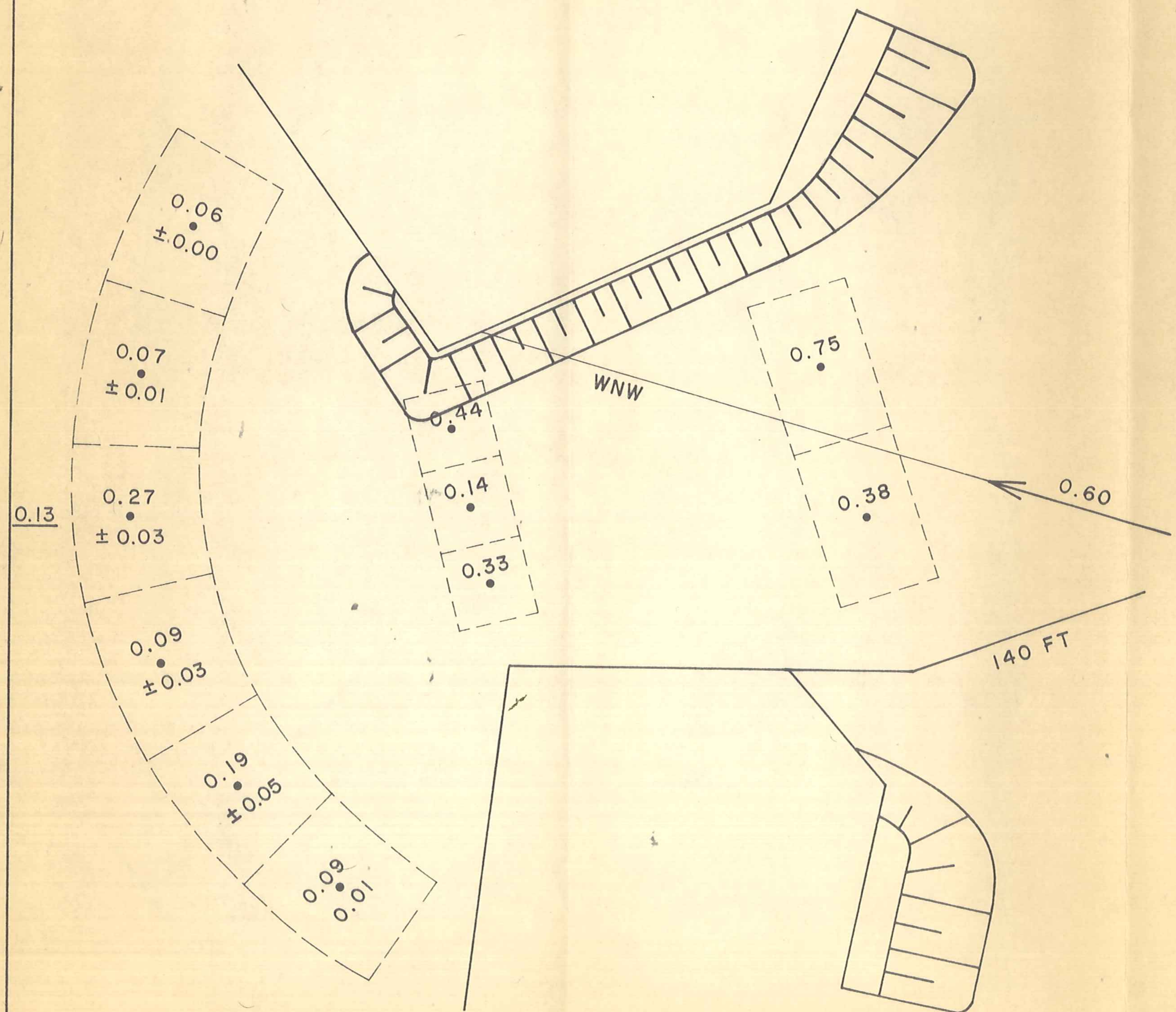


Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 11
TEST A-4





Marina entrance, Harbour Town, Hilton Head Island,	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratoey, Reykjavík, Iceland.	Oct. 1973

SHEET No.12
TEST B-4

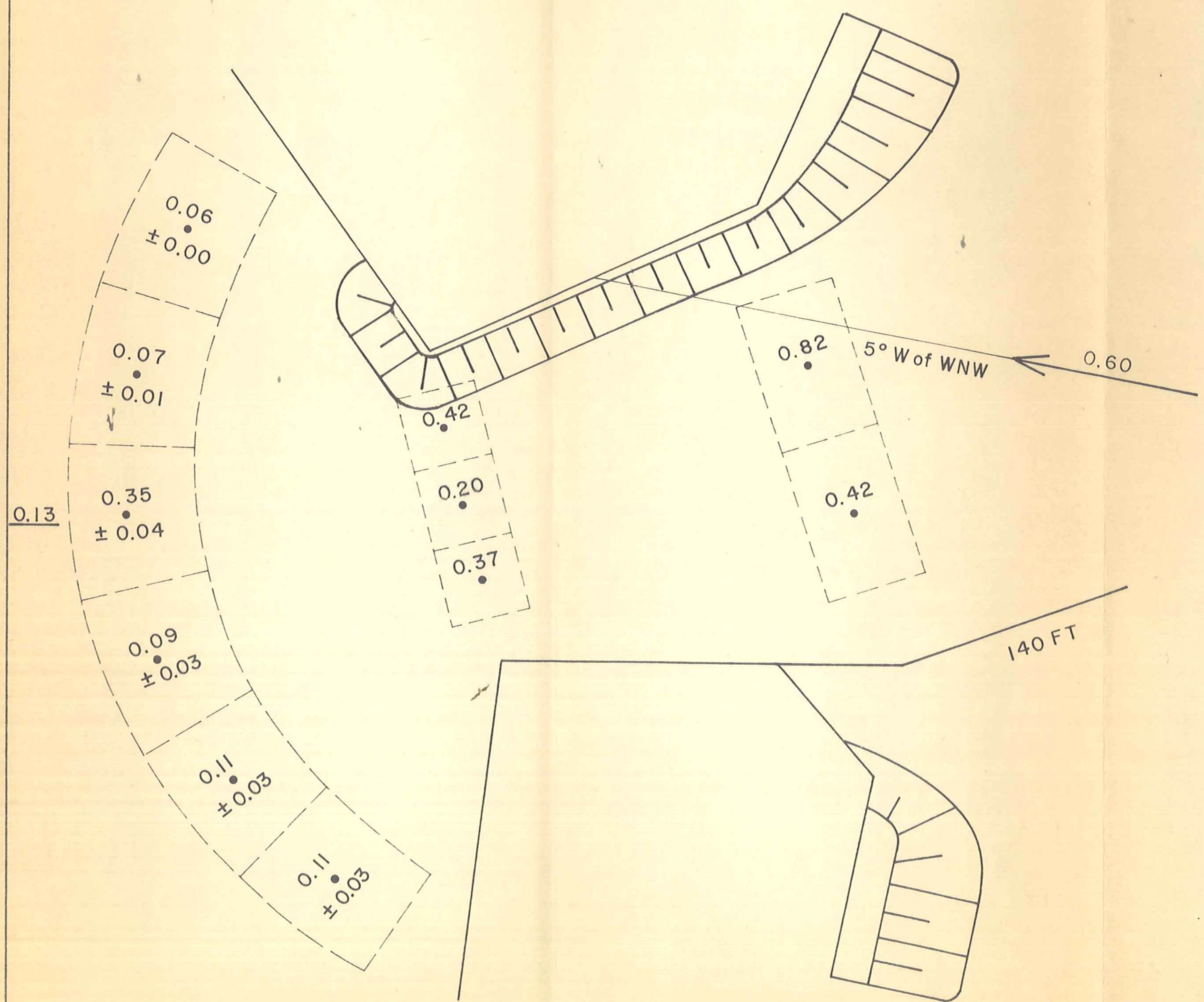
Wave height	0.60 M
Wave Period	3 sec
Wave direction	5^{o} W of WNW

10 0 10 20 30 40 5

Dwg scale 1:600

0.10 0 0.50 1.00

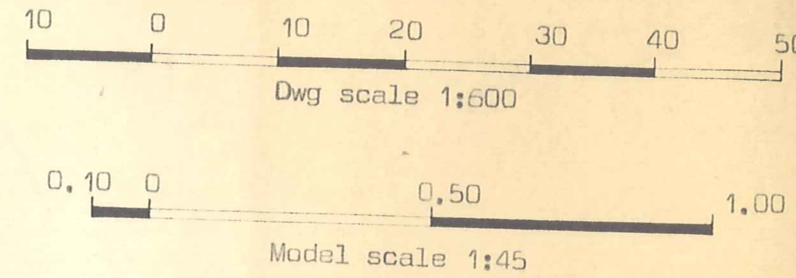
Model scale 1:45

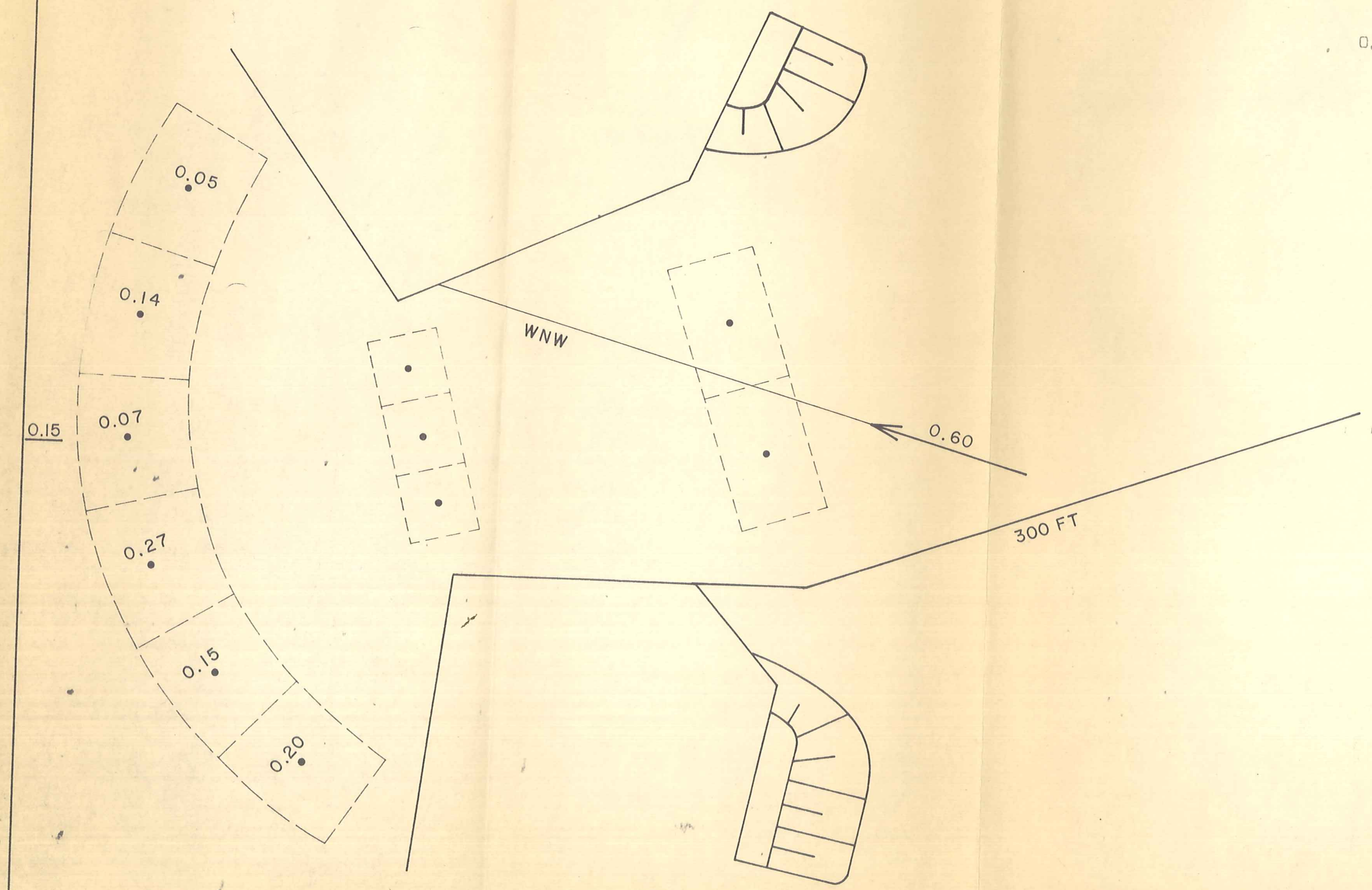


Marina entrance, Hrbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 13
TEST A-5





Marina entrance, Harbour, Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.60 M
Wave period	3 sec
Wave direction	WNW

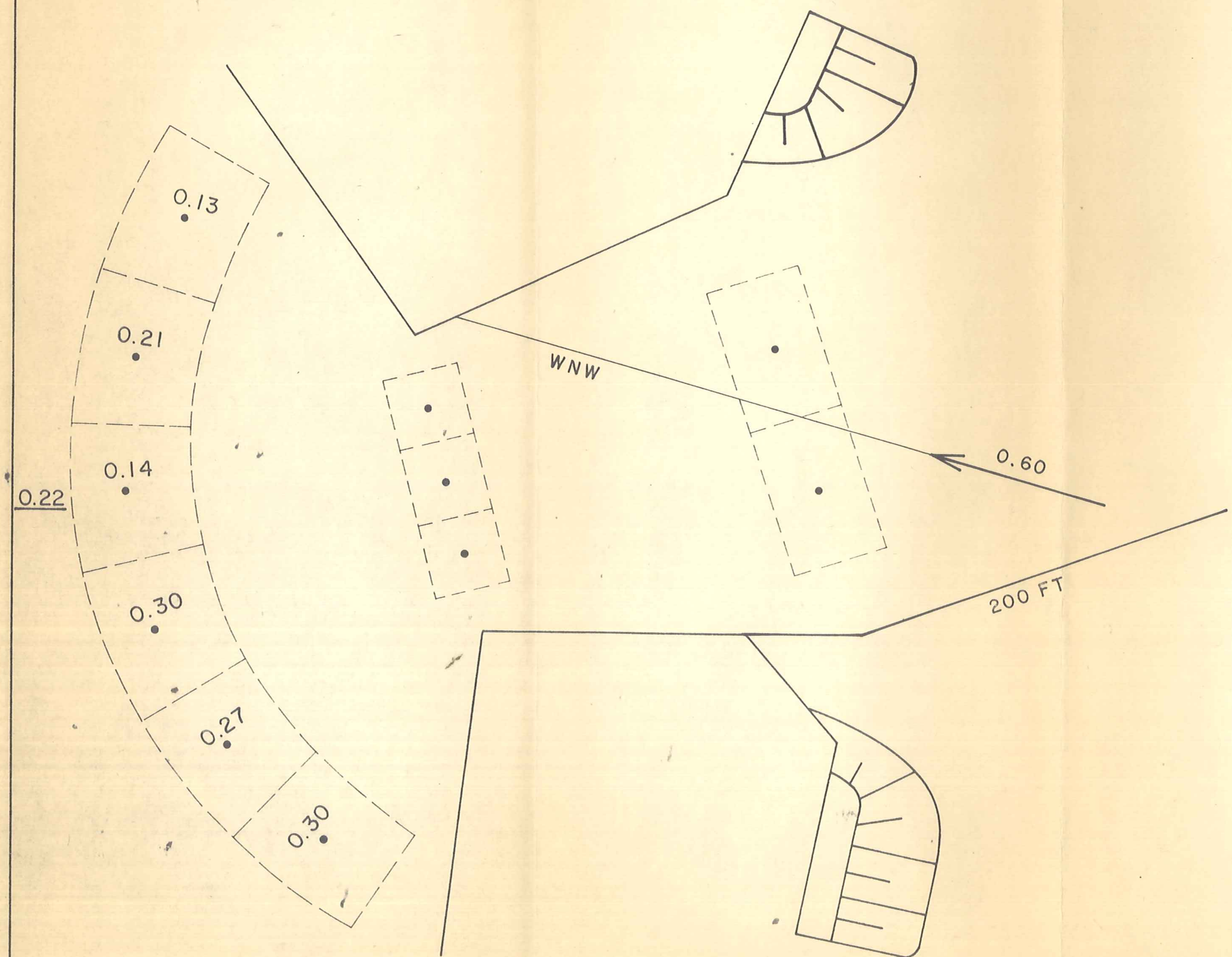
SHEET No. 14
TEST A-6

10 0 10 20 30 40

Dwg scale 1:600

1.10 0 0.50 1.00

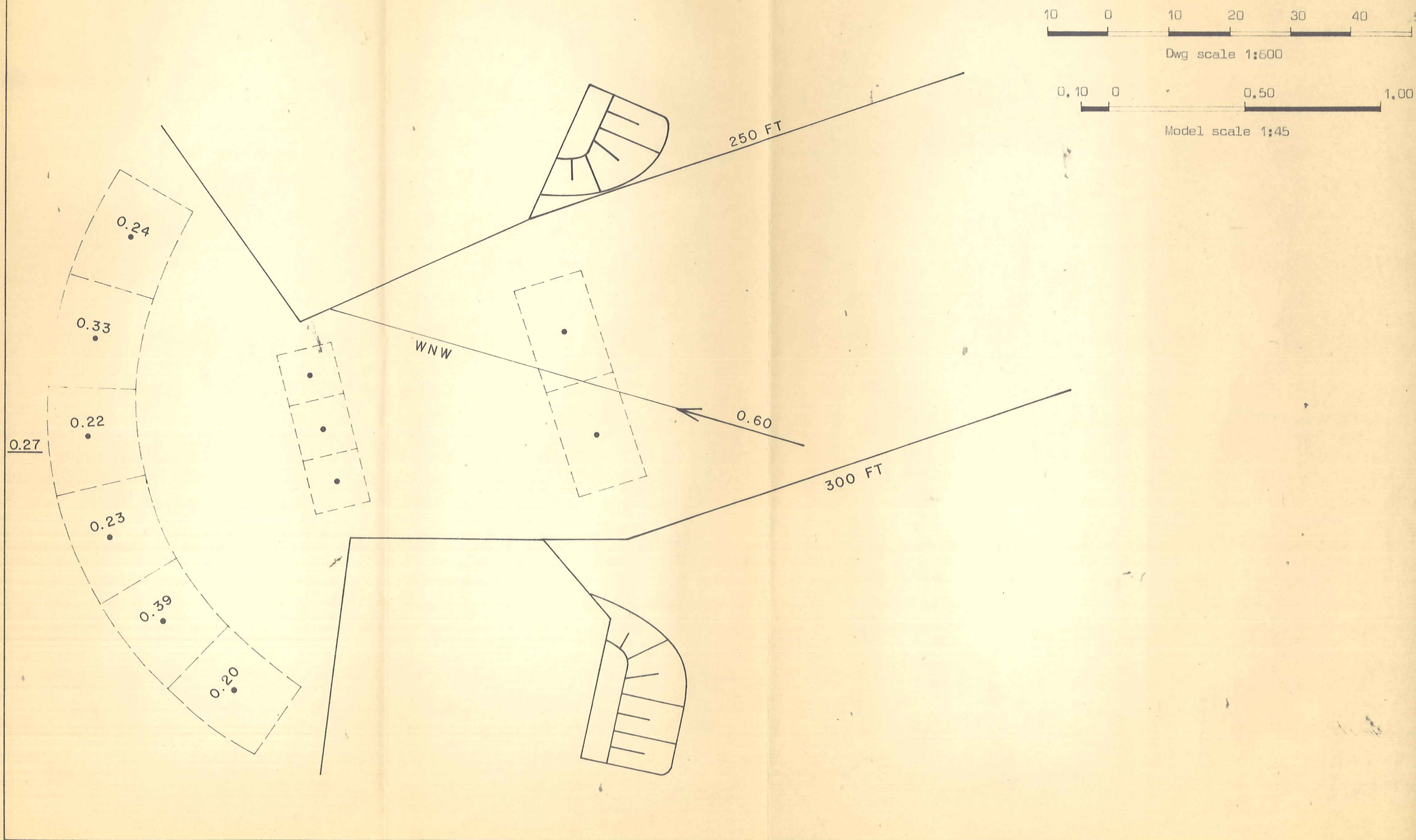
Model scale 1:45



Marina entrance, Harbour Town, Hilton Head Island,	Dwg scale 1:200
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 15
TEST A-7



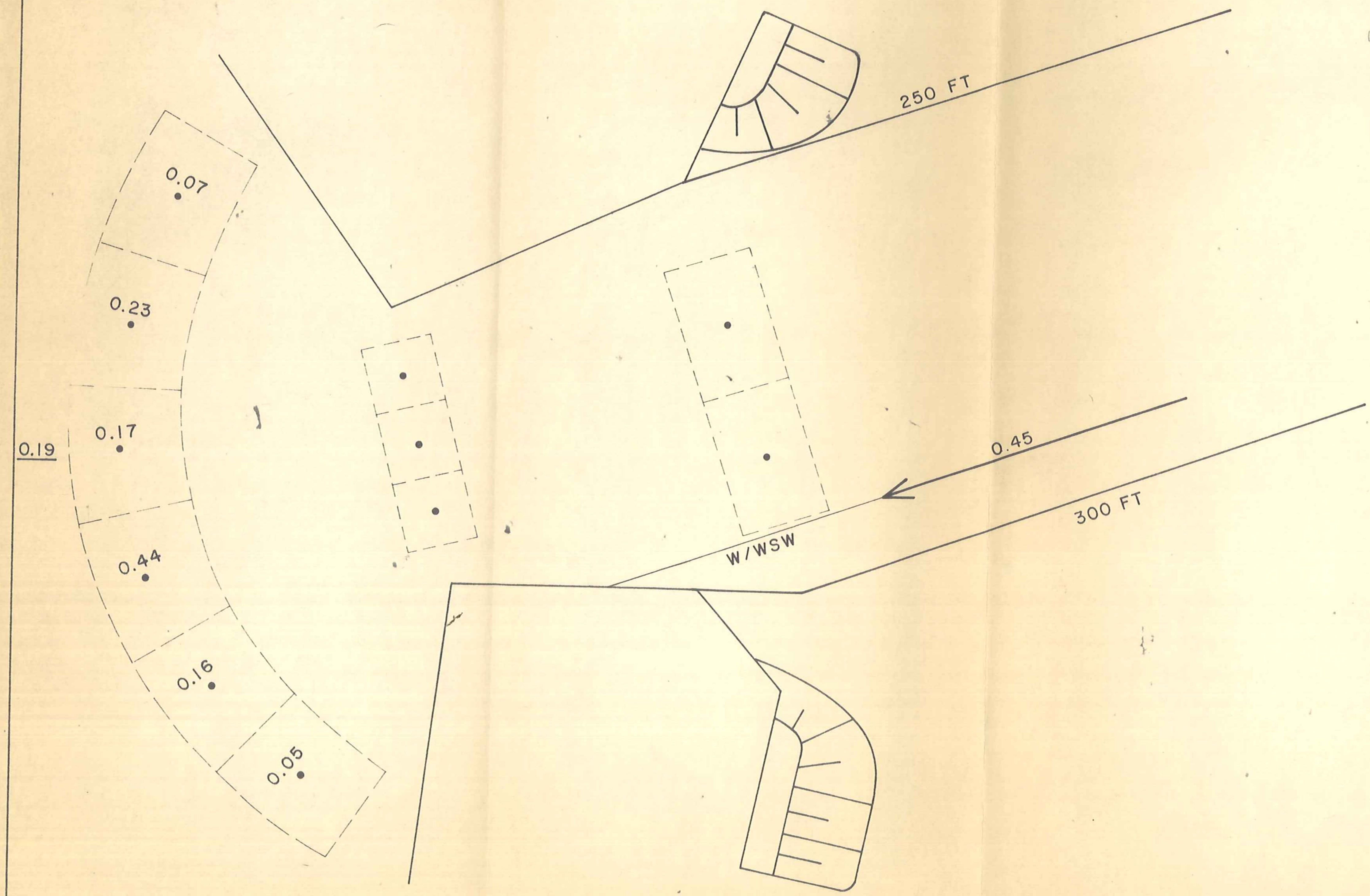
Marina entrance, Harbour Town, Hilton Head Island.	Dwg scale 1:600
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.45 M
Wave Period 3 sec
Wave direction W/WSW

SHEET No. 16
TEST C-2

10 0 10 20 30 40 50
Dwg scale 1:600

0.10 0 0.50 1.00
Model scale 1:45



Marina entrance, Harbour, Town, Hilton Head Island	Dwg scale 1:200
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.60 M
Wave Period	3 sec
Wave direction	WNW

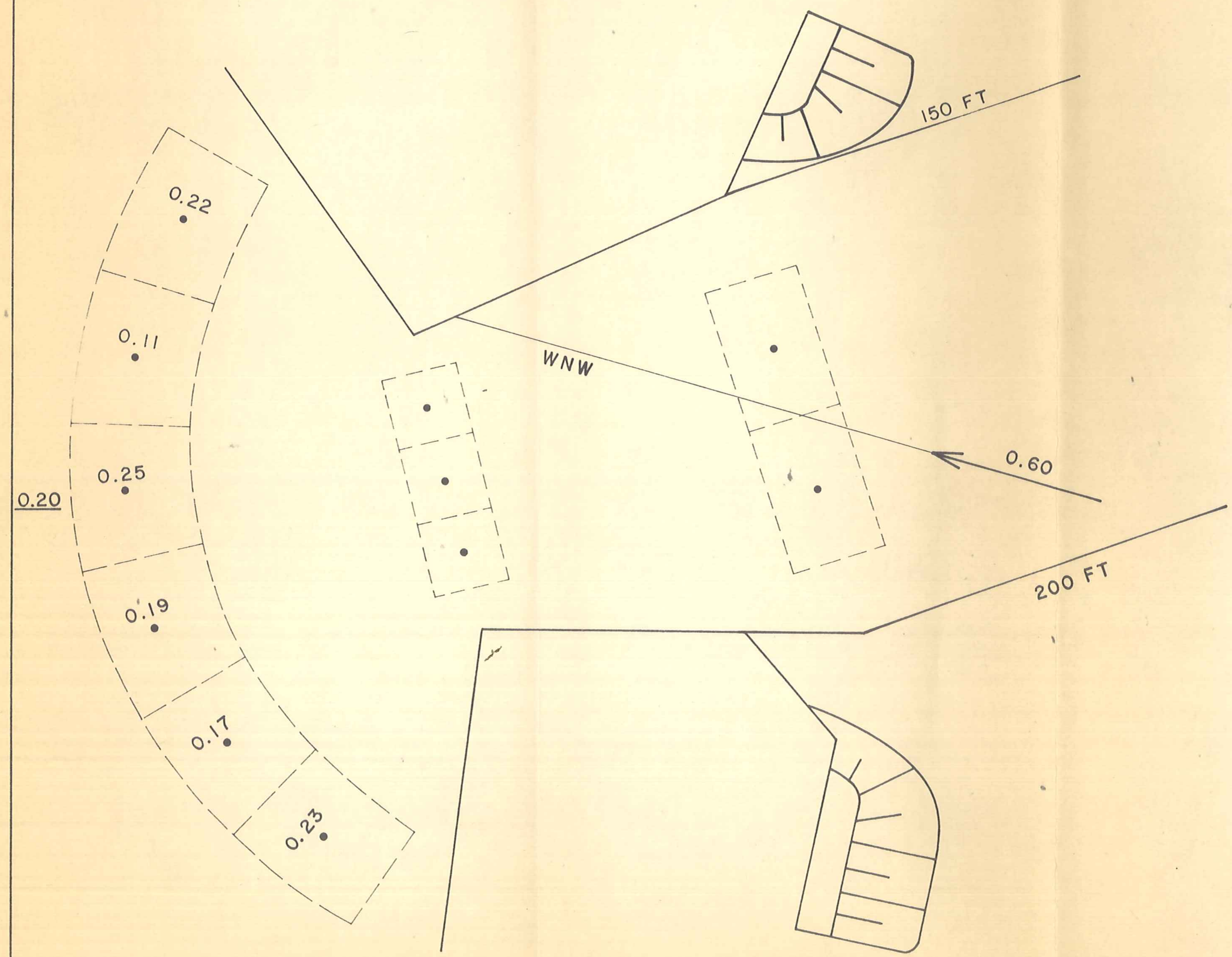
SHEET No. 17
TEST A - 8

10 0 10 20 30 40 50

Dwg scale 1:600

0.10 0 0.50 1.00

Model scale 1:45



Marina enrtance, Harbour, Town, Hilton Head Island,	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

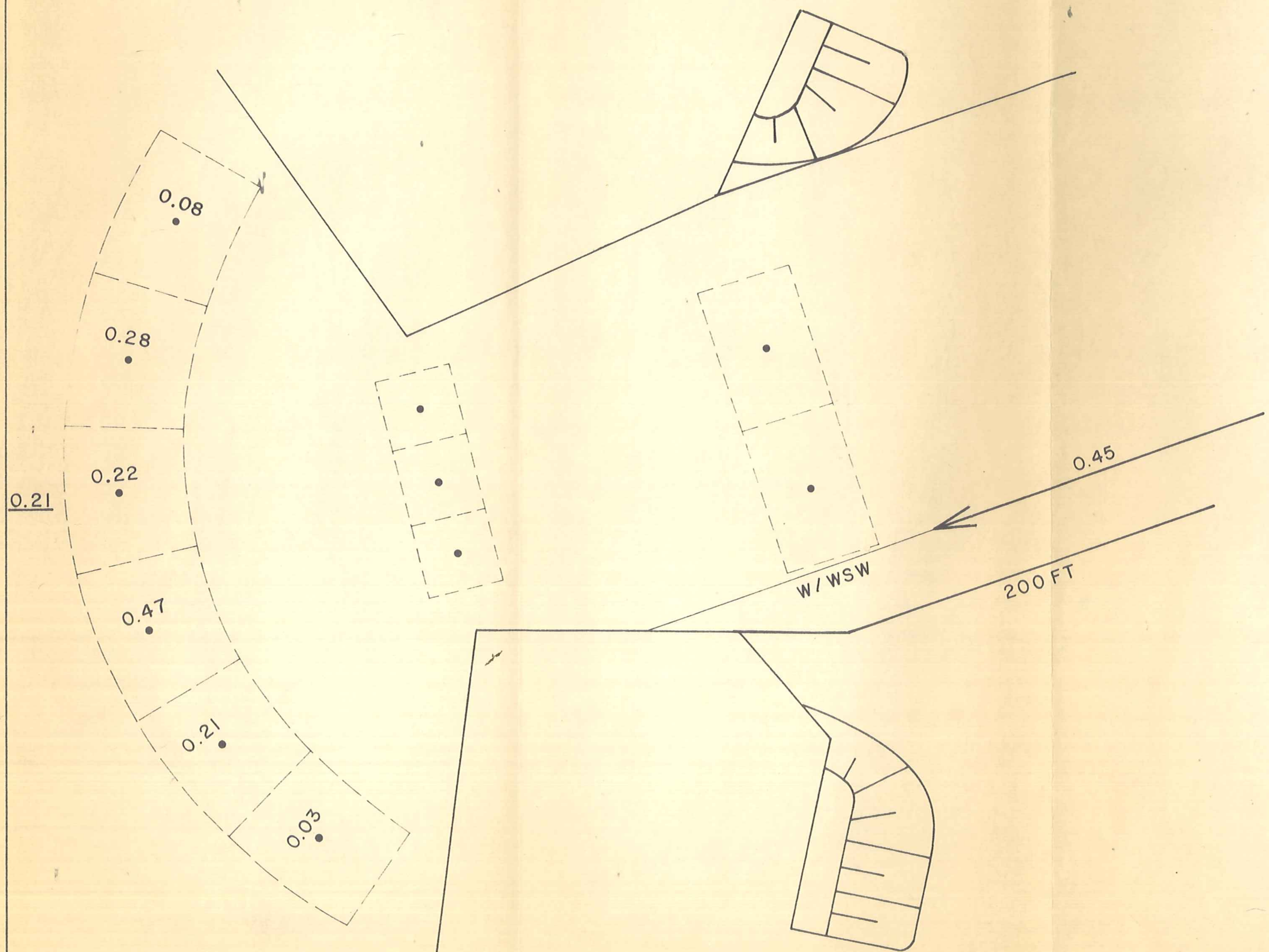
SHEET No. 18
TEST C-3

10 0 10 20 30 40 50

Dwg scale 1:600

0.10 0 0.50 1.00

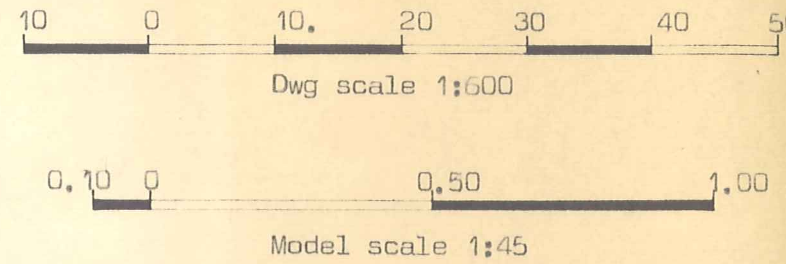
Model scale 1:45

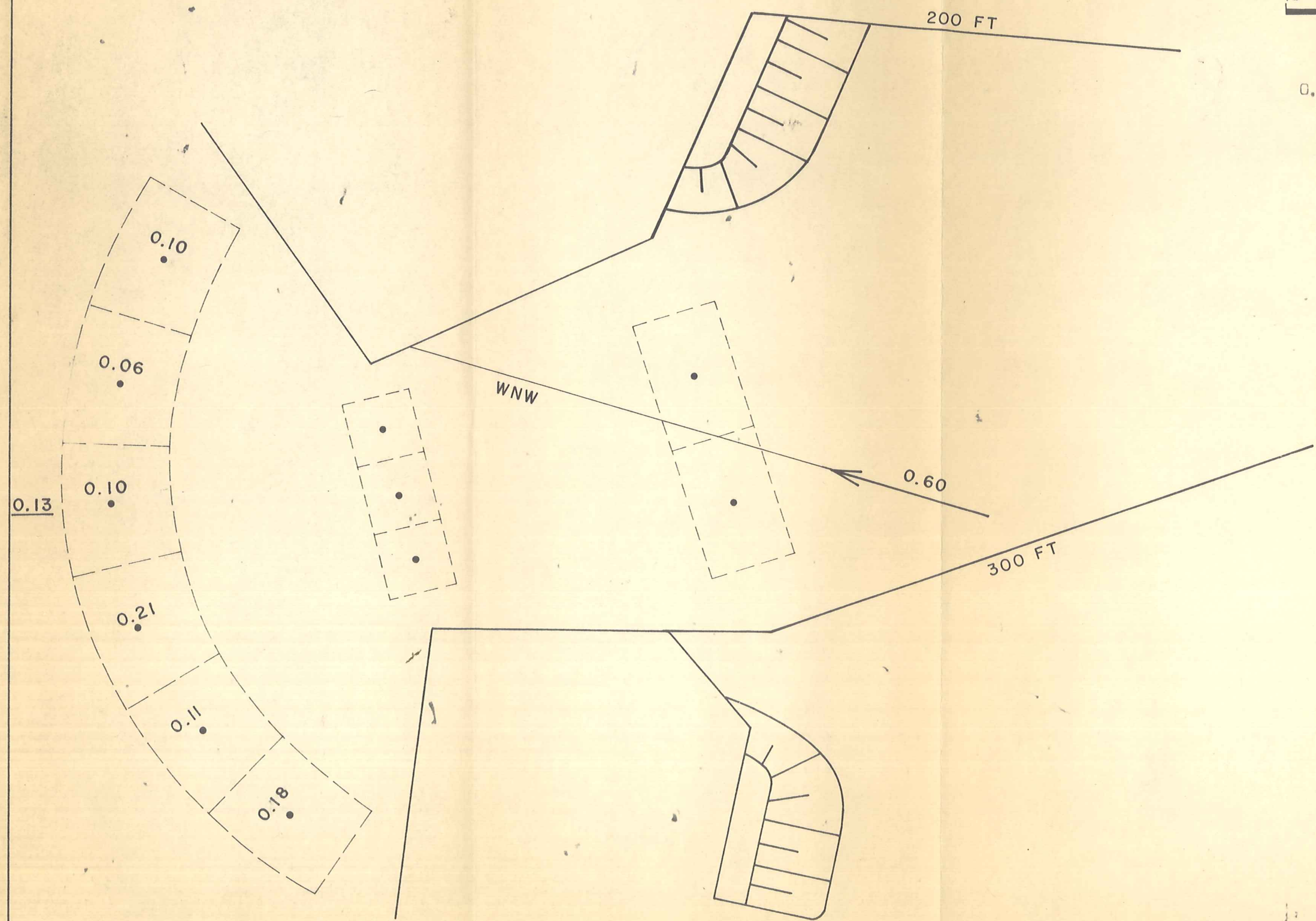


Marina entrance, Harbour, Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave period 3 sec
Wave direction WNW

SHEET No. 19
TEST A-9





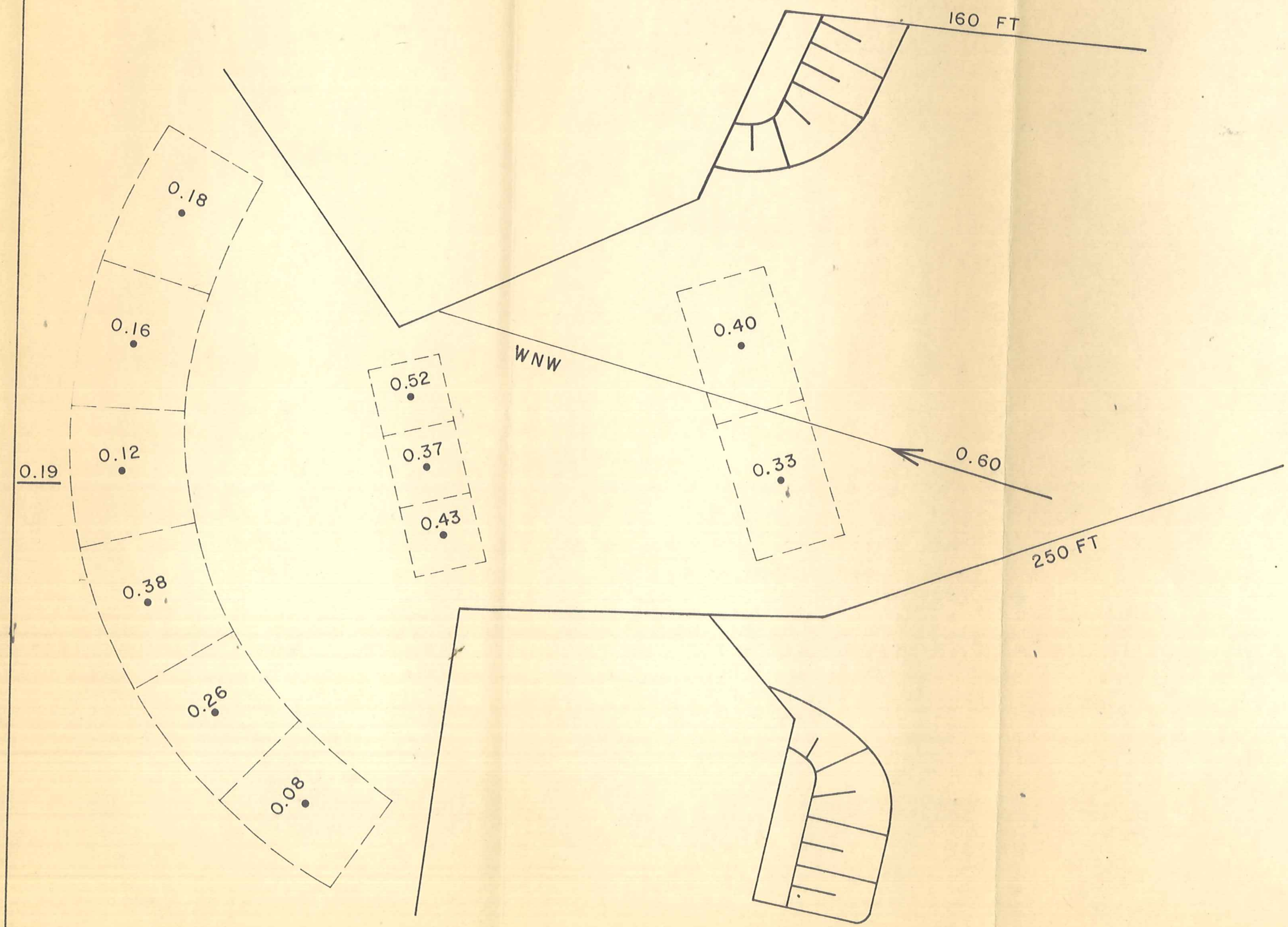
Marina entrance, Harbour, Town, Hilton Head Island	Dwg scale 1:200
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 20
TEST A-10

10 0 10 20 30 40 50
Dwg scale 1:600

0.10 0 0.50 1.00
Model scale 1:45



Marina entrance, Harbour Town, Hilton Head Island,	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland	Oct. 1973

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

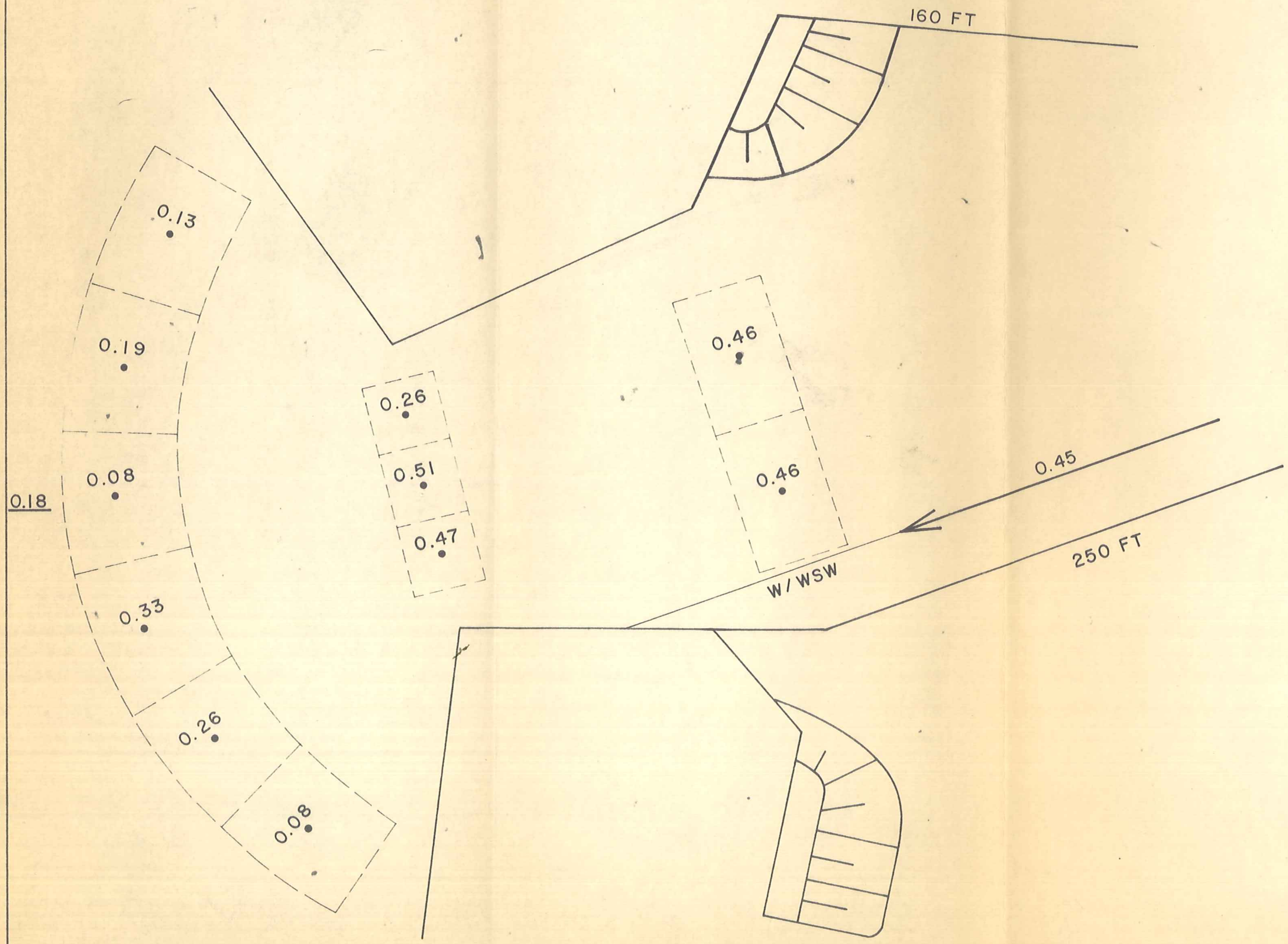
SHEET No. 21
TEST C-4

10 0 10 20 30 40 50

Dwg scale 1:600

0.10 0 0.50 1.00

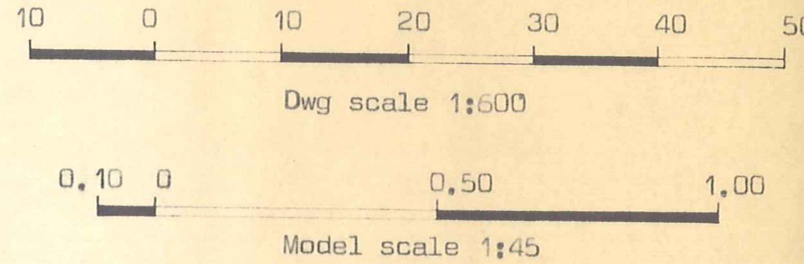
Model scale 1:45

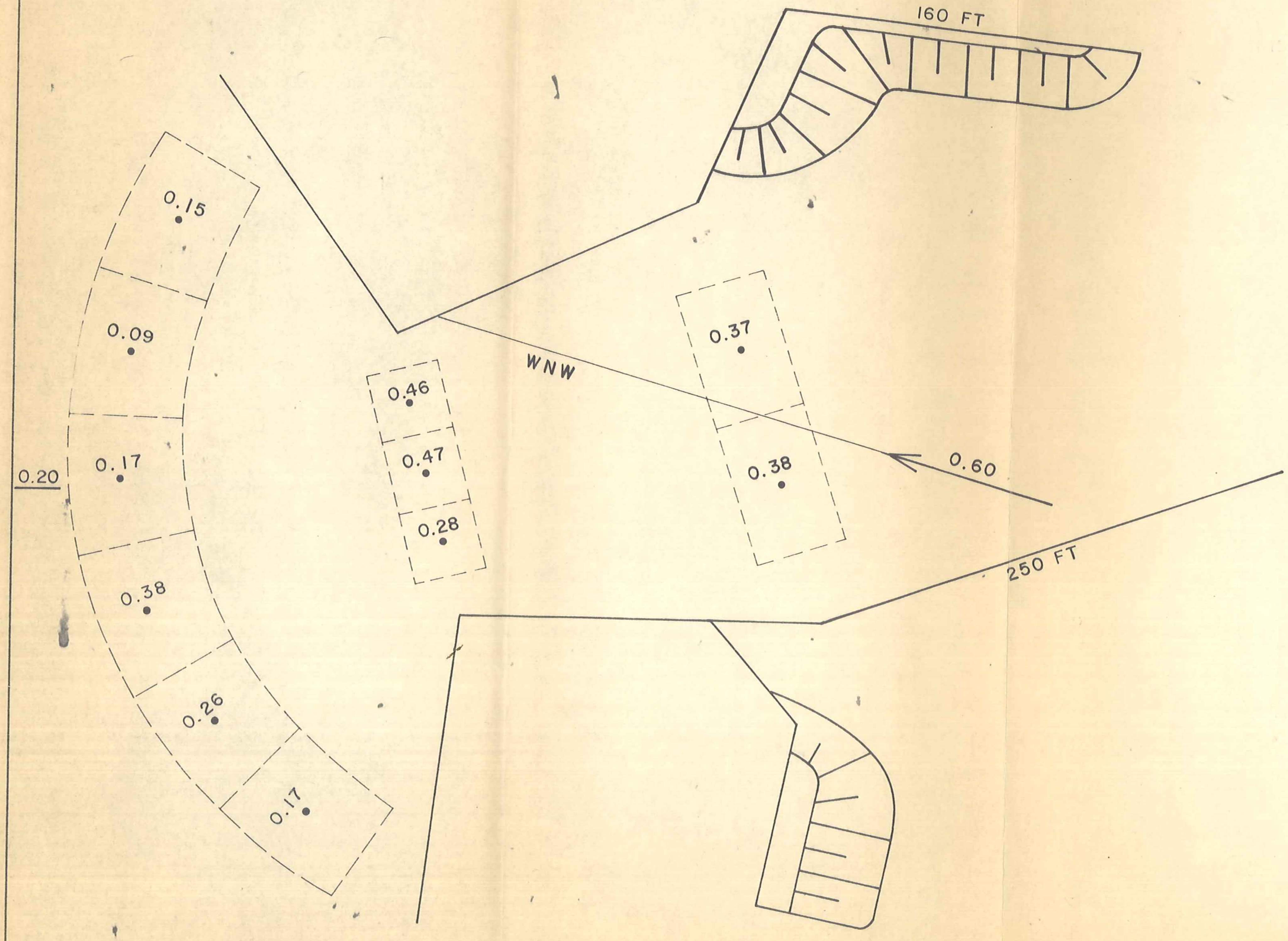


Marina entrance, Harbour, Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic , Laboratory, Reykjavik, Iceland.	Oct. 1973

Wave hight 0.60 M
Wave period 3 sec
Wave direction WNW

SHEET No. 22
TEST A-II





Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland	Oct. 1973

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

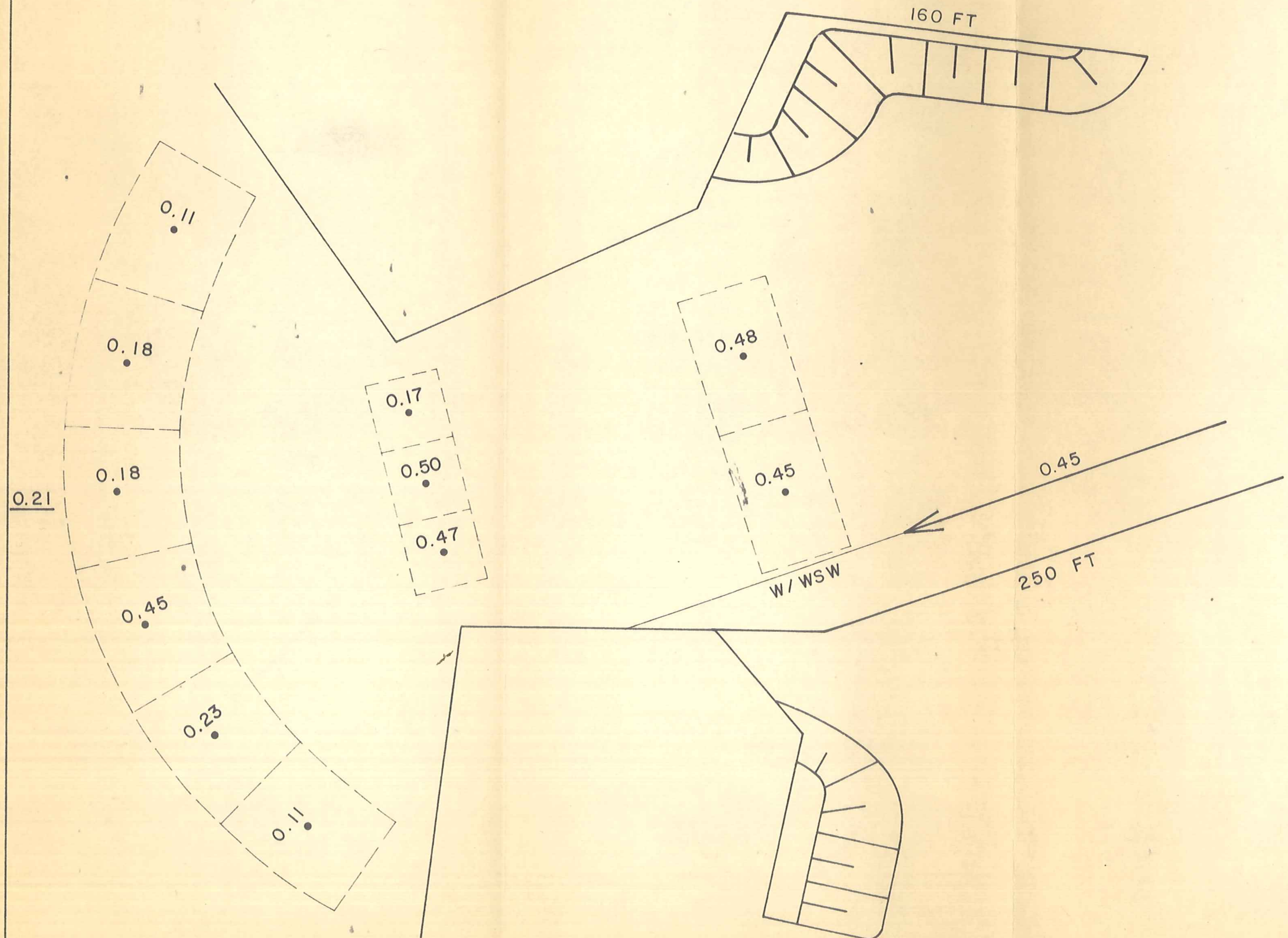
SHEET No. 23
TEST C-5

10 0 10 20 30 40

Dwg scale 1:600

0.10 0 0.50 1.00

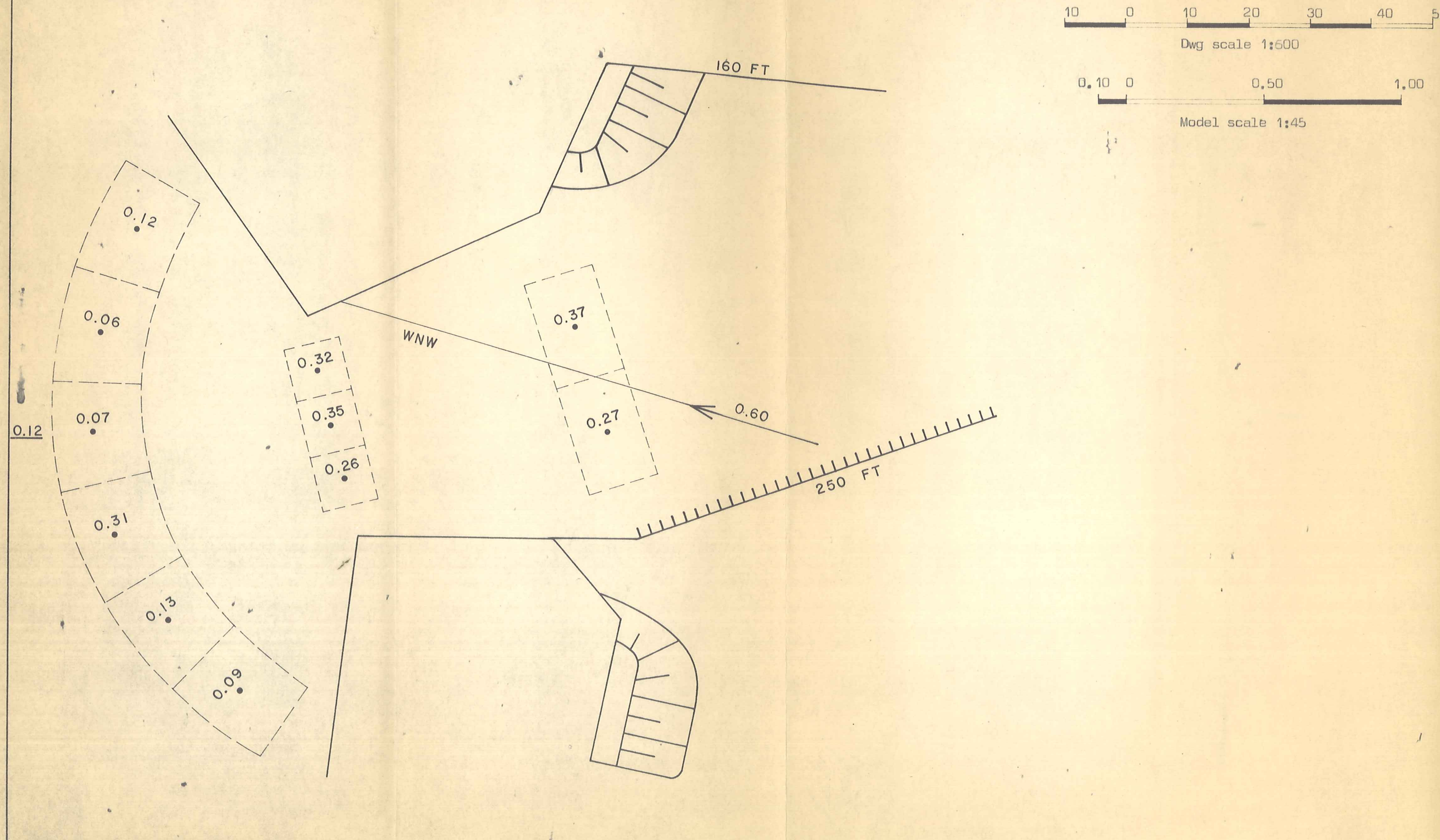
Model scale 1:45



Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

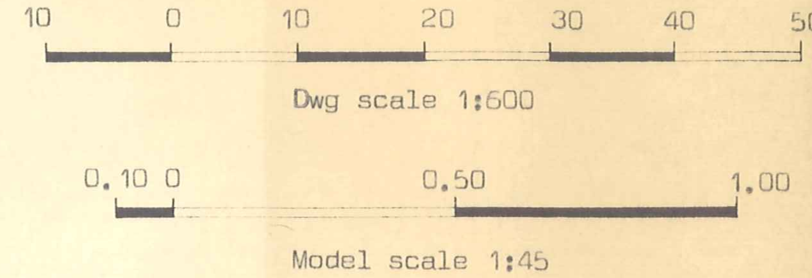
SHEET No. 24
TEST A-12

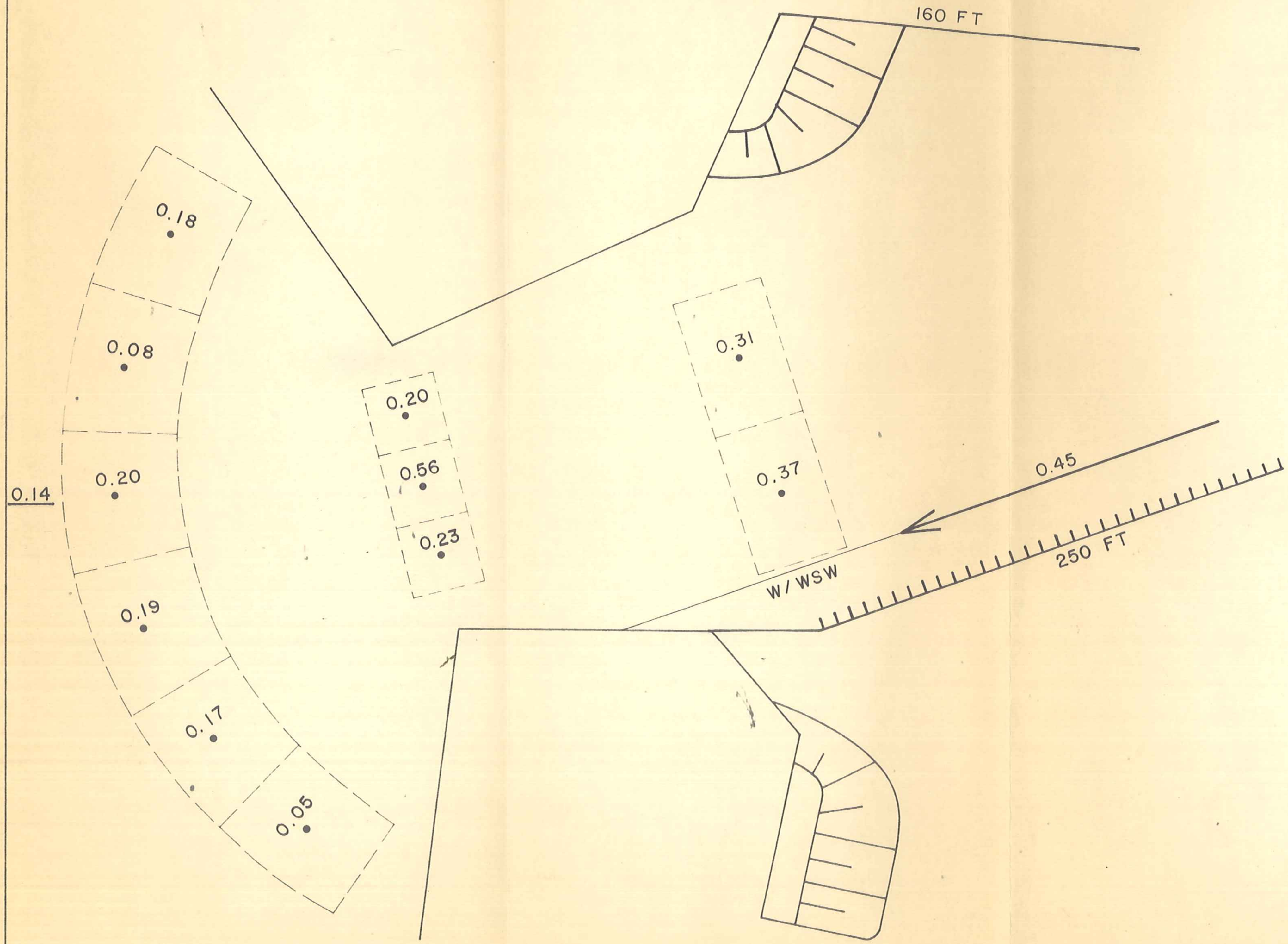


Marina entrance, Harbour. Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973.

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

SHEET No. 25
TEST C-6

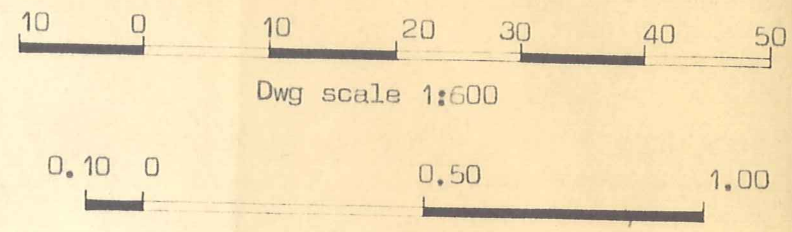


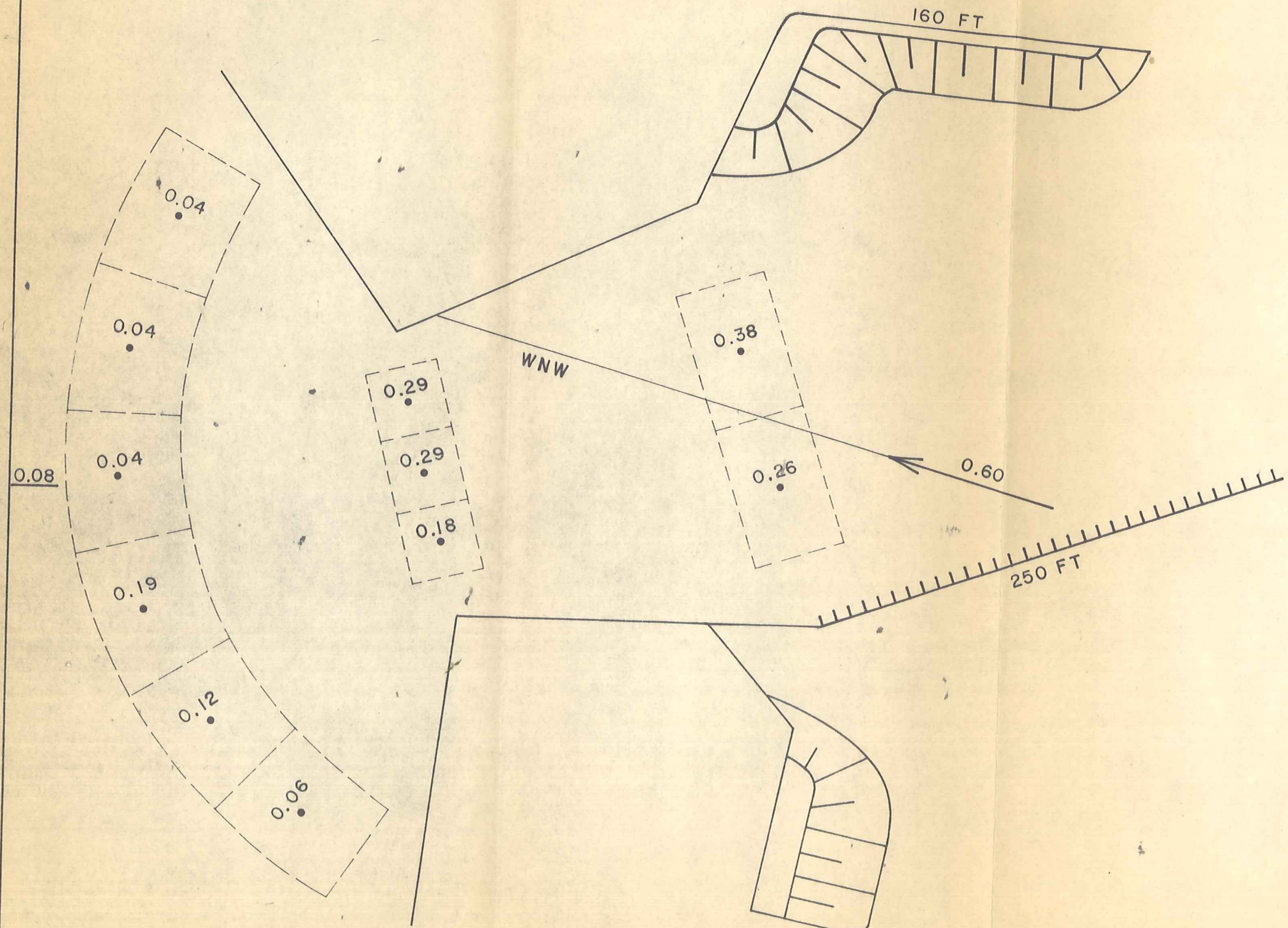


Marina entrance, Harbour, Town, Hilton Head Island,	Dwg scale 1:200
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland	Oct 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 26
TEST A-13





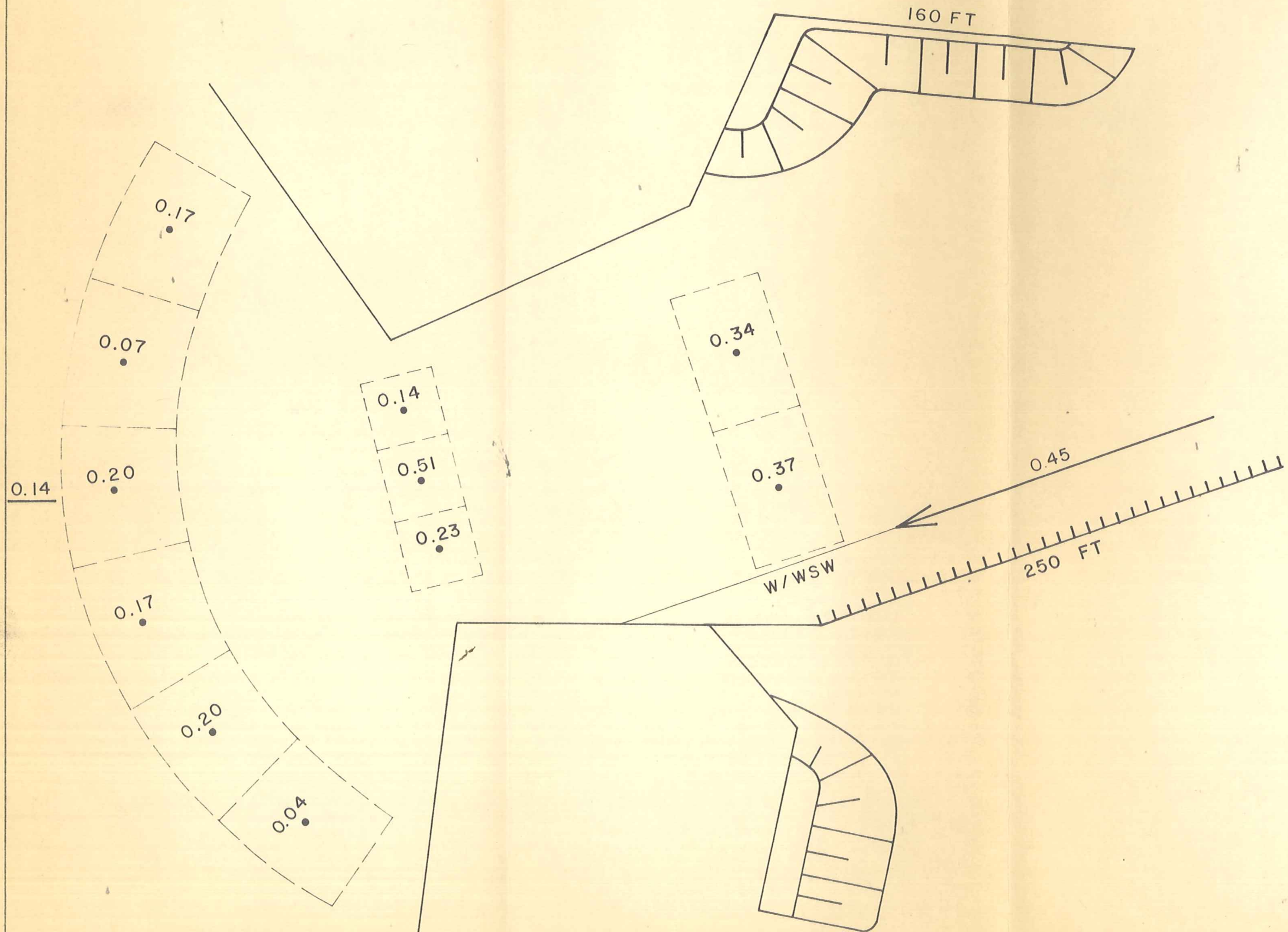
Marina entrance, Harbour Town, Hilton Head Island,	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.45 M
Wave Period 3 sec
Wave direction W/WSW

SHEET No. 27
TEST C-7

10 0 10 20 30 40 50
Dwg scale 1:600

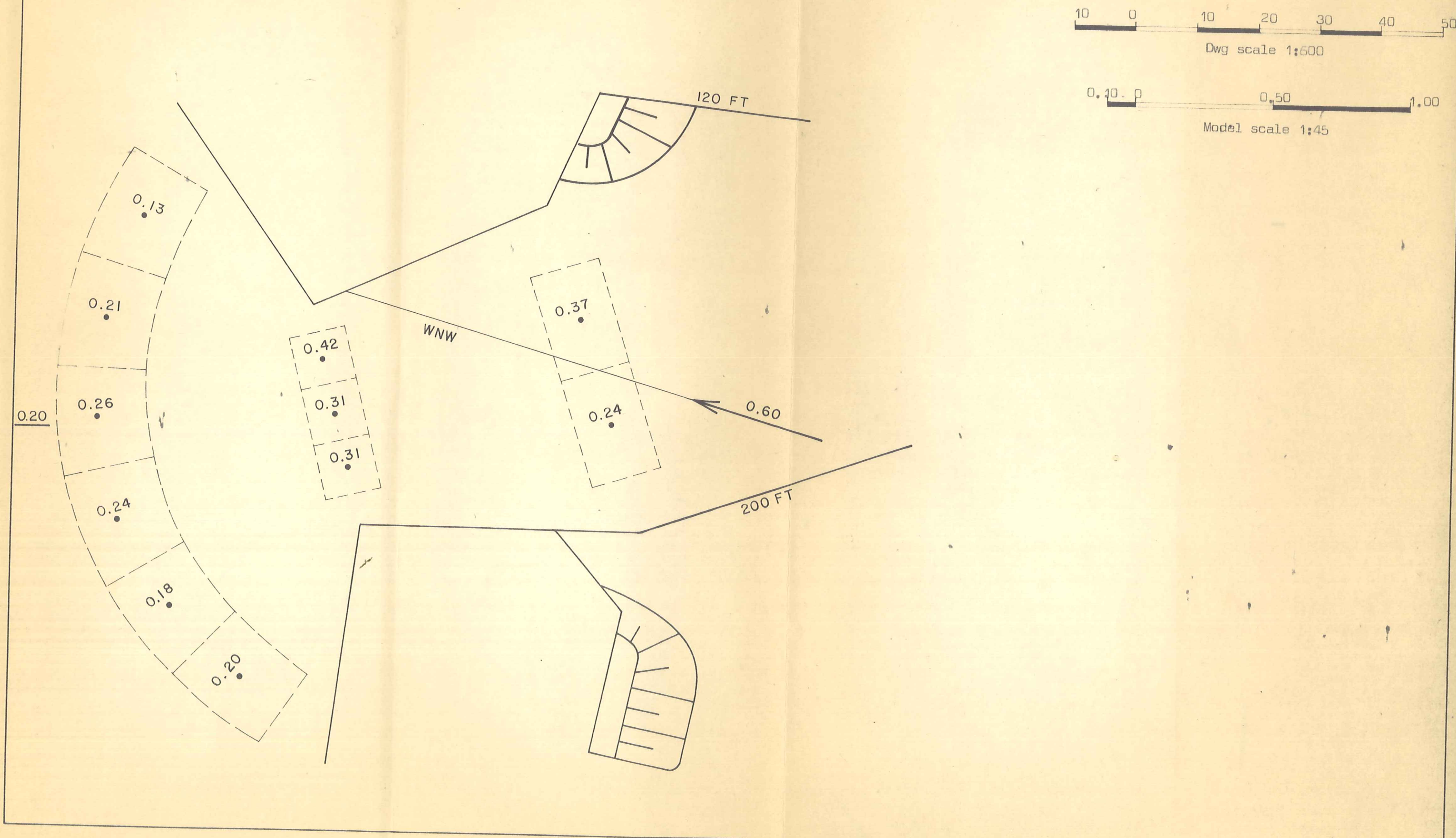
0.10 0 0.50 1.00
Model scale 1:45



Marina entrance, Harbour Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model Study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.60 M
Wave Period	3 sec
Wave direction	WNW

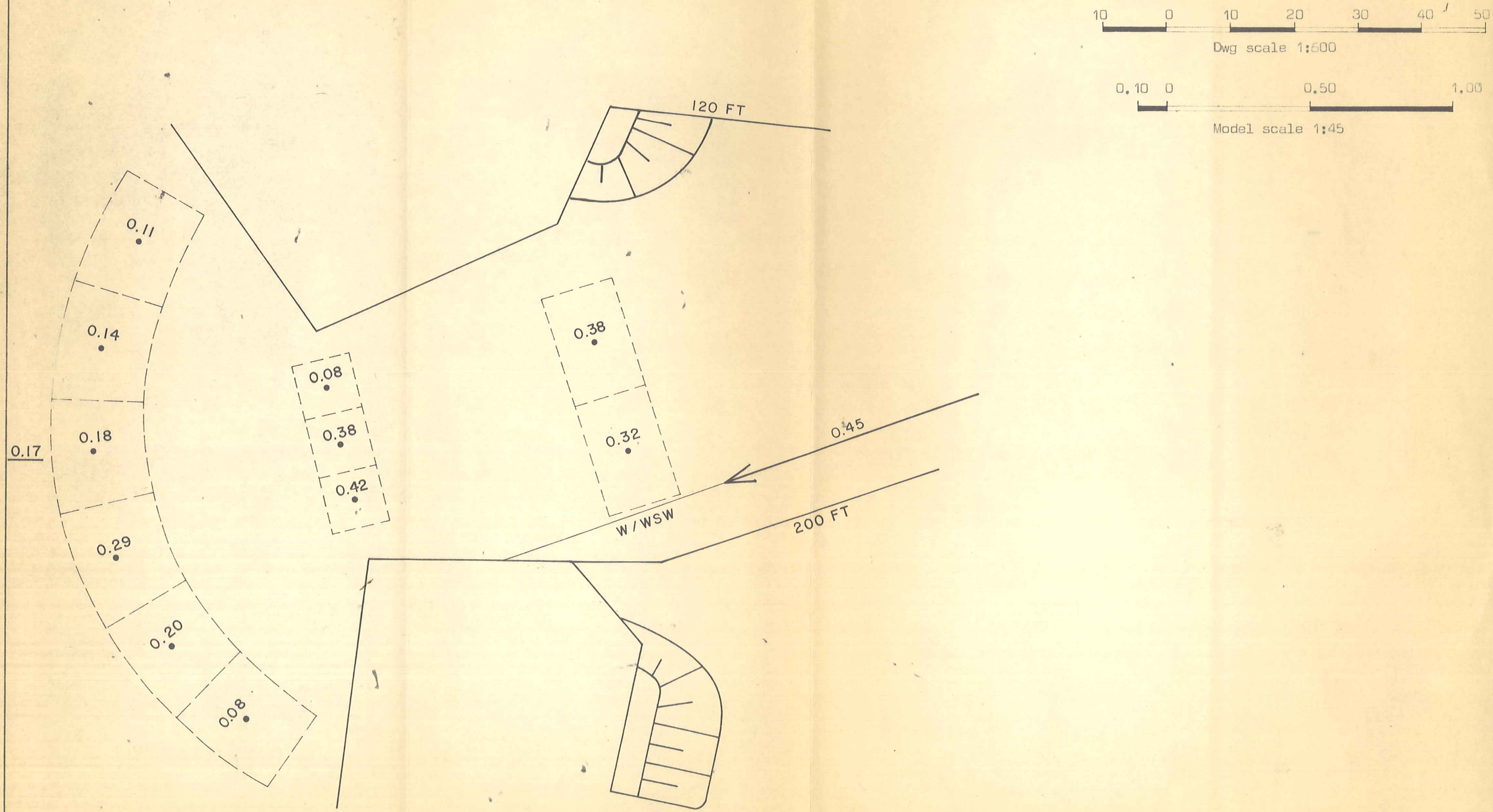
SHEET No. 28
TEST A-14



Marina entrance, Harbour, Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.45M
Wave Period	3 sec
Wave direction	W/WSW

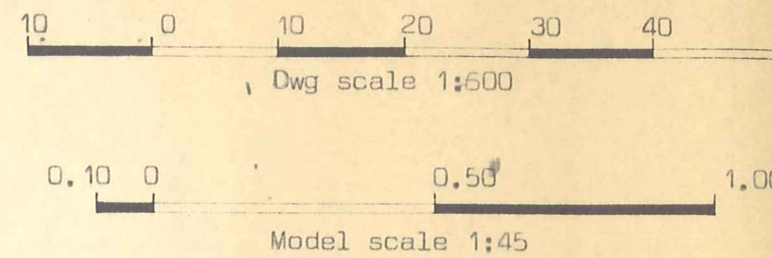
SHEET No. 29
TEST C-8

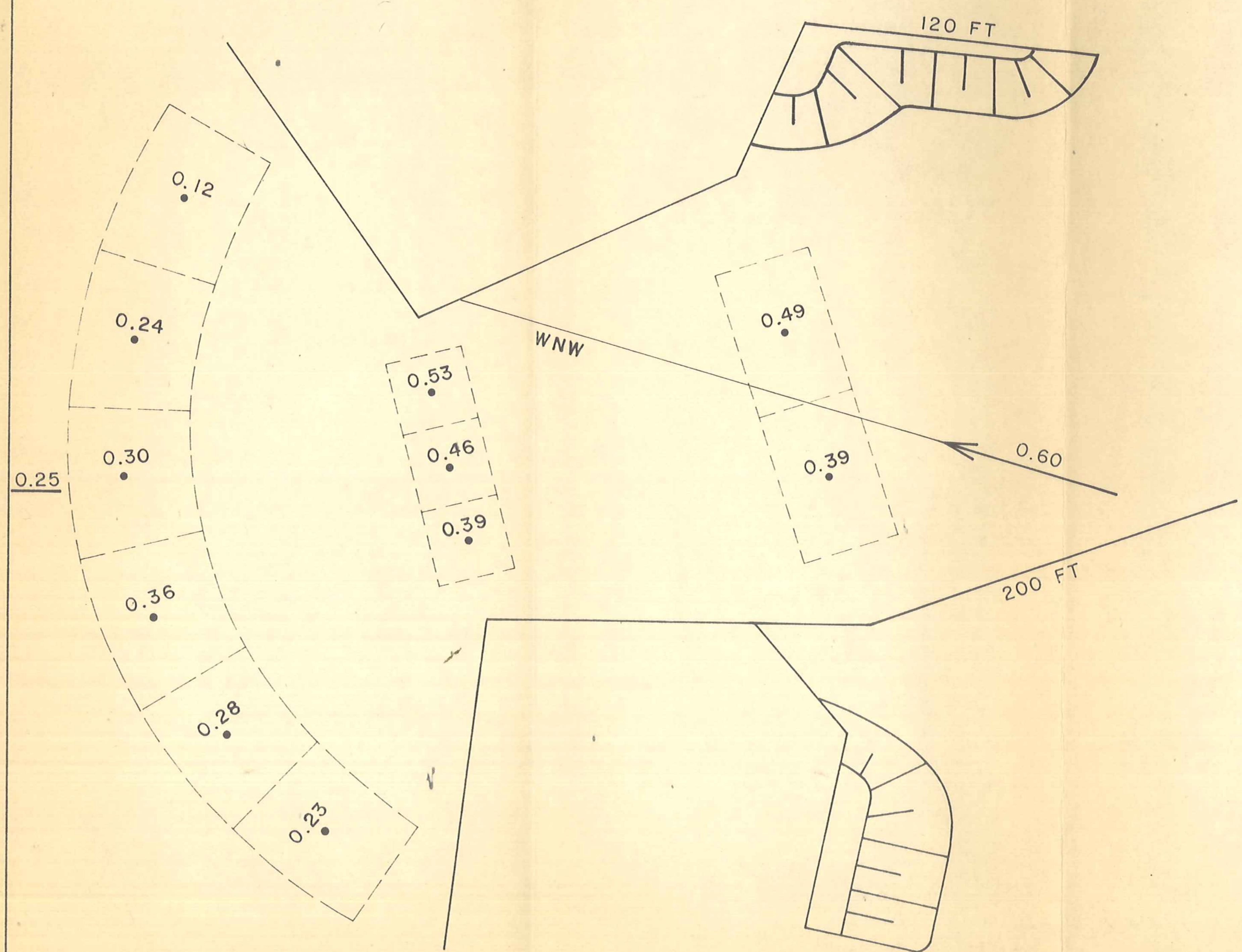


Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:200
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 30
TEST A-15

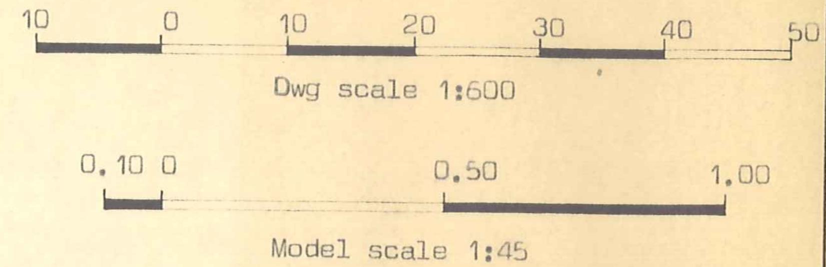


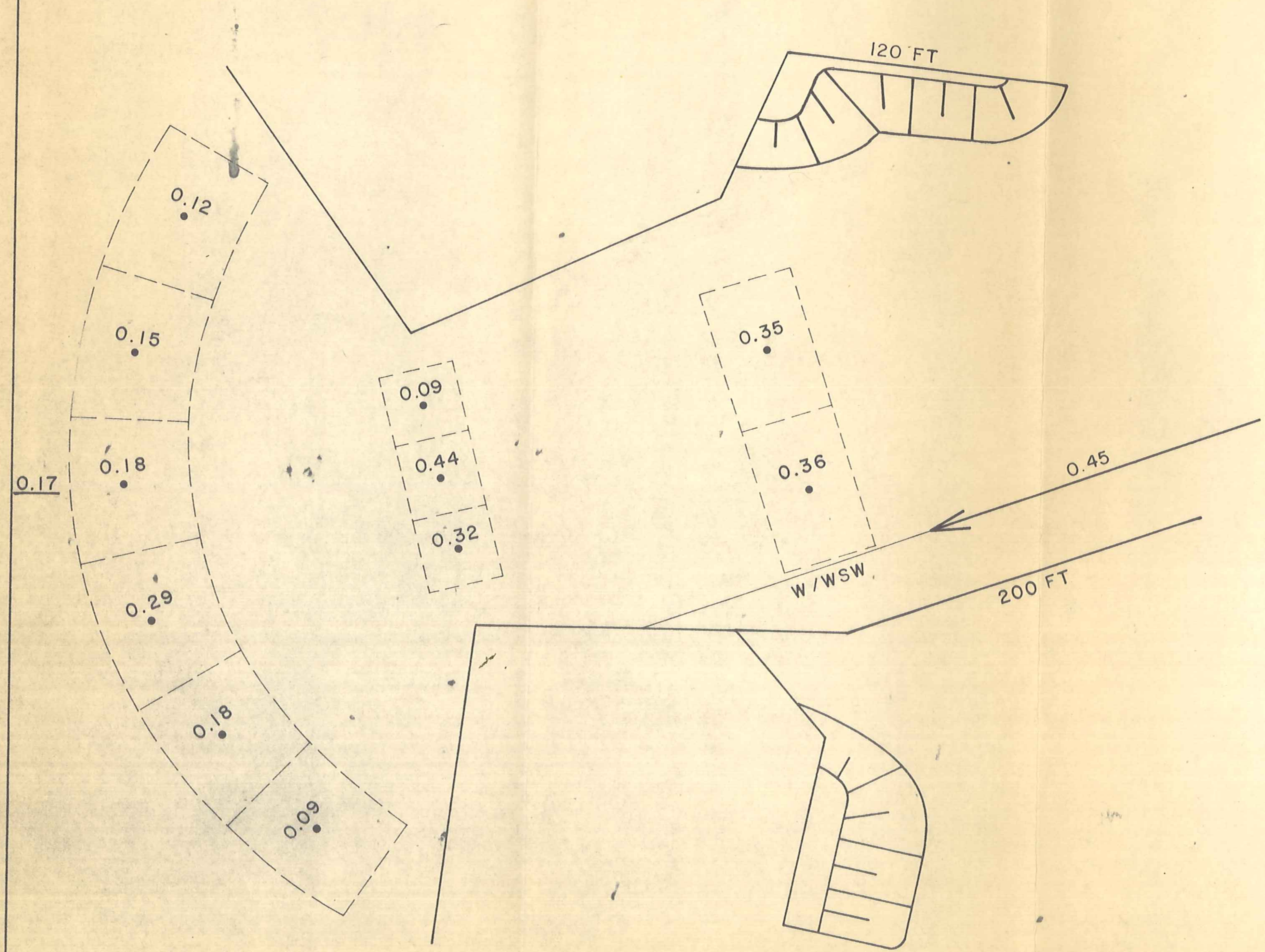


Marina entrance, Harbour. Town, Hilton Head Island. South Carolina	Dwg scale 1:2000
Model study, Scale 1:45	Drawn by B.E.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Chkd by G.V.
	Oct. 1973

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

SHEET No. 31
TEST C-9

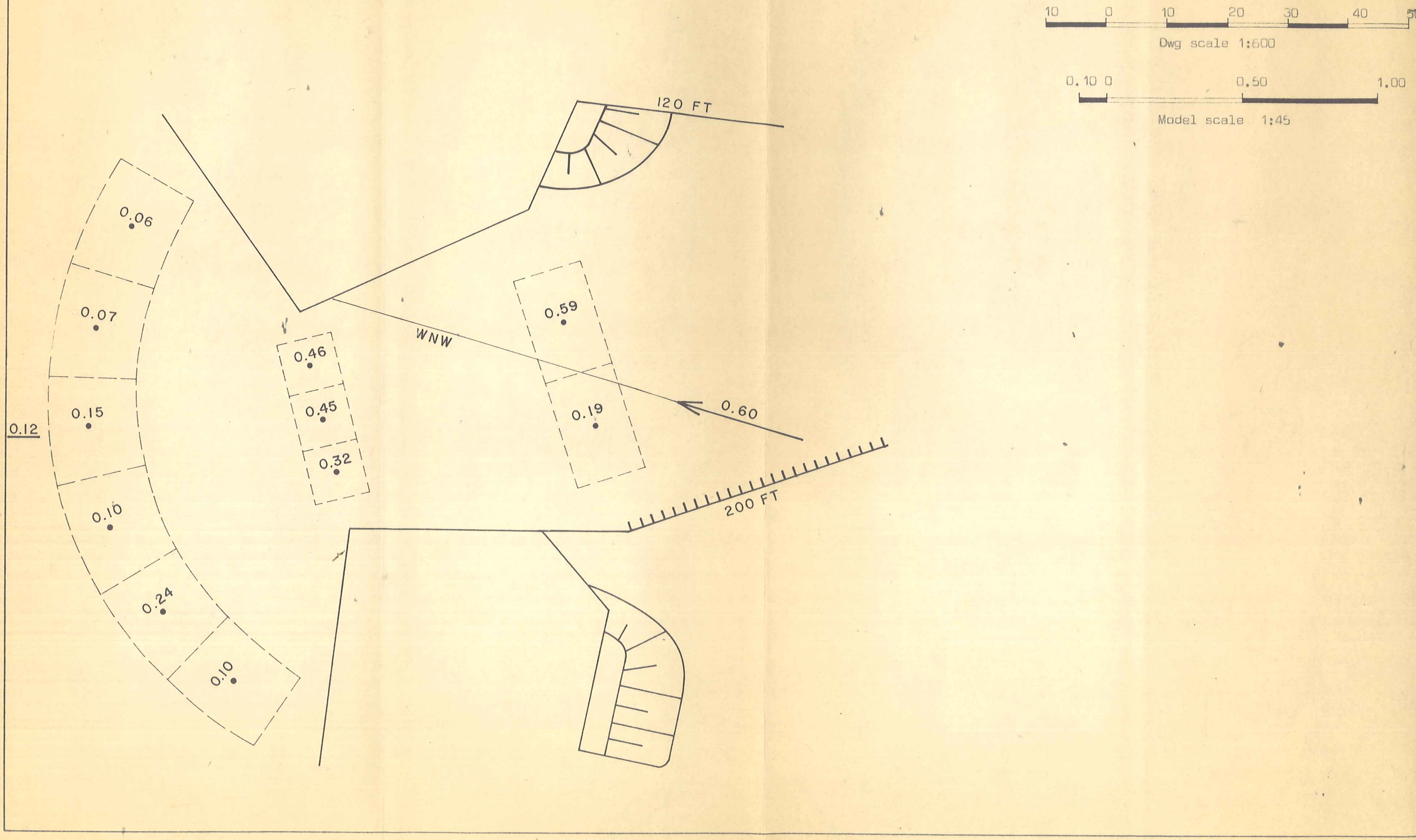




Marina entrance, Harbour Town, Hilton Head Island	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.60 M
Wave Period	3 sec
Wave direction	WNW

SHEET No. 32
TEST A-16



Marina entrance, Harbour Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.45 M
Wave period	3 sec
Wave direction	W/WSW

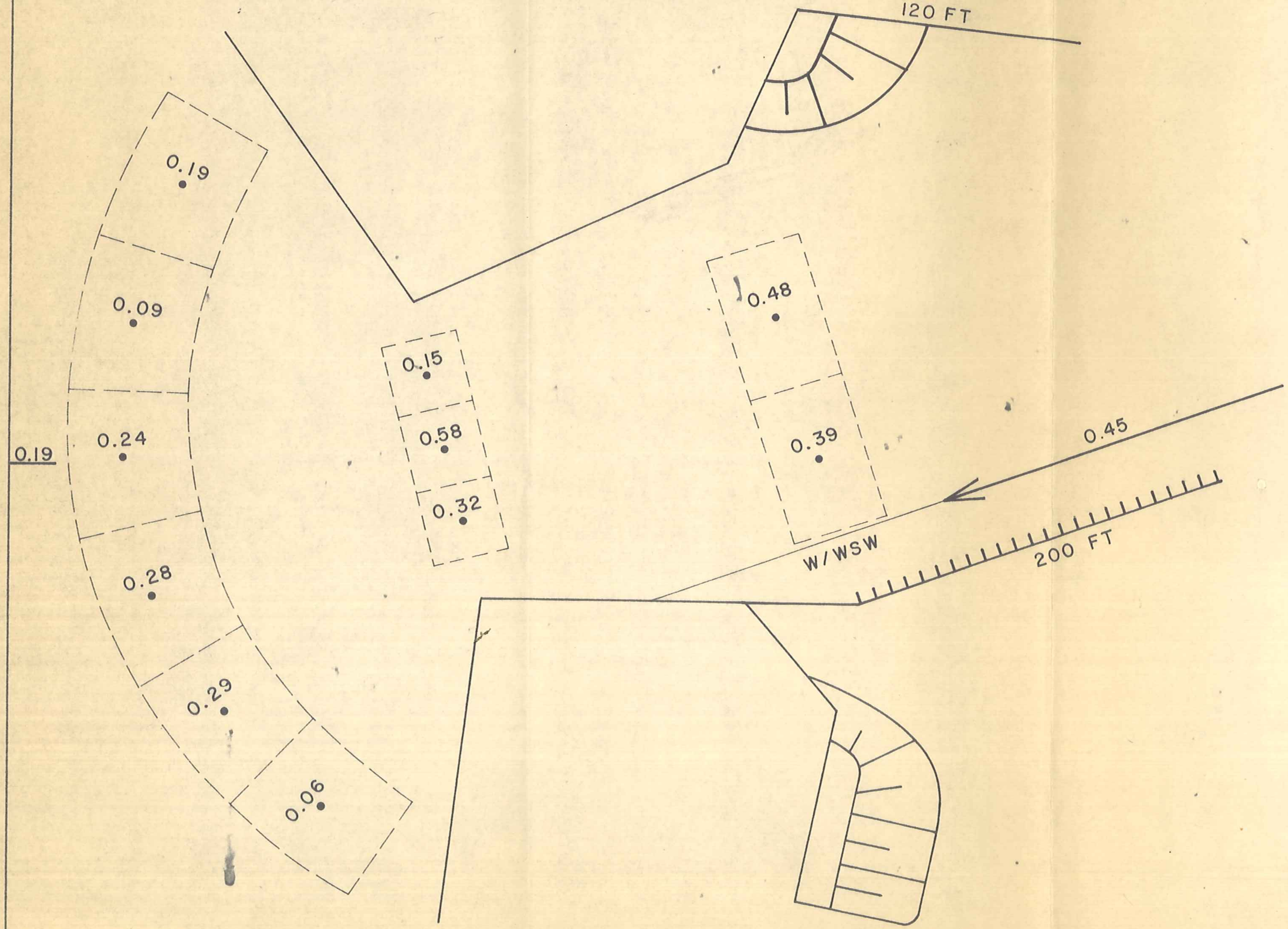
SHEET No. 33
TEST C – 10

10 0 10 20 30 40 50

Dwg scale 1:600

0.10 0 0.50 1.00

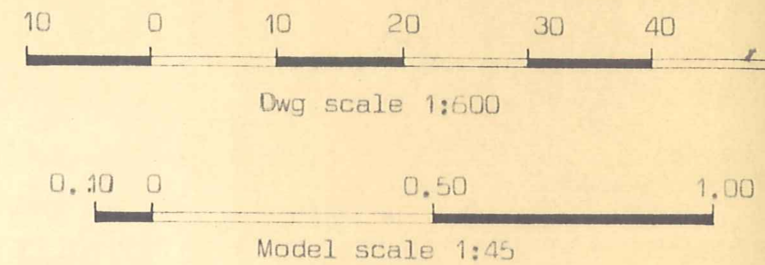
Model scale 1:45

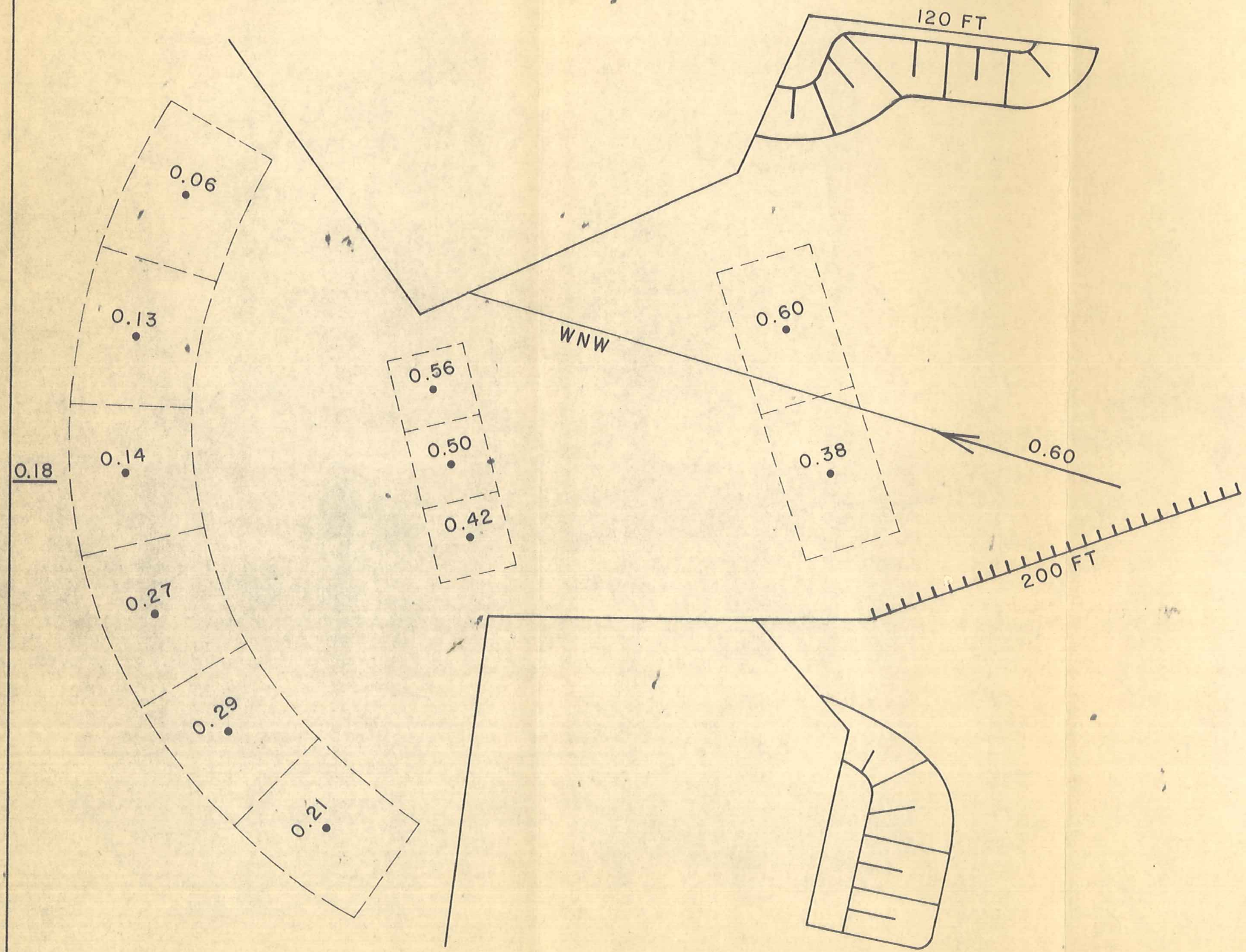


Marina entrance, Harbour Town, Hilton Head Island,	Dwg scale 1:20
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height 0.60 M
Wave Period 3 sec
Wave direction WNW

SHEET No. 34
TEST A – 17





Marina entrance, Harbour Town, Hilton Head Island.	Dwg scale 1:2000
South Carolina	Drawn by B.E.
Model study, Scale 1:45	Chkd by G.V.
Nea Hydraulic, Laboratory, Reykjavík, Iceland.	Oct. 1973

Wave height	0.45 M
Wave Period	3 sec
Wave direction	W/WSW

SHEET No. 35
TEST C – II

10 0 10 20 30 40 50
Dwg scale 1:600

0.10 0 0.50 1.00
Model scale 1:45