

TECHNICAL REPORT HL-80-7

SEABROOK LOCK COMPLEX, LAKE PONTCHARTRAIN, LA. DESIGN FOR WAVE PROTECTION AT LOCK ENTRANCE

Hydraulic Model Investigation

by

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May 1980

Final Report

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20. ABSTRACT (Continued).

breakwater plans involved the placement of either rubble-mound, sheet-pile, or floating structures, or various combinations of these structures arranged to provide wave protection to the lakeward entrance of the proposed lock. An 80-ft-long wave generator and an Automated Data Acquisition and Control System (ADACS) were utilized in model operation. It was concluded from test results that:

- a. Existing conditions are characterized by very rough and turbulent waves in the vicinity of the proposed lock during periods of storm wave attack.
- b. The installation of a rock wave absorber along the vertical and stepped walls in the area will significantly calm wave conditions in the vicinity of the proposed lock.
- c. Wave heights in the proposed lock with no breakwaters installed (Plan 2) would be extremely hazardous (wave heights in excess of 8 ft).
- d. The combined 2,250-ft breakwater length (one outer and two inner breakwaters) of Plan 8 provides wave protection that satisfies the established criterion at the lock entrance and appears to be the most economical rubble-mound breakwater plan tested.
- e. The sheet-pile outer breakwater configurations of Plans 10A, 11B, 12A, and 20A, all in conjunction with two 300-ft-long rubble-mound inner breakwaters, will provide wave protection that meets the established criterion at the lock entrance.
- f. To achieve the established wave-height criterion at the lock entrance with floating structures (providing 50 percent attenuation for waves approaching from a direction perpendicular to the structure), a total breakwater length of 5,088 ft is required (Plan 17C, consisting of two outer and three inner breakwaters).

PREFACE

A request for a model investigation of wave action at the proposed Seabrook Lock, Lake Pontchartrain, Louisiana, was initiated by the District Engineer, U. S. Army Engineer District, New Orleans (LMN). Authorization for the U. S. Army Engineer Waterways Experiment Station (WES) to perform the study was granted by the Office, Chief of Engineers. Funds were authorized by LMN on 3 February 1978.

The model study was conducted at WES during the period April 1978-February 1979 under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory; Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory; Dr. R. W. Whalin, Chief of the Wave Dynamics Division; and Mr. C. E. Chatham, Jr., Chief of the Wave Processes Branch. Testing was performed by Mr. R. R. Bottin, Jr., Project Manager, with the assistance of Mr. H. F. Acuff, Civil Engineering Technician; Mr. R. E. Ankeny, Computer Technician; and SP6 R. J. Seedyk, Jr., U. S. Army. Mr. K. A. Turner, Computer Specialist, was responsible for obtaining wave characteristics at Seabrook by the application of hindcasting techniques. The main text of this report was prepared by Mr. Bottin; Appendix A was prepared by Mr. Turner.

Prior to the model investigation Messrs. Chatham and Bottin visited the LMN office and the Seabrook area to confer with representatives of LMN and to inspect the prototype site. During the course of the investigation, liaison between LMN and WES was maintained by means of conferences, telephone communications, and monthly progress reports.

Messrs. Jay Combe, Cecil Soileau, and Larry Dement of LMN visited WES to observe model operation and participate in conferences during the course of the model study.

COL John L. Cannon, CE, and COL Nelson P. Conover, CE, were Commanders and Directors of WES during the conduct of this investigation and the preparation and publication of this report. Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	25.4	millimetres
feet	0.3048	metres
knots (international)	0.5144444	metres per second
miles per hour (U. S. statute)	1.609344	kilometres per hour
miles (U. S. statute)	1.609344	kilometres
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
square feet	0.09290304	square metres
square miles (U. S. statute)	2.589988	square kilometres

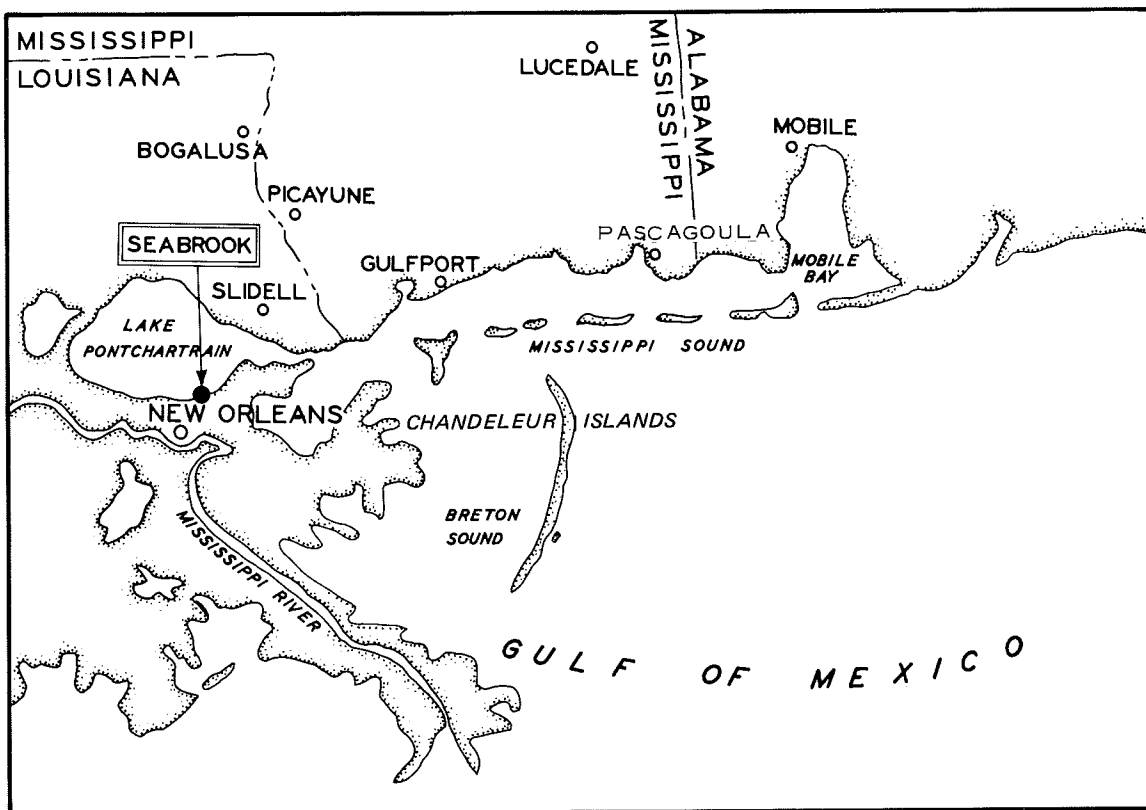


Figure 1. Project location

SEABROOK LOCK COMPLEX, LAKE PONTCHARTRAIN, LA.

DESIGN FOR WAVE PROTECTION AT LOCK ENTRANCE

Hydraulic Model Investigation

PART I: INTRODUCTION

Description of Project

1. The Flood Control Act approved 27 October 1965 authorized a project for hurricane flood protection on Lake Pontchartrain, Louisiana, of which Seabrook Lock (Rock Island District 1977) is a part. The lock complex is proposed for construction on the south shore of Lake Pontchartrain (Figure 1) at its junction with the Inner Harbor Navigation Canal (IHNC) and will consist of three major components: an 84-ft-wide* by 860-ft-long by 16-ft-deep navigation lock, a rock and shell dam, and an outlet structure. All waterborne vessels (recreational small-craft and commercial barge traffic) traveling between Lake Pontchartrain and the IHNC would negotiate the lock.

The Problem

2. The project area (Figure 2) is subjected to storm-generated waves in Lake Pontchartrain (ranging up to 5 ft in height) approaching from northwest, north-northwest, and north. In addition, a vertical seawall on the south shore of the lake tends to reflect a high degree of wave energy back into the lake in the vicinity of the lock site. These conditions could make navigation in the lock entrance difficult and dangerous for waterborne commerce and small-boat traffic.

Proposed Solution

3. The installation of a breakwater lakeward of the lock is

* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

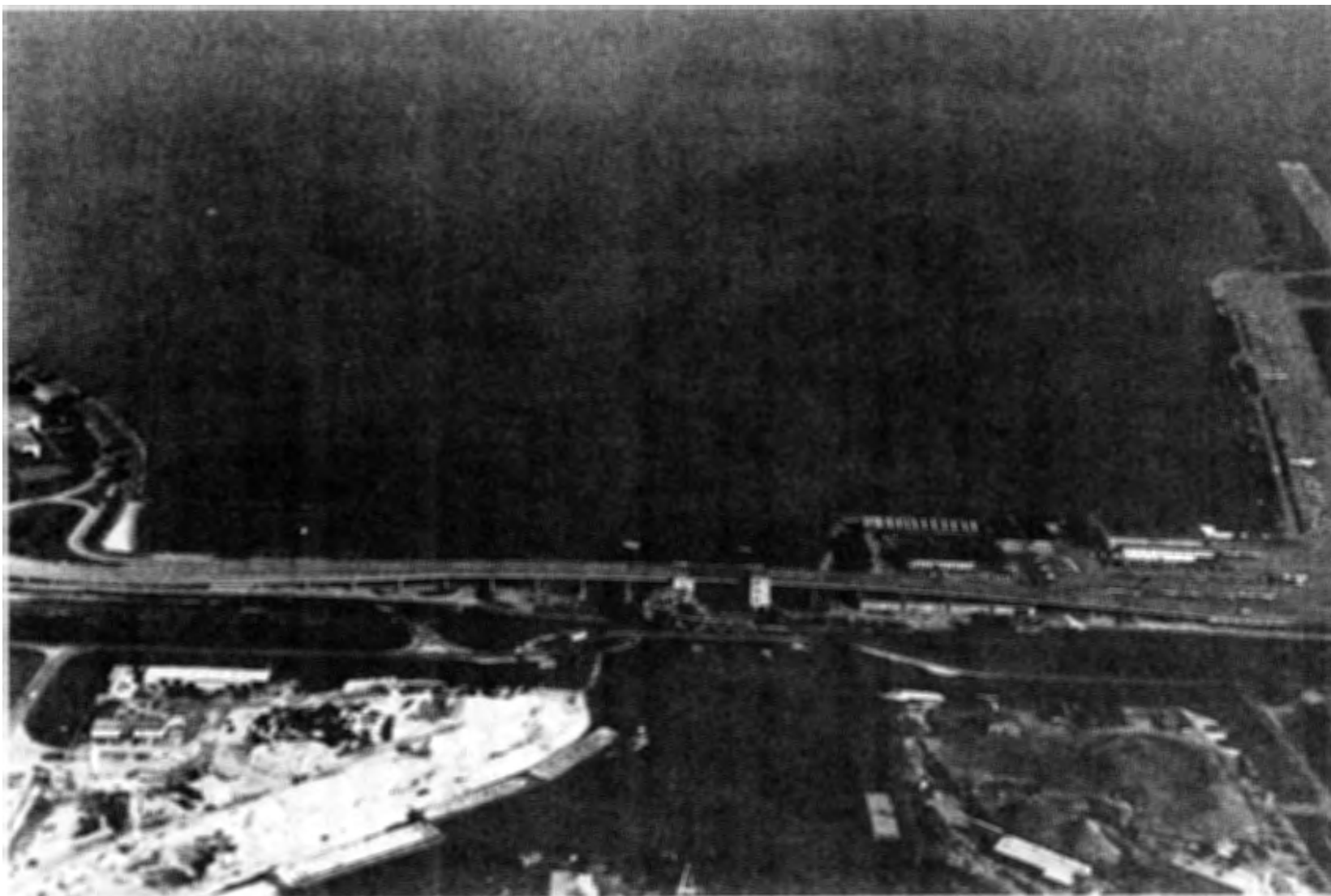


Figure 2. Aerial photograph of proposed lock site

proposed to provide wave protection to the lock entrance. This breakwater could be a fixed-type structure (rubble-mound or cellular sheet pile), a floating structure, or a combination of both. The problem is complicated by the fact that a large hole with depths to 62 ft exists immediately lakeward of the lock. This hole was formed as a result of dredging operations to obtain material for the New Orleans Lakefront Airport. Consideration is being given to installation of a floating breakwater in this vicinity due to the depth of water involved and poor foundation conditions.

Purpose of the Model Study

4. At the request of the U. S. Army Engineer District, New Orleans (LMN), a hydraulic model investigation was initiated by the U. S. Army Engineer Waterways Experiment Station (WES) to:

- a. Determine wave conditions at the lock entrance with no breakwater protection.
- b. Determine the degree of protection afforded by the various proposed breakwater plans.
- c. Develop additional plans as necessary for the alleviation of undesirable wave conditions.
- d. Determine if design modifications of the proposed breakwaters could be made that would reduce construction costs significantly and still provide adequate wave protection.

Wave-Height Criterion

5. For the study reported herein, LMN specified that for an improvement plan to be acceptable, maximum wave heights in the Seabrook Lock entrance should not exceed 2.0 ft. If possible to achieve, however, it is desired that maximum wave heights in the lock entrance not exceed 1.0 ft.

PART II: THE MODEL

Design of Model

6. The Seabrook Lock model (Figure 3) was constructed to an undistorted linear scale of 1:36, model to prototype. Scale selection was based on such factors as:

- a. Depth of water required in the model to prevent excessive bottom friction.
- b. Absolute size of model waves.
- c. Available shelter dimensions and area required for model construction.
- d. Efficiency of model operation.
- e. Available wave-generating and wave-measuring equipment.
- f. Model construction costs.

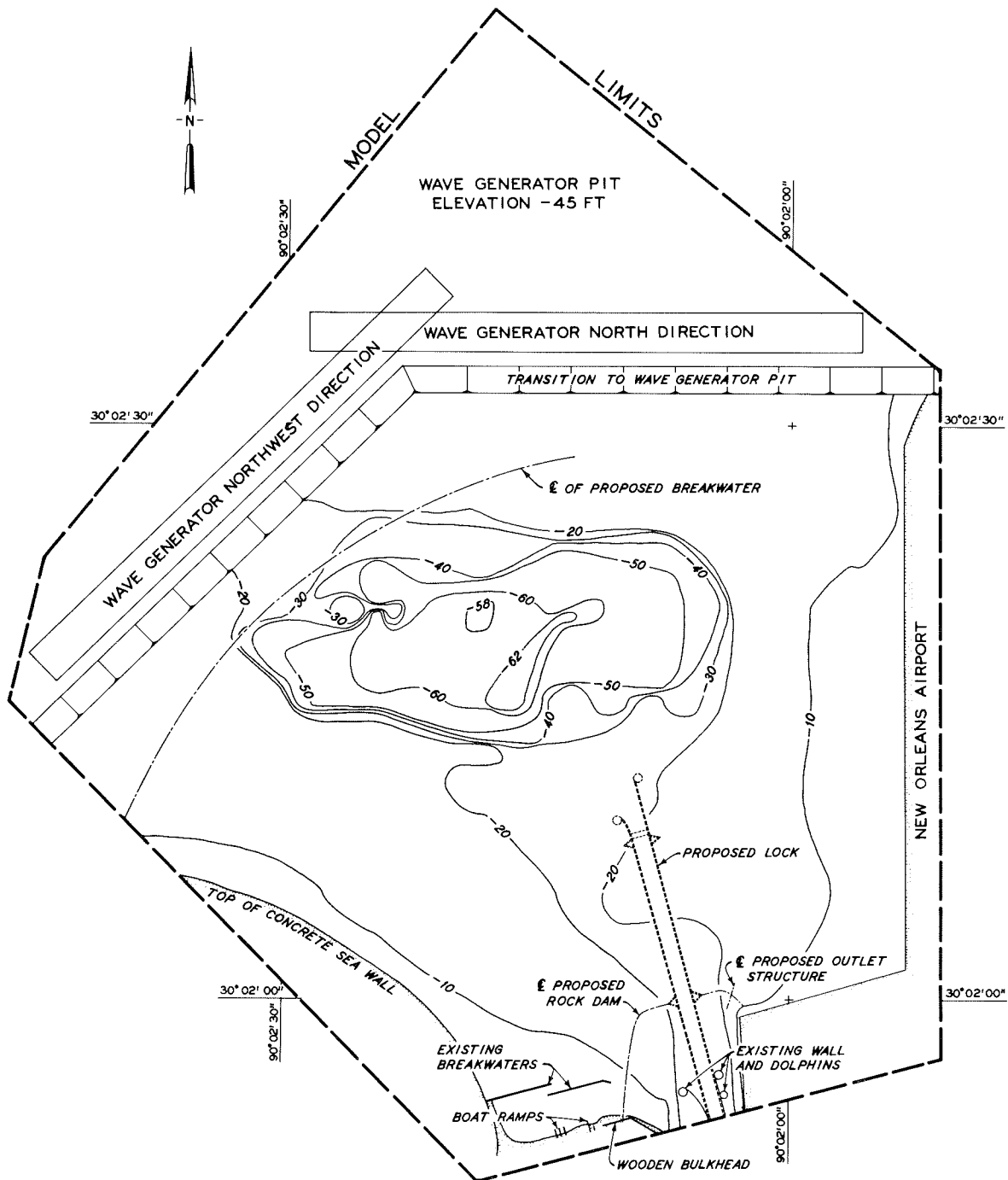
A geometrically undistorted model was necessary to ensure accurate reproduction of short-period wave patterns. Following selection of the linear scale, the model was designed and operated in accordance with Froude's model law (Stevens et al. 1942). The scale relations used for design and operation of the model were as follows:

<u>Characteristic</u>	<u>Dimension*</u>	<u>Model:Prototype Scale Relation</u>
Length	L^{**}	$L_r = 1:36$
Area	L^2	$A_r = L_r^2 = 1:1,296$
Volume	L^3	$V_r = L_r^3 = 1:46,656$
Time	T	$T_r = L_r^{1/2} = 1:6$
Velocity	L/T	$V_r = L_r^{1/2} = 1:6$

* Dimensions are in terms of length and time.

** For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix B).

7. Some of the proposed improvement plans for Seabrook included the use of rubble-mound absorbers and breakwaters. The existing



NOTE: CONTOURS AND ELEVATIONS SHOWN IN FEET
REFERRED TO MEAN LOW GULF LEVEL WHICH
IS 0.78 FEET BELOW MEAN SEA LEVEL.

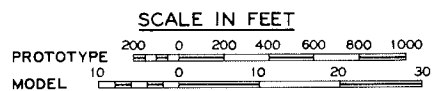


Figure 3. Model layout

revetments also are rubble-mound structures. Based on past experience, 1:36-scale model structures should not create sufficient scale effects to warrant geometric distortion of rock sizes in order to ensure proper transmission and reflection of wave energy. Therefore, rock size selection was based on linear scale relations and an assumed specific weight of 165 lb/ft³ for the prototype rock.

8. Other proposed improvement plans involved the use of steel sheet-pile structures and/or 54-in. prestressed cylinders. In the model these structures were considered to be impervious and were constructed of wood and/or sheet metal.

9. Some proposed improvement plans included the use of floating breakwater structures. Selection of floating model structures was based on the results of two-dimensional wave transmission tests conducted at a 1:36 scale using 4-sec, 4- and 5-ft waves approaching from a direction normal to the structure and a 40-ft depth. A breakwater cross section was selected that provided a transmission coefficient of 0.5 (50 percent attenuation). While these structures (prototype dimensions 96 ft long by 63 ft wide by 6 ft high) were constructed of marine plywood in the model, they could represent any type of floating breakwater that gives 50 percent attenuation.

The Model and Appurtenances

10. The model, which was molded in cement mortar, reproduced the proposed Seabrook Lock Complex, the IHNC at its junction with Lake Pontchartrain, portions of the New Orleans Lakefront Airport and the stepped seawall adjacent to Lakeshore Drive, and underwater contours in Lake Pontchartrain to an offshore depth of 18 ft* (including the -62 ft dredged area) with a sloping transition to the wave generator pit elevation of -45 ft. The total area reproduced in the model was approximately 14,420 sq ft, representing about 0.67 square miles in the prototype. A

* All elevations (el) cited herein are in feet referred to mean low gulf level (mlg) unless otherwise stated.

general view of the model is shown in Figure 4. Vertical control for model construction was based on mgl, el 0.78 ft below mean sea level (msl). Horizontal control was referenced to a local prototype grid system.

11. Model waves were generated by an 80-ft-long piston-type wave generator. The horizontal movement of the piston plate caused a periodic displacement of water incident to this motion. The length of the stroke and the frequency of the piston plate movement were variable over the range necessary to generate waves with the required characteristics. In addition, the wave generator was mounted on retractable casters which enabled it to be positioned to generate waves from the required directions.

12. An Automated Data Acquisition and Control System (ADACS), designed and constructed at WES (Figure 5), was used to secure wave-height data at selected locations in the model. Basically, through the use of a minicomputer, ADACS recorded onto magnetic tape the electrical output of parallel-wire, resistance-type wave gages that measured the change in water-surface elevation with respect to time. The magnetic tape output of ADACS then was analyzed to obtain the wave-height data.

13. A 2-ft (horizontal) solid layer of fiber wave absorber was placed around the inside perimeter of the model to damp any wave energy that might otherwise be reflected from the model walls. In addition, guide vanes were placed along the wave generator sides to ensure proper formation of the wave train incident to the model contours.

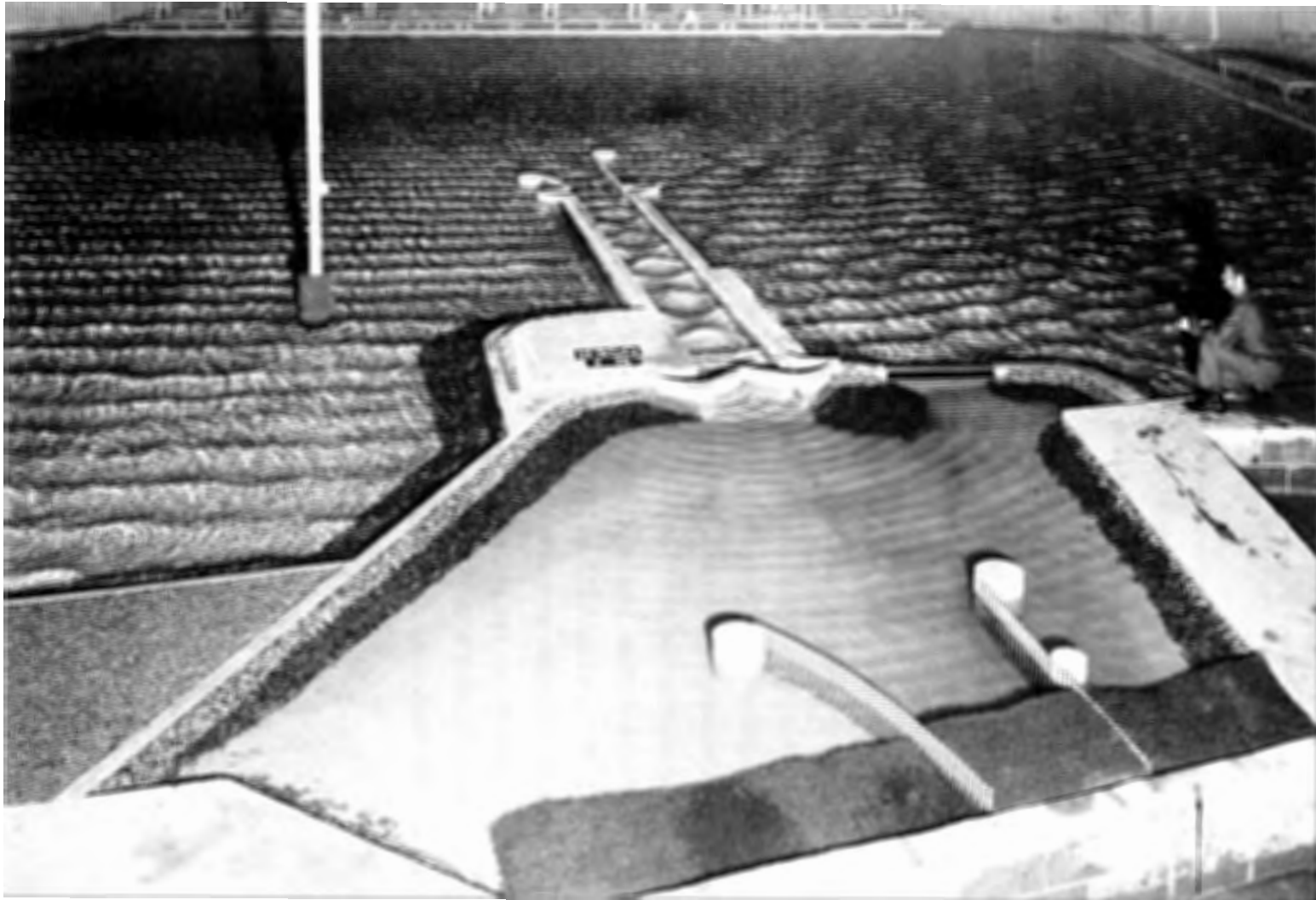


Figure 4. General view of model

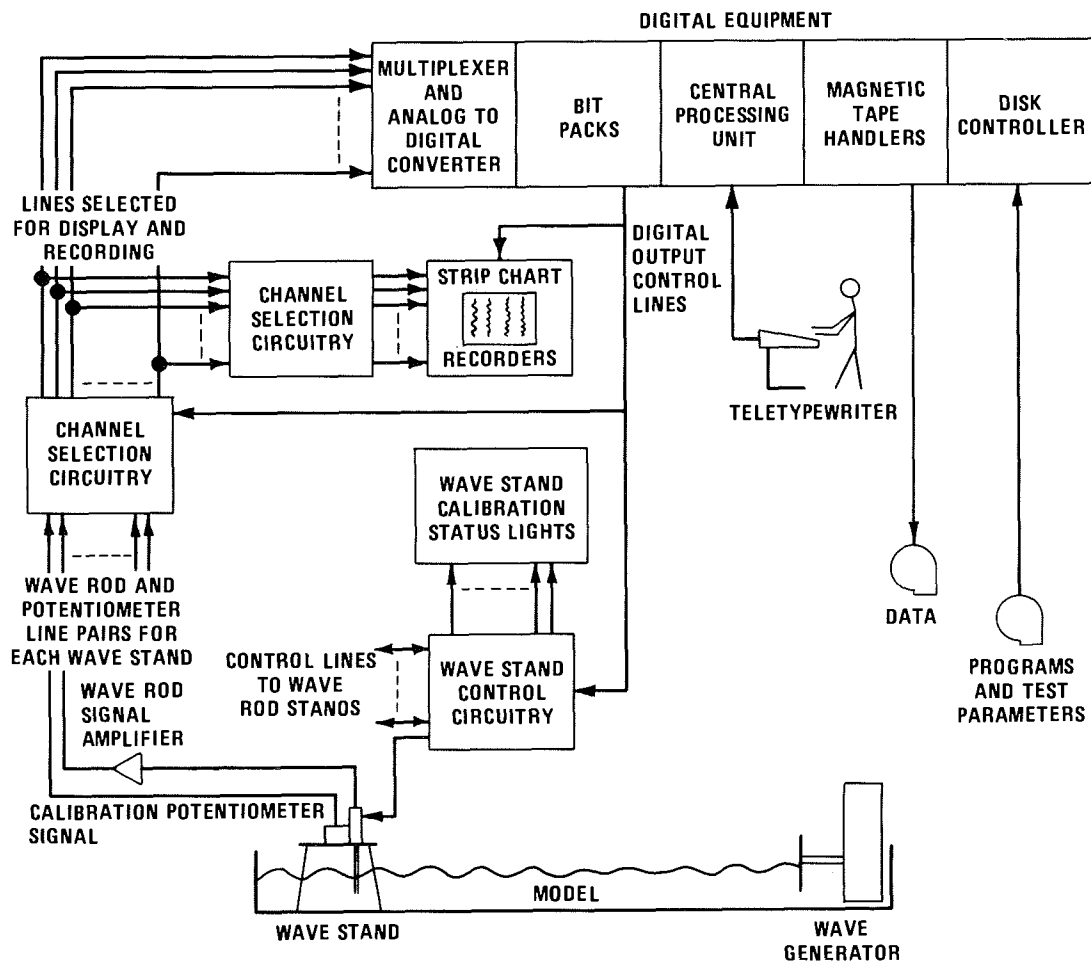


Figure 5. Automated Data Acquisition and Control System (ADACS)

PART III: TEST CONDITIONS AND PROCEDURES

Selection of Test Conditions

Still-water level

14. Still-water levels (swl's) for wave-action models are selected so that various wave-induced phenomena dependent on water depths are accurately reproduced in the model. These phenomena include the refraction of waves in the problem area, overtopping of various structures by waves, reflection of wave energy from various structures, and transmission of wave energy through porous structures.

15. It was desirable to select a model swl that closely approximated the higher water stages which normally occur in the prototype for the following reasons:

- a. The maximum amount of wave energy reaching a coastal area normally occurs during the higher water phase of the local tide cycle.
- b. Most storms moving onshore are characteristically accompanied by a higher water level due to wind tide and shoreward mass transport.
- c. The selection of a high swl helps minimize model scale effects due to viscous bottom friction.

16. Still-water levels of +1.0 and +4.0 ft msl were selected by LMN for use during model testing. The lower value (+1.0 ft) represents mean high gulf level (+0.8 ft) with a 0.2-ft short period rise in local water level due to wind tide, and the higher value (+4.0 ft) represents a lake level that occurs about once a year.

Factors influencing selection of test wave characteristics

17. In planning the testing program for a model investigation of wave-action problems, it is necessary to select dimensions and directions for the test waves that will allow a realistic test of proposed improvement plans and an accurate evaluation of the elements of the various plans. Surface wind waves are generated primarily by the interactions between tangential stresses of wind flowing over water, resonance

between the water surface and atmospheric turbulence, and interactions between individual wave components. The height and period of the maximum wave that can be generated by a given storm depends on the wind speed, the length of time that wind of a given speed continues to blow, and the water distance (fetch) over which the wind blows. Selection of test conditions entails evaluation of such factors as:

- a. The fetch and decay distances (the latter being the distance over which waves travel after leaving the generating area) for various directions from which waves can attack the problem area.
- b. The frequency of occurrence and duration of storm winds from the different directions.
- c. The window(s) from which the site is exposed to wave action.
- d. The alignments, lengths, and locations of various reflecting surfaces at the site.
- e. The refraction of waves caused by differentials in depth in the area seaward of the site, which may create either a concentration or diffusion of wave energy.

Wave refraction

18. When waves move into water of gradually decreasing depth, transformations take place in all wave characteristics except wave period. The most important transformations with respect to selection of test wave characteristics are the changes in wave height and direction of travel due to the phenomenon referred to as wave refraction. The change in wave height and direction can be determined by plotting refraction diagrams and calculating refraction coefficients. These diagrams are constructed by plotting the position of wave orthogonals (lines drawn perpendicular to wave crests) from deep water into shallow water. If it is assumed that waves do not break and there is no lateral flow of energy along the wave crest, the ratio between the wave height in deep water (H_o) and the wave height at any point in shallow water (H) is inversely proportional to the square root of the ratio of the corresponding orthogonal spacings (b_o and b), or $H/H_o = K_s (b_o/b)^{1/2}$. The quantity $(b_o/b)^{1/2}$ is the refraction coefficient, K_r ; K_s is the shoaling coefficient. Thus, the refraction coefficient multiplied

by the shoaling coefficient gives a conversion factor for transfer of deepwater wave heights to shallow-water values. The shoaling coefficient, which is a function of wavelength and water depth, can be obtained from the Shore Protection Manual (CERC 1977).

19. Due to the limited depth in Lake Pontchartrain (-18 ft) and the limited fetch (20 miles), a wave-refraction analysis was not conducted for the Seabrook Lock site. The magnitude and direction of winds approaching Seabrook from over the lake were considered to be the governing factors and all waves were assumed to be locally generated. For this study, critical directions of wave approach were determined to be north, north-northwest, and northwest.

Prototype wave data and
selection of test waves

20. Measured prototype wave data on which a comprehensive statistical analysis of wave conditions could be based were unavailable for the Seabrook area. However, statistical wave hindcast data representative of this area were obtained by the application of hindcasting techniques from CERC (1977) to wind data acquired at the New Orleans International Airport as detailed in Appendix A. Model test waves were selected from these data as shown in the following tabulation:

<u>Direction</u>	<u>Wave Period sec</u>	<u>Wave Height ft</u>
North	3	2
		4
	4	5
North-northwest	3	2
		4
	4	4
Northwest	3	2
		4
	4	4

Analysis of Model Data

21. Relative merits of the various plans tested were evaluated by:

- a. Comparison of wave heights at selected locations in the model.
- b. Visual observations and wave pattern photographs.

In analyzing the wave-height data, the average height of the highest one third of the waves recorded at each gage location was computed. Computed wave heights were adjusted to compensate for excess model attenuation due to viscous bottom friction by application of Keulegan's equation (Keulegan 1950). From this equation, reduction of wave heights in the model (relative to the prototype) can be calculated as a function of water depth, width of wave front, wave period, water viscosity, and distance of wave travel.

PART IV: TESTS AND RESULTS

The Tests

Existing conditions

22. Prior to tests of the various improvement plans, comprehensive tests were conducted for existing conditions. Wave-height data were obtained at the site of the proposed lock and at other locations in the model (Plate 1) for the test waves listed in paragraph 20. Wave pattern photographs were secured for representative test waves.

Prebreakwater conditions and improvement plans

23. Wave-height tests were conducted for 2 prebreakwater conditions (Plans 1 and 2) and for 61 variations in the design elements of various breakwater concepts. Fixed breakwaters (rubble-mound and vertical-wall sheet-pile) and floating breakwaters were tested with variations consisting of changes in the lengths, alignments, crest elevations, and/or cross sections of the structures. Wave pattern photographs were obtained for prebreakwater conditions and the more important breakwater plans. Brief descriptions of the test plans are presented in the following subparagraphs; dimensional details are presented in Plates 2-25.

- a. Plan 1 (Plate 2) consisted of a rock absorber installed along the vertical walls of the New Orleans Lakefront Airport, the stepped concrete seawall west of the proposed lock, and the two existing breakwaters west of the navigation entrance to the Inner Harbor Navigation Canal.
- b. Plan 2 (Plate 3) involved the installation of the proposed lock complex including the 84-ft-wide, 860-ft-long lock, the outlet structure, rock dam, and public parking area. The rock absorber installed for Plan 1 was removed.
- c. Plan 3 (Plate 4) entailed the elements of Plan 2 with two curved rubble-mound breakwaters (aggregate length of 4,500 ft) separated by a 600-ft-wide entrance. The breakwaters were shore-connected at the New Orleans Lakefront Airport and the stepped seawall west of the proposed lock.

- d. Plan 3A (Plate 4) consisted of the elements of Plan 3 with the entrance decreased to 300 ft (increasing the length of the structure to 4,800 ft).
- e. Plan 4 (Plate 5) entailed the elements of Plan 3A except that the entrance between the east and west breakwaters was closed and 1,000 ft of breakwater length was removed from the west end of the west breakwater, resulting in a single 4,100-ft-long rubble-mound structure.
- f. Plan 4A (Plate 5) involved the elements of Plan 4 with an additional 200 ft of breakwater length removed from the western end, resulting in a total breakwater length of 3,900 ft.
- g. Plan 4B (Plate 5) entailed the elements of Plan 4A with an additional 200 ft of breakwater length removed from the western end, resulting in a total breakwater length of 3,700 ft.
- h. Plan 4C (Plate 5) consisted of the elements of Plan 4B with an additional 200 ft of breakwater length removed from the western end, resulting in a total breakwater length of 3,500 ft.
- i. Plan 5 (Plate 6) involved the elements of Plan 4C with 500 ft of breakwater length removed from the eastern end of the rubble-mound structure, resulting in a 3,000-ft-long breakwater.
- j. Plan 5A (Plate 6) entailed the elements of Plan 5 with an additional 300 ft of breakwater length removed from the eastern end, resulting in a total breakwater length of 2,700 ft.
- k. Plan 5B (Plate 6) consisted of the elements of Plan 5A with an additional 200 ft of breakwater length removed from the eastern end, resulting in a total breakwater length of 2,500 ft.
- l. Plan 6 (Plate 7) entailed the elements of Plan 5B with a 300-ft-long rubble-mound inner breakwater installed east of and parallel to the east guide wall at the lock entrance, resulting in a total combined breakwater length of 2,800 ft.
- m. Plan 6A (Plate 7) involved the elements of Plan 6 with 200 ft of breakwater length removed from the eastern end of the outer breakwater, thus reducing the total combined breakwater length to 2,600 ft.
- n. Plan 6B (Plate 7) consisted of the elements of Plan 6A with an additional 200 ft of breakwater length removed from the eastern end of the outer structure, resulting in a total combined breakwater length of 2,400 ft.

- o. Plan 7 (Plate 8) consisted of the elements of Plan 6B with the installation of a 300-ft-long rubble-mound inner breakwater west of the west guide wall at the lock entrance and 330 ft from the east inner breakwater, resulting in a total combined breakwater length of 2,700 ft.
- p. Plan 7A (Plate 8) entailed the elements of Plan 7 with 100 ft of breakwater length removed from the western end of the outer breakwater, thus reducing the total combined breakwater length to 2,600 ft.
- q. Plan 7B (Plate 8) involved the elements of Plan 7A with an additional 100 ft of breakwater length removed from the western end of the outer structure, resulting in a total combined breakwater length of 2,500 ft.
- r. Plan 7C (Plate 8) consisted of the elements of Plan 7B with an additional 200 ft of breakwater length removed from the western end of the outer breakwater, resulting in a total combined breakwater length of 2,300 ft.
- s. Plan 7D (Plate 8) entailed the elements of Plan 7C with an additional 100 ft of breakwater length removed from the western end of the outer structure, resulting in a total combined breakwater length of 2,200 ft.
- t. Plan 8 (Plate 9) involved the elements of Plan 7D with 50 ft of breakwater length added to the eastern end of the outer breakwater, resulting in a total breakwater length of 2,250 ft.
- u. Plan 9 (Plate 10) consisted of the removal of the 1,650-ft-long outer breakwater of Plan 8, thus leaving only the two 300-ft-long inner breakwaters.
- v. Plan 10 (Plate 11) entailed the elements of Plan 9 with the installation of a 1,650-ft-long sheet-pile outer breakwater installed on the same alignment as the Plan 8 rubble-mound structure. The sheet-pile outer structure was 4.5 ft wide with a +10 ft crest elevation (el).
- w. Plan 10A (Plate 11) involved the elements of Plan 10 with the addition of 100 ft in length at the eastern end of the outer breakwater, resulting in a sheet-pile breakwater length of 1,750 ft.
- x. Plan 11 (Plate 12) consisted of the elements of Plan 10A except the outer breakwater crest elevation was reduced from +10 to +6 ft.
- y. Plan 11A (Plate 12) entailed the elements of Plan 11 with the addition of 100 ft in length at the eastern end of the outer structure, resulting in a sheet-pile breakwater length of 1,850 ft.
- z. Plan 11B (Plate 12) involved the elements of Plan 11A with

the addition of 100 ft in length at the western end of the outer breakwater, resulting in a sheet-pile breakwater length of 1,950 ft.

- aa. Plan 12 (Plate 13) consisted of a 1,650-ft-long vertical-wall outer breakwater installed on the same alignment as Plan 10. The structure was 20 ft wide with a +6 ft crest elevation and a rubble fillet on the lakeward side. The two 300-ft-long rubble-mound inner breakwaters were also part of this plan.
- bb. Plan 12A (Plate 13) entailed the elements of Plan 12 with the addition of 100 ft in length at the eastern end of the outer structure, resulting in an outer breakwater length of 1,850-ft.
- cc. Plan 13 (Plate 14) involved the elements of Plan 10A (1,750-ft-long outer sheet-pile breakwater and two rubble-mound inner breakwaters) with the 300-ft-long rubble-mound inner breakwater installed west of the lock entrance removed.
- dd. Plan 13A (Plate 14) consisted of the elements of Plan 13 with the addition of 200 ft in length to the western end of the outer breakwater, resulting in a 1,950-ft-long outer sheet-pile breakwater.
- ee. Plan 13B (Plate 14) involved the elements of Plan 13A with the addition of 200 ft in length to the western end of the outer breakwater, resulting in a sheet-pile breakwater length of 2,150 ft.
- ff. Plan 13C (Plate 14) entailed the elements of Plan 13B with the addition of 200 ft in length to the western end of the outer structure, resulting in a sheet-pile breakwater length of 2,350 ft.
- gg. Plan 14 (Plate 15) consisted of the elements of Plan 13C with a 288-ft-long floating breakwater installed west of and parallel to the west guide wall at the lock entrance.
- hh. Plan 14A (Plate 15) entailed the elements of Plan 14 with 200 ft of breakwater length removed from the western end of the outer structure, resulting in a sheet-pile breakwater length of 2,150 ft.
- ii. Plan 15 (Plate 16) consisted of a straight, 2,208-ft-long floating outer breakwater with the 300-ft-long rubble-mound inner breakwater east of and parallel to the lock entrance.
- jj. Plan 15A (Plate 16) entailed the elements of Plan 15 with a 384-ft-long floating structure installed northwest of the lock entrance. For this and subsequent floating breakwater plans, total floating breakwater lengths are shown on the referenced plates.

- kk. Plan 15B (Plate 16) involved the elements of Plan 15A with 192 ft of breakwater length added to the north end of the 384-ft-long floating structure.
- ll. Plan 15C (Plate 16) consisted of the elements of Plan 15B with the addition of a 288-ft-long floating structure installed west of and parallel to the lock entrance.
- mm. Plan 15D (Plate 16) involved the elements of Plan 15A with the 288-ft-long floating structure installed west of and parallel to the lock entrance.
- nn. Plan 15E (Plate 16) entailed the elements of Plan 15D, but the 384-ft-long floating breakwater installed north-west of the lock entrance was removed.
- oo. Plan 15F (Plate 17) consisted of the elements of Plan 15 with a 480-ft-long floating breakwater installed near the outer breakwater.
- pp. Plan 15G (Plate 18) entailed the elements of Plan 15 with a 480-ft-long floating breakwater installed near the lock entrance.
- qq. Plan 15H (Plate 18) involved the elements of 15G with 96 ft of breakwater length removed from the eastern end of the outer floating structure.
- rr. Plan 15I (Plate 18) entailed the elements of Plan 15H with an additional 96 ft of breakwater length removed from the eastern end of the outer floating structure.
- ss. Plan 16 (Plate 18) consisted of the elements of Plan 15H with the 300-ft-long rubble-mound inner breakwater structure removed.
- tt. Plan 16A (Plate 19) entailed the elements of Plan 16 with a 288-ft-long floating breakwater installed east of and parallel to the lock entrance.
- uu. Plan 16B (Plate 19) involved the elements of Plan 16A with a 384-ft-long floating structure installed northeast of the lock entrance.
- vv. Plan 16C (Plate 19) consisted of the elements of Plan 16B with the 288-ft-long floating breakwater parallel to the lock entrance removed.
- ww. Plan 16D (Plate 20) entailed the elements of Plan 16 with a 576-ft-long floating breakwater installed northeast of the lock entrance.
- xx. Plan 17 (Plate 21) consisted of the elements of Plan 16B with a 960-ft-long floating breakwater installed parallel to and shoreward of the outer breakwater.

- yy. Plan 17A (Plate 21) involved the elements of Plan 17 but the 288-ft-long floating breakwater installed east of and parallel to the lock entrance was increased to 384 ft in length.
- zz. Plan 17B (Plate 22) entailed the elements of Plan 17A with the 960-ft-long floating breakwater increased to 1,344 ft in length (192 ft added on each end).
- aaa. Plan 17C (Plate 22) involved the elements of Plan 17B but the 1,344-ft-long floating breakwater increased to 1,728 ft in length (192 ft again added on each end).
- bbb. Plan 18 (Plate 23) consisted of the elements of Plan 17C but the 1,728-ft-long floating breakwater was decreased to 864 ft in length (432 ft removed on each end). An additional 864-ft-long floating breakwater was installed parallel to and lakeward of the outer floating structure.
- ccc. Plan 19 (Plate 24) included a curved 2,050-ft-long sheet-pile outer breakwater (similar to Plan 11B with slightly different alignment) with one 325-ft-long sheet-pile inner breakwater installed east of and parallel to the east guide wall at the lock entrance and one 300-ft-long sheet-pile inner breakwater installed west of the west guide wall at the lock entrance. The inner breakwaters were spaced 300 ft apart and all the sheet-pile structures were 5.5 ft wide with a crest elevation of +6 ft.
- ddd. Plan 19A (Plate 24) entailed the elements of Plan 19 with the addition of 100 ft in length at the eastern end of the outer breakwater.
- eee. Plan 19B (Plate 24) involved the elements of Plan 19A with the addition of 100 ft in length at the eastern end of the outer breakwater.
- fff. Plan 19C (Plate 24) involved the elements of Plan 19B with the addition of 100 ft in length at the eastern end of the outer breakwater.
- ggg. Plan 19D (Plate 24) entailed the elements of Plan 19C with the addition of 100 ft in length to the western end of the outer breakwater.
- hhh. Plan 19E (Plate 24) involved the elements of Plan 19D with the addition of 100 ft in length to the western end of the outer breakwater.
- iii. Plan 19F (Plate 24) consisted of the elements of Plan 19E with the addition of 100 ft in length to the western end of the outer breakwater.
- jjj. Plan 20 (Plate 25) consisted of the outer breakwater of

Plan 19 with two 300-ft-long rubble-mound inner breakwaters installed parallel to the lock entrance and 360 ft apart.

kkk. Plan 20A (Plate 25) entailed the elements of Plan 20 with the addition of 100 ft in length to the eastern end of the outer breakwater.

Wave-height tests

24. Wave-height tests for prebreakwater conditions (Plans 1 and 2) and the major breakwater improvement plans (Plans 8, 9, 17C, and 20A) were conducted using test waves from all three test directions (i.e. N, NNW, and NW). Tests involving modifications to the various breakwaters were limited to the most critical directions of wave approach. Wave gage locations for the various test plans are shown in Plates 2-25.

Tests conducted for intermediate stages of lock construction

25. After completion of model testing of the various improvement plans, LMN requested that tests be conducted to determine wave heights in the temporary entrance and mooring areas that will be used during various phases of lock construction. Results of these tests will be published in a separate report.

Test Results

26. In evaluating test results, the relative merits of each plan were based on an analysis of measured wave heights. Model wave heights (significant wave height or $H_{1/3}$) were tabulated (Tables 1-32) to show measured values at selected locations.

Existing conditions

27. Wave-height measurements obtained for existing conditions are presented in Table 1. For the +1 ft swl, maximum wave heights obtained at the proposed location of the lakeward lock entrance (gage 6) were 5.4 ft for 4-sec, 4-ft waves from NW and at the proposed location of the inner lock entrance (gage 3) were 5.9 ft for 4-sec, 4-ft waves from NW and 4-sec, 5-ft waves from N. For the +4 ft swl, maximum wave heights at the proposed location of the lakeward lock entrance (gage 6)

were 6.1 ft for 4-sec, 4-ft waves from NNW and at the proposed location of the inner entrance (gage 3) were 6.4 ft for 4-sec, 5-ft waves from N. Typical wave patterns obtained for existing conditions are shown in Photos 1-7.

Prebreakwater conditions
and improvement plans

28. Results of wave-height tests with Plan 1 installed in the model are presented in Table 2. For the +1 ft swl, maximum wave heights were 4.1 ft at the proposed location of the lakeward lock entrance (gage 6) and 4.8 ft at the proposed location of the inner lock entrance (gage 3), both occurring for 4-sec, 5-ft test waves from N. For the +4 ft swl, maximum wave heights were 4.8 ft at the proposed location of the lakeward lock entrance (gage 6) and 5.2 ft at the proposed location of the inner lock entrance (gage 3), both occurring for 4-sec, 5-ft test waves from N. Typical wave patterns obtained for Plan 1 are shown in Photos 8-14.

29. Wave heights secured with Plan 2 installed with the lakeward lock gates open and the rear lock gates closed are presented in Table 3. For the +1 ft swl, maximum wave heights were 7.1 ft at the lakeward lock entrance (gage 6) and 8.4 ft at the rear of the lock (gage 3), both for 4-sec, 5-ft test waves from N. For the +4 ft swl, maximum wave heights were 6.3 ft in the lakeward lock entrance (gage 7) and 8.5 ft in the rear of the lock, again for 4-sec, 5-ft test waves from N. Results of wave-height tests for Plan 2 with the lakeward lock-entrance gates closed are presented in Table 4. Maximum wave heights obtained were 9.6 ft and 10.0 ft (gage 6) for the +1 and +4 ft swl's, respectively (both occurring for 4-sec, 5-ft test waves from N). Typical wave patterns obtained for Plan 2 with the lakeward lock gates open are shown in Photos 15-21.

30. Wave-height measurements obtained for Plan 3 for test waves from NW and NNW with the lakeward lock gates open and the rear lock gates closed are presented in Table 5. For the +1 ft swl, maximum wave heights were 3.8 ft at the lakeward lock entrance (gage 7) for 4-sec, 4-ft waves from NW and 3.5 ft at the rear of the lock (gage 3) for 4-sec, 4-ft waves from NNW. For the +4 ft swl, maximum wave heights

were 3.3 ft in the lakeward lock entrance for 3-sec, 4-ft test waves from NNW and 5.2 ft in the rear of the lock for 4-sec, 4-ft test waves from NNW. Results of wave-height tests for Plan 3 with both lock gates closed are presented in Table 6. Maximum wave heights obtained for the +1 ft swl were 4.4 ft for 4-sec, 4-ft waves from NNW. For the +4 ft swl, maximum wave heights were 3.2 ft for 3-sec, 4-ft waves from NNW and 4-sec, 4-ft waves from NW.

31. Results of wave-height tests obtained for Plan 3A for test waves from NNW are presented in Tables 7 and 8. With the lakeward lock gates open and the rear lock gates closed and the +1 ft swl, maximum wave heights were 3.3 ft at the lakeward lock entrance (gage 6) and 2.8 ft at the rear of the lock (gage 3) for 4-sec, 4-ft test waves. For the +4 ft swl, maximum wave heights were 2.1 ft at the lakeward lock entrance (gage 7) for 3-sec, 4-ft and 4-sec, 4-ft test waves and 4.0 ft at the rear of the lock for 4-sec, 4-ft test waves. With the lakeward lock entrance gates closed, maximum wave heights of 3.9 ft were recorded at gage 6 for 4-sec, 4-ft test waves for both the +1 and +4 ft swl's. Typical wave patterns obtained for Plan 3A with the lakeward lock gates open are shown in Photos 22-27.

32. Results of wave-height tests conducted for Plans 4-4C with the lakeward lock gates open for 4-sec, 4-ft test waves from NW with the +1 ft swl are presented in Table 9. A curve depicting maximum wave height at the lakeward lock entrance versus length of breakwater removed is shown in Plate 26. Plan 4C (removal of 1,600 ft of breakwater) resulted in a maximum wave height of 1.9 ft in the lakeward lock entrance (gage 6).

33. Results of wave-height measurements for Plans 5-5B with the lakeward lock gates open installed for 4-sec, 5-ft test waves from N are presented in Table 10. Again a curve was plotted depicting maximum wave height at the lakeward lock entrance versus length of breakwater removed and is shown in Plate 27. Plan 5B (removal of 1,000 ft of breakwater) resulted in a maximum wave height of 1.8 ft in the lakeward lock entrance (gage 7) for the +1 ft swl. For the +4 ft swl, a maximum wave height of 1.5 ft (gage 7) was obtained.

34. Wave heights obtained for Plans 6-6B with the lakeward lock gates open for 4-sec, 5-ft waves from N are presented in Table 11. A curve showing maximum wave height at the lakeward lock entrance versus length of breakwater removed is presented in Plate 28. A maximum wave height of 2.1 ft (gage 7) was obtained for Plan 6B (removal of 1,400 ft of breakwater). For 4-sec, 4-ft test waves from NW (Table 11), Plan 6B yielded a maximum wave height of 1.6 ft (gage 6).

35. Results of wave-height measurements obtained for Plans 7-7D with the lakeward lock gates open for test waves from NW are presented in Table 12. A maximum wave height of 1.7 ft was obtained in the lakeward lock entrance (gage 7) for Plan 7D for 3-sec, 4-ft test waves with the +4 ft swl. For the +1 ft swl, the maximum wave height obtained for Plan 7D in the lakeward lock entrance was 1.5 ft, also for 3-sec, 4-ft test waves.

36. Results of wave-height tests conducted for Plans 7D and 8 with the lakeward lock gates open for representative test waves from N are presented in Table 13. A maximum wave height of 2.5 ft was obtained in the lakeward lock entrance (gage 7) with Plan 7D installed for 4-sec, 5-ft test waves with the +4 ft swl; while a maximum wave height of 1.7 ft was obtained in the lakeward lock entrance for Plan 8 for several of the waves.

37. Results of comprehensive wave-height tests conducted for Plan 8 are presented in Tables 14 and 15. With the lakeward lock gates open and the rear lock gates closed (Table 14), the maximum wave height at the lakeward lock entrance (gage 7) was 1.7 ft for several of the test waves for both the +1 and +4 ft swl's. The maximum wave height at the rear of the lock (gage 3) was 1.8 ft for 4-sec, 5-ft test waves from N with the +1 ft swl. For the +4 ft swl, the maximum wave height at the rear of the lock was 1.0 ft (gage 3) for 4-sec, 5-ft test waves from N. With both lock gates closed (Table 15), the maximum wave height obtained between the guide walls for the +1 ft swl was 1.7 ft (gage 7) for 3-sec, 4-ft test waves from NW. For the 4-ft swl, the maximum wave height between the guide walls was 2.1 ft (gage 7) for 4-sec, 5-ft test waves

from N. Typical wave patterns for Plan 8 with the lakeward lock gates open are shown in Photos 28-41.

38. Results of wave-height measurements obtained for Plan 9 with the lakeward lock gates open and the rear lock gates closed are presented in Table 16. For the +1 ft swl, maximum wave heights were 4.7 ft at the lakeward lock entrance (gage 7) for 4-sec, 5-ft waves from N and 6.0 ft at the rear of the lock (gage 3) for 4-sec, 4-ft waves from NNW. For the +4 ft swl, maximum wave heights were 5.7 ft in the lakeward lock entrance (gage 7) and 8.1 ft in the rear of the lock for 4-sec, 5-ft waves from N. Wave heights for Plan 9 with both lock gates closed are presented in Table 17. The maximum wave height obtained between the guide walls for the +1 ft swl was 6.9 ft (gage 6) for 4-sec, 4-ft waves from NNW. For the +4 ft swl, the maximum wave height obtained between the guide walls was 5.1 ft for 4-sec, 5-ft test waves from N and 4-sec, 4-ft waves from NNW. Typical wave patterns obtained for Plan 9 with the lakeward lock gates open are shown in Photos 42-48.

39. Wave-height data obtained for Plans 10 and 10A with the lakeward lock gates open are presented in Table 18 for test waves from N. For the +1 ft swl, maximum wave heights of 0.9 ft and 0.7 ft were obtained in the immediate lakeward lock entrance (gage 6) and maximum wave heights of 1.9 and 1.5 ft were obtained between the guide walls (gage 7) for Plans 10 and 10A, respectively. For the +4 ft swl, maximum wave heights of 1.4 ft and 0.9 ft in the immediate lakeward lock entrance and 2.4 ft and 1.8 ft between the guide walls were obtained for Plans 10 and 10A, respectively. Results of wave-height tests for Plan 10A for test waves from NW are also shown in Table 18. For the +1 ft swl, the maximum wave height obtained in the immediate lakeward lock entrance was 0.9 ft and the maximum wave height obtained between the guide walls was 1.2 ft. For the +4 ft swl, maximum wave heights were 0.9 ft in the immediate lakeward lock entrance and 1.4 ft between the guide walls for Plan 10A. Typical wave patterns secured for Plan 10A with the lakeward lock gates open are shown in Photos 49-54.

40. Results of wave-height tests obtained for Plans 11-11B with the lakeward lock gates open are presented in Table 19. Tests were conducted

for Plans 11 and 11A for test waves from N and for Plans 11A and 11B for test waves from NW. For test waves from N with the +1 ft swl, maximum wave heights were 1.1 and 0.8 ft at the immediate lakeward lock entrance (gage 6) and 2.4 and 1.3 ft between the guide walls (gage 7) for Plans 11 and 11A, respectively. For the +4 ft swl, maximum wave heights were 1.3 and 1.0 ft at the immediate lakeward lock entrance and 2.5 and 1.4 ft between the guide walls for Plans 11 and 11A, respectively. Maximum wave heights for the +1 ft swl for test waves from NW were 0.9 ft at the immediate lakeward lock entrance for both Plans 11A and 11B and 1.5 and 1.4 ft between the guide walls for Plans 11A and 11B, respectively. For the +4 ft swl, maximum wave heights were 1.5 and 1.0 ft at the immediate lakeward lock entrance and 1.9 and 1.4 ft between the guide walls for Plans 11A and 11B, respectively. Typical wave patterns obtained for Plan 11B with the lakeward lock gates open are shown in Photos 55-60.

41. Wave heights obtained for Plans 12 and 12A with the lakeward lock gates open for test waves from N are presented in Table 20. For the +1 ft swl, maximum wave heights of 0.8 and 0.6 ft in the immediate lakeward lock entrance (gage 6), and 1.9 and 1.2 ft between the guide walls (gage 7) were obtained for Plans 12 and 12A, respectively. For the +4 ft swl, Plans 12 and 12A produced maximum wave heights of 1.2 and 0.8 ft in the immediate lakeward lock entrance and 2.3 and 1.6 ft between the guide walls. Results of wave-height tests for Plan 12A for test waves from NW are also shown in Table 20. For the +1 ft swl, the maximum wave height obtained in the immediate lakeward lock entrance was 1.0 ft; and the maximum wave height obtained between the guide walls was 1.5 ft. For the +4 ft swl, the maximum wave height was 1.1 ft in the immediate lakeward lock entrance and 1.9 ft between the guide walls. Typical wave patterns obtained for Plan 12A with the lakeward lock gates open are shown in Photos 61-66.

42. Wave heights obtained for Plans 13-13C with the lakeward lock gates open for representative test waves from NW are presented in Table 21. For the +1 ft swl, maximum wave heights of 2.9, 2.2, 1.9, and 1.4 ft were recorded in the immediate lakeward lock entrance

(gage 6); and maximum wave heights of 2.9, 2.2, 1.5, and 1.6 ft were obtained between the guide walls (gage 7) for Plans 13-13C, respectively. For the +4 ft swl, maximum wave heights of 2.8, 2.0, 1.9, and 1.7 ft in the immediate lakeward lock entrance and 2.5, 2.3, 1.8 and 1.4 ft between the guide walls were obtained for Plans 13-13C, respectively.

43. Results of wave-height tests with Plans 14 and 14A with the lakeward lock gates open for test waves from NW are presented in Table 22. For the +1 ft swl, maximum wave heights of 0.6 and 0.7 ft were obtained in the immediate lakeward lock entrance (gage 6); and maximum wave heights of 0.9 and 1.2 ft were obtained between the guide walls (gage 7) for Plans 14 and 14A, respectively. For the +4 ft swl, maximum wave heights of 0.8 and 0.6 ft in the immediate lakeward lock entrance and 0.9 and 1.9 ft between the guide walls were obtained for Plans 14 and 14A, respectively.

44. Wave-height measurements obtained for Plans 15-15G with the lakeward lock gates open for test waves from NW are presented in Table 23. Maximum wave heights of 2.1, 1.7, 1.2, 1.1, 1.2, 1.4, 1.6, and 1.0 ft were obtained in the immediate lakeward lock entrance (gage 6); and maximum wave heights of 1.7, 1.6, 1.5, 1.4, 1.9, 2.2, 2.1, and 1.2 ft were recorded between the guide walls (gage 7) for Plans 15-15G, respectively.

45. Results of wave-height tests for Plans 15G-15I and Plans 16-16D with the lakeward lock gates open for test waves from N with the +1 ft swl are presented in Table 24. Wave heights of 0.9, 0.9, and 1.1 ft were obtained in the immediate lakeward lock entrance (gage 6), and maximum wave heights of 1.1, 1.2, and 1.8 ft were recorded between the guide walls (gage 7) for Plans 15G-15I, respectively. For Plans 16-16D, respectively, maximum wave heights of 2.6, 2.5, 1.0, 2.3, and 1.4 ft were obtained in the immediate lakeward lock entrance, and maximum wave heights of 2.0, 1.6, 1.4, 1.3, and 2.5 ft were secured between the guide walls. Wave heights for Plan 16B for test waves from N with the +4 ft swl are also presented in Table 24. Maximum wave heights of 1.0 ft in the immediate lakeward lock entrance and 1.8 ft between the guide walls were obtained.

46. Wave height data for Plan 16B and Plans 17-17C with the lakeward lock gates open for test waves from NNW are presented in Table 25. Plan 16B resulted in maximum wave heights of 1.5 ft in the immediate lakeward lock entrance (gage 6) and 2.4 ft between the guide walls (gage 7) for the +4 ft swl. Plans 17-17B, respectively, yielded maximum wave heights of 2.5, 1.5, and 1.0 ft in the immediate lakeward lock entrance; and maximum wave heights of 1.4, 1.8, and 1.3 ft between the guide walls with the +1 ft swl. For the +4 ft swl, maximum wave heights of 1.4 and 0.9 ft were obtained in the immediate lakeward lock entrance; and maximum wave heights of 1.0 and 1.3 ft were obtained between the guide walls for Plans 17B and 17C, respectively.

47. Results of comprehensive wave height tests conducted for Plan 17C are presented in Tables 26 and 27. With the lakeward lock gates open and the rear lock gates closed (Table 26), maximum wave heights for the +1 ft swl were 1.3 ft between the guide walls (gage 7) for 4-sec, 5-ft test waves from N; 1.2 ft at the immediate lakeward lock entrance (gage 6) for 4-sec, 4-ft test waves from NNW; and 2.1 ft at the rear of the lock (gage 3) for 4-sec, 4-ft test waves from NNW. For the +4 ft swl, maximum wave heights were 1.5 ft between the guide walls for 4-sec, 4-ft waves from NW; 1.2 ft in the immediate lakeward lock entrance for 3-sec, 4-ft waves from NW; and 1.6 ft at the rear of the lock for 4-sec, 4-ft waves from NNW. With both lock gates closed (Table 27), the maximum wave height obtained between the guide walls for the +1 ft swl was 1.2 ft for 4-sec, 5-ft waves from N. For the +4 ft swl, the maximum wave height obtained between the guide walls was 1.4 ft for 4-sec, 4-ft test waves from NW. Typical wave patterns obtained for Plan 17C with the lakeward lock gates open are shown in Photos 67-75.

48. Results of wave-height tests with Plan 18 with the lakeward lock gates open installed for test waves from NNW are presented in Table 28. For the +1 ft swl, maximum wave heights were 0.7 ft in the immediate lakeward lock entrance (gage 6) and 0.8 ft between the guide walls (gage 7). For the +4 ft swl, maximum wave heights were 1.2 ft and 0.9 ft in the immediate lakeward lock entrance and between the guide walls, respectively.

49. Results of wave-height tests conducted for Plans 19-19C using test waves from N and Plans 19C-19F using test waves from NW are presented in Table 29, all for conditions of the lakeward lock gates open. For test waves from N, maximum wave heights obtained in the immediate lakeward lock entrance (gage 6) were 1.7, 2.1, 1.6, and 1.7 ft and maximum wave heights obtained between the guide walls (gage 7) were 2.4, 2.6, 2.2, and 2.2 ft for Plans 19-19C, respectively. For test waves from NW, maximum wave heights were 2.6, 2.2, 2.1, and 1.4 ft in the immediate lakeward lock entrance and 2.6, 2.2, 1.7, and 1.5 ft between the guide walls for Plans 19C-19F, respectively. Typical wave patterns obtained for Plan 19F with the lakeward lock gates open are shown in Photos 76-79.

50. Wave-height data obtained for Plans 20-20A for test waves from N and Plan 20A for test waves from NW using the +1 and +4 ft swl's are presented in Table 30, all for conditions of the lakeward lock gates open. For test waves from N with the +1 ft swl, maximum wave heights were 0.8 and 1.0 ft at the immediate lakeward lock entrance (gage 6) and 1.6 and 1.0 ft between the guide walls (gage 7) for Plans 20 and 20A, respectively. For the +4 ft swl, maximum wave heights in the immediate lakeward lock entrance were 1.2 and 1.0 ft for Plans 20 and 20A, respectively, and maximum wave heights between the guide walls were 2.0 ft for both plans. For test waves from NW, maximum wave heights of 1.0 ft in the immediate lakeward lock entrance and 1.2 ft between the guide walls were obtained for Plan 20A using the +1 ft swl. For the +4 ft swl, maximum wave heights of 0.8 and 1.7 ft were obtained in the immediate lakeward lock entrance and between the guide walls, respectively.

51. Results of comprehensive wave-height tests conducted for Plan 20A are presented in Tables 31 and 32. With the lakeward lock gates open and the rear lock gates closed (Table 31), maximum wave heights for the +1 ft swl were 1.6 ft between the guide walls (gage 7) for 4-sec, 4-ft test waves from NNW; 1.0 ft at the immediate lakeward lock entrance (gage 6) for 4-sec, 5-ft test waves from N and for 4-sec, 4-ft test waves from NW; and 0.9 ft at the rear of the lock (gage 3) for 4-sec, 4-ft test waves from NW. For the +4 ft swl, maximum wave heights were

2.0 ft between the guide walls for 4-sec, 4-ft test waves from NNW; 1.1 ft at the immediate lakeward lock entrance for 3-sec, 4-ft test waves from NNW; and 2.2 ft at the rear of the lock for 4-sec, 4-ft test waves from NNW. With both lock gates closed (Table 32), the maximum wave height obtained between the guide walls for the +1 ft swl was 1.3 ft for 3-sec, 4-ft test waves from NW and 4-sec, 4-ft test waves from NNW. For the +4 ft swl, the maximum wave height obtained was 1.8 ft between the guide walls for 3-sec, 4-ft test waves from N. Typical wave pattern photographs obtained for Plan 20A with the lakeward lock gates open are shown in Photos 80-86.

52. Plan 20A was subjected to hurricane wave conditions in the model. With an swl of +8.5 ft msl, wave heights up to 8.2 ft were generated from N. Visual observations revealed no overtopping of the lock walls. The outer breakwater was removed and the lock was subjected to the above test waves from N and NW using the +8.5 ft swl. For these tests, observations revealed no substantial overtopping of the lock walls and only negligible overtopping of the lakeward lock gates for N test direction.

Discussion of test results

53. Test results for existing conditions revealed rough and turbulent wave conditions in the vicinity of the proposed lock with wave heights in excess of 6 ft for several of the test waves. Very confused wave patterns resulted from the reflection of waves from the vertical and stepped walls in the area. In locations where reflected and incident wave crests coincided, wave heights up to 9.9 ft were recorded.

54. The installation of the rock wave absorber along the vertical walls of the New Orleans Lakefront Airport and along the stepped concrete seawall west of the proposed lock (Plan 1) significantly calmed wave conditions in the vicinity of the proposed lock. Wave patterns were uniform and there was no splash-over onto the overbank as was the case for existing conditions.

55. Test results obtained with the proposed lock installed in the model with no breakwaters (Plan 2) revealed wave heights in the lock

entrance in excess of 7 ft and wave heights inside the lock in excess of 8 ft.

56. Waves penetrating the navigation openings of the shore-connected rubble-mound breakwaters of Plans 3 and 3A diffracted very little at the breakwater heads, thus transmitting wave energy directly to the lakeward lock entrance, resulting in wave heights in excess of 3 ft for both plans.

57. The 2,500-ft-long rubble-mound breakwater of Plan 5B, which was formed by the incremental removal of breakwater length from each shore, resulted in wave heights of less than 2 ft in the lock entrance. This outer breakwater can be reduced by an additional 850 ft with the installation of two 300-ft-long rubble-mound inner structures parallel to the lock entrance (Plan 8) and still meet the established wave-height criterion of 2 ft at the lock entrance. The reduction of the outer breakwater length will also improve navigation by allowing a straighter approach to the lock entrance.

58. Plan 8 is considered the optimum rubble-mound structure with respect to cost and wave protection provided. This plan reduced the total breakwater length from 4,500 ft (Plan 3, originally proposed breakwater plan) to 2,250 ft (1,650 ft outer breakwater in conjunction with two 300-ft-long inner breakwaters). Plan 8 resulted in wave heights of less than 1 ft in the immediate lakeward lock entrance and less than 2 ft between the guide walls.

59. The 1,850-ft-long sheet-pile breakwaters of Plans 10A and 12A, the 1,950-ft-long sheet-pile breakwater of Plan 11B, and the 2,150-ft-long sheet-pile breakwater of Plan 20A, all in conjunction with the two 300-ft-long rubble-mound inner breakwaters at the lakeward lock entrance, provided wave heights within the established wave-height criterion. The breakwater configuration of Plan 20A was considered the optimum since the outer sheet-pile breakwater was oriented so that it would not be constructed in water depths any greater than 20 ft. Also the interior rubble-mound breakwaters of Plan 20A were installed far enough apart to allow space for maintenance of the guide walls.

60. The 2,150-ft-long sheet-pile outer breakwater in conjunction

with one 300-ft-long rubble-mound inner breakwater and one 288-ft-long inner floating breakwater (Plan 14A) resulted in wave heights within the established criterion.

61. Test results for floating breakwaters indicated that a 5,088-ft-long floating structure (Plan 17C) was required to reduce wave heights in the lakeward lock entrance to an acceptable level. It should be noted that floating breakwaters tested in the model provided 50 percent attenuation for 4-sec waves approaching from a direction perpendicular to the structure. Lengths of the structure may be reduced, particularly the outer breakwater, for floating structures that would provide greater attenuation.

PART V: CONCLUSIONS

62. Based on the results of the hydraulic model investigation reported herein, it is concluded that:

- a. Existing conditions are characterized by very rough and turbulent waves in the vicinity of the proposed lock during periods of storm wave attack.
- b. The installation of a rock wave absorber along the vertical and stepped walls in the area will significantly calm wave conditions in the vicinity of the proposed lock.
- c. Wave heights in the proposed lock with no breakwaters installed (Plan 2) would be extremely hazardous (wave heights in excess of 8 ft).
- d. The combined 2,250-ft breakwater length (one outer and two inner breakwaters) of Plan 8 provides wave protection that satisfies the established criterion at the lock entrance and appears to be the most economical rubble-mound breakwater plan tested.
- e. The sheet-pile outer breakwater configurations of Plans 10A, 11B, 12A, and 20A, all in conjunction with two 300-ft-long rubble-mound inner breakwaters, will provide wave protection which meets the established criterion at the lock entrance.
- f. To achieve the established wave-height criterion at the lock entrance with floating structures (providing 50 percent attenuation for waves approaching from a direction perpendicular to the structure), a total breakwater length of 5,088 ft is required (Plan 17C, consisting of two outer and three inner breakwaters).

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TABLE 1
WAVE HEIGHTS FOR EXISTING CONDITIONS

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 1	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT													
N	3.0	2.0	1.3	2.8	1.9	1.1	1.4	2.3	1.9	2.6	2.4	1.2	2.2
		4.0	2.7	3.9	3.9	3.6	4.4	4.7	4.5	3.8	5.4	1.8	5.0
NNW	4.0	5.0	4.3	5.3	5.9	4.0	5.3	5.3	5.3	6.5	5.9	2.5	5.4
		3.0	2.5	1.4	2.6	3.1	3.3	1.8	2.9	2.3	2.4	1.6	1.9
NW	4.0	4.0	3.4	3.2	3.8	4.7	4.6	4.3	4.4	4.5	5.1	4.7	4.9
		3.0	2.4	1.4	2.6	4.2	2.6	2.3	2.0	2.7	2.2	2.3	1.4
	4.0	4.0	2.8	4.0	4.4	4.8	3.9	3.9	4.3	4.4	5.4	5.4	4.6
		4.0	2.2	3.8	5.9	3.1	3.9	5.4	6.5	4.1	5.6	4.1	4.2
SWL = +4 FT													
N	3.0	2.0	2.3	2.9	2.7	2.8	3.2	2.3	3.3	2.4	3.0	1.5	2.6
		4.0	2.8	3.6	3.5	3.3	3.6	3.7	4.0	4.0	4.3	2.1	5.3
NNW	4.0	5.0	4.7	7.1	6.4	3.8	5.3	5.0	6.3	5.2	6.4	2.7	6.0
		3.0	1.8	2.4	1.8	3.1	3.1	3.3	2.4	2.0	2.1	1.8	2.1
NW	4.0	4.0	3.6	3.4	3.7	3.8	4.6	4.0	4.5	4.5	5.0	5.5	4.8
		3.0	2.9	4.7	4.2	4.8	6.7	6.1	3.8	5.5	4.7	4.8	4.3
	4.0	4.0	1.5	2.5	3.3	4.4	2.0	2.2	2.0	2.7	2.5	2.4	1.4
		4.0	2.9	3.9	5.6	6.4	4.5	4.0	4.0	4.9	5.0	4.7	4.9
	4.0	4.0	2.9	6.5	5.2	9.9	6.4	4.6	3.4	3.3	5.0	4.1	4.3

TABLE 2
WAVE HEIGHTS FOR PLAN 1

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 1	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT													
N	3.0	2.0	1.1	2.6	1.5	1.2	1.8	2.4	2.6	2.1	2.3	1.3	1.8
		4.0	2.5	3.2	3.2	3.1	3.1	3.5	3.7	4.2	4.5	1.5	4.8
NNW	4.0	5.0	4.0	4.5	4.8	2.6	4.4	4.1	4.1	4.5	5.1	2.0	4.0
	3.0	2.0	2.1	2.5	2.9	3.2	2.5	2.2	2.2	2.4	1.8	1.8	1.8
NW		4.0	3.0	3.0	3.3	3.4	3.5	3.7	3.9	4.6	4.8	4.7	4.7
	4.0	4.0	2.4	3.2	3.7	3.0	3.7	3.2	3.3	4.8	3.7	3.3	3.5
	3.0	2.0	2.4	2.2	2.5	2.5	2.9	2.6	2.7	2.5	2.2	2.4	1.5
		4.0	2.4	2.7	2.8	3.0	3.5	3.7	3.9	3.9	4.7	4.7	3.9
	4.0	4.0	0.9	3.0	2.4	2.9	3.5	2.3	2.8	3.7	4.0	3.6	3.7
SWL = +4 FT													
N	3.0	2.0	2.3	3.1	2.2	2.8	2.7	3.0	3.0	2.2	2.2	0.8	1.9
		4.0	3.0	3.7	3.7	3.1	3.7	3.8	4.0	4.2	4.5	1.8	4.3
NNW	4.0	5.0	5.1	4.2	5.2	3.3	4.1	4.8	4.2	5.0	4.7	2.0	4.2
	3.0	2.0	2.4	2.6	2.9	2.9	2.9	3.0	2.5	2.3	2.0	1.7	2.1
NW		4.0	3.4	3.1	3.4	3.4	3.6	3.8	3.6	3.5	4.2	5.0	4.4
	4.0	4.0	1.6	3.2	4.1	2.7	3.4	4.0	3.5	4.6	4.2	3.3	3.8
	3.0	2.0	2.3	2.4	2.5	2.4	2.1	2.0	2.1	2.4	2.1	2.6	1.6
		4.0	3.0	3.0	3.0	2.7	3.2	3.5	3.9	5.0	4.9	4.1	4.9
	4.0	4.0	1.8	3.1	3.4	3.8	3.8	3.6	3.6	3.7	4.0	4.2	4.3

TABLE 3
WAVE HEIGHTS FOR PLAN 2 WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT									
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10	GAGE 11
<u>SWL = +1 FT</u>												
N	3.0	2.0	1.7	0.6	2.2	0.5	2.1	1.0	2.3	2.0	1.6	2.3
		4.0	2.0	4.1	3.9	3.9	3.8	3.8	4.4	4.6	4.6	4.9
NNW	4.0	5.0	4.7	8.4	4.3	7.9	7.1	4.8	6.1	5.5	4.5	6.0
	3.0	2.0	1.7	1.6	2.0	1.7	2.3	1.9	1.8	2.1	2.1	1.9
NW		4.0	3.1	3.7	3.2	3.3	4.0	4.2	4.4	4.6	5.2	4.4
	4.0	4.0	3.1	5.1	2.5	5.3	5.4	4.3	3.1	3.1	4.0	4.2
	3.0	2.0	1.5	0.9	1.0	0.7	2.5	1.9	2.3	2.2	2.3	1.1
		4.0	2.3	2.8	4.0	2.7	3.2	4.1	4.2	4.2	4.7	4.0
	4.0	4.0	1.1	3.3	4.1	1.0	5.4	1.6	4.5	3.8	3.9	3.4
<u>SWL = +4 FT</u>												
N	3.0	2.0	2.6	1.2	2.7	0.8	2.3	1.6	1.9	2.5	2.0	2.3
		4.0	2.1	4.5	3.6	3.7	4.2	3.5	3.5	4.0	4.3	4.8
NNW	4.0	5.0	3.2	8.5	4.4	7.7	5.4	6.3	5.1	6.4	4.5	5.4
	3.0	2.0	2.1	1.9	2.5	2.0	3.4	2.3	2.5	2.3	1.9	2.3
NW		4.0	2.6	3.9	3.5	3.1	4.2	3.6	4.5	4.2	4.6	4.5
	4.0	4.0	2.2	5.9	3.5	3.9	2.1	4.3	3.7	3.7	4.8	4.6
	3.0	2.0	1.1	0.8	1.8	0.8	1.5	2.0	2.9	1.6	2.6	2.1
		4.0	2.8	2.6	4.7	2.4	3.5	4.7	4.2	4.2	4.9	4.3
	4.0	4.0	0.8	4.3	5.3	2.6	1.7	3.2	3.3	4.6	4.0	3.3

TABLE 4

WAVE HEIGHTS FOR PLAN 2 WITH BOTH LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>	
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>
<u>SWL = +1 FT</u>				
NORTH	3.0	2.0	2.3	1.2
		4.0	5.8	4.6
	4.0	5.0	9.6	5.6
NNW	3.0	2.0	3.4	2.4
		4.0	4.5	4.4
	4.0	4.0	6.4	6.2
NW	3.0	2.0	3.4	2.2
		4.0	4.0	3.6
	4.0	4.0	4.3	1.9
<u>SWL = +4 FT</u>				
NORTH	3.0	2.0	2.7	1.7
		4.0	4.9	3.9
	4.0	5.0	10.0	5.5
NNW	3.0	2.0	3.3	3.6
		4.0	4.3	4.7
	4.0	4.0	7.1	4.3
NW	3.0	2.0	3.2	2.0
		4.0	4.5	4.7
	4.0	4.0	4.6	5.6

TABLE 5
WAVE HEIGHTS FOR PLAN 3 WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT									
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT												
NW	3.0	2.0	0.2	<0.1	1.0	0.3	0.3	0.4	0.2	0.7	<0.1	1.9
		4.0	0.3	0.5	1.7	0.9	1.1	1.4	0.8	1.8	0.2	3.6
NNW	4.0	4.0	0.3	1.6	0.9	1.7	2.3	3.8	1.1	1.6	0.8	2.9
	3.0	2.0	0.6	0.3	0.9	1.0	0.9	1.9	0.7	1.7	0.2	1.5
		4.0	1.4	2.4	2.4	2.7	2.8	2.5	1.3	3.7	0.4	4.5
	4.0	4.0	0.5	3.5	0.6	3.2	3.2	1.8	1.2	3.4	0.3	4.0
SWL = +4 FT												
NW	3.0	2.0	0.1	0.1	1.9	0.2	0.2	0.5	0.2	0.5	<0.1	1.8
		4.0	0.4	0.7	2.3	0.9	1.5	1.5	0.6	1.3	0.2	4.7
NNW	4.0	4.0	0.1	2.3	1.7	3.3	2.3	2.6	0.8	1.3	0.8	3.6
	3.0	2.0	0.9	0.7	2.0	0.6	1.6	1.8	0.6	1.7	0.2	1.8
		4.0	1.8	2.7	2.6	2.5	2.4	3.3	1.0	4.3	0.4	5.0
	4.0	4.0	0.8	5.2	1.3	4.3	3.0	3.2	0.7	3.2	0.5	4.4

TABLE 6

WAVE HEIGHTS FOR PLAN 3 WITH BOTH LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>	
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>
<u>SWL = +1 FT</u>				
NW	3.0	2.0	0.6	0.2
		4.0	1.4	1.5
	4.0	4.0	2.2	2.9
NNW	3.0	2.0	1.5	1.9
		4.0	2.6	3.5
	4.0	4.0	4.4	2.6
<u>SWL = +4 FT</u>				
NW	3.0	2.0	0.2	0.4
		4.0	1.7	1.7
	4.0	4.0	2.4	3.2
NNW	3.0	2.0	1.5	2.8
		4.0	2.4	3.2
	4.0	4.0	2.6	1.9

TABLE 7
WAVE HEIGHTS FOR PLAN 3A WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT									
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT												
NNW	3.0	2.0	0.4	0.2	0.4	0.5	0.5	1.0	0.2	1.3	0.1	1.9
	4.0	4.0	0.9	0.9	1.4	1.0	1.5	2.1	0.6	2.8	0.2	4.6
			0.7	2.8	1.1	1.2	3.3	1.3	0.3	2.4	0.2	4.0
SWL = +4 FT												
	3.0	2.0	0.3	0.3	1.4	0.4	1.1	1.3	0.3	1.4	0.1	2.0
		4.0	1.2	1.4	1.6	1.8	1.7	2.1	1.2	2.9	0.2	4.8
	4.0	4.0	0.9	4.0	1.8	3.9	2.1	2.0	0.7	2.5	0.4	4.8

TABLE 8

WAVE HEIGHTS FOR PLAN 3A WITH BOTH LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>	
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>
<u>SWL = +1 FT</u>				
NNW	3.0	2.0	0.5	1.2
		4.0	1.3	2.5
	4.0	4.0	3.9	0.7
<u>SWL = +4 FT</u>				
NNW	3.0	2.0	0.8	1.9
		4.0	1.6	2.4
	4.0	4.0	3.9	2.7

TABLE 9
WAVE HEIGHTS FOR PLANS 4-4C WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED (SWL = +1 FT)

<u>TEST WAVE</u>			<u>WAVE HEIGHT, FT</u>				
<u>DIRECTION</u>	<u>PERIOD</u>	<u>HEIGHT</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>
	<u>SEC</u>	<u>FT</u>	<u>3</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
<u>PLAN 4</u>							
NW	4.0	4.0	0.2	0.2	0.8	0.5	0.4
<u>PLAN 4A</u>							
		4.0	0.2	0.2	0.9	0.8	0.3
<u>PLAN 4B</u>							
		4.0	0.2	0.2	1.2	1.0	0.7
<u>PLAN 4C</u>							
		4.0	1.1	1.0	1.9	0.8	1.7

TABLE 10

WAVE HEIGHTS FOR PLANS 5-5B WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>				
	<u>PERIOD</u>	<u>HEIGHT</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>
	<u>SEC</u>	<u>FT</u>	<u>3</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>9</u>
<u>PLAN 5 - SWL = +1 FT</u>							
NORTH	4	5	0.2	0.2	0.3	0.3	0.7
<u>PLAN 5A - SWL = +1 FT</u>							
NORTH	4	5	0.5	0.4	0.6	1.2	1.0
<u>PLAN 5B - SWL = +1 FT</u>							
NORTH	4	5	0.6	0.5	0.6	1.8	1.3
<u>PLAN 5B - SWL = +4 FT</u>							
NORTH	4	5	1.0	0.6	1.1	1.5	0.9

TABLE 11

WAVE HEIGHTS FOR PLANS 6-6B WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
SWL = +1 FT

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>					
	<u>PERIOD</u>	<u>HEIGHT</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>	<u>GAGE</u>
	<u>SEC</u>	<u>FT</u>	<u>3</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
<u>PLAN 6</u>								
NORTH	4	5	0.4	0.2	0.2	0.4	--	0.9
<u>PLAN 6A</u>								
NORTH	4	5	0.8	0.3	0.4	1.0	--	0.8
<u>PLAN 6B</u>								
NORTH	4	5	1.7	1.2	0.8	2.1	--	1.9
<u>PLAN 6B</u>								
NW	4	4	1.2	1.0	1.6	1.2	1.1	--

TABLE 12

WAVE HEIGHTS FOR PLANS 7-7D WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
FOR TEST WAVES FROM NW

TEST WAVE			WAVE HEIGHT, FT					
PLAN NO.	PERIOD SEC	HEIGHT FT	GAGE 3	GAGE 5	GAGE 6	GAGE 7	GAGE 7A	GAGE 8
<u>SWL = +1 FT</u>								
7	4	4	0.5	0.3	0.1	--	0.9	1.5
7A	4	4	0.3	0.3	0.2	--	0.9	1.9
7B	4	4	0.3	0.3	0.3	--	1.0	1.7
7C	4	4	0.7	0.7	0.5	1.0	1.7	3.1
7D	3	4	--	--	1.0	1.5	2.5	--
7D	4	4	--	--	0.5	0.7	1.4	--
<u>SWL = +4 FT</u>								
7D	3	4	--	--	0.7	1.7	2.9	--
7D	4	4	--	--	0.5	1.2	2.4	--

TABLE 13

WAVE HEIGHTS FOR PLANS 7D AND 8 WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED FOR TEST WAVES FROM N

<u>PLAN NO.</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
7D	3	4	0.8	1.4	2.5
7D	4	5	0.9	1.9	2.4
<u>SWL = +4 FT</u>					
7D	3	4	1.1	1.5	2.7
7D	4	5	1.1	2.5	3.9
<u>SWL = +1 FT</u>					
8	3	4	0.8	1.6	2.4
8	4	5	0.7	1.7	2.2
<u>SWL = +4 FT</u>					
8	3	4	0.9	1.7	2.9
8	4	5	0.5	1.7	2.9

TABLE 14

WAVE HEIGHTS FOR PLAN 8 WITH LAKEWARD LOCK GATES

OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 7A	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT													
N	3.0	2.0	0.3	0.1	1.1	<0.1	0.4	0.5	0.8	0.4	0.9	0.3	0.7
		4.0	0.5	0.7	3.4	0.5	0.8	1.6	2.4	0.9	1.0	0.4	1.1
NNW	4.0	5.0	0.5	1.8	2.8	1.4	0.7	1.7	2.2	0.4	1.6	0.7	1.3
		3.0	0.3	<0.1	0.3	0.2	0.1	0.3	0.2	0.5	0.5	0.2	0.2
NW	4.0	4.0	1.4	0.2	2.0	0.3	0.7	0.9	1.4	2.4	0.9	0.3	0.4
		4.0	0.7	0.5	0.9	0.5	0.4	0.4	1.0	1.3	1.0	0.8	0.8
	3.0	2.0	2.0	0.2	0.2	0.4	0.6	0.5	1.4	2.5	0.4	0.5	0.2
		4.0	3.1	0.9	0.9	0.7	0.9	1.7	2.8	4.2	0.7	0.8	0.8
	4.0	4.0	3.4	0.8	0.8	0.5	0.9	1.1	1.8	4.0	0.8	1.2	0.4
SWL = +4 FT													
N	3.0	2.0	0.4	0.2	1.5	0.3	0.4	0.5	1.4	0.3	0.7	0.3	1.2
		4.0	0.6	0.8	3.6	0.9	0.9	1.7	2.9	0.7	1.1	0.5	1.1
NNW	4.0	5.0	0.9	1.0	2.8	0.9	0.5	1.7	2.9	1.0	1.3	1.3	1.5
		3.0	1.1	<0.1	1.4	0.1	0.2	0.2	0.5	0.7	0.4	0.1	0.4
NW	4.0	4.0	1.7	0.3	3.1	0.4	0.8	1.1	1.8	2.2	1.3	0.5	0.6
		4.0	1.0	0.6	1.3	0.5	0.3	1.2	1.7	1.7	1.6	1.1	0.4
	3.0	2.0	1.8	0.3	0.3	0.3	0.7	1.2	1.6	2.9	0.2	0.5	0.2
		4.0	3.0	0.5	0.9	0.5	0.9	1.7	2.9	4.2	1.0	1.3	0.5
	4.0	4.0	4.4	0.7	0.9	0.5	0.4	0.8	1.9	3.9	0.6	1.1	0.3

TABLE 15

WAVE HEIGHTS FOR PLAN 8 WITH BOTH LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT		
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 7A
SWL = +1 FT					
N	3.0	2.0	0.5	0.5	0.8
		4.0	1.1	1.5	2.8
NNW	3.0	5.0	1.1	1.3	2.1
		2.0	<0.1	0.1	0.2
NW	4.0	4.0	0.5	0.8	1.6
		4.0	0.6	0.5	1.1
	3.0	2.0	0.3	0.6	1.2
		4.0	1.0	1.7	2.8
	4.0	4.0	0.8	0.7	1.5
SWL = +4 FT					
N	3.0	2.0	0.4	0.8	1.3
		4.0	1.3	1.6	2.9
NNW	3.0	5.0	0.5	2.1	2.9
		2.0	0.2	0.3	0.2
NW	4.0	4.0	0.6	1.0	1.3
		4.0	0.6	1.2	0.7
	3.0	2.0	0.4	1.1	1.6
		4.0	1.0	1.9	2.9
	4.0	4.0	0.6	1.0	2.1

TABLE 16
WAVE HEIGHTS FOR PLAN 9 WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 7A	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT													
N	3.0	2.0	0.9	0.3	0.6	1.0	1.0	1.6	1.5	2.3	2.8	1.4	1.9
		4.0	1.3	2.9	2.7	2.8	2.2	3.5	3.4	3.8	4.7	2.9	4.8
NNW	4.0	5.0	3.0	5.5	2.0	5.4	6.0	4.7	5.9	4.2	5.5	2.9	5.2
		3.0	2.3	1.7	1.4	1.9	3.0	2.3	2.5	2.3	2.6	2.2	2.0
NW	4.0	4.0	2.5	3.3	2.7	3.4	3.9	3.7	3.6	4.2	4.7	4.6	4.2
		3.0	3.0	6.0	1.1	3.4	4.3	3.3	2.0	3.3	3.6	3.2	3.5
	3.0	2.0	2.0	0.5	1.5	0.9	0.7	1.4	1.4	2.4	1.6	1.9	1.7
		4.0	3.0	1.9	2.8	1.8	1.8	2.5	3.5	4.3	4.3	4.7	3.1
	4.0	4.0	2.1	2.7	4.6	2.4	2.8	0.5	3.0	5.1	4.2	3.7	3.3
SWL = +4 FT													
N	3.0	2.0	2.0	0.4	2.5	2.0	1.2	2.7	1.9	3.8	2.7	1.4	3.5
		4.0	1.3	4.5	4.2	3.1	3.5	3.7	4.4	4.3	5.5	3.3	6.9
NNW	4.0	5.0	1.2	8.1	2.6	6.1	4.1	5.7	7.1	5.2	7.5	3.1	6.3
		3.0	1.9	1.8	1.5	2.0	3.1	2.1	2.7	2.7	2.6	2.2	2.2
NW	4.0	4.0	2.8	3.4	3.3	3.3	3.9	3.8	4.4	4.1	4.5	4.8	4.5
		3.0	2.6	5.7	1.2	4.7	2.3	4.4	2.7	3.8	4.7	3.1	3.6
	3.0	2.0	2.7	0.7	1.2	1.1	1.1	2.1	2.1	2.7	1.8	2.3	1.8
		4.0	2.7	2.0	3.8	1.9	2.1	2.8	4.0	4.0	4.5	4.7	3.2
	4.0	4.0	1.5	4.2	4.8	4.4	3.2	1.9	3.7	3.3	4.4	3.4	2.8

TABLE 17

WAVE HEIGHTS FOR PLAN 9 WITH BOTH LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT		
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 7A
SWL = +1 FT					
N	3.0	2.0	1.9	1.6	1.3
		4.0	3.4	3.8	3.2
NNW	3.0	4.0	6.8	4.6	5.3
		2.0	2.3	3.7	4.4
NW	4.0	4.0	4.5	3.4	3.8
		4.0	6.9	3.8	1.9
	3.0	2.0	1.7	1.5	1.3
		4.0	1.9	2.3	3.7
	4.0	4.0	3.1	1.0	2.6
SWL = +4 FT					
N	3.0	2.0	1.9	2.4	2.1
		4.0	4.4	3.6	4.3
NNW	3.0	4.0	2.9	5.1	6.2
		2.0	2.4	3.2	4.2
NW	4.0	4.0	4.4	4.0	4.4
		4.0	5.1	3.7	2.2
	3.0	2.0	2.0	1.8	1.8
		4.0	1.8	2.6	3.6
	4.0	4.0	3.2	2.0	3.1

TABLE 18
WAVE HEIGHTS FOR PLANS 10 AND 10A WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

DIRECTION	TEST WAVE		WAVE HEIGHT, FT		
	PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 7A
N			<u>PLAN 10 SWL = +1 FT</u>		
	3.0	4.0	0.7	1.0	1.9
	4.0	5.0	0.9	1.9	2.5
			<u>PLAN 10 SWL = +4 FT</u>		
	3.0	4.0	0.9	1.2	2.0
	4.0	5.0	1.4	2.4	3.5
			<u>PLAN 10A SWL = +1 FT</u>		
	3.0	4.0	0.6	1.0	1.6
	4.0	5.0	0.7	1.5	1.9
			<u>PLAN 10A SWL = +4 FT</u>		
	3.0	4.0	0.6	1.0	1.7
	4.0	5.0	0.9	1.8	2.8
NW			<u>PLAN 10A SWL = +1 FT</u>		
	3.0	4.0	0.9	1.2	2.2
	4.0	4.0	0.5	1.0	1.7
			<u>PLAN 10A SWL = +4 FT</u>		
	3.0	4.0	0.8	1.4	2.2
	4.0	4.0	0.9	0.9	1.6

TABLE 19

WAVE HEIGHTS FOR PLANS 11-11B WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>PLAN 11 SWL = +1 FT</u>					
NORTH	3.0	4.0	0.7	1.0	1.7
	4.0	5.0	1.1	2.4	3.4
<u>PLAN 11 SWL = +4 FT</u>					
	3.0	4.0	1.3	1.5	2.4
	4.0	5.0	1.3	2.5	2.7
<u>PLAN 11A SWL = +1 FT</u>					
	3.0	4.0	0.5	0.8	1.4
	4.0	5.0	0.8	1.3	1.6
NW	3.0	4.0	0.9	1.5	2.1
	4.0	4.0	0.7	0.6	1.3
<u>PLAN 11A SWL = +4 FT</u>					
NORTH	3.0	4.0	1.0	1.4	2.2
	4.0	5.0	0.8	1.3	2.2
NW	3.0	4.0	1.2	1.9	2.7
	4.0	4.0	1.5	1.3	1.7
<u>PLAN 11B SWL = +1 FT</u>					
	3.0	4.0	0.9	1.2	1.8
	4.0	4.0	0.6	1.4	1.9
<u>PLAN 11B SWL = +4 FT</u>					
	3.0	4.0	1.0	1.4	2.3
	4.0	4.0	0.5	1.3	1.4

TABLE 20

WAVE HEIGHTS FOR PLANS 12 AND 12A WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>PLAN 12 SWL = +1 FT</u>					
NORTH	3.0	4.0	0.8	1.2	2.0
	4.0	5.0	0.6	1.9	2.4
<u>PLAN 12 SWL = +4 FT</u>					
NORTH	3.0	4.0	0.8	1.4	2.2
	4.0	5.0	1.2	2.3	3.2
<u>PLAN 12A SWL = +1 FT</u>					
NORTH	3.0	4.0	0.6	0.9	1.8
	4.0	5.0	0.5	1.2	1.4
NW	3.0	4.0	1.0	1.2	2.3
	4.0	4.0	0.8	1.5	2.0
<u>PLAN 12A SWL = +4 FT</u>					
NORTH	3.0	4.0	0.8	1.1	2.0
	4.0	5.0	0.6	1.6	2.1
NW	3.0	4.0	0.9	1.9	2.7
	4.0	4.0	1.1	1.8	2.6

TABLE 21

WAVE HEIGHTS FOR PLANS 13-13C WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
FOR TEST WAVES FROM NORTHWEST

<u>PLAN NO.</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
13	3	4	2.9	2.9	3.0
	4	4	2.3	1.4	2.4
13A	3	4	2.2	1.8	2.1
	4	4	1.5	2.2	1.4
13B	3	4	1.9	1.5	1.7
	4	4	1.0	1.5	1.0
13C	3	4	1.4	1.6	1.3
	4	4	0.7	0.9	0.8
<u>SWL = +4 FT</u>					
13	3	4	2.8	2.5	2.6
	4	4	1.8	1.7	2.3
13A	3	4	2.0	2.3	2.2
	4	4	2.0	2.2	1.8
13B	3	4	1.9	1.8	1.7
	4	4	1.0	1.3	1.2
13C	3	4	1.7	1.4	1.4
	4	4	0.6	0.9	0.7

TABLE 22

WAVE HEIGHTS FOR PLANS 14 AND 14A WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
FOR TEST WAVES FROM NW

<u>PLAN NO.</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
14	3	4	0.6	0.9	1.5
	4	4	0.5	0.6	0.7
14A	3	4	0.7	1.2	1.7
	4	4	0.7	1.2	0.9
<u>SWL = +4 FT</u>					
14	3	4	0.8	0.8	1.5
	4	4	0.7	0.9	0.9
14A	3	4	0.6	1.1	1.7
	4	4	0.5	1.9	1.7

TABLE 23

WAVE HEIGHTS FOR PLANS 15-15G WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
FOR TEST WAVES FROM NW

<u>PLAN NO.</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +4 FT</u>					
15	3	4	2.1	1.7	1.7
	4	4	0.7	0.9	1.4
15A	3	4	1.7	1.6	1.5
	4	4	0.4	1.3	1.0
15B	3	4	1.0	1.4	1.7
	4	4	0.6	1.5	1.4
<u>SWL = +1 FT</u>					
15B	3	4	1.1	1.4	1.4
	4	4	1.2	1.4	1.6
15C	3	4	0.8	1.4	1.6
	4	4	1.1	1.0	1.3
15D	3	4	1.0	1.9	1.5
	4	4	1.2	1.8	1.6
15E	3	4	0.9	2.2	2.0
	4	4	1.4	1.1	0.6
15F	3	4	1.2	1.1	1.3
	4	4	1.6	2.1	1.5
15G	3	4	1.0	1.2	1.9
	4	4	0.9	1.0	1.2

TABLE 24

WAVE HEIGHTS FOR PLANS 15G-16D WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED FOR TEST WAVES FROM N

<u>PLAN NO.</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
15G	3	4	0.8	1.0	1.7
	4	5	0.9	1.1	1.0
15H	3	4	0.9	1.2	1.7
	4	5	0.9	1.1	1.8
15I	3	4	1.1	1.3	1.9
	4	5	0.8	1.8	2.6
16	3	4	1.7	1.5	2.3
	4	5	2.6	2.0	2.4
16A	3	4	1.1	1.6	1.9
	4	5	2.5	1.0	2.3
16B	3	4	0.9	1.3	1.3
	4	5	1.0	1.4	2.3
16C	3	4	1.2	1.3	1.3
	4	5	2.3	1.3	2.4
16D	3	4	1.1	1.4	1.5
	4	5	1.4	2.5	3.0
<u>SWL = +4 FT</u>					
16B	3	4	0.9	1.1	1.1
	4	5	1.0	1.8	3.4

TABLE 25

WAVE HEIGHTS FOR PLANS 16B AND 17-17C WITH LAKEWARD
LOCK GATES OPEN AND INNER LOCK GATES CLOSED
FOR TEST WAVES FROM NNW

<u>PLAN NO.</u>	<u>TEST WAVES</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +4 FT</u>					
16B	3	4	1.4	1.8	1.4
	4	4	1.5	2.4	2.2
<u>SWL = +1 FT</u>					
17	3	4	0.9	1.1	1.0
	4	4	2.5	1.4	1.0
17A	3	4	0.7	0.9	0.8
	4	4	1.5	1.8	1.0
17B	3	4	0.7	0.9	0.8
	4	4	1.0	1.3	0.7
<u>SWL = +4 FT</u>					
17B	3	4	0.7	1.0	0.7
	4	4	1.4	1.0	0.9
17C	3	4	0.8	1.0	0.7
	4	4	0.9	1.3	0.8

TABLE 26
WAVE HEIGHTS FOR PLAN 17C WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 7A	GAGE 8	GAGE 9	GAGE 10	GAGE 11
SWL = +1 FT													
N	3	2	0.1	0.1	0.3	0.1	0.3	0.3	0.2	0.3	0.5	0.3	0.8
		4	0.3	0.3	1.9	0.2	0.4	0.7	0.8	0.8	1.0	0.6	1.2
	4	5	0.4	1.4	1.1	0.6	0.7	1.3	1.7	1.4	1.7	0.5	1.2
NNW	3	2	0.2	0.2	0.7	0.1	0.3	0.4	0.5	0.4	0.3	0.7	0.4
		4	0.4	0.6	2.0	0.4	0.6	0.8	0.6	1.0	0.8	1.1	0.9
	4	4	0.7	2.1	0.9	1.1	1.2	1.0	0.5	1.3	1.2	1.4	0.9
NW	3	2	1.1	0.1	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.5	0.2
		4	1.7	0.5	0.4	0.6	0.9	1.1	0.8	2.4	0.9	1.3	0.8
	4	4	2.5	0.5	0.5	0.7	1.0	0.6	1.0	0.7	0.6	1.9	0.8
SWL = +4 FT													
N	3	2	0.1	0.1	1.1	0.1	0.2	0.2	0.5	0.4	0.3	0.3	0.7
		4	0.4	0.3	2.5	0.2	0.6	0.7	0.9	0.9	1.1	0.5	1.6
	4	5	0.2	1.0	2.1	0.8	0.6	1.0	1.9	1.9	1.7	1.0	1.9
NNW	3	2	0.2	0.2	0.6	0.2	0.4	0.4	0.3	0.4	0.5	0.7	0.4
		4	0.4	0.6	2.3	0.4	0.6	1.0	0.7	1.0	1.0	1.0	1.1
	4	4	0.6	1.6	0.9	1.2	0.8	1.2	0.7	0.8	0.6	1.5	1.2
NW	3	2	1.7	0.3	0.1	0.2	0.3	0.5	0.5	0.6	0.6	0.5	0.5
		4	2.0	0.6	0.4	0.6	1.2	1.0	1.1	1.5	0.9	0.8	0.9
	4	4	1.2	1.2	0.5	0.8	0.9	1.5	1.0	1.0	0.8	2.1	0.8

TABLE 27

WAVE HEIGHTS FOR PLAN 17C WITH BOTH LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVES</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
N	3	2	0.5	0.3	0.3
		4	0.6	0.7	0.7
	4	5	0.9	1.2	1.5
NNW	3	2	0.3	0.5	0.5
		4	0.7	0.8	0.7
	4	4	1.8	0.8	0.8
NW	3	2	0.3	0.3	0.2
		4	1.0	1.1	1.0
	4	4	1.2	0.5	0.8
<u>SWL = +4 FT</u>					
N	3	2	0.4	0.3	0.5
		4	0.7	0.7	0.9
	4	5	0.6	1.2	2.2
NNW	3	2	0.3	0.4	0.4
		4	0.8	0.8	0.7
	4	4	1.3	1.1	0.9
NW	3	2	0.6	0.4	0.6
		4	1.2	0.8	0.9
	4	4	0.7	1.4	0.8

TABLE 28

WAVE HEIGHTS FOR PLAN 18 WITH LAKEWARD LOCK GATES OPEN
AND INNER LOCK GATES CLOSED FOR TEST WAVES FROM NNW

TEST WAVE		WAVE HEIGHT, FT		
PERIOD SEC	HEIGHT FT	GAGE 6	GAGE 7	GAGE 7A
<u>SWL = +1 FT</u>				
3	2	0.3	0.3	0.4
	4	0.6	0.8	0.6
4	4	0.7	0.8	0.9
<u>SWL = +4 FT</u>				
3	2	0.2	0.4	0.3
	4	0.7	0.9	0.7
4	4	1.2	0.9	1.5

TABLE 29

WAVE HEIGHTS FOR PLANS 19-19F WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED
SWL = +1 FT

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>PLAN 19</u>					
N	3	4	1.1	1.8	1.6
	4	5	1.7	2.4	1.3
<u>PLAN 19A</u>					
N	3	4	1.0	2.3	2.6
	4	5	2.1	2.6	1.7
<u>PLAN 19B</u>					
N	3	4	1.1	1.6	1.4
	4	5	1.6	2.2	1.3
<u>PLAN 19C</u>					
N	3	4	1.1	1.2	1.1
	4	5	1.7	2.2	1.8
NW	3	4	2.6	2.6	3.0
	4	4	2.3	2.2	2.1
<u>PLAN 19D</u>					
NW	3	4	2.2	2.2	2.7
	3	4	1.4	1.2	1.8
<u>PLAN 19E</u>					
NW	3	4	1.7	1.7	2.8
	4	4	2.1	1.5	1.7
<u>PLAN 19F</u>					
NW	3	4	1.4	1.5	2.0
	4	4	0.9	1.1	0.7

TABLE 30

WAVE HEIGHTS FOR PLANS 20-20A WITH LAKEWARD LOCK
GATES OPEN AND INNER LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>PLAN 20 SWL = +1 FT</u>					
N	3	4	0.7	1.3	2.0
	4	5	0.8	1.6	2.1
<u>PLAN 20 SWL = +4 FT</u>					
N	3	4	1.2	1.5	1.8
	4	5	1.2	2.0	2.2
<u>PLAN 20A SWL = +1 FT</u>					
N	3	2	0.2	0.5	0.7
		4	0.5	0.8	1.2
	4	5	1.0	1.0	1.4
<u>PLAN 20A SWL = +4 FT</u>					
	3	2	0.3	0.4	1.0
		4	1.0	1.3	1.5
	4	5	1.0	2.0	2.2
<u>PLAN 20A SWL = +1 FT</u>					
NW	3	2	0.3	0.6	1.1
		4	0.9	1.2	2.2
	4	4	1.0	0.8	1.5
<u>PLAN 20A SWL = +4 FT</u>					
NW	3	2	0.5	0.7	1.6
		4	0.8	1.6	2.5
	4	4	0.6	1.7	2.1

TABLE 31
WAVE HEIGHTS FOR PLAN 20A WITH LAKEWARD LOCK GATES
OPEN AND INNER LOCK GATES CLOSED

TEST WAVE			WAVE HEIGHT, FT										
DIRECTION	PERIOD SEC	HEIGHT FT	GAGE 2	GAGE 3	GAGE 4	GAGE 5	GAGE 6	GAGE 7	GAGE 7A	GAGE 8	GAGE 9	GAGE 10	GAGE 11
<u>SWL = +1 FT</u>													
N	3	2	0.1	0.1	1.1	0.1	0.1	0.5	0.7	0.4	0.4	0.2	0.5
		4	0.4	0.5	2.4	0.5	0.6	1.0	1.3	0.9	1.4	0.9	1.2
	4	5	0.7	0.8	2.2	0.7	1.0	1.0	1.1	1.5	1.5	1.3	2.0
NNW	3	2	0.5	0.2	1.3	0.2	0.3	0.5	0.6	1.0	0.9	0.4	0.6
		4	0.9	0.2	1.8	0.3	0.4	0.7	0.8	1.1	1.0	0.7	1.0
	4	4	0.9	0.8	2.4	0.6	0.9	1.6	1.9	1.8	1.4	1.2	1.2
NW	3	2	1.6	0.1	0.1	0.1	0.6	0.6	1.3	2.5	0.1	0.4	0.8
		4	2.4	0.7	0.5	0.5	0.7	1.2	2.1	3.4	1.1	1.2	0.9
	4	4	2.1	0.9	0.5	0.4	1.0	1.0	1.5	3.8	0.6	0.9	0.9
<u>SWL = +4 FT</u>													
N	3	2	0.2	0.4	1.4	0.2	0.4	0.6	0.5	0.7	0.7	0.7	1.0
		4	0.7	1.1	2.8	1.2	1.0	1.3	1.6	1.9	2.1	1.8	2.4
	4	5	1.2	2.1	2.7	1.2	1.0	1.8	2.2	2.2	2.2	3.2	3.1
NNW	3	2	0.6	0.4	0.8	0.3	0.5	0.6	0.8	0.8	0.7	0.8	1.0
		4	1.0	0.9	1.6	0.8	1.1	1.2	1.4	1.3	1.3	1.8	1.6
	4	4	1.3	2.2	1.7	1.1	0.7	2.0	1.1	0.8	1.2	1.5	1.4
NW	3	2	2.2	0.2	0.1	0.5	0.2	1.0	1.6	2.1	0.3	0.6	0.5
		4	2.4	1.0	1.1	0.9	0.9	1.8	2.9	3.8	1.5	1.7	1.2
	4	4	3.8	1.2	1.4	0.7	0.6	1.7	1.8	3.2	1.0	1.4	1.5

TABLE 32

WAVE HEIGHTS FOR PLAN 20A WITH BOTH LOCK GATES CLOSED

<u>DIRECTION</u>	<u>TEST WAVE</u>		<u>WAVE HEIGHT, FT</u>		
	<u>PERIOD</u> <u>SEC</u>	<u>HEIGHT</u> <u>FT</u>	<u>GAGE</u> <u>6</u>	<u>GAGE</u> <u>7</u>	<u>GAGE</u> <u>7A</u>
<u>SWL = +1 FT</u>					
N	3	2	0.1	0.5	0.4
		4	0.6	1.0	1.3
	4	5	1.1	0.8	1.1
NNW	3	2	0.3	0.5	0.6
		4	0.5	0.7	0.9
	4	4	1.0	1.3	1.6
NW	3	2	0.8	1.0	1.4
		4	1.2	1.3	2.4
	4	4	1.6	1.0	1.6
<u>SWL = +4 FT</u>					
N	3	2	0.4	0.6	0.6
		4	1.3	1.8	1.5
	4	5	1.6	1.6	1.9
NNW	3	2	0.9	0.6	0.6
		4	1.5	1.3	1.3
	4	4	1.7	1.0	1.9
NW	3	2	0.5	1.1	1.8
		4	1.3	1.6	2.9
	4	4	0.8	1.4	1.8



Photo 1. Typical wave patterns for existing conditions;
3-sec, 4-ft waves from N; swl = +1 ft msl



Photo 2. Typical wave patterns for existing conditions;
4-sec, 5-ft waves from N; swl = +1 ft msl



Photo 3. Typical wave patterns for existing conditions;
3-sec, 4-ft waves from NNW; swl = +1 ft msl



Photo 4. Typical wave patterns for existing conditions;
4-sec, 4-ft waves from NNW; swl = +1 ft msl



Photo 5. Typical wave patterns for existing conditions;
3-sec, 4-ft waves from NW; swl = +1 ft msl



Photo 6. Typical wave patterns for existing conditions;
4-sec, 4-ft waves from NW; swl = +1 ft msl

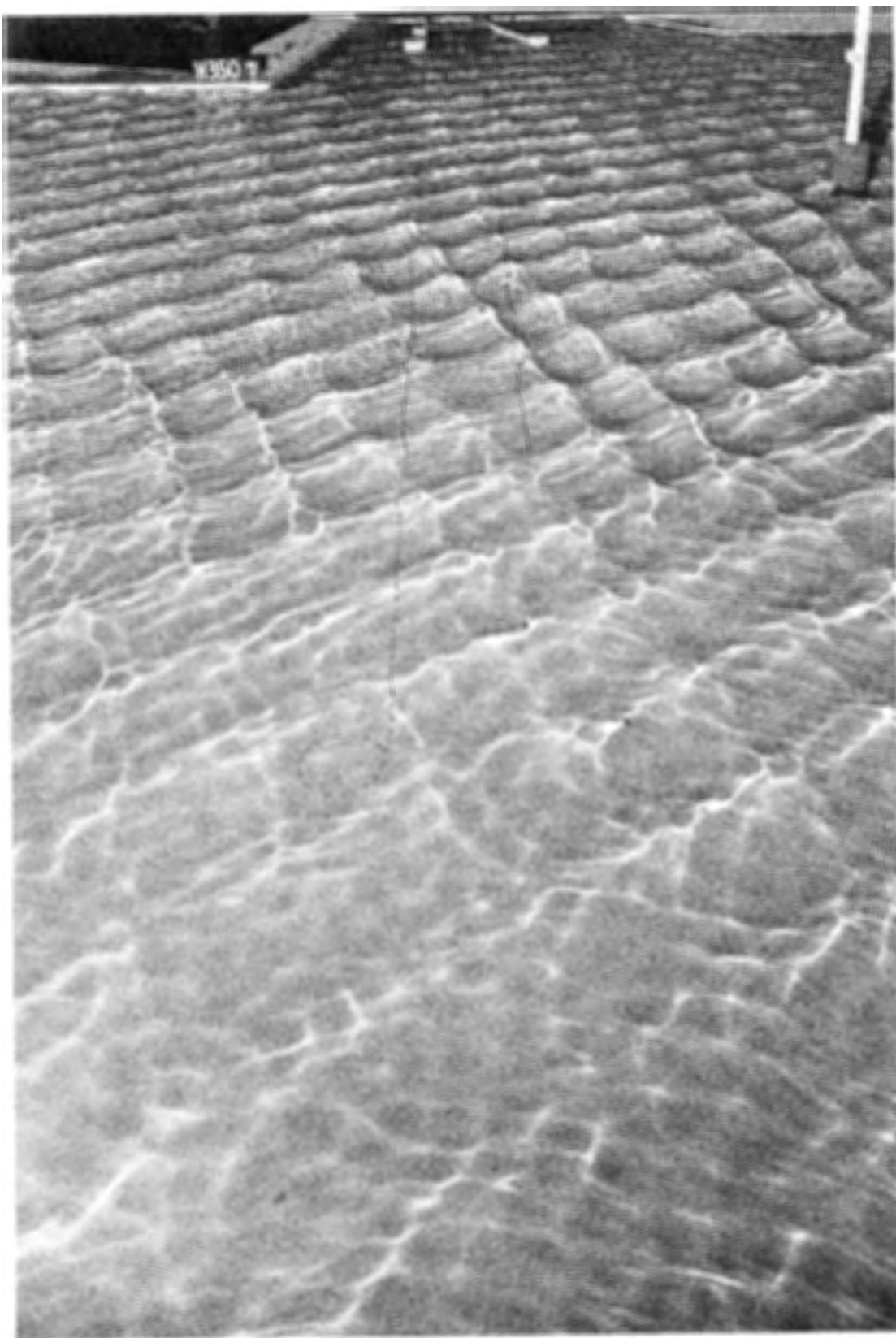


Photo 7. Typical wave patterns for existing cond.
4-sec, 4-ft waves from NW; swl = +4 ft msl



Photo 8. Typical wave patterns for Plan 1; 3-sec, 4-ft waves from N;
swl = +1 ft msl



Photo 9. Typical wave patterns for Plan 1; 4-sec, 5-ft waves from N;
swl = +1 ft msl



Photo 10. Typical wave patterns for Plan 1; 3-sec, 4-ft waves from NNW; swl = +1 ft msl

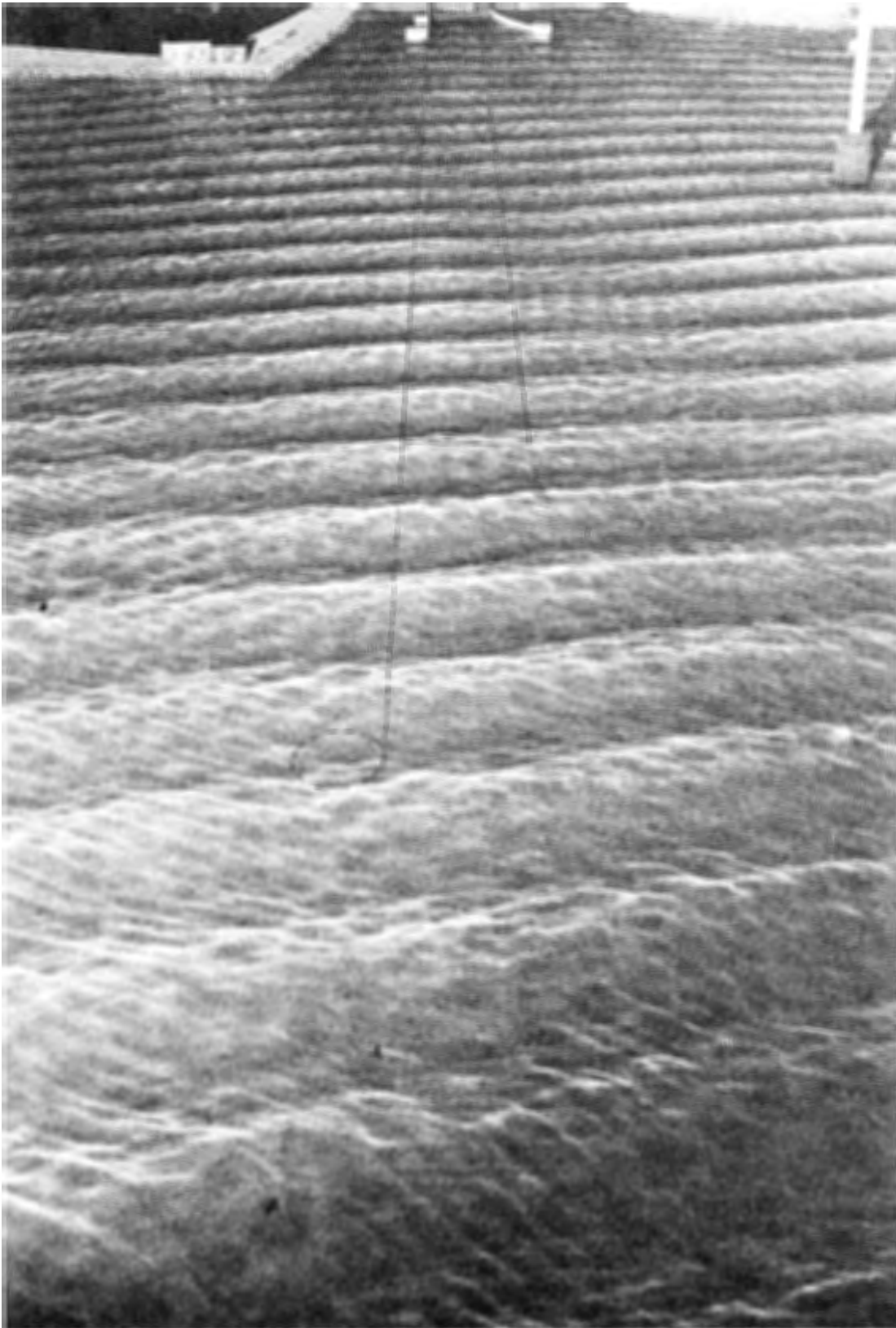


Photo 11. Typical wave patterns for Plan 1; 4-sec, 4-ft waves from NNW; swl = +1 ft msl



Photo 12. Typical wave patterns for Plan 1; 3-sec, 4-ft waves from NW; swl = +1 ft msl

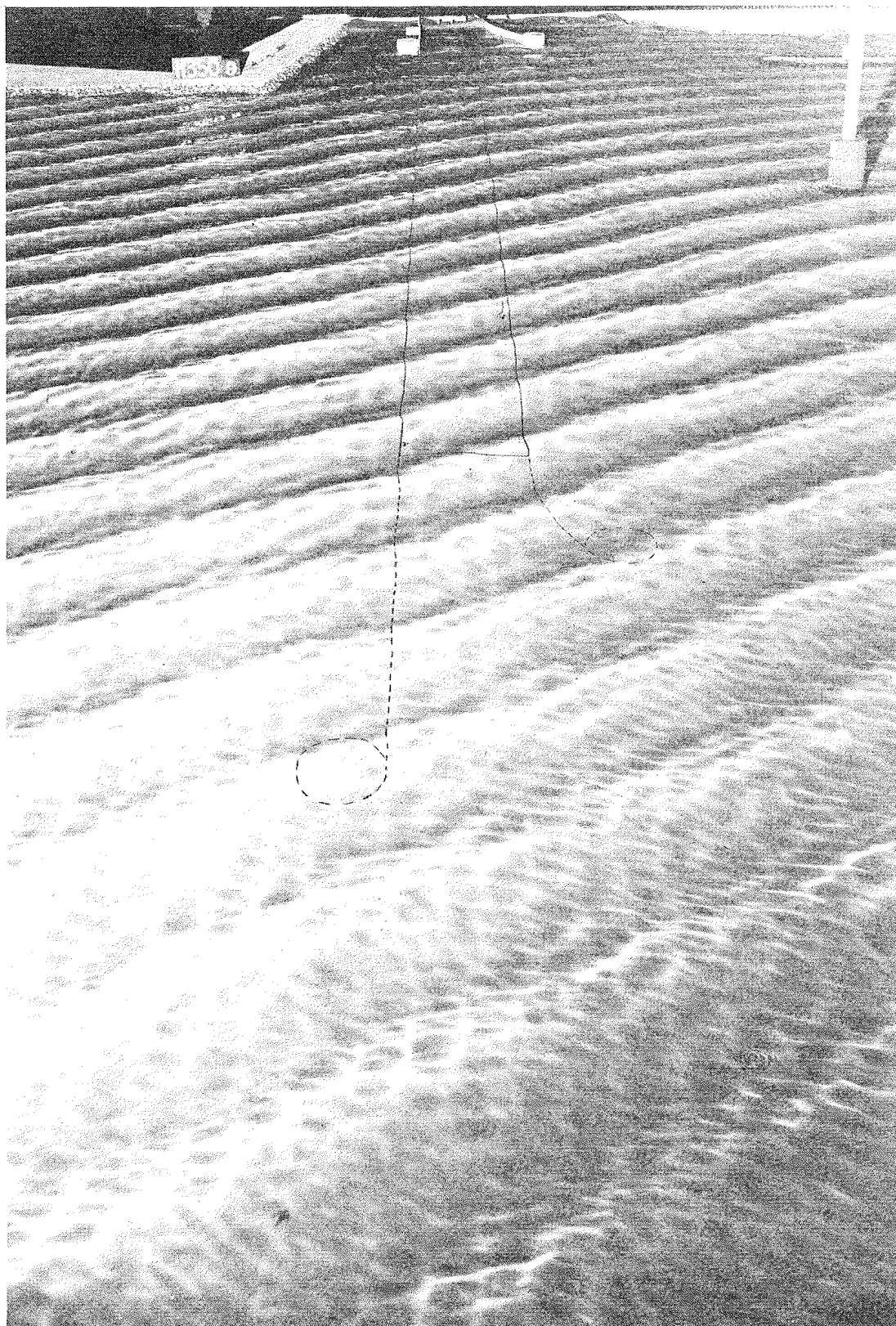


Photo 13. Typical wave patterns for Plan 1; 4-sec, 4-ft waves from NW; swl = +1 ft msl

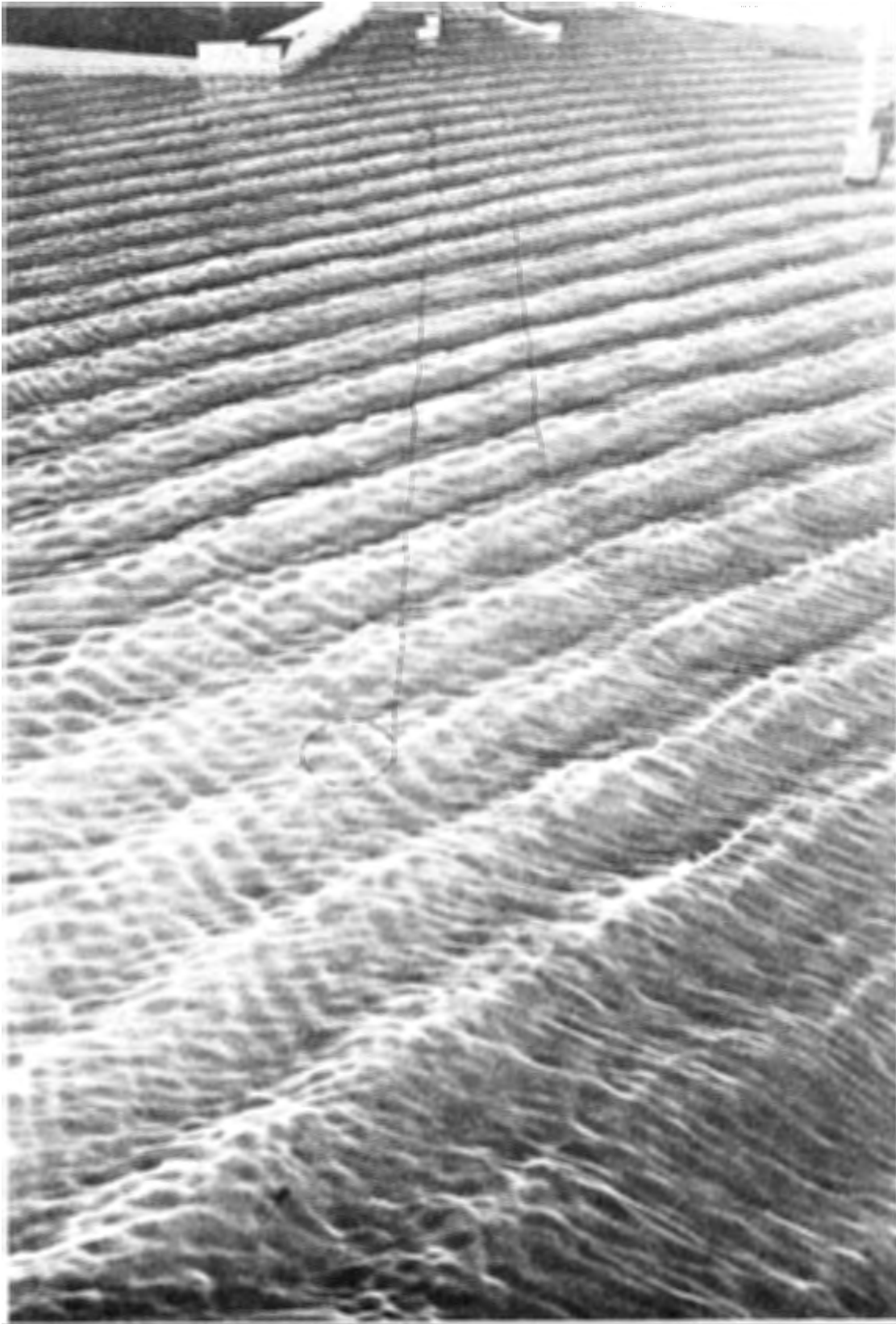


Photo 14. Typical wave patterns for Plan 1; 4-sec, 4-ft waves from
NW; swl = +4 ft msl

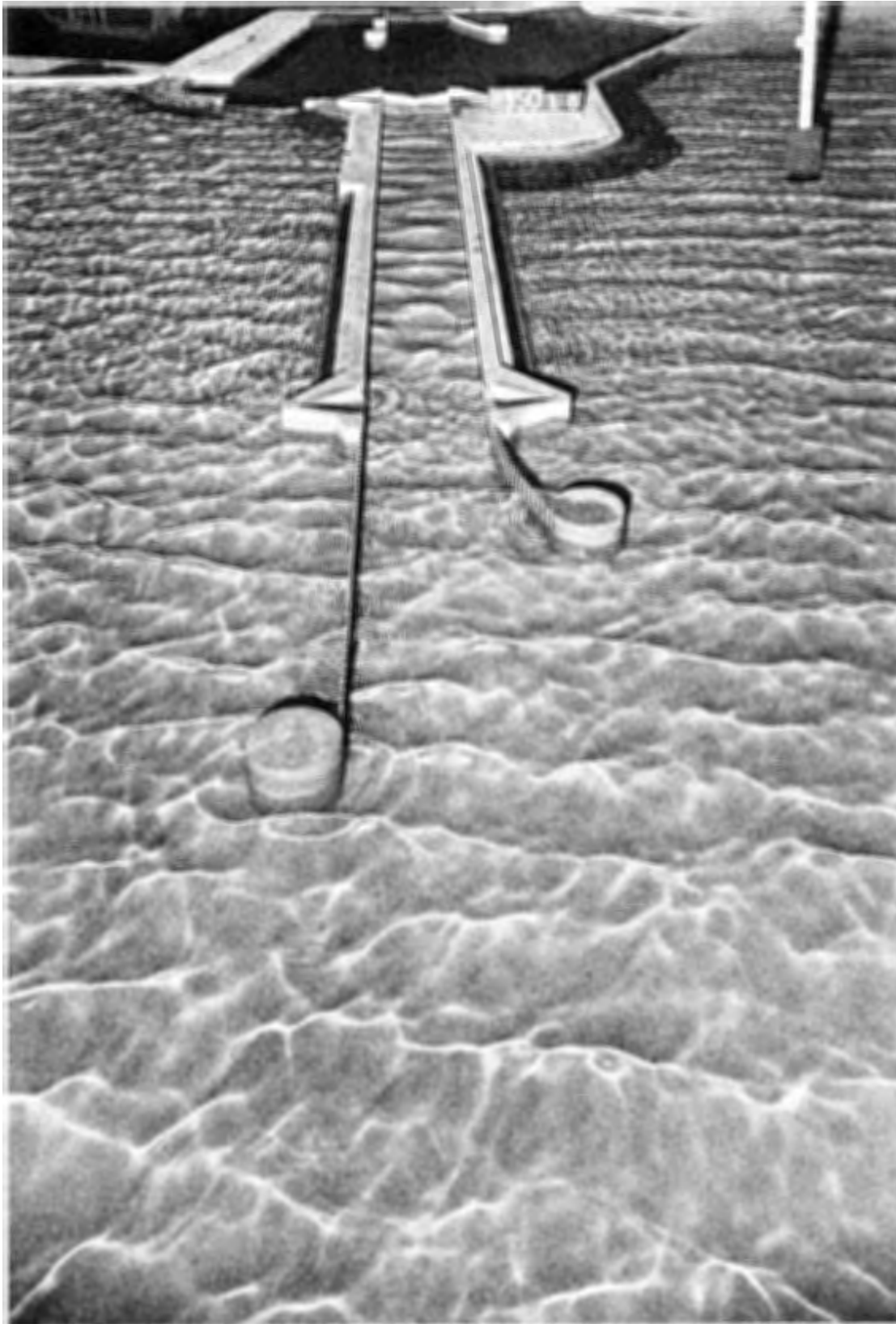


Photo 15. Typical wave patterns at lock entrance for Plan 2; 3-sec,
4-ft waves from N; swl = +1 ft msl

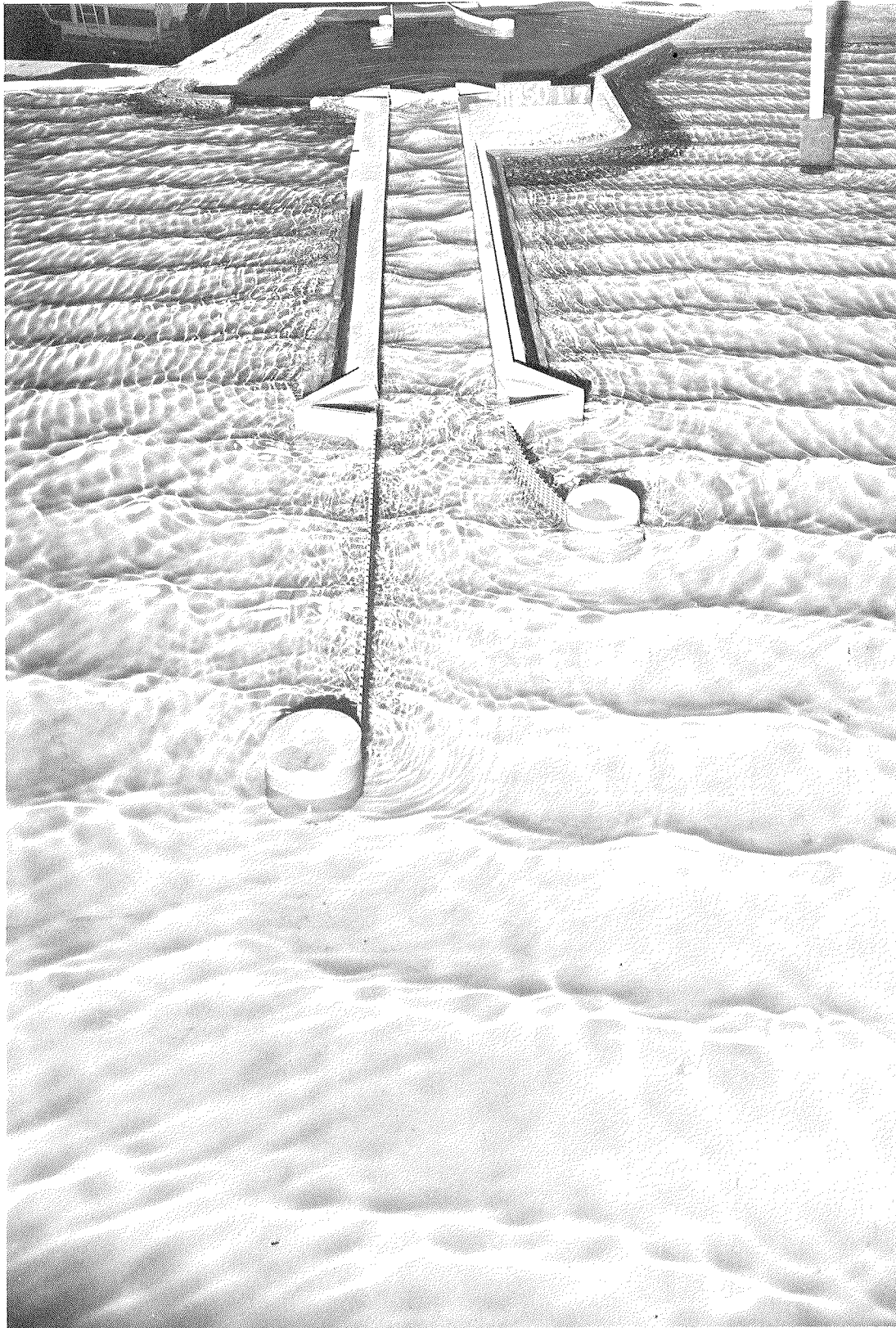


Photo 16. Typical wave patterns at lock entrance for Plan 2; 4-sec,
5-ft waves from N; swl = +1 ft msl

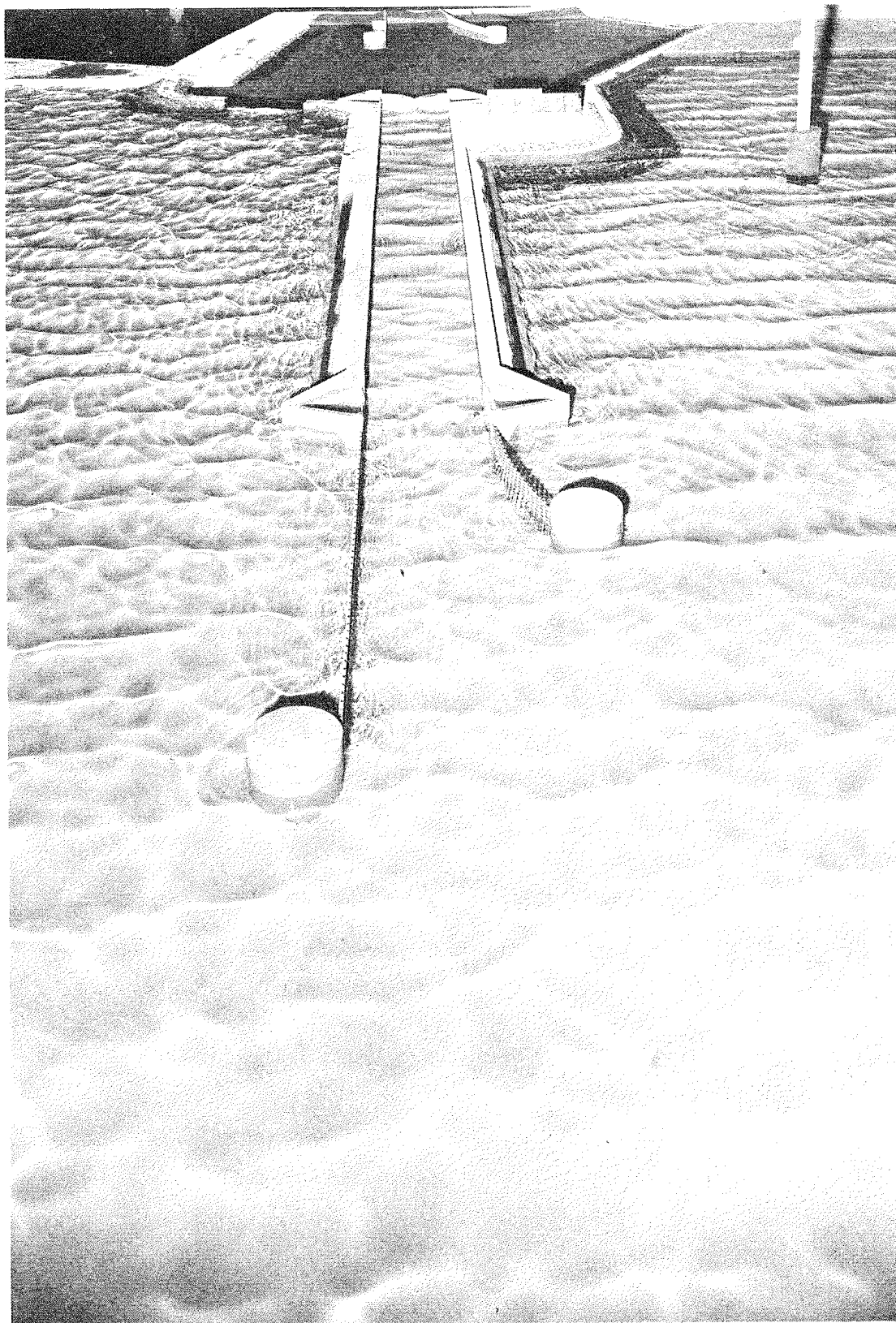


Photo 17. Typical wave patterns at lock entrance for Plan 2; 3-sec,
4-ft waves from NNW; swl = +1 ft msl

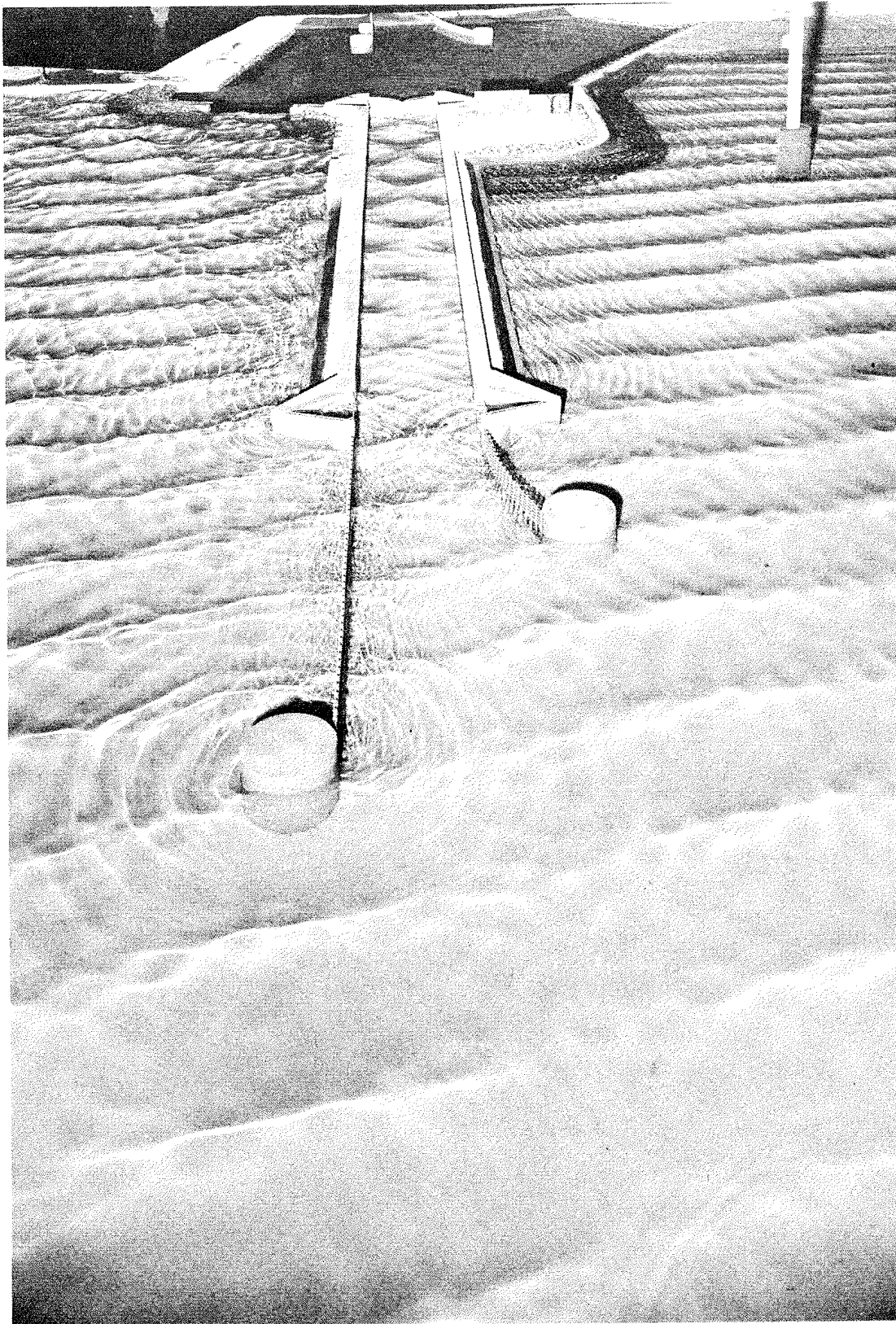


Photo 18. Typical wave patterns at lock entrance for Plan 2; 4-sec,
4-ft waves from NNW; swl = +1 ft msl



Photo 19. Typical wave patterns at lock entrance for Plan 2; 3-sec,
4-ft waves from NW; swl = +1 ft msl

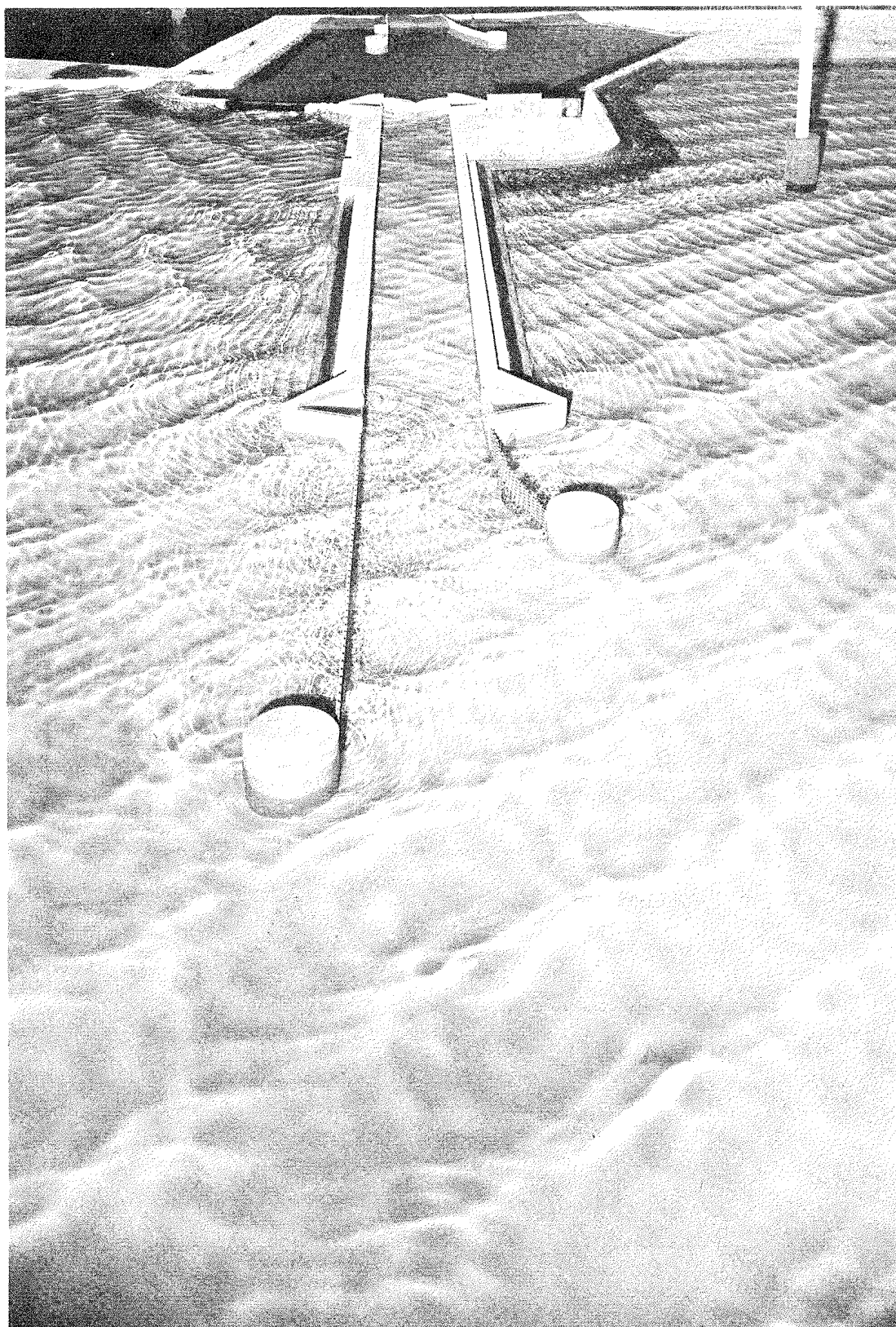


Photo 20. Typical wave patterns at lock entrance for Plan 2; 4-sec,
4-ft waves from NW; swl = +1 ft msl

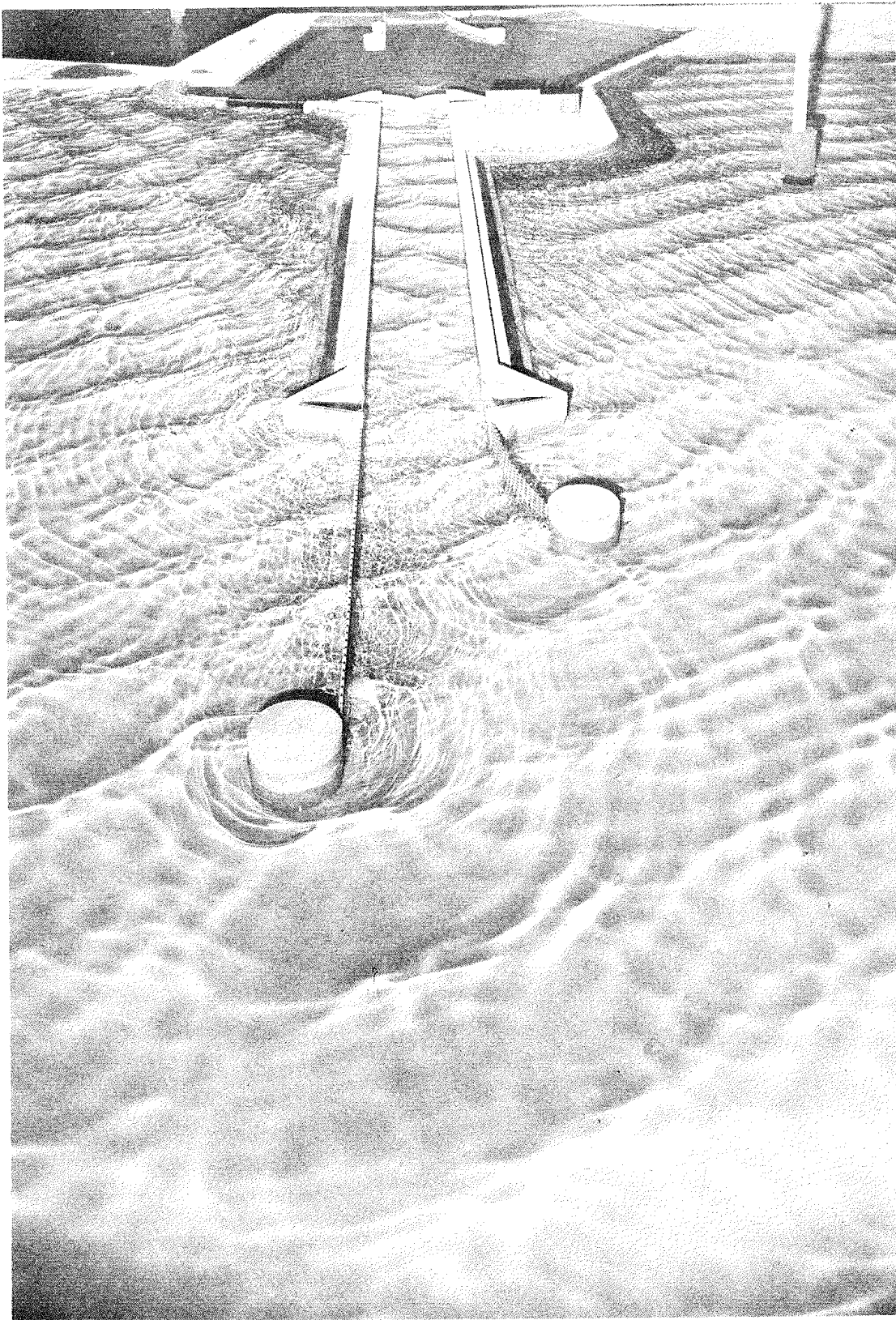


Photo 21. Typical wave patterns at lock entrance for Plan 2; 4-sec,
4-ft waves from NW; swl = +4 ft msl

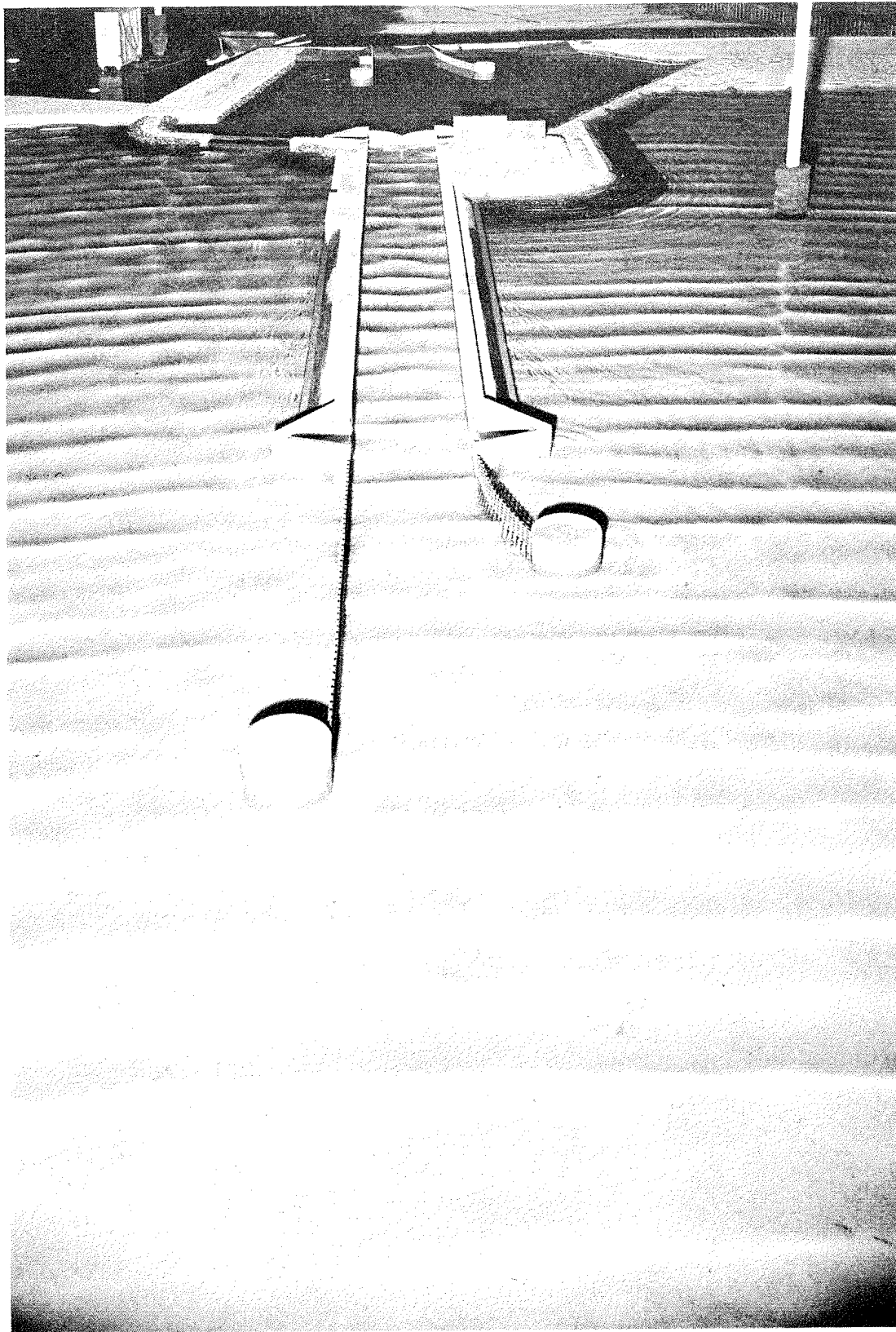


Photo 22. Typical wave patterns at lock entrance for Plan 3A; 3-sec,
4-ft waves from NNW; swl = +1 ft msl

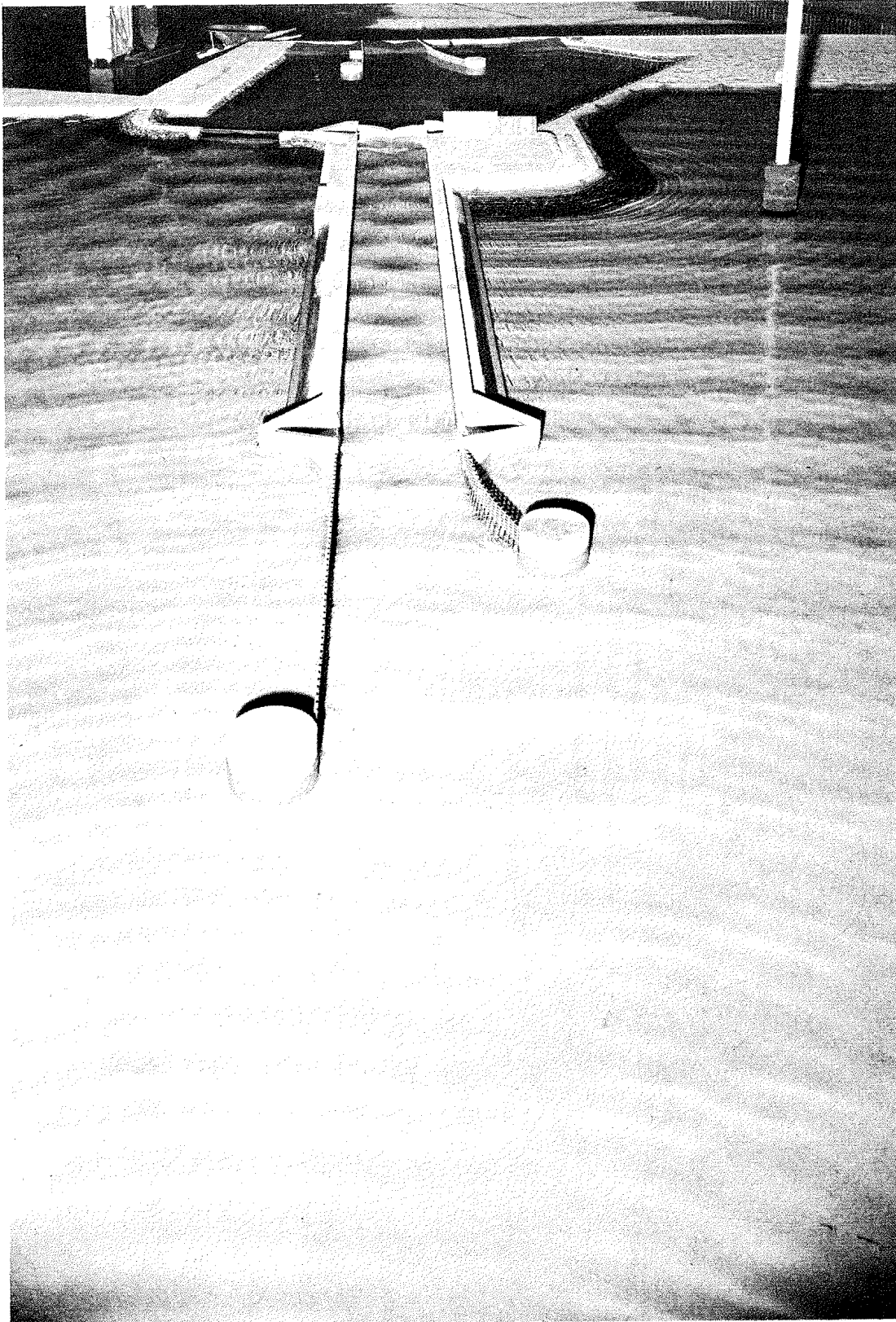


Photo 23. Typical wave patterns at lock entrance for Plan 3A; 4-sec,
4-ft waves from NNW; swl = +1 ft msl

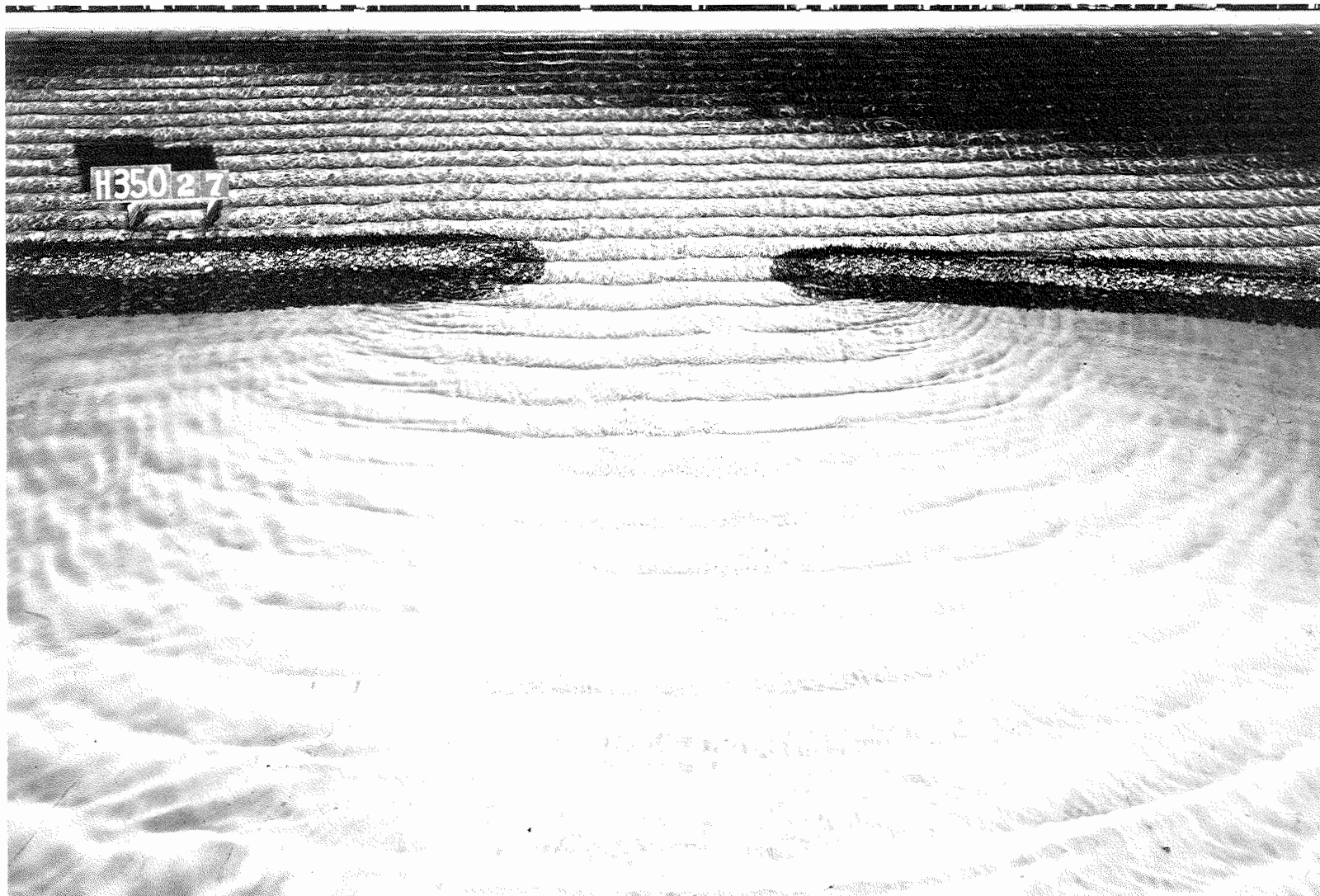


Photo 24. Typical wave patterns between breakwaters for Plan 3A; 3-sec, 4-ft waves from NNW;
swl = +1 ft msl

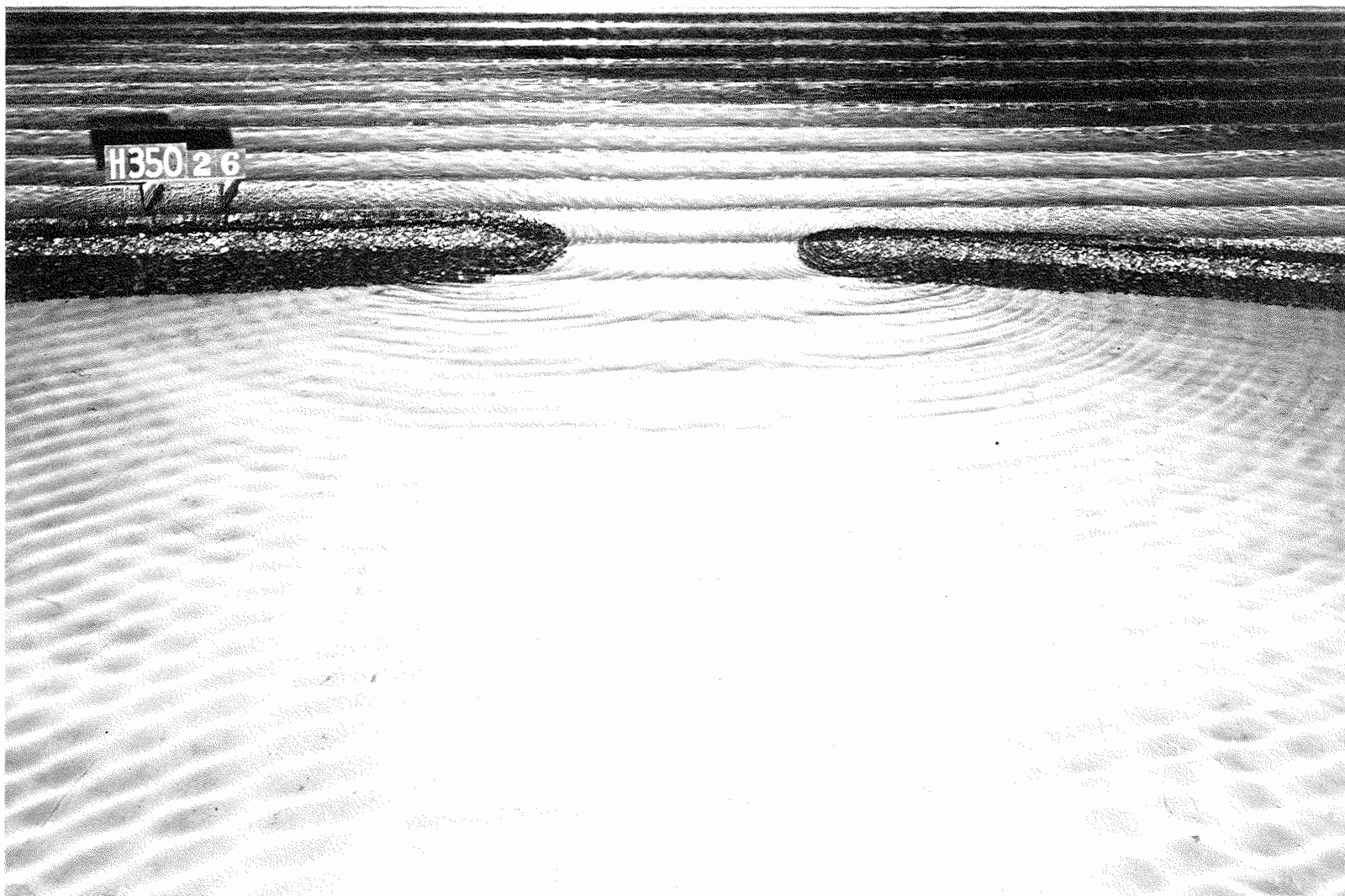


Photo 25. Typical wave patterns between breakwaters for Plan 3A; 4-sec, 4-ft waves from NNW;
swl = +1 ft msl

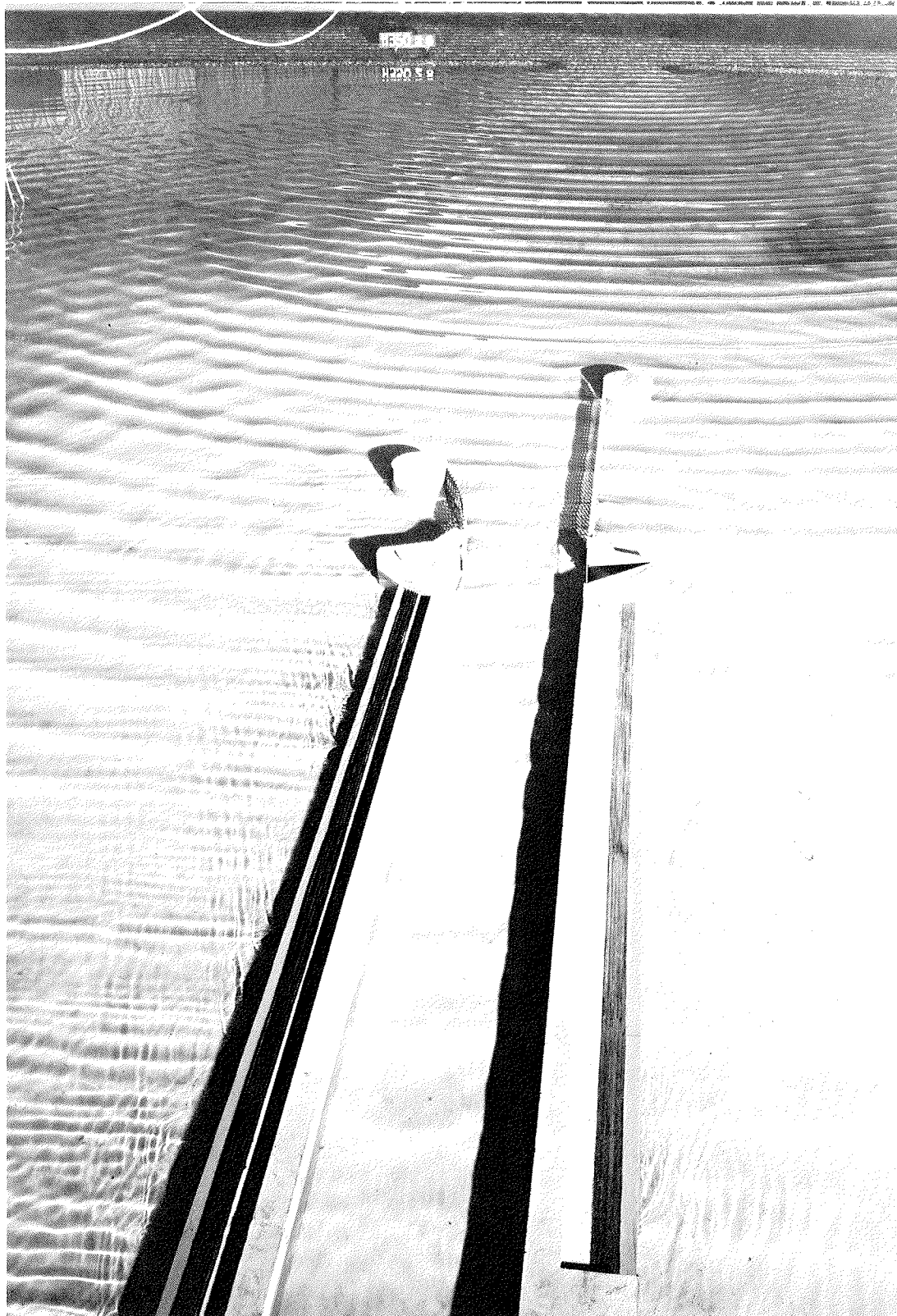


Photo 26. Typical wave patterns for Plan 3A; 3-sec, 4-ft waves from NNW; swl = +1 ft msl

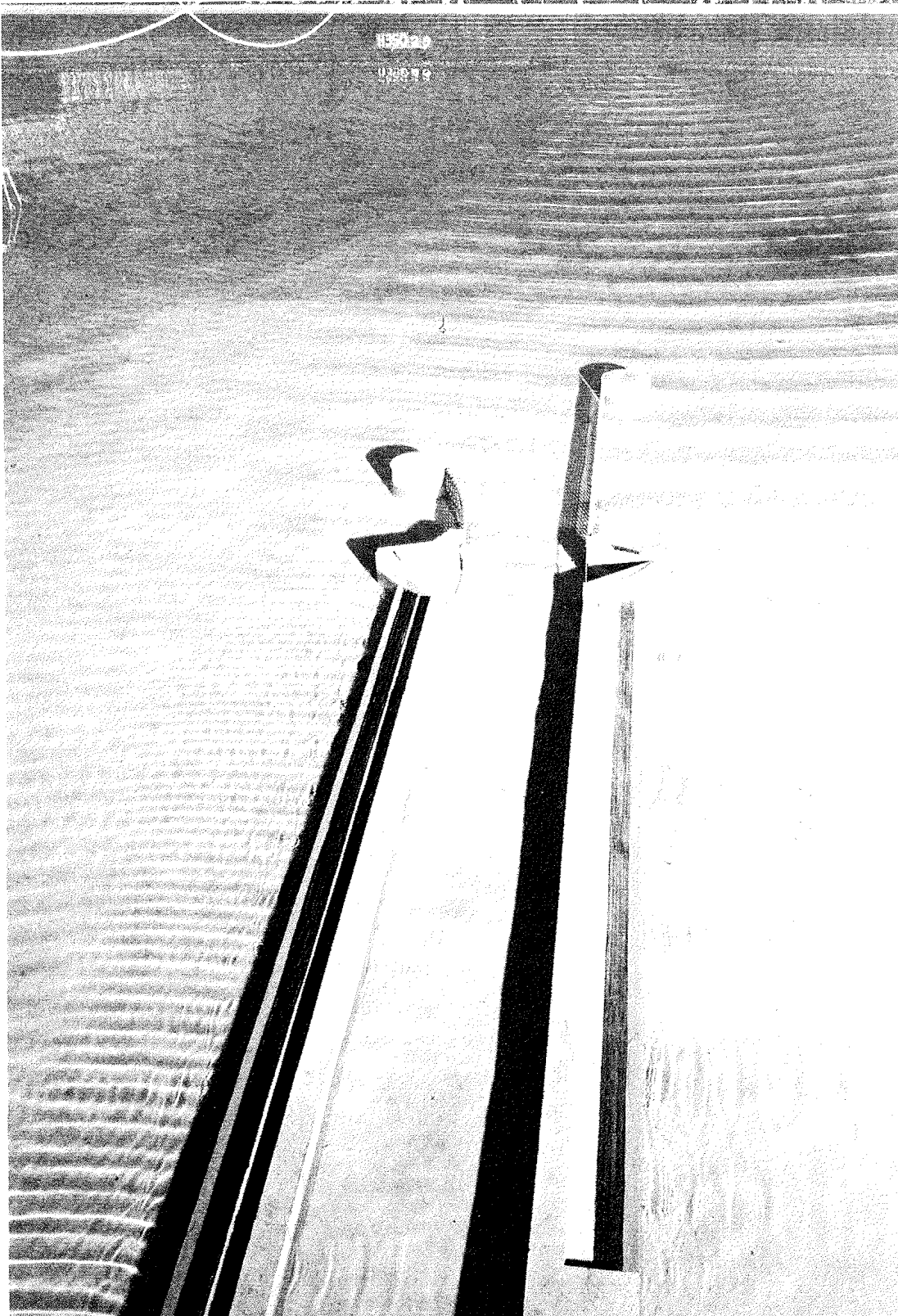


Photo 27. Typical wave patterns for Plan 3A; 4-sec, 4-ft waves from NNW; swl = +1 ft msl

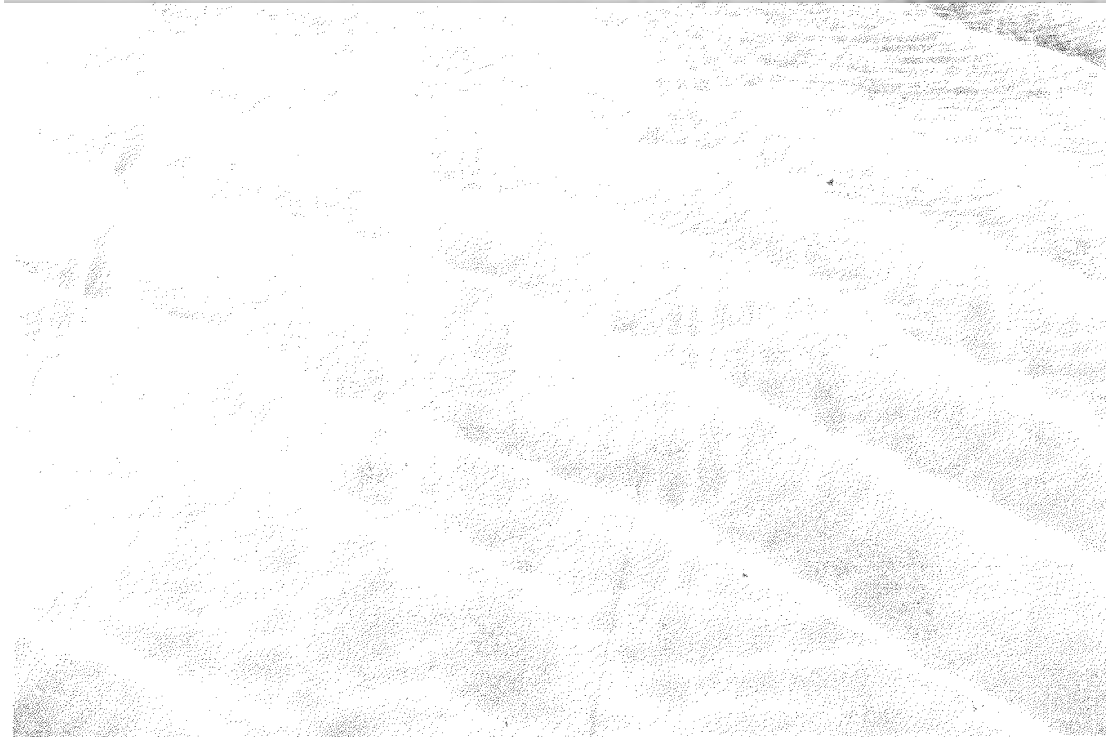
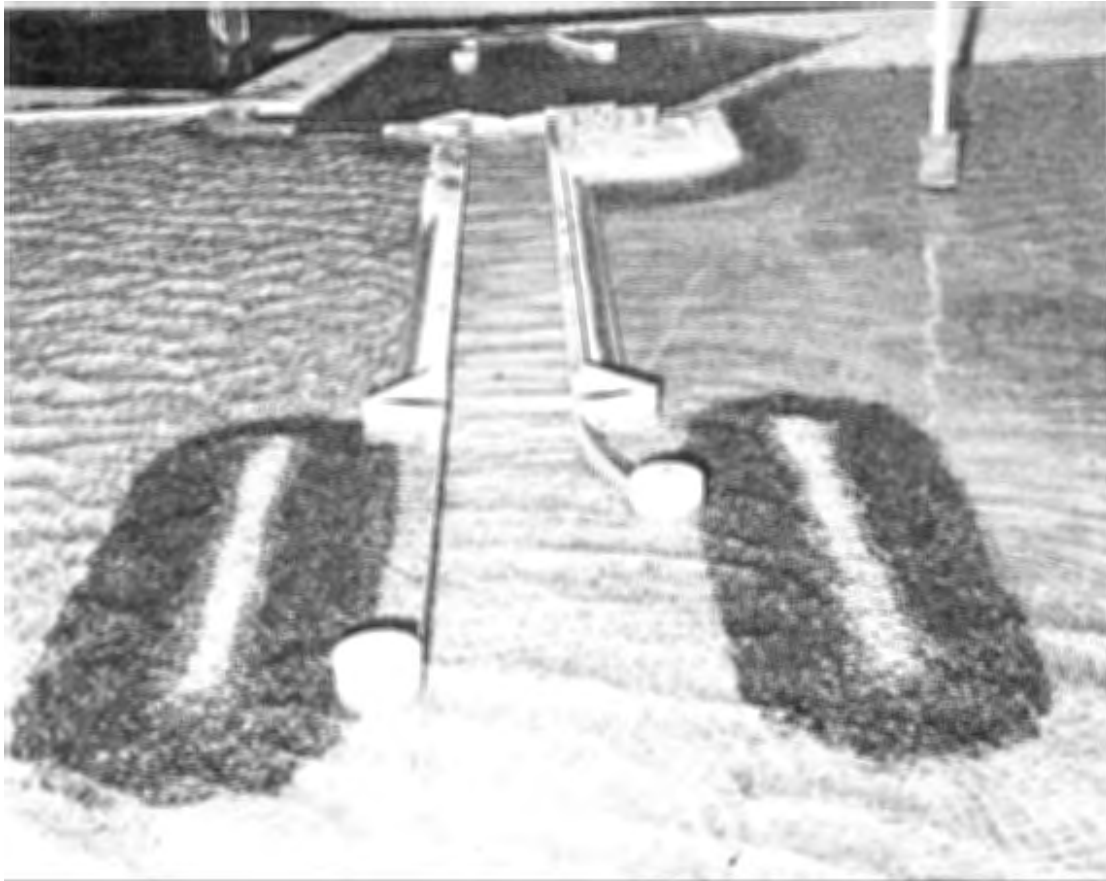


Photo 28. Typical wave patterns at lock entrance for Plan 8; 3-sec,
4-ft waves from N; swl = +1 ft msl

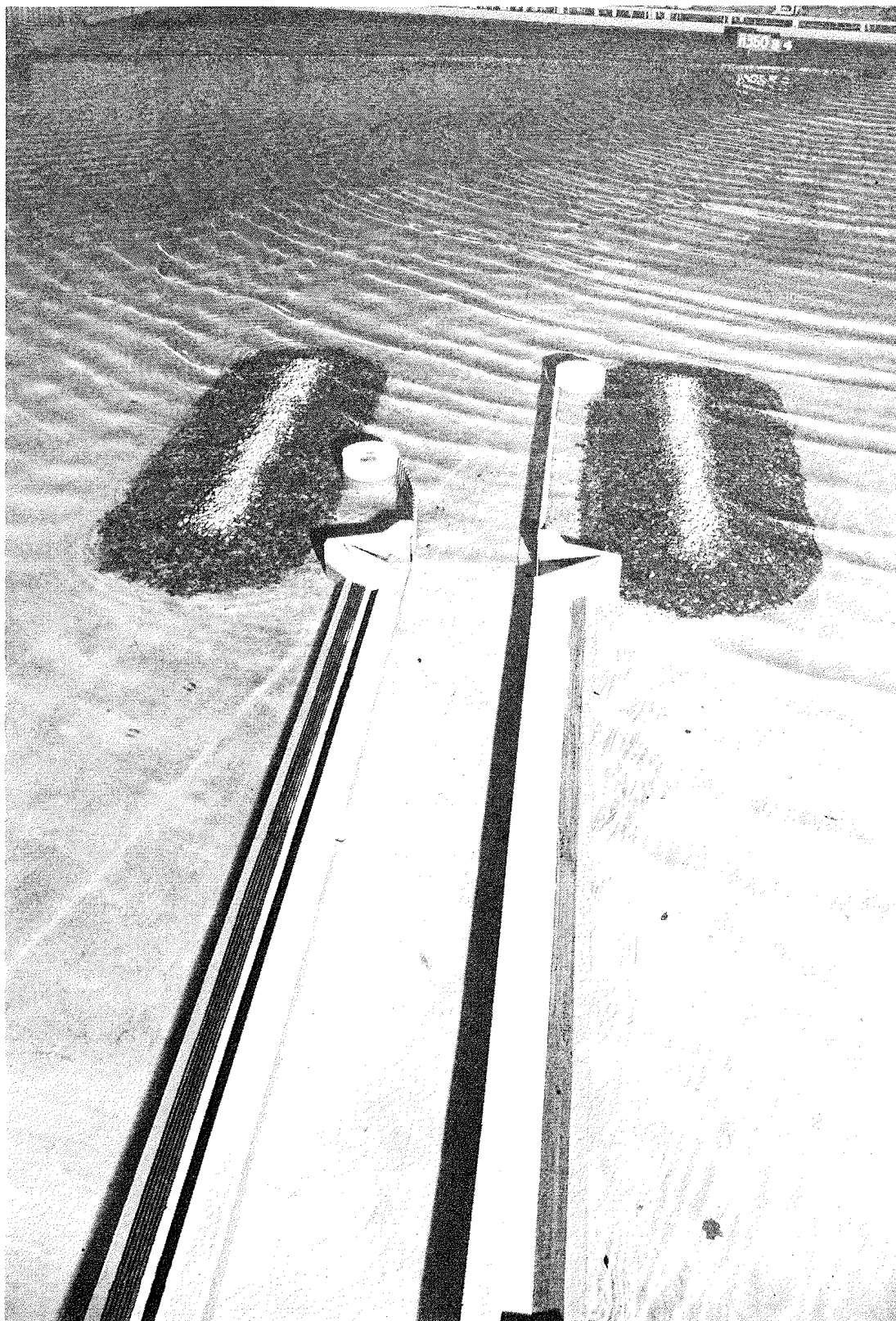


Photo 29. Typical wave patterns for Plan 8; 3-sec, 4-ft waves from N; swl = +1 ft msl

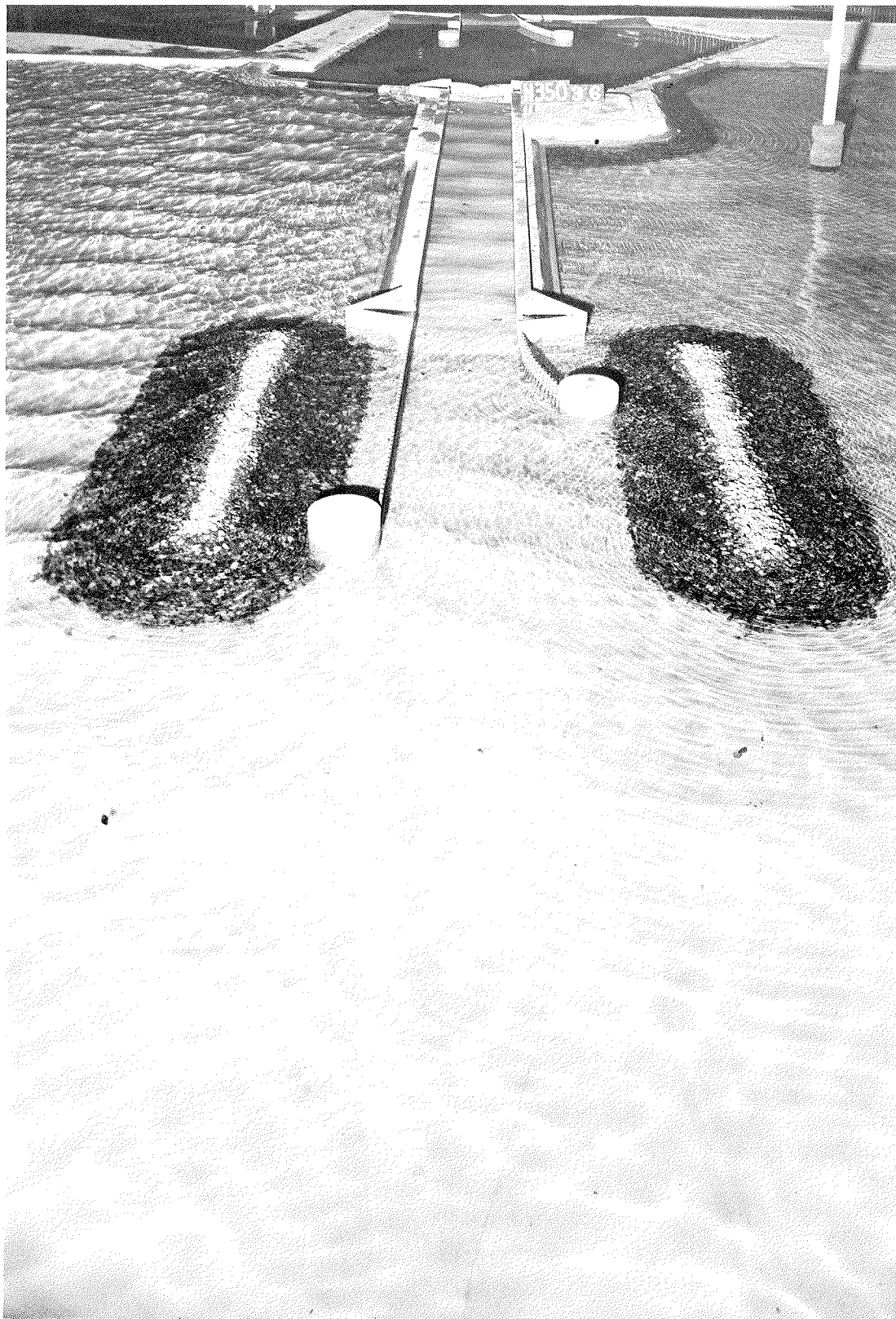


Photo 30. Typical wave patterns at lock entrance for Plan 8; 4-sec,
5-ft waves from N; swl = +1 ft msl

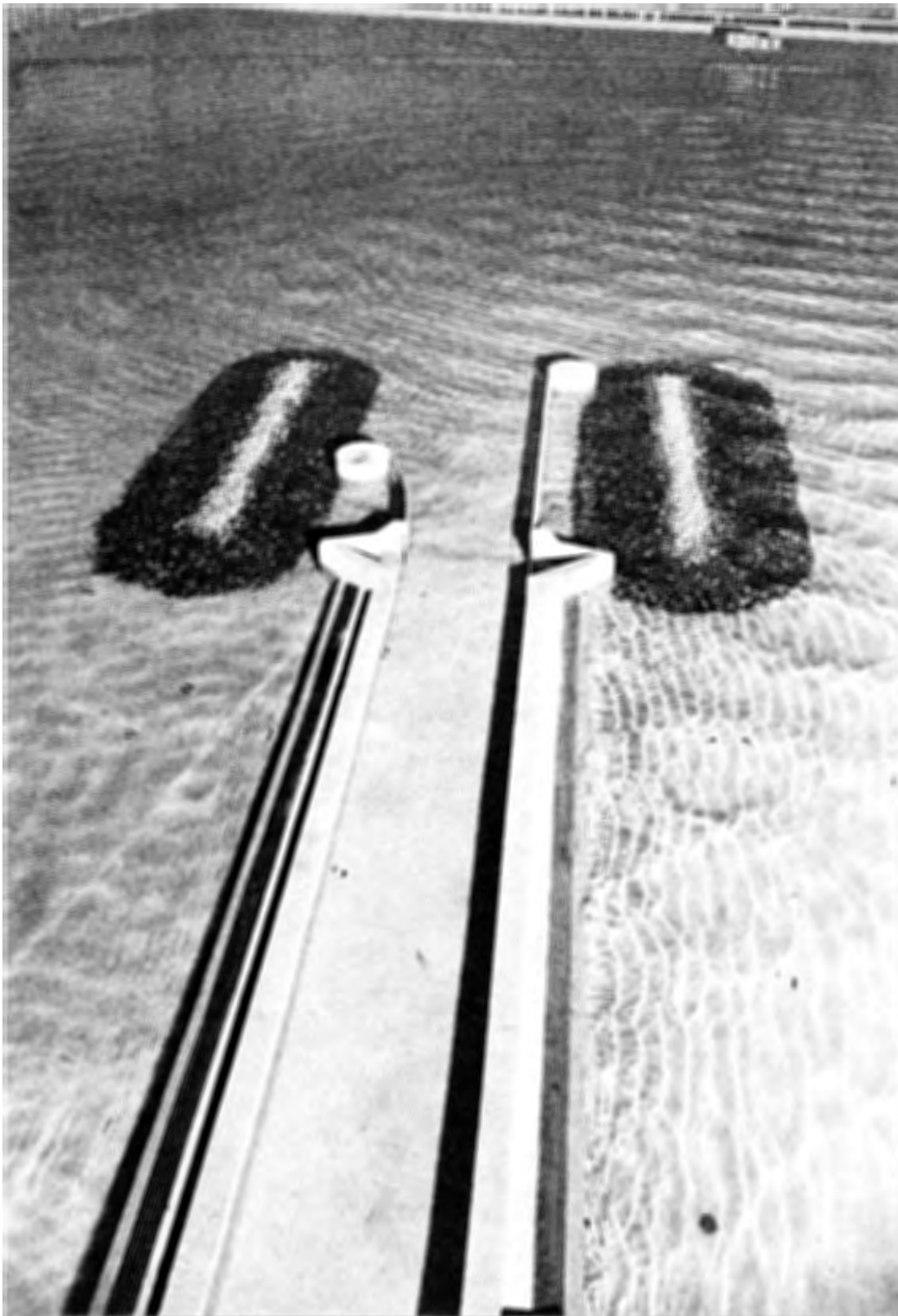


Photo 31. Typical wave patterns for Plan 8; 4-sec, 5-ft waves from N; swl = +1 ft msl

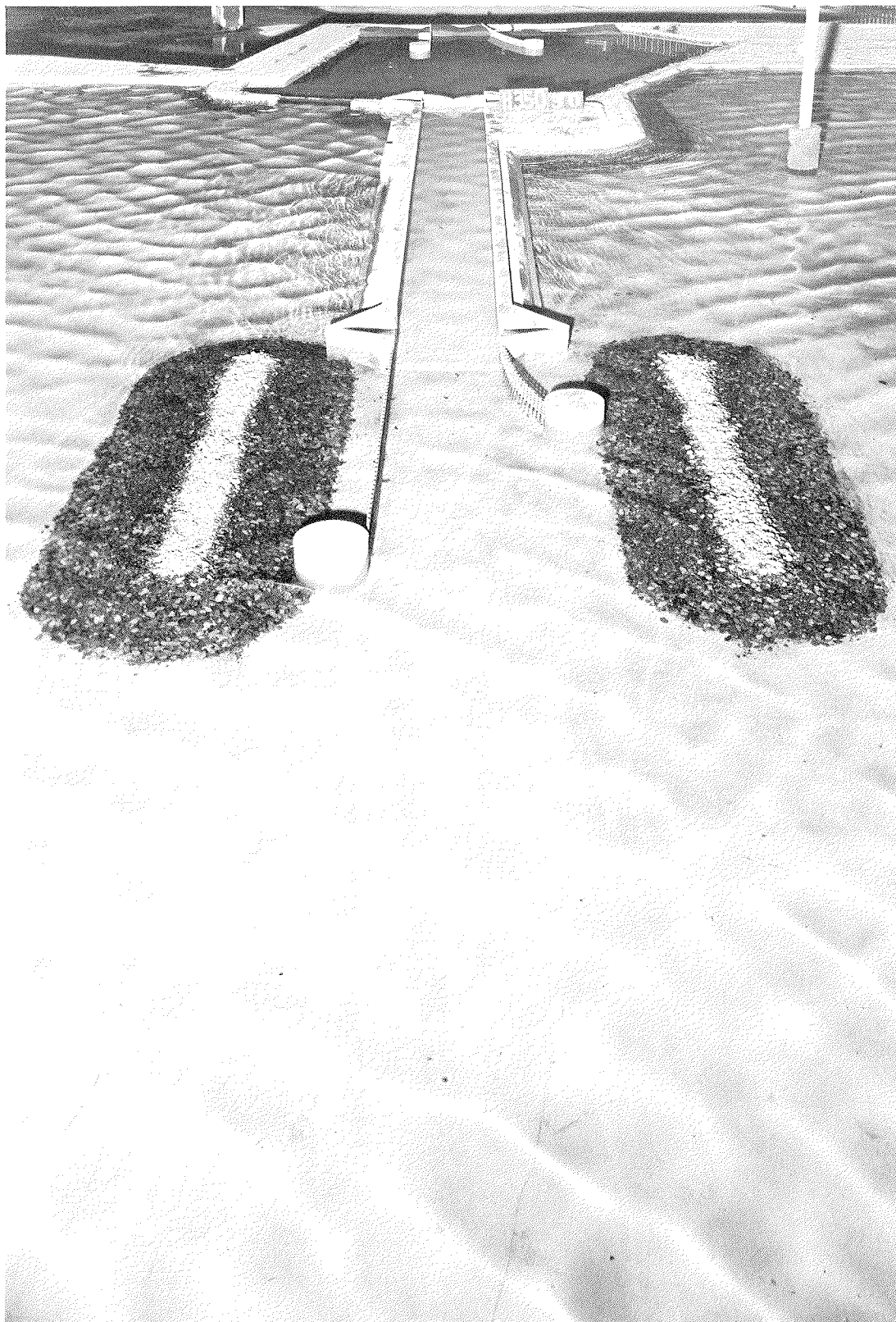


Photo 32. Typical wave patterns at lock entrance for Plan 8; 3-sec
4-ft waves from NNW; swl = +1 ft msl

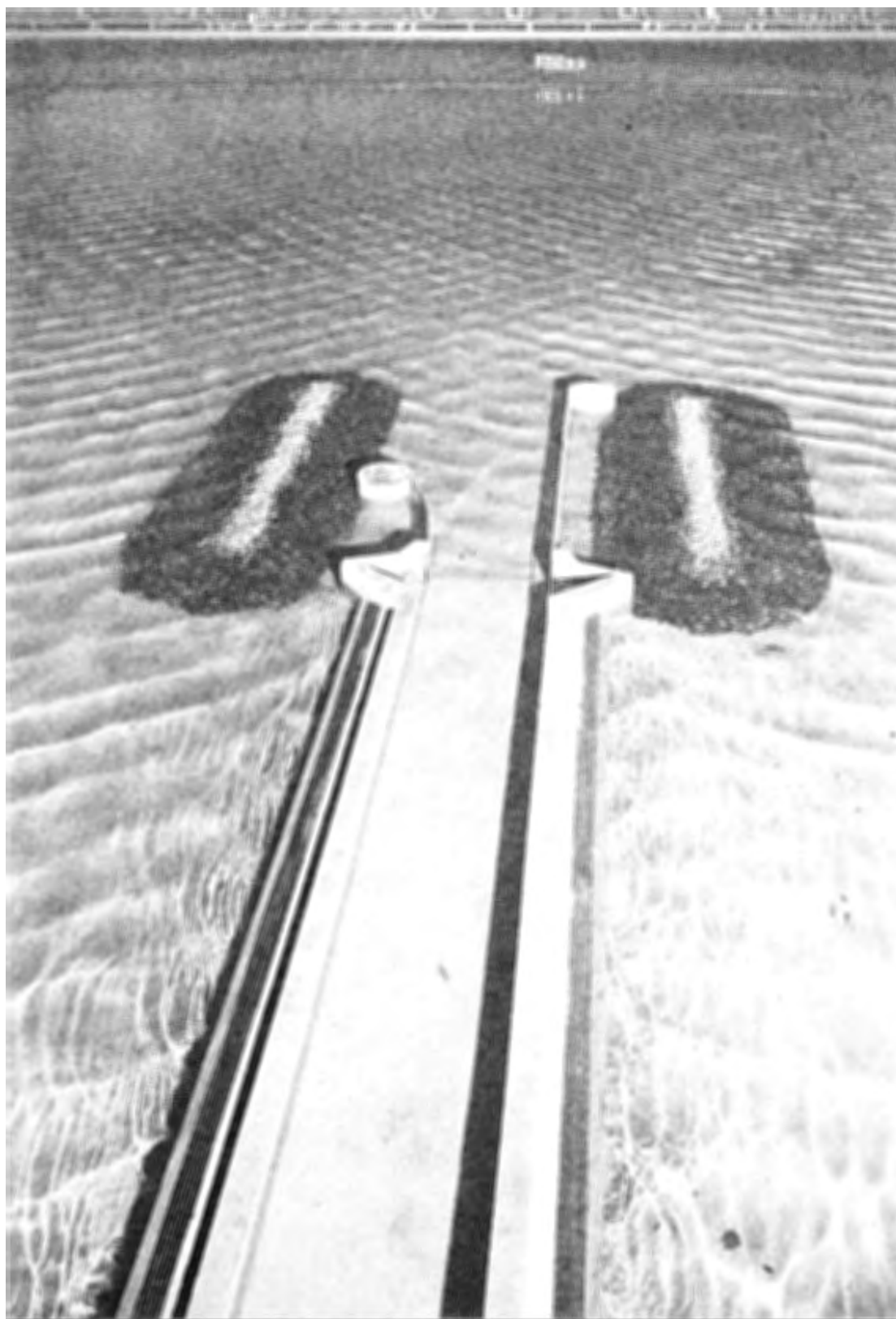


Photo 33. Typical wave patterns for Plan 8; 3-sec, 4-ft waves from NNW; swl = +1 ft msl

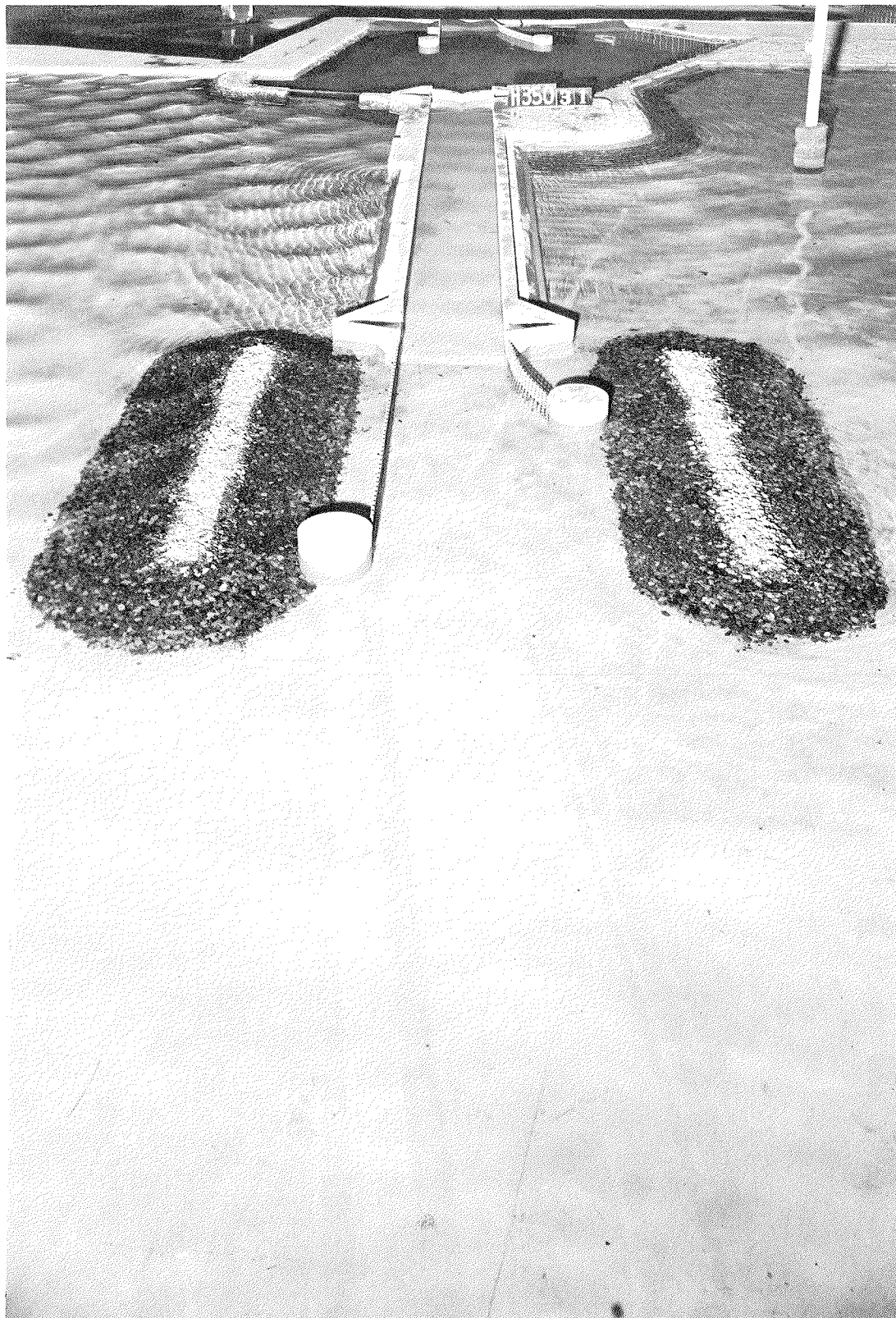


Photo 34. Typical wave patterns at lock entrance for Plan 8; 4-sec,
4-ft waves from NNW; swl = +1 ft msl

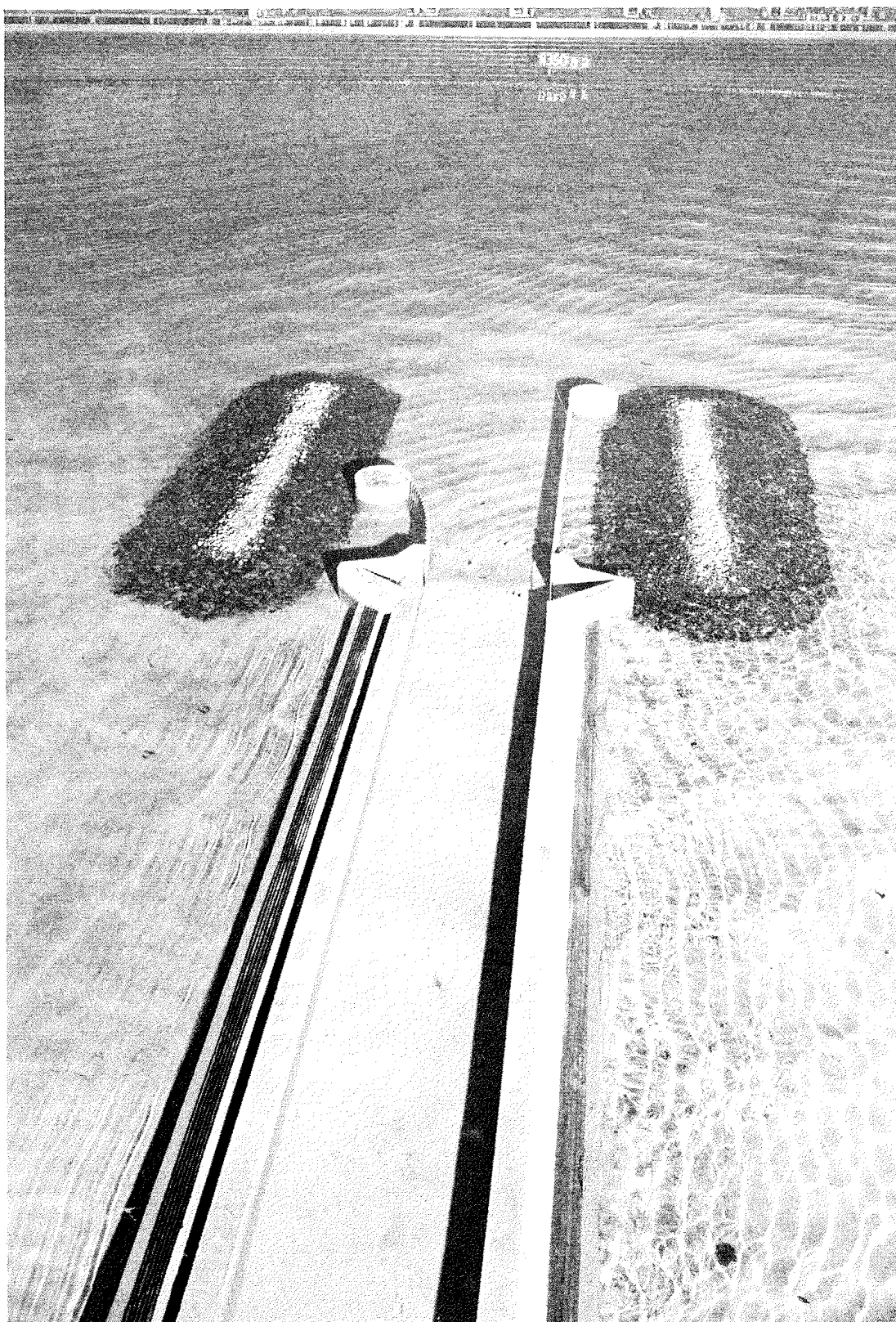


Photo 35. Typical wave patterns for Plan 8; 4-sec, 4-ft waves from NNW; swl = +1 ft msl

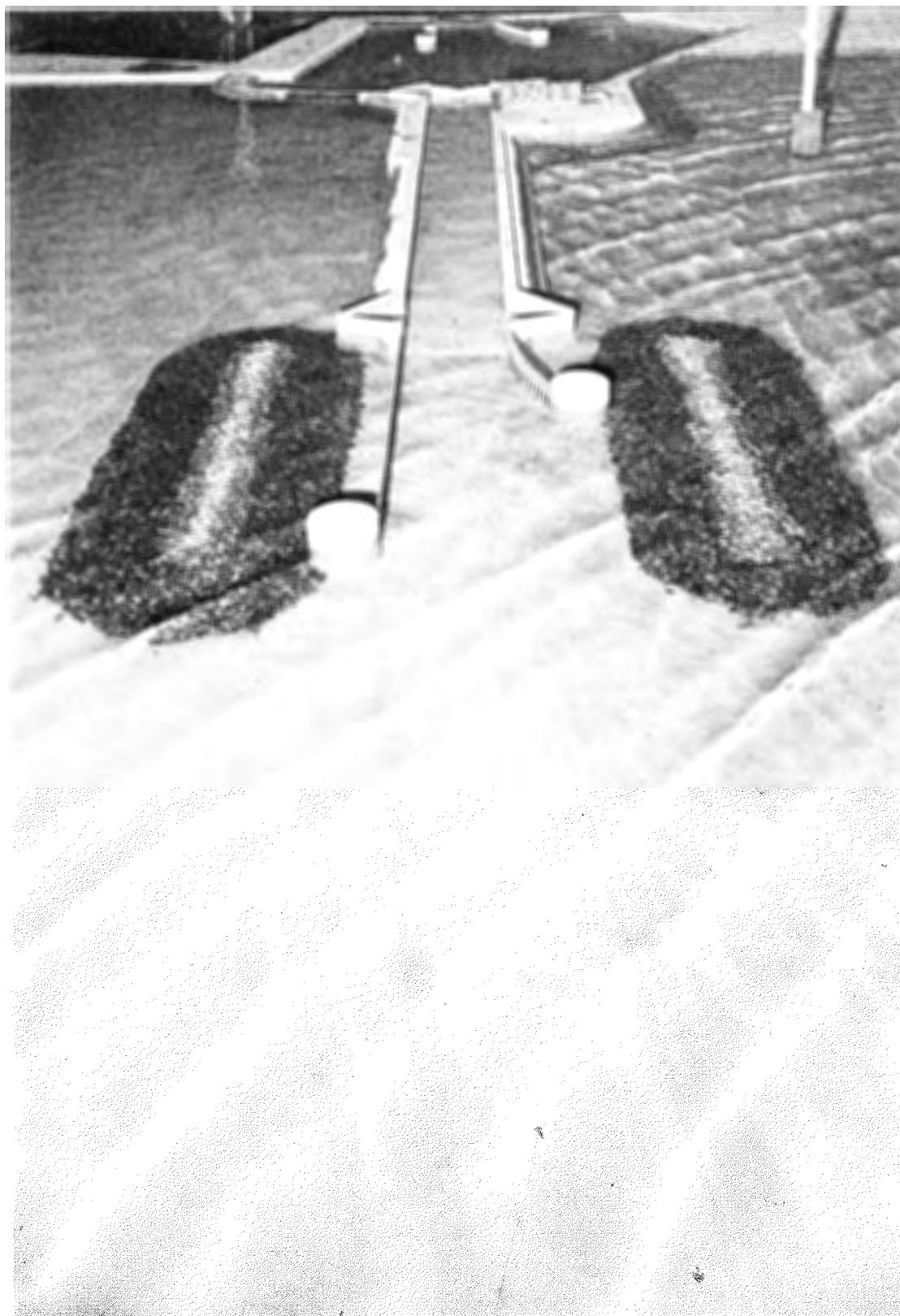


Photo 36. Typical wave patterns at lock entrance for Plan 8; 3-sec,
4-ft waves from NW; swl = +1 ft msl

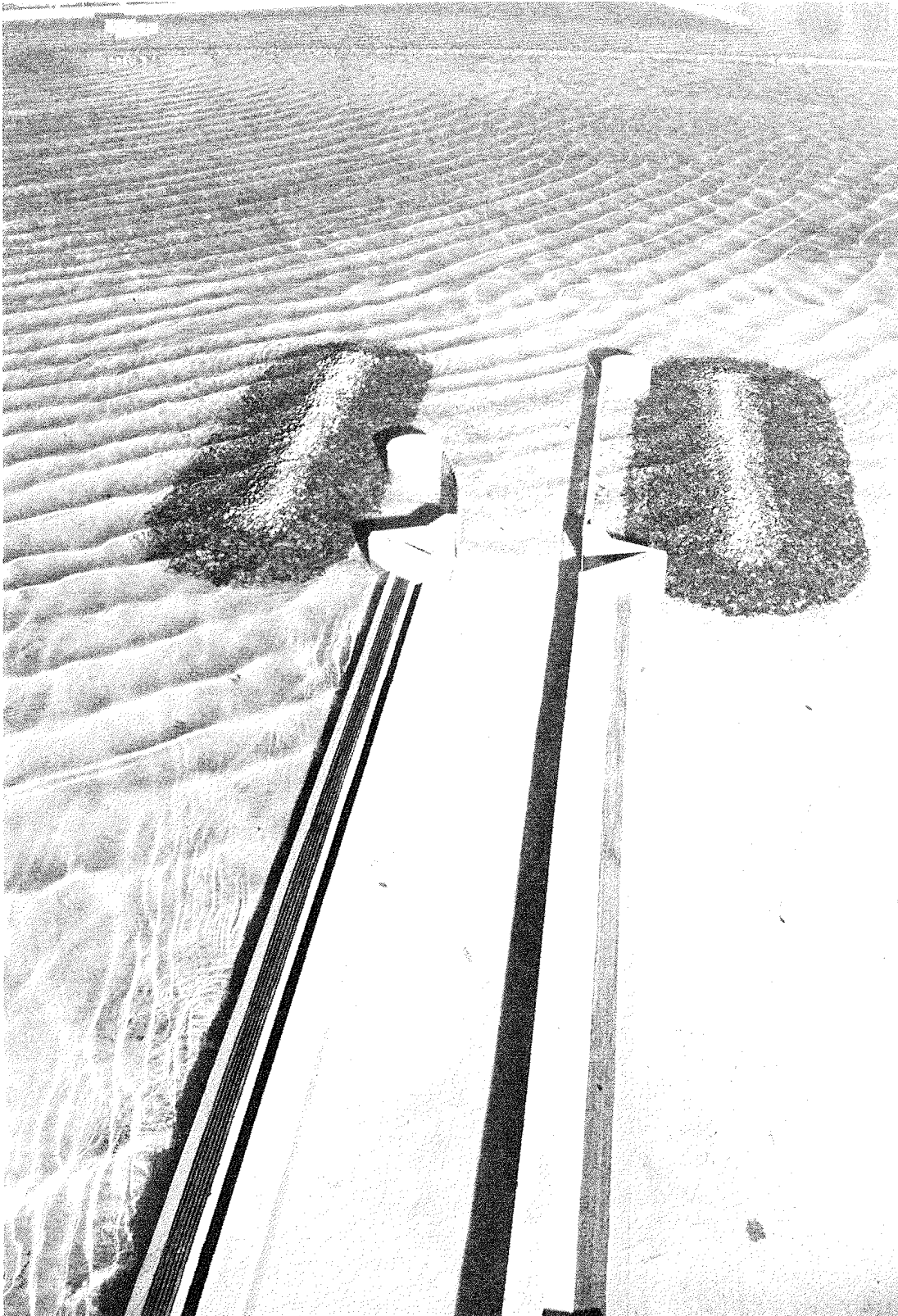


Photo 37. Typical wave patterns for Plan 8; 3-sec, 4-ft waves from
NW; swl = +1 ft msl

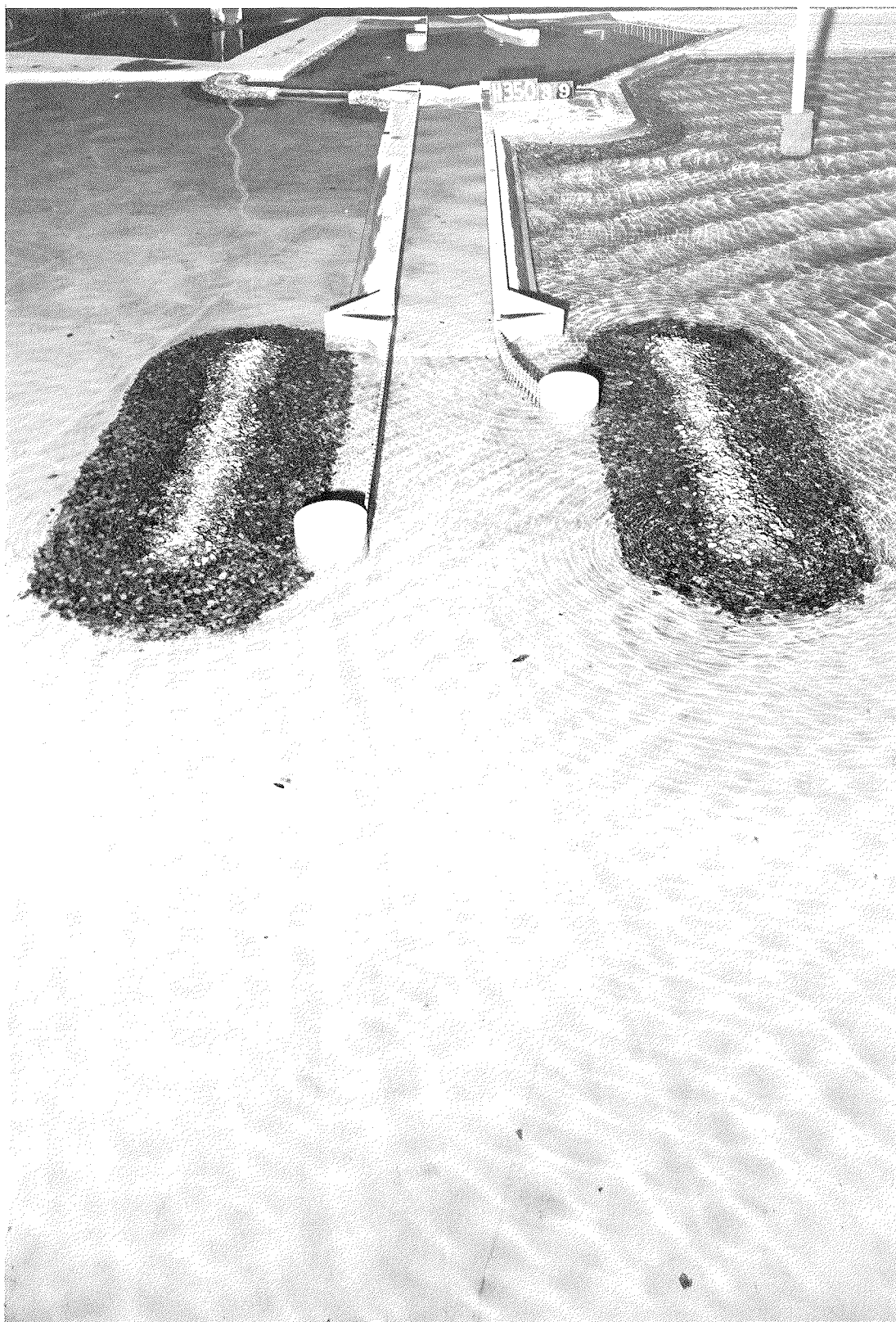


Photo 38. Typical wave patterns at lock entrance for Plan 8; 4-sec,
4-ft waves from NW; swl = +1 ft msl

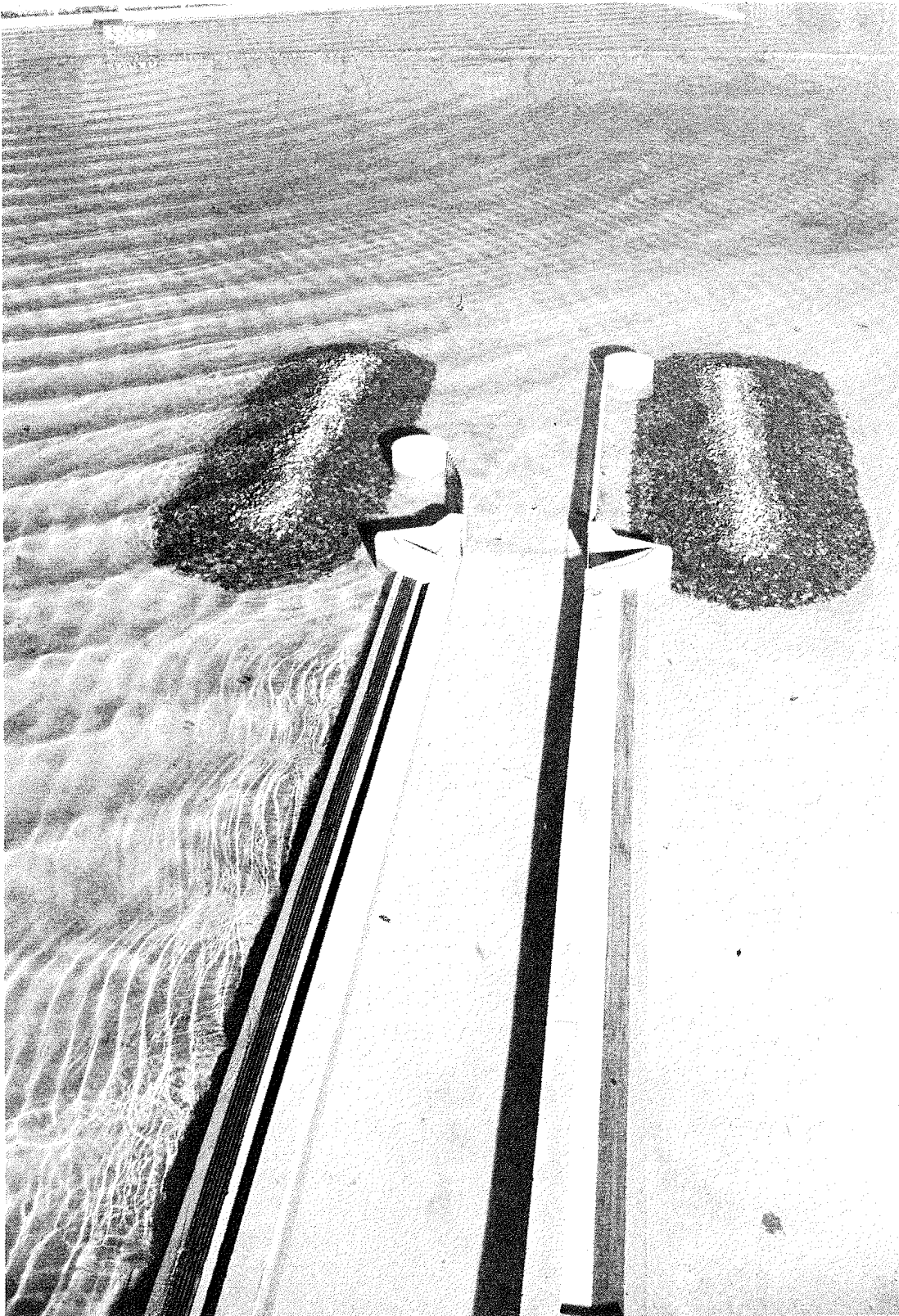


Photo 39. Typical wave patterns for Plan 8; 4-sec, 4-ft waves from NW; swl = +1 ft msl

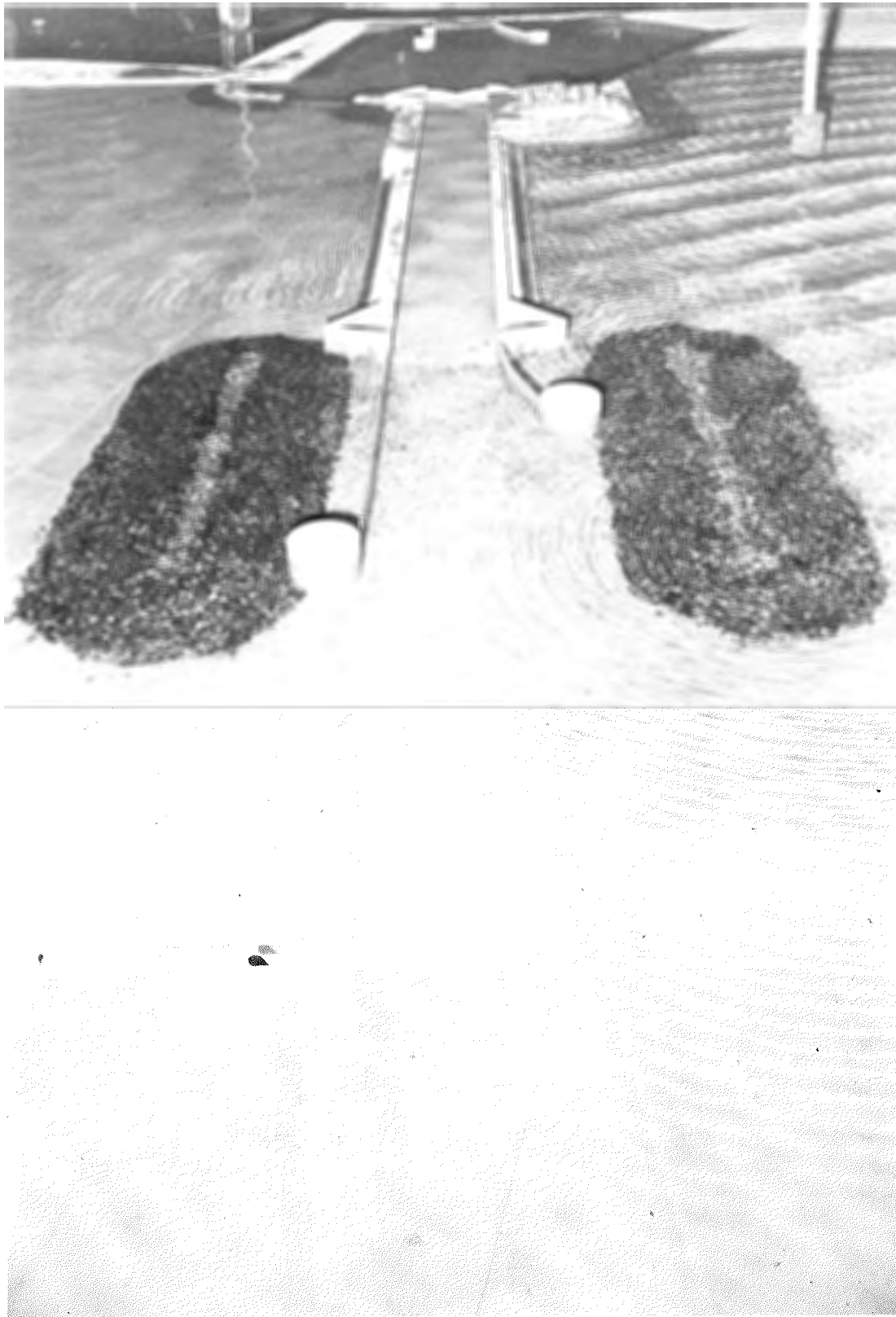


Photo 40. Typical wave patterns at lock entrance for Plan 8; 4-sec,
4-ft waves from NW; swl = +4 ft msl

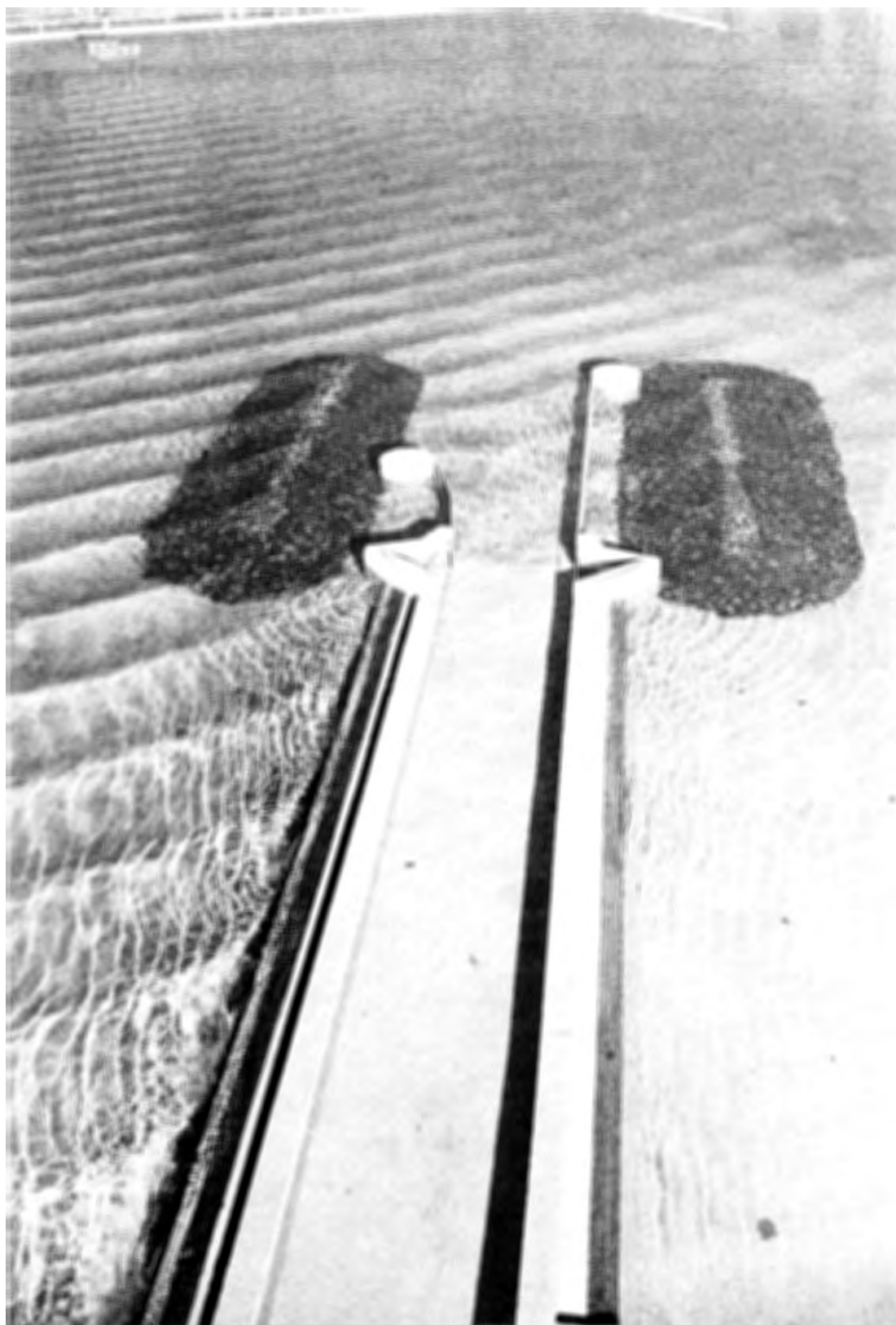


Photo 41. Typical wave patterns for Plan 8; 4-sec, 4-ft waves from
NW; swl = +4 ft msl

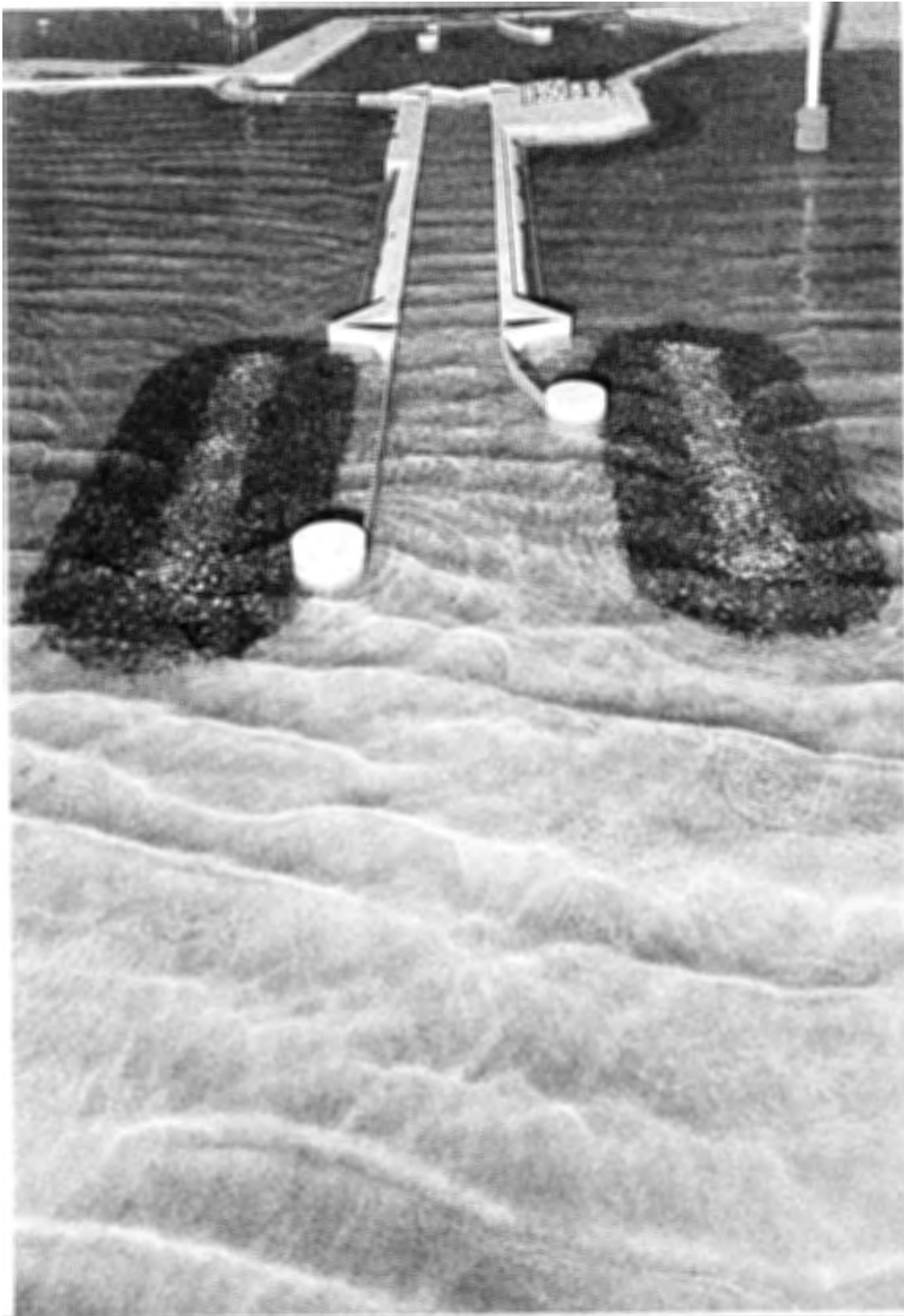


Photo 42. Typical wave patterns at lock entrance for Plan 9; 3-sec,
4-ft waves from N; swl = +1 ft msl

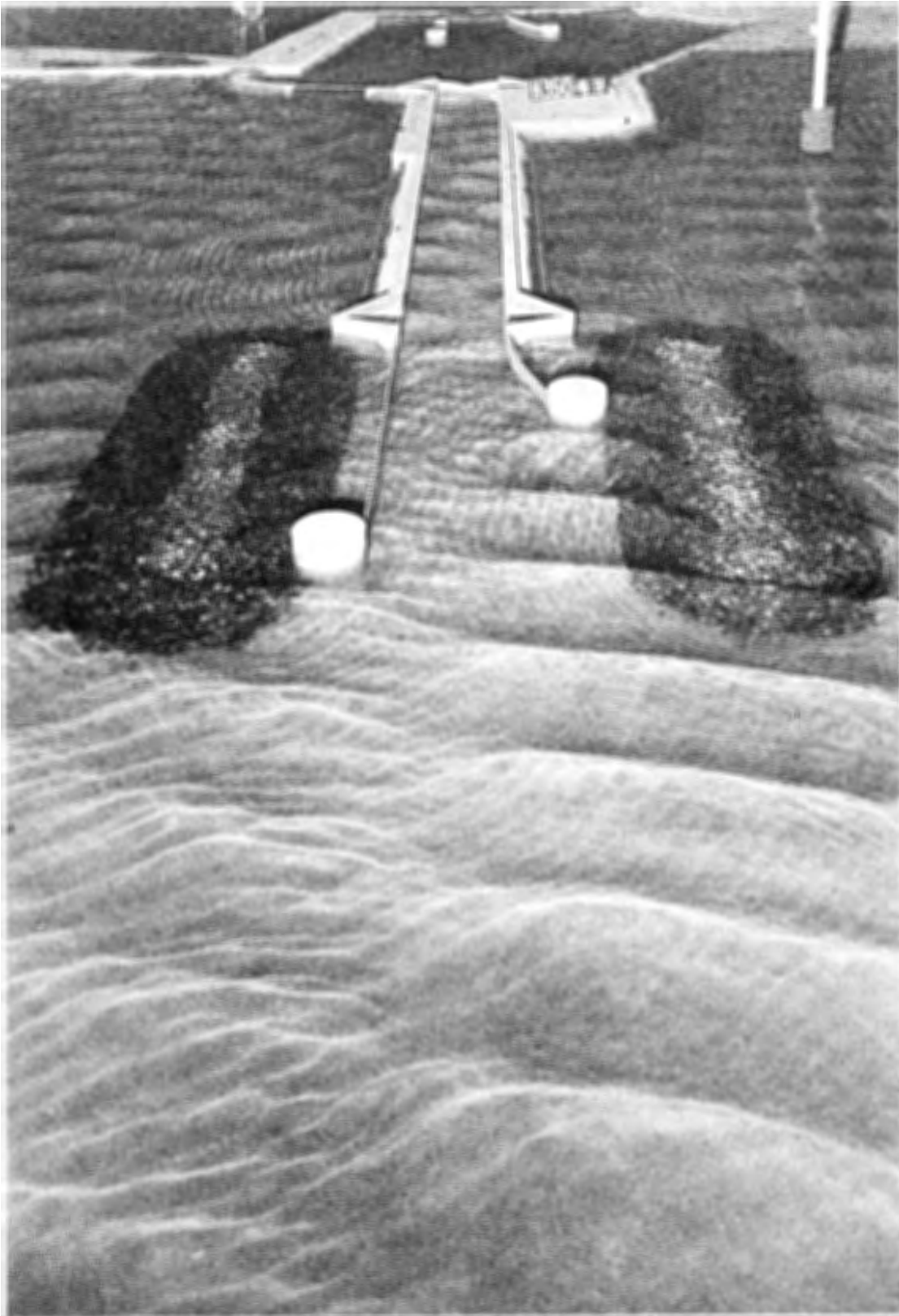


Photo 43. Typical wave patterns at lock entrance for Plan 9; 4-sec,
5-ft waves from N; swl = +1 ft msl

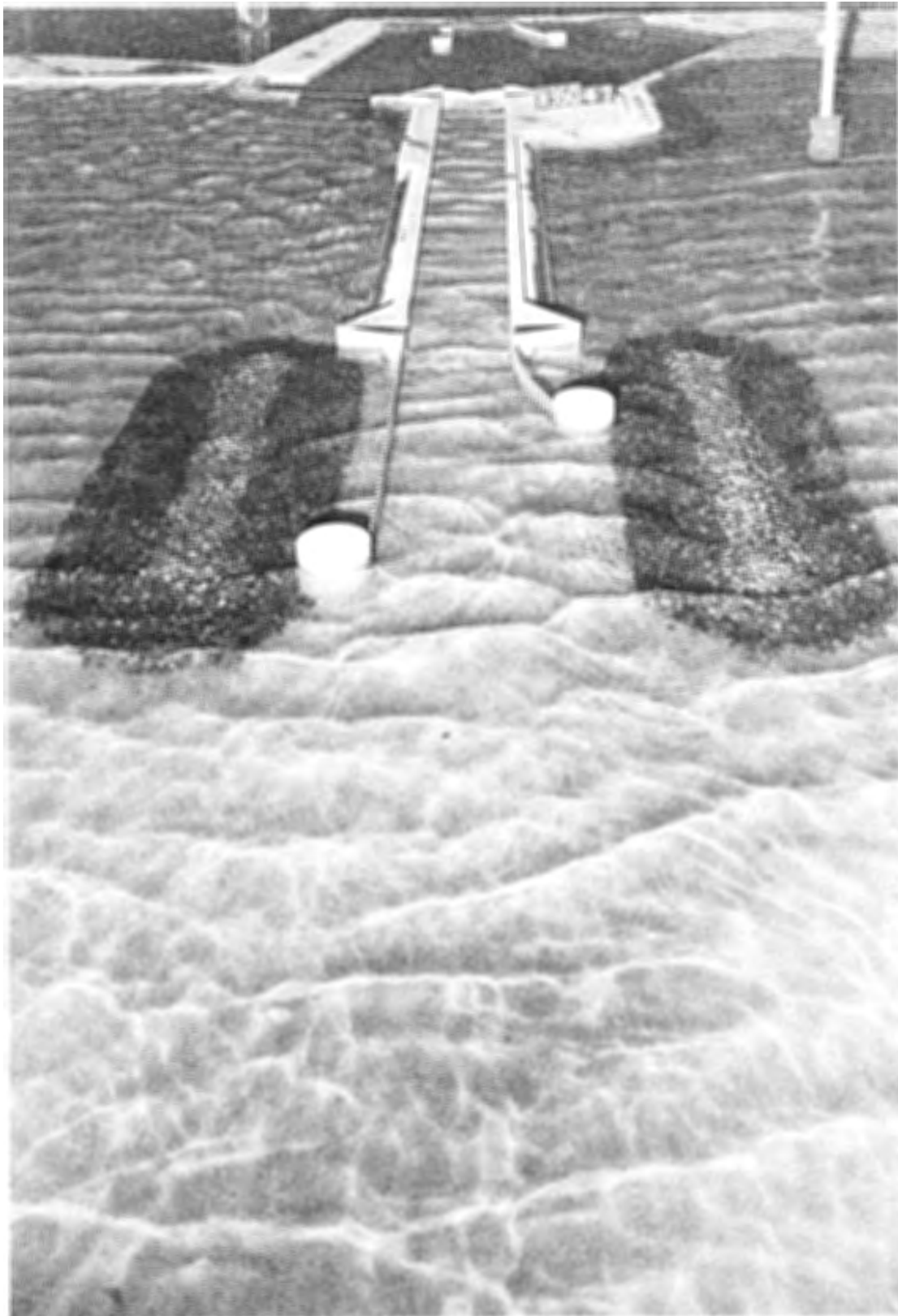


Photo 44. Typical wave patterns at lock entrance for Plan 9; 3-sec,
4-ft waves from NNW; swl = +1 ft msl

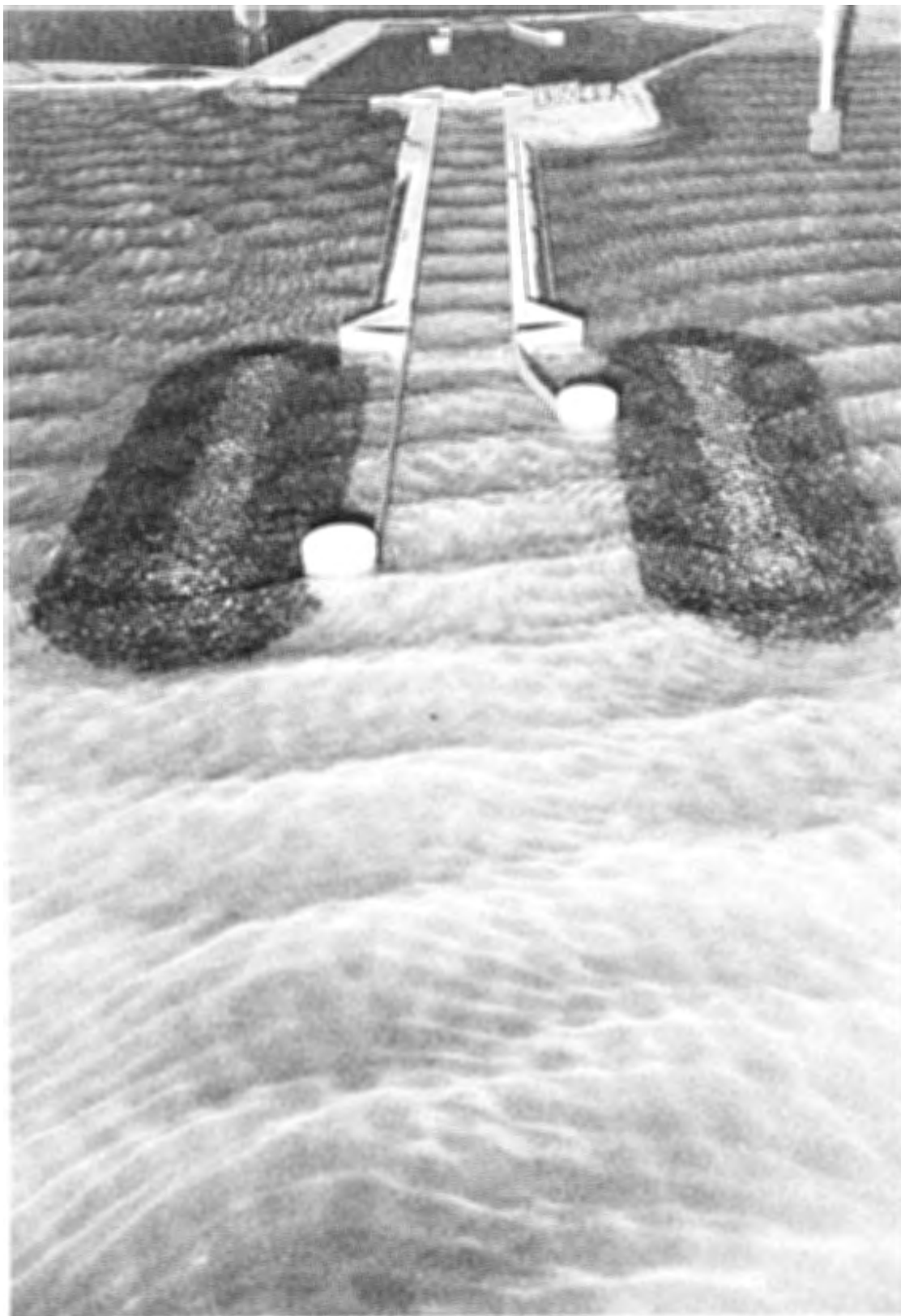


Photo 45. Typical wave patterns at lock entrance for Plan 9; 4-sec,
4-ft waves from NNW; swl = +1 ft msl

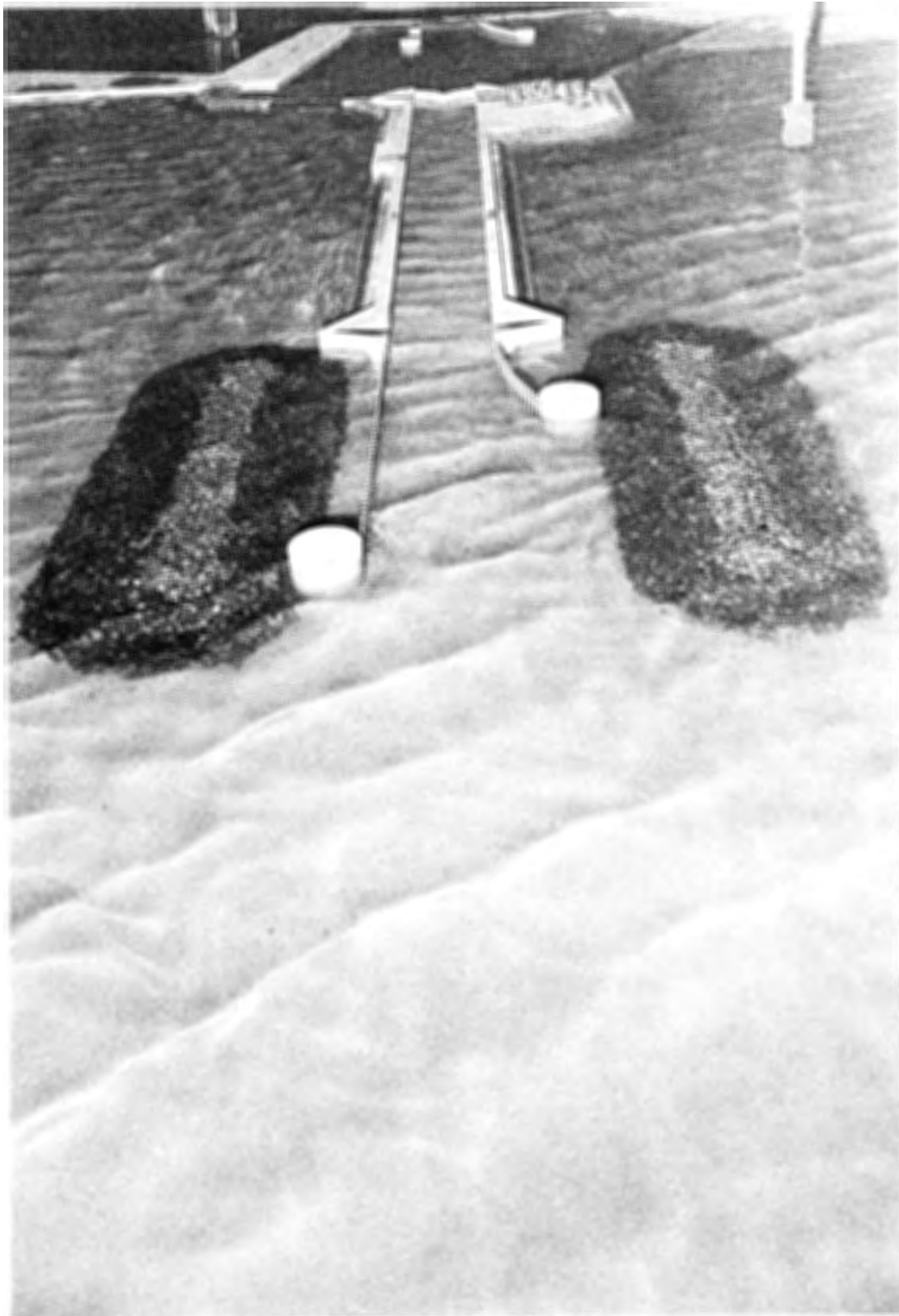


Photo 46. Typical wave patterns at lock entrance for Plan 9; 3-sec,
4-ft waves from NW; swl = +1 ft msl

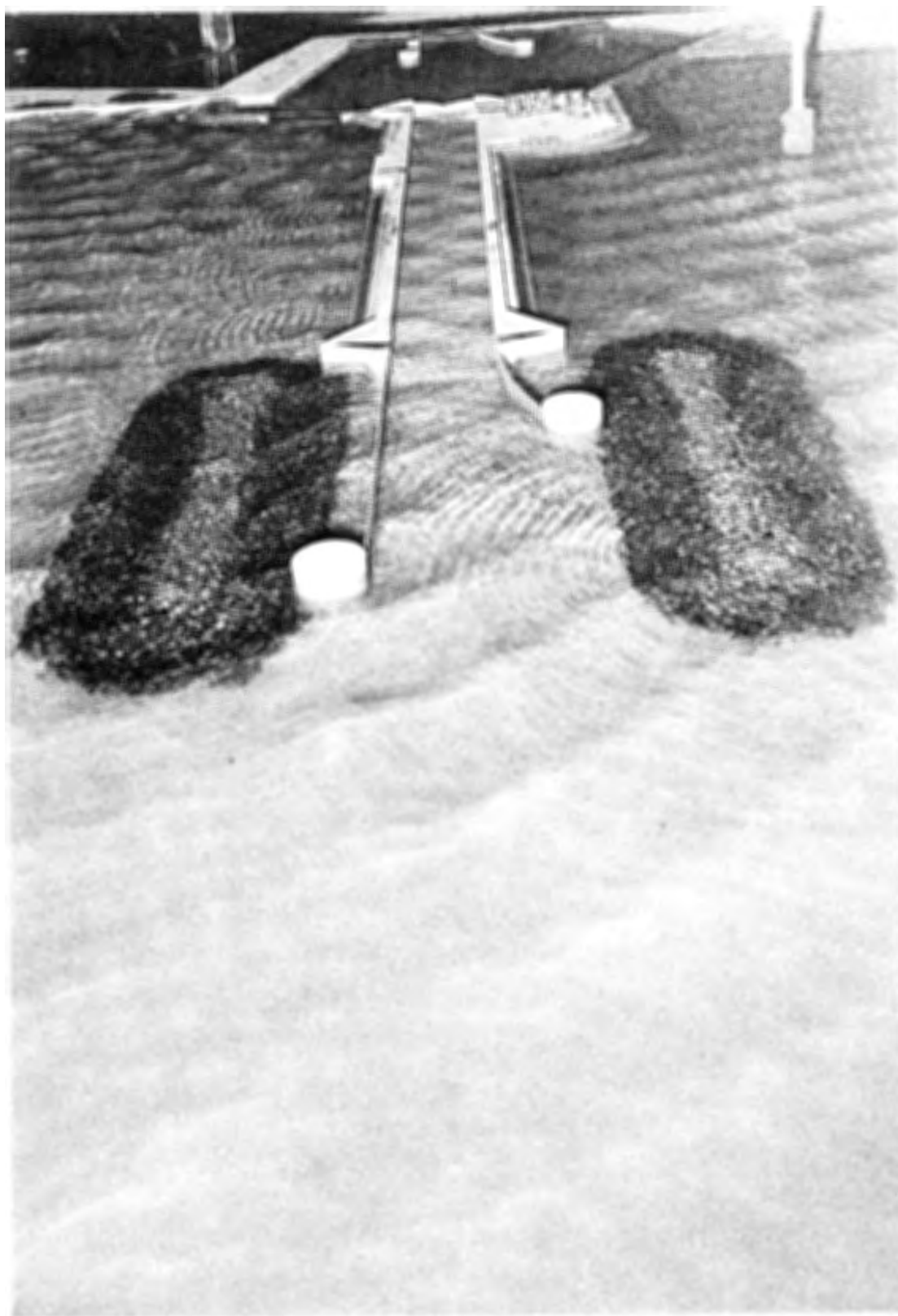


Photo 47. Typical wave patterns at lock entrance for Plan 9; 4-sec,
4-ft waves from NW; swl = +1 ft msl

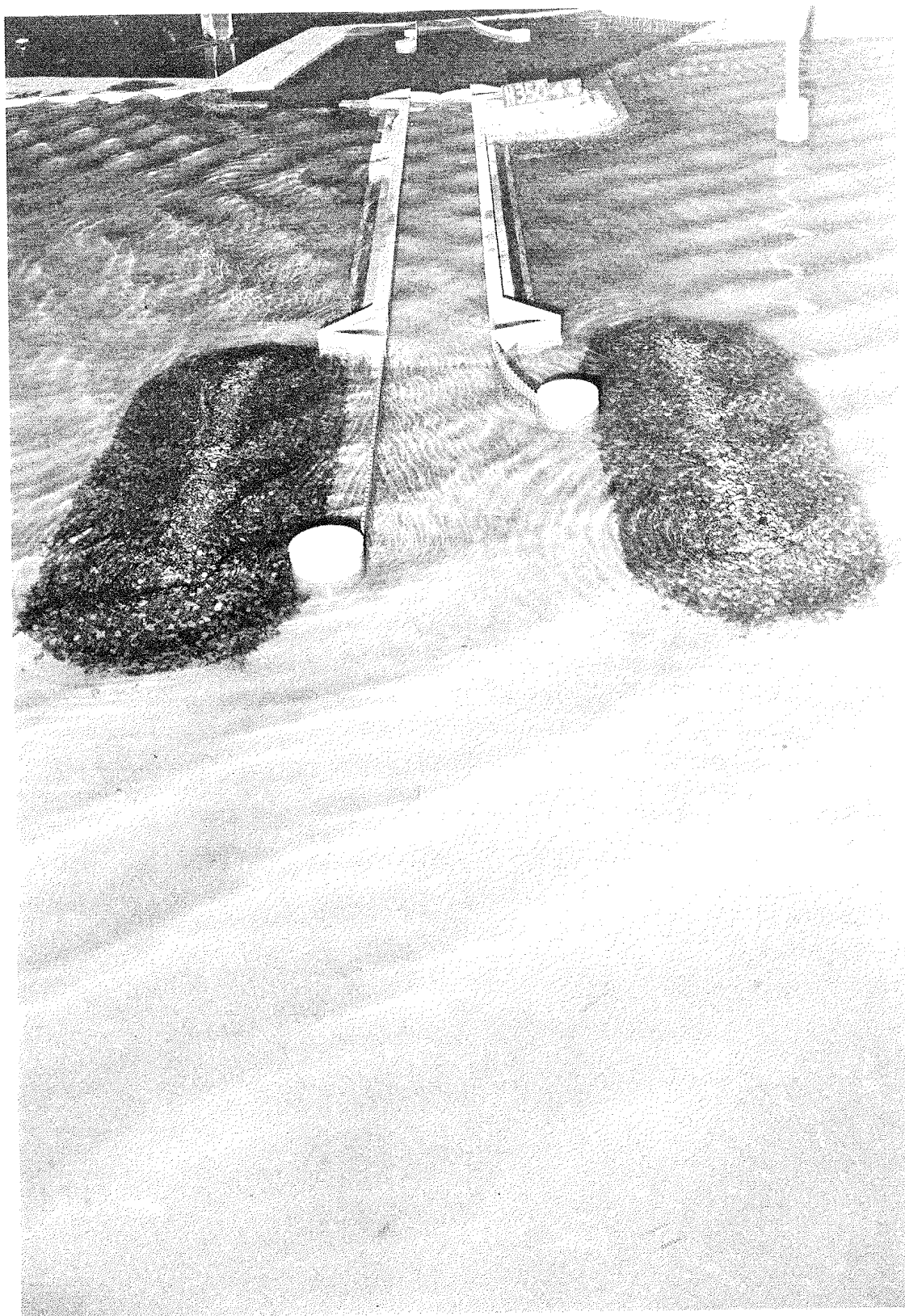


Photo 48. Typical wave patterns at lock entrance for Plan 9; 4-sec,
4-ft waves from NW; swl = +4 ft msl

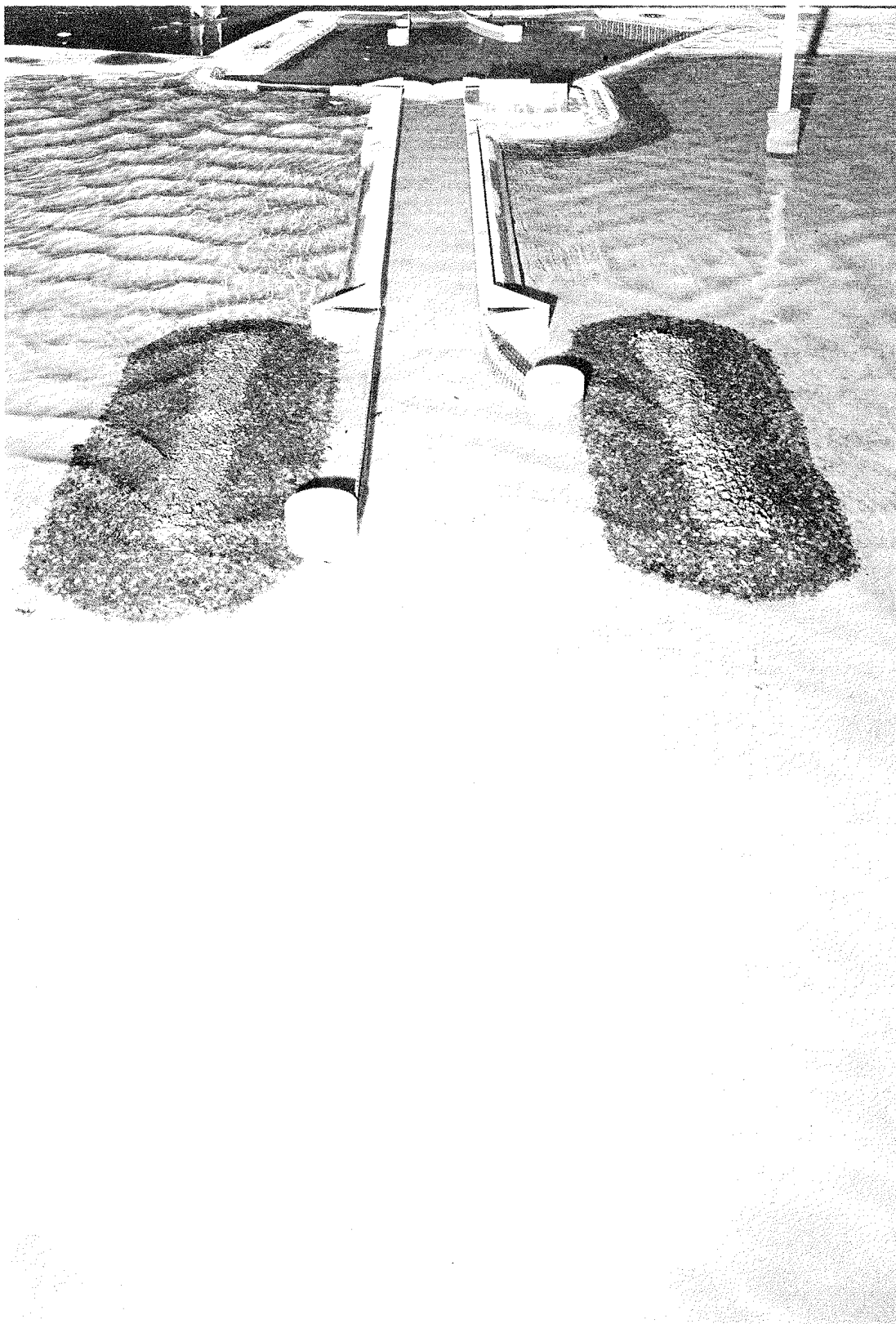


Photo 49. Typical wave patterns at lock entrance for Plan 10A; 4-sec,
5-ft waves from N; swl = +1 ft msl



Photo 50. Typical wave patterns at breakwater for Plan 10A; 4-sec, 5-ft waves from N; swl = +1 ft msl

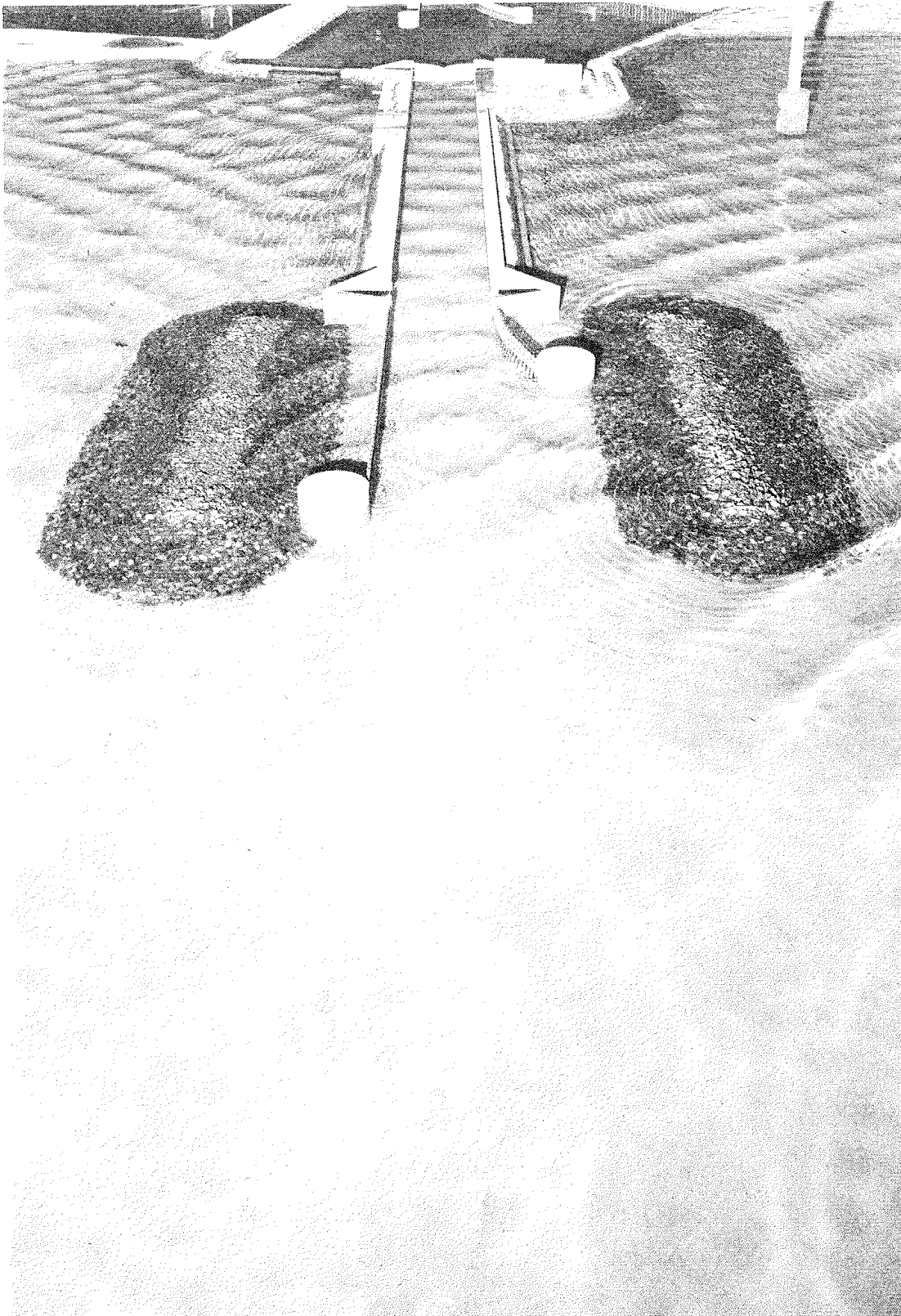


Photo 51. Typical wave patterns at lock entrance for Plan 10A; 4-sec,
4-ft waves from NW; swl = +1 ft msl



Photo 52. Typical wave patterns at breakwater for Plan 10A; 4-sec,
4-ft waves from NW; swl = +1 ft msl

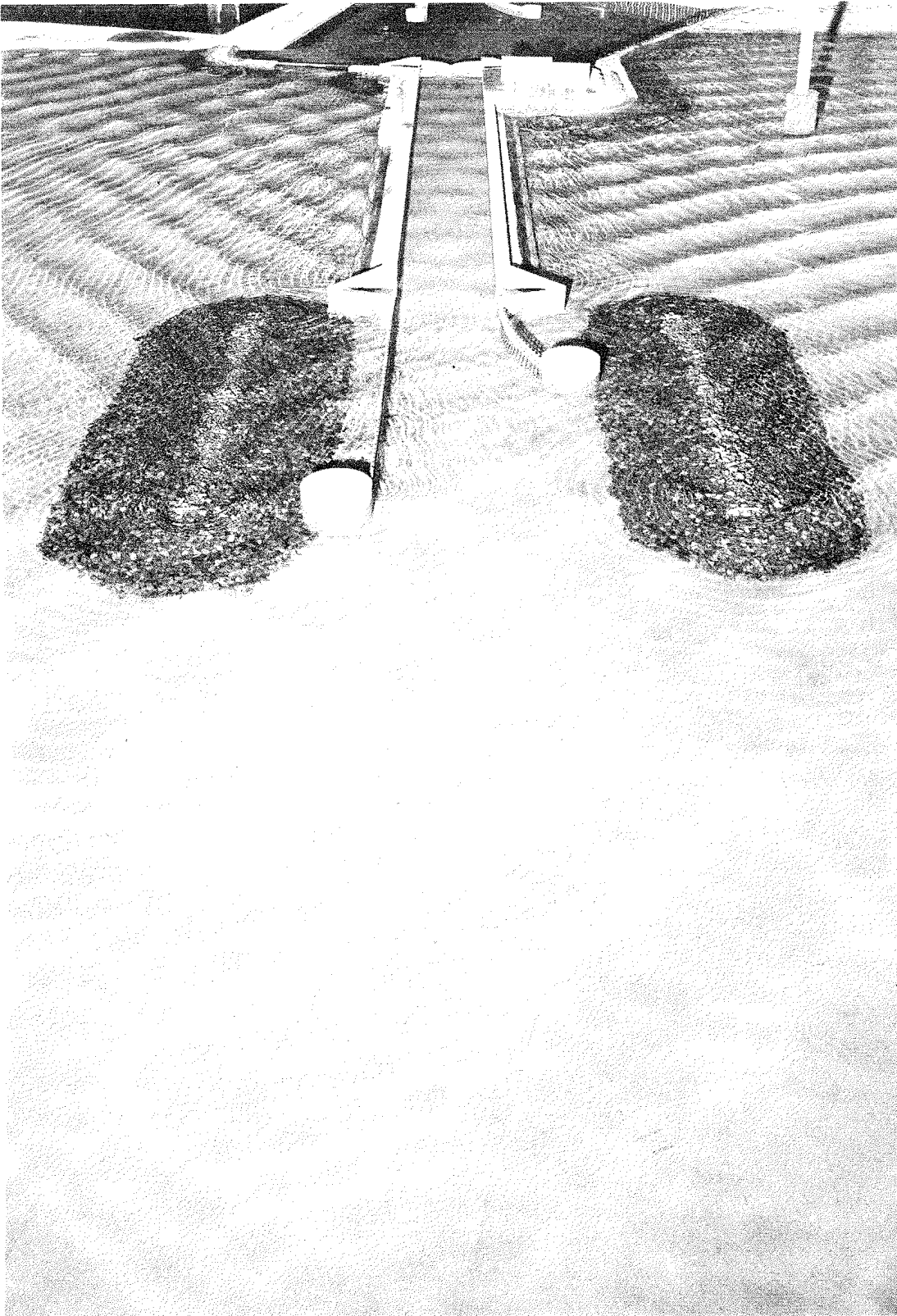


Photo 53. Typical wave patterns at lock entrance for Plan 10A; 4-sec,
4-ft waves from NW; swl = +4 ft msl



Photo 54. Typical wave patterns at breakwater for Plan 10A; 4-sec,
4-ft waves from NW; swl = +4 ft msl

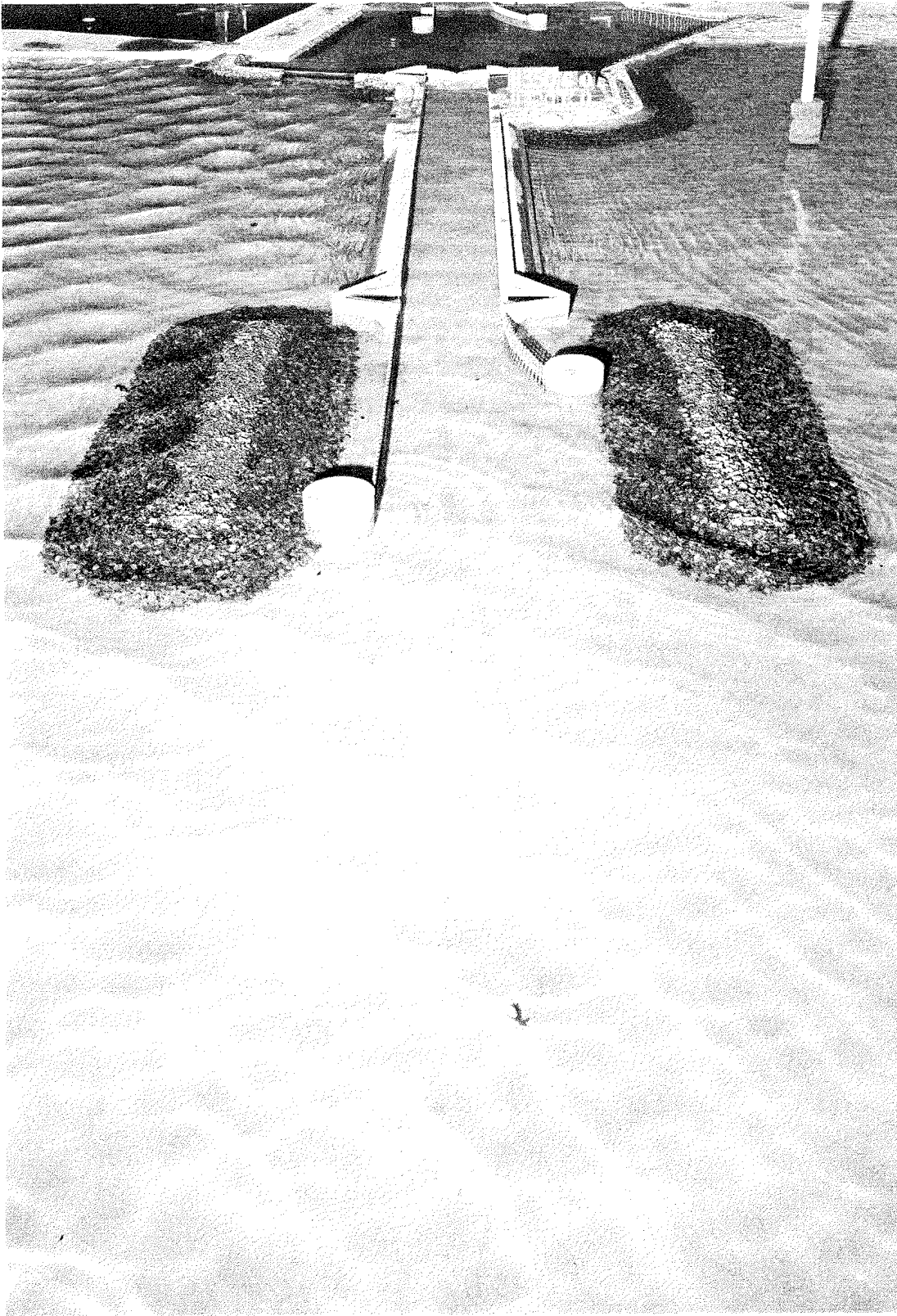


Photo 55. Typical wave patterns at lock entrance for Plan 11B; 4-sec,
5-ft waves from N; swl = +1 ft msl



Photo 56. Typical wave patterns at breakwater for Plan 11B; 4-sec, 5-ft waves from N; swl = +1 ft msl

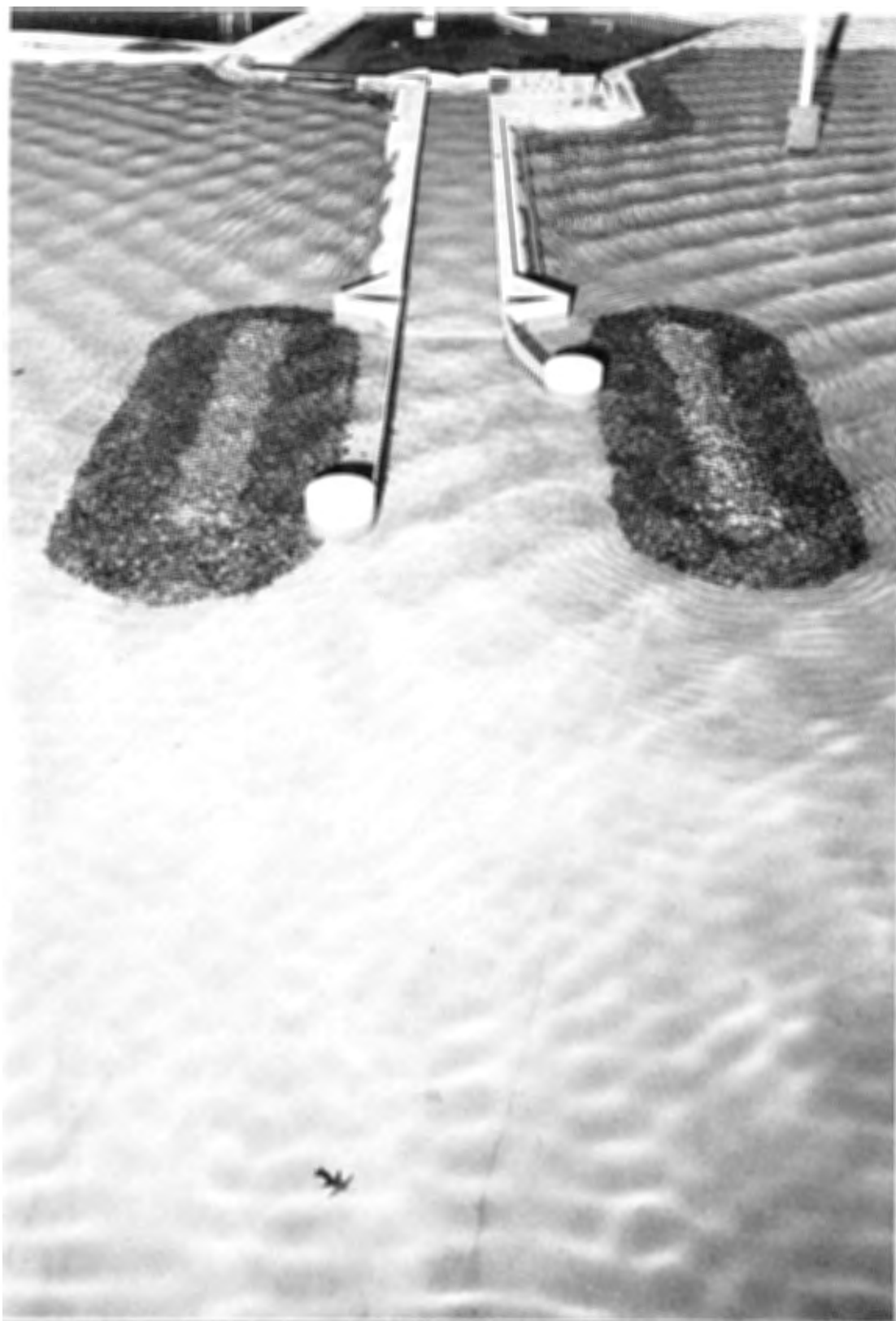


Photo 57. Typical wave patterns at lock entrance for Plan 11B; 4-sec,
4-ft waves from NW; swl = +1 ft msl



Photo 58. Typical wave patterns at breakwater for Plan 11B; 4-sec,
4-ft waves from NW; swl = +1 ft msl

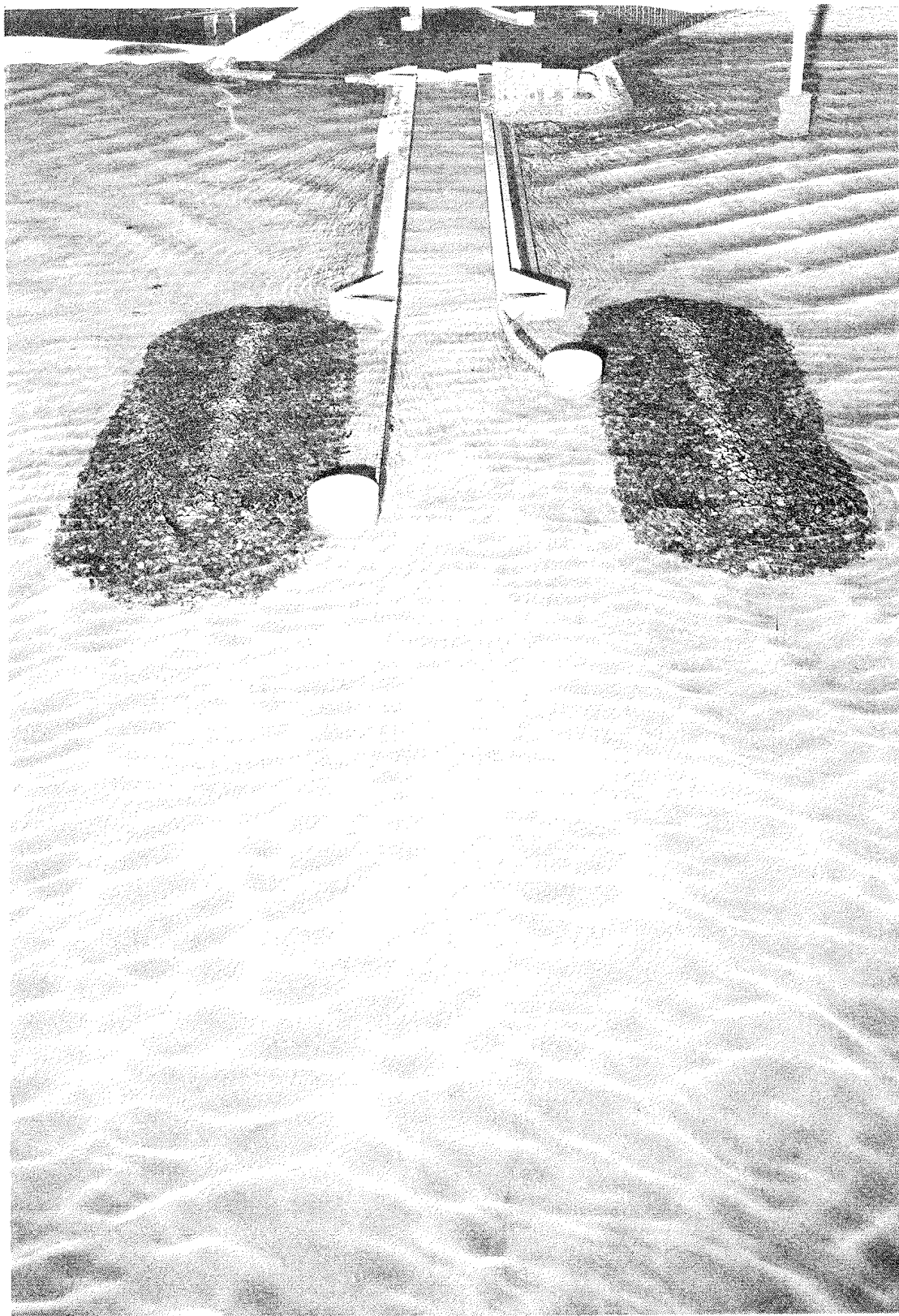


Photo 59. Typical wave patterns at lock entrance for Plan 11B; 4-sec,
4-ft waves from NW; swl = +4 ft msl



Photo 60. Typical wave patterns at breakwater for Plan 11B; 4-sec,
4-ft waves from NW; swl = +4 ft msl

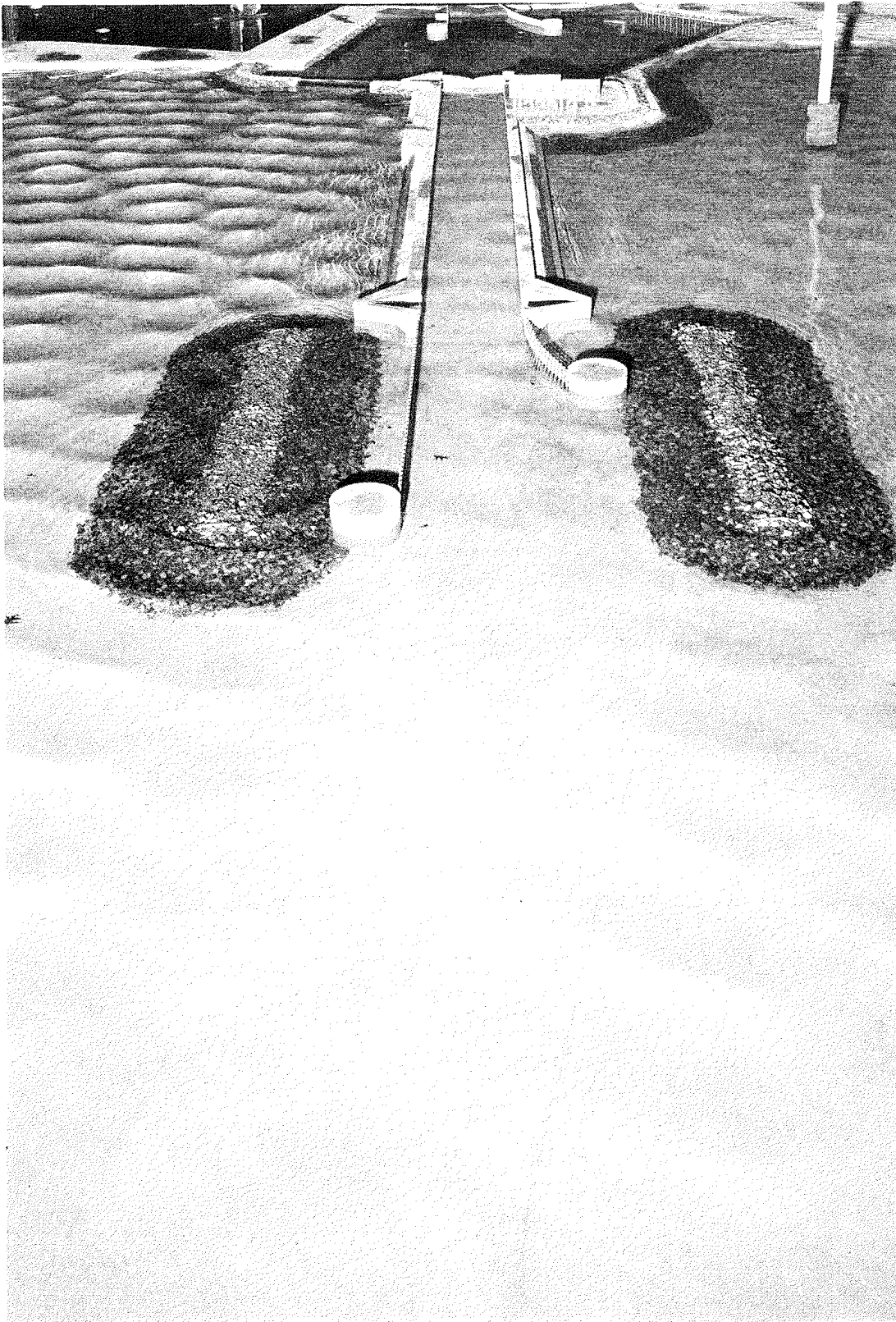


Photo 61. Typical wave patterns at lock entrance for Plan 12A; 4-sec,
5-ft waves from N; swl = +1 ft msl



Photo 62. Typical wave patterns at breakwater for Plan 12A; 4-sec,
5-ft waves from N; swl = +1 ft msl

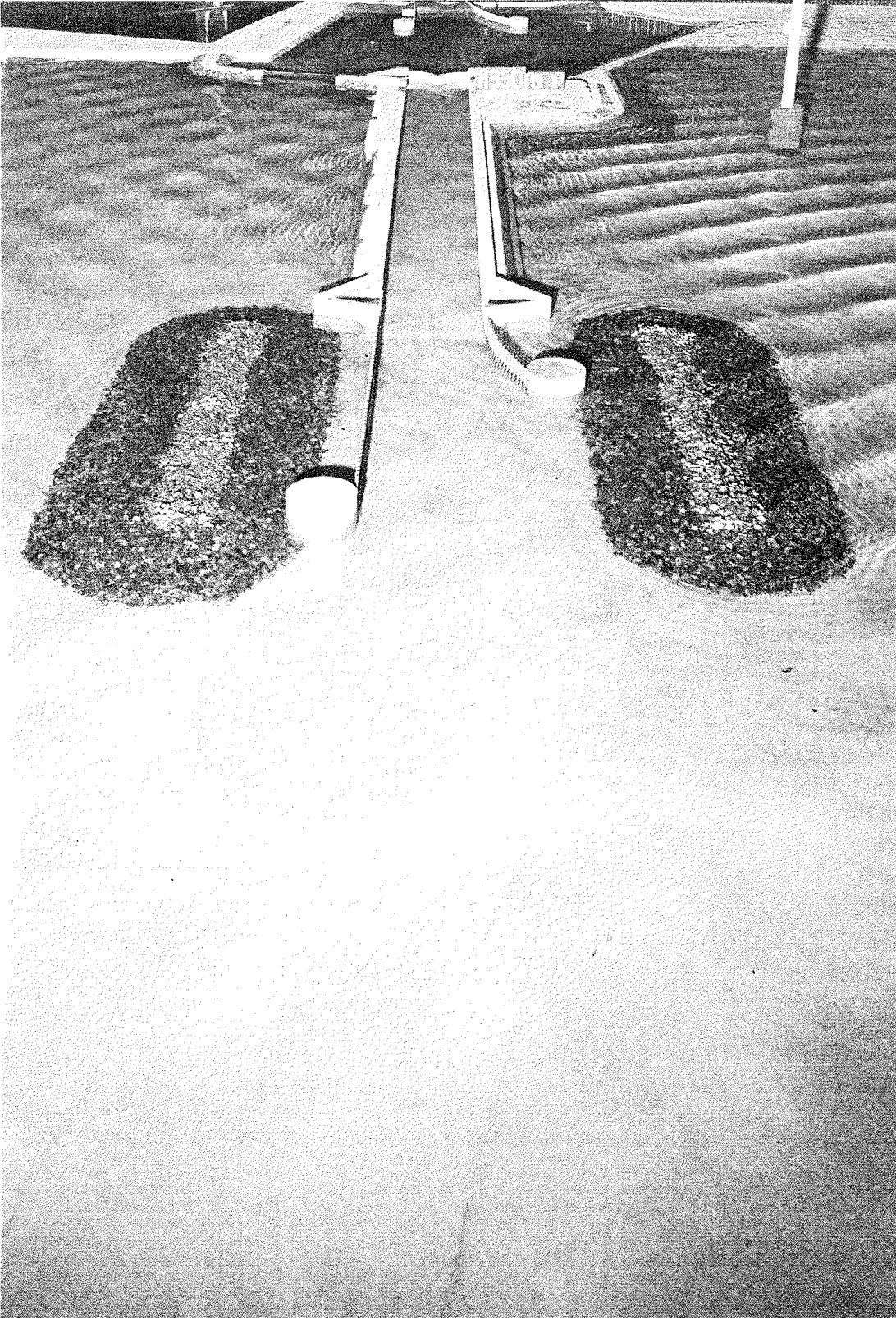


Photo 63. Typical wave patterns at lock entrance for Plan 12A; 4-sec,
4-ft waves from NW; swl = +1 ft msl

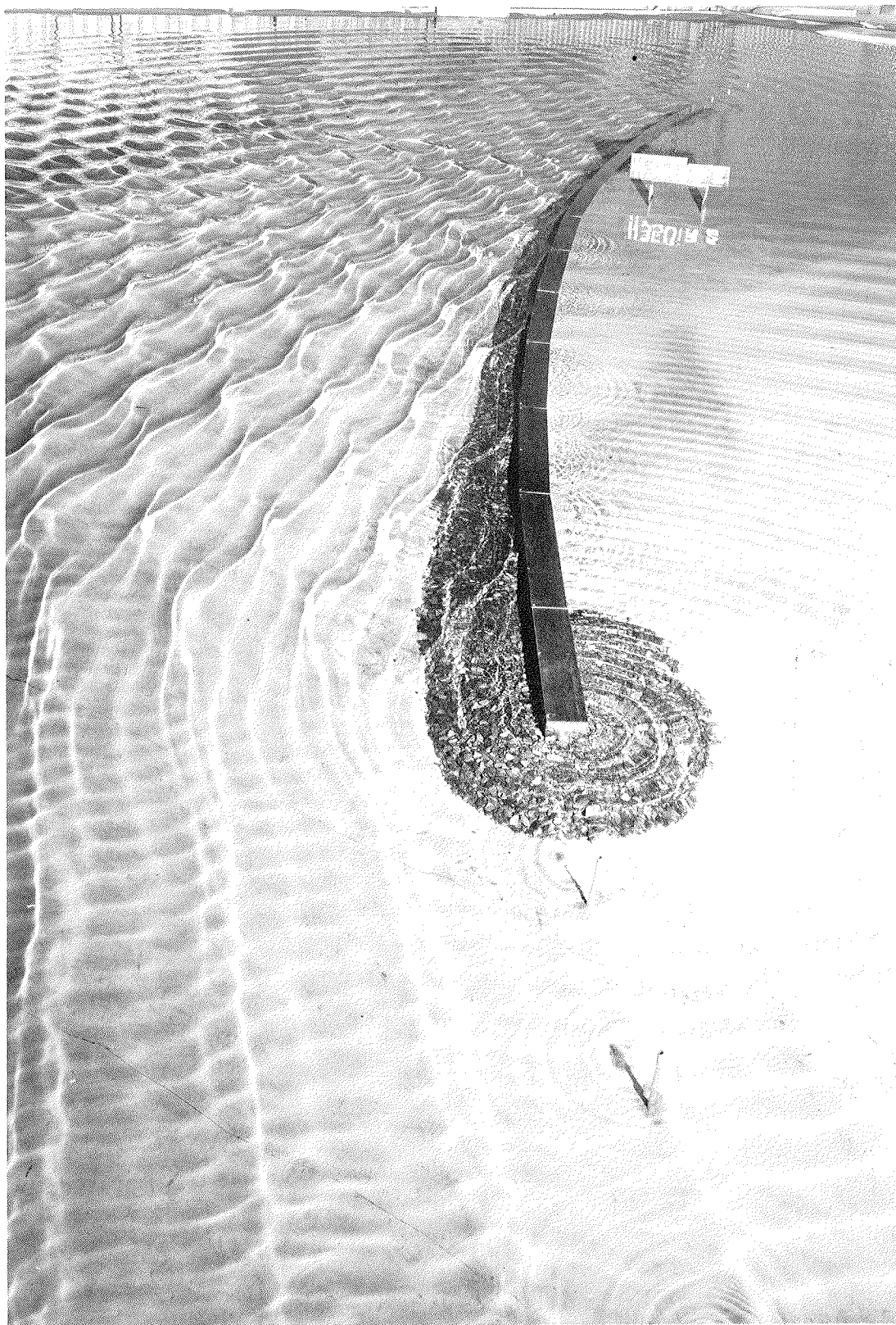


Photo 64. Typical wave patterns at breakwater for Plan 12A; 4-sec,
4-ft waves from NW; swl = +1 ft msl

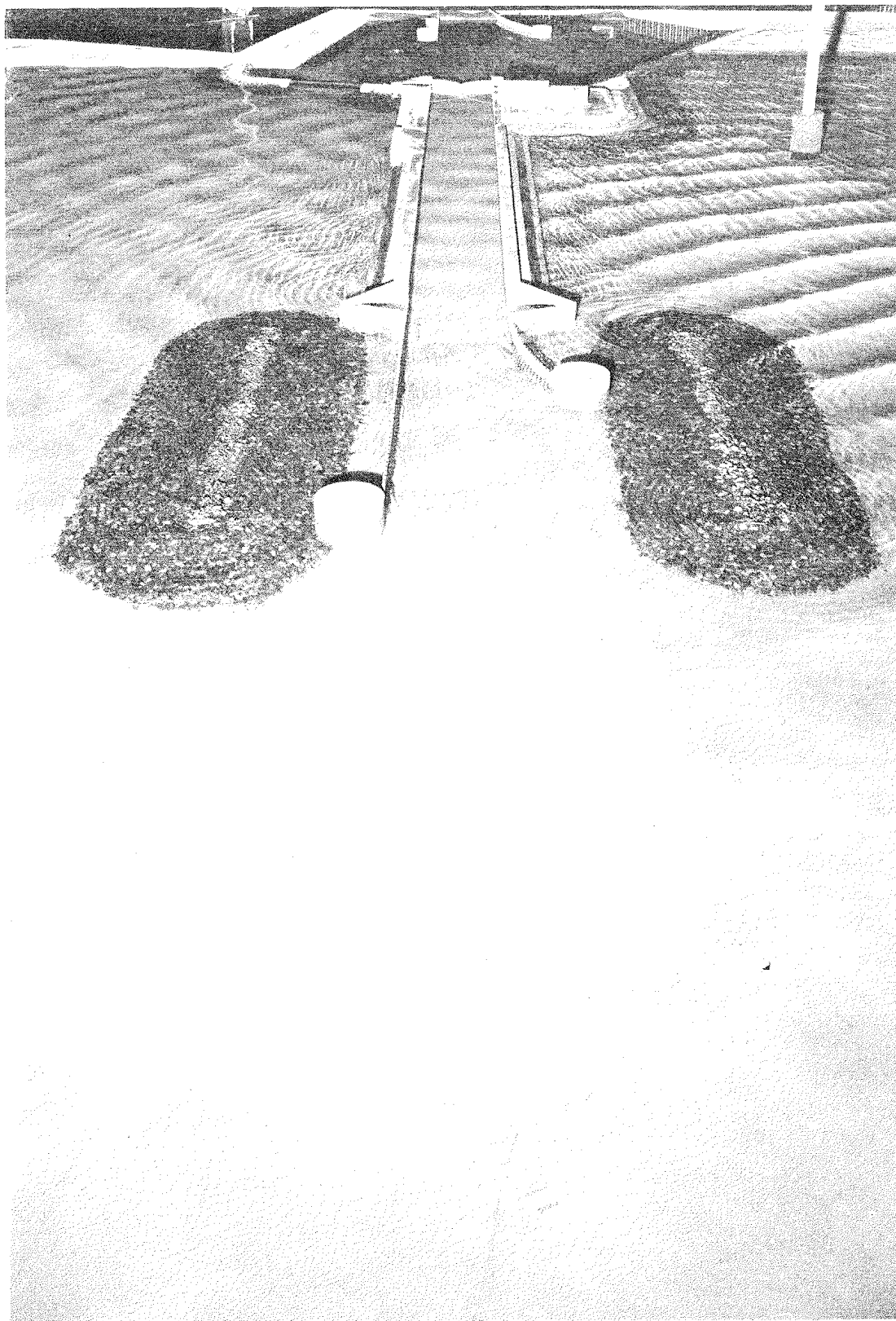


Photo 65. Typical wave patterns at lock entrance for Plan 12A; 4-sec,
4-ft waves from NW; swl = +4 ft msl

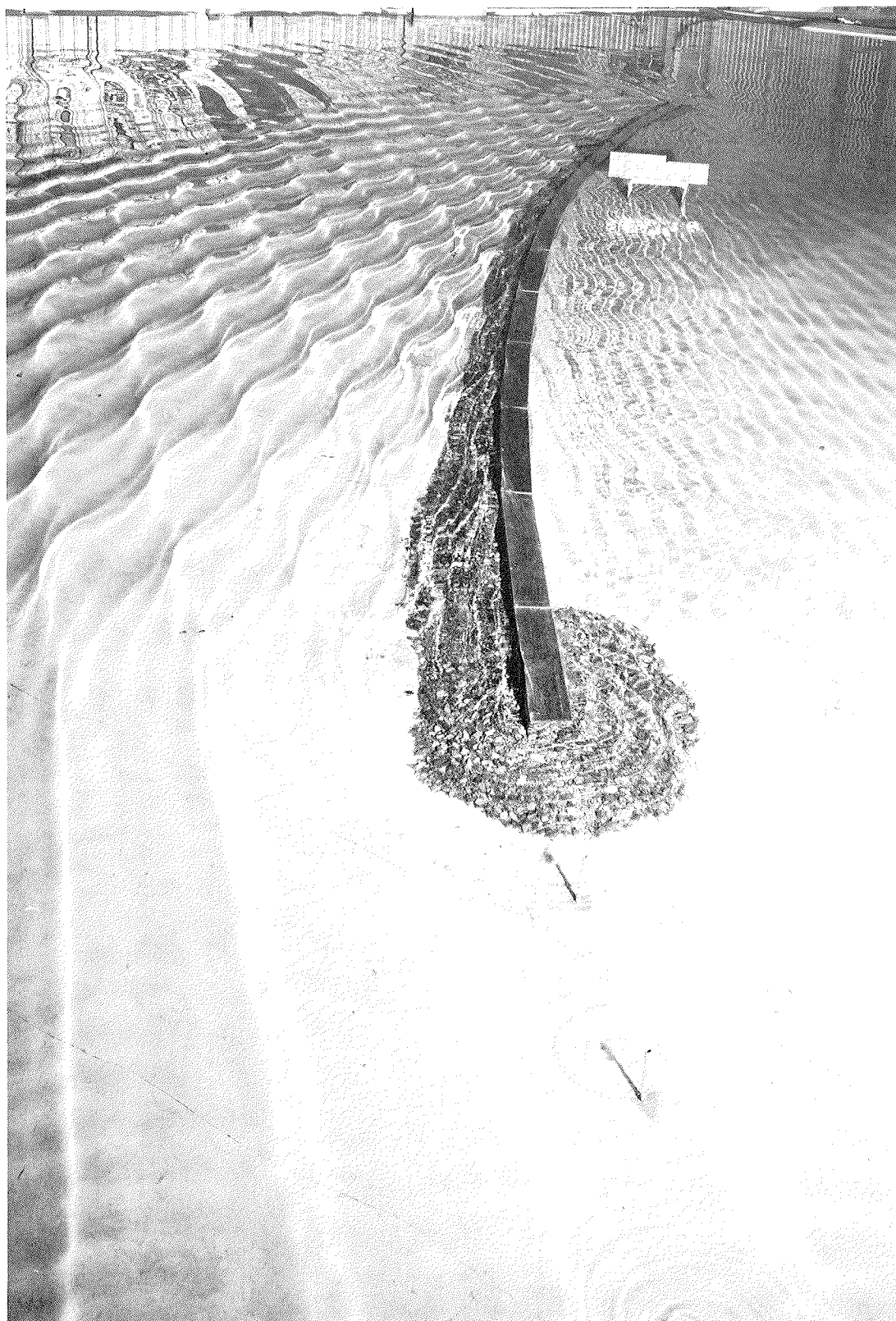


Photo 66. Typical wave patterns at breakwater for Plan 12A; 4-sec,
4-ft waves from NW; swl = +4 ft msl



Photo 67. Typical wave patterns at lock entrance for Plan 17C; 4-sec,
5-ft waves from N; swl = +1 ft msl

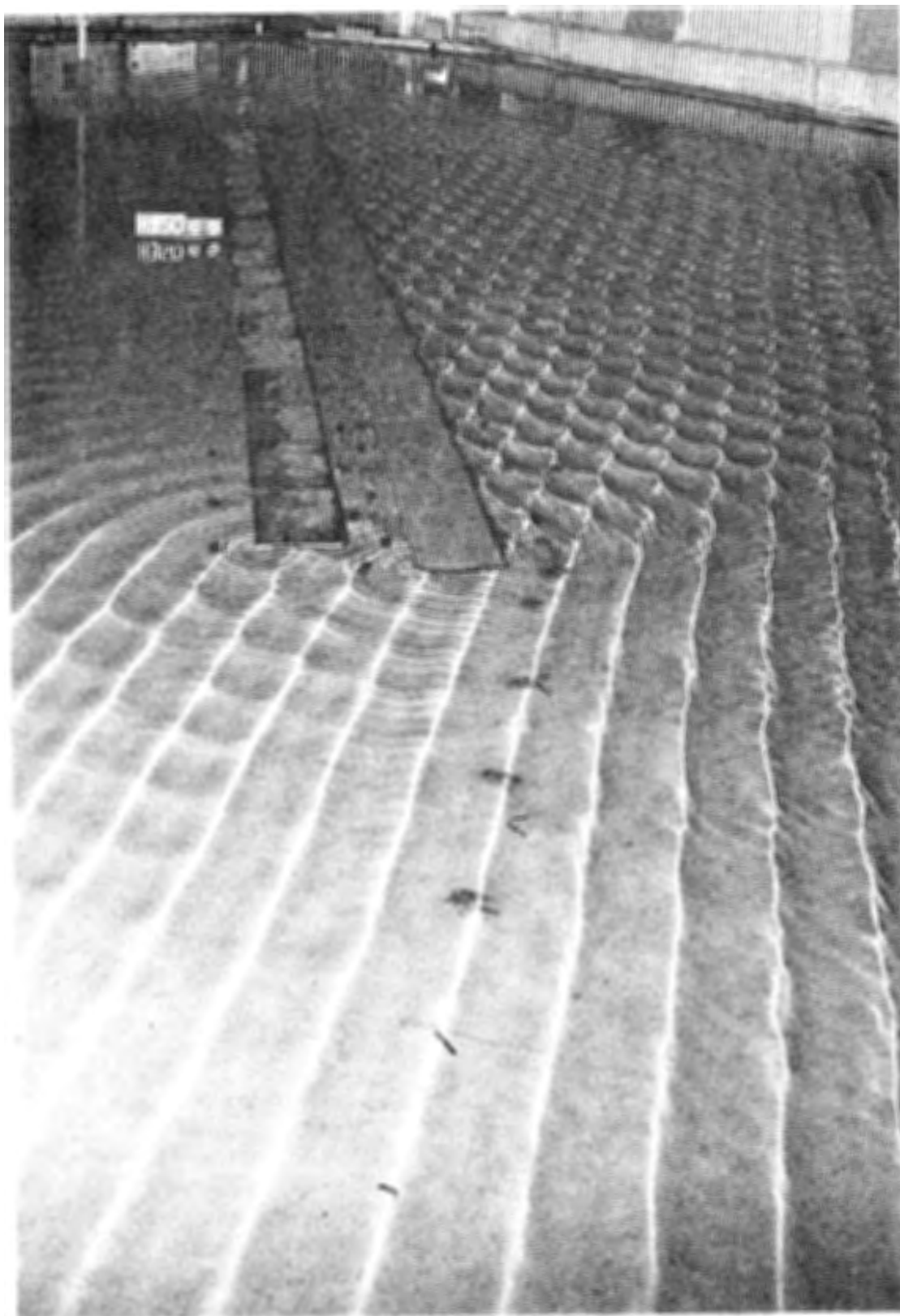


Photo 68. Typical wave patterns at breakwater for Plan 17C; 3-sec,
4-ft waves from N; swl = +1 ft msl



Photo 69. Typical wave patterns at breakwater for Plan 17C; 4-sec, 5-ft waves from N; swl = +1 ft msl

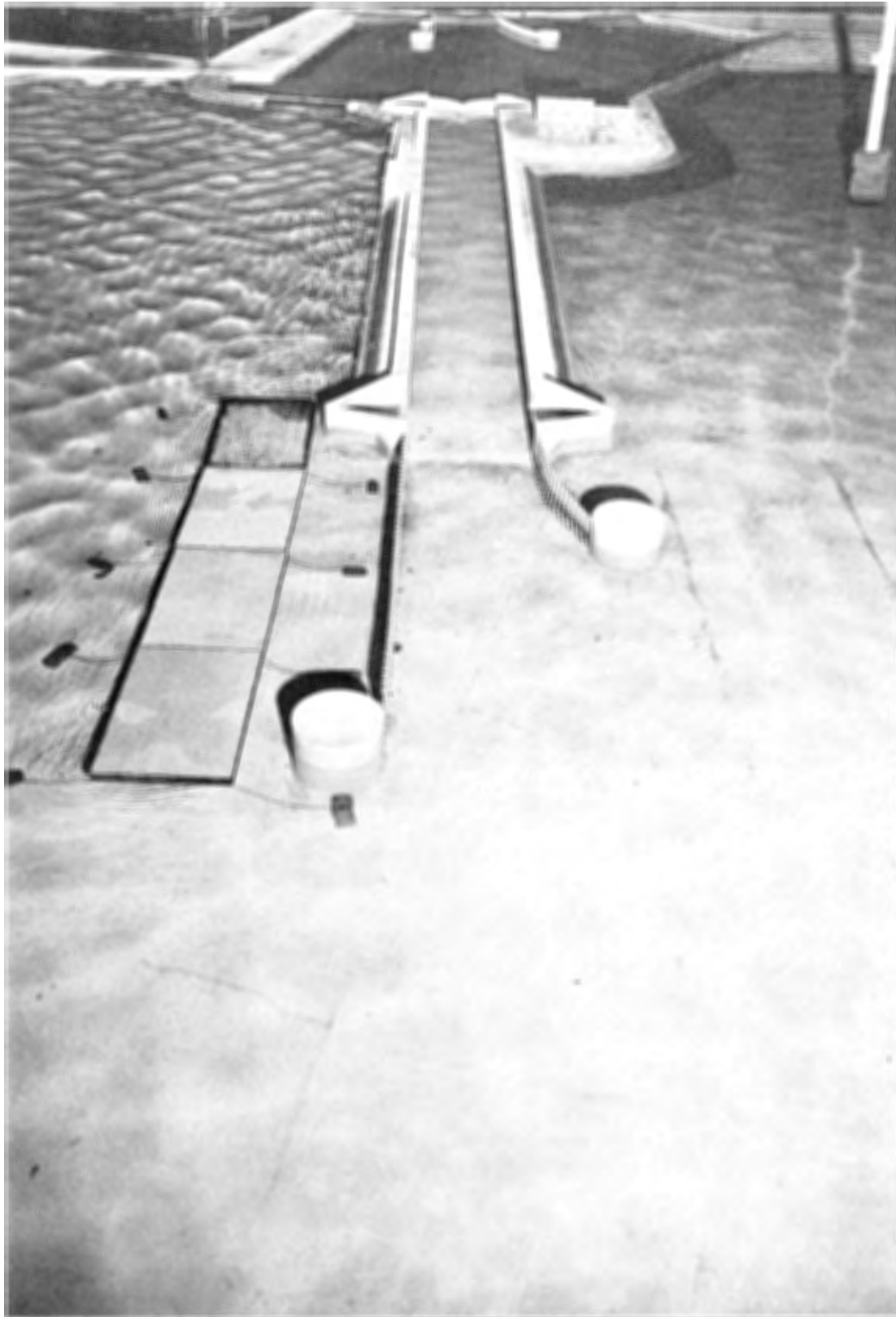


Photo 70. Typical wave patterns at lock entrance for Plan 17C; 3-sec,
4-ft waves from NNW; swl = +1 ft msl

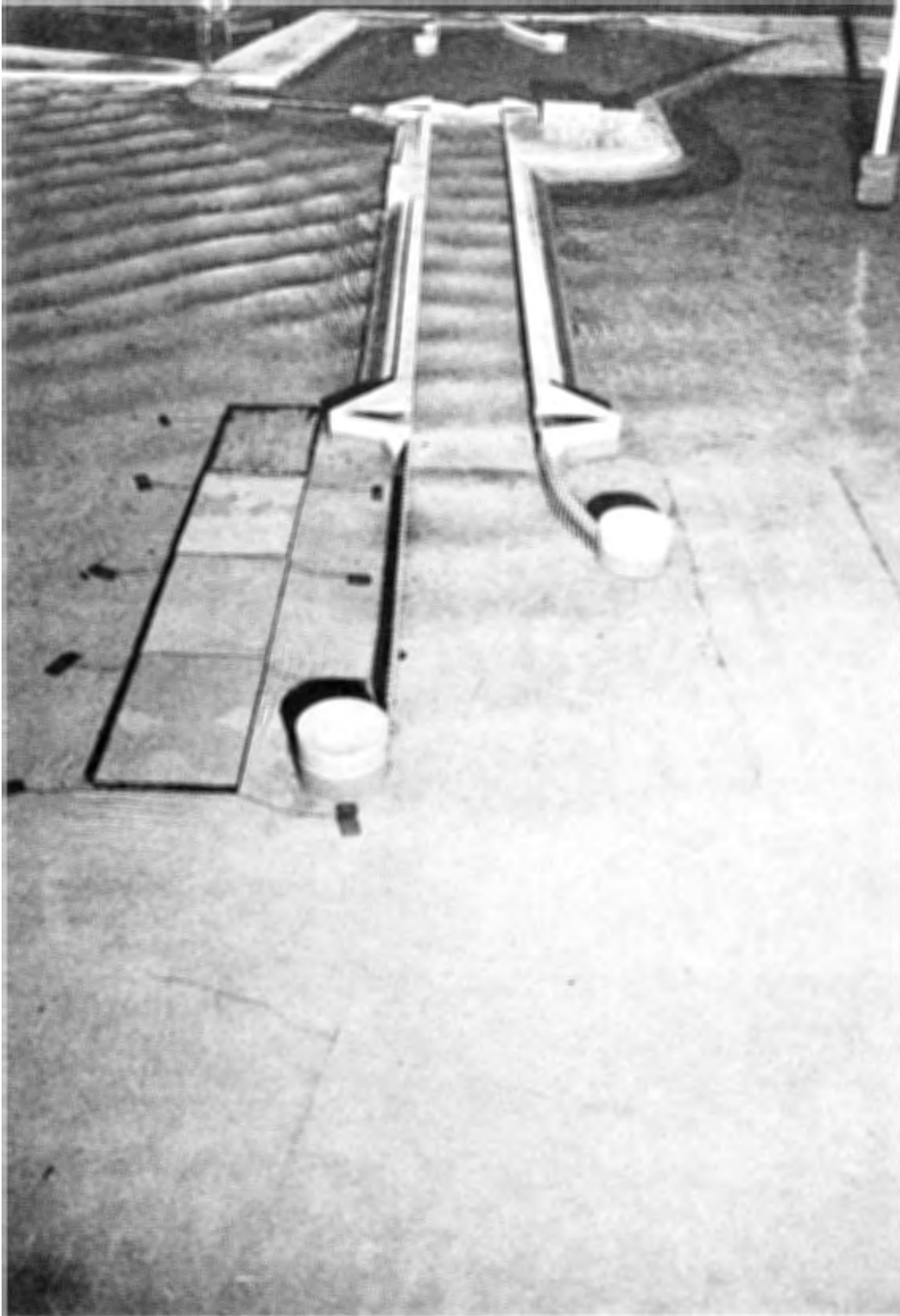


Photo 71. Typical wave patterns at lock entrance for Plan 17C; 4-sec,
4-ft waves from NNW; swl = +1 ft msl

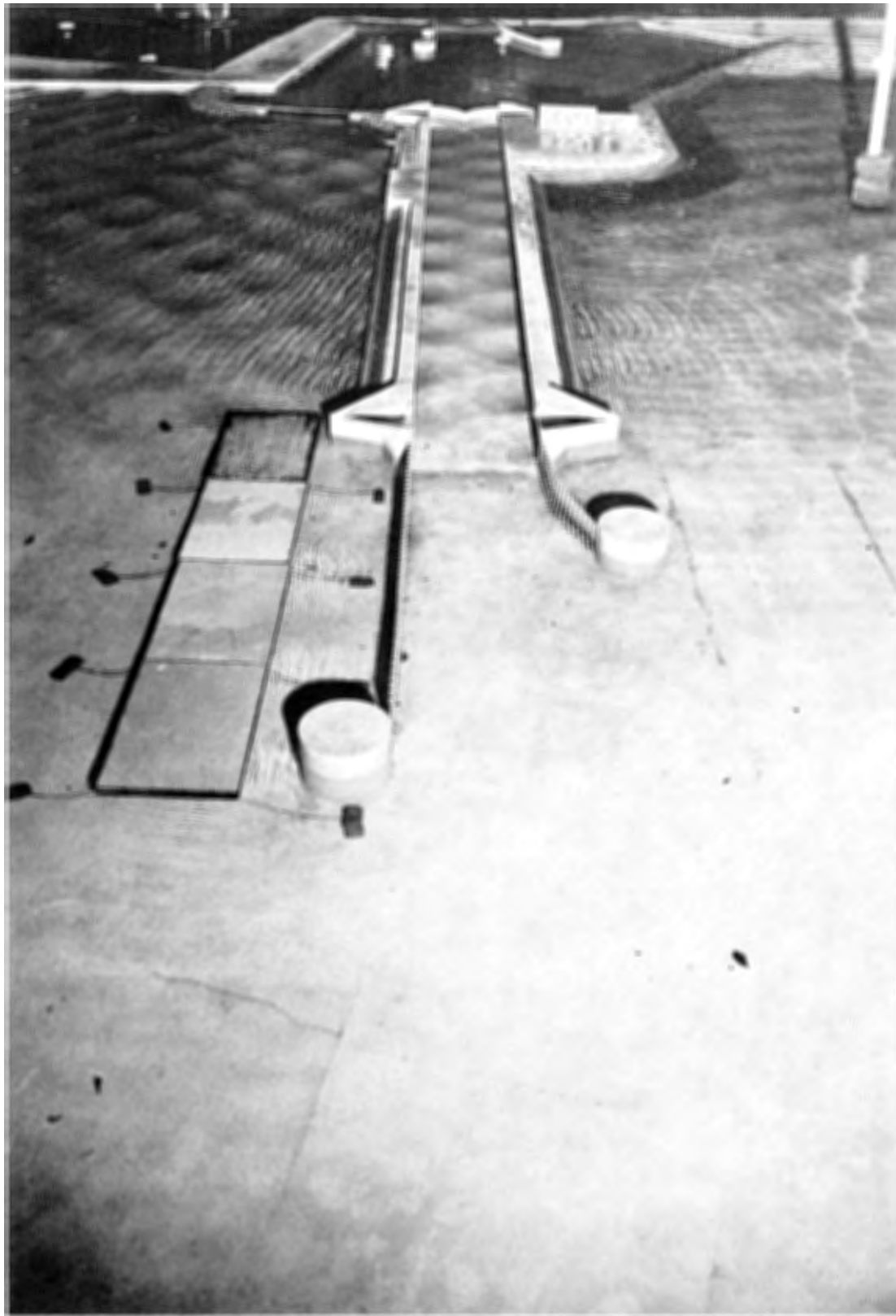


Photo 72. Typical wave patterns at lock entrance for Plan 17C; 4-sec,
4-ft waves from NW; swl = +1 ft msl



Photo 73. Typical wave patterns at breakwater for Plan 17C; 4-sec,
4-ft waves from NW; swl = +1 ft msl

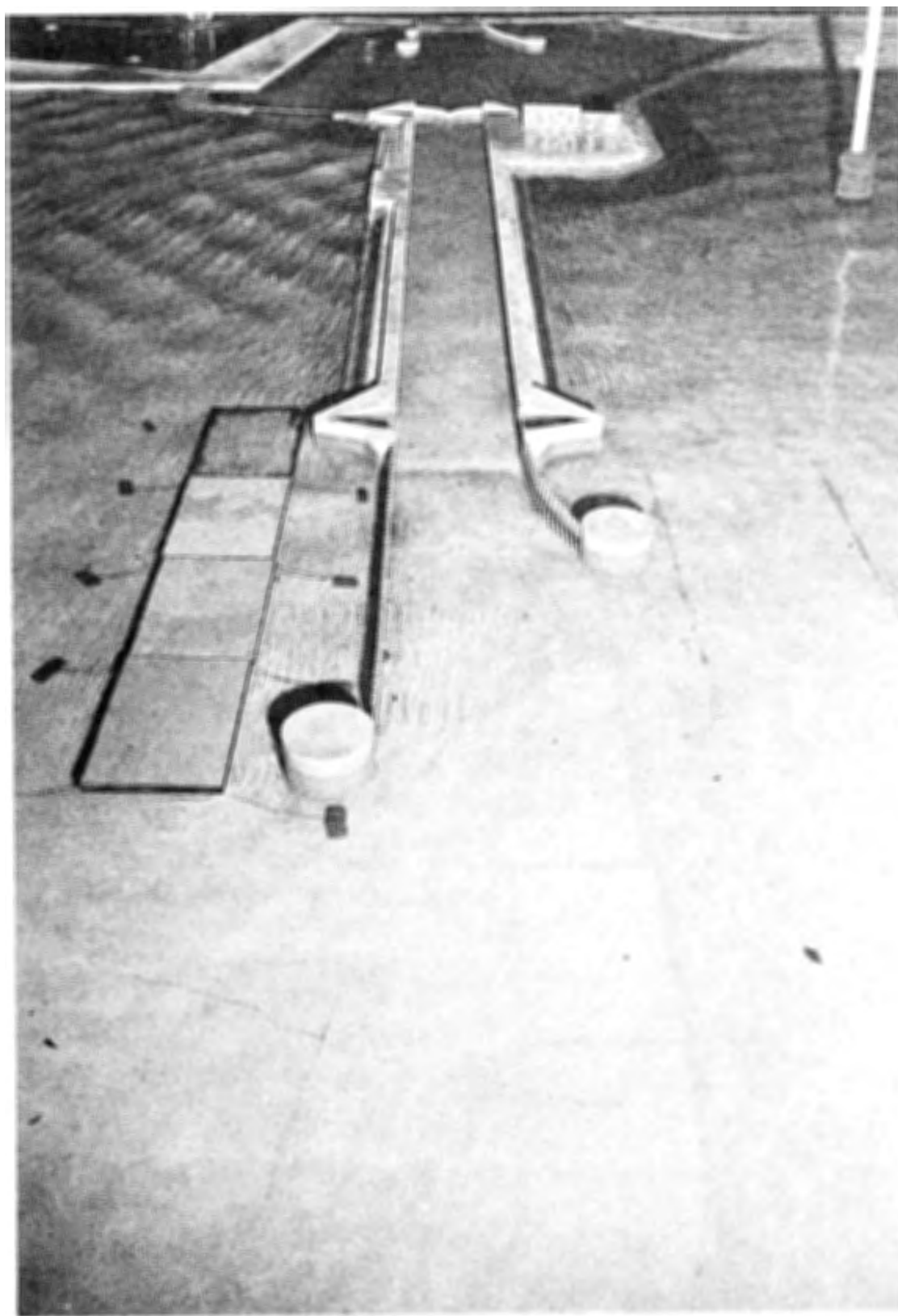


Photo 74. Typical wave patterns at lock entrance for Plan 17C; 4-sec,
4-ft waves from NW; swl = +4 ft msl



Photo 75. Typical wave patterns at breakwater for Plan 17C; 4-sec,
4-ft waves from NW; swl = +4 ft msl



Photo 76. Typical wave patterns at lock entrance for Plan 19F; 3-sec,
4-ft waves from N; swl = +1 ft msl



Photo 77. Typical wave patterns at lock entrance for Plan 19F; 4-sec, 5-ft waves from N; swl = +1 ft msl

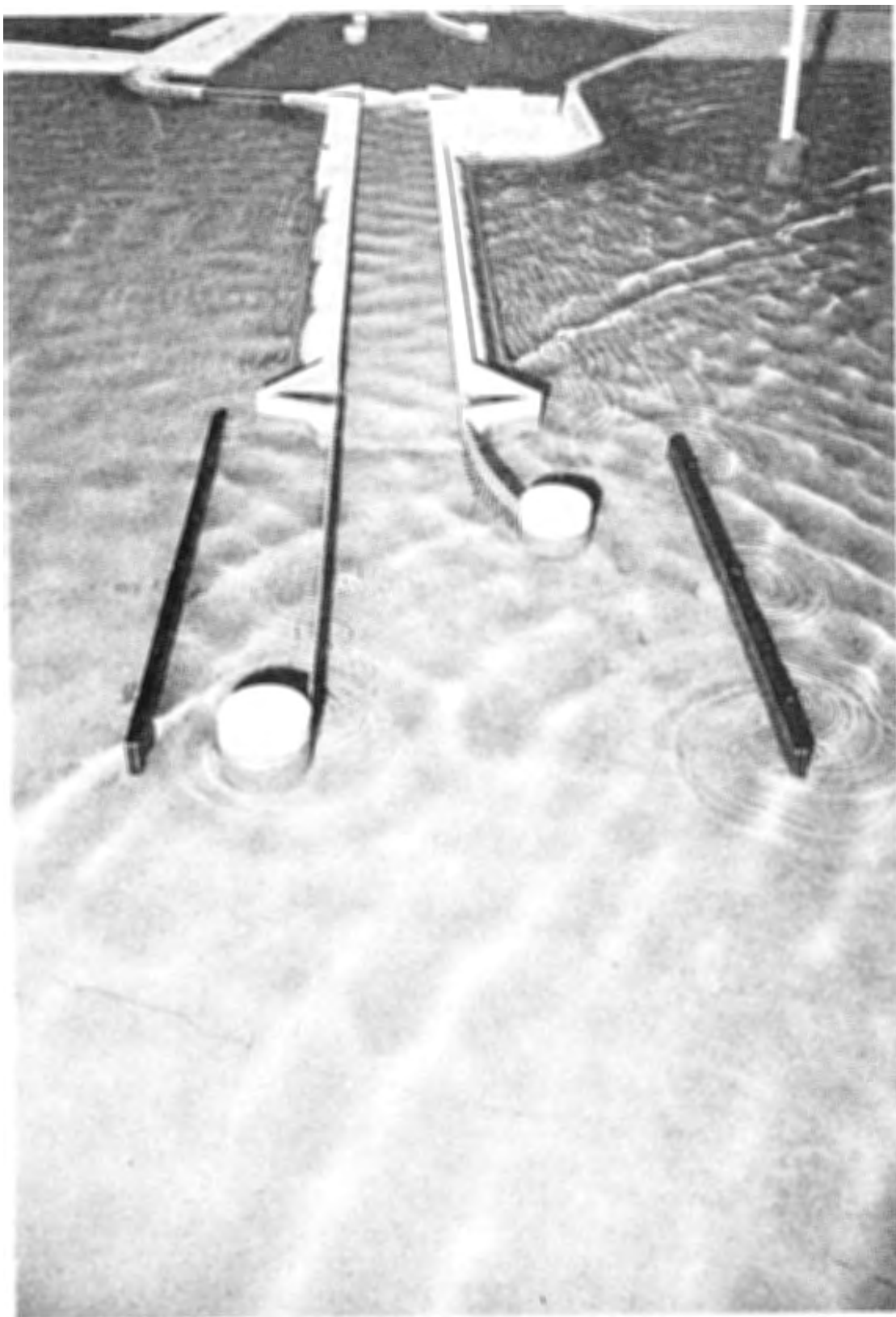


Photo 78. Typical wave patterns at lock entrance for Plan 19F; 3-sec,
4-ft waves from NW; swl = +1 ft msl

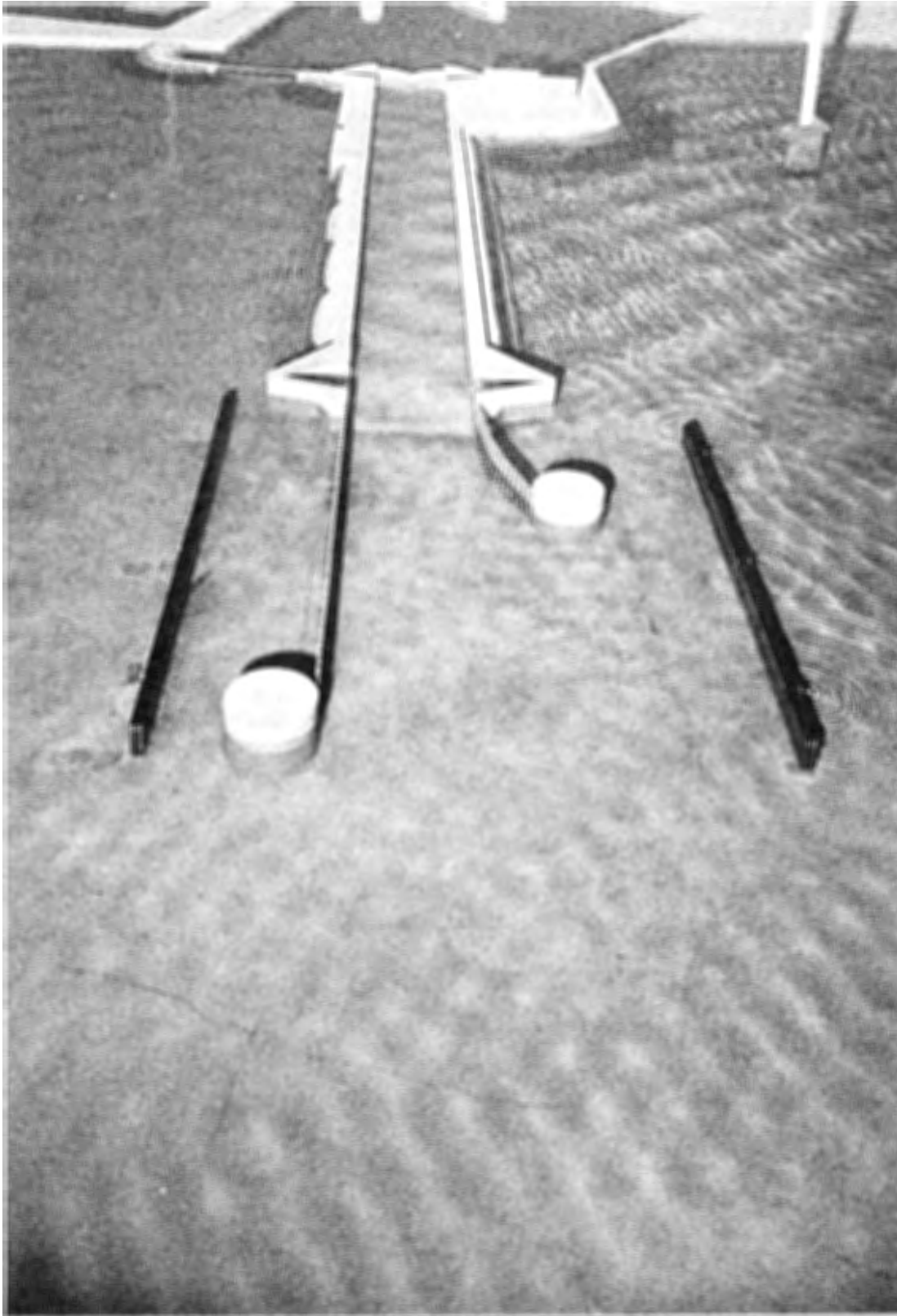


Photo 79. Typical wave patterns at lock entrance for Plan 19F; 4-sec,
4-ft waves from NW; swl = +1 ft msl

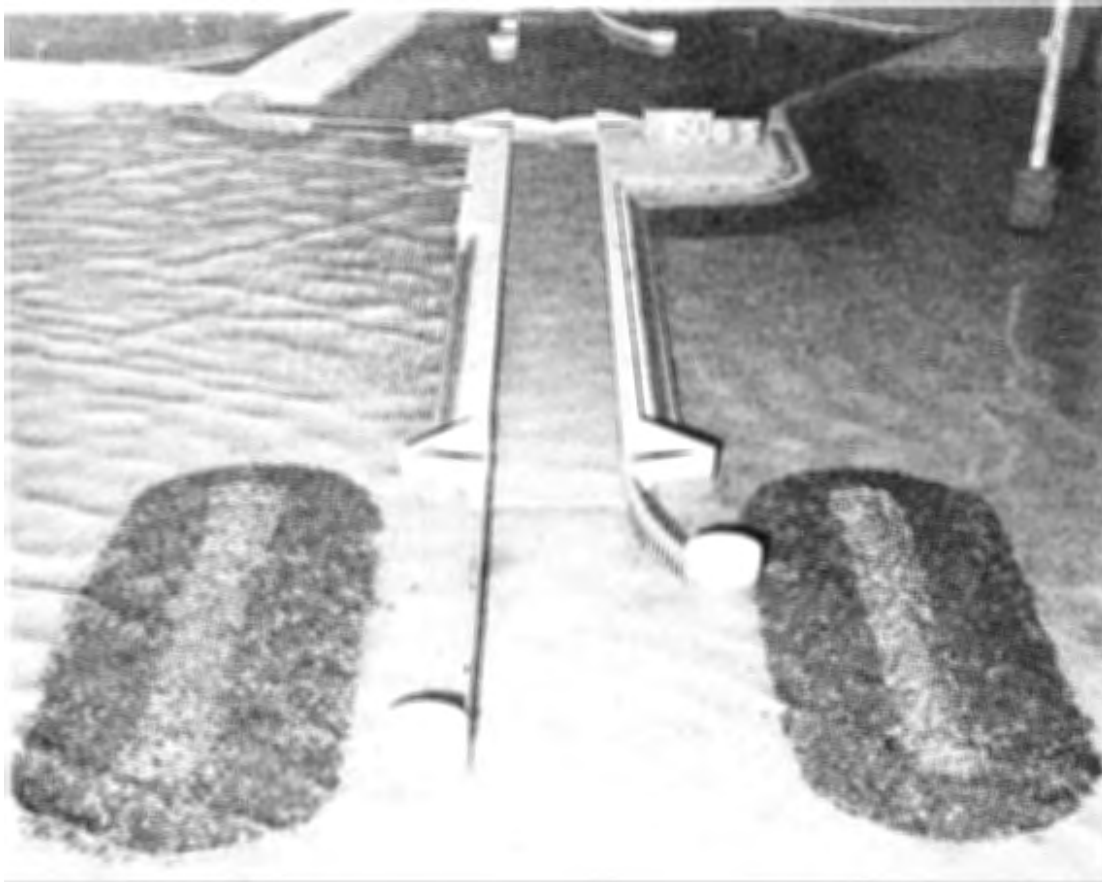


Photo 80. Typical wave patterns at lock entrance for Plan 20A; 3-sec,
4-ft waves from N; swl = +1 ft msl

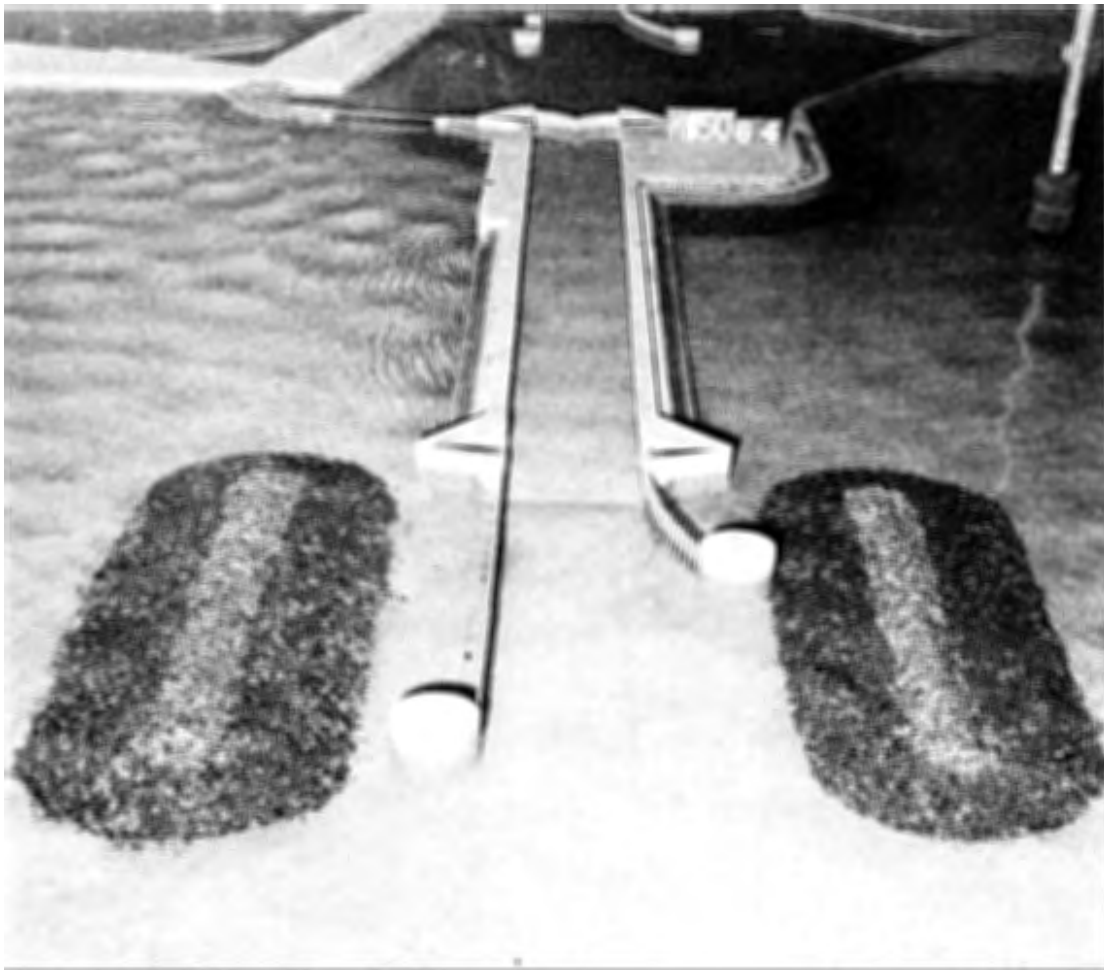


Photo 81. Typical wave patterns at lock entrance for Plan 20A; 4-sec,
5-ft waves from N; swl = +1 ft msl

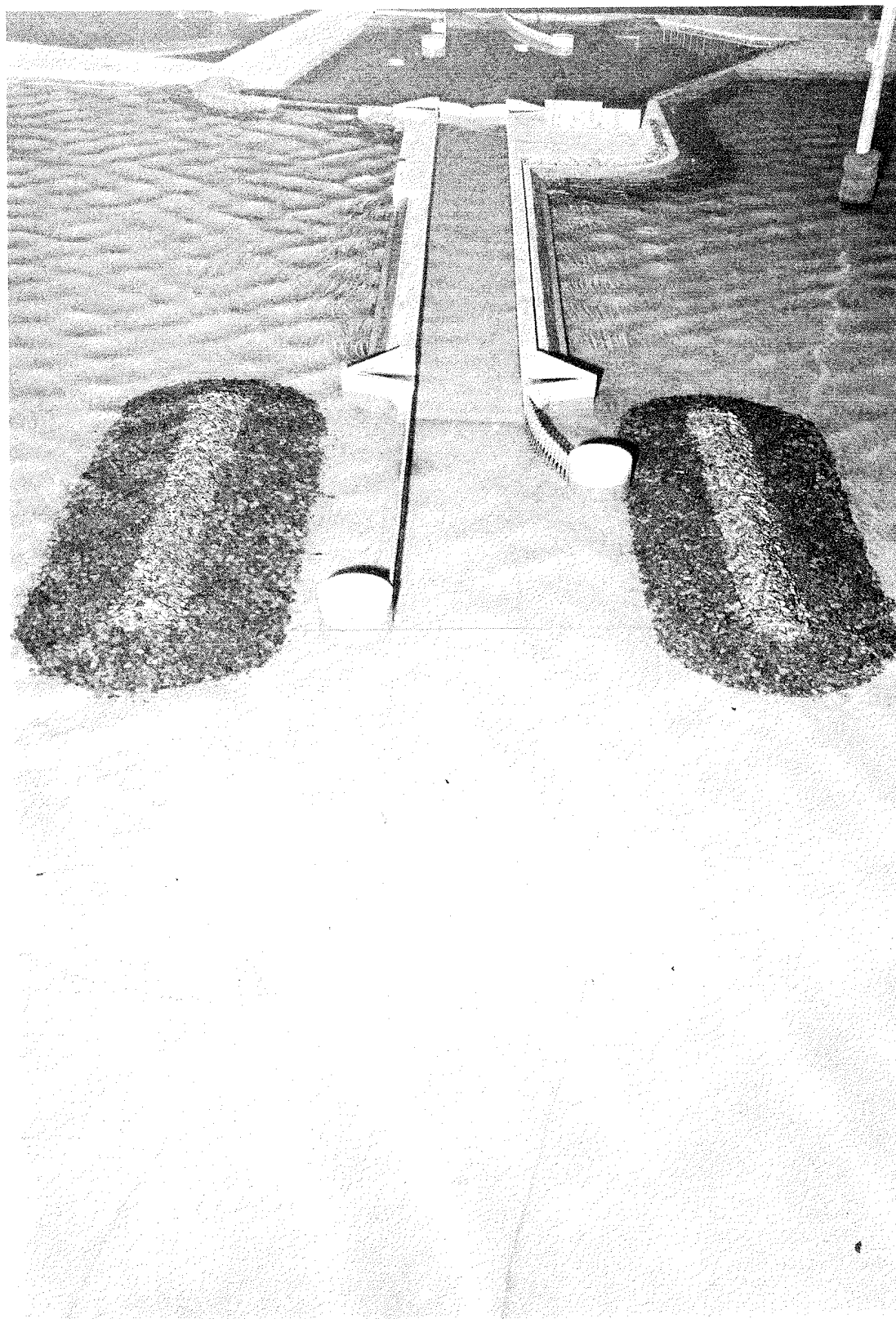


Photo 82. Typical wave patterns at lock entrance for Plan 20A; 3-sec,
4-ft waves from NNW; swl = +1 ft msl

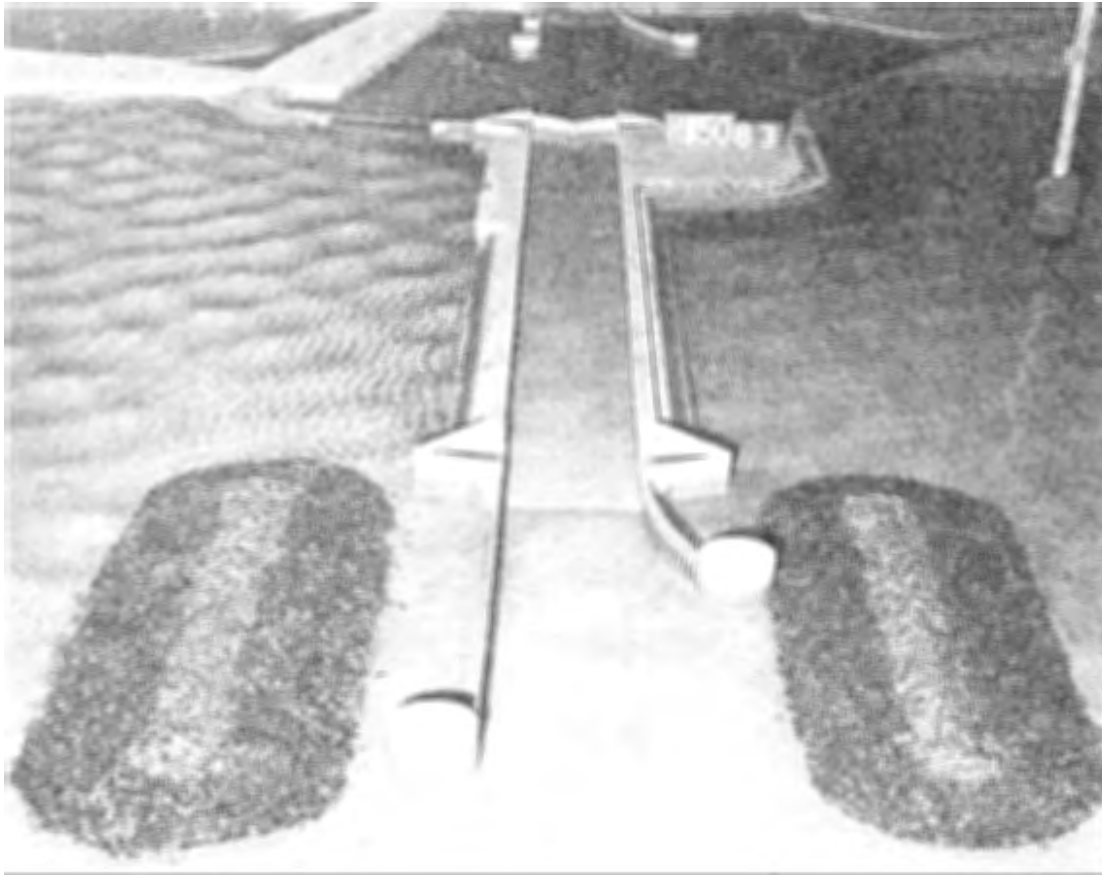


Photo 83. Typical wave patterns at lock entrance for Plan 20A; 4-sec,
4-ft waves from NNW; swl = +1. ft msl



Photo 84. Typical wave patterns at lock entrance for Plan 20A; 3-sec,
4-ft waves from NW; swl = +1 ft msl

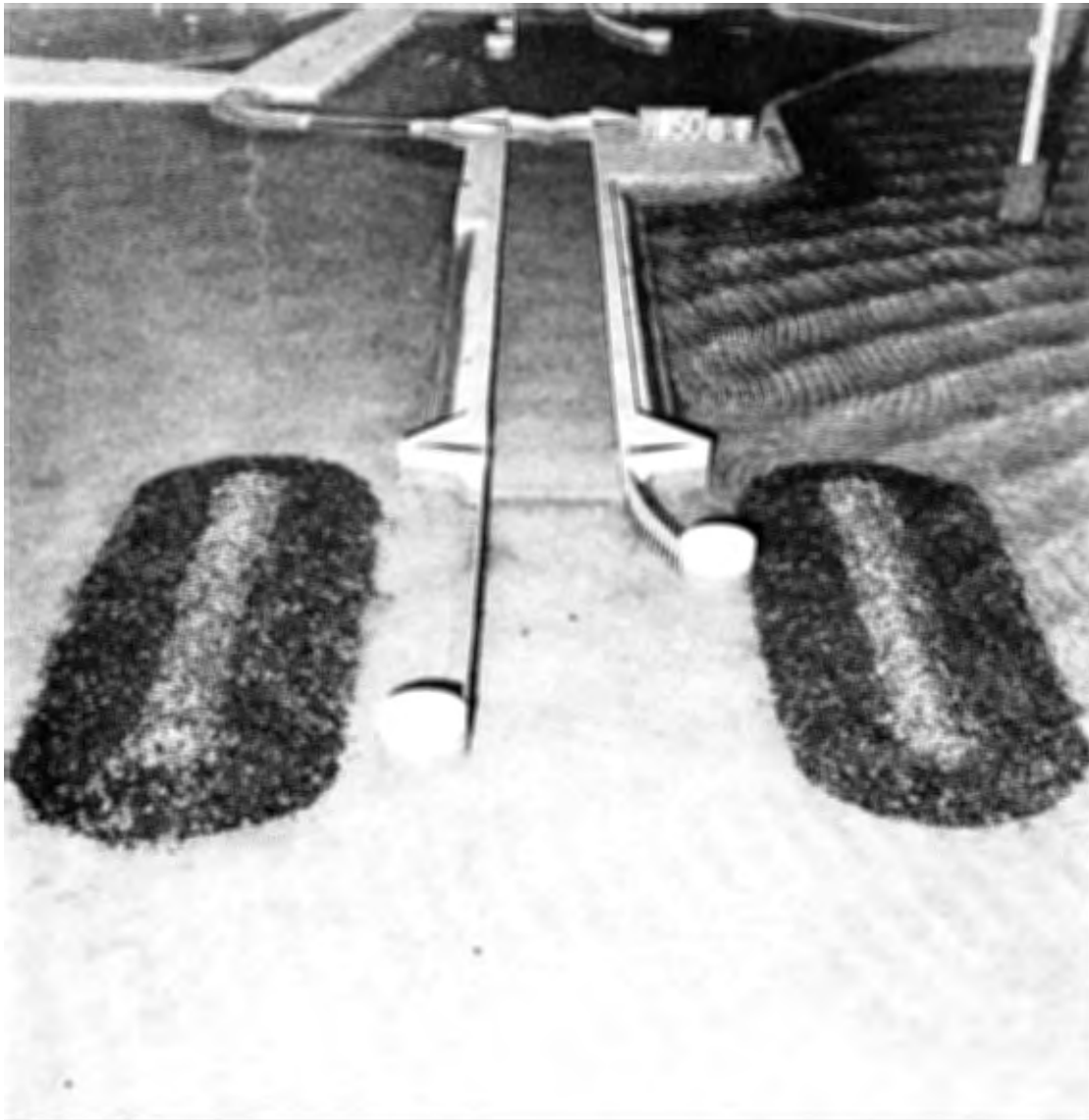
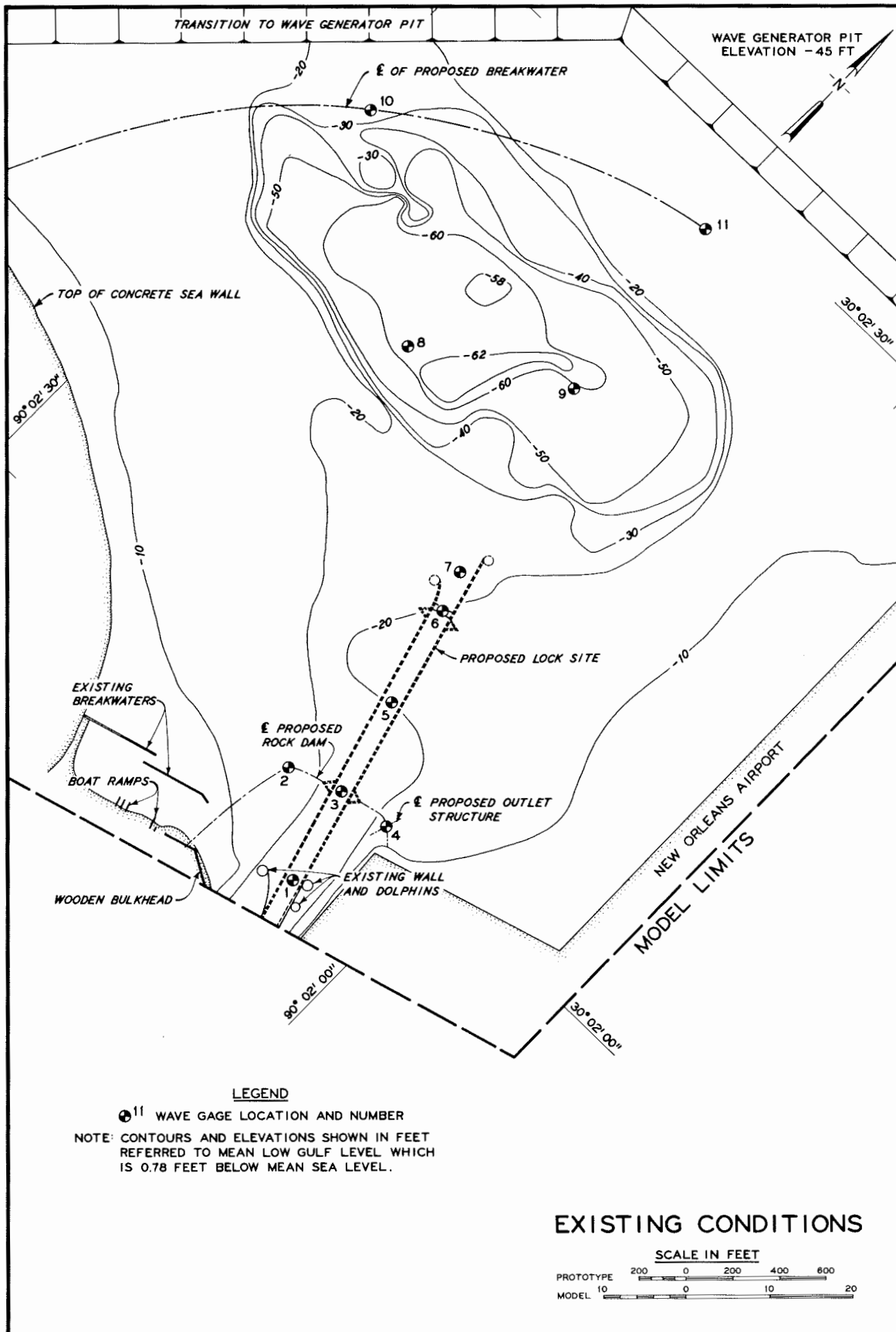


Photo 85. Typical wave patterns at lock entrance for Plan 20A; 4-sec,
4-ft waves from NW; swl = +1 ft msl



Photo 86. Typical wave patterns at lock entrance for Plan 20A; 4-sec,
4-ft waves from NW; swl = +4 ft msl



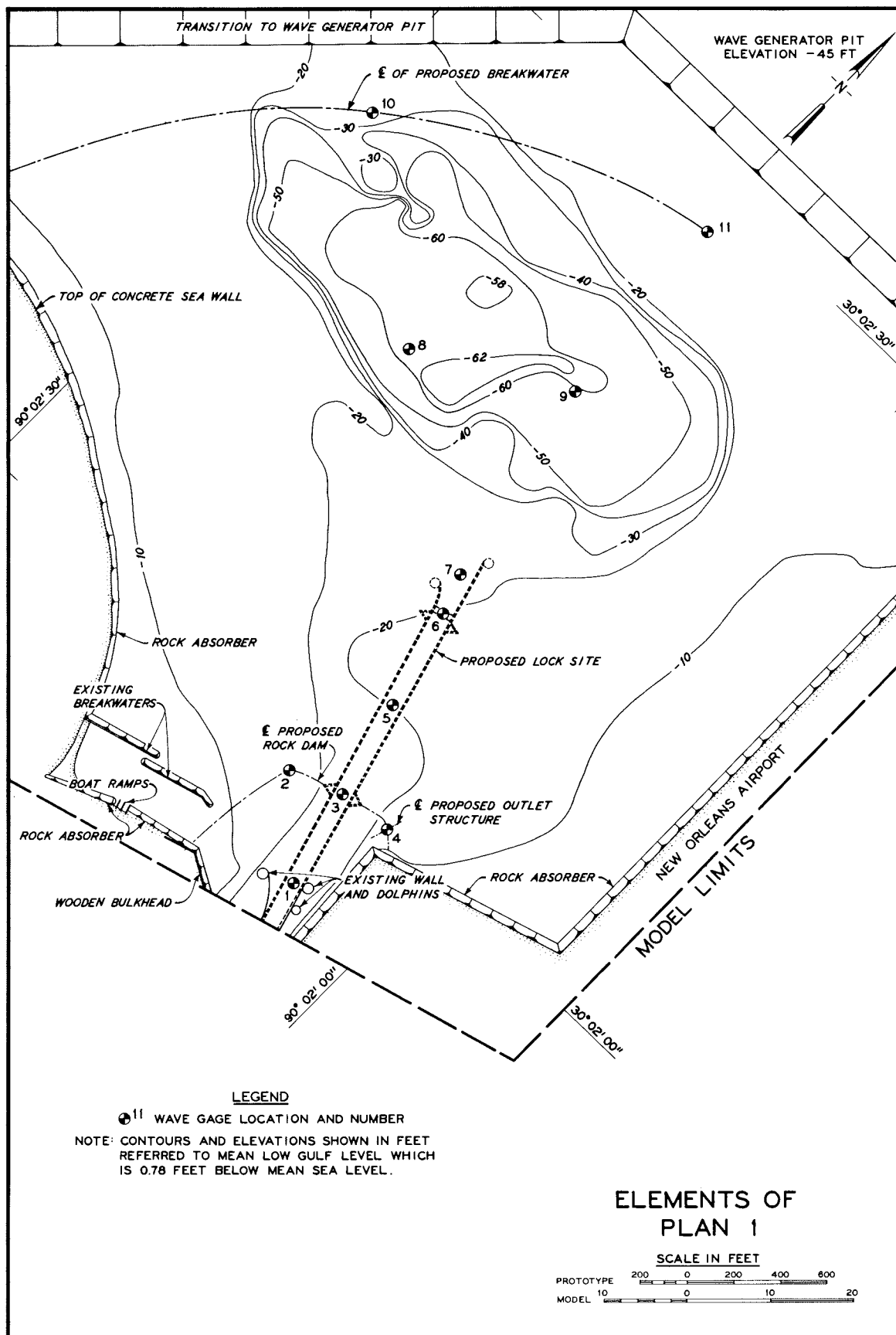
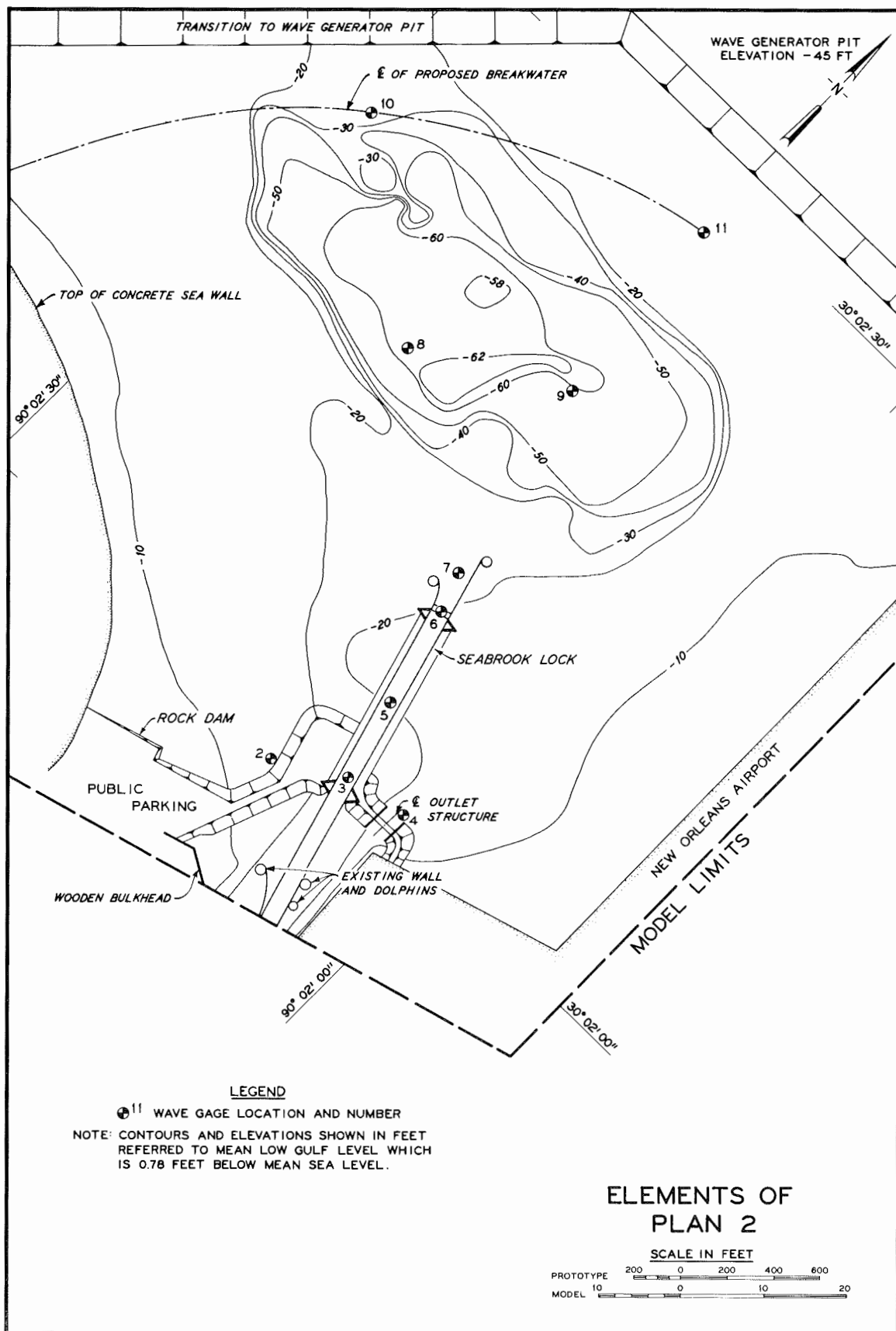


PLATE 2



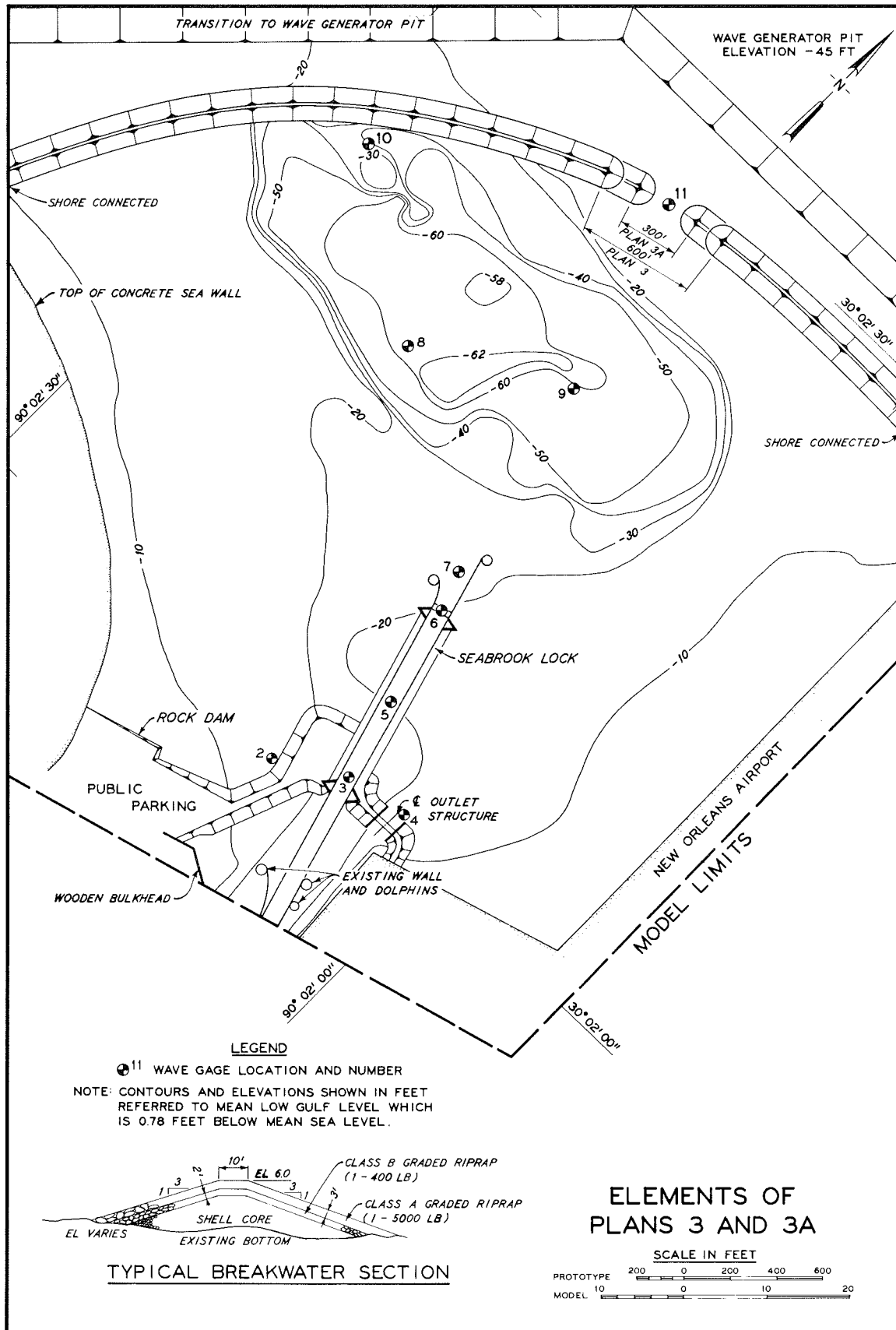
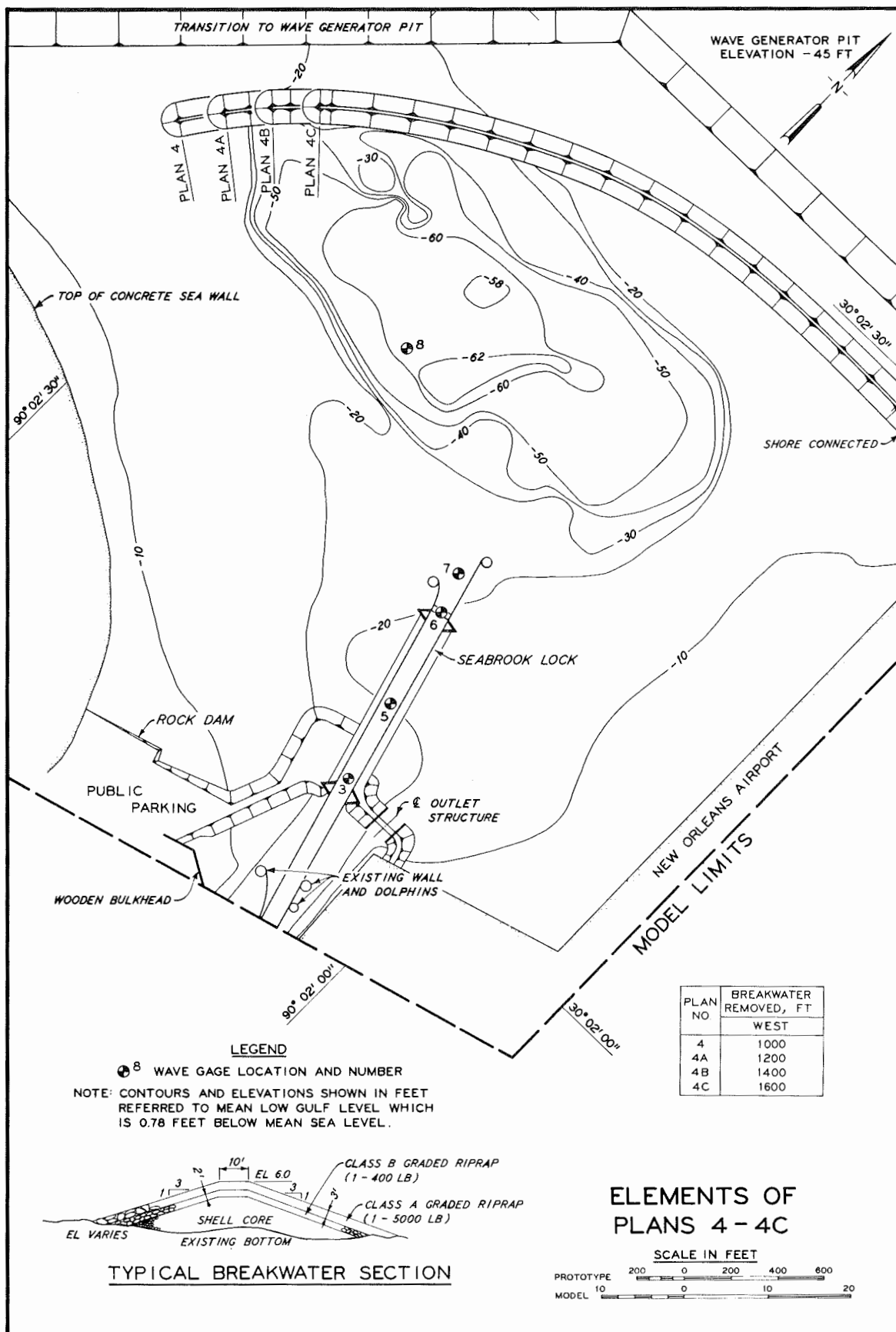


PLATE 4



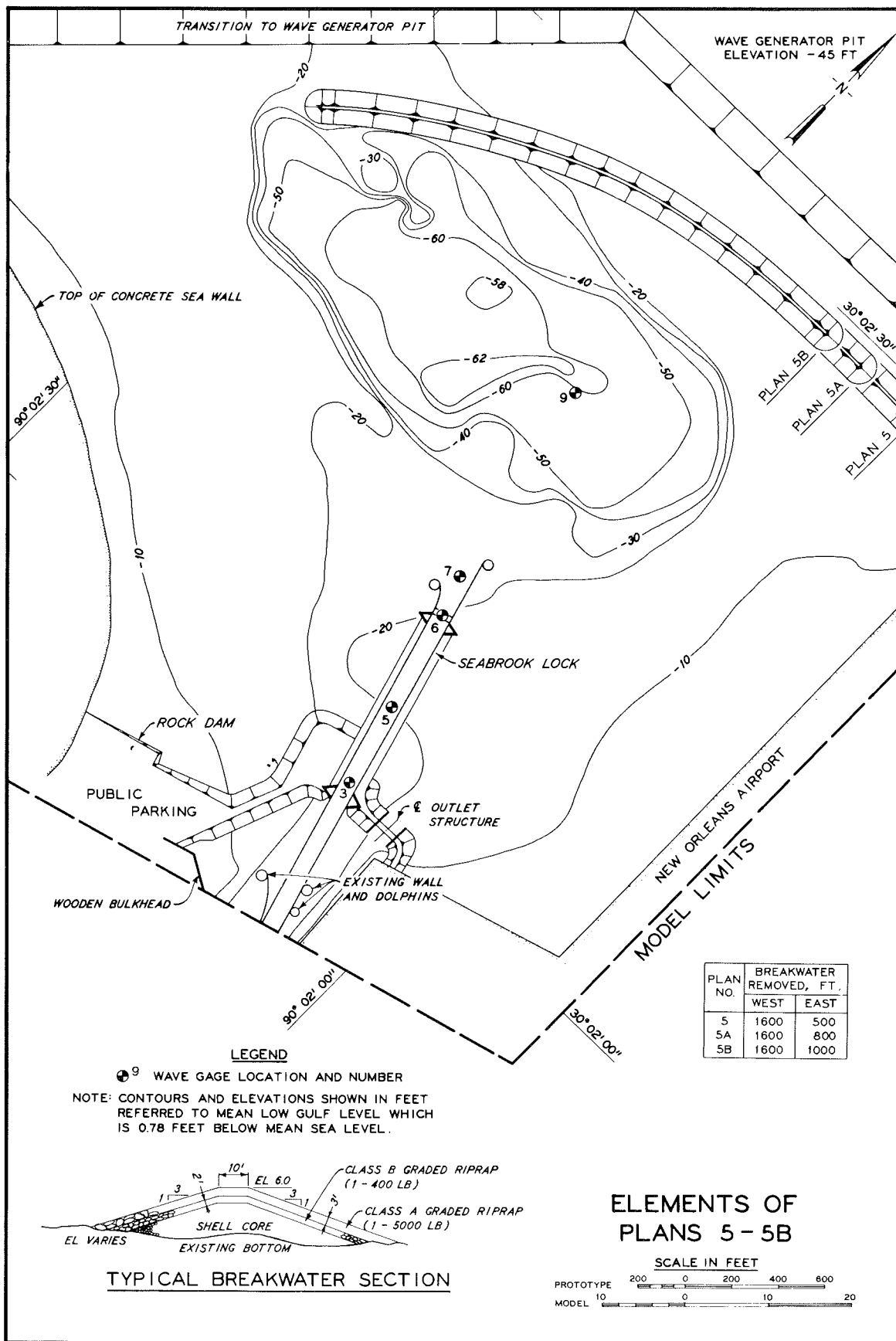
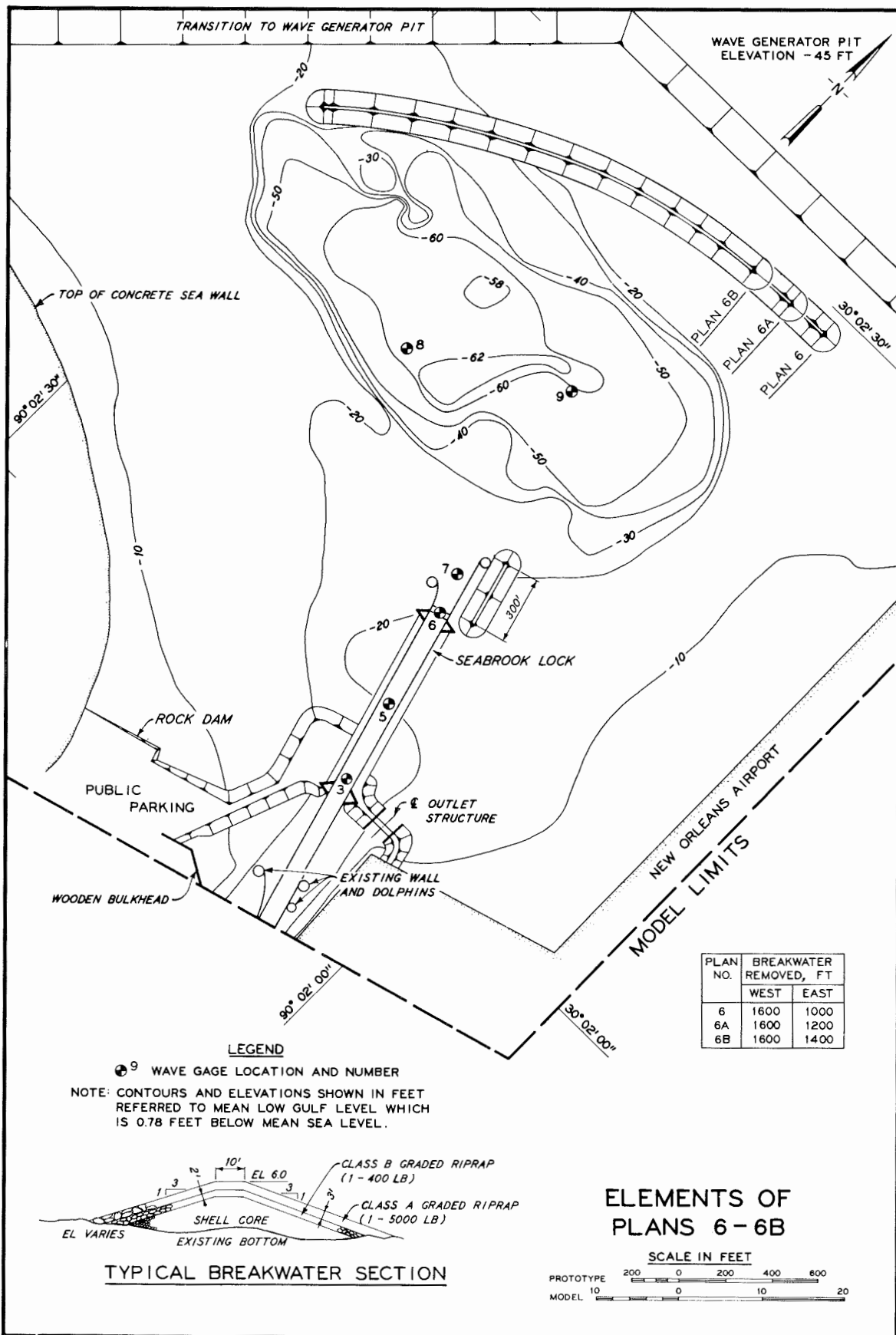
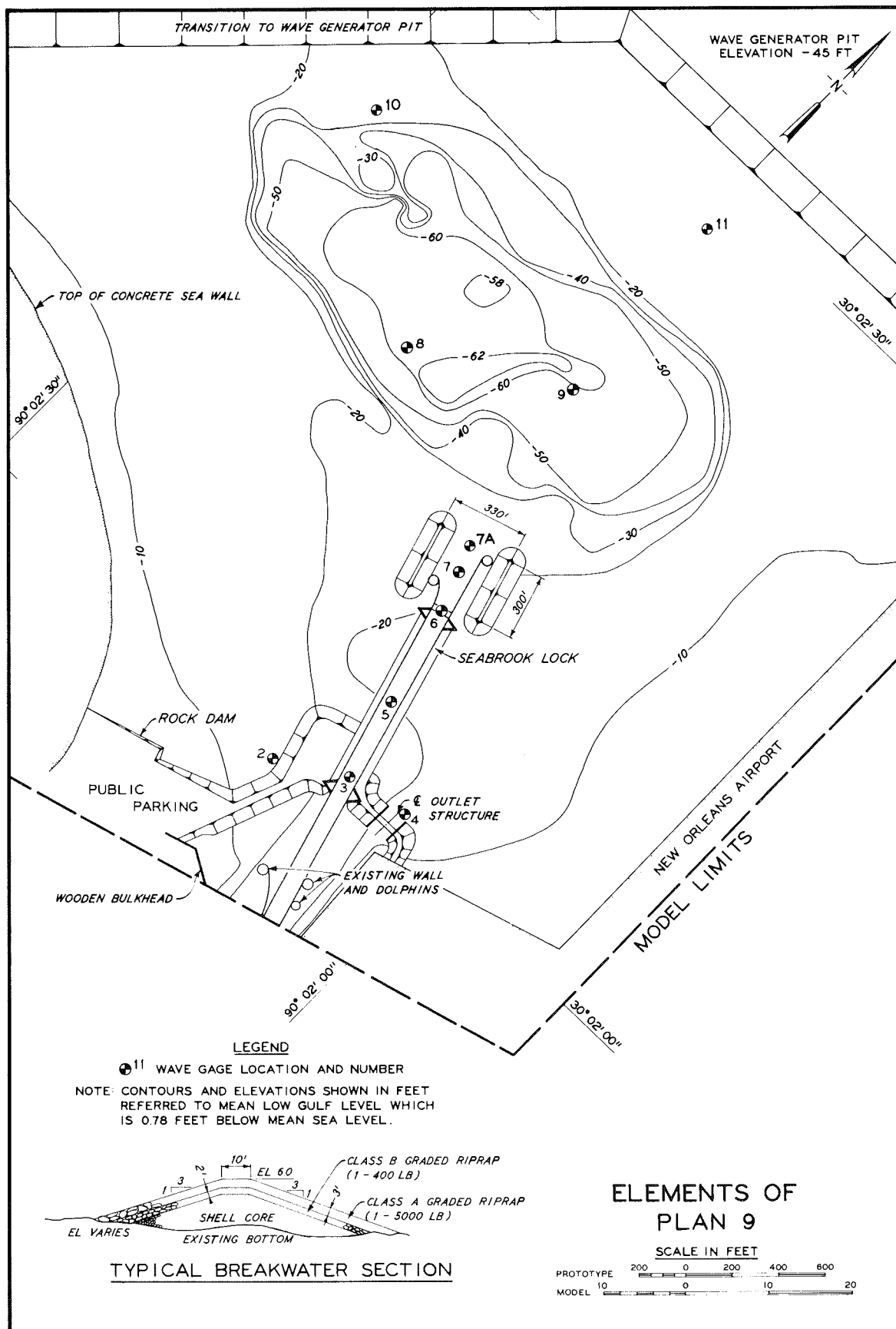
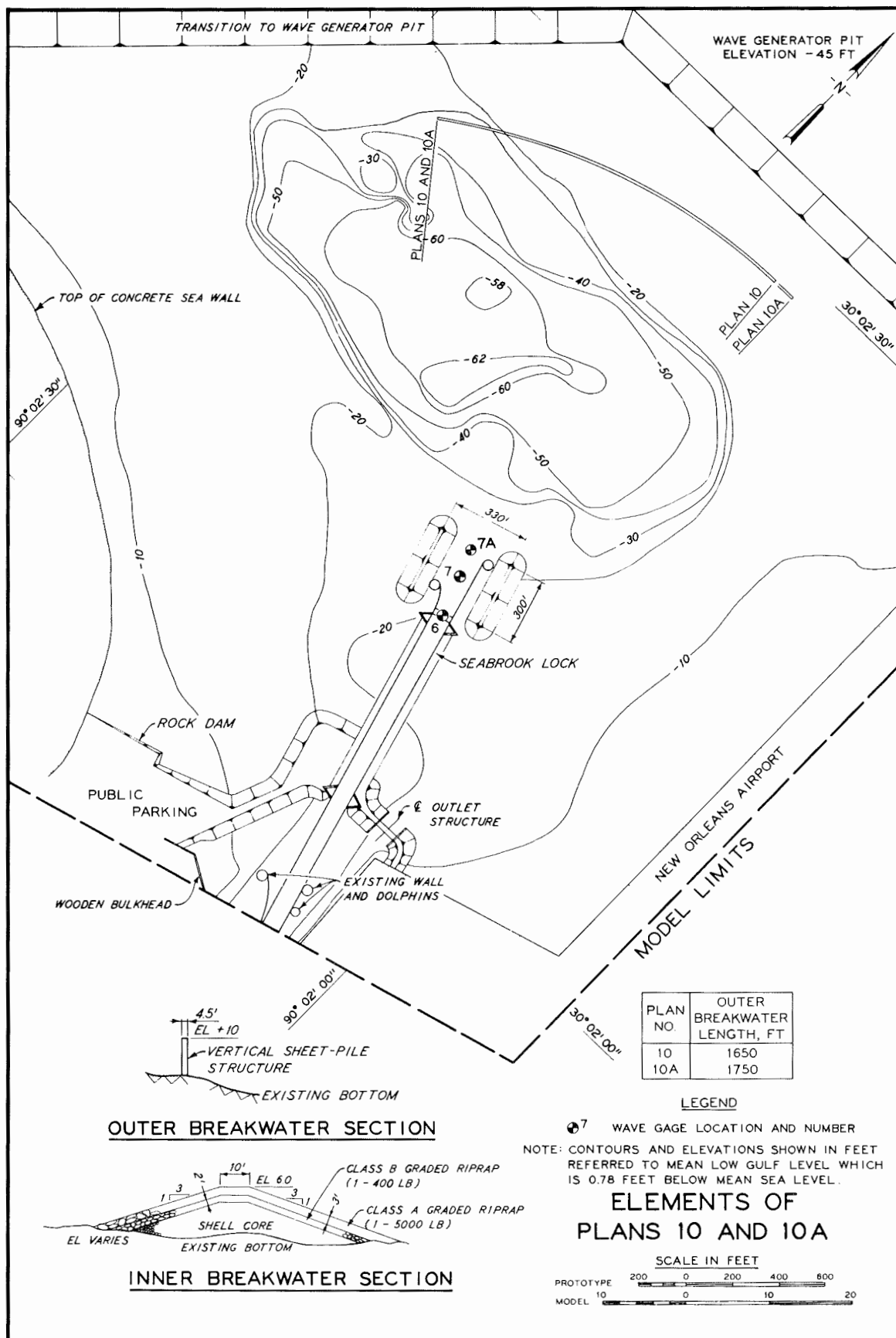


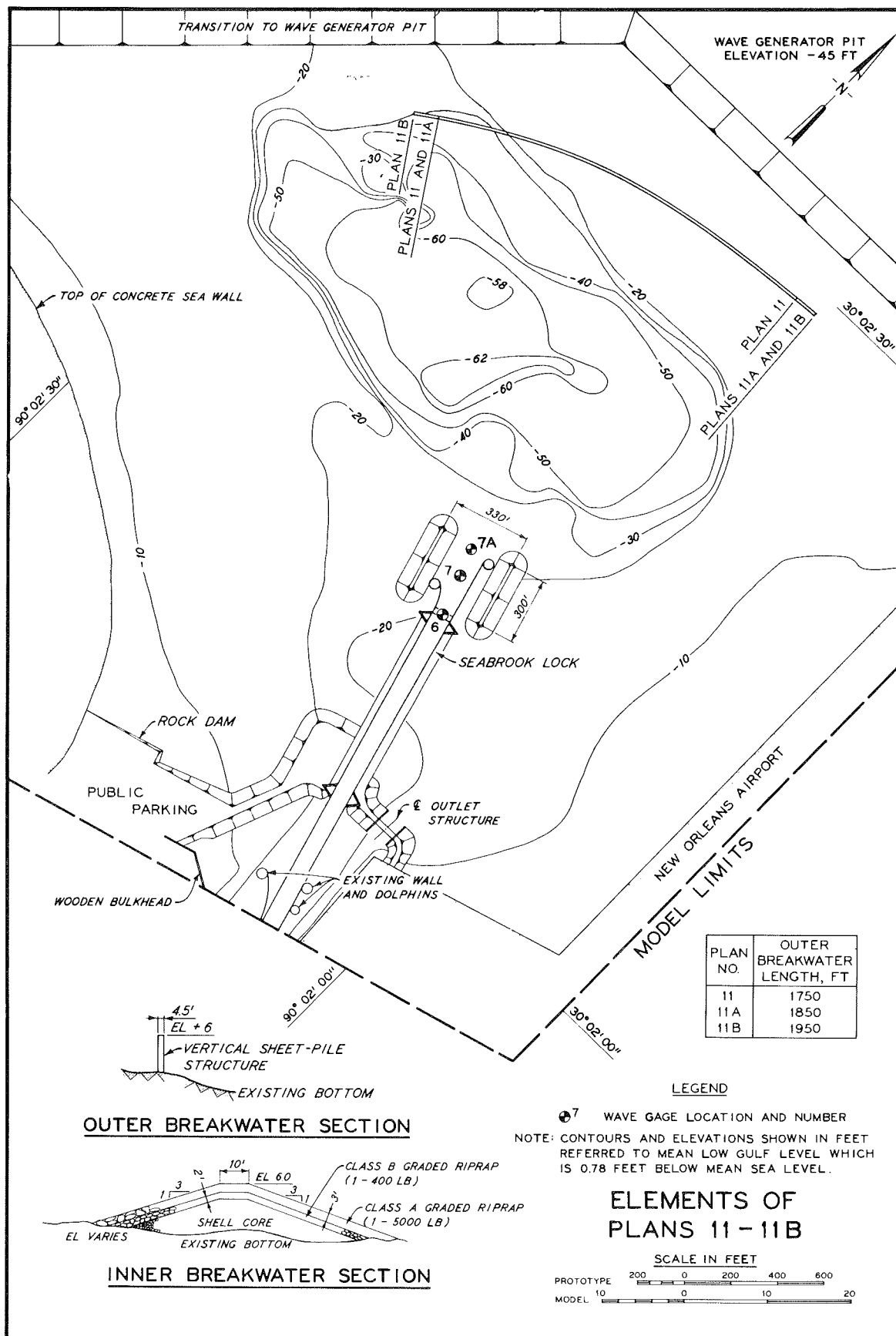
PLATE 6

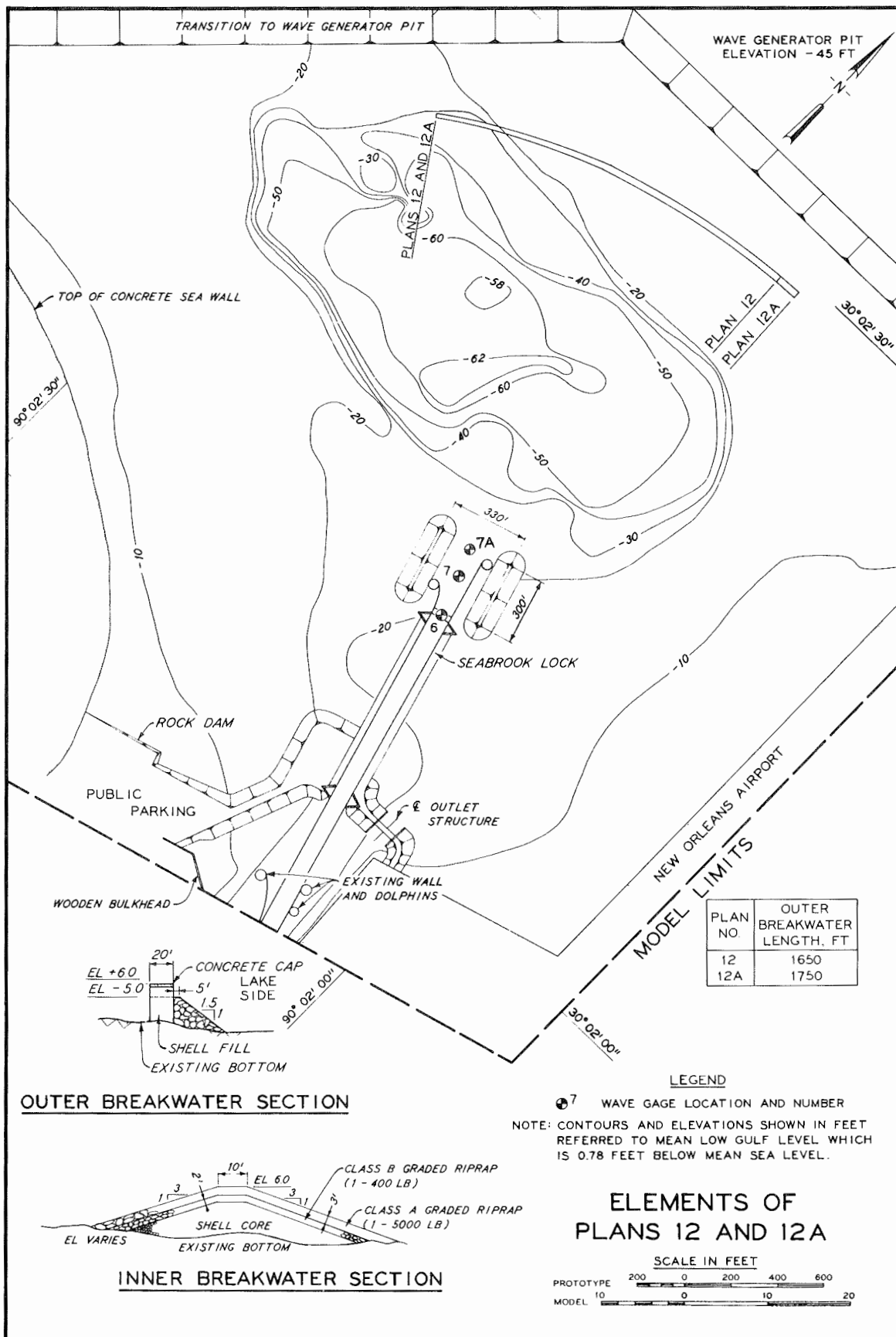


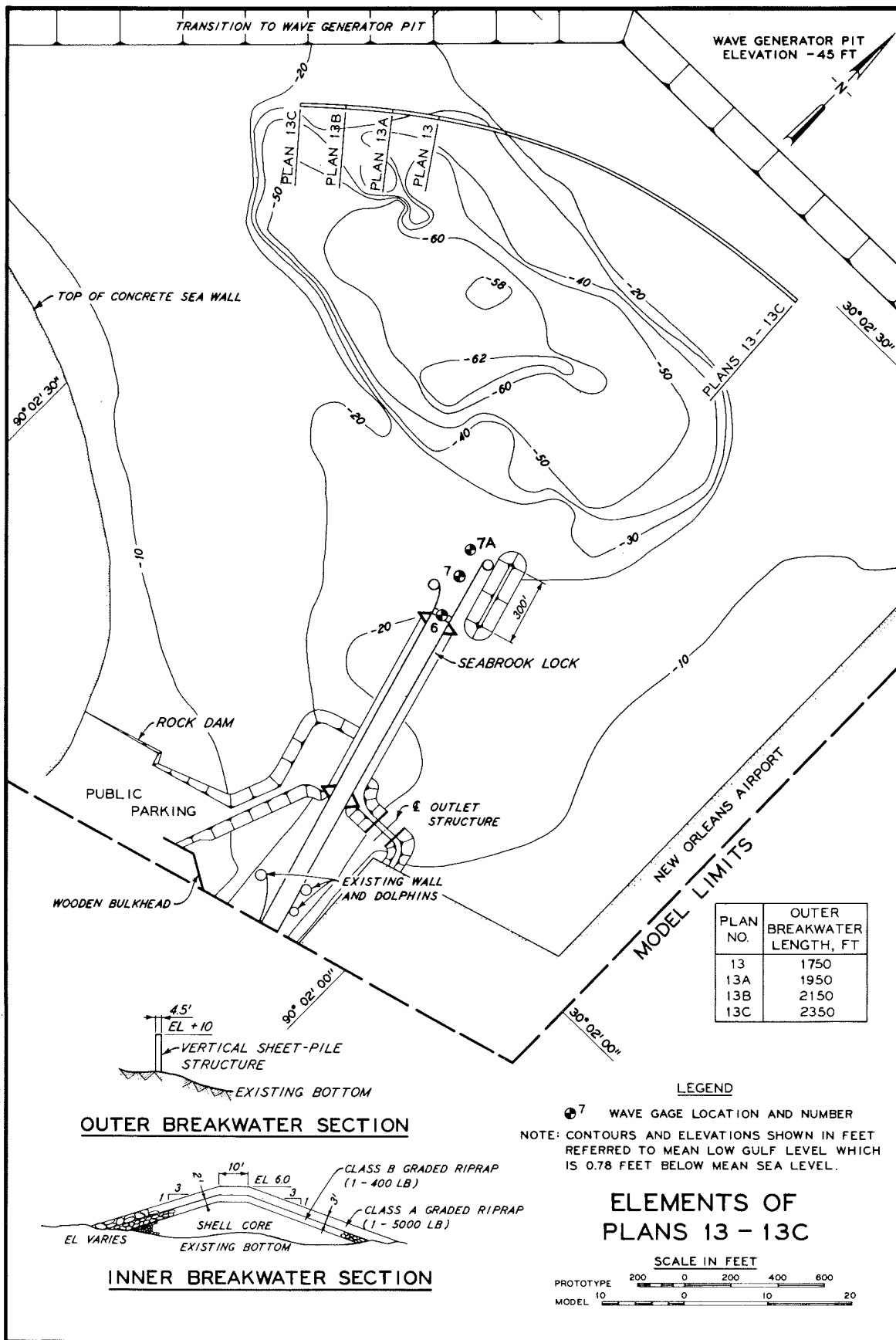


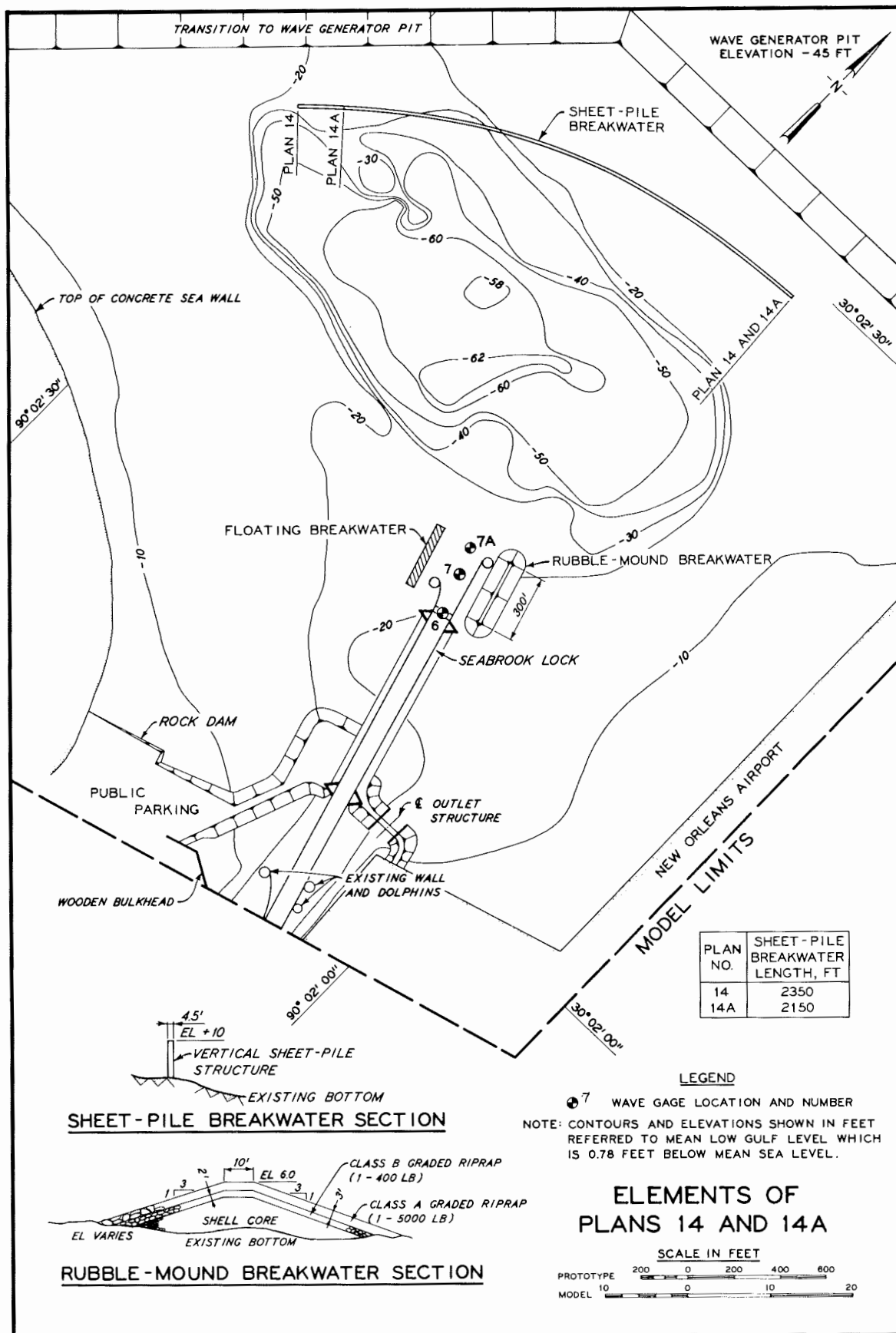












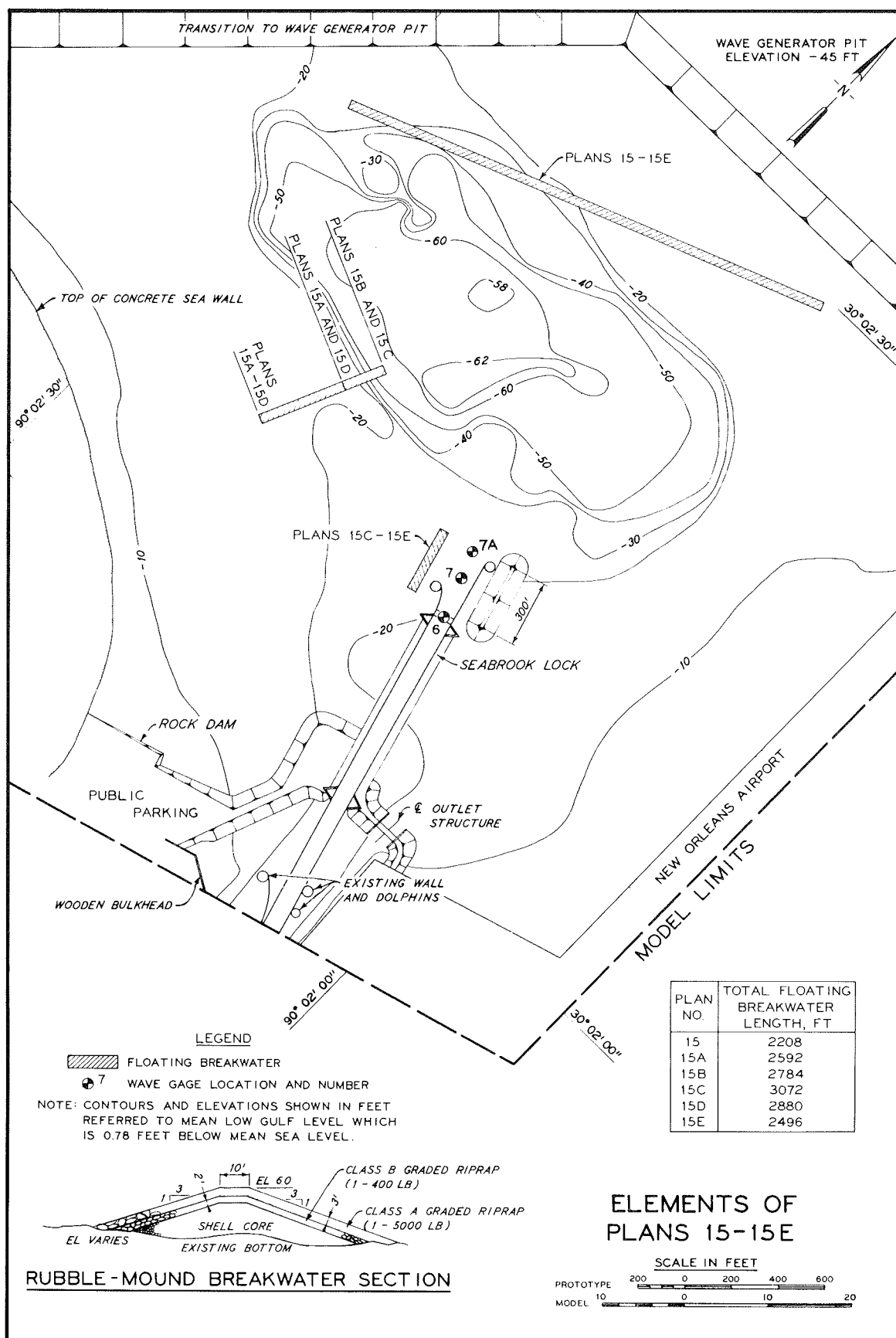
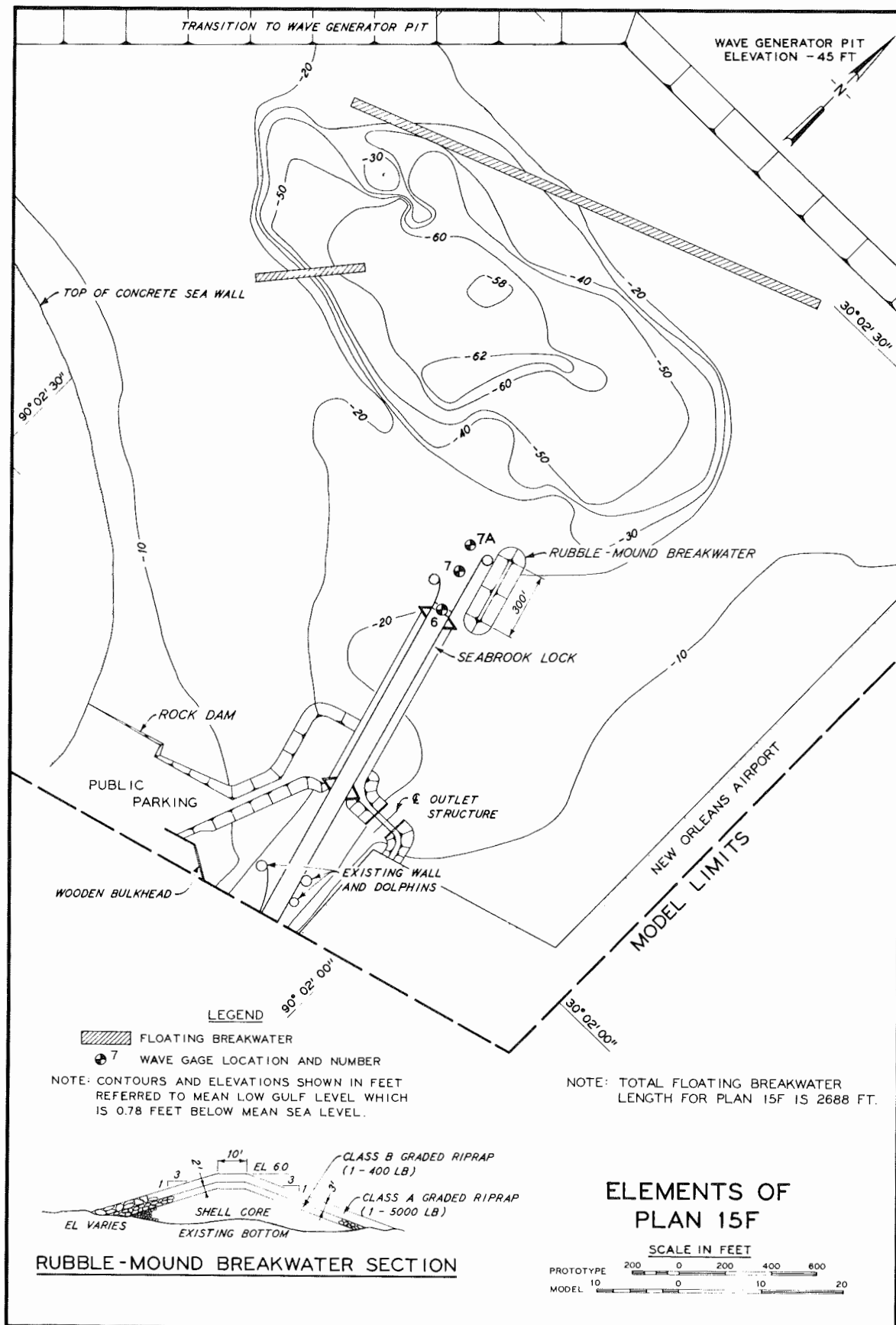
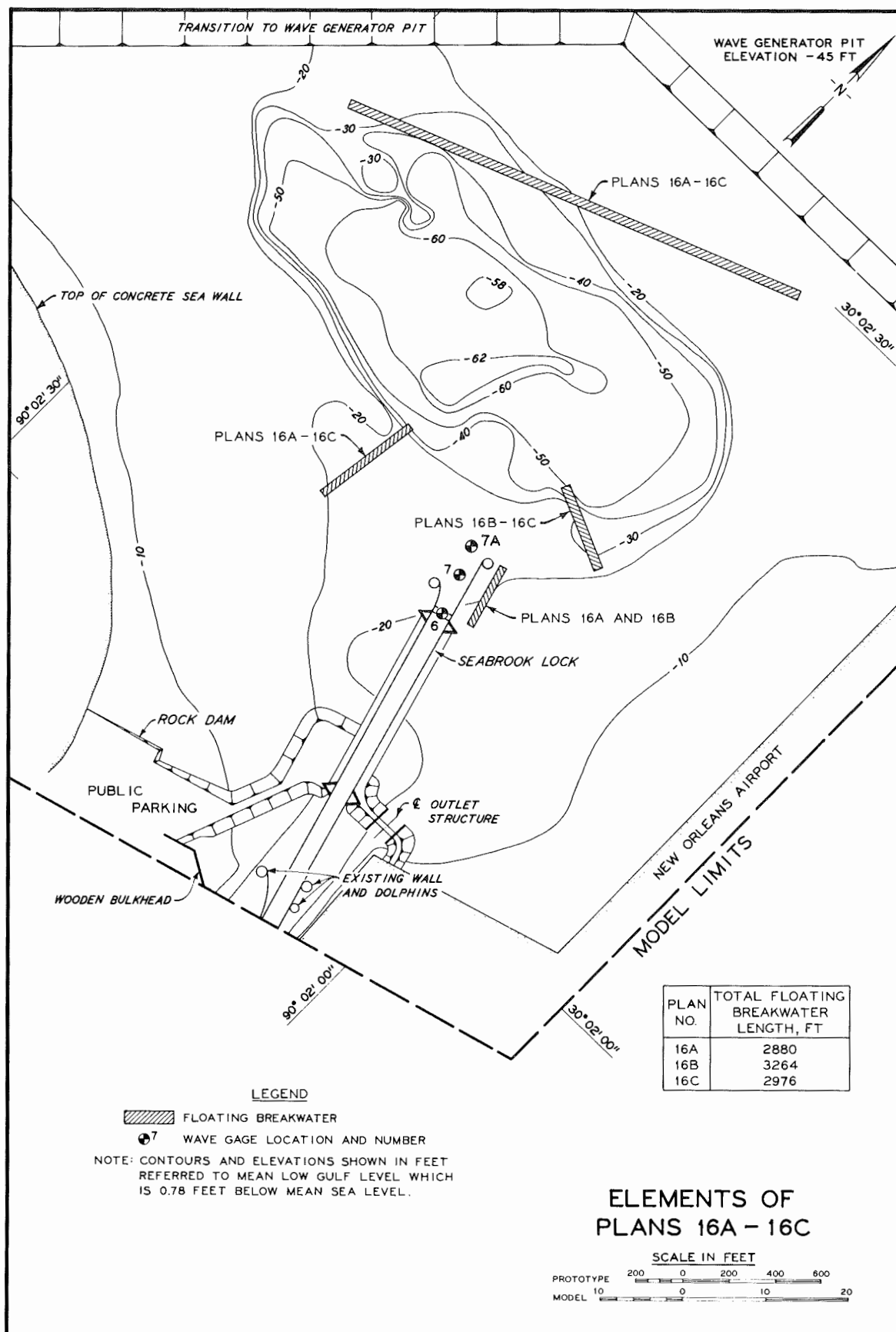
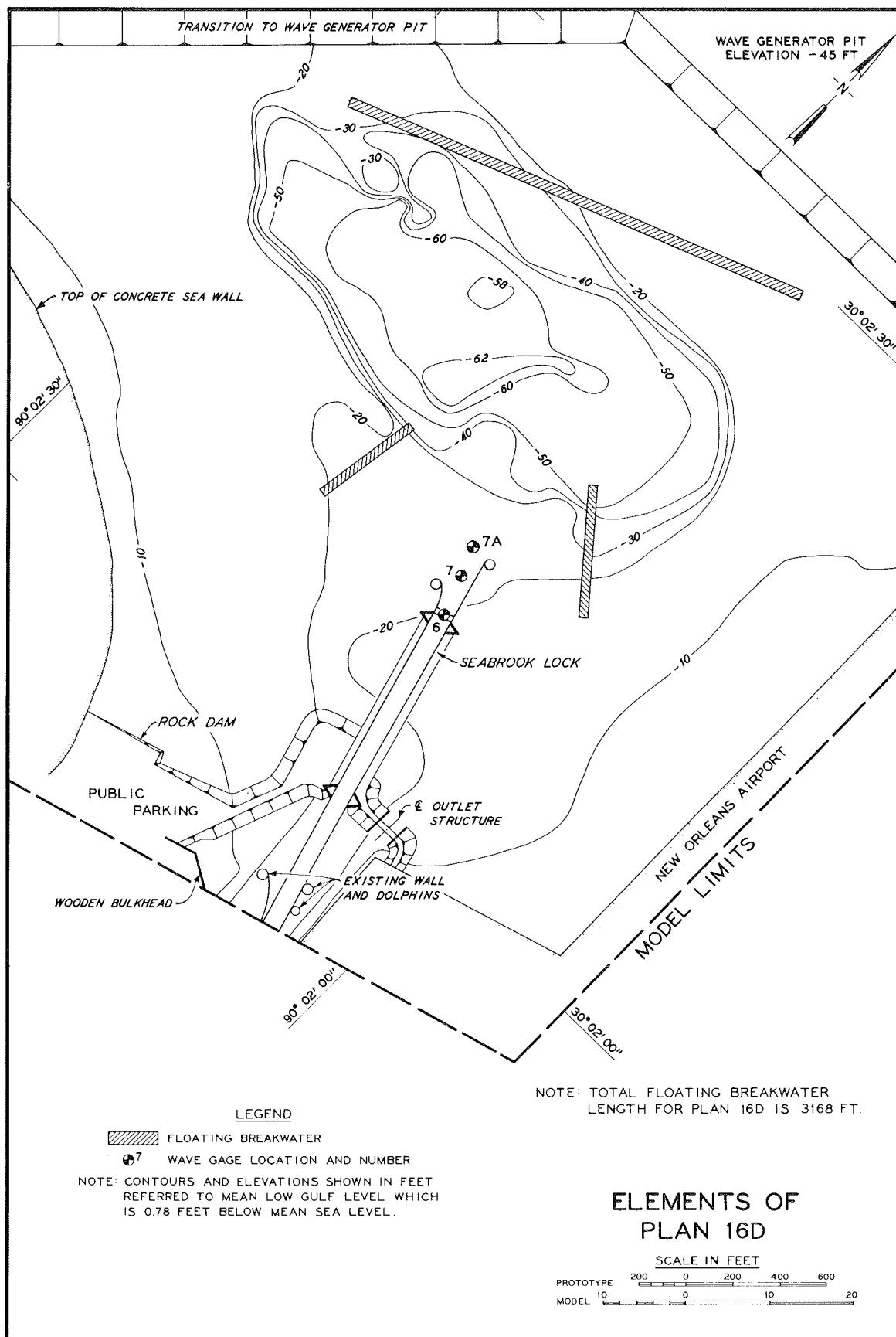


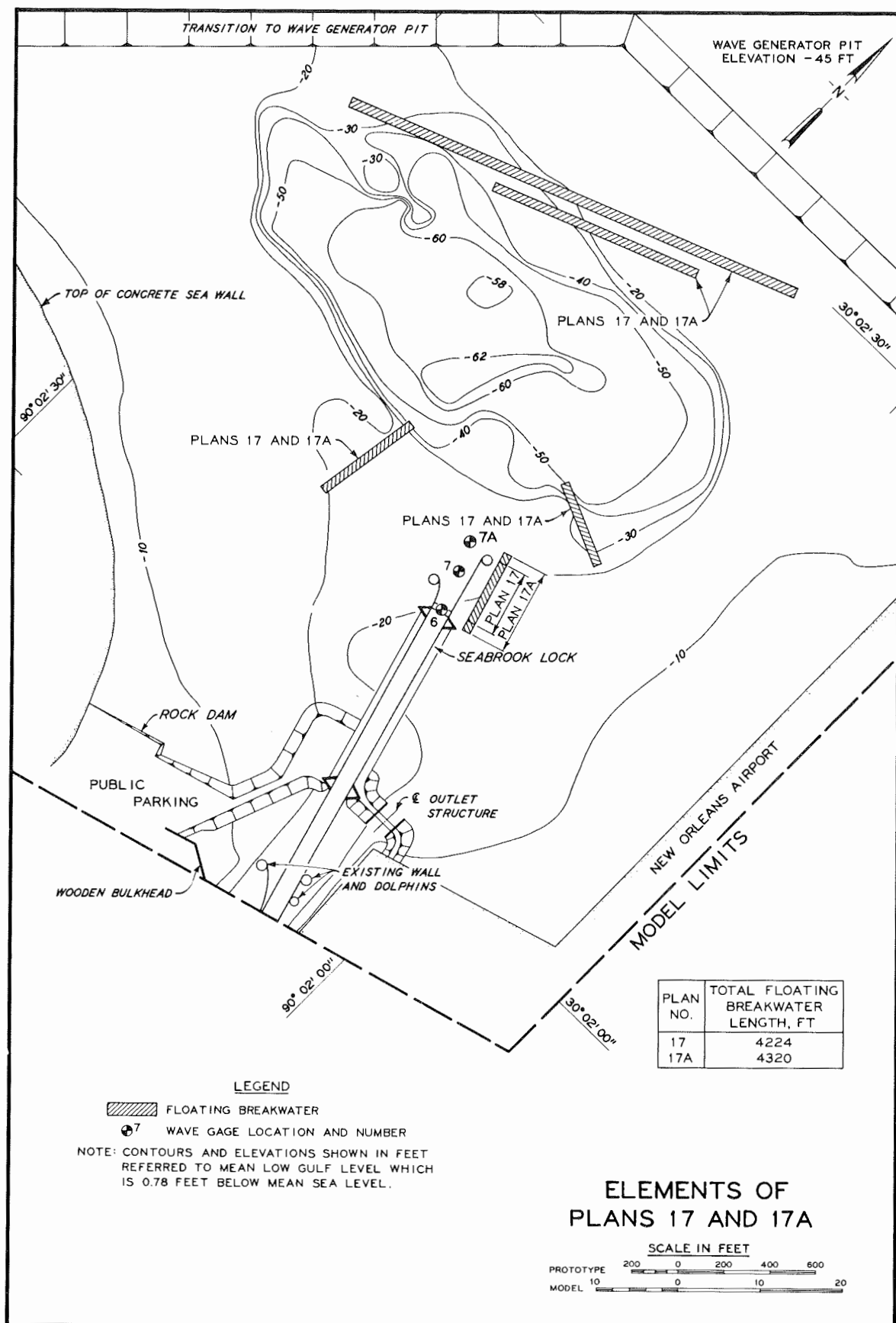
PLATE 16

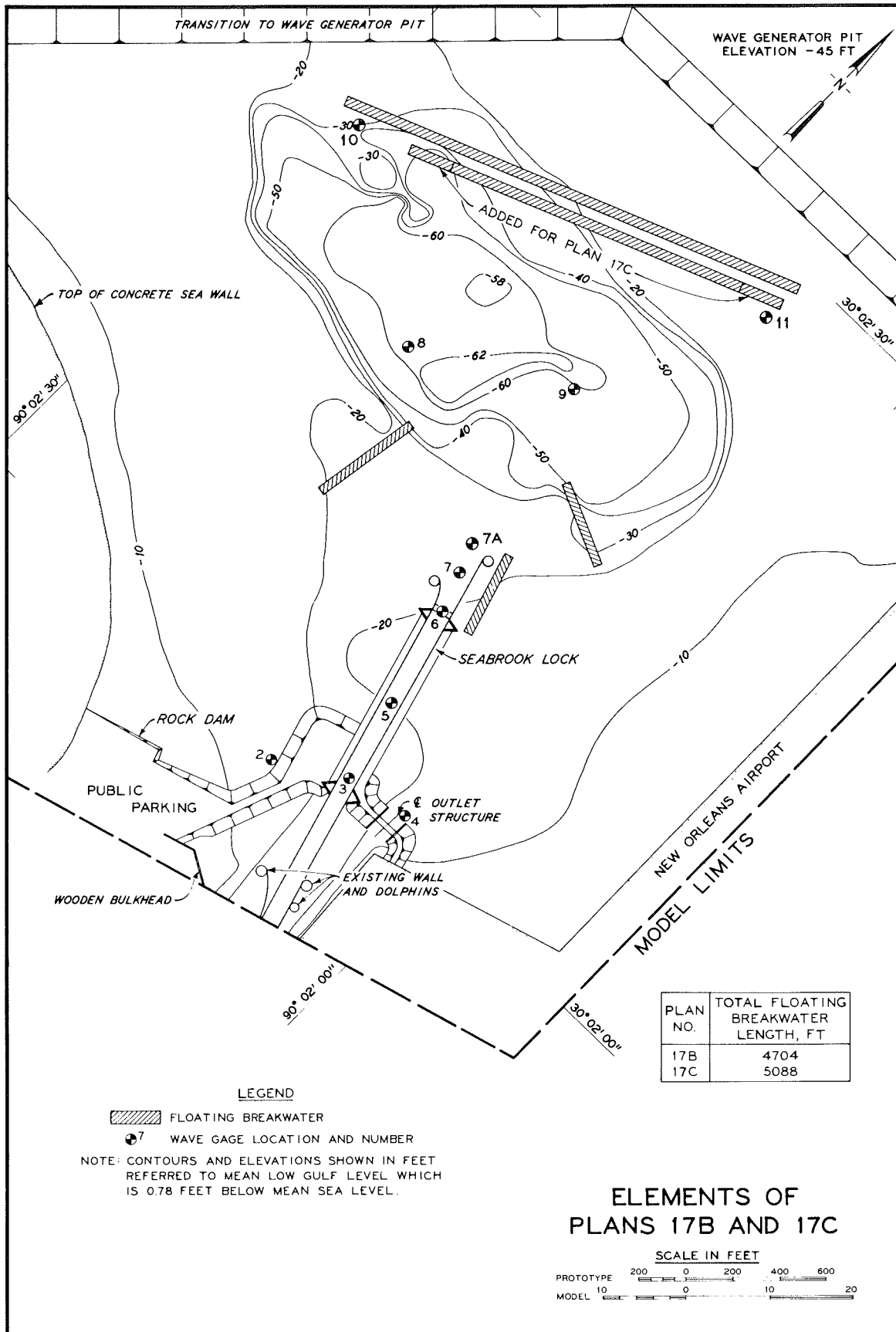


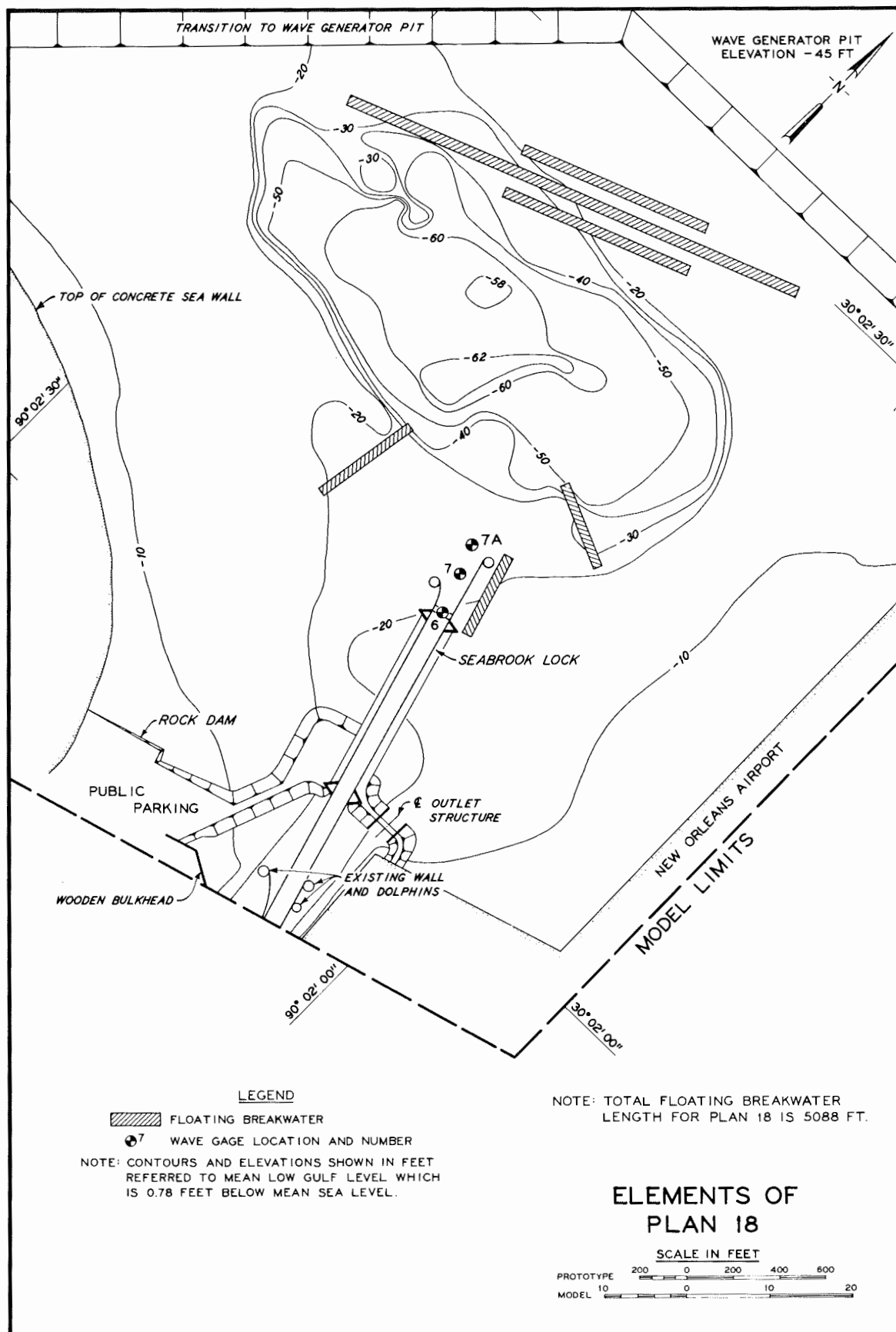


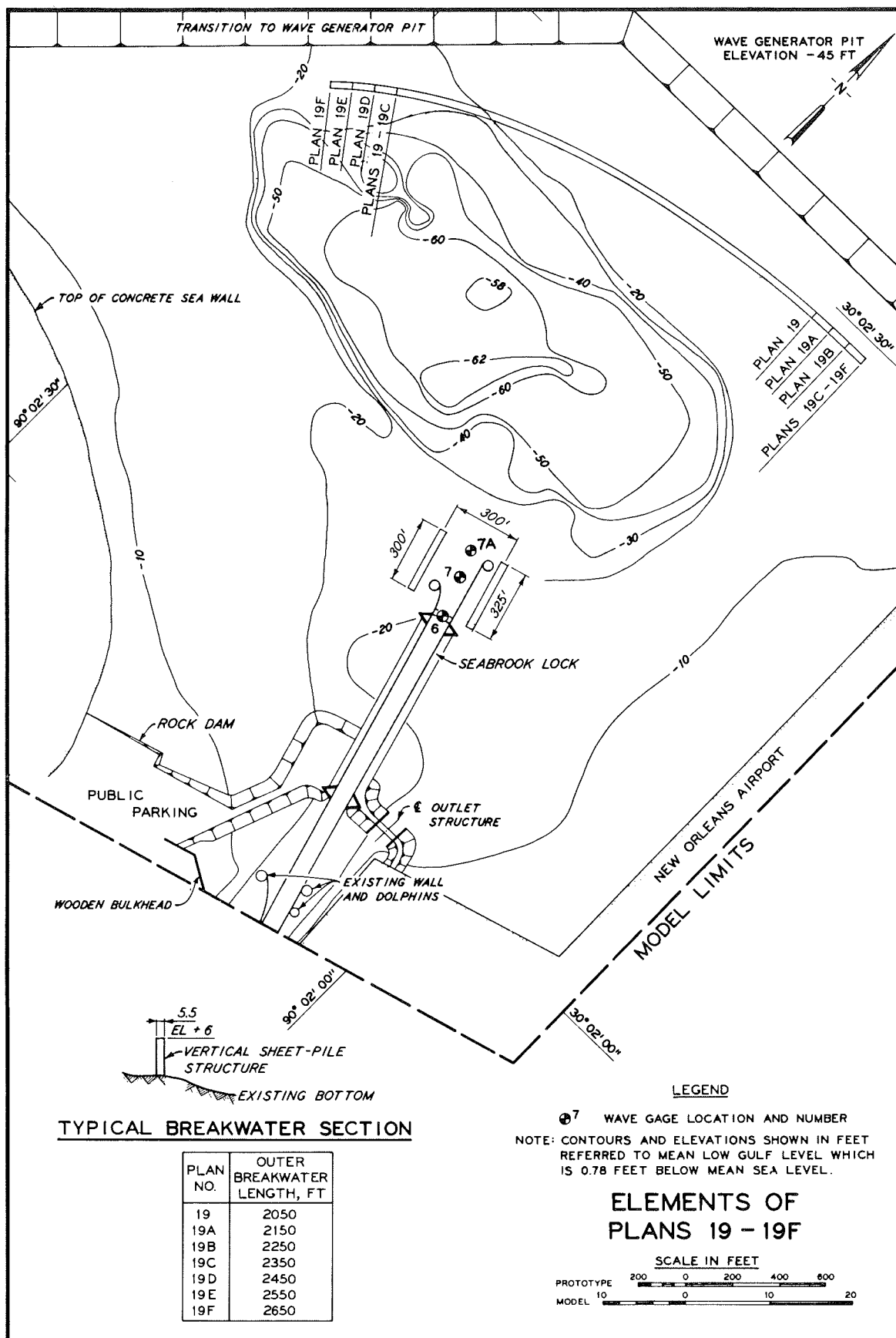


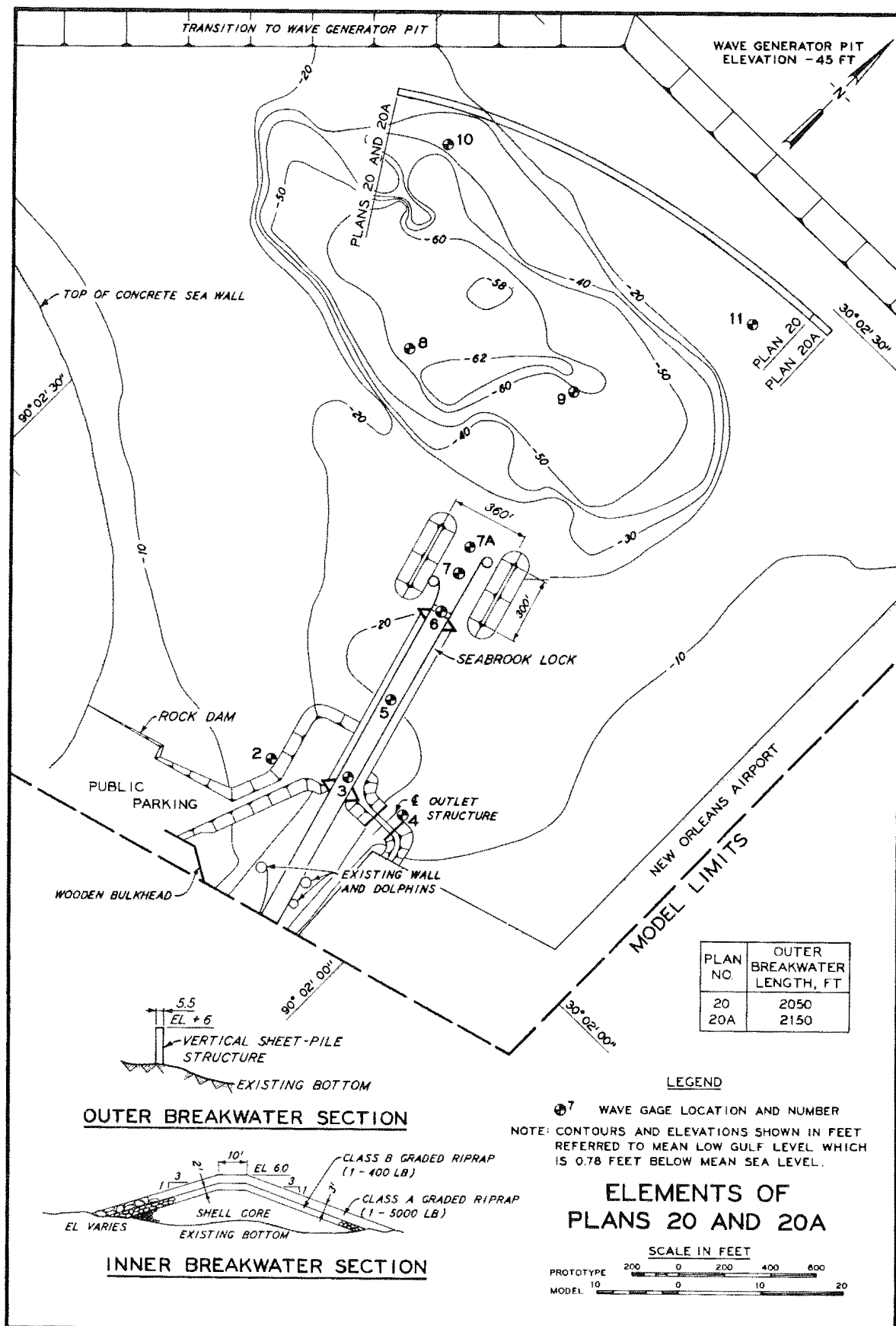


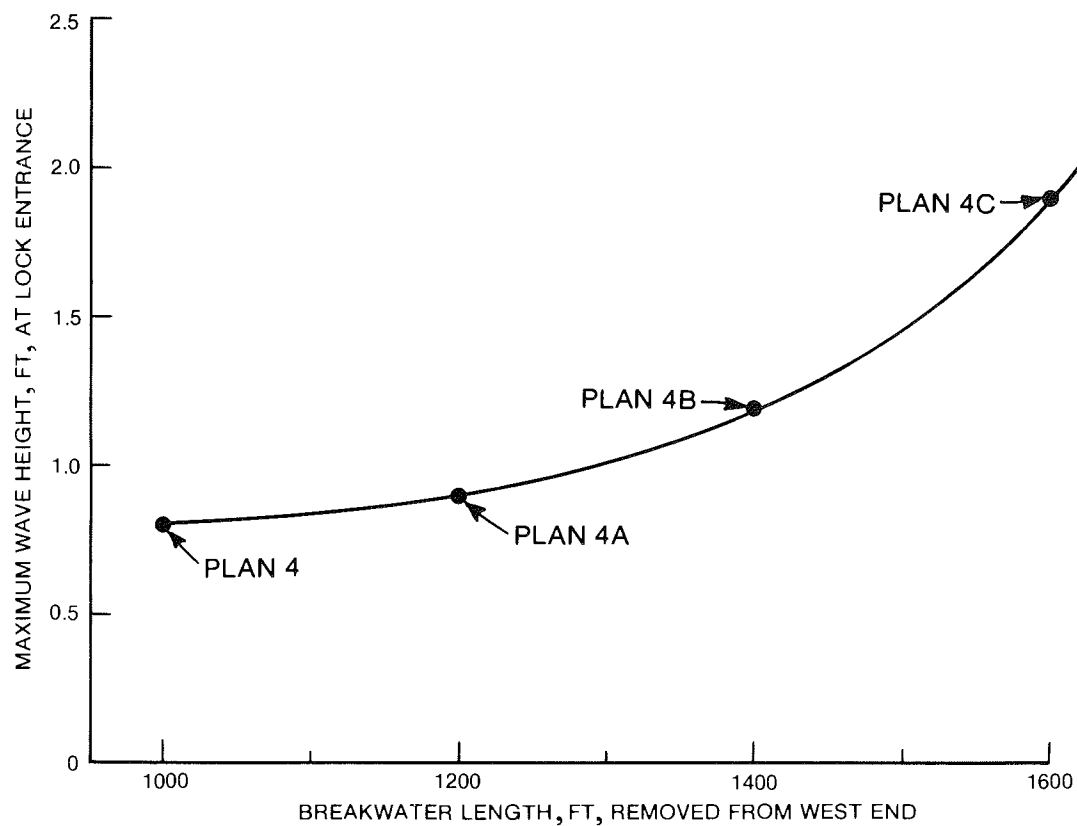






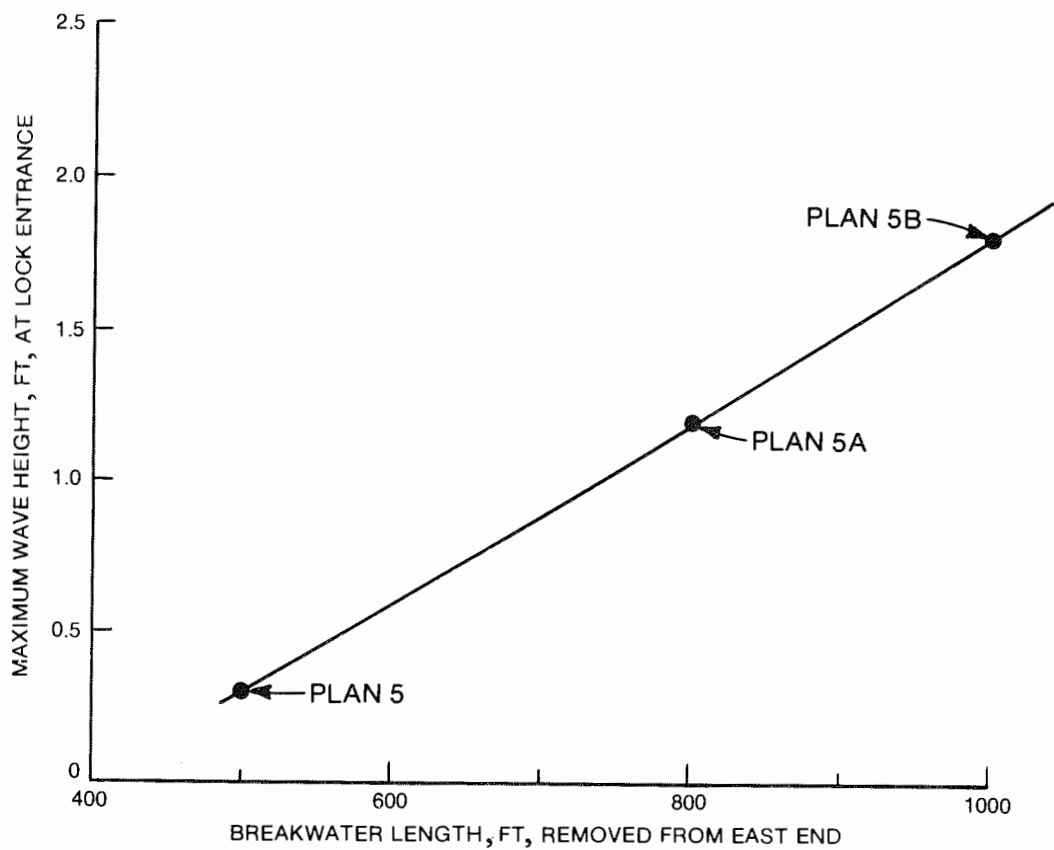






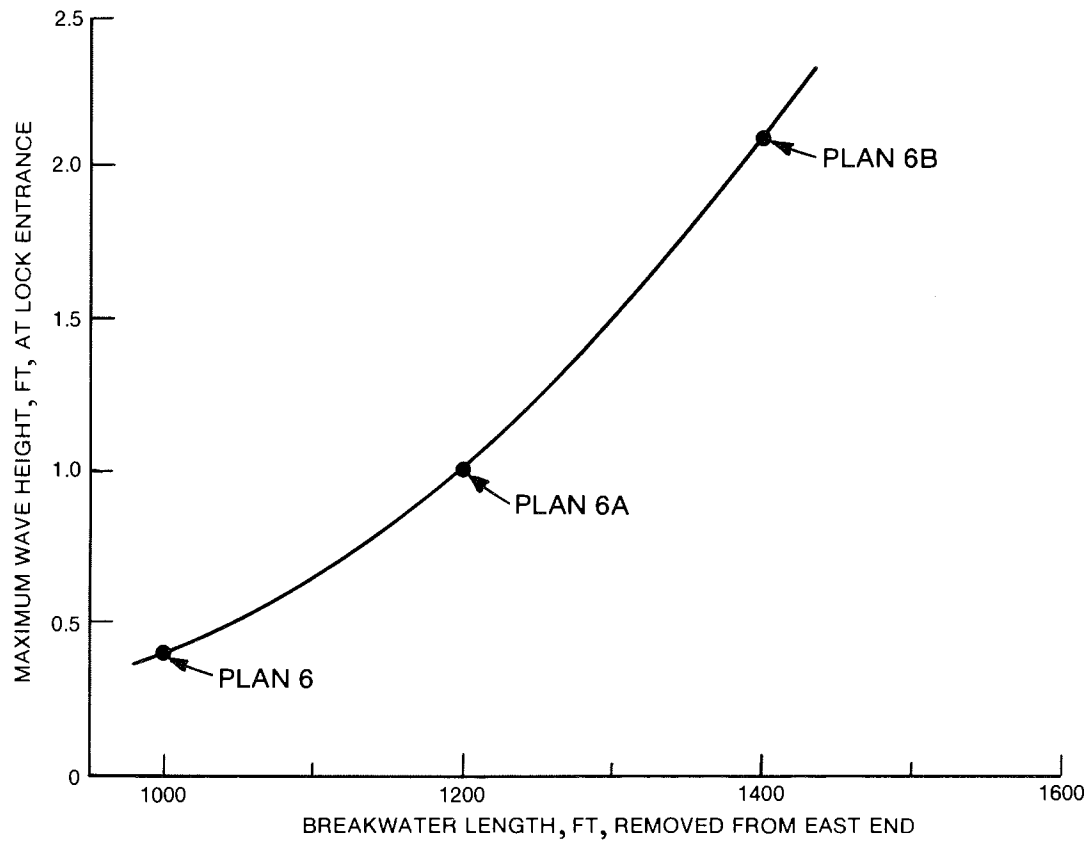
NOTE: DATA OBTAINED FOR 4-SEC, 4-FT WAVES
FROM NORTHWEST (SWL = +1 FT)
LAKEWARD LOCK GATES OPEN

MAXIMUM WAVE HEIGHTS AT
LOCK ENTRANCE FOR PLANS
4, 4A, 4B, AND 4C



NOTE: DATA OBTAINED FOR 4-SEC, 5-FT WAVES
FROM NORTH (SWL = +1 FT)
LAKEWARD LOCK GATES OPEN

MAXIMUM WAVE HEIGHTS AT
LOCK ENTRANCE FOR
PLANS 5-5B



NOTE: DATA OBTAINED FOR 4-SEC, 5-FT WAVES
FROM NORTH (SWL = +1 FT)
LAKEWARD LOCK GATES OPEN

MAXIMUM WAVE HEIGHTS AT
LOCK ENTRANCE FOR
PLANS 6-6B

APPENDIX A: WAVE HINDCAST FOR SEABROOK LOCK SITE

1. A wave hindcasting method from CERC (1977) and wind data acquired from January 1949 to December 1975 at the New Orleans International Airport were used to determine wave characteristics at the site of the proposed Seabrook Lock on Lake Pontchartrain.

2. New Orleans International Airport is located approximately 13.5 miles west of the proposed Seabrook Lock and approximately 3 miles south of the waterfront of Lake Pontchartrain. Wind velocities and directions were recorded every hour from January 1949 through December 1964 and from January 1968 through June 1969. Wind data were recorded every 3 hr from January 1965 through December 1967 and from July 1969 through December 1975. There was no distinction between a zero velocity (no wind) and an observation that was erroneous or not recorded due to equipment malfunctions. Thus all such observations are referred to as missed observations. The observations that were not recorded due to sampling every 3 hr, as opposed to every hour, also are referred to as missed observations.

3. In the case of the Seabrook Lock, hindcasts only for those wind directions that could generate waves affecting the lock area were considered. These directions were categorized into three general directions: NW (304° - 326°), NNW (326° - 349°), and N (349° - 11°). Since winds from the boundary directions [WNW (281° - 304°) and NNE (11° - 34°)] also transmit partial energy to waves from NW and N, respectively, these boundary directions (WNW and NNE) were considered as transmitting a partial wave height into the NW and N directions. This partial wave height is defined as:

$$\begin{aligned} \text{N wave height} &= \text{NNE wave height} \left(\frac{2}{\pi} \int_{-\pi/2}^{-\pi/8} \cos^2 \theta d\theta \right) \\ &= \text{NNE wave height} (0.262) \end{aligned}$$

Thus, wave heights considered coming from the NNE direction are included

as coming from the N direction but with approximately one-fourth the wave height as from the NNE. The same is true for waves from the WNW direction being considered in the NW grouping.

4. Since the wind observations were made at New Orleans International Airport, a distance of approximately 3 miles from Lake Pontchartrain, a land-wind transformation was necessary. The transformation described by Drs. Donald T. Resio and C. Linwood Vincent of WES (1977) was used for this application. Since land-sea temperature difference data that possibly could affect the land-wind transformations were not available, this difference was considered to be zero.

5. The following formula was used to transfer wind velocity data recorded at New Orleans International Airport to wind velocities over Lake Pontchartrain.

$$WW = LW \cdot Ri$$

where

WW = wind velocity over Lake Pontchartrain, knots

LW = wind velocity at New Orleans International Airport, knots

Ri = land-wind transformation coefficient derived from Figure 3 of "Estimation of Winds over the Great Lakes" (Resio and Vincent 1977).

Ri = 2.75 when $0 < LW < 4$
1.88 when $4 < LW < 7$
1.63 when $7 < LW < 10$
1.47 when $10 < LW < 13$
1.36 when $13 < LW < 16$
1.32 when $16 < LW < 19$
1.29 when $19 < LW < 22$
1.24 when $22 < LW < 25$
1.22 when $25 < LW < 28$
1.20 when $28 < LW < 31$
1.16 when $31 < LW < 34$
1.14 when $34 < LW < 37$
1.12 when $37 < LW < 40$
1.10 when $40 < LW < 43$
1.08 when $43 < LW < 46$
1.07 when $46 < LW < 49$
1.05 when $49 < LW < 52$
1.03 when $52 < LW < 55$
1.01 when $55 < LW < 58$
0.99 when $58 < LW$

6. Wave period and wave height then were computed from this adjusted wind velocity by the following formulas obtained from CERC (1977).

$$H_o = \frac{U^2}{32.2} \cdot 0.283 \tanh \left[0.578 \left(\frac{32.2 \text{ di}}{U^2} \right)^{0.75} \right] \\ \cdot \tanh \left\{ \frac{0.125 \left(\frac{32.2 \text{ Fi}}{U^2} \right)^{0.42}}{\tanh \left[0.578 \left(\frac{32.2 \text{ di}}{U^2} \right)^{0.75} \right]} \right\}$$

$$T_o = \frac{2\pi U}{32.2} \cdot 1.2 \cdot \tanh \left[0.52 \left(\frac{32.2 \text{ di}}{U^2} \right)^{0.375} \right] \\ \cdot \tanh \left\{ \frac{0.077 \left(\frac{32.2 \text{ Fi}}{U^2} \right)^{0.25}}{\tanh \left[0.52 \left(\frac{32.2 \text{ di}}{U^2} \right)^{0.375} \right]} \right\}$$

where

H_o = wave height, ft

U = wind velocity, ft/sec

T_o = wave period, sec

di = average depth, ft, along fetch (Plate A1)

d_{WNW} = 12.5

d_{NW} = 13.3

d_{NNW} = 12.9

d_N = 14.0

d_{NNE} = 13.4

Fi = fetch, ft (distance wind travels over water) (Plate A1)

$$\begin{aligned}
F_{WNW} &= 133,700 \\
F_{NW} &= 125,600 \\
F_{NNW} &= 136,700 \\
F_N &= 103,300 \\
F_{NNE} &= 84,400
\end{aligned}$$

As mentioned in paragraph 3, the wave heights as computed for the WNW and NNE were multiplied by 0.262 and considered to be from the NW and N directions, respectively.

7. Tables of number of wave observations for respective wave period groupings (Tables A1-A36) for the three directions previously mentioned were compiled for each month of the year. Also compiled were cumulative tables of (a) all months for each of the three directions (Tables A37-A39), (b) the three directions for each month (Tables A40-A51), and (c) all months and all three directions (Table A52).

8. In order to provide users of the data presented in Tables A1-A52 guidance on the magnitude of winds required to generate certain wave characteristics, tables were derived (A53-A57) of wind speeds (in knots) from the five selected directions.

TABLE A1

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JANUARY
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	422.	877.	0.	0.	0.	1300.
01-02	0.	151.	416.	0.	0.	0.	567.
02-03	0.	0.	681.	0.	0.	0.	681.
03-04	0.	0.	12.	7.	0.	0.	19.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	573.	1986.	7.	0.	0.	2567.

20088. POSSIBLE OBSERVATIONS

5416. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A2

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JANUARY
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	93.	0.	0.	0.	0.	93.
01-02	0.	104.	338.	0.	0.	0.	442.
02-03	0.	0.	525.	0.	0.	0.	525.
03-04	0.	0.	30.	2.	0.	0.	32.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	197.	893.	2.	0.	0.	1092.

20088. POSSIBLE OBSERVATIONS

5416. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A3

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JANUARY
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	4.	199.	302.	2.	0.	0.	507.
01-02	0.	69.	203.	0.	0.	0.	272.
02-03	0.	0.	267.	0.	0.	0.	267.
03-04	0.	0.	22.	1.	0.	0.	23.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	4.	268.	794.	3.	0.	0.	1069.

20088. POSSIBLE OBSERVATIONS

5416. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A4

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR FEBRUARY
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	321.	828.	0.	0.	0.	1150.
01-02	0.	147.	420.	0.	0.	0.	567.
02-03	0.	0.	565.	0.	0.	0.	565.
03-04	0.	0.	11.	1.	0.	0.	12.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	468.	1824.	1.	0.	0.	2294.

18288. POSSIBLE OBSERVATIONS

4781. MISSED OBSERVATIONS

4496. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A5

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR FEBRUARY
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	100.	0.	0.	0.	0.	100.
01-02	0.	95.	264.	0.	0.	0.	359.
02-03	0.	0.	470.	0.	0.	0.	470.
03-04	0.	0.	17.	0.	0.	0.	17.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	195.	751.	0.	0.	0.	946.

18288. POSSIBLE OBSERVATIONS

4781. MISSED OBSERVATIONS

4496. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A6

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR FEBRUARY
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	196.	360.	0.	0.	0.	557.
01-02	0.	64.	188.	0.	0.	0.	252.
02-03	0.	0.	269.	0.	0.	0.	269.
03-04	0.	0.	12.	0.	0.	0.	12.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	260.	829.	0.	0.	0.	1090.

18288. POSSIBLE OBSERVATIONS

4781. MISSED OBSERVATIONS

4496. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A7

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MARCH
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	311.	665.	0.	0.	0.	976.
01-02	0.	143.	361.	0.	0.	0.	504.
02-03	0.	0.	424.	0.	0.	0.	424.
03-04	0.	0.	28.	2.	0.	0.	30.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	454.	1478.	2.	0.	0.	1934.

20088. POSSIBLE OBSERVATIONS

5360. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A8

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MARCH
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	90.	0.	0.	0.	0.	93.
01-02	0.	86.	252.	0.	0.	0.	338.
02-03	0.	0.	440.	0.	0.	0.	440.
03-04	0.	0.	16.	1.	0.	0.	17.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	176.	708.	1.	0.	0.	888.

20088. POSSIBLE OBSERVATIONS

5360. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A9

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MARCH
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	223.	373.	0.	0.	0.	597.
01-02	0.	71.	179.	0.	0.	0.	250.
02-03	0.	0.	341.	0.	0.	0.	341.
03-04	0.	0.	15.	5.	0.	0.	20.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	294.	908.	5.	0.	0.	1208.

20088. POSSIBLE OBSERVATIONS

5360. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A10

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR APRIL
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	295.	531.	0.	0.	0.	826.
01-02	0.	119.	310.	0.	0.	0.	429.
02-03	0.	0.	306.	0.	0.	0.	306.
03-04	0.	0.	18.	0.	0.	0.	18.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	414.	1165.	0.	0.	0.	1579.

19440. POSSIBLE OBSERVATIONS

5348. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A11

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR APRIL
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	78.	0.	0.	0.	0.	78.
01-02	0.	67.	188.	0.	0.	0.	255.
02-03	0.	0.	279.	0.	0.	0.	279.
03-04	0.	0.	9.	0.	0.	0.	9.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	145.	476.	0.	0.	0.	621.

19440. POSSIBLE OBSERVATIONS

5348. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A12

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR APRIL
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	222.	269.	1.	0.	0.	493.
01-02	0.	63.	136.	0.	0.	0.	199.
02-03	0.	0.	159.	0.	0.	0.	159.
03-04	0.	0.	5.	1.	0.	0.	6.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	285.	569.	2.	0.	0.	857.

19440. POSSIBLE OBSERVATIONS

5348. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A13

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MAY
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	411.	471.	0.	0.	0.	885.
01-02	0.	194.	331.	0.	0.	0.	525.
02-03	0.	0.	189.	0.	0.	0.	189.
03-04	0.	0.	5.	1.	0.	0.	6.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	605.	996.	1.	0.	0.	1605.

20088. POSSIBLE OBSERVATIONS

5918. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A14

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MAY
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	117.	0.	0.	0.	0.	117.
01-02	0.	92.	232.	0.	0.	0.	324.
02-03	0.	0.	170.	0.	0.	0.	170.
03-04	0.	0.	5.	2.	0.	0.	7.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	209.	407.	2.	0.	0.	618.

20088. POSSIBLE OBSERVATIONS

5918. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A15

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MAY
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	336.	128.	0.	0.	0.	464.
01-02	0.	96.	137.	0.	0.	0.	233.
02-03	0.	0.	75.	0.	0.	0.	75.
03-04	0.	0.	0.	1.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	432.	340.	1.	0.	0.	773.

20088. POSSIBLE OBSERVATIONS

5918. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A16

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JUNE
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	440.	347.	0.	0.	0.	788.
01-02	0.	165.	320.	0.	0.	0.	485.
02-03	0.	0.	64.	0.	0.	0.	64.
03-04	0.	0.	0.	0.	0.	0.	0.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	605.	731.	0.	0.	0.	1337.

19440. POSSIBLE OBSERVATIONS

6093. MISSED OBSERVATIONS

4200. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A17

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JUNE
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	166.	0.	0.	0.	0.	166.
01-02	0.	119.	205.	0.	0.	0.	324.
02-03	0.	0.	54.	0.	0.	0.	54.
03-04	0.	0.	1.	0.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	285.	260.	0.	0.	0.	545.

19440. POSSIBLE OBSERVATIONS

6093. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A18

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JUNE
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	489.	171.	0.	0.	0.	661.
01-02	0.	94.	138.	0.	0.	0.	232.
02-03	0.	0.	59.	0.	0.	0.	59.
03-04	0.	0.	1.	0.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	583.	369.	0.	0.	0.	953.

19440. POSSIBLE OBSERVATIONS

6093. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A19

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JULY
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	442.	242.	0.	0.	0.	684.
01-02	0.	164.	239.	0.	0.	0.	403.
02-03	0.	0.	35.	0.	0.	0.	35.
03-04	0.	0.	0.	0.	0.	0.	0.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	606.	516.	0.	0.	0.	1122.

20088. POSSIBLE OBSERVATIONS

7094. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A20

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JULY
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	153.	0.	0.	0.	0.	154.
01-02	0.	148.	224.	0.	0.	0.	372.
02-03	0.	0.	60.	0.	0.	0.	60.
03-04	0.	0.	0.	1.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	301.	284.	1.	0.	0.	587.

20088. POSSIBLE OBSERVATIONS

7094. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A21

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JULY
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	671.	277.	0.	0.	0.	948.
01-02	0.	150.	169.	0.	0.	0.	319.
02-03	0.	0.	47.	0.	0.	0.	47.
03-04	0.	0.	1.	0.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	821.	494.	0.	0.	0.	1315.

20088. POSSIBLE OBSERVATIONS

7094. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A22

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR AUGUST
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	608.	424.	0.	0.	0.	1033.
01-02	0.	219.	328.	0.	0.	0.	547.
02-03	0.	0.	79.	0.	0.	0.	79.
03-04	0.	0.	4.	1.	0.	0.	5.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	827.	835.	1.	0.	0.	1664.

20088. POSSIBLE OBSERVATIONS

7355. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A23

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR AUGUST
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	195.	0.	0.	0.	0.	197.
01-02	0.	133.	259.	0.	0.	0.	392.
02-03	0.	0.	89.	0.	0.	0.	89.
03-04	0.	0.	1.	1.	0.	0.	2.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	328.	349.	1.	0.	0.	680.

20088. POSSIBLE OBSERVATIONS

7355. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A24

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR AUGUST
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	668.	196.	0.	0.	0.	864.
01-02	0.	122.	153.	0.	0.	0.	275.
02-03	0.	0.	59.	0.	0.	0.	59.
03-04	0.	0.	0.	0.	0.	0.	0.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	790.	408.	0.	0.	0.	1198.

20088. POSSIBLE OBSERVATIONS

7355. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A25

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR SEPTEMBER
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	598.	754.	0.	0.	0.	1354.
01-02	0.	172.	374.	0.	0.	0.	546.
02-03	0.	0.	217.	0.	0.	0.	217.
03-04	0.	0.	3.	3.	0.	0.	6.
04-05	0.	0.	0.	1.	0.	0.	1.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	770.	1348.	4.	0.	0.	2124.

19440. POSSIBLE OBSERVATIONS

7010. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A26

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR SEPTEMBER
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	153.	0.	0.	0.	0.	154.
01-02	0.	84.	182.	0.	0.	0.	266.
02-03	0.	0.	117.	0.	0.	0.	117.
03-04	0.	0.	2.	0.	0.	0.	2.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	237.	301.	0.	0.	0.	539.

19440. POSSIBLE OBSERVATIONS

7010. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A27

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR SEPTEMBER
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	331.	78.	0.	0.	0.	412.
01-02	0.	50.	92.	0.	0.	0.	142.
02-03	0.	0.	34.	0.	0.	0.	34.
03-04	0.	0.	0.	1.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	381.	204.	1.	0.	0.	589.

19440. POSSIBLE OBSERVATIONS

7010. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A28

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR OCTOBER
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	625.	932.	1.	0.	0.	1560.
01-02	0.	254.	492.	0.	0.	0.	746.
02-03	0.	0.	413.	0.	0.	0.	413.
03-04	0.	0.	17.	2.	0.	0.	19.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	879.	1854.	3.	0.	0.	2738.

20088. POSSIBLE OBSERVATIONS

7331. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A29

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR OCTOBER
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	196.	0.	0.	0.	0.	199.
01-02	0.	120.	263.	0.	0.	0.	383.
02-03	0.	0.	302.	0.	0.	0.	302.
03-04	0.	0.	1.	0.	0.	0.	1.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	316.	566.	0.	0.	0.	885.

20088. POSSIBLE OBSERVATIONS

7331. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A30

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR OCTOBER
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	5.	312.	181.	0.	0.	0.	498.
01-02	0.	88.	136.	0.	0.	0.	224.
02-03	0.	0.	126.	0.	0.	0.	126.
03-04	0.	0.	0.	0.	0.	0.	0.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	5.	400.	443.	0.	0.	0.	848.

20088. POSSIBLE OBSERVATIONS

7331. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A31

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR NOVEMBER
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	529.	873.	0.	0.	0.	1404.
01-02	0.	169.	423.	0.	0.	0.	592.
02-03	0.	0.	649.	0.	0.	0.	649.
03-04	0.	0.	35.	3.	0.	0.	38.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	698.	1980.	3.	0.	0.	2683.

19440. POSSIBLE OBSERVATIONS

6173. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A32

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR NOVEMBER
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	126.	0.	0.	0.	0.	127.
01-02	0.	112.	269.	0.	0.	0.	381.
02-03	0.	0.	447.	0.	0.	0.	447.
03-04	0.	0.	41.	6.	0.	0.	47.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	238.	757.	6.	0.	0.	1002.

19440. POSSIBLE OBSERVATIONS

6173. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A33

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR NOVEMBER
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	0.	294.	262.	1.	0.	0.	557.
01-02	0.	95.	175.	0.	0.	0.	270.
02-03	0.	0.	207.	0.	0.	0.	207.
03-04	0.	0.	33.	5.	0.	0.	38.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	389.	677.	6.	0.	0.	1072.

19440. POSSIBLE OBSERVATIONS

6173. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A34

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR DECEMBER
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	499.	882.	0.	0.	0.	1384.
01-02	0.	184.	437.	0.	0.	0.	621.
02-03	0.	0.	504.	0.	0.	0.	504.
03-04	0.	0.	22.	3.	0.	0.	25.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	683.	1845.	3.	0.	0.	2534.

20088. POSSIBLE OBSERVATIONS

6138. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A35

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR DECEMBER
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	107.	0.	0.	0.	0.	109.
01-02	0.	103.	323.	0.	0.	0.	426.
02-03	0.	0.	526.	0.	0.	0.	526.
03-04	0.	0.	22.	2.	0.	0.	24.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	210.	871.	2.	0.	0.	1085.

20088. POSSIBLE OBSERVATIONS

6138. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A36

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR DECEMBER
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	224.	299.	0.	0.	0.	525.
01-02	0.	78.	205.	0.	0.	0.	283.
02-03	0.	0.	293.	0.	0.	0.	293.
03-04	0.	0.	13.	2.	0.	0.	15.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	302.	810.	2.	0.	0.	1116.

20088. POSSIBLE OBSERVATIONS

6138. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A37

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR 27 YEARS
N DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	16.	5501.	7826.	1.	0.	0.	13344.
01-02	0.	2081.	4451.	0.	0.	0.	6532.
02-03	0.	0.	4126.	0.	0.	0.	4126.
03-04	0.	0.	155.	23.	0.	0.	178.
04-05	0.	0.	0.	1.	0.	0.	1.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	16.	7582.	16558.	25.	0.	0.	24181.

236664. POSSIBLE OBSERVATIONS

74017. MISSED OBSERVATIONS

46832. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A38

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR 27 YEARS
NNW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	13.	1574.	0.	0.	0.	0.	1587.
01-02	0.	1263.	2999.	0.	0.	0.	4262.
02-03	0.	0.	3479.	0.	0.	0.	3479.
03-04	0.	0.	145.	15.	0.	0.	160.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	13.	2837.	6623.	15.	0.	0.	9488.

236664. POSSIBLE OBSERVATIONS

74017. MISSED OBSERVATIONS

46832. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A39

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR 27 YEARS
NW DIRECTION

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	18.	4165.	2896.	4.	0.	0.	7083.
01-02	0.	1040.	1911.	0.	0.	0.	2951.
02-03	0.	0.	1936.	0.	0.	0.	1936.
03-04	0.	0.	102.	16.	0.	0.	118.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	18.	5205.	6845.	20.	0.	0.	12088.

236664. POSSIBLE OBSERVATIONS

74017. MISSED OBSERVATIONS

46832. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A40

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JANUARY
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	5.	714.	1179.	2.	0.	0.	1900.
01-02	0.	324.	957.	0.	0.	0.	1281.
02-03	0.	0.	1473.	0.	0.	0.	1473.
03-04	0.	0.	64.	10.	0.	0.	74.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	5.	1038.	3673.	12.	0.	0.	4728.

20088. POSSIBLE OBSERVATIONS

5416. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A41

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR FEBRUARY
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	617.	1188.	0.	0.	0.	1807.
01-02	0.	306.	872.	0.	0.	0.	1178.
02-03	0.	0.	1304.	0.	0.	0.	1304.
03-04	0.	0.	40.	1.	0.	0.	41.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	923.	3404.	1.	0.	0.	4330.

18288. POSSIBLE OBSERVATIONS

4781. MISSED OBSERVATIONS

4496. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A42

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MARCH
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	4.	624.	1038.	0.	0.	0.	1666.
01-02	0.	300.	792.	0.	0.	0.	1092.
02-03	0.	0.	1205.	0.	0.	0.	1205.
03-04	0.	0.	59.	8.	0.	0.	67.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	4.	924.	3094.	8.	0.	0.	4030.

20088. POSSIBLE OBSERVATIONS

5360. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A43

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR APRIL
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	595.	800.	1.	0.	0.	1397.
01-02	0.	249.	634.	0.	0.	0.	883.
02-03	0.	0.	744.	0.	0.	0.	744.
03-04	0.	0.	32.	1.	0.	0.	33.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	844.	2210.	2.	0.	0.	3057.

19440. POSSIBLE OBSERVATIONS

5348. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A44

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR MAY
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	864.	599.	0.	0.	0.	1466.
01-02	0.	382.	700.	0.	0.	0.	1082.
02-03	0.	0.	434.	0.	0.	0.	434.
03-04	0.	0.	10.	4.	0.	0.	14.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	1246.	1743.	4.	0.	0.	2996.

20088. POSSIBLE OBSERVATIONS

5918. MISSED OBSERVATIONS

4960. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A45

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JUNE
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	2.	1095.	518.	0.	0.	0.	1615.
01-02	0.	378.	663.	0.	0.	0.	1041.
02-03	0.	0.	177.	0.	0.	0.	177.
03-04	0.	0.	2.	0.	0.	0.	2.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	2.	1473.	1360.	0.	0.	0.	2835.

19440. POSSIBLE OBSERVATIONS

6093. MISSED OBSERVATIONS

4800. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A46

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR JULY
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	1.	1266.	519.	0.	0.	0.	1786.
01-02	0.	462.	632.	0.	0.	0.	1094.
02-03	0.	0.	142.	0.	0.	0.	142.
03-04	0.	0.	1.	1.	0.	0.	2.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	1.	1728.	1294.	1.	0.	0.	3024.

20088. POSSIBLE OBSERVATIONS

7094. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A47

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR AUGUST
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	1471.	620.	0.	0.	0.	2094.
01-02	0.	474.	740.	0.	0.	0.	1214.
02-03	0.	0.	227.	0.	0.	0.	227.
03-04	0.	0.	5.	2.	0.	0.	7.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	1945.	1592.	2.	0.	0.	3542.

20088. POSSIBLE OBSERVATIONS

7355. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A48

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR SEPTEMBER
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	6.	1082.	832.	0.	0.	0.	1920.
01-02	0.	306.	648.	0.	0.	0.	954.
02-03	0.	0.	368.	0.	0.	0.	368.
03-04	0.	0.	5.	4.	0.	0.	9.
04-05	0.	0.	0.	1.	0.	0.	1.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	6.	1388.	1853.	5.	0.	0.	3252.

19440. POSSIBLE OBSERVATIONS

7010. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A49

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR OCTOBER
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	10.	1133.	1113.	1.	0.	0.	2257.
01-02	0.	462.	891.	0.	0.	0.	1353.
02-03	0.	0.	841.	0.	0.	0.	841.
03-04	0.	0.	18.	2.	0.	0.	20.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	10.	1595.	2863.	3.	0.	0.	4471.

20088. POSSIBLE OBSERVATIONS

7331. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A50

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR NOVEMBER
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	3.	949.	1135.	1.	0.	0.	2088.
01-02	0.	376.	867.	0.	0.	0.	1243.
02-03	0.	0.	1303.	0.	0.	0.	1303.
03-04	0.	0.	109.	14.	0.	0.	123.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	3.	1325.	3414.	15.	0.	0.	4757.

19440. POSSIBLE OBSERVATIONS

6173. MISSED OBSERVATIONS

4320. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A51

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR DECEMBER
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	7.	830.	1181.	0.	0.	0.	2018.
01-02	0.	365.	965.	0.	0.	0.	1330.
02-03	0.	0.	1323.	0.	0.	0.	1323.
03-04	0.	0.	57.	7.	0.	0.	64.
04-05	0.	0.	0.	0.	0.	0.	0.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	7.	1195.	3526.	7.	0.	0.	4735.

20088. POSSIBLE OBSERVATIONS

6138. MISSED OBSERVATIONS

4464. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A52

FREQUENCIES OF WAVE HEIGHT AND PERIOD
FOR 27 YEARS
CUMULATIVE

WAVE HEIGHT (FT)	WAVE PERIOD (SEC)						TOTAL
	<1	1-2	2-3	3-4	4-5	>5	
00-01	47.	11240.	10722.	5.	0.	0.	22014.
01-02	0.	4384.	9361.	0.	0.	0.	13745.
02-03	0.	0.	9541.	0.	0.	0.	9541.
03-04	0.	0.	402.	54.	0.	0.	456.
04-05	0.	0.	0.	1.	0.	0.	1.
05-06	0.	0.	0.	0.	0.	0.	0.
TOTAL	47.	15624.	30026.	60.	0.	0.	45757.

236664. POSSIBLE OBSERVATIONS

74017. MISSED OBSERVATIONS

46832. MISSED OBSERVATIONS DUE TO CHANGE IN SAMPLING INTERVAL

TABLE A53

WIND VELOCITY REQUIRED TO GENERATE VARIOUS
WAVE CHARACTERISTICS FROM
DIRECTION 1 (NNE)*

WAVE HEIGHT FT	WIND VELOCITY (KNOTS) FOR WAVE PERIODS (SEC) OF			
	<1	1-2	2-3	3-4
0-1	0.00-2.75**	5.50-11.28	11.41-33.60	34.80-41.04
	(0-1)†	(2-6)	(7-28)	(29-36)
1-2				42.18-86.13
				(37-87)
3-4				

NOTE: NO OBSERVATION OF LAND WIND SPEED (LW) OVER 36 KNOTS.
 ONE OBSERVATION OF LAND WIND SPEED (LW) OVER 28 KNOTS.

* INCLUDED AS COMING FROM N.

** TRANSFORMED WIND VELOCITY OVER LAKE PONTCHARTRAIN (WW).

† WIND VELOCITY AS RECORDED AT NEW ORLEANS INTERNATIONAL
 AIRPORT (LW).

TABLE A54

WIND VELOCITY REQUIRED TO GENERATE VARIOUS
WAVE CHARACTERISTICS FROM
DIRECTION 2 (N)

WAVE HEIGHT FT	WIND VELOCITY (KNOTS) FOR WAVE PERIODS (SEC) OF			
	<1	1-2	2-3	3-4
0-1	0.00-2.75*	5.50-7.52		
	(0-1)**	(2-4)		
1-2		9.40-11.28	11.41-14.70	
		(5-6)	(7-10)	
2-3			16.17-27.09	
			(11-21)	
3-4			27.28-30.50	31.72-41.04
			(22-25)	(26-36)
4-5				42.18-60.39
				(37-61)

NOTE: ONE OBSERVATION OF LAND WIND SPEED (LW) OVER 36 KNOTS.
 23 OBSERVATIONS OF LAND WIND SPEED (LW) OVER 25 KNOTS.

* TRANSFORMED WIND VELOCITY OVER LAKE PONTCHARTRAIN (WW).

** WIND VELOCITY AS RECORDED AT NEW ORLEANS INTERNATIONAL
 AIRPORT (LW).

TABLE A55

WIND VELOCITY REQUIRED TO GENERATE VARIOUS
WAVE CHARACTERISTICS FROM
DIRECTION 3 (NNW)

WAVE HEIGHT FT	WIND VELOCITY (KNOTS) FOR WAVE PERIODS (SEC) OF			
	<1	1-2	2-3	3-4
0-1	0.00-2.75*	5.50-7.52		
	(0-1)**	(2-4)		
1-2		9.40-11.28	11.41-16.17	
		(5-6)	(7-11)	
2-3			17.64-27.28	
			(12-22)	
3-4			28.52-32.94	33.60-44.00
			(23-27)	(28-40)
4-5				45.10-67.32
				(41-68)

NOTE: NO OBSERVATIONS OF LAND WIND SPEED (LW) OVER 40 KNOTS.

15 OBSERVATIONS OF LAND WIND SPEED (LW) OVER 27 KNOTS.

* TRANSFORMED WIND VELOCITY OVER LAKE PONTCHARTRAIN (WW).

** WIND VELOCITY AS RECORDED AT NEW ORLEANS INTERNATIONAL AIRPORT (LW).

TABLE A56

WIND VELOCITY REQUIRED TO GENERATE VARIOUS
WAVE CHARACTERISTICS FROM
DIRECTION 4 (NW)

WAVE HEIGHT FT	WIND VELOCITY (KNOTS) FOR WAVE PERIODS (SEC) OF			
	<1	1-2	2-3	3-4
0-1	0.00-2.75*	5.50-7.52		
	(0-1)**	(2-4)		
1-2		9.40-11.28	11.41-14.70	
		(5-6)	(7-10)	
2-3			16.17-27.09	
			(11-21)	
3-4			27.28-31.72	32.94-43.68
			(22-26)	(27-39)
4-5				44.00-64.35
				(40-65)

NOTE: NO OBSERVATIONS OF LAND WIND SPEED (LW) OVER 39 KNOTS.
 16 OBSERVATIONS OF LAND WIND SPEED (LW) OVER 26 KNOTS.

* TRANSFORMED WIND VELOCITY OVER LAKE PONTCHARTRAIN (WW).

** WIND VELOCITY AS RECORDED AT NEW ORLEANS INTERNATIONAL
 AIRPORT (LW).

TABLE A57

WIND VELOCITY REQUIRED TO GENERATE VARIOUS
WAVE CHARACTERISTICS FROM
DIRECTION 5 (WNW)**

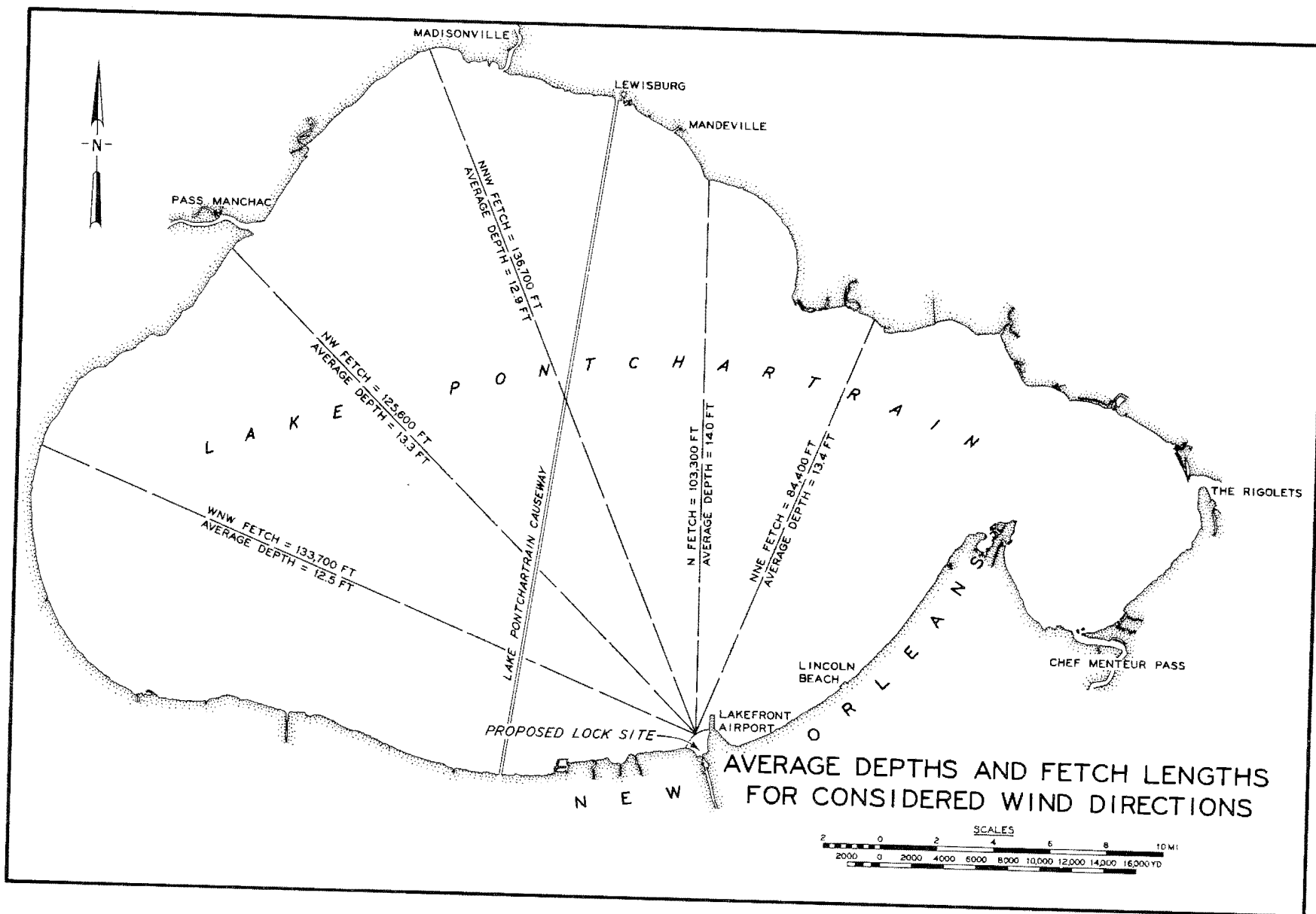
WAVE HEIGHT FT	WIND VELOCITY (KNOTS) FOR WAVE PERIODS (SEC) OF			
	<1	1-2	2-3	3-4
0-1	0.00-2.75**	5.50-11.28	11.41-33.60	34.80-42.56
	(0-1)†	(2-6)	(7-28)	(29-38)
1-2				43.68-91.08
				(39-92)
3-4				

NOTE: NO OBSERVATIONS OF LAND WIND SPEED (LW) OVER 38 KNOTS.
 4 OBSERVATIONS OF LAND WIND SPEED (LW) OVER 28 KNOTS.

* INCLUDED AS COMING FROM NW.

** TRANSFORMED WIND VELOCITY OVER LAKE PONTCHARTRAIN (WW).

† WIND VELOCITY AS RECORDED AT NEW ORLEANS INTERNATIONAL AIRPORT (LW).



APPENDIX B: NOTATION

A	Area
b	Shallow-water orthogonal spacing
b_o	Deepwater orthogonal spacing
$(b_o/b)^{1/2}$	Refraction coefficient, K_r
d_i	Average depth along fetch
F_i	Length of fetch
H	Shallow-water wave height
H_o	Deepwater wave height
$H_{1/3}$	Significant wave height
K_r	Refraction coefficient
K_s	Shoaling coefficient
L	Length
LW	Wind velocity at New Orleans International Airport
R_i	Land-wind transform coefficient
T_o	Wave period
U	Wind velocity
T	Time
V	Velocity
Ψ	Volume
WW	Wind velocity over Lake Pontchartrain
θ	Direction of wind heading

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Bottin, Robert R

Seabrook Lock Complex, Lake Pontchartrain, La., design for wave protection at lock entrance; hydraulic model investigation / by Robert R. Bottin, Jr., Kent A. Turner. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1980.

37, [181] p., [15] leaves of plates : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; HL-80-7)

Prepared for U. S. Army Engineer District, New Orleans, New Orleans, Louisiana.

References: p. 37.

1. Breakwaters. 2. Hydraulic models. 3. Locks (Waterways). 4. Seabrook Lock Complex. 5. Water wave action on maritime structures. I. Turner, Kent A., joint author. II. United States. Army. Corps of Engineers. New Orleans District. III. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; HL-80-7.

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