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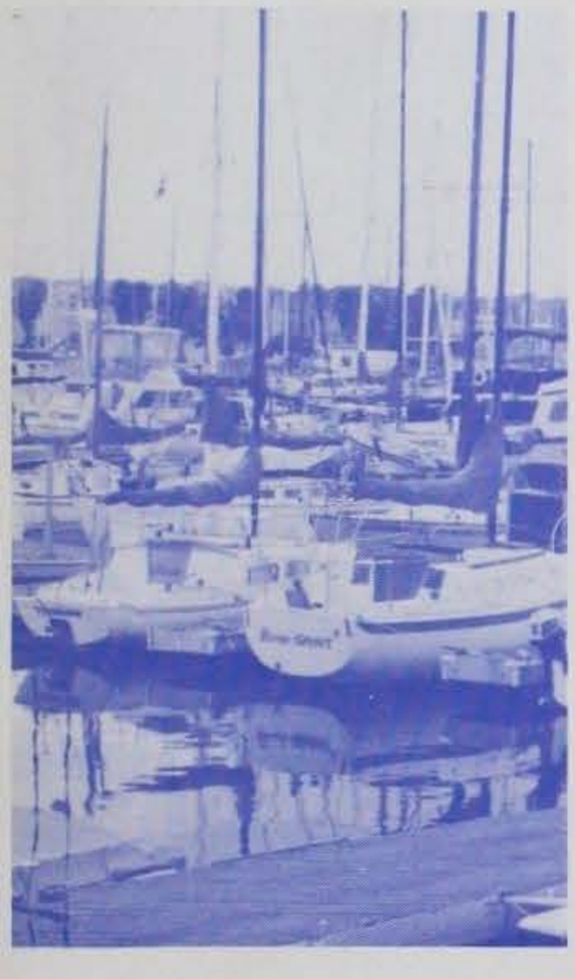

WATER WAVE EFFECTS AT REDONDO BEACH KING HARBOR, CALIFORNIA

by

Lyndell Z. Hales

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Three separate and distinct (although interrelated) problems exist at Redondo Beach King Harbor, California, at the present time: recurring, but infrequent, structural damage to the breakwater; excessive wave activity in the harbor caused by waves penetrating through and overtopping the permeable rubble-mound breakwater; and shoaling of the harbor navigation channel and boat mooring area. The US Army Engineer Waterways Experiment Station was requested to: (a) perform a water wave refraction/diffraction/shoaling analysis of the 1983 winter storms to determine the wave characteristics and frequencies-of-occurrence at the breakwater structure site for the extreme storm events of historical record and for the higher sea waves which overtop the lower portion of the breakwater on an average annual basis; (b) determine the magnitude of wave penetration through the permeable rubble-mound structure, overtopping of the structure, and total wave transmission into the harbor; (c) evaluate the effect of raising the crest elevation of

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the structure on wave transmission into the harbor; (d) estimate the structure armor stone required for stability based on the return period of storm waves of various heights; and (e) propose alternative structural measures for reducing excess waves in Basin 3 and reducing harbor shoaling by sediment penetration through the breakwater.

The following conclusions were reached: (a) excessive wave damage occurs in the harbor by storm waves overtopping the +11.5-ft Mean Lower Low Water (MLLW) section of the breakwater; (b) storms of the winter of 1982-1983 occurred at extreme high tide elevation (+8.0 ft MLLW), with unusually long periods (conditions for which the structure was not designed to withstand); (c) higher waves of the spectrum overtopped the +20-ft MLLW section of the breakwater at extreme tide level; (d) wave energy also penetrates through all sections of the permeable breakwater; (e) wave energy propagating through the unrestricted entrance channel to the harbor contributes to the damages of Moles C and D and to the damages in Basin 3; (f) structural damage recurs to the breakwater because the structure is underdesigned with respect to the storm wave energy that it is required to withstand; (g) the 1964 design wave was based on only 3 years of hindcast wave data, producing a 1964 design wave height of 17 ft; (h) hindcast storm wave data since 1900 indicate the design wave height for a 50-year recurrence interval should be around 20 ft; (i) stability testing of the 17-ft design wave indicated the stone size for stability should be approximately 15 tons, although the structure was actually constructed with 13-ton stone; and (j) harbor shoaling occurs because of littoral material from upcoast penetrating through the permeable breakwater.

To alleviate the extensive damages which periodically occur at Redondo Beach King Harbor, California, the following recommendations are made which will reduce excessive wave activity and shoaling in the harbor; (a) raise the crest elevation of the existing +11.5-ft MLLW section of the breakwater to +22.0 ft MLLW and effectively seal this portion of the structure during rehabilitation work; (b) seal the remainder of the permeable breakwater with chemical grouting materials; (c) extend the south breakwater at least 500 ft into the harbor; (d) install baffles (prestressed concrete sheet-pile groins) at the entrance to Basin 3; and (e) provide additional revetment material to the slopes of Moles B, C, D, and E. Because of potential effects on tidal circulation in the harbor by proposed structural modifications, extensive physical and/or numerical simulation modeling will be necessary prior to major harbor improvements.

PREFACE

The study reported herein was requested by US Army Engineer District, Los Angeles (SPL). This investigation was conducted by personnel of the US Army Engineer Waterways Experiment Station (WES) Coastal Engineering Research Center (CERC) during the period January 1985 through January 1986. Messrs. Angel P. Fuertes, Project Manager, and Alan E. Alcorn, former Project Manager, were the SPL Technical Monitors during this study and during the preparation and publication of this report.

This study by Dr. Lyndell Z. Hales, Research Hydraulic Engineer, Coastal Processes Branch, CERC, involved the application of a refraction/diffraction/shoaling numerical simulation model titled Regional Coastal Processes Wave Transformation Model (RCPWAVE) for water wave nearshore transformation which was conceived and developed by Mr. Bruce A. Ebersole, Research Hydraulic Engineer, Coastal Processes Branch, CERC. The consultation and assistance of Mr. Ebersole in adapting RCPWAVE to the specific requirements of the Redondo Beach King Harbor, California, submarine canyon region are acknowledged with appreciation. Dr. Hales prepared this report under the direct supervision of Mr. H. Lee Butler and Dr. Edward F. Thompson, Chief and Acting Chief, Research Division, CERC, respectively; and under the general supervision of Dr. James R. Houston and Mr. Charles C. Calhoun, Jr., Chief and Assistant Chief, CERC, respectively.

Commander and Director of WES during the publication of this report was COL Dwayne C. Lee, CE. Technical Director was Dr. Robert W. Whalin.

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CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
feet per second	0.3048	metres per second
feet-feet per second	0.0929	metres-metres per second
feet per second per second	0.3048	metres per second per second
inches	25.4	millimetres
miles (US statute)	1.609344	kilometres
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
tons (2,000 lb, mass)	907.1847	kilograms

WATER WAVE EFFECTS AT REDONDO BEACH KING HARBOR, CALIFORNIA

PART I: INTRODUCTION

Location and Background

1. Redondo Beach King Harbor (formerly Redondo Beach Harbor), California, is a small craft harbor located on the Pacific coast of the United States at the southern end of Santa Monica Bay (Figure 1). It lies within the City of Redondo Beach, about 17 miles* southwest of the business center of the City of Los Angeles. The harbor is entirely man-made, and serves as a port of call for visiting craft from the entire Pacific coast. Commercial, recreational, and sportfishing boats, and boats for rent, serve local residents and tourists from all over the nation. The harbor is situated near excellent fishing banks favorable to both sport and commercial fishing. When properly protected, the harbor will provide a safe haven for small craft from the most extreme weather conditions. The layout of the breakwaters and the location of the boat mooring areas are shown in Figure 2, with the general harbor plan and breakwater stationing presented in Figure 3.

2. Since initial construction of the Redondo Beach King Harbor breakwater in 1937, and following subsequent modifications and improvements in 1958, 1960, 1964, and 1977, the breakwater has been subjected to periodic damage by severe storm systems which rise in the North Pacific Ocean and propagate in an easterly direction toward the coast of California. The breakwater provided protection for the harbor from the storm which occurred in 1959. That storm did minor damage to the breakwater (which was repaired in 1960), but no damage was reported within the interior harbor as no facilities had been developed at that time. Storms occurring in December 1962 and February 1963 fully demonstrated the inadequacy of the breakwater for protecting those recently developed small craft facilities within the harbor. These storms, while doing only minor damage to the breakwater, caused about $431,000 damage

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* A table of factors for converting US customary units of measurement to metric (SI) units is presented on page 4.

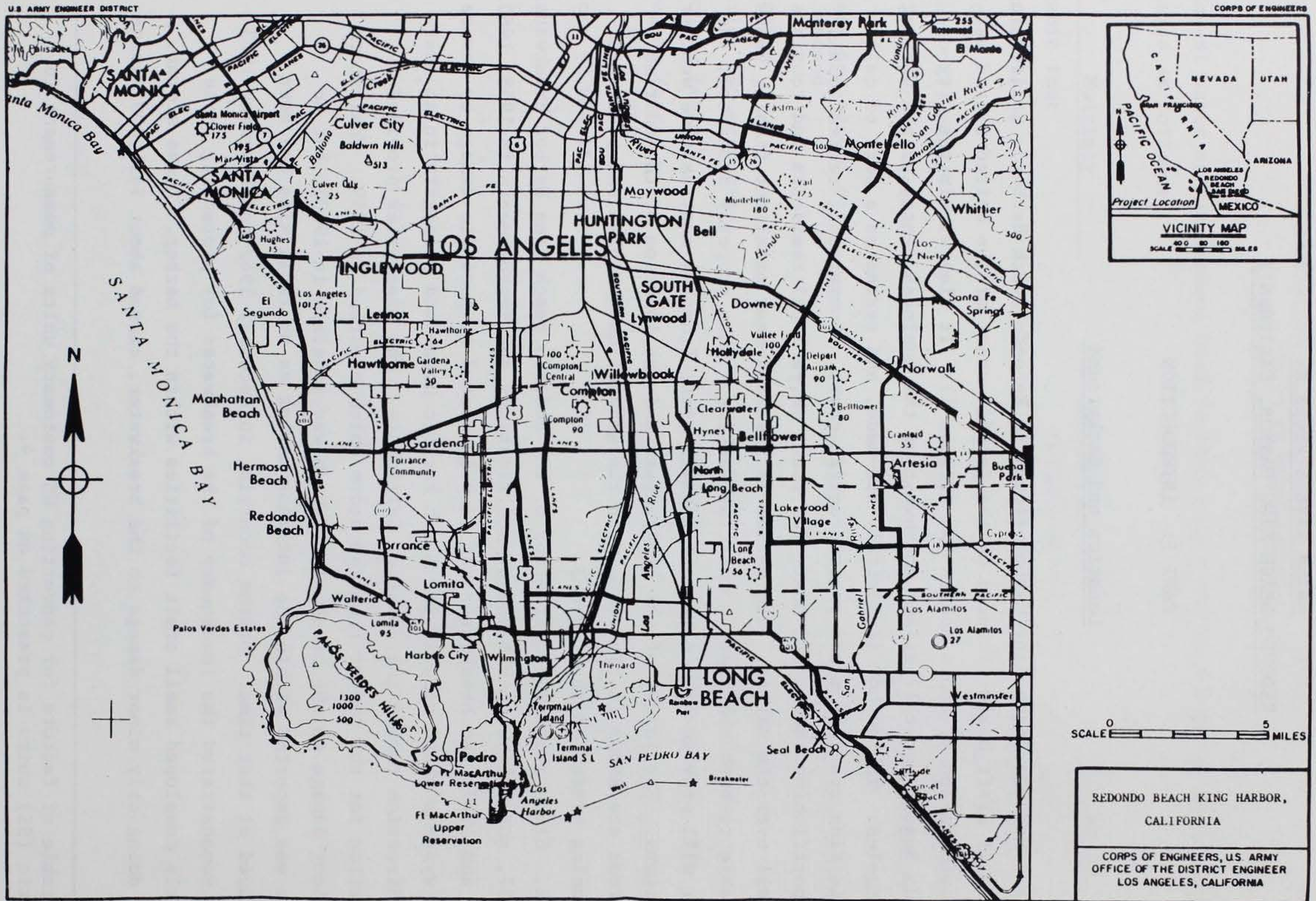


Figure 1. Location map, Redondo Beach King Harbor, California

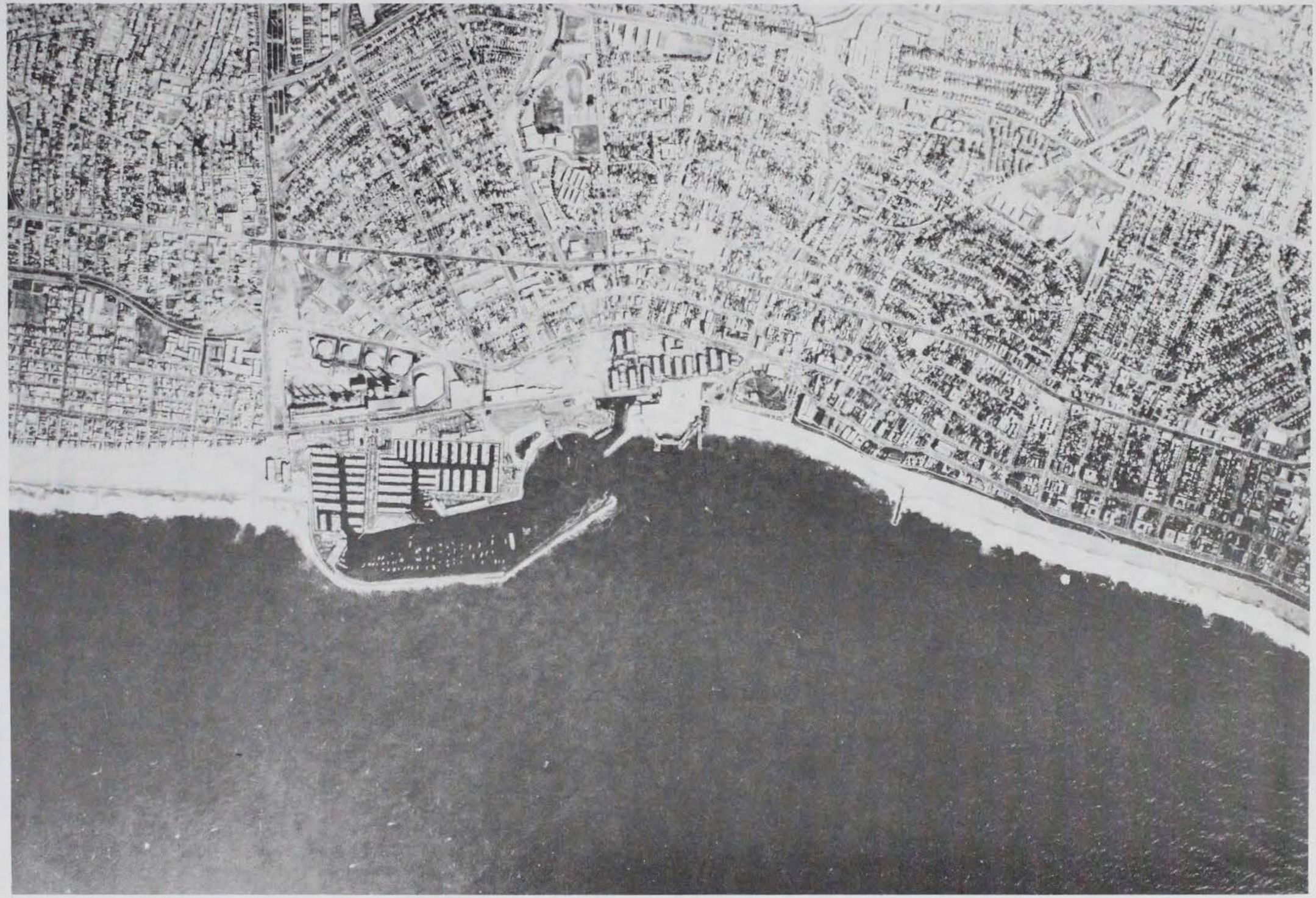


Figure 2. Redondo Beach King Harbor, California, breakwater layout and boat mooring areas

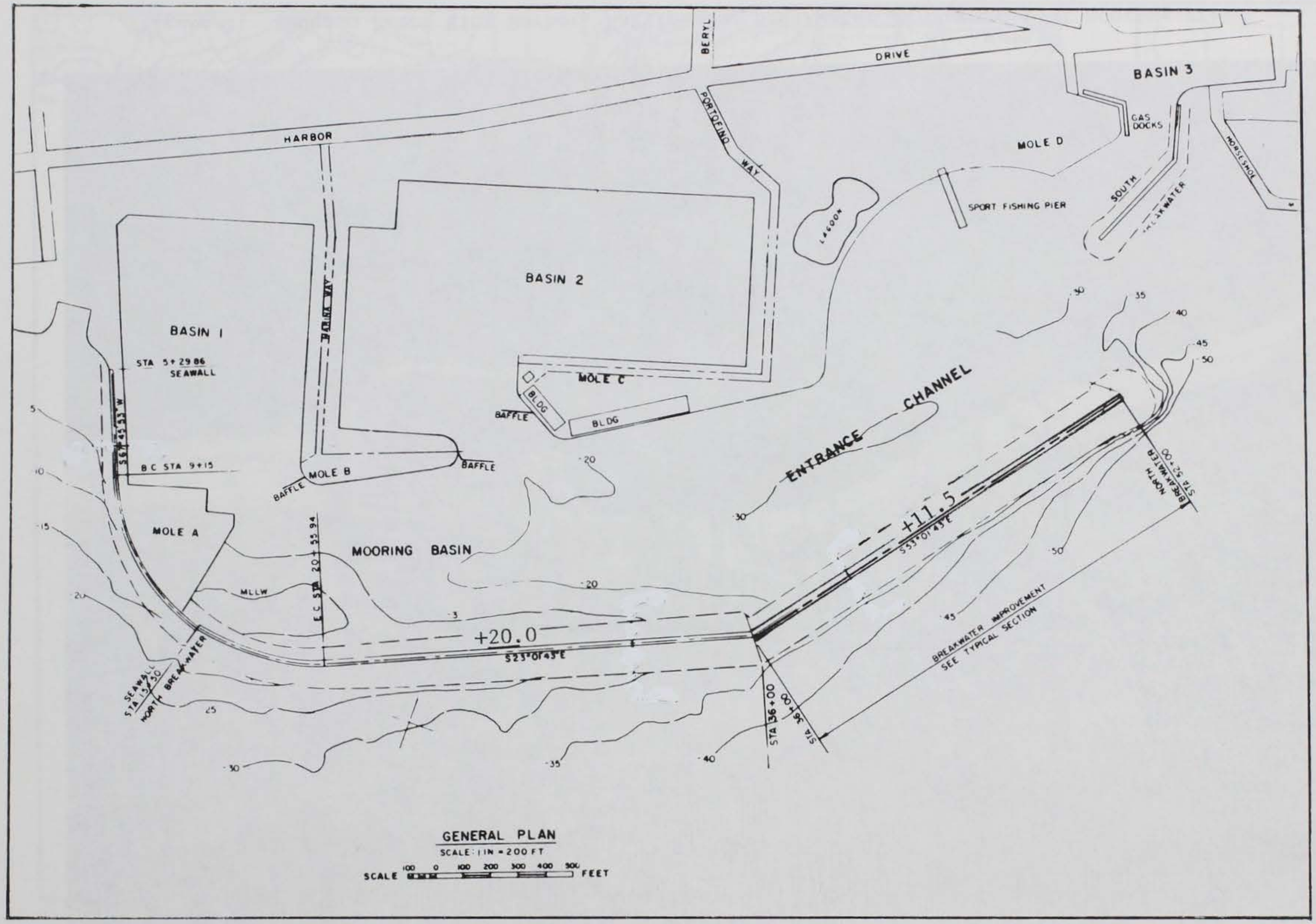


Figure 3. General harbor plan and breakwater stationing, Redondo Beach King Harbor, California

to small boats and mooring facilities within the harbor. During storms of 1978 and 1980, the north breakwater sustained damage at nine sections with major voids occurring at Stations 16+00 and 22+00. The repair work was initiated in February 1982 and was completed in March 1982 at a cost of $304,000. The disastrous storms of January-March 1983 caused significant damage at several locations along the north breakwater. The most significant was a breach 70 ft long, between Stations 19+70 and 20+40, at the outer reach of the breakwater curved section. The repair work required approximately 5,300 tons of new capstone and 1,700 tons of corestone. In addition, there was sloughing in about seven separate locations that required 4,000 tons of capstone replacement. This work was completed in October 1983, at a cost of approximately $400,000.

3. Redondo Beach King Harbor experienced intense winter storms in 1962, 1963, 1966, 1978, 1980, and 1983 (US Army Engineer District, Los Angeles, 1984). The storm in February 1963 originated 300 mi west-northwest of Redondo Beach with significant deep water wave heights up to 18 ft with periods of 14 sec. The storms of February 1980 produced deep water wave heights of 18 ft with periods up to 18 sec. During January-March 1983, eight discrete storm systems were identified which passed through the Southern California area. Maximum significant deep water wave heights ranged from 14 to 23 ft, with peak periods from 17 to 22 sec. The storms during this period were especially destructive because: (a) storms coincided with large astronomical tides; (b) El Nino climatic anomaly resulted in a rise of sea level of 8 in; (c) strong winds probably elevated the water surface by around 1 ft; and (d) barometric pressure drop during the passage of the storm fronts elevated the sea level by 0.2 to 0.3 ft.

4. Estimated storm damage to private and public property in Redondo Beach King Harbor amounted to $431,000 in 1963; $47,000 in 1978; $4,000,000 in 1980; and $2,700,000 in 1983. Damage occurred in the three basins and the four moles with the significant damage occurring in Moles C and D, and in Basin 3, primarily due to lack of protection by the +11.5 ft Mean Low Low Water (MLLW) breakwater and without the benefit of concrete baffles at the basin entrance. Typical storm damage in the harbor included: (a) cleats pulled out of the docks; (b) boats damaged in their slips; (c) moorings dragged; (d) wear and tear on mooring lines; (e) City-owned water front property flooded; (f) destruction of property due to wave forces; and

(g) small boats capsized.

Statements of the Problems

5. Three separate and distinct (although inter-related) problems exist at Redondo Beach King Harbor at the present time: (a) recurring, but infrequent, structural damage to the breakwater; (b) excessive wave activity in the harbor caused by waves penetrating through and overtopping the permeable rubble mound breakwater; and (c) shoaling of the harbor navigation channel and boat mooring areas.

Structural Damage to the Breakwater

6. Development of the harbor was started in 1939 when a 1,470-ft stone breakwater was constructed with Public Works Administration funds. Following storm damages in 1953, the breakwater was extended in length to its present extent which terminates at Station 52+00, with a crest elevation of +14.0 ft MLLW. Following storm damages in December 1962 and February 1963, the structure crest elevation was increased to +22.0 ft MLLW between Stations 15+50 and 36+00. The City of Redondo Beach constructed an 8-ft-high Galveston-type seawall between Stations 5+30 and 15+50, bringing this top elevation to +22.0 ft MLLW, also.

7. The structural design of the rubble mound breakwater was based upon the most recent guidance provided by US Army Engineer Beach Erosion Board (1961). Statistical hindcast wave studies were prepared for US Army Engineer District, Los Angeles, by National Marine Consultants (1960), and Marine Advisers (1961). The hindcast data presented for Stations 6 and 7 by National Marine Consultants, and for Station A by Marine Advisers, were considered to be the best available basic data for determining design wave characteristics at the breakwater site.

8. After adjusting for refraction and shoaling coefficients to obtain wave characteristics at the breakwater improvement project, a 17-ft, 13-sec wave was selected as the design wave. More extensive wave hindcast efforts in recent years indicate this significant wave height is exceeded a large percentage of the time. Less frequent waves of the spectrum may indeed reach heights which are at least twice as large as this wave which was utilized as the design wave for the structure. Hence, it appears the size of the rubble mound armor stone may be underdesigned from the standpoint of

stability, based on recurring damage to the structure, and on better knowledge regarding existing wave climate at the structure site.

Excessive Wave Activity in the Harbor

9. The most recent topographic survey of the breakwater (August 1985) indicates the crest elevation of the northern-most portion (Stations 15+50 to 36+00) to be +20.0 ft MLLW. This portion was constructed in 1964 to a crest elevation of +22.0 ft MLLW. The southern portion of this breakwater (Stations 36+00 to 52+00) now has a crest elevation of +11.5 ft MLLW, although it was constructed in 1964 to a crest elevation of +14.0 ft MLLW.

10. Storm waves frequently overtop the +11.5 ft MLLW breakwater section and create undesirable wave action in Redondo Beach King Harbor when occurring at high tide. Loss of life and serious injuries to fishermen on the breakwater have been directly attributed to these excessive waves. Energy from these waves passes through the mooring area and enters the boat basins, causing damage to boat hulls, mooring lines, and docking and launching facilities. Waterfront property is subjected to damaging wave forces and flooding. Overtopping waves and wave energy penetration through the breakwater make Redondo Beach King Harbor an unsafe port of refuge during times of high tide and large storm waves.

11. The +11.5 ft MLLW breakwater section is not adequate to dissipate or reflect wave energy from large storm waves during high tide. The areas behind the +11.5 ft MLLW section (the mooring basin, Moles C and D, and Basins 2 and 3) are vulnerable to damage caused by the energy of waves which is transmitted past the breakwater. Although waves overtop the +20.0 ft MLLW section to some extent during extremely high tide and large storm waves, damage behind this portion is significantly less than storm damage behind the +11.5 ft MLLW breakwater section.

Harbor Shoaling

12. The longshore drift of littoral material in the surf zone along this region of coastline is predominately in a southeasterly direction. This is apparent from the relatively large beach area which exists on the northwesterly side of Redondo Beach King Harbor, and the beach erosion which has occurred on the southeasterly side of the Harbor. The Harbor construction effectively interrupted the natural passage of littoral material downcoast. The dominant wave climate of the region approaches from a direction, and is refracted by the nearshore underwater hydrography, such that the potential

exists for transporting material in a southeasterly direction on a net annual basis. In recent years, shoal material has been accumulating in the Harbor entrance channel and boat mooring areas to such an extent that maintenance dredging must be performed in the relatively near future to alleviate this unacceptable condition which is interferring with normal recreational activities, and incurring lost revenues by restricting mooring space.

13. It is estimated that approximately 125,000 cu yd of shoal material has accumulated between breakwater Stations 15+00 and 32+00, along the inner side of the breakwater and into the navigation channel. This shoaling of the harbor at the up- and down-coast permeable breakwater structures reduces mooring for commercial craft and hampers navigation. Preliminary studies of the shoaling problem indicate that littoral material is passing through the north breakwater along the improved section, and through the south breakwater at the beachfront interface.

Purpose of the Study

14. Local interests desire major structural modifications to the breakwater to eliminate undesirable wave action within the Harbor. This will allow normal business and social activities to continue. Existing leaseholders will have the opportunity to further develop their leaseholds which will increase the recreational activity in the harbor. Plans for new restaurants, hotels, and beautification projects are being considered upon completion of the breakwater improvements.

15. The US Army Engineer District, Los Angeles (1984) has considered the alternative of raising the crest elevation of the southernmost portion of the north breakwater from +11.5 ft MLLW to the crest elevation of the higher section of that structure (+20.0 ft MLLW) in finite increments of approximately 4 ft each. Other plans tentatively being considered include raising the entire structure to the original elevation of the northernmost portion (+22.0 ft MLLW), or raising the entire structure to a crest elevation of +26.0 ft MLLW. It probably would not be practical to consider a finite increase in crest elevation of less than 4 ft because of the diameter of the stone required for stability under the design wave conditions.

16. The US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, was requested by US Army Engineer District, Los Angeles,

to provide engineering data and analysis of the aforementioned problems which presently exist at Redondo Beach King Harbor, California, so that further investigations may continue through a feasibility study of potential alternative solutions to these problems. Specifically, the Coastal Engineering Research Center was requested to perform the following tasks:

Task A

17. Perform a water wave refraction/diffraction/shoaling analysis at Mean Lower Low Water (MLLW), Mean Higher High Water (MHHW), and at the extreme high tide elevation of the 1983 winter storms to determine the wave characteristics and frequencies-of-occurrence at the breakwater structure site for the extreme storm events of historical record, and for the higher sea waves which overtop the lower portion of the breakwater on an average annual basis.

Task B

18. Determine the magnitude of wave penetration through the permeable rubble mound structure, overtopping of the structure, and total wave transmission past the structure into the Harbor for the existing condition crest elevations of the north breakwater (+20.0 ft MLLW between Stations 15+50 and 36+00, and +11.5 ft MLLW between Stations 36+00 and 52+00), and for the 1964 as-constructed crest elevations (+22.0 ft MLLW between Stations 15+50 and 36+00, and +14.0 ft MLLW between Stations 36+00 and 52+00). Perform all computations at tide elevations of MLLW, MHHW, and the extreme high tide elevation of the 1983 winter storms.

Task C

19. Evaluate the effect of raising the crest elevation of the structure on wave penetration through the structure, overtopping of the structure, and total wave transmission past the structure into the Harbor. Specifically, evaluate the effects of raising the crest elevation of the +11.5 ft MLLW section to +18.0 ft MLLW, and to +22.0 ft MLLW. Then consider the effects of raising the entire breakwater to a crest elevation of +26.0 ft MLLW.

Task D

20. Estimate the structure armor stone size required for stability based on results of the water wave refraction/diffraction/shoaling analysis which indicates the return period (frequency-of-occurrence) of storm waves of various heights.

Task E

21. Propose alternative structural measures for reducing excess wave

activity in Basin 3, and propose alternative solutions for alleviating the Harbor shoaling problem caused by sediment penetration through the porous north breakwater. Such potential sealing solutions may include but are not limited to chemical and cement grouts, bitumarin grouting methods, or void sealing by stone placement procedures.

PART II: HISTORICAL DEVELOPMENT OF REDONDO BEACH KING HARBOR, CALIFORNIA

Project Authorization

22. Redondo Beach King Harbor was authorized by Act of Congress, Public Law 516, Eighty-first Congress, second session, approved 17 May 1950 in accordance with the plan published in House Document No. 303-81-1. Details of the design of the existing project are contained in Design Memorandum No. 1, "General Design for Redondo Beach Harbor, California", June 1955, and Design Memorandum No. 2, "General Design for Redondo Beach King Harbor, California", March 1964. The project name was changed from Redondo Beach Harbor, California, to Redondo Beach King Harbor, California, by Act of Congress, Public Law 87-874, Eighty-seventy Congress, approved 23 October 1962.

Development of the Harbor

23. The man-made Redondo Beach King Harbor consists of two permeable rubble mound breakwaters about 4,885 ft long. The south breakwater has a crest elevation of +12.0 ft MLLW and is 600 ft long. The north breakwater is 4,285 ft long and has a crest elevation of +20.0 ft MLLW between Stations 15+50 and 36+00, and a crest elevation of +11.5 ft MLLW between Stations 36+00 and 52+00. The interior harbor consists of three boat basins enclosed by moles, all with revetted slopes. The entrance consists of an opening about 600 ft wide for navigation between the breakwaters at the head of the Redondo Submarine Canyon. The southern end of the north breakwater was terminated at its present location because the water depths near the Canyon were becoming so great that excessive amounts of stone were necessary to construct the breakwater in this region. Natural depths through the entrance vary from 27 to 30 ft.

24. Development of the Harbor was initiated in 1939 when a 1,470-ft stone breakwater was constructed with Public Works Administration funds. This breakwater provided inadequate protection from wave action while interrupting the littoral transport and causing severe erosion of the beach downcoast. A Federal project for improvement was authorized in 1950. Plans for Federal improvement of the project were accelerated as a result of severe damage by

storms occurring in 1953, and a general design memorandum was prepared in 1955. Construction of the improved Federal breakwater, which raised the 1939 breakwater crest elevation to +14 ft MLLW and added 2,830 ft of new breakwater, was completed in May 1958. This breakwater provided protection for the harbor from the storm occurring in 1959. This storm did minor damage to the breakwater, which was repaired in 1960, but no damage was reported within the interior harbor since no facilities had been developed at that time.

25. Development of the interior harbor was started by the City of Redondo Beach in September 1960. At that time, to provide protection from west-to-northwesterly storms, the City constructed an 8-ft-high Galveston-type seawall between Stations 5+30 and 15+50 of the north breakwater.

26. The major part of the construction of the basins and moles was completed by July 1961, and Basin 1 was opened for berthing at that time. Shortly thereafter, it became evident to the City that the seawall would not reduce the undesirable wave action within the Harbor, and the City initiated a study of the problem in December 1961. It was determined that undesirable wave action in the Harbor was primarily caused by excessive wave energy passing through and over the permeable rubble mound breakwater which had a crest elevation of +14.0 ft MLLW. Average annual waves frequently overtopped this structure, particularly at high tide elevations.

27. The storms which occurred during December 1962 and February 1963 fully demonstrated the inadequacy of this breakwater with a crest elevation of +14.0 ft MLLW for protecting small craft facilities within the Harbor. These storms, while doing only minor damage to the breakwater, caused about $431,000 damage to small boats and mooring facilities within the Harbor.

28. A study of remedial measures for Redondo Beach King Harbor was authorized by Office, Chief of Engineers in March 1963. General Design Memorandum No. 2 was prepared in March 1964 which recommended raising the core elevation to +9.0 ft MLLW and the crest elevation to +22.0 ft MLLW on the Harbor side of the north breakwater between Stations 15+50 and 36+00. The construction of this improvement was completed in November 1964.

29. As an interim solution pending the original breakwater modification, the City of Redondo Beach constructed three timber baffle walls at the mouths of Basins 1 and 2. These baffles were intended as a temporary solution to lessen surge and were completed in February 1964. When the breakwater modifications were completed in November 1964, the baffles were removed after

they had been damaged by marine borers. At that time it was found that the surge problem in Basins 1 and 2 was somewhat similar to that experienced prior to the modification of the breakwater.

30. In January 1975, a Reconnaissance Report was prepared by US Army Engineer District, Los Angeles, to investigate the problem of wave energy entering Basins 1 and 2. This report recommended constructing three prestressed concrete groins at the entrances of the basins. Construction of the groins was completed in April 1977 at a cost of approximately $400,000. The groins are maintained and operated by the City of Redondo Beach. These groins have performed as designed when consideration is given to the fact that they are operating in conjunction with the raised breakwater elevation between Stations 15+50 and 36+00. Surge in Basins 1 and 2 has been limited to an acceptable level. Locations of these baffles are shown in Figure 3.

31. Maintenance repairs have been affected to the north breakwater twice since its completion. During the storms of 1978 and 1980, the north breakwater sustained damage at nine sections with the major voids occurring at Stations 16+00 and 22+00. This location is at, and slightly south of, the curved portion of the north breakwater. The repair work was initiated in February 1982 and was completed in March 1982 at a cost of $304,000. The disastrous storms of January-March 1983 caused significant damage at several locations along this structure. The most significant was a breach 70 ft long, just south of the curved portion. All stone work repairs were completed in October 1983 at a cost of approximately $400,000. It appears there may be some inherent structural instability at this curved section which initiates a failure mechanism. The 1983 repairs are shown in Figures 4 and 5.

32. Even though the structural damage has been repaired, storm waves still frequently overtop the +11.5 ft MLLW portion of the north breakwater at the present time, and create undesirable wave action in the harbor. These waves create hazardous conditions for navigation, endangerment of life, and damage to waterfront property and small craft. US Army Engineer District, Los Angeles (1984), has recommended that feasibility studies continue to correct an existing undesirable condition at Redondo Beach King Harbor, California.

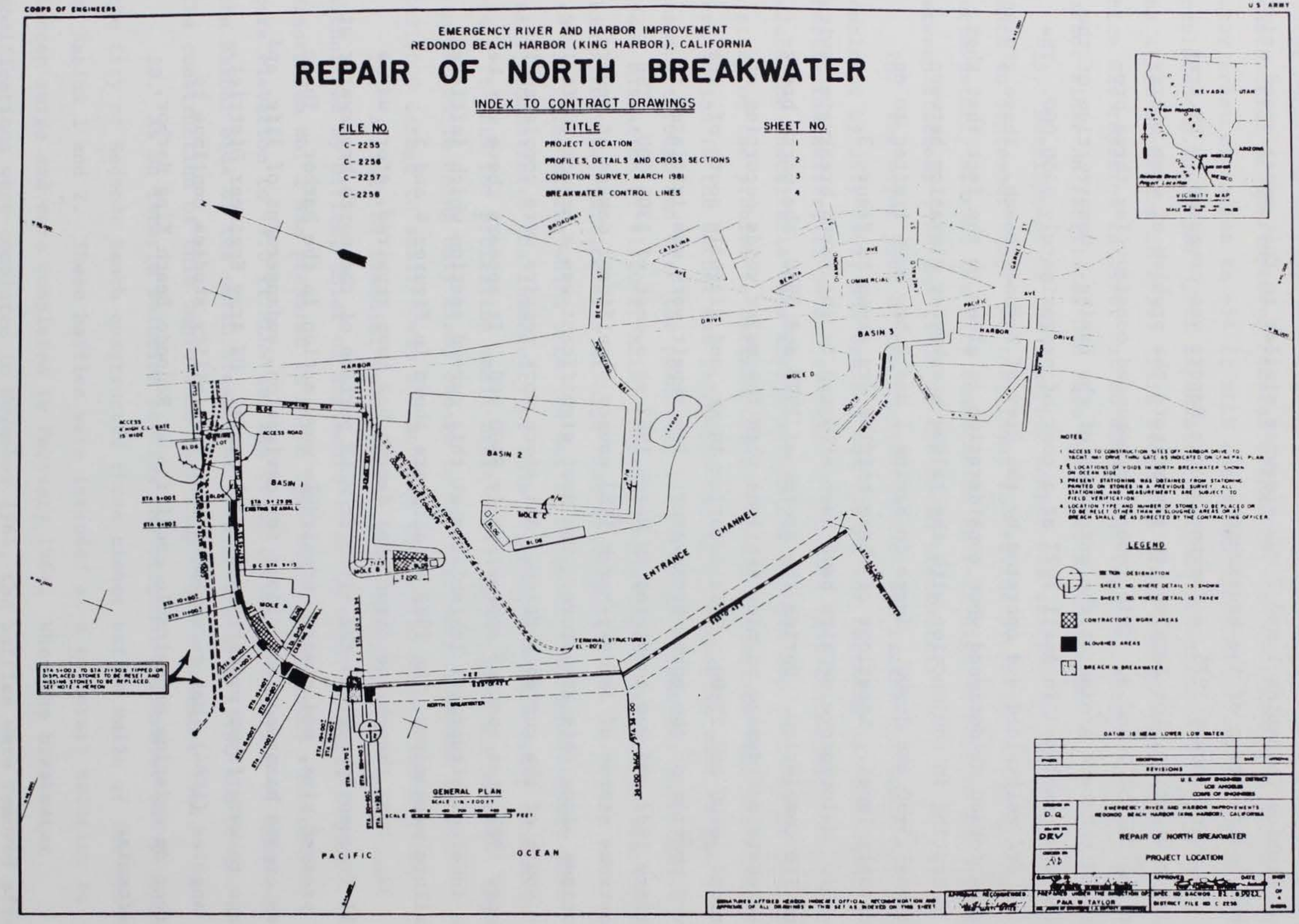


Figure 4. 1983 Breakwater repair locations, Redondo Beach King Harbor, California

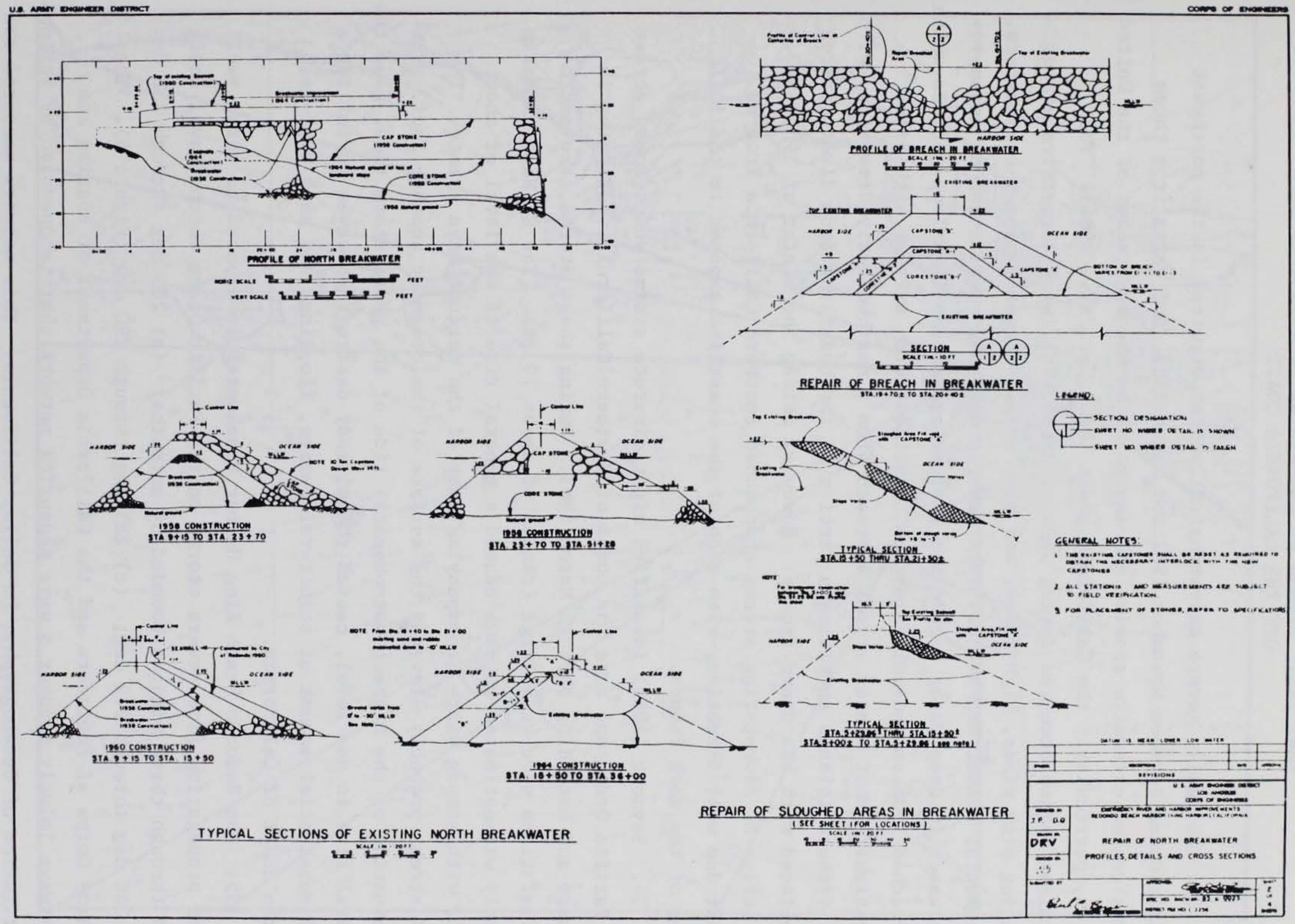


Figure 5. 1983 Breakwater repair details, Redondo Beach King Harbor, California

PART III: STORMS OF THE WINTER OF 1982-1983 OFF THE CALIFORNIA COAST

33. Unusually severe extratropical storms occurred in the northeast Pacific Ocean between November 1982 and March 1983, and waves from these storms caused extensive erosion and damage along the west coast of the United States, particularly the California coast (Dean, et. al., 1984). The stormiest period occurred during January-March 1983, with successive storms bringing high winds, high tides, and high waves. Several piers, breakwaters, revetments, homes, and beaches were damaged due to a combination of unusually high waves in deep water beyond the sheltering islands with long periods which approached from an unusual direction coincident with extreme high water elevations. Most winter storms approach from a northwesterly direction, with the offshore islands shielding a portion of the coastline from direct forces associated with the storm fronts. However, during the winter of 1982-1983, the series of devastating storms approached Southern California from an almost due west direction, with much of the coastline exposed to the full power of the wave fronts.

34. Seymour (1983) identified eight discrete storms which moved across the Pacific Ocean and onto the coast of Southern California, beginning in January and extending through March 1983. During these storms, the astronomical tides were very large (ranges of about 10 ft). The El Nino climatic anomaly was estimated to have caused a general rise of sea level of about 8 in, with strong winds accompanying mahy of the intense wave events. The wind stress probably elevated the surface of the ocean by another foot. The combination of the highest astronomical tide of the year, storm tide, plus the general rise in sea level, caused the already destructive waves to inflict a very substantial amount of structural damage, flooding, and sand over-wash to the coast of California.

35. The Redondo Beach King Harbor breakwater is exposed to large swell waves propagating from severe storms on the Pacific Ocean which travel eastward through three windows bounded by azimuths: (a) 205 deg through 235 deg; (b) 240 deg through 272 deg; (c) 283 deg through 290 deg (Figure 6). The US Army Corps of Engineers and the California Department of Boating and Waterways jointly sponsor a wave measuring network that is operated by Scripps Institution of Oceanography, La Jolla, California. This network measured the

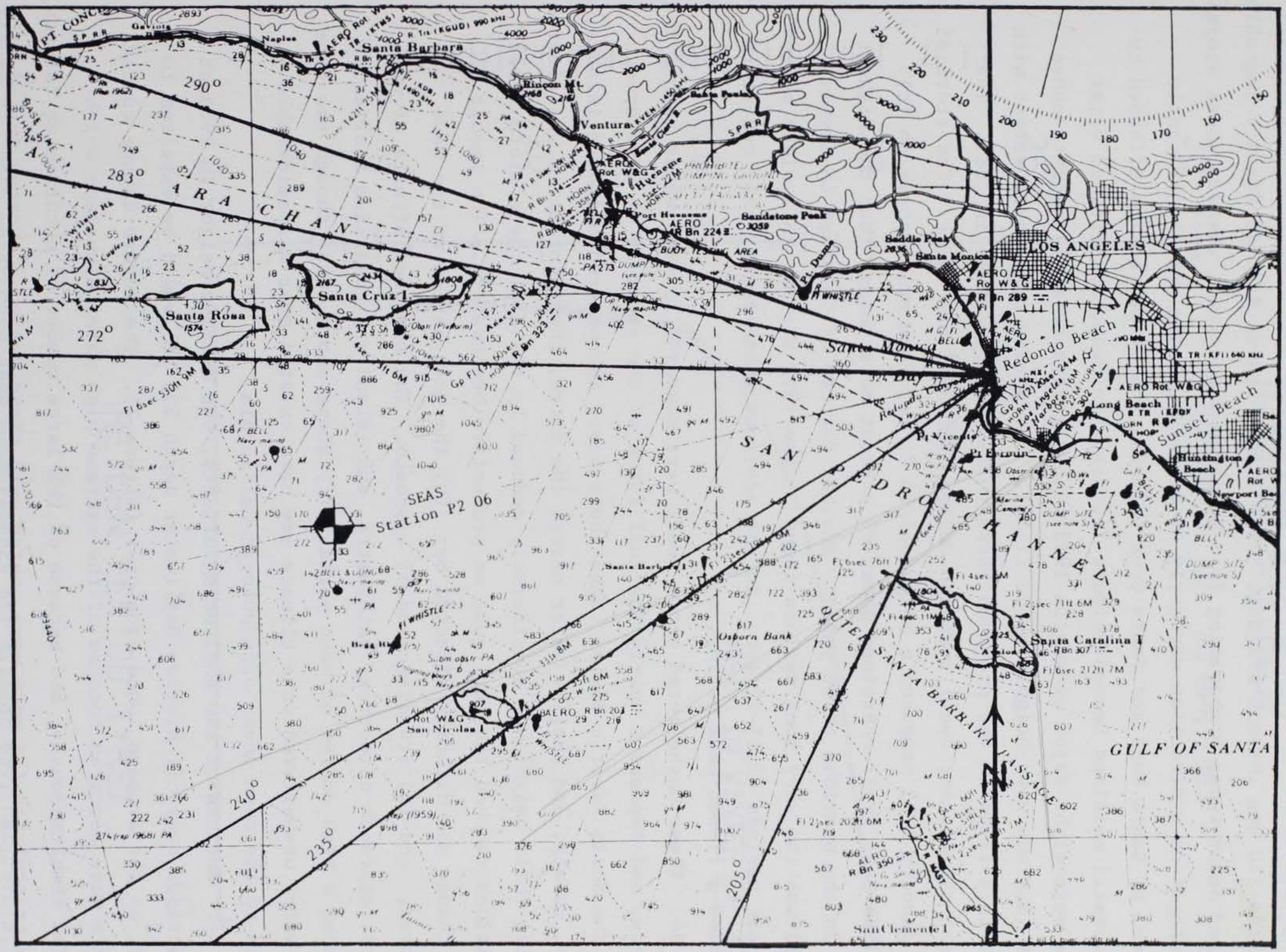


Figure 6. Redondo Beach King Harbor, California, storm swell exposure windows

waves in deep, unsheltered water which eventually reached Redondo Beach by propagating essentially eastward through the wave exposure window bounded by azimuths 240 deg through 272 deg. This window leaves Redondo Beach vulnerable to open ocean waves propagating from westerly directions, whereas those storms arriving from a direction northerly of azimuth 272 deg are significantly altered by Santa Rosa and Santa Cruz Islands, and by protection afforded by the coastal mainland beyond azimuth 290 deg. In deep, unsheltered water there were eight major storms in 1983 with significant swell heights above 14 ft (maximum wave heights above 21 ft). There were only seven storms with swell this large in the previous three years, four of those in 1982. The highest significant swell recorded during 1980-1982 was 18 ft. The storm of late January 1983 produced a height of 24 ft (maximum swell above 36 ft). The 1983 peak swell contained about 80 percent more energy than the highest ones in the previous three years. Another feature of interest to Seymour (1983) was the very long periods found in the 1983 storms. All eight storms had peak periods of 17-22 sec. In the previous three years, only one storm exceeded a 17-sec peak period.

36. These unsheltered storm swell were measured in deep water beyond the islands, and represent nearly the full force of the storm as it developed over the North Pacific Basin. When these waves encountered offshore islands, banks, shoals, and shallow water nearer the shore, their intensity was altered. Usually their height was considerably reduced by the time these storm swell conditions reached the surf zone or protective breakwaters. The amount of this change was directly affected by: (a) the peak period in the wave spectrum, and (b) its direction of approach. The combined effects of wave period, approach direction, bathymetry, and island and coastline sheltering produced a high degree of wave variability along shore, even though the same deep water unsheltered wave climate may have existed over a considerable region of the open ocean off Southern California.

37. Because of the sheltering effects, the maximum height in 1983 at the Scripps buoy off Mission Bay (water depth 550 ft) would be expected to occur, on the average, once each year (Figure 7). The severe damage caused by this wave occurred because of the extreme high water elevation which existed simultaneously, and because of the large number of occurrences (storms) which transmitted far more wave energy onto shore during a shorter period of time than ever previously experienced. At Sunset Beach, California, approxi-

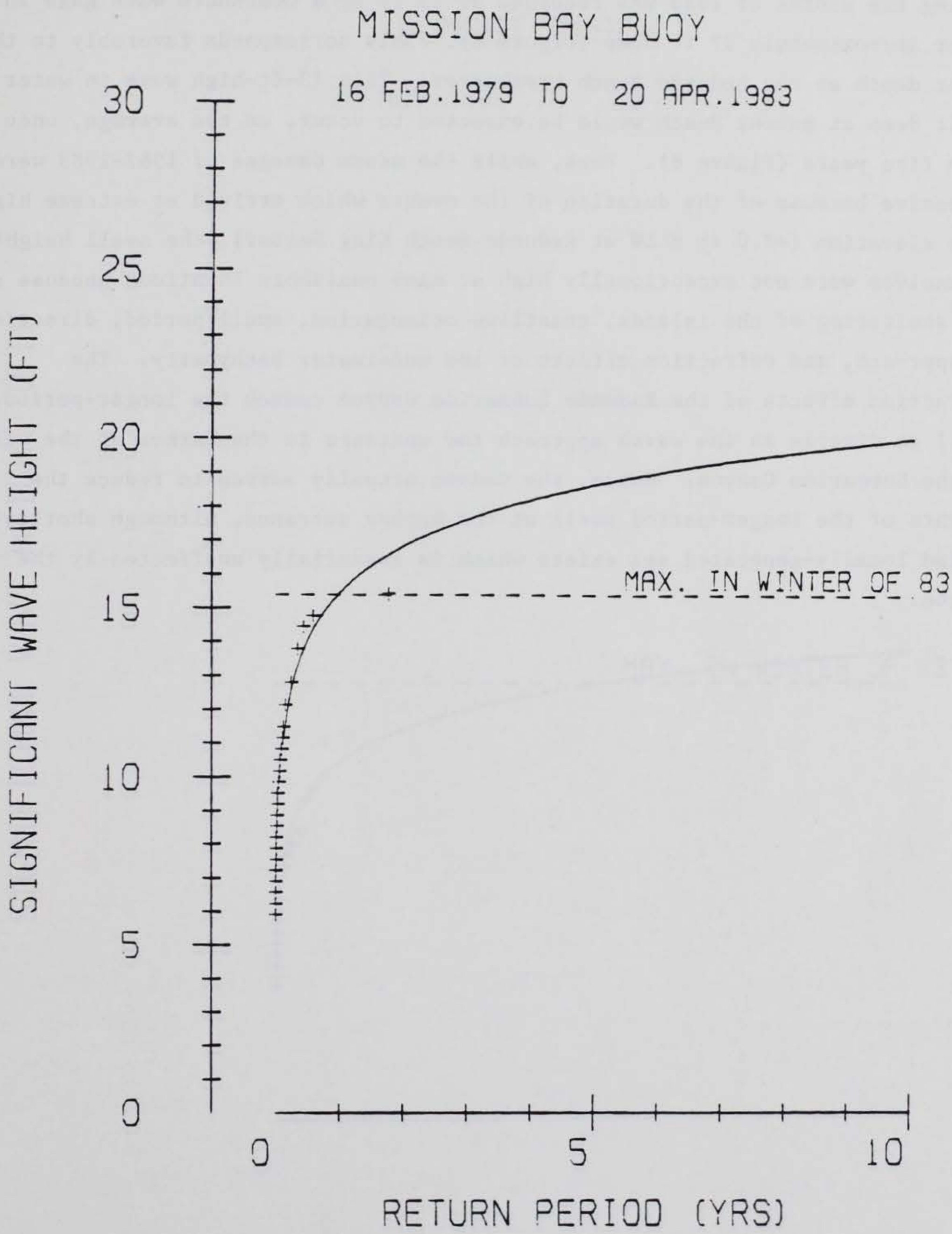


Figure 7. Deep water wave gage measurements off Mission Bay, California, for 1979-1983, water depth at gage approximately 550 ft, (after Seymour, 1983)

mately 20 mi distance south of Redondo Beach, the maximum significant swell during the storms of 1983 was recorded as 13 ft by a nearshore wave gage in water approximately 27 ft deep (Figure 8). This corresponds favorably to the water depth at the Redondo Beach breakwater. This 13-ft-high wave in water 27 ft deep at Sunset Beach would be expected to occur, on the average, once each five years (Figure 8). Thus, while the storm damages of 1982-1983 were extensive because of the duration of the events which arrived at extreme high tide elevation (+8.0 ft MLLW at Redondo Beach King Harbor), the swell heights themselves were not exceptionally high at many nearshore locations because of the sheltering of the islands, coastline orientation, swell period, direction of approach, and refraction effects of the underwater bathymetry. The refraction effects of the Redondo Submarine Canyon causes the longer-period swell to diverge as the waves approach the entrance to the Harbor at the head of the Submarine Canyon. Hence, the Canyon actually serves to reduce the heights of the longer-period swell at the Harbor entrance, although shorter-period locally-generated sea exists which is essentially unaffected by the Canyon.

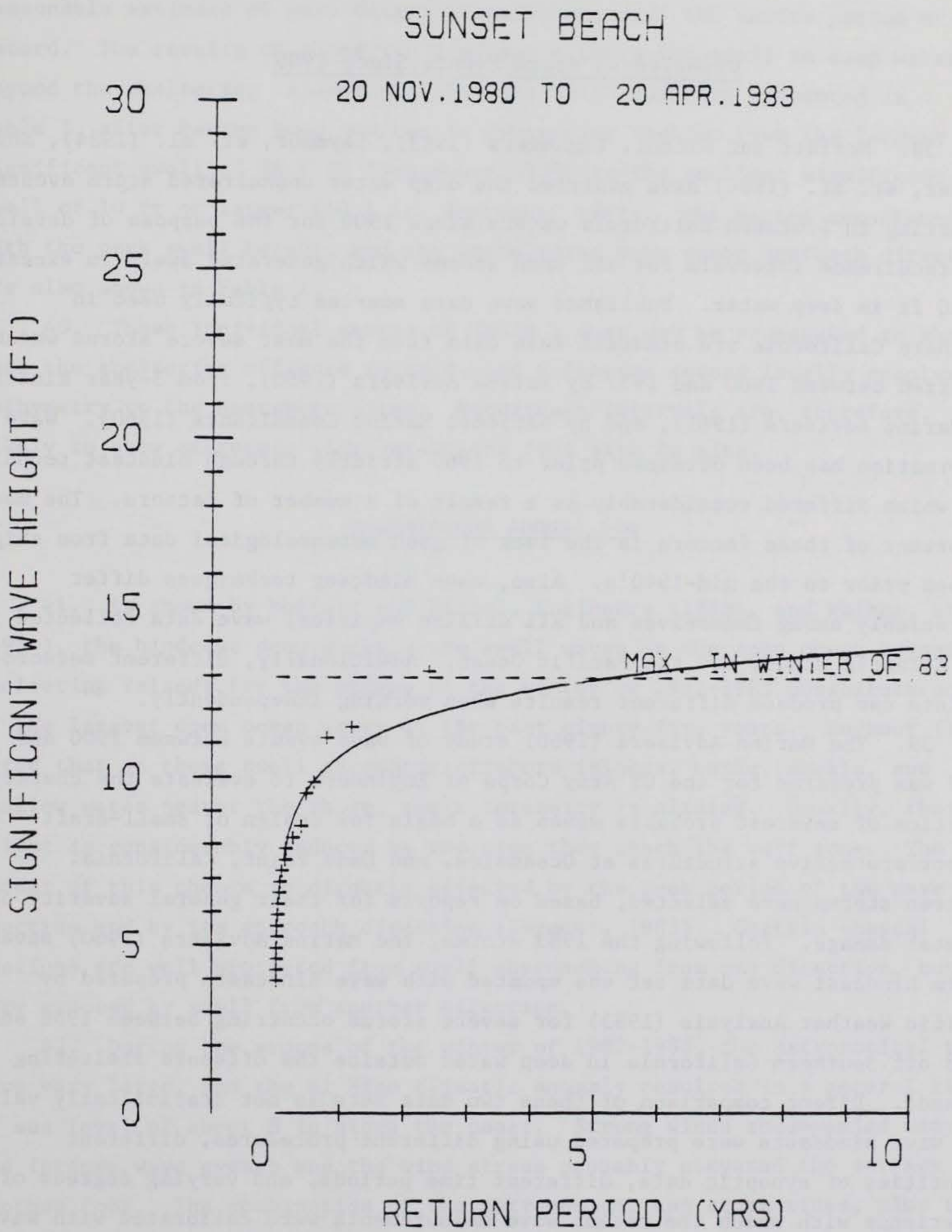


Figure 8. Nearshore wave gage measurements at Sunset Beach, California, for 1980-1983, water depth at gage approximately 27 ft, (after Seymour, 1983)

PART IV: DEEP WATER WAVES OFF REDONDO BEACH KING HARBOR, CALIFORNIA

Unsheltered Storm Events Since 1900

38. Moffatt and Nichol, Engineers (1983), Seymour, et. al. (1984), and Walker, et. al. (1984) have analyzed the deep water unsheltered storm events occurring in Southern California waters since 1900 for the purpose of developing recurrence intervals for all such storms which generated swell in excess of 10 ft in deep water. Published wave data sources typically used in Southern California are hindcast wave data from the most severe storms which occurred between 1900 and 1957 by Marine Advisers (1960), from 3-year hindcasts by Marine Advisers (1961), and by National Marine Consultants (1960). Wave information has been obtained prior to 1960 strictly through hindcast techniques which differed considerably as a result of a number of factors. The most important of these factors is the lack of good meteorological data from ships at sea prior to the mid-1940's. Also, wave hindcast techniques differ appreciably among themselves and all utilize empirical wave data collected in the Atlantic Ocean, not the Pacific Ocean. Additionally, different meteorologists can produce different results when working independently.

39. The Marine Advisers (1960) study of wave events between 1900 and 1957 was prepared for the US Army Corps of Engineers to evaluate the characteristics of severest probable waves as a basis for design of small-craft harbor protective structures at Oceanside, and Dana Point, California. Fifteen storms were selected, based on reports for their general severity or coastal damage. Following the 1983 storms, the Marine Advisers (1960) severe storm hindcast wave data set was updated with wave hindcasts prepared by Pacific Weather Analysis (1983) for severe storms occurring between 1958 and 1983 off Southern California in deep water outside the offshore sheltering islands. Direct comparison of these two data sets is not statistically valid. The wave hindcasts were prepared using different procedures, different quantities of synoptic data, different time periods, and varying degrees of experience with which the recent wave measurements were calibrated with wave hindcasts. While the proper procedure would be to update all storms of record using similar hindcast procedures, such an effort has not been performed in this locality at the present time. It was assumed by Walker, et. al. (1984)

that the methodologies of the two hindcasts are similar enough to permit a reasonable estimate of wave height distribution over the entire period of record. The results of these two hindcast efforts for swell in deep water beyond the sheltering islands off Southern California are presented in Table 1, after having been ordered in descending fashion from the largest significant swell of 26.9 ft (September 1939) to the smallest significant swell of 10 ft or larger (10.1 ft, September 1982). The period associated with the peak swell height, and the unsheltered deep water approach direction, are also shown in Table 1.

40. These individual storms of Table 1 must now be propagated to shore past the sheltering offshore islands, and refracted across locally complex bathymetry to the nearshore sites. Recurrence intervals are, therefore, likely to show extremely wide variations from site to site.

Unsheltered Annual Sea

41. As shown by Moffatt and Nichol, Engineers (1983), and Walker, et. al. (1984), the hindcast deep water storm swell waves on the open ocean beyond the sheltering islands for the storms of the winter of 1982-1983 constitute some of the largest open ocean waves of the past eighty-five years. Seymour (1983) noted that as these swell encounter offshore islands, banks, shoals, and shallow water nearer the shore, their intensity is altered. Usually, their height is considerably reduced by the time they reach the surf zone. The amount of this change is directly affected by the peak period of the wave spectrum and by its approach direction (Seymour, 1983). Certain coastal sections are well protected from swell approaching from one direction, but are very exposed by swell from another direction.

42. During the storms of the winter of 1982-1983, the astronomical tides were very large, and the El Nino climatic anomaly resulted in a general rise of sea level of about 8 in along the coast. Strong winds accompanied many of the intense wave events and the wind stress probably elevated the surface by another foot. The combination of the astronomical and storm tides, plus the general rise in sea level, caused the already destructive waves to inflict a very substantial amount of structural damage. Jetties and breakwaters, which are particularly sensitive to super-elevations of sea level, were damaged all

Table 1

Southern California

Unsheltered Deep Water Storm Swell Events

Date of Storm	Unsheltered Deep Water Significant Wave Height, H_s (ft)	Wave Period, T (sec)	Unsheltered Deep Water Approach Azimuth, (deg)
September 1939	26.9	14.0	205
April 1958	25.1	17.5	293
March 1983	23.6	18.5	263
January 1981	21.5	15.5	269
January 1983	21.0	20.5	283
November 1982	20.4	10.5	293
February 1963	19.5	13.5	269
January 1978	18.6	16.5	284
February 1960	18.3	18.5	294
January 1958	18.1	13.5	270
March 1904	17.9	12.0	225
March 1912	17.5	11.5	270
February 1983	17.1	16.5	275
February 1915	16.5	12.4	280
January 1915	16.3	11.8	205
January 1943	16.2	10.8	180
January 1953	16.0	19.2	260
February 1969	15.6	14.5	284
February 1980	15.6	14.5	255
January 1981	15.4	17.5	265
December 1969	14.4	20.5	276
January 1916	14.0	9.6	250
December 1914	13.0	9.9	180
February 1926	12.6	16.0	260
April 1926	11.8	13.8	270
March 1952	11.7	11.7	250
December 1937	11.6	16.4	270
August 1972	11.6	17.5	156
September 1963	10.3	14.5	167
September 1982	10.1	17.5	158

Developed from Walker, et. al. (1984)

along the coast during this winter (Seymour, 1983).

43. Even though the coastal damage caused by these storms was great because of the large tide elevations which occurred simultaneously with the arrival of the storm swell waves, the actual wave heights observed at the shoreline were not exceedingly large. The sheltering effects of the offshore islands and the wave height reduction caused by refraction from underwater bathymetry resulted in waves whose return period was not unusually long. While the coastal damage caused by the hindcast peak of the storm spectra in deep unsheltered open ocean water may at some locations be significant, in other locations these swell wave heights were no larger than those waves associated with the annual sea wave conditions. Hence, the locally-generated sea which accompanied the propagation of the storm systems onshore from a westerly-to-easterly direction was a direct contributing factor to the amount of damage experienced by coastal structures in relatively shielded locations.

44. The Corps of Engineers requirement for wave climate data is extensive for all coastal areas of the United States. The needs range from estimates of the probability of extreme wave heights by direction for structural design to a synoptic directional wave climate for sediment transport calculations. Estimates of yearly and seasonal variability in the wave climate are also desired. Since the exact requirements for the data vary with Corps organizational elements and on a project-to-project basis, a computer-based analysis system has been designed to give site-specific access to the wave data base for individual calculations. This storage, retrieval, and computation system is the Sea-State Engineering Analysis System (SEAS).

45. The Wave Information Study group of US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, is preparing a 20-year wave hindcast for the Pacific coast of the United States. Wind fields for the North Pacific have been hindcast from meteorological records. These wind fields have been used as input to a directional dpectral deepwater wave model to provide a 20-year (1956-1975) wave hindcast for deepwater sites. The extension of these deep water hindcasts into intermediate water depths (Phase 2) has also been completed. Statistically analyzed hindcast results are now available in the SEAS system which provide the annual sea and the annual swell wave heights at the Phase 2 locations along the coast of Southern California (Ragsdale, 1983).

46. A SEAS Phase 2 data station (Station P2 06) is located mid-way between Santa Rosa Island and San Nicolas Island, directly offshore from Redondo Beach King Harbor, California (Figure 6). The hindcast sea data for this location have been accessed, and are shown in Table 2. The sheltering effects of the islands have not been taken into account in these data; hence, these sea data, along with the storm swell data of Table 1, must be processed through an island sheltering numerical program to obtain the sheltered deep water sea and swell heights, and altered directions of approach for input to the refraction/diffraction/shoaling numerical model.

Island Sheltering Effects

47. If the Redondo Beach King Harbor breakwater were not sheltered by the offshore islands, waves would arrive from a wide range of directions, even if the direction of the wind in the generating area were relatively constant. According to Arthur (1951), variability of wave direction makes a path of at least 45 deg on each side of the wind. A directional beam pattern of wave intensity of the form $(1 + \cos 2\theta)$ has been used to approximate this spreading function. In effect, the intensity is proportional to the square of the wave height, which is consistent with observational data. The result of island sheltering, then, is to prevent certain parts of the wave rose from reaching the protected area.

48. In investigating island sheltering, the first consideration is to determine which directions of approach are open to waves of various periods and which are blocked. This cannot be accomplished by simply inspecting the sea level contours of the islands, because shoal water can act as a barrier just as effectively as an island shore. The blocking action depends on both water depth and wave period, with long-period waves requiring deeper water for passage than short-period waves. As a result, any given opening between two islands will present a narrower portal to a long-period wave than it will to a short-period wave. With the aid of precise bottom contour charts, all such avenues of approach were determined for Redondo Beach King Harbor. The required integrations were performed by digital computer utilizing a numerical program developed by US Army Engineer District, Los Angeles. The results of these integrations provided the sheltered storm swell and sea characteristics on the landward side of the islands but still in deep water, resulting from

Table 2

Annual Significant Sea Wave Heights

Frequency of Occurrence (Percent x 100)

Unsheltered Deep Water Azimuth = 270 deg.

Sea-State Engineering Analysis System (SEAS)

SEAS Phase 2, Station 06

Sea Wave Height (meters)	Sea Wave Period (second)						
	0.0 to 3.0	3.0 to 5.0	5.0 to 7.0	7.0 to 9.0	9.0 to 11.0	11.0 to 13.0	13.0 to 15.0
0.0--0.5			11	0	0	0	0
0.5--1.0			22	13	2	0	0
1.0--1.5			15	26	6	1	0
1.5--2.0			23	24	13	3	1
2.0--2.5			7	20	16	10	4
2.5--3.0			*	10	10	9	12
3.0--3.5				8	5	8	17
3.5--4.0				*	*	*	19
4.0--4.5							16
4.5--5.0							*
5.0--5.5							
5.5--6.0							

* Trace

the passage of the storm swell events of Table 1, and the annual sea waves of Table 2. These sheltered deep water storm swell and sea events must still be propagated to the Redondo Beach King Harbor breakwater over the complex nearshore bathymetry and Redondo Submarine Canyon.

49. The island sheltering theory yields not only height-reduction percentages but indicates modifications in direction as well. Periods are assumed to remain unchanged. The direction modifications are necessary because, in some cases, sheltering will block out part or all of the primary central portion of the direction sector of a train of approaching waves. When this happens, the wave energy reaching the hindcast point will obviously come from around the two ends of the barrier, and the resulting modified wave train will come from a direction that is within the original sector but modified toward that end of the barrier around which the larger part of the remaining wave energy came. The island sheltering coefficients, or the percentage remaining of the original deep water unsheltered heights, and the sheltered direction of approach for all the storm swell and annual sea waves under consideration at Redondo Beach King Harbor, were applied to the unsheltered deep water storm swell hindcasts presented by Walker, et. al. (1984), and to the deep water unsheltered annual sea wave characteristics developed by SEAS, respectively. The resulting sheltered deep water storm swell which must still be refracted/diffracted/shoaled to the Redondo Beach King Harbor breakwater is presented in Table 3. The computer program for performing the island sheltering wave modifications, developed by US Army Engineer District, Los Angeles, is presented in Appendix G. It was determined that only the 10 sec, 12 sec, and 14 sec annual sea waves were of sufficient magnitude to adversely affect the breakwater and harbor complex by overtopping. For the maximum significant annual sea waves with these periods from the approach direction of 270 deg azimuth, there resulted approximately a 25 percent reduction in wave height, and an alteration in approach direction of approximately 12 deg to the southwest (258 deg sheltered deep water approach azimuth).

Table 3

Redondo Beach King Harbor, California

Sheltered Deep Water Storm Swell Characteristics

Date of Storm	Unsheltered Deep Water Significant Wave Height, H_s (ft)	Wave Period, T (sec)	Unsheltered Deep Water Approach Azimuth, (deg)	Island Sheltering Coefficient, K_I	Sheltered Deep Water Significant Wave Height, H_s (ft)	Sheltered Deep Water Approach Azimuth, (deg)
September 1939	26.9	14.0	205	0.67	18.0	224
April 1958	25.1	17.5	293	0.57	14.3	268
March 1983	23.6	18.5	263	0.80	18.9	253
January 1981	21.5	15.5	269	0.76	16.3	257
January 1983	21.0	20.5	283	0.66	13.9	264
November 1982	20.4	10.5	293	0.57	11.6	268
February 1963	19.5	13.5	269	0.76	14.8	257
January 1978	18.6	16.5	284	0.65	12.1	264
February 1960	18.3	18.5	294	0.56	10.3	269
January 1958	18.1	13.5	270	0.75	13.6	258
March 1904	17.9	12.0	225	0.83	14.9	235
March 1912	17.5	11.5	270	0.75	13.1	258
February 1983	17.1	16.5	275	0.71	12.1	260
February 1915	16.5	12.4	280	0.67	11.1	263
January 1915	16.3	11.8	205	0.67	10.9	224
January 1943	16.2	10.8	180	0.43	7.0	214
January 1953	16.0	19.2	260	0.82	13.1	251
February 1969	15.6	14.5	284	0.65	10.1	264

(Table 3 Continued)

(Table 3 Continued)

Redondo Beach King Harbor, California

Sheltered Deep Water Storm Swell Characteristics

Date of Storm	Unsheltered Deep Water Significant Wave Height, H_s (ft)	Wave Period, T (sec)	Unsheltered Deep Water Approach Azimuth, (deg)	Island Sheltering Coefficient, K_I	Sheltered Deep Water Significant Wave Height, H_s (ft)	Sheltered Deep Water Approach Azimuth, (deg)
February 1980	15.6	14.5	255	0.86	13.4	248
January 1981	15.4	17.5	265	0.79	12.2	255
December 1969	14.4	20.5	276	0.70	10.1	261
January 1916	14.0	9.6	250	0.88	12.3	245
December 1914	13.0	9.9	180	0.43	5.6	214
February 1926	12.6	16.0	260	0.82	10.3	251
April 1926	11.8	13.8	270	0.75	8.9	259
March 1952	11.7	11.7	250	0.88	10.3	245
December 1937	11.6	16.4	270	0.75	8.7	258
August 1972	11.6	17.5	156	----*	----*	---*
September 1963	10.3	14.5	167	0.23	2.4	208
September 1982	10.1	17.5	158	----*	----*	---*

* Long period swell from this deep water unsheltered direction of approach could not reach the structure.

PART V: WATER WAVE REFRACTION/DIFFRACTION/SHOALING MODEL (RCPWAVE)

50. A numerical model RCPWAVE (Regional Coastal Processes Wave Transformation Model) was developed by Ebersole, et. al., (1985) which predicts the transformation of monochromatic waves over complex bathymetry and includes refractive, diffractive, and shoaling effects. Finite difference approximations are used to solve the governing equations and the solution is obtained for a finite number of rectilinear grid cells which comprise the domain of interest. The following is presented in the manner of Ebersole (1985).

Governing Equations

51. During recent years there has developed a definite need for an efficient and effective method for the estimation of wave conditions over a sometimes large expanse of shoreline with arbitrary shape and bathymetry. Much of the early work in this area was based on wave ray methods and manual construction of refraction diagrams using linear, gravity wave theory. During the 1960's and early 1970's, the linear wave refraction problem was solved in a more efficient way through the use of the digital computer. All of these methods, however, addressed the refraction problem only.

52. The numerical model RCPWAVE computes the wave field resulting from the transformation of an incident, linear, monochromatic wave over a region of arbitrary extent and bathymetry. Both refraction and diffraction are included in the model since the latter effect becomes increasingly important in regions with complex bathymetry. Shoaling effects are inherently included in the model. The solution technique employed is a finite difference approach. Thus, the wave climate in terms of wave height, H, wave period, T, and wave direction of approach, θ, is available at a large number of computational points throughout the domain of interest, and not just along wave rays. Computationally, the model is very efficient for modeling large areas of coastline subjected to widely varying wave conditions, and therefore is an extremely useful tool in the solution of many types of coastal engineering problems.

53. The propagation of harmonic, linear water waves in two horizontal dimensions has been described by Berkhoff (1972) as:

$$\frac{\partial}{\partial x}\left(cc_g \frac{\partial \phi}{\partial x}\right) + \frac{\partial}{\partial y}\left(cc_g \frac{\partial \phi}{\partial y}\right) + \sigma^2 \frac{c_g}{c} \phi = 0 \tag{1}$$

where

x = horizontal dimension, ft
y = horizontal dimension, ft
ϕ = complex velocity potential, ft^2/sec
σ = angular frequency, $(2\pi/T)$, 1/sec
T = wave period, sec
c = wave celerity, ft/sec
c_g = group celerity, ft/sec
k = wave number, $(2\pi/L)$, 1/ft
L = wavelength, ft
n = parameter relating wave celerity to group celerity, dimensionless
g = gravitational acceleration, 32.174 ft/sec^2

Equation 1 is often referred to as the "mild slope" equation due to the inherent assumption that the bottom slope is small. Because of its elliptic nature, this equation has been most successfully solved in the past by the use of finite element methods, especially for long wave and tsunami propagation problems. However, for short wave application along the open coast, the solution of this equation often becomes computationally unfeasible. Ebersole (1985) developed an alternative method for solving open coast wave propagation problems.

54. Consider the complex velocity potential:

$$\phi = ae^{is} \tag{2}$$

where

$a(x,y)$ = wave amplitude, $(H/2)$, ft
$H(x,y)$ = wave height, ft
$s(x,y)$ = phase function of the wave, dimensionless

Neglecting reflection, by substituting this expression for the velocity potential into Equation 1, and retaining diffraction effects in the direction of wave propagation, the following equations can be derived:

$$\frac{1}{a}\left[\frac{\partial^2 a}{\partial x^2} + \frac{\partial^2 a}{\partial y^2} + \frac{1}{cc_g}\left(\nabla a \cdot \nabla(cc_g)\right)\right] + k^2 - \left|\nabla \vec{s}\right|^2 = 0 \tag{3}$$

$$\nabla \cdot (a^2 c c_g \nabla \vec{s}) = 0 \tag{4}$$

where ∇ is the horizontal gradient operator.

55. It is assumed that no energy is propagated along wave crests, but instead, the wave phase function changes to accommodate any horizontal variation in the wave height. This is the effect of diffraction. The magnitude of this phase change is given by Equation 3. Utilizing the property of the irrotationality of the gradient of the wave phase function:

$$\nabla \times (\nabla \vec{s}) = 0 \tag{5}$$

and by letting:

$$\nabla \vec{s} = |\nabla \vec{s}| \cos \theta \, \vec{i} + |\nabla \vec{s}| \sin \theta \, \vec{j} \tag{6}$$

where $\vec{i}$ and $\vec{j}$ are unit vectors in the x and y directions, respectively, the local wave angle, $\theta(x,y)$, can be found from the expression:

$$\frac{\partial}{\partial x} (|\nabla \vec{s}| \sin \theta) - \frac{\partial}{\partial y} (|\nabla \vec{s}| \cos \theta) = 0 \tag{7}$$

Using Equation 6, Equation 4 can be rewritten as:

$$\frac{\partial}{\partial x} (a^2 c c_g \, |\nabla \vec{s}| \cos \theta) + \frac{\partial}{\partial y} (a^2 c c_g |\nabla \vec{s}| \sin \theta) = 0 \tag{8}$$

This energy equation can be used to determine wave amplitude once the local wave angle and the magnitude of the change in the phase function are known.

56. When diffraction effects are neglected, Equation 3 becomes the eikonal equation for the wave number, k . Equation 6 then reduces to:

$$\frac{\partial}{\partial x} (k \sin \theta) - \frac{\partial}{\partial y} (k \cos \theta) = 0 \tag{9}$$

and Equation 4 becomes:

$$\nabla \cdot (a^2 c c_g \, k) = 0 \tag{10}$$

Equations 9 and 10, along with the dispersion relation, represent the transformation of waves, taking into account pure refraction only.

57. When the quantity $H/2$ is substituted for the wave amplitude, a, in Equations 3, 7, and 8, a set of three equations result which can be solved in terms of the wave height, H, wave direction of approach, θ, and $|\nabla\vec{s}|$:

$$|\nabla\vec{s}|^2 = k^2 + \frac{1}{H}\left[\frac{\partial^2 H}{\partial x^2} + \frac{\partial^2 H}{\partial y^2} + \frac{1}{cc_g}\left(\frac{\partial H}{\partial x}\frac{\partial cc_g}{\partial x} + \frac{\partial H}{\partial y}\frac{\partial cc_g}{\partial y}\right)\right] \tag{11}$$

$$\frac{\partial}{\partial x}\left(H^2\, cc_g|\nabla\vec{s}|\cos\theta\right) + \frac{\partial}{\partial y}\left(H^2\, cc_g|\nabla\vec{s}|\sin\theta\right) = 0 \tag{12}$$

$$\frac{\partial}{\partial x}\left(|\nabla\vec{s}|\sin\theta\right) - \frac{\partial}{\partial y}\left(|\nabla\vec{s}|\cos\theta\right) = 0 \tag{7}$$

Equations 7, 11, and 12 describe the full refraction/diffraction/shoaling phenomena, under the assumptions that the bottom slopes are small, the waves are linear, harmonic, and irrotational, and that wave reflections are negligible. Any energy losses due to bottom friction or percolation are considered insignificant in this development.

Numerical Solution

58. The set of equations 7, 11, and 12 are solved by RCPWAVE using finite difference methods which require that a computational grid system be constructed. Definition of the coordinate system and the grid scheme is shown in Figure 9. In this figure, $A_{I,J}$ designates the location of all variables which vary in space, and are defined at the grid centers.

59. Specification of the deep water wave parameters of height, H_o, direction of approach angle, θ_o, and wave period, T, constitute the only wave input required by the model. Using this wave period, along with the depth matrix describing the bathymetry in the area of interest, the dispersion relation can be solved for the wave number, k. Using these values of k, the celerity, c, and group velocity, c_g, can be computed at every point on the grid. From Snell's law:

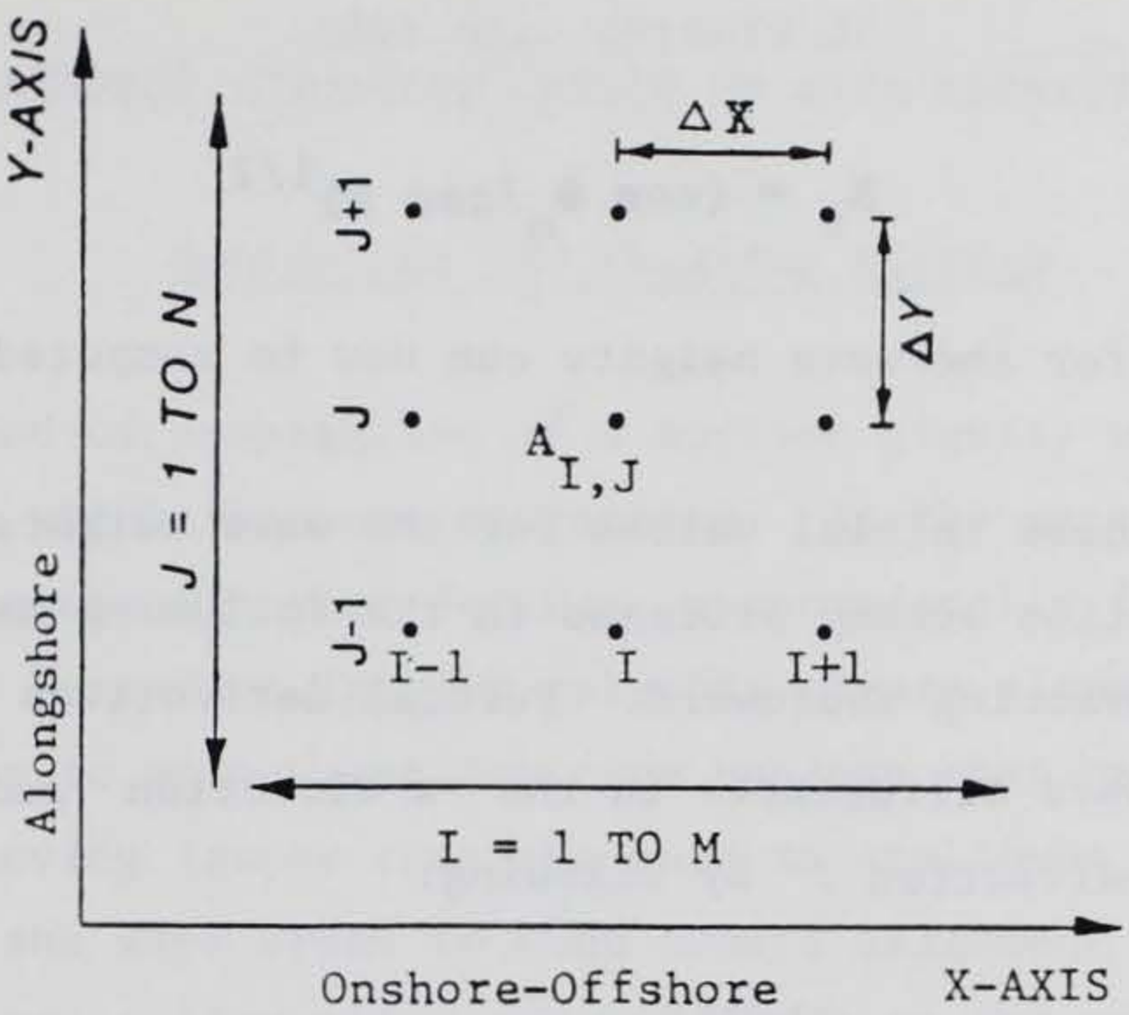


Figure 9. RCPWAVE coordinate system and grid computational scheme, (after Ebersole, et. al., 1985)

$$\frac{\sin\theta}{c} = \frac{\sin\theta_o}{c_o} \tag{13}$$

where

$$c_o = \frac{gT}{2\pi} \tag{14}$$

Hence, a first estimate of the wave angles can be calculated everywhere on the domain of interest. Letting the local wave height, H, be equal to the product of the deep water value, H_o, a shoaling coefficient, K_s, and a refraction coefficient, K_r:

$$H = H_o K_s K_r \tag{15}$$

where

$$K_s = \left(1/\tanh(kh)\left[1 + 2kh/\sinh(2kh)\right]\right)^{1/2} \tag{16}$$

and

$$K_r = (\cos \theta_o / \cos \theta)^{1/2} \tag{17}$$

The initial estimate for the wave heights can now be computed over the entire area of the grid.

60. Utilizing these initial values for the wave heights, H, and wave angles, θ, the solution scheme proceeds in the following manner, starting with row M-3 and advancing shoreward. Partial derivatives in Equation 7 are approximated with forward differences in the x-direction and with central differences in the y-direction. By allowing:

$$|\nabla \vec{s}| = k \tag{18}$$

a relaxation for the wave angles on row M-3 can be performed. Using these angles, again assuming Equation 18 is correct, and again taking forward differences in the x-direction and central differences in the y-direction, a relaxation of Equation 12 can be performed to obtain the wave heights on row M-3. To this point, only pure refraction theory has been used to arrive at a new solution for the wave heights and angles along the row.

61. The effect of diffraction is now included by approximating the y-derivatives in Equation 11 with central differences, and the x-derivatives with backward differences. Therefore, a new value of the magnitude of the wave phase function gradient, $(\nabla \vec{s})$, can be computed for all the points on row M-3. This re-specification of the "wave number", k, is essentially an estimation of the effect of diffraction. Equations 7 and 12 are then, again, used to relax towards solutions of the wave angle, θ, and the wave height, H, using the updated values of the wave number, k. This procedure is repeated row by row until the shoreline is reached, or other areas of interest are covered computationally.

PART VI: EFFECTS OF REDONDO SUBMARINE CANYON ON WAVE REFRACTION

Refraction and Shoaling Effects

62. The speed of propagation of a surface gravity wave depends on the depth of water in which the wave propagates. As the wave celerity decreases with depth, the wavelength must decrease proportionally for the period to remain constant. Variation in wave velocity occurs along the crest of a wave moving at an angle to underwater contours because that part of the wave in deeper water is moving faster than the part in shallower water. This variation causes the wave crest to bend toward alignment with the contours. This bending effect, called refraction, depends on the relation of water depth to wavelength. It is analogous to refraction of other types of waves, such as light or sound.

63. As waves propagate from deep water into shallower water, changes other than refraction take place. The assumption generally made is that there is no loss of wave energy and negligible reflection. The power being transmitted by the wave train in water of any depth is equal to the power being transmitted by the wave system in deep water. The wave period remains constant in water of any depth, whereas the wavelength, velocity, and height vary.

64. The transformation of irregular ocean waves is a complex process which is not fully understood. The usual method of treating the problem, which is quite successful, is to represent the actual system by a series of sinusoidal waves of different heights, periods, and phases. Such a system now has a two-dimensional energy spectrum. The wave statistics being analyzed in the present study are treated in such a manner.

65. The effects of refraction and shoaling are important for several reasons. These phenomena determine the wave height in any particular water depth for a given set of incident deepwater wave conditions; i.e., wave height, wave period, and direction of propagation in deep water. Refraction and shoaling, therefore, have significant influence on the wave height and distribution of wave energy along the coast. The change of wave direction of different parts of the wave results in convergence or divergence of wave energy, and materially affects the forces exerted by waves on structures.

Redondo Beach King Harbor Computational Grid

66. A variable-spaced rectangular numerical grid (116 rows of cells in an offshore direction and 76 rows of cells in the alongshore direction, total of 8,816 grid cells) covering the problem area and extending 12.6 mi offshore and 19.8 mi alongshore was developed. The depth grid was oriented such that Cell 34 alongshore coincided with the curved section of the breakwater at Cell 10 offshore. The section of breakwater from Station 20+50 to Station 36+00 was aligned with the y-axis of the numerical grid. Hence, the pertinent data pertaining to the +20.0 ft MLLW crest elevation of the structure was obtained at Cells 34-38 on row 10. The +11.5 ft MLLW crest elevation portion of the breakwater is oriented at an angle to the +20.0 ft MLLW crest elevation section of the structure. The pertinent data for the +11.5 ft MLLW crest elevation section is obtained from Cells 39-41 on rows 9, 8, and 7, respectively. The orientation of the breakwater is shown in Figure 10, with a portion of the depth grid for the +8.0 ft MLLW tide elevation (actual tide elevation of the 1982-1983 winter storms) presented in Figure 11. This particular portion of the variable-spaced grid has an aspect ratio of 1-to-2. In the vicinity of the structure, the width of the cells in the alongshore direction is 400 ft while the width of the cells in the offshore direction is 200 ft. Hence, this distorted plan view of the numerical grid does not present a true picture of the spatial magnitude of the Redondo Submarine Canyon. However, it does represent the depth of the Canyon in this near-structure region, with the head of the Canyon approaching the entrance to Redondo Beach King Harbor.

Refraction by Redondo Submarine Canyon

67. Initial insight into the manner in which ocean waves are affected by the Redondo Submarine Canyon near the breakwater can be obtained from wave ray displays of US Army Engineer District, Los Angeles (1964, 1966). Figures 12-14 detail the divergence of waves with period of 12 sec from an approach azimuth of 260 deg, period of 13 sec from an approach azimuth of 285 deg, and period of 15 sec from an approach azimuth of 286 deg, respectively. It appears from these displays that the Canyon causes a wave height reduction of up to 95 percent (refraction coefficient = 0.05) for the 15 sec wave with a

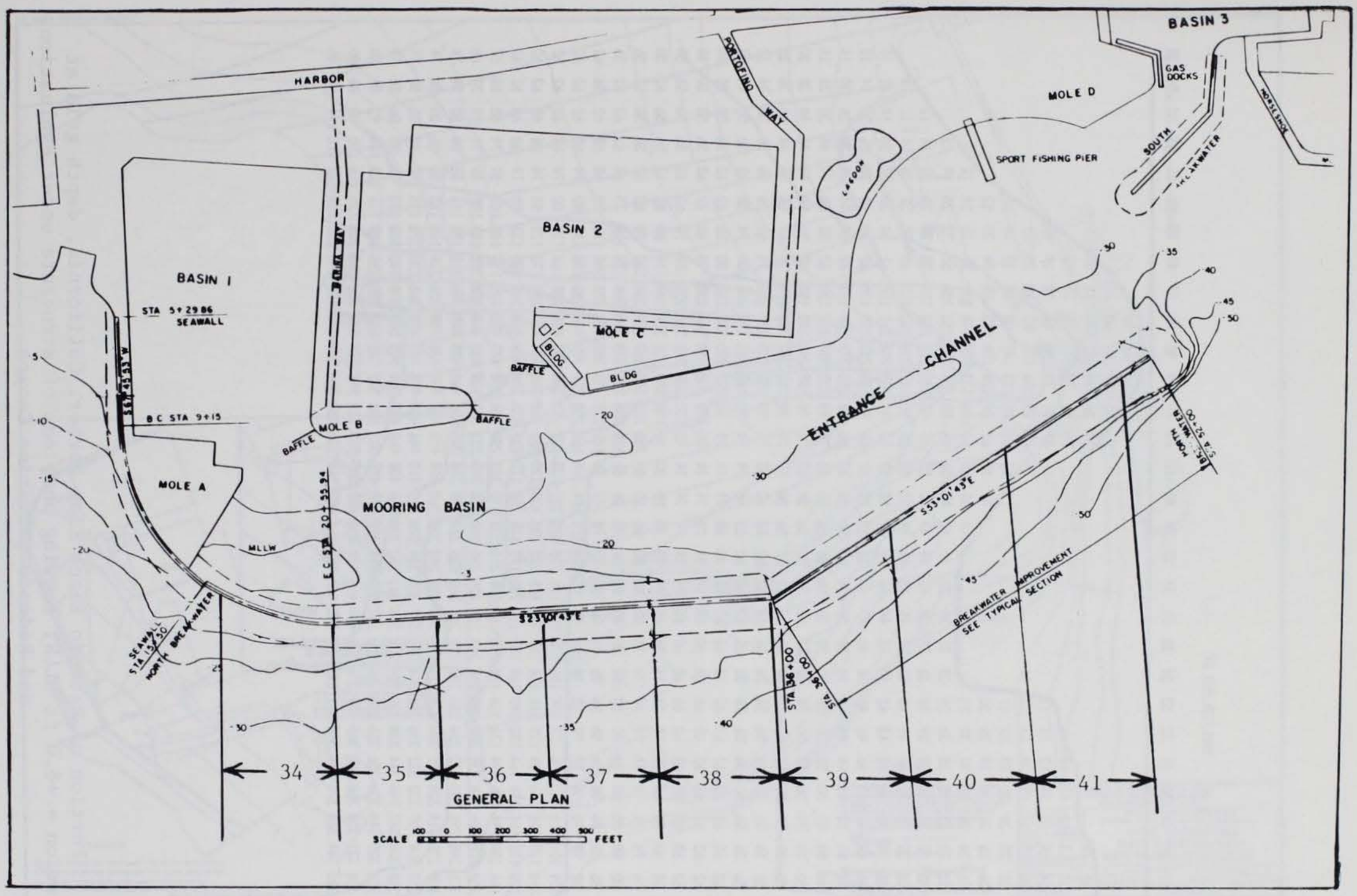


Figure 10. Redondo Beach King Harbor, California, breakwater sections 34-41 for estimating storm swell and average annual sea wave heights at the breakwater

WATER DEPTHS (MULTIPLIED BY 1.)

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				17	12	10									
2 :																			16	17	12	10	10								
3 :	12	12	12	11														25	26	24	21	18	14	10							
4 :	13	13	13	13	12	12	10											34	42	39	57	33	23	12							
5 :	14	14	14	14	14	14	13	11	11									37	71	79	88	68	38	14	10						
6 :	20	20	20	20	17	17	20	17	13									43	76	106	114	83	43	20	12						
7 :	26	26	20	20	20	20	25	22	17								42	54	82	123	142	98	68	32	14	10					
8 :	26	32	26	26	26	26	29	26	20							41	47	60	84	128	158	123	83	44	20	12					
9 :	32	32	26	26	26	26	32	30	23						40	45	50	64	86	133	178	146	101	56	26	14	12				
10 :	38	38	32	32	33	35	35	36	29	25	31	34	37	40	43	48	52	65	88	138	198	153	108	57	32	20	14	12			
11 :	38	38	38	32	34	36	38	39	34	36	35	38	42	44	47	50	55	65	90	143	213	158	113	58	38	26	20	14	12		
12 :	44	44	38	38	38	38	40	41	40	40	39	41	43	46	49	52	57	66	92	148	228	163	115	60	50	32	26	14	12	10	
13 :	44	44	38	38	40	40	43	43	43	43	43	44	46	49	52	55	59	66	94	168	243	161	118	61	50	38	32	20	14	12	10
14 :	50	50	44	44	42	42	46	46	46	46	46	47	48	52	53	58	61	68	96	178	258	178	120	62	50	44	38	26	20	14	12
15 :	50	50	44	44	44	44	44	44	44	44	50	50	50	50	50	56	62	68	98	188	278	188	123	62	50	44	38	38	26	20	14
16 :	56	56	44	50	50	50	50	50	50	50	50	56	56	56	56	56	62	74	98	188	284	218	128	62	50	50	44	44	38	26	14
17 :	56	56	50	50	50	50	50	50	50	50	50	56	56	56	56	56	62	74	98	188	296	248	158	68	56	50	44	44	44	38	20
18 :	56	56	50	50	50	50	50	50	50	50	56	62	62	62	56	56	62	74	98	188	308	308	188	74	62	56	50	44	44	38	26
19 :	62	62	56	56	56	56	56	56	56	56	56	62	62	62	62	62	68	74	98	188	308	328	200	74	62	56	56	50	50	44	32
20 :	62	62	56	56	56	56	56	56	56	56	62	62	62	62	62	68	74	74	98	188	318	332	208	80	74	58	62	56	50	44	38
21 :	62	62	62	62	62	62	62	62	62	62	62	62	68	68	68	74	74	74	98	188	328	338	218	88	68	62	62	56	50	50	44
22 :	62	62	62	62	62	62	62	68	68	68	68	68	74	74	74	74	74	88	108	208	338	348	228	98	68	62	62	56	50	50	44
23 :	68	68	62	68	68	68	68	68	68	68	68	68	74	74	74	74	74	93	133	228	348	368	238	108	78	62	62	56	56	56	50
24 :	68	68	68	68	68	68	74	74	74	74	74	74	74	80	80	80	80	98	158	248	358	378	248	118	88	62	62	56	56	62	50
25 :	74	74	74	74	74	74	74	74	74	74	74	80	80	80	86	80	80	108	183	268	368	388	258	128	98	68	62	56	56	62	56
26 :	80	80	80	80	80	80	80	80	80	80	80	80	80	86	92	86	86	128	208	288	378	398	268	138	108	73	68	62	62	62	56
27 :	86	86	86	86	86	86	86	86	86	86	86	86	86	92	98	92	86	148	233	308	388	408	278	148	113	78	68	68	62	56	62
28 :	92	92	92	98	98	104	98	92	92	98	104	98	98	104	110	104	104	168	258	328	398	418	288	158	118	83	74	68	62	62	62
29 :	98	98	104	110	116	122	116	110	104	116	128	110	116	116	122	122	122	188	283	348	408	428	298	168	123	88	74	68	62	62	62
30 :	104	104	116	128	134	146	134	122	116	134	158	122	122	122	128	128	128	208	308	368	413	438	308	178	128	93	74	68	68	62	62
31 :	110	110	128	158	164	176	164	152	140	164	188	158	158	170	176	188	176	238	333	388	418	448	318	188	133	98	74	68	68	62	62
32 :	116	116	146	188	194	206	194	176	164	188	218	188	200	218	230	248	242	258	358	408	423	458	328	198	138	103	80	74	68	68	62
33 :	122	122	158	218	236	254	230	206	188	218	248	218	224	230	248	308	308	333	383	428	428	468	338	208	148	108	80	74	74	74	68
34 :	128	122	176	248	296	308	272	254	236	248	278	266	248	236	260	338	368	388	408	448	453	478	348	218	158	113	86	80	80	74	74
35 :	140	128	188	278	314	320	320	308	278	278	308	308	278	248	278	368	408	418	433	468	478	488	358	228	168	113	86	86	80	80	74
36 :	152	140	218	308	320	332	332	326	308	314	320	332	320	314	308	392	418	446	458	488	493	498	368	238	178	113	92	92	86	80	74
37 :	164	188	248	308	332	344	344	338	332	326	332	356	362	362	380	416	458	468	483	508	508	508	378	248	188	113	98	98	86	80	74
38 :	176	218	278	320	344	356	356	356	356	356	356	380	398	416	458	488	498	503	508	528	523	518	388	258	198	116	110	104	92	80	80
39 :	182	248	308	332	356	368	368	368	374	374	374	404	416	428	458	488	508	518	533	548	538	528	398	268	208	128	116	110	98	86	80
40 :	188	278	320	344	368	374	386	386	392	392	404	428	440	452	464	482	518	538	558	568	558	538	408	278	228	134	122	116	104	92	86

Figure 11. Portion of Redondo Beach King Harbor, California, depth grid at tide elevation = +8.0 ft MLLW, showing portions of structure under evaluation, and Redondo Submarine Canyon

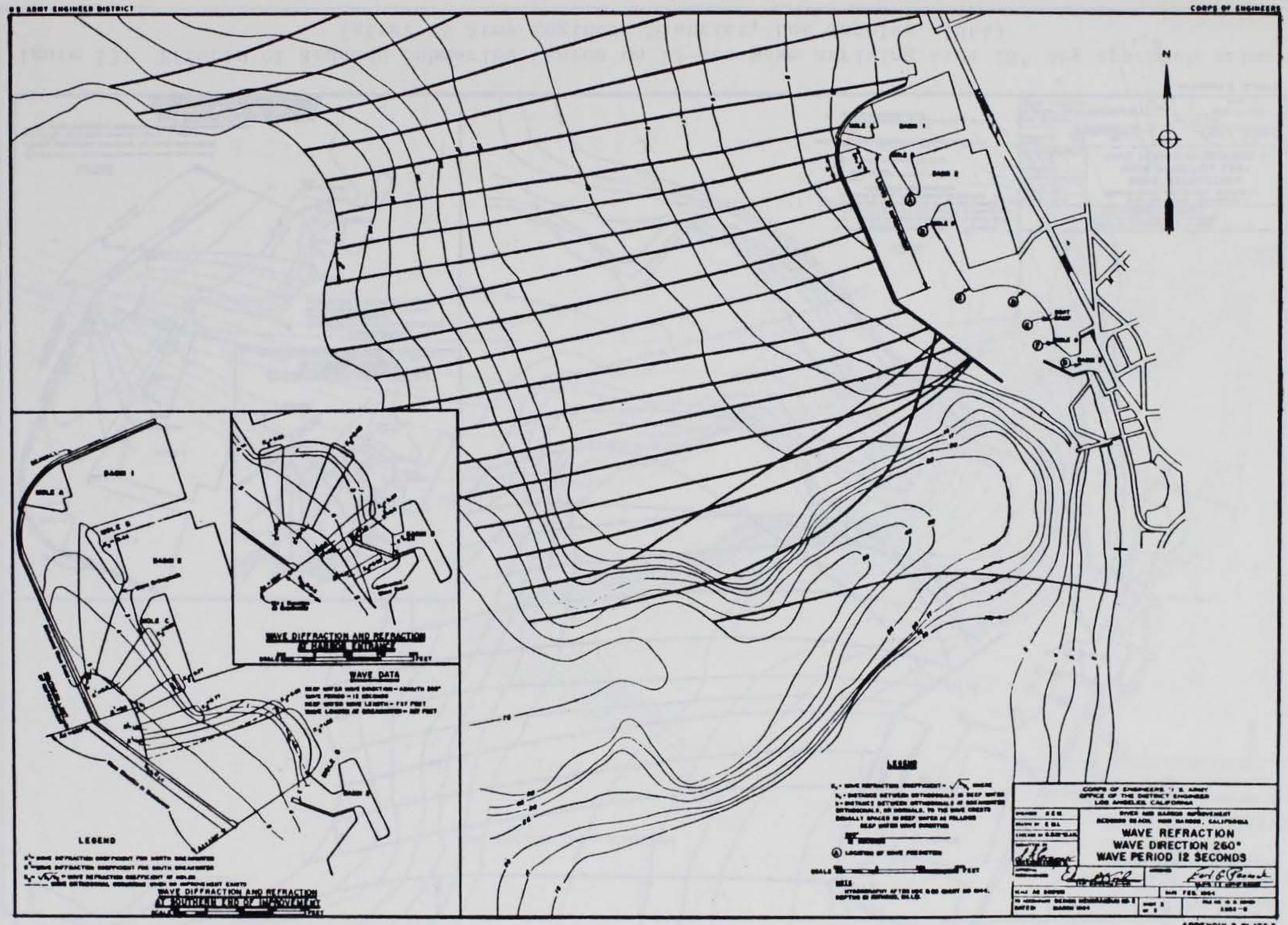


Figure 12. Effect of Redondo Submarine Canyon on 12-sec wave arriving from 260 deg approach azimuth, (after US Army Engineer District, Los Angeles, 1964)

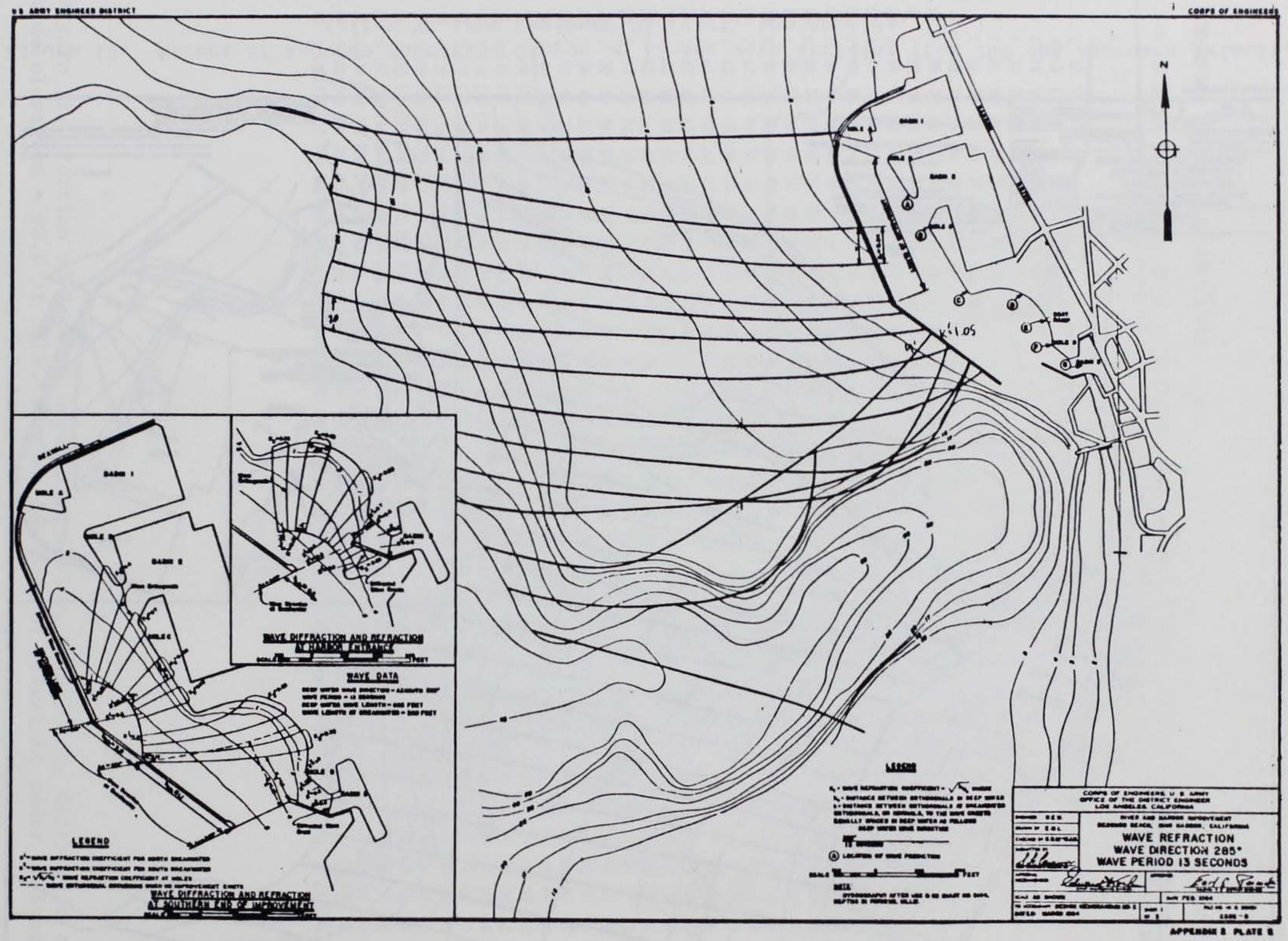


Figure 13. Effects of Redondo Submarine Canyon on 13-sec wave arriving from 285 deg approach azimuth, (after US Army Engineer District, Los Angeles, 1964)

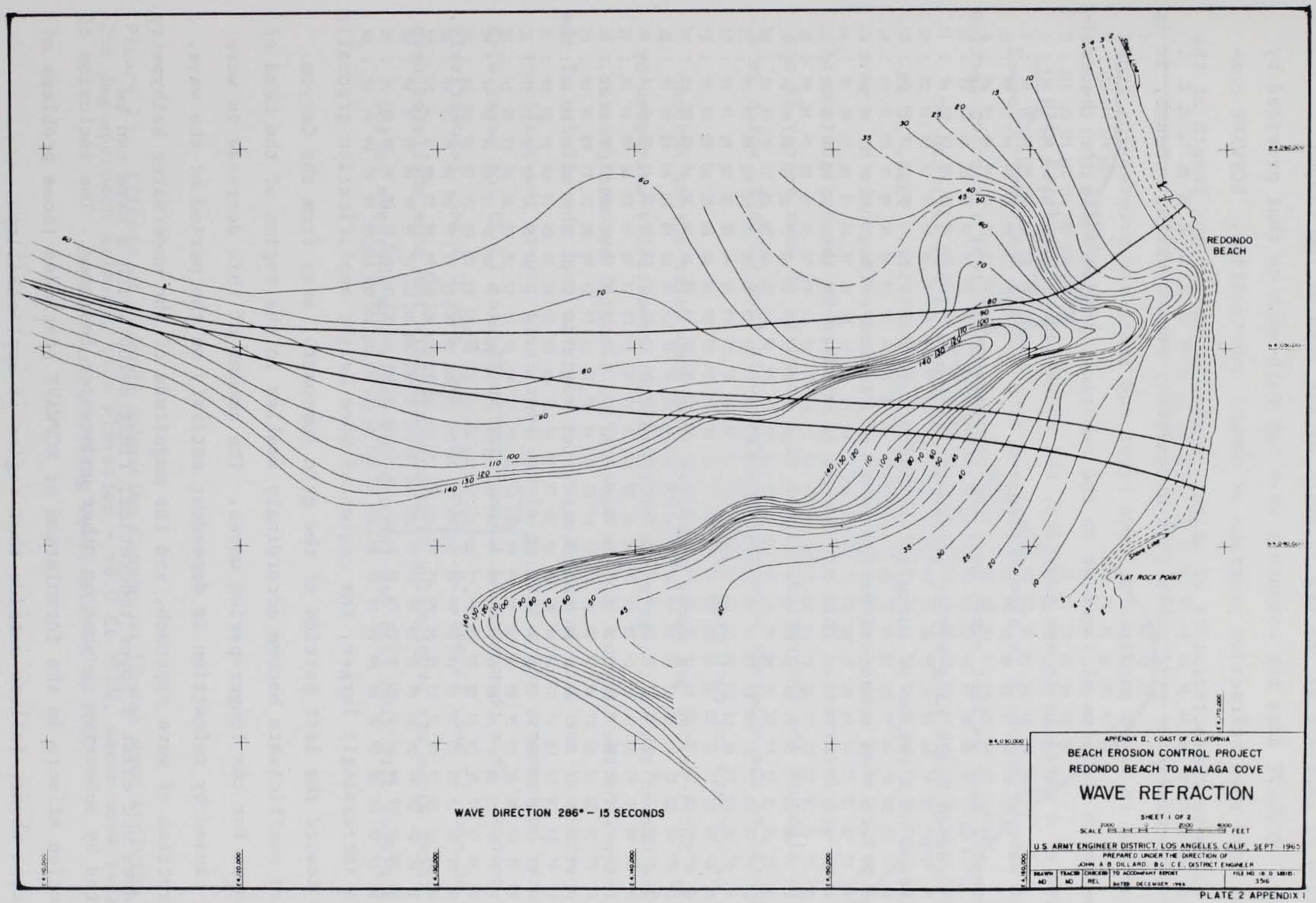


Figure 14. Effects of Redondo Submarine Canyon on 15-sec wave arriving from 286 deg approach azimuth, (after US Army Engineer District, Los Angeles, 1966)

direction of approach of 286 deg azimuth, at the head of the Canyon.

68. RCPWAVE does not compute a wave ray path such as that provided by earlier wave wave refraction programs or manual construction. RCPWAVE computes the wave characteristics of height, angle, celerity, and length at the center of rectilinear grid cells (not necessarily square cells). Hence, it is not possible to tag a particle of wave crest and trace its progression from deep water to the area of interest on the numerical grid. While the theoretical path of a particle is not provided, the uncertainty associated with crossed wave orthogonals is also eliminated from RCPWAVE analysis. Crossed orthogonals, such as that shown near the +11.5 ft MLLW crest elevation section of the Redondo Beach King Harbor breakwater (Figures 12 and 13), can be interpreted as a region of turbulent breaking wave activity. Thus, it is known a priori that computations shoreward of crossed orthogonals by a wave ray method are incorrect. This problem is eliminated by the application of RCPWAVE, although the theoretical travel of a particle of wave energy is not as dramatic to the observer viewing the output data from RCPWAVE, which is a matrix of numbers for each grid cell.

69. Short-period sea waves propagate from deep water across Redondo Submarine Canyon toward the entrance of the Harbor essentially unimpeded by the existence of the Canyon. As the wave period (length) becomes greater, those portions of the wave in shallower water begin to feel the effects of the underwater bathymetry, and a turning of the wave crest toward the shallower region occurs. This phenomena is illustrated in Figures 15-20 for waves with period 10 sec, 12 sec, 14 sec, 16.5 sec, 18.5 sec, and 20.5 sec, respectively. All of these waves are propagating from approximately the same sheltered deep water approach direction (258 deg through 269 deg). As the wave period becomes increasingly larger, the region of wave height amplification gradually shifts toward the left portion of the grid (upcoast), away from the Canyon. The wave coefficients become accordingly smaller in the region of the head of the Canyon for the longer-period waves. The amount of this decrease in wave height caused by refraction is dependent entirely on the period of the wave, the direction of wave approach, and the magnitude of the underwater bathymetry. There does not exist a lower theoretical limit below which a wave can be refracted by submarine canyons or other underwater features. The inclusion of diffraction effects in the formulation of RCPWAVE precludes those problems of refraction theory failure outside that region of applicability.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																				44	42	42									
2																			59	44	42	42	43								
3	116	114	114	117														78	54	41	38	38	42	5[illegible]							
4	114	112	112	113	114	110	113											77	51	39	35	35	40	56							
5	111	110	111	112	111	107	105	118	13[illegible]									81	52	39	36	35	40	56	7[illegible]						
6	104	102	103	104	107	103	98	105	12[illegible]									82	55	42	38	37	40	53	79						
7	99	98	104	104	103	100	93	99	113								111	83	57	45	41	39	40	53	80	10[illegible]					
8	99	95	99	99	98	95	91	96	108							124	111	85	60	48	44	42	42	53	79	99	[illegible]				
9	96	95	99	99	97	95	90	94	104						118	121	111	88	63	50	47	44	45	56	77	96	106				
10	93	93	96	95	93	91	90	91	99	105	101	99	100	106	115	119	111	90	66	53	49	47	48	58	75	90	104	113			
11	94	93	93	95	92	90	89	91	96	98	99	97	98	103	112	117	111	92	69	55	52	49	51	60	74	86	98	110	114		
12	92	91	93	92	91	89	89	90	94	97	97	96	96	101	110	115	110	93	71	58	55	52	54	62	74	84	95	109	114	117	
13	92	92	93	92	90	89	88	90	93	96	96	95	95	100	108	113	110	94	73	61	58	54	56	65	75	83	91	102	110	113	117
14	91	91	92	90	89	88	87	89	93	95	95	94	94	98	106	111	109	95	75	64	61	58	59	67	76	82	89	97	103	110	114
15	92	91	92	90	88	87	88	90	93	95	94	93	93	97	105	110	108	95	77	66	64	61	61	69	76	82	88	92	99	104	111
16	91	90	92	89	87	86	87	89	92	94	95	92	93	96	102	108	107	95	78	69	67	65	64	70	76	81	87	91	95	101	110
17	91	90	91	89	87	86	87	89	92	94	94	93	93	95	101	106	106	95	79	71	70	68	68	71	77	81	87	92	94	96	104
18	91	91	91	89	87	86	87	89	92	94	93	92	92	94	99	105	104	95	80	73	73	72	72	73	77	81	87	93	95	95	99
19	91	90	90	88	86	85	86	88	91	93	93	93	92	94	97	102	103	94	81	75	76	76	75	73	77	81	86	93	95	93	95
20	91	90	90	87	86	85	86	89	91	93	93	93	92	93	96	101	102	94	81	77	80	79	77	74	77	81	86	93	96	93	91
21	91	91	89	87	85	85	86	88	91	92	92	93	92	92	95	100	101	93	81	79	83	83	80	75	77	81	87	94	96	92	89
22	91	91	89	87	85	85	86	88	91	92	92	92	92	92	94	99	100	91	81	82	86	85	82	76	77	81	88	95	96	92	88
23	91	90	89	86	85	84	86	89	92	92	91	91	92	92	93	98	99	91	82	85	89	88	84	76	77	82	89	95	95	91	88
24	91	90	89	86	85	84	86	89	92	92	90	91	93	92	92	97	98	90	85	88	91	90	86	77	77	82	89	95	95	90	87
25	91	90	89	86	85	84	86	90	92	92	90	91	93	92	92	96	97	90	87	91	93	92	87	79	78	83	90	95	95	90	86
26	91	90	89	86	85	85	87	90	93	92	90	91	93	92	92	95	95	91	90	93	95	93	89	80	79	83	90	95	95	90	86
27	91	91	89	86	85	85	87	91	93	91	89	91	93	93	92	94	94	92	93	95	96	94	90	81	79	84	90	95	94	90	85
28	91	91	89	87	86	86	88	91	93	91	90	91	93	93	92	93	93	93	95	96	97	95	91	83	80	84	91	95	94	88	85
29	91	91	89	87	87	88	89	92	93	92	91	92	94	94	93	94	93	95	96	97	97	96	92	84	81	85	92	95	93	88	84
30	91	91	90	88	89	90	91	93	94	93	94	93	94	94	94	93	93	96	98	98	98	96	93	86	82	86	93	94	91	88	84
31	92	92	91	90	91	93	94	94	95	95	96	96	96	97	97	97	96	98	98	98	98	97	93	87	83	87	93	94	91	87	84
32	92	92	92	93	94	95	96	96	96	97	98	97	98	99	99	99	98	98	99	99	98	97	94	89	85	88	93	93	90	86	84
33	92	92	93	94	96	97	97	97	97	98	99	99	99	99	100	100	99	99	99	99	98	98	95	90	86	89	93	92	89	86	84
34	92	92	94	96	97	98	98	99	99	99	100	100	100	100	100	100	99	99	99	99	99	98	96	91	88	90	93	91	89	86	84
35	93	92	95	97	98	99	99	99	99	100	100	100	100	100	100	100	100	99	99	99	99	98	96	92	89	91	92	91	88	86	84
36	94	93	96	98	98	99	99	99	100	100	100	100	101	100	100	100	100	99	99	99	99	98	97	93	91	91	92	90	88	87	84
37	95	96	97	98	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	94	92	91	92	90	88	87	84
38	96	97	98	99	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	95	94	92	92	90	88	86	84
39	96	98	99	99	99	99	100	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	96	94	92	92	90	88	87	84
40	97	99	99	99	99	99	100	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	99	97	96	93	92	91	88	87	85

Figure 15. Effects of Redondo Submarine Canyon on 10-sec wave arriving from 258 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				23	24	24									
2 :																			29	23	24	24	28								
3 :	122	119	117	119														39	26	22	21	22	25	34							
4 :	120	117	115	115	115	111	118											39	25	21	19	21	24	35							
5 :	118	114	114	113	111	107	107	125	14									42	26	20	19	20	24	35	53						
6 :	109	106	105	105	106	103	97	110	133									45	28	21	20	21	24	34	54						
7 :	103	100	105	104	102	100	93	103	122								87	48	29	23	22	22	24	34	57	78					
8 :	103	97	100	99	96	94	91	99	115							130	92	52	32	25	24	24	25	34	57	78					
9 :	99	97	100	98	96	94	90	96	110						144	131	97	57	35	27	25	25	27	37	57	76	90				
10 :	97	94	96	94	91	89	90	93	104	113	112	113	119	132	140	131	101	62	38	29	28	27	29	39	55	72	88	101			
11 :	97	94	93	94	90	88	88	92	101	105	108	109	114	126	136	131	104	67	41	32	30	29	32	41	56	70	84	100	109		
12 :	95	92	93	91	88	87	88	92	98	103	106	107	112	123	133	130	106	72	45	34	32	31	34	43	57	69	82	99	108	118	
13 :	95	93	93	90	87	86	87	91	97	102	104	105	109	119	129	128	108	76	49	37	35	33	36	46	58	68	79	93	105	114	122
14 :	94	91	91	88	86	85	86	90	96	101	103	103	106	115	126	126	109	79	52	40	38	36	38	49	59	68	77	88	99	111	119
15 :	94	92	91	88	85	84	86	91	97	102	101	102	105	113	124	125	110	82	56	43	41	39	41	52	61	69	76	84	95	106	118
16 :	93	90	91	86	83	82	85	89	95	99	101	100	103	110	119	123	111	84	59	46	44	42	44	54	62	68	75	83	91	103	117
17 :	93	91	89	86	83	82	85	89	95	99	101	100	102	108	117	121	110	86	62	49	48	45	47	56	63	69	76	84	90	98	111
18 :	94	91	89	85	82	82	85	90	95	99	99	99	101	106	115	118	109	87	64	52	52	50	51	57	63	68	75	85	93	97	106
19 :	93	90	88	84	81	81	84	89	94	97	99	99	101	105	111	115	107	88	66	55	55	54	54	59	64	68	75	85	93	95	102
20 :	93	91	88	84	81	81	84	89	94	97	98	99	101	103	109	112	105	88	67	58	59	58	57	59	65	69	75	87	95	95	96
21 :	93	91	87	83	80	80	83	88	93	96	98	99	100	101	106	110	105	87	68	61	63	62	60	61	65	69	76	88	95	94	93
22 :	94	91	87	83	80	80	83	88	93	95	96	98	99	100	103	109	105	86	68	64	67	66	62	62	65	69	78	89	95	94	92
23 :	93	91	87	82	79	79	83	89	94	95	95	97	99	100	102	107	104	86	69	68	71	69	65	62	65	70	79	90	94	93	91
24 :	93	91	87	82	79	79	82	89	94	95	94	96	100	99	99	104	102	85	71	71	75	72	67	63	65	71	80	91	95	92	90
25 :	92	90	86	81	78	79	83	90	95	95	93	95	99	99	98	102	100	85	73	75	78	75	70	64	65	72	81	92	95	92	88
26 :	92	90	86	81	78	79	83	90	95	94	92	95	100	99	96	100	97	84	76	79	81	77	72	65	66	72	82	92	96	92	87
27 :	92	90	86	81	78	79	83	90	95	93	91	95	99	98	96	97	95	84	79	82	83	79	73	67	67	73	83	93	96	92	85
28 :	91	90	85	80	78	79	83	90	95	93	90	95	99	98	95	95	92	85	83	84	85	81	75	68	67	73	85	94	95	89	84
29 :	91	90	85	80	79	80	84	90	94	92	91	95	98	98	95	93	91	86	85	87	86	83	76	69	68	74	86	94	94	88	84
30 :	91	90	85	80	80	82	85	90	94	93	92	95	98	97	95	92	89	87	88	88	87	84	78	71	69	76	88	94	92	88	83
31 :	91	90	85	82	82	84	87	90	93	94	94	96	98	99	96	93	90	89	90	89	88	85	80	72	70	77	89	94	91	86	82
32 :	91	90	86	83	84	87	89	91	93	95	97	97	100	101	99	96	92	90	91	90	89	86	81	74	71	79	90	93	90	85	82
33 :	90	90	86	85	87	90	91	93	94	96	99	99	101	101	99	97	94	92	91	90	90	87	83	75	73	81	91	92	88	84	81
34 :	90	89	87	87	90	93	94	95	96	98	100	101	102	101	99	98	95	93	91	91	90	88	84	77	74	82	90	90	87	83	80
35 :	90	89	88	90	92	94	96	97	97	99	102	103	103	101	100	98	95	93	91	91	91	89	86	79	76	84	90	89	86	83	80
36 :	91	89	89	92	93	95	96	97	98	100	102	104	104	103	100	98	95	93	92	91	91	90	87	80	78	85	89	88	85	83	80
37 :	91	90	91	93	94	96	97	98	99	100	102	104	105	104	101	98	95	93	92	91	92	91	89	82	80	85	88	87	85	82	80
38 :	92	92	92	94	95	96	97	98	99	101	103	105	105	104	101	98	95	93	92	92	92	92	90	84	82	85	88	86	84	82	79
39 :	92	93	94	95	96	97	98	99	100	101	103	105	105	104	101	98	95	92	92	92	92	93	91	85	83	86	88	86	83	81	79
40 :	92	95	95	95	96	97	98	99	100	102	104	105	105	104	101	97	94	92	92	92	93	93	92	87	85	86	87	85	82	80	79

Figure 16. Effects of Redondo Submarine Canyon on 12-sec wave arriving from 258 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				11	12	13									
2 :																			13	11	12	13	14								
3 :	121	117	115	118														16	12	11	11	12	14	1[illegible]							
4 :	119	114	113	114	117	117	130											16	12	10	10	11	13	19							
5 :	117	112	111	111	112	113	120	148	17[illegible]									18	12	10	10	10	13	19	30						
6 :	107	103	102	102	107	109	107	129	163									19	13	10	10	11	13	19	31						
7 :	101	97	102	102	103	104	103	120	148								33	20	14	11	11	11	13	19	33	4[illegible]					
8 :	102	93	96	96	96	99	100	114	139							77	38	22	15	12	12	12	14	19	33	50					
9 :	98	94	96	95	95	98	99	111	133						122	83	43	24	17	13	13	13	15	20	34	49	62				
10 :	95	91	92	91	90	92	98	107	125	139	137	138	140	139	124	88	49	27	19	15	14	14	16	22	34	47	61	75			
11 :	95	91	89	90	89	91	96	106	120	128	132	133	134	135	123	93	54	30	21	16	15	15	18	23	34	46	59	74	86		
12 :	93	89	89	86	86	89	95	105	117	125	129	129	131	132	123	96	59	34	23	17	16	16	19	25	36	46	58	75	86	98	
13 :	93	89	89	86	85	88	94	104	115	123	126	125	126	128	122	99	64	38	25	19	18	18	20	27	37	46	56	70	83	96	110
14 :	92	87	86	83	83	87	92	102	113	122	124	123	123	124	120	101	69	42	28	21	20	19	22	30	38	46	55	66	79	95	109
15 :	92	88	86	83	82	85	93	103	114	123	122	121	121	122	120	102	73	46	31	23	22	21	23	32	40	48	54	63	76	91	109
16 :	91	86	86	81	80	83	91	101	111	119	122	119	117	118	115	102	76	49	33	26	24	23	25	34	41	48	55	63	73	90	108
17 :	92	87	84	80	79	83	91	101	111	119	122	119	117	116	113	101	78	53	36	28	27	25	27	36	43	49	56	64	74	87	104
18 :	92	87	84	80	79	83	91	101	111	119	120	117	115	113	111	100	79	55	39	31	29	28	30	38	44	49	56	66	77	86	100
19 :	91	86	82	78	77	81	89	99	109	116	119	117	115	111	108	98	78	57	42	34	32	31	32	39	45	50	55	67	79	85	97
20 :	92	87	83	78	77	80	89	99	109	116	117	118	114	110	106	96	78	58	43	36	35	34	35	40	46	51	56	69	81	86	92
21 :	92	87	81	76	75	79	87	98	108	114	117	118	113	107	102	94	79	59	45	39	38	37	37	42	47	51	58	71	82	86	89
22 :	92	88	82	76	75	79	87	97	107	112	115	116	112	105	99	93	80	59	45	41	42	40	39	43	48	52	59	73	83	87	89
23 :	92	87	82	75	74	77	86	98	108	112	114	116	112	104	96	92	81	60	46	44	45	43	42	44	49	54	61	74	83	86	87
24 :	92	88	81	75	74	77	85	98	108	111	112	114	113	103	93	89	79	60	47	47	48	46	44	45	49	55	63	76	84	87	87
25 :	91	87	80	75	73	76	85	98	108	111	111	113	112	103	91	87	79	61	49	50	51	49	46	46	49	56	64	77	86	87	85
26 :	91	87	80	74	73	75	84	98	108	110	109	113	113	101	89	84	77	61	51	53	54	51	48	47	50	56	65	79	88	87	84
27 :	91	87	80	74	72	75	84	97	108	109	108	112	112	101	87	81	75	61	54	56	57	54	50	49	51	57	67	81	90	87	81
28 :	90	87	80	73	72	75	83	97	108	107	106	111	110	99	85	77	71	61	57	58	59	56	52	50	52	58	69	83	89	85	80
29 :	90	87	79	73	72	75	82	95	106	106	105	110	109	98	84	75	69	62	59	61	61	58	54	52	53	59	72	85	89	84	79
30 :	89	87	79	73	73	76	82	94	105	106	105	110	108	97	84	73	67	63	62	63	63	61	56	54	54	61	75	86	87	83	77
31 :	89	87	79	73	74	77	83	93	103	106	107	109	106	96	83	72	66	64	64	65	65	62	58	55	55	62	77	86	86	82	76
32 :	88	86	79	74	75	79	84	92	101	106	109	109	106	96	84	72	66	64	66	67	67	64	60	57	56	64	79	86	85	80	75
33 :	88	86	80	76	78	82	86	92	100	107	111	110	106	96	84	73	67	66	67	68	68	66	62	58	57	67	81	86	83	78	74
34 :	87	86	80	78	81	85	88	93	101	108	114	112	106	95	83	74	69	67	68	69	69	68	64	60	59	69	81	84	82	77	72
35 :	87	85	80	80	83	87	91	95	102	109	115	114	106	94	83	75	70	68	69	70	71	70	67	62	61	72	82	83	81	76	71
36 :	87	84	81	82	85	88	92	96	102	110	116	116	107	95	83	75	70	69	70	71	72	72	69	64	63	73	81	82	79	75	70
37 :	87	84	82	83	86	89	92	97	103	111	117	117	109	96	84	75	71	69	70	72	74	73	71	65	66	74	81	81	79	74	69
38 :	87	85	83	85	87	90	93	97	103	112	118	118	109	97	84	76	71	70	71	73	75	75	73	68	67	75	80	80	77	73	67
39 :	87	86	85	86	88	91	94	98	104	112	118	118	109	96	84	75	71	70	72	74	76	77	75	70	69	75	80	79	76	71	66
40 :	87	87	86	87	89	92	95	98	104	112	119	119	110	96	83	75	71	71	73	75	78	78	77	72	71	76	80	79	74	69	66

Figure 17. Effects of Redondo Submarine Canyon on 14-sec wave arriving from 258 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																				5	5	6									
2																			6	5	5	6	8								
3	116	116	122	135														6	5	5	5	5	6	8							
4	113	113	119	129	144	153	174											6	5	4	4	5	6	9							
5	110	110	116	126	139	149	161	192	21									7	5	4	4	4	6	9	14						
6	101	100	106	116	132	143	145	169	19									7	5	4	4	5	6	8	15						
7	95	94	105	115	127	138	139	157	180								12	8	6	5	5	5	5	8	15	24					
8	95	89	96	107	118	130	136	151	170							25	13	9	6	5	5	5	6	9	16	24					
9	91	89	97	105	117	130	135	147	163						52	28	15	10	7	6	5	5	6	9	16	24	32				
10	87	86	92	100	110	122	134	143	154	152	127	106	90	75	55	32	18	11	8	6	6	6	7	10	16	23	32	41			
11	88	85	88	98	108	121	133	143	150	140	123	102	87	74	57	36	20	13	9	7	6	6	8	11	17	23	31	41	50		
12	85	83	87	93	104	119	132	142	146	137	120	99	84	74	59	40	23	15	10	7	7	7	9	11	18	23	31	41	50	62	
13	85	82	87	92	102	117	130	142	145	136	117	96	81	72	60	43	26	17	11	9	8	8	9	13	18	24	30	39	49	61	78
14	84	80	83	88	99	115	128	141	144	135	116	94	79	69	61	46	29	19	13	9	9	8	10	14	19	24	30	37	46	60	78
15	84	80	83	87	97	113	130	143	146	138	115	92	77	68	61	48	32	21	15	10	10	9	11	16	20	25	30	35	45	59	79
16	83	78	82	84	94	109	127	140	143	135	115	90	74	65	59	49	35	23	17	12	11	10	12	17	21	26	30	35	43	59	80
17	83	79	79	83	92	109	127	141	144	135	115	90	73	64	58	49	37	26	19	14	12	11	13	18	23	27	31	36	44	58	78
18	84	79	79	81	91	108	127	142	146	136	113	89	71	61	57	50	38	28	21	15	13	12	14	19	24	27	31	37	47	58	78
19	82	78	76	78	88	105	125	140	144	133	113	89	70	60	55	49	38	29	22	17	15	14	16	21	25	28	31	38	49	59	77
20	83	78	76	77	86	104	125	141	145	134	111	88	69	58	54	48	39	30	24	19	17	15	17	21	26	29	32	40	52	60	74
21	83	78	74	75	83	100	122	140	144	132	111	88	68	55	51	48	40	30	24	20	19	17	18	23	27	29	33	42	53	62	73
22	84	78	74	74	82	99	122	139	144	131	108	86	66	53	49	48	42	31	25	22	20	19	20	24	28	30	34	44	54	64	74
23	83	77	74	72	79	96	120	141	146	132	108	86	66	52	47	47	43	32	25	23	23	21	21	24	28	32	36	45	56	65	75
24	83	78	72	71	78	94	117	141	147	131	106	84	66	50	44	45	43	33	26	25	25	23	23	25	29	33	37	47	58	67	76
25	83	77	71	70	75	91	117	142	149	131	105	82	64	49	42	44	43	34	27	27	27	25	24	26	29	34	39	48	61	69	76
26	82	77	71	68	74	88	114	142	150	131	103	82	64	48	40	41	42	34	28	29	28	26	26	27	30	35	40	50	64	72	76
27	82	77	70	67	72	86	111	141	150	130	101	81	63	47	38	39	41	34	30	30	30	28	27	28	31	36	41	53	68	73	74
28	82	77	70	66	71	83	108	140	151	130	98	79	61	45	37	37	39	35	32	32	32	30	28	29	32	36	43	57	69	73	74
29	81	77	69	65	69	81	105	136	150	129	96	77	59	44	36	35	37	35	33	34	34	32	30	31	33	37	46	60	70	74	74
30	81	77	69	64	68	79	102	133	149	130	96	76	57	43	36	34	36	35	35	36	36	33	31	32	34	38	49	62	71	74	73
31	80	77	69	63	67	79	100	129	146	130	98	74	55	41	35	32	34	35	36	37	37	35	33	34	35	40	52	64	72	74	73
32	79	77	68	63	68	79	98	126	144	132	100	73	53	41	35	32	34	36	38	39	39	37	34	35	36	41	54	66	72	73	73
33	79	76	68	64	68	79	98	124	142	133	103	72	52	40	35	33	34	37	39	40	40	38	36	37	37	44	57	67	71	73	72
34	78	76	68	65	70	80	97	122	141	135	106	72	51	40	35	34	35	38	40	42	41	40	38	38	38	46	59	67	71	73	71
35	77	75	68	66	71	80	97	121	141	137	109	74	50	39	35	35	36	39	41	43	43	41	40	39	40	50	61	67	72	73	71
36	76	74	68	67	72	80	96	120	141	139	112	75	50	39	35	35	37	40	42	44	45	43	42	41	42	52	61	67	72	73	70
37	76	72	68	69	73	80	95	119	141	141	114	77	50	39	36	36	38	40	43	45	46	45	44	42	44	53	62	68	73	73	69
38	76	72	69	70	73	80	94	117	140	143	117	79	51	39	36	37	39	42	44	47	48	47	46	44	46	54	62	69	73	72	68
39	76	72	70	71	74	80	92	115	140	145	120	81	51	39	37	37	40	42	45	48	49	48	48	46	47	55	64	70	72	71	67
40	75	73	71	72	75	80	91	112	139	147	124	83	52	40	37	38	40	43	47	49	51	50	50	48	49	57	65	70	71	69	66

Figure 18. Effects of Redondo Submarine Canyon on 16.5-sec wave arriving from 264 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	3	4									
2 :																			3	3	3	4	4								
3 :	146	152	158	166														4	3	3	3	3	4	5							
4 :	143	148	156	161	160	148	139											4	3	3	2	3	3	5							
5 :	140	146	154	159	156	144	129	125	118									4	3	2	2	3	3	5	8						
6 :	128	134	142	147	150	140	117	110	109									4	3	3	3	3	3	5	9						
7 :	121	126	142	147	145	136	113	103	98								6	5	4	3	3	3	3	5	9	15					
8 :	121	120	134	139	138	129	111	99	92							13	7	5	4	3	3	3	3	5	10	15					
9 :	115	120	134	139	138	131	111	96	87						29	15	8	5	4	3	3	3	4	6	10	15	20				
10 :	111	116	128	133	132	123	111	94	81	68	53	49	49	44	32	18	10	6	5	4	3	4	4	6	10	14	20	26			
11 :	111	116	123	133	132	124	110	93	79	61	50	46	47	45	35	20	12	7	5	4	4	4	5	6	10	14	20	26	32		
12 :	108	112	124	129	129	124	110	93	76	59	47	43	45	45	37	23	13	9	6	5	4	4	5	7	11	14	20	26	32	40	
13 :	107	112	124	129	128	123	110	93	75	57	45	41	43	44	39	26	15	10	7	5	4	5	5	8	11	15	19	25	31	39	53
14 :	105	109	120	125	127	124	110	93	74	56	43	38	40	42	40	29	18	12	8	6	5	5	6	9	12	15	19	23	29	39	53
15 :	105	109	120	126	127	124	113	95	75	56	42	36	38	41	40	32	20	13	9	6	6	5	6	10	13	16	19	22	28	38	54
16 :	102	107	120	123	125	122	111	93	72	54	41	35	36	39	39	33	23	15	10	7	6	6	7	10	13	16	19	22	27	39	55
17 :	102	107	116	123	126	124	113	94	72	53	40	34	35	38	39	34	24	17	12	8	7	6	8	11	14	17	20	23	28	38	54
18 :	102	107	116	123	127	126	115	96	72	52	38	32	33	37	39	34	26	18	13	9	8	7	9	12	15	18	20	23	30	37	55
19 :	100	105	114	120	125	125	114	95	71	50	37	31	32	36	38	34	26	19	15	11	9	8	10	13	16	18	20	24	32	39	55
20 :	99	104	113	121	126	127	117	96	71	49	35	30	31	34	37	35	27	20	16	12	10	9	10	14	17	19	20	25	33	40	53
21 :	99	104	111	118	125	126	117	96	70	47	34	30	30	32	36	35	28	21	17	13	11	10	11	15	17	19	21	27	34	41	53
22 :	98	104	111	119	126	128	119	96	69	45	32	29	28	30	34	35	30	21	17	14	13	11	12	15	18	20	22	28	35	43	54
23 :	96	101	110	117	124	128	119	98	69	44	31	28	28	29	33	35	31	22	17	15	14	13	13	16	18	21	23	29	36	45	55
24 :	95	101	108	117	126	130	120	99	69	42	29	27	28	28	31	34	32	23	18	16	15	14	14	16	19	22	24	30	38	47	57
25 :	93	98	105	115	125	129	123	101	69	40	28	26	27	27	29	33	32	24	19	18	17	15	15	17	19	22	25	31	40	49	58
26 :	91	96	103	114	124	130	124	102	68	38	26	26	27	27	27	31	32	25	20	19	18	16	16	18	20	23	26	32	44	52	58
27 :	89	94	101	112	124	131	125	103	68	37	24	25	27	26	26	30	31	25	21	20	19	18	17	18	21	24	27	34	47	54	58
28 :	87	92	99	110	123	129	125	104	68	35	23	24	26	25	25	28	30	26	22	22	21	19	18	19	22	24	28	38	49	54	58
29 :	85	90	95	107	122	130	125	102	66	33	21	23	25	25	25	26	28	26	23	23	22	20	19	20	22	25	30	40	50	55	59
30 :	83	87	92	103	121	131	126	102	65	32	21	23	25	25	24	25	27	26	25	24	23	21	20	21	23	26	32	42	51	57	59
31 :	80	85	89	99	119	132	127	101	63	31	20	22	24	24	24	24	25	26	26	25	24	22	21	22	24	27	35	44	52	57	59
32 :	78	82	85	96	118	134	130	102	63	31	20	21	23	24	24	23	25	26	27	27	25	23	22	23	24	28	37	47	53	57	60
33 :	76	79	81	92	117	137	134	104	62	32	21	20	22	24	24	24	25	27	28	28	26	24	23	24	25	29	39	48	53	57	60
34 :	74	76	77	88	115	139	138	107	62	32	21	20	22	24	24	24	25	27	28	29	28	26	25	25	26	31	41	48	54	58	59
35 :	72	73	73	84	112	141	144	112	65	33	22	20	22	23	24	25	26	28	29	30	29	27	26	26	27	34	43	49	55	59	59
36 :	71	70	69	80	108	140	149	119	68	34	22	21	22	23	24	26	27	29	30	31	30	28	27	27	29	36	43	49	56	60	59
37 :	71	67	66	77	103	138	153	127	74	35	23	21	22	23	25	26	28	29	31	32	31	29	29	29	30	37	44	51	57	60	59
38 :	70	66	65	74	98	134	156	136	81	37	24	22	22	24	25	27	29	30	32	33	32	31	30	30	32	38	45	52	58	60	58
39 :	70	66	64	72	92	128	157	144	90	40	24	22	22	24	26	27	29	31	33	34	34	32	32	32	33	39	46	53	58	59	57
40 :	69	66	65	70	87	122	156	152	100	43	25	22	23	24	26	28	30	32	34	35	35	33	33	33	34	40	48	54	58	58	57

Figure 19. Effects of Redondo Submarine Canyon on 18.5-sec wave arriving from 269 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	2									
2 :																			2	2	2	2	2								
3 :	99	75	56	43														2	2	2	2	2	2	3							
4 :	97	72	54	41	32	27	28											2	2	1	1	2	2	3							
5 :	94	70	52	39	30	25	25	32	41									2	2	1	1	1	2	3	5						
6 :	86	63	47	35	28	24	22	26	35									2	2	1	1	2	2	3	5						
7 :	80	58	46	34	26	23	20	23	30								3	3	2	2	1	2	2	3	5	8					
8 :	80	55	42	31	24	21	19	22	27							6	3	3	2	2	1	2	2	3	5	8	11				
9 :	76	55	41	30	24	21	19	20	25						15	7	4	3	2	2	2	2	2	3	5	8	11				
10 :	74	52	39	28	22	19	19	19	23	26	28	31	31	26	17	8	5	3	3	2	2	2	2	3	5	8	11	15			
11 :	74	52	36	27	21	18	18	19	21	23	26	29	30	27	19	10	5	4	3	2	2	2	3	3	5	8	11	15	19		
12 :	72	50	36	26	20	18	18	18	20	22	24	27	29	27	20	12	6	4	3	2	2	2	3	4	6	8	11	15	18	24	
13 :	73	49	35	25	19	17	17	18	19	21	23	25	28	27	22	14	8	5	4	3	2	2	3	4	6	8	10	14	18	24	34
14 :	72	48	33	23	18	17	17	17	19	20	22	24	26	27	23	16	9	6	4	3	3	3	3	5	6	8	10	13	17	24	34
15 :	72	48	33	23	18	16	16	17	18	20	21	23	25	26	24	18	11	7	5	3	3	3	3	5	7	9	10	12	16	23	35
16 :	72	46	32	22	17	16	16	16	17	19	21	22	24	25	24	19	12	8	5	4	3	3	4	5	7	9	11	12	16	23	36
17 :	73	47	31	21	17	16	16	16	17	18	20	21	23	25	24	19	14	9	6	4	4	3	4	6	8	9	11	13	16	23	36
18 :	74	47	30	20	16	15	16	16	17	18	19	20	22	24	24	20	14	10	7	5	4	4	4	6	8	10	11	13	18	23	36
19 :	74	46	29	19	15	15	15	15	16	17	19	20	21	23	24	20	15	11	8	6	5	4	5	7	9	10	11	14	19	24	37
20 :	75	47	29	19	15	15	15	15	16	17	18	19	21	23	24	21	15	11	9	6	5	5	5	7	9	10	11	14	20	25	36
21 :	77	47	28	18	15	14	15	15	15	16	17	19	20	21	23	21	16	12	9	7	6	5	6	8	10	11	12	15	20	26	36
22 :	79	48	28	18	14	14	15	15	14	15	17	18	19	20	22	21	17	12	10	8	7	6	6	8	10	11	13	16	21	28	37
23 :	80	48	28	17	14	14	14	15	14	15	16	18	19	19	21	21	18	13	10	8	7	7	7	9	10	12	13	17	22	29	39
24 :	83	49	27	17	14	14	14	14	14	14	16	17	18	18	20	21	19	14	10	9	8	7	8	9	11	12	14	17	23	31	40
25 :	86	50	27	16	13	13	14	14	14	14	15	17	18	18	19	21	20	14	11	10	9	8	8	9	11	13	14	18	25	33	42
26 :	90	51	27	16	13	13	14	14	14	13	15	17	18	17	18	20	19	15	11	11	10	9	9	10	11	13	15	19	28	36	43
27 :	95	53	27	16	13	13	13	14	14	13	14	17	18	17	17	19	19	15	12	11	11	9	9	10	12	14	15	20	31	37	43
28 :	101	56	28	16	13	12	13	14	14	13	13	16	17	17	16	17	18	15	13	12	11	10	10	11	12	14	16	23	32	38	44
29 :	108	61	29	16	13	12	12	14	14	12	13	16	17	16	16	16	17	16	13	13	12	11	10	11	13	15	18	25	34	40	44
30 :	116	67	31	16	13	12	12	13	13	12	12	15	17	16	15	16	17	16	14	14	13	11	11	12	13	15	19	27	35	41	45
31 :	123	75	34	17	14	12	12	13	13	12	12	14	16	16	15	15	16	16	15	14	13	12	11	13	14	16	21	29	37	42	45
32 :	131	85	39	18	14	12	11	12	13	12	12	14	15	16	15	14	15	16	15	15	14	13	12	13	14	16	22	31	38	43	46
33 :	137	94	46	21	16	12	11	12	12	12	12	13	15	16	15	14	15	16	16	16	15	13	13	14	15	18	25	32	38	43	46
34 :	141	104	56	24	18	12	11	11	12	12	12	13	14	16	16	15	15	16	16	16	15	14	14	15	15	19	27	33	39	44	46
35 :	146	111	65	30	19	13	12	11	12	12	13	13	14	15	16	15	16	16	17	17	16	15	15	16	16	21	28	34	41	45	47
36 :	150	118	73	38	21	13	12	12	12	12	13	13	14	15	15	16	16	17	17	17	17	15	16	16	17	23	29	35	42	46	47
37 :	155	124	80	47	24	15	12	12	12	12	13	13	14	15	16	16	17	17	18	18	18	16	17	17	19	24	30	37	43	47	47
38 :	156	133	91	57	28	16	13	12	12	12	13	14	14	15	16	16	17	18	18	19	18	17	17	18	20	25	31	38	44	47	46
39 :	155	140	102	68	33	18	14	12	12	12	13	14	15	15	16	17	17	18	19	19	19	18	18	19	21	26	33	39	45	47	45
40 :	151	145	114	80	41	21	15	13	12	12	13	14	15	16	16	17	18	19	19	20	20	19	20	20	22	27	34	41	45	46	45

Figure 20. Effects of Redondo Submarine Canyon on 20.5-sec wave arriving from 261 deg approach azimuth, tide elevation = +8.0 ft MLLW, water wave refraction/diffraction/shoaling coefficients (x 100)

RCPWAVE Verification by Laboratory Data

70. Comparisons between RCPWAVE results and observed laboratory data were used to verify the accuracy of this theoretical model. The ability of RCPWAVE to simulate wave transformation outside the surf zone was checked using data collected during laboratory experiments conducted by Berkhoff, et. al., (1982). These experiments were conducted in a wave tank in which wave conditions resulting from the propagation of a monochromatic, plane wave train over complex bathymetry were measured. The bathymetry consisted of an elliptical shoal superposed on a plane beach (Figure 21). The shoal acts as a lens and focuses incoming wave energy into a strong convergence zone, resulting in a decrease in wave energy in other regions (coefficients significantly less than 1.0). This experiment provided a set of data which could be used to verify the ability of RCPWAVE to compute accurate solutions to problems where refraction theory breaks down. It also provided definitive documentation of the lower magnitudes to which wave heights could be reduced by the combined effects of refraction and diffraction. Wave height data were collected at many locations within the experimental zone, along the eight cross sections shown in Figure 21. RCPWAVE was used to simulate the same experiments. Simulated wave heights were then compared with observed experimental data, and the results and comparisons are presented in Figures 22 and 23. It is easily seen from Figure 23 that wave coefficients approach 0.15 in the region of greatest wave height reduction due to refraction and diffraction.

71. Other laboratory experimental data also exist which confirm the ability of refraction and diffraction to produce reductions in wave height of similar magnitudes. Ito and Tanimoto (1972) performed similar experiments to those of Berkhoff, et. al., (1982) using an almost identical arrangement. Results of this second set of experimental data are presented in Figure 24, where it is easily perceived that the wave height reduction coefficients approach 0.15 to 0.20, which compares favorably with the other experimental data of Berkhoff, et. al., (1982), and also with the simulation modeling of RCPWAVE for the same experimental arrangement.

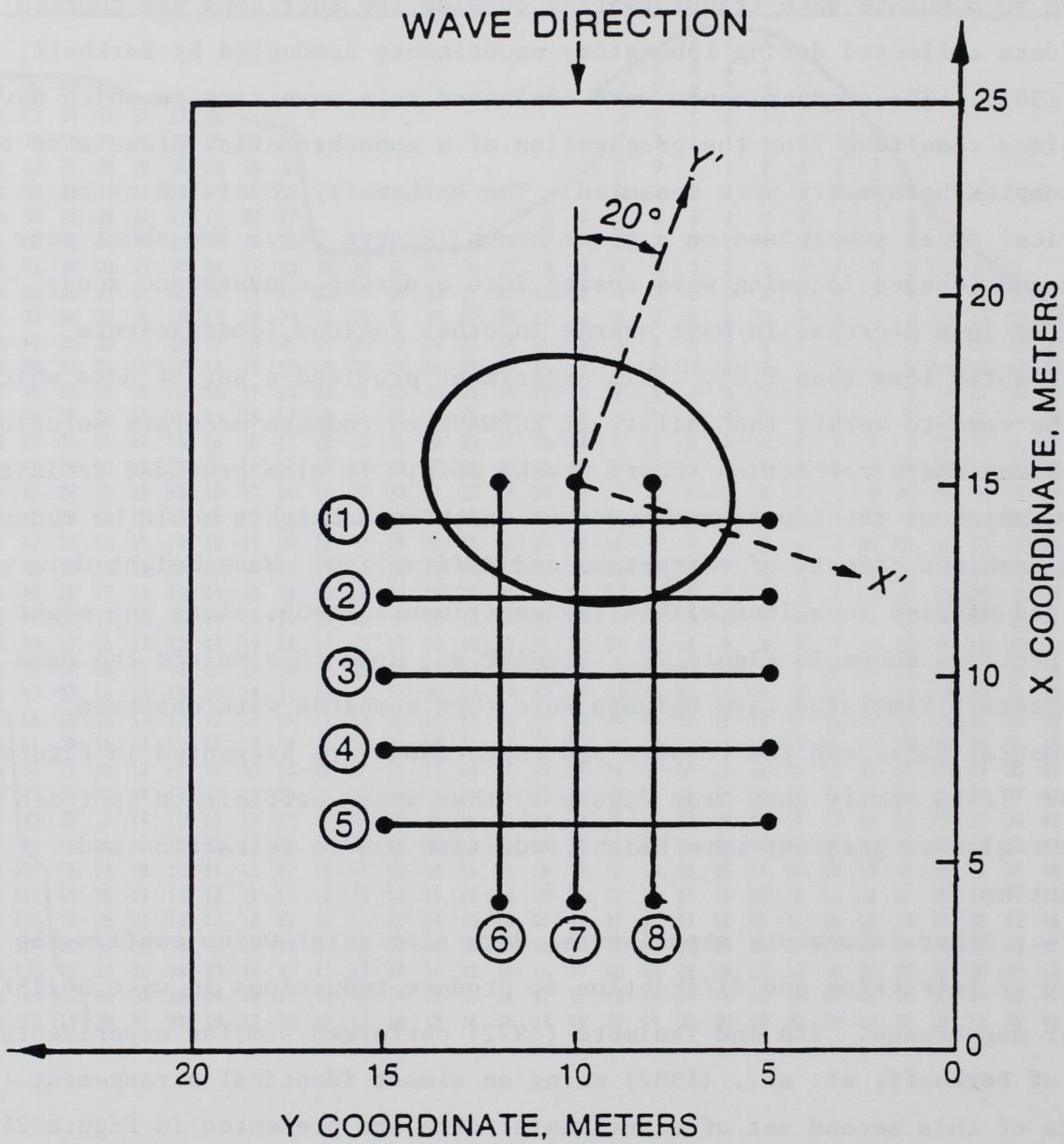


Figure 21. Elliptical shoal geometry used to verify RCPWAVE with experimental data for identical arrangement, (after Berkhoff, et. al., 1982)

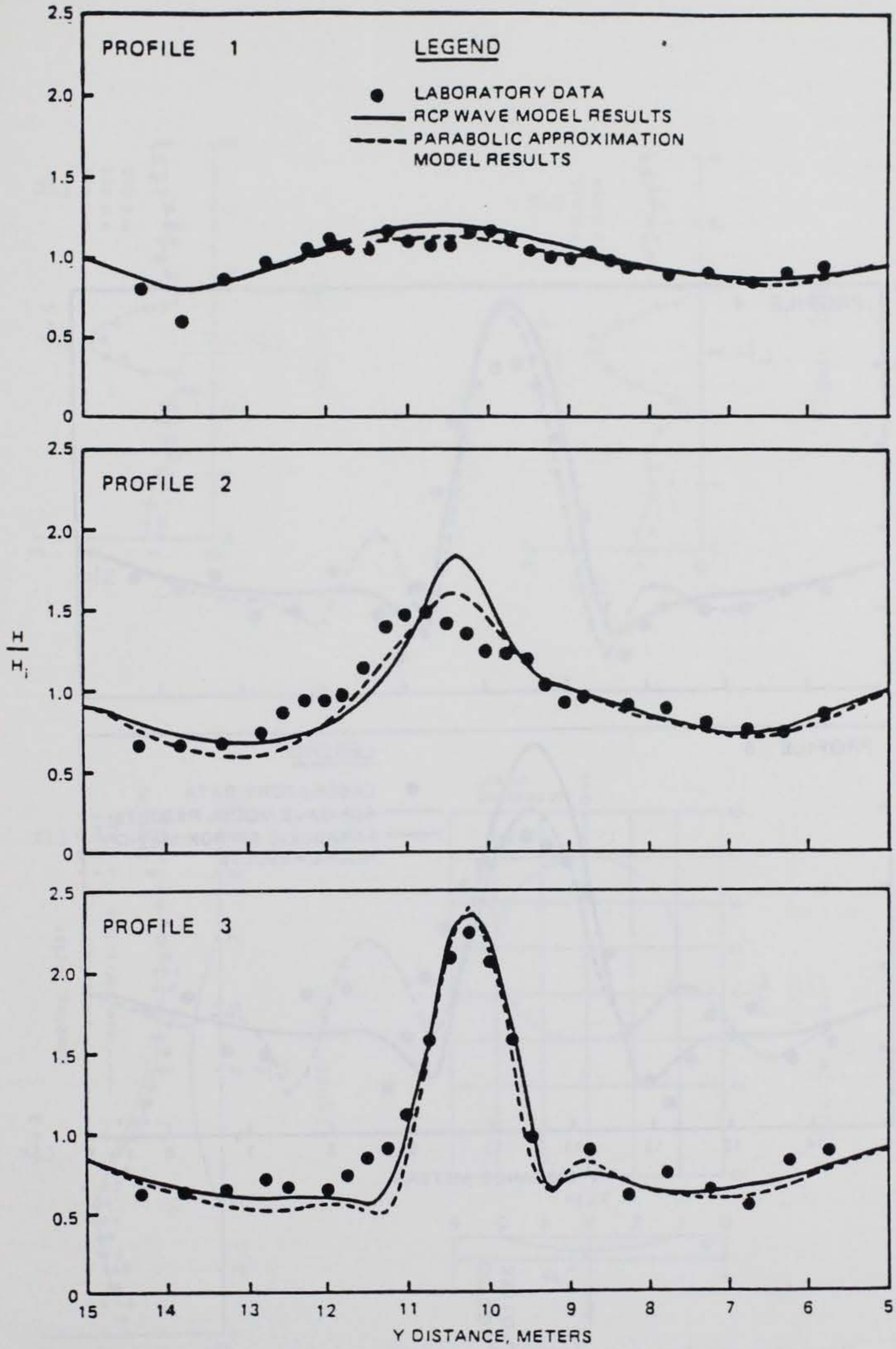


Figure 22. Comparisons between RCPWAVE results and observed experimental data, (after Ebersole, et. at., 1985)

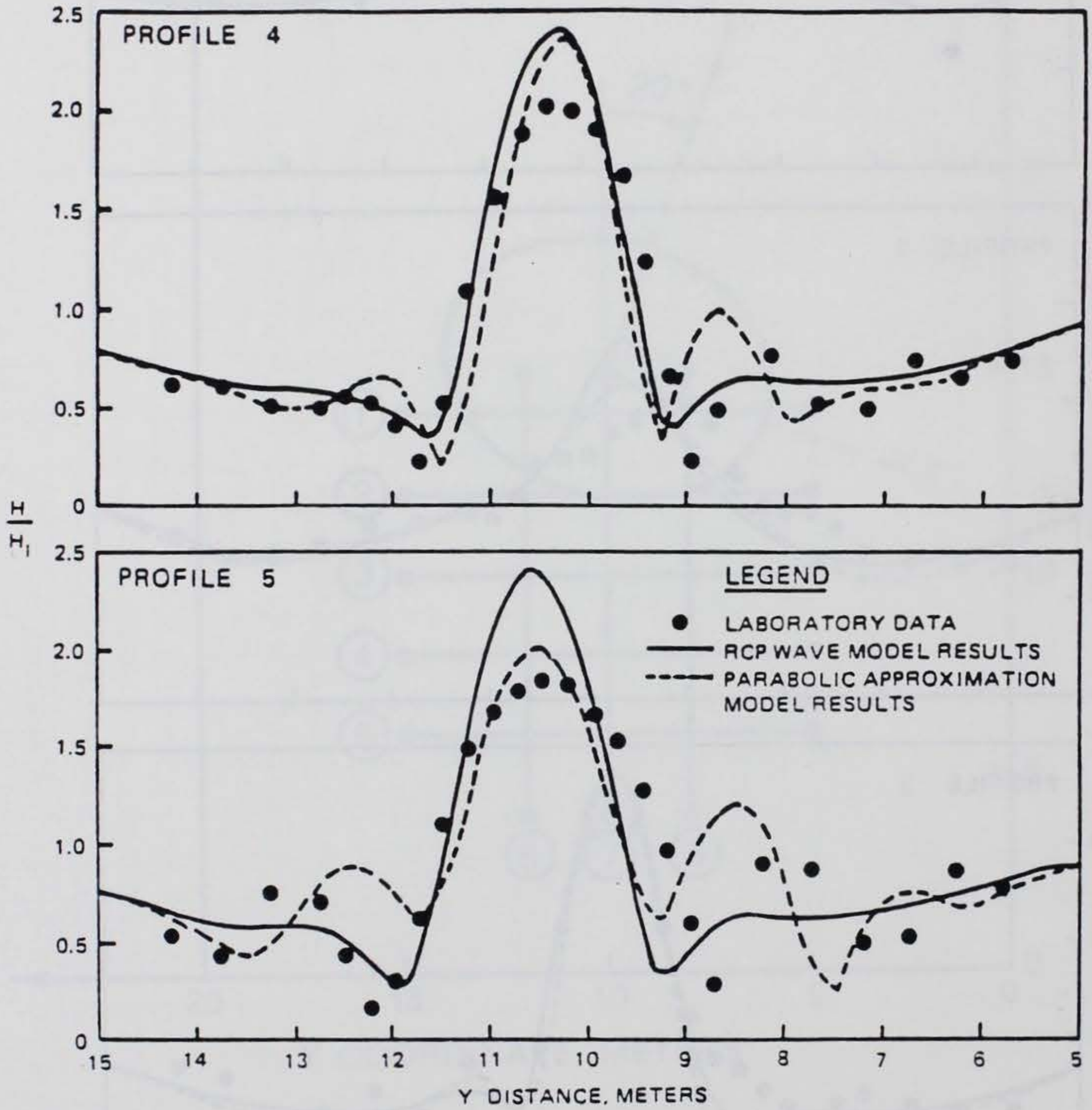


Figure 23. Comparisons between RCPWAVE results and observed experimental data, showing minimal experimental values of wave height coefficients of 0.15, (after Ebersole, et. al., 1985)

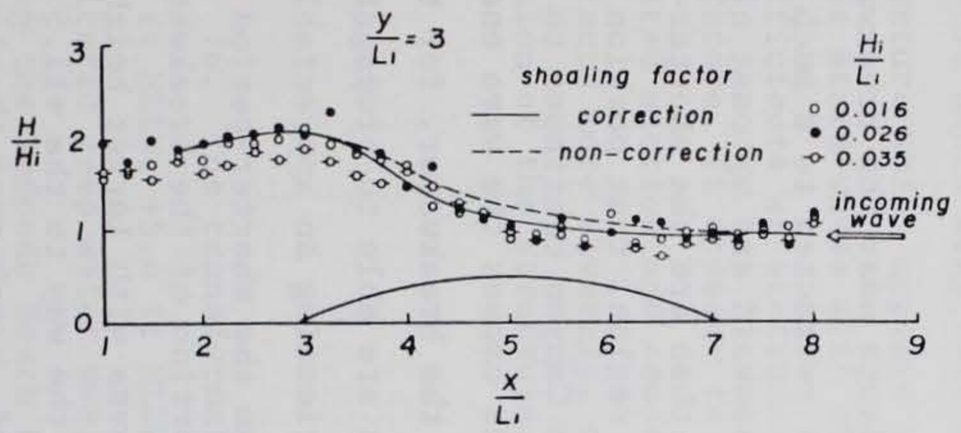


Figure 24b.

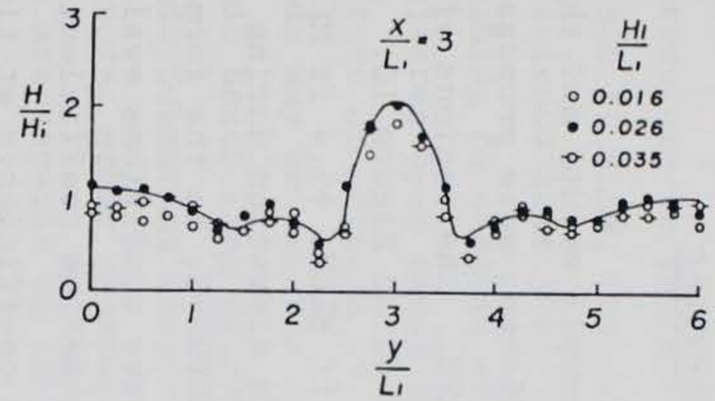


Figure 24c.

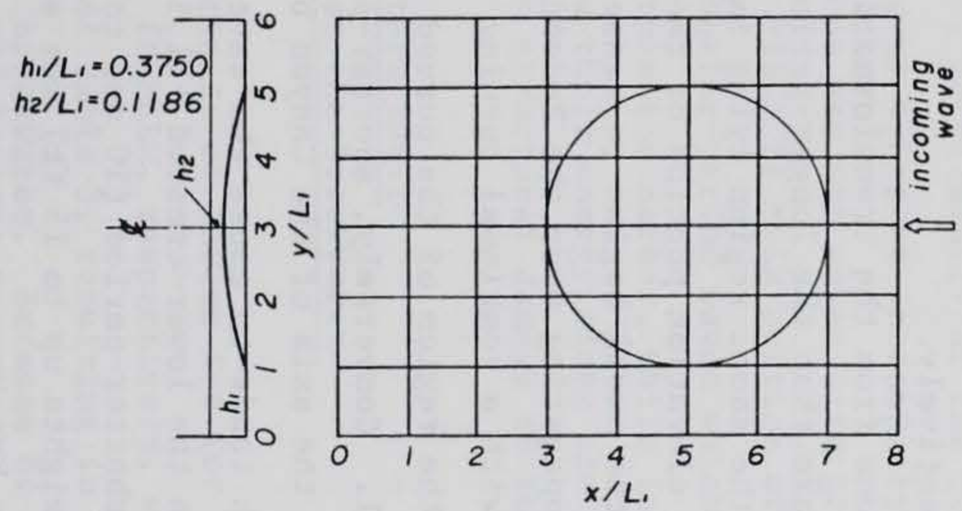


Figure 24a.

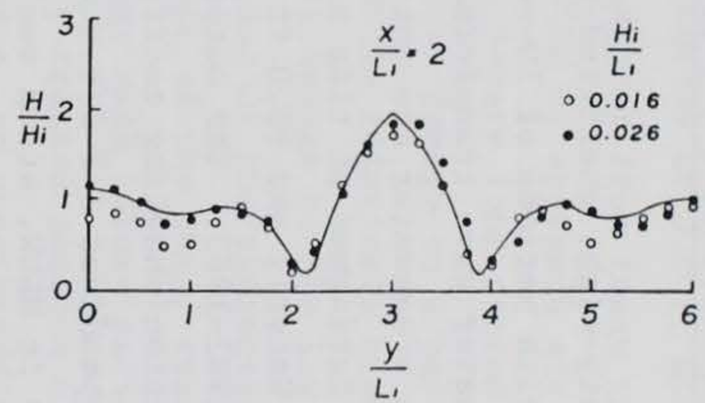


Figure 24d.

Figure 24. Comparison of combined wave refraction and diffraction theory with results of experimental study, showing minimal experimental values of wave height coefficients of 0.15 to 0.20, (after Ito and Tanimoto, 1972)

PART VII: WAVE HEIGHTS AT REDONDO BEACH KING HARBOR BREAKWATER

Storm Swell

Transformation Coefficients at the Breakwater

72. The twenty-eight sheltered deep water storm swell events and the annual sea waves with periods of 10-sec, 12-sec, and 14-sec, were propagated shoreward by the water wave transformation model RCPWAVE. The regions of interest along the breakwater are noted as sections 34-41 on Figure 10. All computations were performed at tide elevations of 0.0 ft MLLW, +5.4 ft MLLW (Mean Higher High Water), and +8.0 ft MLLW (actual tide elevation during the winter storms of 1982-1983. The output from program RCPWAVE, in the form of refraction/diffraction/shoaling coefficients for all wave conditions evaluated, is presented in Appendixes A-F for storm swell transformation coefficients at tide elevation 0.0 ft MLLW, storm swell transformation coefficients at tide elevation +5.4 ft MLLW, storm swell transformation coefficients at tide elevation +8.0 ft MLLW, annual sea transformation coefficients at tide elevation 0.0 ft MLLW, annual sea transformation coefficients at tide elevation +5.4 ft MLLW, and annual sea transformation coefficients at tide elevation +8.0 ft MLLW, respectively.

73. Indications from the transformation coefficients near the breakwater of Appendixes A-F are that the longer-period waves are refracted to a much greater extent by the shoal region lying immediately seaward and upcoast of the 20.0 ft MLLW crest elevation portion of the structure than are the shorter-period waves. As the swell begins to sense the shoal region, that portion of the swell crest propagating over the Redondo Submarine Canyon continues to advance shoreward with a continual turning motion which causes the wave energy to concentrate in the region of the curved portion of the breakwater, for the longer-period swell. Conversely, shorter-period waves are able to propagate much further along the axis of the Canyon before experiencing an appreciable bottom effect which tends to cause the wave energy from the shorter-period waves to impinge on the lower-crested +11.5 ft MLLW portion of the breakwater. This implies that shorter-period (10 sec to 14 sec) waves with larger heights (significant sea heights up to 15 ft) may advance all the way to the +11.5 ft MLLW section of the breakwater essentially undiminished, break over the low-

crested section of the structure, and cause damage within the Harbor.

74. The transformation coefficients for the twenty-eight storm events of record from 1900 to the present time which are physically capable of reaching the Redondo Beach King Harbor breakwater are presented for sections 34-41 along the structure in Tables 4-6 for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, respectively. It is apparent from these transformation coefficients that swell period and direction of approach are critical items pertaining to whether or not an extremely severe long-period swell on the unsheltered open ocean will be able to cause damage to a particular coastal structure or portion of the shoreline. While relatively high swell with long periods may be capable of inducing minimal damage to the low section of the Redondo Beach King Harbor breakwater because of the protection afforded by the Redondo Submarine Canyon, and the existence of the shoal region in front of the structure, other shorter-period waves exist with return periods such that these waves are capable of overtopping the lower-crested section of the breakwater several times each year at high tide. Hence, an understanding of the propagation mechanism is essential for evaluating the potential impact of particular storm events on a structure.

75. Certain long period swell has caused significant damage to the Redondo Beach King Harbor breakwater, particularly at the curved portion of the structure which appears to exhibit some inherent instability. At the same time, those storm waves with shorter periods are the waves with greater transformation coefficients at sections 39-41 (the +11.5 ft MLLW portion of the breakwater). Therefore, it appears to be those shorter-period waves which overtop the low-crested section and cause damage within the Harbor, while longer-period swell refracts more severely, concentrates their energy along the +20.0 ft MLLW portion of the structure, and causes structural damage to the breakwater.

Storm Swell Heights at the Breakwater

76. The transformation coefficients of Tables 4-6 for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, respectively, were applied to the sheltered deep water swell heights of Table 3, resulting in the swell heights along the Redondo Beach King Harbor breakwater. Because of uneven refraction and shoaling effects, there exists a non-uniform distribution (gradient) of

Table 4

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = 0.0 MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	1.24	1.24	1.26	1.24	1.06	0.68	0.35	0.20
April 1958	17.5	268	1.19	0.89	0.72	0.64	0.55	0.34	0.14	0.07
March 1983	18.5	253	0.48	0.51	0.57	0.59	0.51	0.29	0.12	0.06
January 1981	15.5	257	1.46	1.20	1.04	0.96	0.87	0.62	0.29	0.15
January 1983	20.5	264	0.28	0.29	0.31	0.31	0.24	0.12	0.04	0.03
November 1982	10.5	268	1.06	1.00	0.98	0.98	1.04	1.22	1.37	1.27
February 1963	13.5	257	1.48	1.43	1.42	1.46	1.47	1.28	0.76	0.30
January 1978	16.5	264	1.56	1.24	1.01	0.87	0.72	0.46	0.20	0.10
February 1960	18.5	269	0.64	0.52	0.51	0.51	0.45	0.26	0.10	0.05
January 1958	13.5	258	1.46	1.42	1.43	1.49	1.52	1.34	0.80	0.31
March 1904	12.0	235	1.14	1.10	1.13	1.18	1.15	0.94	0.59	0.33
March 1912	11.5	258	1.21	1.16	1.16	1.22	1.36	1.49	1.33	0.84
February 1983	16.5	260	1.21	0.93	0.79	0.74	0.67	0.45	0.20	0.10
February 1915	12.4	263	1.17	1.14	1.16	1.27	1.47	1.66	1.44	0.80
January 1915	11.8	224	1.18	1.11	1.09	1.05	0.92	0.68	0.43	0.27
January 1943	10.8	214	0.95	0.88	0.84	0.78	0.68	0.52	0.37	0.26
January 1953	19.2	251	0.47	0.50	0.54	0.55	0.46	0.25	0.10	0.05
February 1969	14.5	264	1.44	1.47	1.54	1.64	1.63	1.33	0.65	0.21

(Table 4 Continued)

(Table 4 Continued)

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = 0.0 MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	1.15	1.02	1.00	1.05	1.03	0.79	0.40	0.20
January 1981	17.5	255	0.55	0.55	0.61	0.65	0.59	0.37	0.16	0.08
December 1969	20.5	261	0.29	0.31	0.33	0.32	0.26	0.13	0.05	0.03
January 1916	9.6	245	1.17	1.09	1.08	1.12	1.19	1.23	1.11	0.82
December 1914	9.9	214	0.93	0.87	0.82	0.77	0.68	0.54	0.41	0.30
February 1926	16.0	251	0.85	0.77	0.81	0.87	0.83	0.58	0.27	0.14
April 1926	13.8	259	1.49	1.46	1.47	1.52	1.52	1.30	0.73	0.27
March 1952	11.7	245	1.27	1.19	1.19	1.25	1.30	1.22	0.87	0.47
December 1937	16.4	258	1.08	0.85	0.76	0.74	0.68	0.46	0.21	0.11
August 1972	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	0.84	0.80	0.77	0.71	0.58	0.35	0.20	0.12
September 1982	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.

Table 5

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = +5.4 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	1.16	1.17	1.19	1.17	1.02	0.69	0.37	0.21
April 1958	17.5	268	1.21	0.93	0.74	0.64	0.55	0.36	0.16	0.08
March 1983	18.5	253	0.44	0.48	0.54	0.57	0.51	0.31	0.14	0.07
January 1981	15.5	257	1.41	1.19	1.04	0.96	0.87	0.66	0.34	0.17
January 1983	20.5	264	0.26	0.28	0.30	0.30	0.25	0.13	0.05	0.03
November 1982	10.5	268	1.00	0.97	0.95	0.95	1.00	1.14	1.29	1.26
February 1963	13.5	257	1.37	1.35	1.36	1.40	1.43	1.30	0.86	0.38
January 1978	16.5	264	1.53	1.26	1.04	0.89	0.74	0.50	0.23	0.11
February 1960	18.5	269	0.66	0.52	0.49	0.49	0.44	0.28	0.12	0.06
January 1958	13.5	258	1.35	1.33	1.36	1.43	1.47	1.36	0.91	0.39
March 1904	12.0	235	1.08	1.06	1.10	1.14	1.12	0.95	0.63	0.37
March 1912	11.5	258	1.13	1.10	1.10	1.16	1.28	1.42	1.33	0.94
February 1983	16.5	260	1.21	0.95	0.80	0.74	0.67	0.47	0.23	0.12
February 1915	12.4	263	1.09	1.08	1.10	1.19	1.37	1.57	1.46	0.94
January 1915	11.8	224	1.10	1.06	1.04	1.00	0.90	0.59	0.46	0.29
January 1943	10.8	214	0.90	0.85	0.81	0.76	0.67	0.53	0.39	0.28
January 1953	19.2	251	0.43	0.47	0.52	0.53	0.46	0.27	0.12	0.06
February 1969	14.5	264	1.31	1.36	1.45	1.57	1.61	1.40	0.80	0.27

(Table 5 Continued)

(Table 5 Continued)

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = +5.4 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	1.11	0.99	0.97	1.01	1.01	0.82	0.46	0.23
January 1981	17.5	255	0.51	0.51	0.57	0.61	0.58	0.39	0.18	0.09
December 1969	20.5	261	0.27	0.29	0.31	0.31	0.26	0.14	0.06	0.03
January 1916	9.6	245	1.10	1.05	1.04	1.07	1.13	1.18	1.09	0.86
December 1914	9.9	214	0.89	0.84	0.80	0.75	0.67	0.55	0.43	0.33
February 1926	16.0	251	0.82	0.75	0.77	0.83	0.81	0.60	0.31	0.15
April 1926	13.8	259	1.37	1.37	1.40	1.46	1.48	1.33	0.84	0.34
March 1952	11.7	245	1.20	1.14	1.14	1.20	1.25	1.20	0.92	0.54
December 1937	16.4	258	1.08	0.86	0.75	0.73	0.68	0.49	0.24	0.12
August 1972	17.5	--- *	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	0.79	0.76	0.74	0.69	0.57	0.37	0.22	0.14
September 1982	17.5	--- *	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.

Table 6

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = +8.0 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	1.13	1.14	1.16	1.14	1.00	0.69	0.39	0.22
April 1958	17.5	268	1.23	0.95	0.76	0.65	0.56	0.38	0.18	0.09
March 1983	18.5	253	0.43	0.47	0.53	0.56	0.51	0.33	0.15	0.07
January 1981	15.5	257	1.40	1.19	1.05	0.96	0.88	0.68	0.37	0.18
January 1983	20.5	264	0.26	0.27	0.29	0.29	0.25	0.14	0.06	0.03
November 1982	10.5	268	0.98	0.95	0.94	0.94	0.98	1.11	1.26	1.25
February 1963	13.5	257	1.33	1.31	1.32	1.38	1,41	1.31	0.90	0.42
January 1978	16.5	264	1.52	1.27	1.06	0.90	0.75	0.52	0.25	0.12
February 1960	18.5	269	0.68	0.53	0.49	0.49	0.44	0.29	0.13	0.06
January 1958	13.5	258	1.30	1.30	1.33	1.40	1.45	1.37	0.95	0.44
March 1904	12.0	235	1.07	1.05	1.08	1.13	1.11	0.95	0.65	0.39
March 1912	11.5	258	1.10	1.08	1.08	1.13	1.24	1.39	1.33	0.97
February 1983	16.5	260	1.22	0.97	0.81	0.74	0.67	0.49	0.25	0.12
February 1915	12.4	263	1.07	1.06	1.08	1.16	1.32	1.53	1.46	0.99
January 1915	11.8	224	1.07	1.04	1.02	0.99	0.89	0.69	0.47	0.31
January 1943	10.8	214	0.88	0.84	0.80	0.75	0.67	0.53	0.40	0.29
January 1953	19.2	251	0.42	0.46	0.51	0.52	0.46	0.28	0.12	0.06
February 1969	14.5	264	1.26	1.32	1.41	1.53	1.60	1.43	0.87	0.31

(Table 6 Continued)

(Table 6 Continued)

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Tide Elevation = +8.0 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	1.09	0.98	0.96	1.00	0.99	0.83	0.49	0.24
January 1981	17.5	255	0.51	0.51	0.56	0.60	0.58	0.40	0.19	0.10
December 1969	20.5	261	0.26	0.28	0.31	0.31	0.26	0.15	0.06	0.03
January 1916	9.6	245	1.07	1.03	1.02	1.06	1.11	1.16	1.09	0.87
December 1914	9.9	214	0.87	0.82	0.79	0.75	0.67	0.55	0.44	0.34
February 1926	16.0	251	0.81	0.74	0.76	0.81	0.80	0.62	0.33	0.16
April 1926	13.8	259	1.32	1.33	1.36	1.43	1.47	1.35	0.89	0.39
March 1952	11.7	245	1.17	1.12	1.12	1.18	1.24	1.20	0.94	0.58
December 1937	16.4	258	1.09	0.87	0.76	0.72	0.67	0.50	0.26	0.13
August 1972	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	0.77	0.74	0.72	0.68	0.57	0.38	0.23	0.14
September 1982	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.

swell heights along the structure. These data are presented in Tables 7-9 for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, respectively. Here it is apparent that the longer-period swell concentrates its energy along the +20.0 ft MLLW crest elevation portion of the structure, with section 34 (the curved section) experiencing a high degree of breaking swell because of slightly shallower water depth (shoal) in this region.

77. The breakwater was designed to withstand wave heights of 17 ft with periods of 13 seconds. While the significant swell of the storm of February 1983 was only 14.8 ft, the period of 16.5 sec, when combined with an extreme tide elevation of +8.0 ft MLLW, induced forces far exceeding those which the structure was designed to withstand. Because this series of storms battered the structure for such an extended period of time, fatigue failure probably resulted, with the storm swell of March 1983 (18.5-sec period) initiating the actual failure mechanism. The extreme high tides caused forces on the prototype structure which had not been evaluated during physical model testing.

78. Hindcast wave studies prepared in 1960 from synoptic weather charts for the 3-yr period 1956-1958 were used in predicting maximum deep water waves. The resulting design wave of 17-ft, 13-sec was approximately the same as the significant waves occurring during the storm of February 1963. This design wave for Design Memorandum No. 2 (US Army Engineer District, Los Angeles, 1964) was significantly higher than any waves considered in Design Memorandum No. 1 (US Army Engineer District, Los Angeles, 1955).

79. Extensive wave refraction analyses were presented in the inclosures to Review of Reports, Redondo Beach Harbor, California (US Army Engineer District, Los Angeles, 1949), and in Design Memorandum No. 1. These analyses show that little or no convergence of orthogonals would occur between the angle point of the north breakwater and the seawall (the reach of the proposed improvement, the presently existing +20.0 ft MLLW crest elevation portion). The greatest wave heights caused by convergence would occur between the Harbor mouth and the angle point of the north breakwater (the presently existing +11.5 ft MLLW crest elevation section). Crossed orthogonals in this area indicate that this is a high energy area. Those conclusions appear consistent with the results of RCPWAVE for similar period waves. Based on the conclusions of the 1949 and 1955 studies, smaller capstone (10 tons) was placed on the +20.0 ft MLLW crest elevation section, and 13-ton capstone was placed on the +11.5 ft MLLW crest elevation portion of the breakwater.

Table 7

Redondo Beach King Harbor, California

Significant Swell Heights, H_s, at the Structure

Tide Elevation = 0.0 MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	15.1**	20.3**	22.7	22.3	19.1	12.2	6.3	3.6
April 1958	17.5	268	15.3**	12.7	10.3	9.2	7.9	4.9	2.0	1.0
March 1983	18.5	253	9.1	9.6	10.8	11.2	9.6	5.5	2.3	1.1
January 1981	15.5	257	15.2**	19.6	17.0	15.7	14.2	10.1	4.7	2.5
January 1983	20.5	264	3.9	4.0	4.3	4.3	3.3	1.7	0.6	0.4
November 1982	10.5	268	12.3	11.6	11.4	11.4	12.1	14.2	15.9	14.7
February 1963	13.5	257	15.1**	20.2**	21.0	21.6	21.8	18.9	11.3	4.4
January 1978	16.5	264	15.3**	15.0	12.2	10.5	8.7	5.6	2.4	1.2
February 1960	18.5	269	6.6	5.4	5.3	5.3	4.6	2.7	1.0	0.5
January 1958	13.5	258	15.1**	19.3	19.5	20.3	20.7	18.2	10.9	4.2
March 1904	12.0	235	14.9**	16.4	16.8	17.6	17.1	14.0	8.8	4.9
March 1912	11.5	258	14.9**	15.2	15.2	16.0	17.8	19.5	17.4	11.0
February 1983	16.5	260	14.6	11.3	9.6	9.0	8.1	5.5	2.4	1.2
February 1915	12.4	263	13.0	12.7	12.9	14.1	16.3	18.4	16.0	8.9
January 1915	11.8	224	12.9	12.1	11.9	11.5	10.0	7.4	4.7	2.9
January 1943	10.8	214	6.7	6.2	5.9	5.5	4.8	3.6	2.6	1.8
January 1953	19.2	251	6.2	6.6	7.1	7.2	6.0	3.3	1.3	0.7
February 1969	14.5	264	14.5	14.9	15.6	16.6	16.5	13.4	6.6	2.1

(Table 7 Continued)

** Breaking wave.

(Table 7 Continued)

Redondo Beach King Harbor, California

Significant Swell Height, H_s, at the Structure

Tide Elevation = 0.0 MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	15.2**	13.7	13.4	14.1	13.8	10.6	5.4	2.7
January 1981	17.5	255	6.7	6.7	7.4	7.9	7.2	4.5	2.0	1.0
December 1969	20.5	261	2.9	3.1	3.3	3.2	2.6	1.3	0.5	0.3
January 1916	9.6	245	14.4	13.4	13.3	13.8	14.6	15.1	13.7	10.1
December 1914	9.9	214	5.2	4.9	4.6	4.3	3.8	3.0	2.3	1.7
February 1926	16.0	251	8.8	7.9	8.3	9.0	8.6	6.0	2.8	1.4
April 1926	13.8	259	13.3	13.0	13.1	13.5	13.5	11.6	6.5	2.4
March 1952	11.7	245	13.1	12.3	12.3	12.9	13.4	12.6	9.0	4.8
December 1937	16.4	258	9.4	7.4	6.6	6.4	5.9	4.0	1.8	1.0
August 1972	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	2.0	1.9	1.9	1.7	1.4	0.8	0.5	0.3
September 1982	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.
** Breaking wave.

Table 8

Redondo Beach King Harbor, California

Significant Swell Heights, H_s, at the Structure

Tide Elevation = +5.4 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	19.7**	21.1	21.4	21.1	18.4	12.4	6.7	3.8
April 1958	17.5	268	17.3	13.3	10.6	9.2	7.9	5.2	2.3	1.1
March 1983	18.5	253	8.3	9.1	10.2	10.8	9.6	5.9	2.7	1.3
January 1981	15.5	257	19.9**	19.4	17.0	15.7	14.2	10.8	5.5	2.8
January 1983	20.5	264	3.6	3.9	4.2	4.2	3.5	1.8	0.7	0.4
November 1982	10.5	268	11.6	11.3	11.0	11.0	11.6	13.3	15.0	14.6
February 1963	13.5	257	19.6**	20.0	20.1	20.7	21.2	19.2	12.7	5.6
January 1978	16.5	264	18.5	15.3	12.6	10.8	9.0	6.1	2.8	1.3
February 1960	18.5	269	6.8	5.4	5.1	5.1	4.5	2.9	1.2	0.6
January 1958	13.5	258	18.4	18.1	18.5	19.5	20.0	18.5	12.4	5.3
March 1904	12.0	235	16.1	15.8	16.4	17.0	16.7	14.2	9.4	5.5
March 1912	11.5	258	14.8	14.4	14.4	15.2	16.8	18.6	17.4	12.3
February 1983	16.5	260	14.6	11.5	9.7	9.0	8.1	5.7	2.8	1.5
February 1915	12.4	263	12.1	12.0	12.2	13.2	15.2	17.4	16.2	10.4
January 1915	11.8	224	12.0	11.6	11.3	10.9	9.8	7.5	5.0	3.2
January 1943	10.8	214	6.3	6.0	5.7	5.3	4.7	3.7	2.7	2.0
January 1953	19.2	251	5.6	6.2	6.8	6.9	6.0	3.5	1.6	0.8
February 1969	14.5	264	13.2	13.7	14.7	15.9	16.3	14.1	8.1	2.7

(Table 8 Continued)

** Breaking wave.

(Table 8 Continued)

Redondo Beach King Harbor, California

Significant Swell Heights, H_s, at the Structure

Tide Elevation = +5.4 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	14.9	13.3	13.0	13.5	13.5	11.0	6.2	3.1
January 1981	17.5	255	6.2	6.2	7.0	7.4	7.1	4.8	2.2	1.1
December 1969	20.5	261	2.7	2.9	3.1	3.1	2.6	1.4	0.6	0.3
January 1916	9.6	245	13.5	12.9	12.8	13.2	13.9	14.5	13.4	10.6
December 1914	9.9	214	5.0	4.7	4.5	4.2	3.8	3.1	2.4	1.9
February 1926	16.0	251	8.5	7.7	7.9	8.6	8.3	6.2	3.2	1.6
April 1926	13.8	259	12.2	12.2	12.5	13.0	13.2	11.8	7.5	3.0
March 1952	11.7	245	12.4	11.7	11.7	12.4	12.9	12.4	9.5	5.6
December 1937	16.4	258	9.4	7.5	6.5	6.4	5.9	4.3	2.1	1.0
August 1972	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	1.9	1.8	1.8	1.7	1.4	0.9	0.5	0.3
September 1982	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.

Table 9

Redondo Beach King Harbor, California

Significant Swell Heights, H_s, at the Structure

Tide Elevation = +8.0 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
September 1939	14.0	224	20.3	20.5	20.9	20.5	18.0	12.4	7.0	4.0
April 1958	17.5	268	17.6	13.6	10.9	9.3	8.0	5.4	2.6	1.3
March 1983	18.5	253	8.1	8.9	10.0	10.6	9.6	6.2	2.8	1.3
January 1981	15.5	257	22.1**	19.4	17.1	15.7	14.3	11.1	6.0	2.9
January 1983	20.5	264	3.6	3.8	4.0	4.0	3.5	2.0	0.8	0.4
November 1982	10.5	268	11.4	11.0	10.9	10.9	11.4	12.9	14.6	14.5
February 1963	13.5	257	19.7	19.4	19.5	20.4	20.9	19.4	13.3	6.2
January 1978	16.5	264	18.4	15.4	12.8	10.9	9.1	6.3	3.0	1.5
February 1960	18.5	269	7.0	5.5	5.1	5.1	4.5	3.0	1.3	0.6
January 1958	13.5	258	17.7	17.7	18.1	19.0	19.7	18.6	12.9	6.0
March 1904	12.0	235	15.9	15.7	16.1	16.8	16.5	14.1	9.7	5.8
March 1912	11.5	258	14.4	14.2	14.2	14.8	16.2	18.2	17.4	12.7
February 1983	16.5	260	14.8	11.7	9.8	9.0	8.1	5.9	3.0	1.5
February 1915	12.4	263	11.9	11.8	12.0	12.9	14.7	17.0	16.2	11.0
January 1915	11.8	224	11.7	11.3	11.1	10.8	9.7	7.5	5.1	3.4
January 1943	10.8	214	6.2	5.9	5.6	5.3	4.7	3.7	2.8	2.0
January 1953	19.2	251	5.5	5.6	6.7	6.8	6.0	3.7	1.6	0.8
February 1969	14.5	264	12.7	13.3	14.2	15.5	16.2	14.4	8.8	3.1

(Table 9 Continued)

** Breaking wave.

(Table 9 Continued)

Redondo Beach King Harbor, California

Significant Swell Heights, H_s, at the Structure

Tide Elevation = +8.0 ft MLLW

Date of Storm	Swell Period, T (sec)	Sheltered Deep Water Approach Azimuth, (deg)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
February 1980	14.5	248	14.6	13.1	12.9	13.4	13.3	11.1	6.6	3.2
January 1981	17.5	255	6.2	6.2	6.8	7.3	7.1	4.9	2.3	1.2
December 1969	20.5	261	2.6	2.8	3.1	3.1	2.6	1.5	0.6	0.3
January 1916	9.6	245	13.2	12.7	12.6	13.0	13.7	14.3	13.4	10.7
December 1914	9.9	214	4.9	4.6	4.4	4.2	3.8	3.1	2.5	1.9
February 1926	16.0	251	8.3	7.6	7.8	8.3	8.2	6.4	3.4	1.7
April 1926	13.8	259	11.8	11.8	12.1	12.7	13.1	12.0	7.9	3.5
March 1952	11.7	245	12.1	11.5	11.5	12.2	12.8	12.4	9.7	6.0
December 1937	16.4	258	9.5	7.6	6.6	6.3	5.8	4.4	2.3	1.1
August 1972	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*
September 1963	14.5	208	1.9	1.8	1.7	1.6	1.4	0.9	0.6	0.3
September 1982	17.5	---*	----*	----*	----*	----*	----*	----*	----*	----*

* Long period swell from deep water unsheltered direction of approach could not reach the structure.

80. Because the Redondo Beach King Harbor breakwater has experienced several damage conditions since its inception, it appears the structure may have been designed for wave parameters which are less than that experienced by the structure quite frequently. The very short wave hindcast records which were used to deduce the design wave may have been too limited temporally to indicate the longer-period waves which the structure is now known to be required to withstand. Additionally, the wave height appears to be less than a relatively frequently occurring value. The results of the early hand-constructed refraction analyses appears to be inconsistent with state-of-the-art numerical transformation methods regarding the concentration of wave energy from long-period swell along the +20.0 ft MLLW crest elevation section of the breakwater (particularly section 34, the curved portion which has experienced several damage events).

Storm Swell

Frequency of Occurrence at the Breakwater

81. The recurrence interval is defined as the average interval in years between the occurrence of swell of specified magnitude, and an equal or larger value. The ith largest swell in a data series has been equaled or exceeded i times in the period of record, N years, and the best estimate of its recurrence interval, RI_i, is:

$$RI_i = \frac{N + 1}{i} \tag{19}$$

Several other formulas have been suggested for the computation of recurrence intervals, or return periods. The disagreement between the various formulas is limited to the larger swell where i is small. If i equals 5 or more, the computed plotting positions by all methods are almost identical.

82. If an event has a true recurrence interval of RI_i years, then the probability, P, that it will be equaled or exceeded in any one year is:

$$P = \frac{1}{RI_i} \tag{20}$$

Since the only possibilities are that the event will or will not occur in any one year, the probability that it will not occur in a given year is $(1 - P)$.

From the principles of probability, the probability, J, that at least one event which equals or exceeds the RI_i-year event will occur in any series of S years is:

$$J = 1 - (1 - P)^S \tag{21}$$

Table 10 has been computed from Equation 21, and shows that there is a 40 percent chance the 100-year swell (or greater) will occur in any 50-year period, and even a 22 percent chance the 100-year swell will occur in any 25-year period. While there is only a 64 percent chance the 50-year swell will occur in any 50-year period, there is a 36 percent chance the 50-year swell will not occur during the next 50 years. Thus, there is no guarantee the recurrence intervals computed for the larger swell of a series by Equation 21 are actually going to be those precise intervals which really occur.

83. Because the second highest wave in some years will exceed the annual wave for many years which is included in an annual series method of wave

Table 10

Probability, J, That an Event of Given Recurrence Interval, RI, Will Be Equaled or Exceeded During Periods of Various Lengths

Recurrence Interval, RI (years)	Period of Time (years)							
	1	5	10	25	50	100	200	500
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	0.5	0.97	0.999	*	*	*	*	*
5	0.2	0.67	0.89	0.996	*	*	*	*
10	0.1	0.41	0.65	0.93	0.995	*	*	*
50	0.02	0.10	0.18	0.40	0.64	0.87	0.98	*
100	0.01	0.05	0.10	0.22	0.40	0.63	0.87	0.993
200	0.005	0.02	0.05	0.12	0.22	0.39	0.63	0.92

* In these cases, J can never be exactly 1.00, but for all practical purposes its value may be taken as unity.

analysis, the partial duration series is often used as an alternative. The partial duration series consists of all waves above some arbitrary base value of wave height. In the particular storm swell study by Walker, et. al., (1984), the base value of swell height was taken to be 10 ft in unsheltered deep water on the open ocean. When lesser swell heights are of special interest, and particularly where a recurrence interval of around 1 year is desired, the partial duration series should be used by simply plotting swell heights versus recurrence intervals and sketching a curve by eye (Linsley and Franzini, 1964).

84. In order to be able to display and compare the swell height gradients along the +20.0 ft MLLW crest elevation section of the breakwater for recurrence interval purposes, the swell heights for each of the twenty-eight storms of record which reached the structure were averaged across sections 34-38, from the data of Tables 7-9 for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, respectively. This provided one average swell height across sections 34-38 for each of the twenty-eight storms, for each of the three tide elevations. These resulting average significant swell heights across sections 34-38 are presented in Table 11.

85. The probability of exceedence each year, P , was determined by Equation 21 for each of the events of record of Table 11, and plotted on Plates 1-3, for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, respectively. From this display of the storm swell data, it is possible to state, for example (from Plate 3, at a tide elevation of +8.0 ft MLLW), "There is a 20 percent chance that a swell wave 10.5 ft or higher will occur each year," or, for example, "There is a 0.05 probability that a swell wave 17 ft high or higher will occur each year," or, for example, "There is a 2 percent chance that a swell wave 20.5 ft high or higher will occur each year." From this method of partial duration series analysis, we are in a position to make inferences about the probability that swell waves of various heights will occur each year. The data of Plates 1-3 are based entirely on swell wave heights.

86. Review of structure history indicates the Redondo Beach King Harbor breakwater may be underdesigned with respect to longer-period swell now known to frequently exist at the structure, and also with regard to the design still water elevation. The storms of the winter of 1982-1983 occurred at the maximum lunar tide of the year, and caused additional wind and wave set-up on the order of 2.0 ft to 2.5 ft. It is believed these storms arrived at a tide elevation of +8.0 ft MLLW. To estimate the recurrence interval of storm swell

Table 11

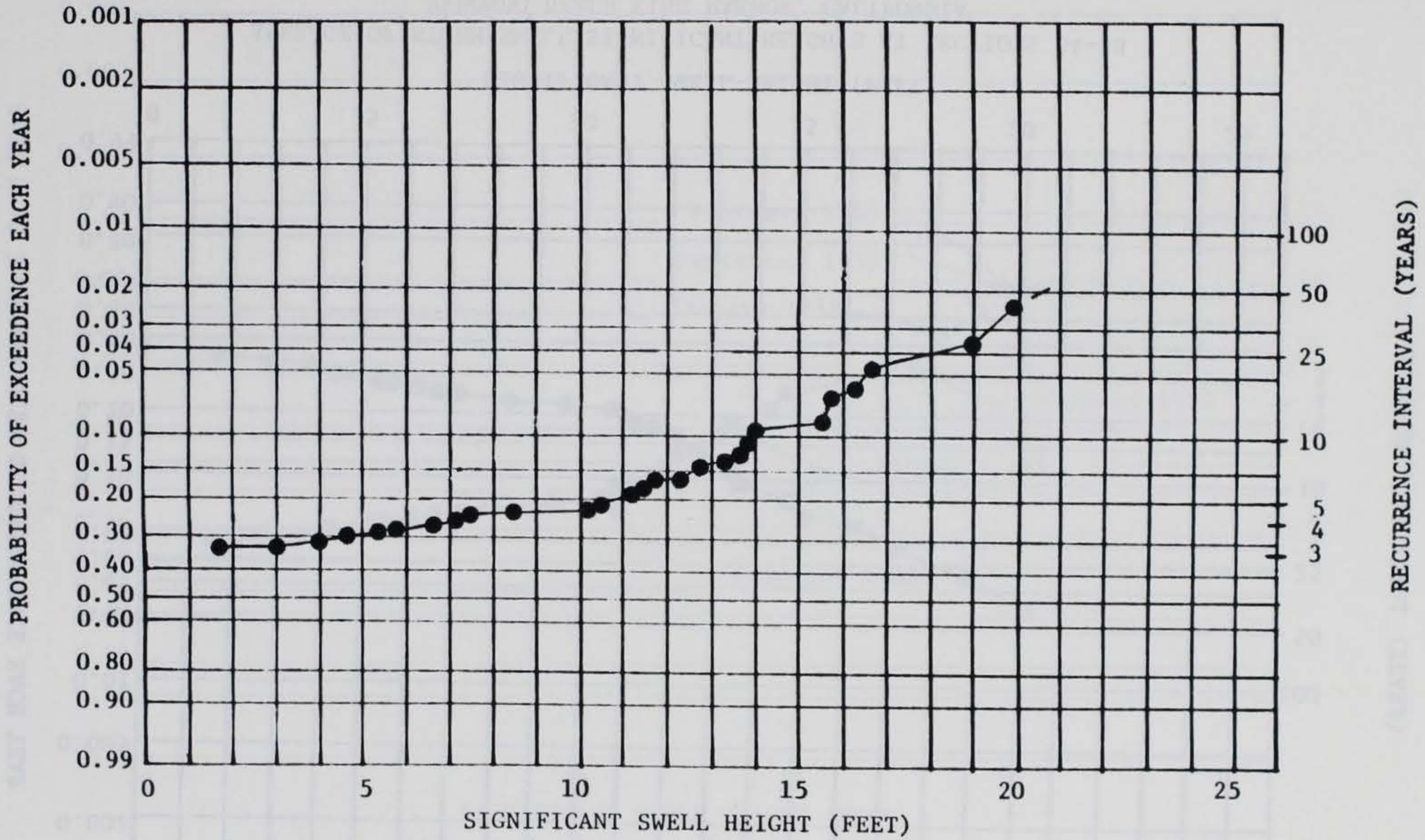
Redondo Beach King Harbor, California

Storm Swell Characteristics at the Structure

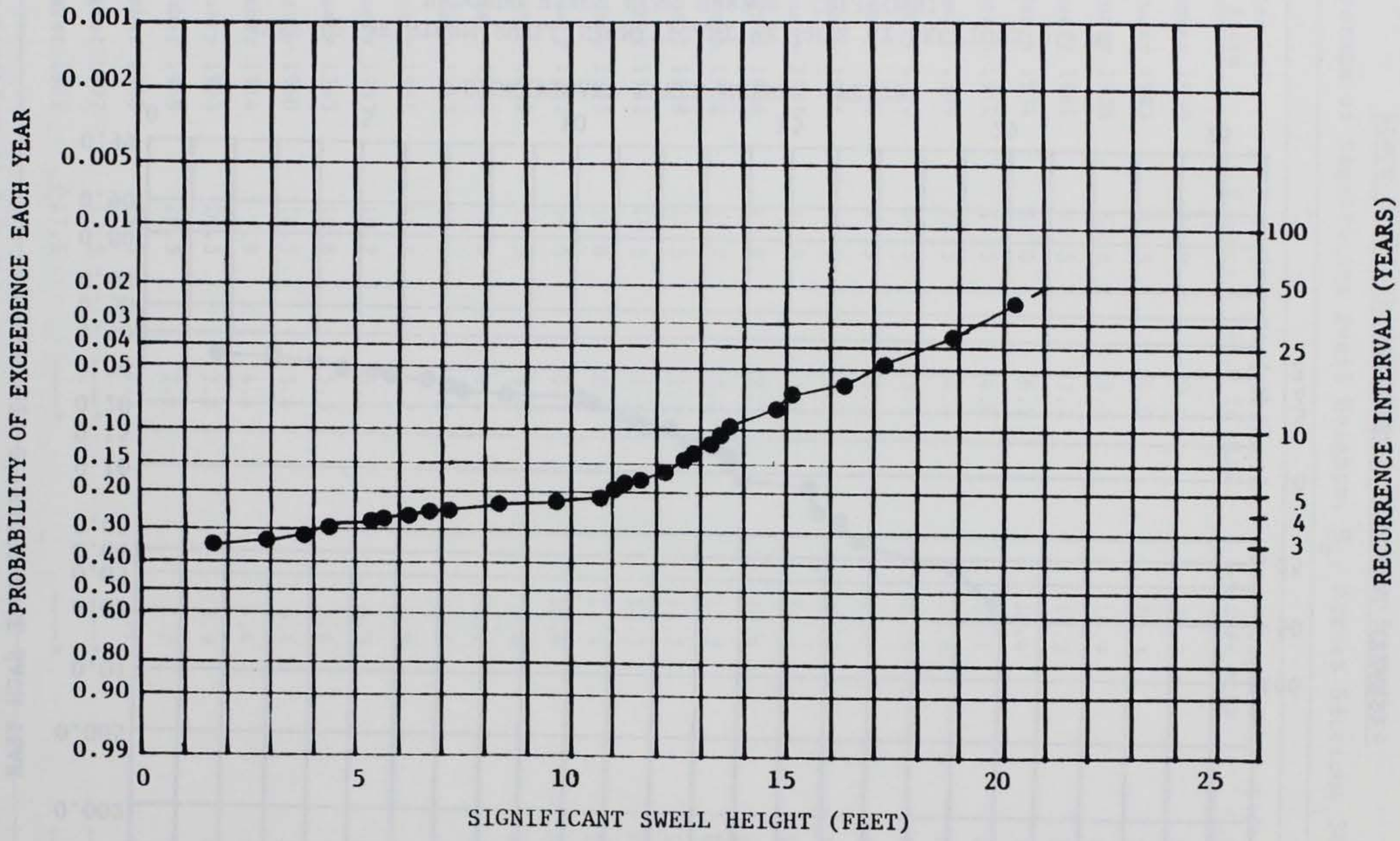
Average of Significant Swell Heights, H_s, Across Sections 34-38

Date of Storm	Period T (sec)	Tide Elevation, +8.0 ft MLLW	Tide Elevation, +5.4 ft MLLW	Tide Elevation 0.0 ft MLLW
September 1939	14.0	20.0	20.3	19.9
February 1963	13.5	20.0	20.3	19.9
January 1958	13.5	18.4	18.9	19.0
January 1981	15.5	17.7	17.2	16.3
March 1904	12.0	16.2	16.4	16.6
March 1912	11.5	14.8	15.1	15.8
February 1969	14.5	14.4	14.8	15.6
February 1980	14.5	13.5	13.6	14.0
January 1978	16.5	13.3	13.2	12.3
January 1916	9.6	13.0	13.3	13.9
February 1915	12.4	12.7	12.9	13.8
April 1926	13.8	12.3	12.6	13.3
March 1952	11.7	12.0	12.2	12.8
April 1958	17.5	11.9	11.7	11.1
November 1982	10.5	11.1	11.3	11.8
January 1915	11.8	10.9	11.1	11.7
February 1983	16.5	10.7	10.6	10.5
March 1983	18.5	9.4	9.6	10.1
February 1926	16.0	8.0	8.2	8.5
December 1937	16.4	7.2	7.1	7.1
January 1981	15.5	6.7	6.8	7.2
January 1953	19,2	6,1	6,3	6,6
January 1943	10.8	5.5	5.6	5.8
February 1960	18.5	5.4	5.4	5.4
December 1914	9.9	4.4	4.4	4.6
January 1983	20.5	3.8	3.9	4.0
December 1969	20.5	2.8	2.9	3.0
September 1963	14.5	1.7	1.7	1.8
August 1972	17.5	----*	----*	----*
September 1982	17.5	----*	----*	----*

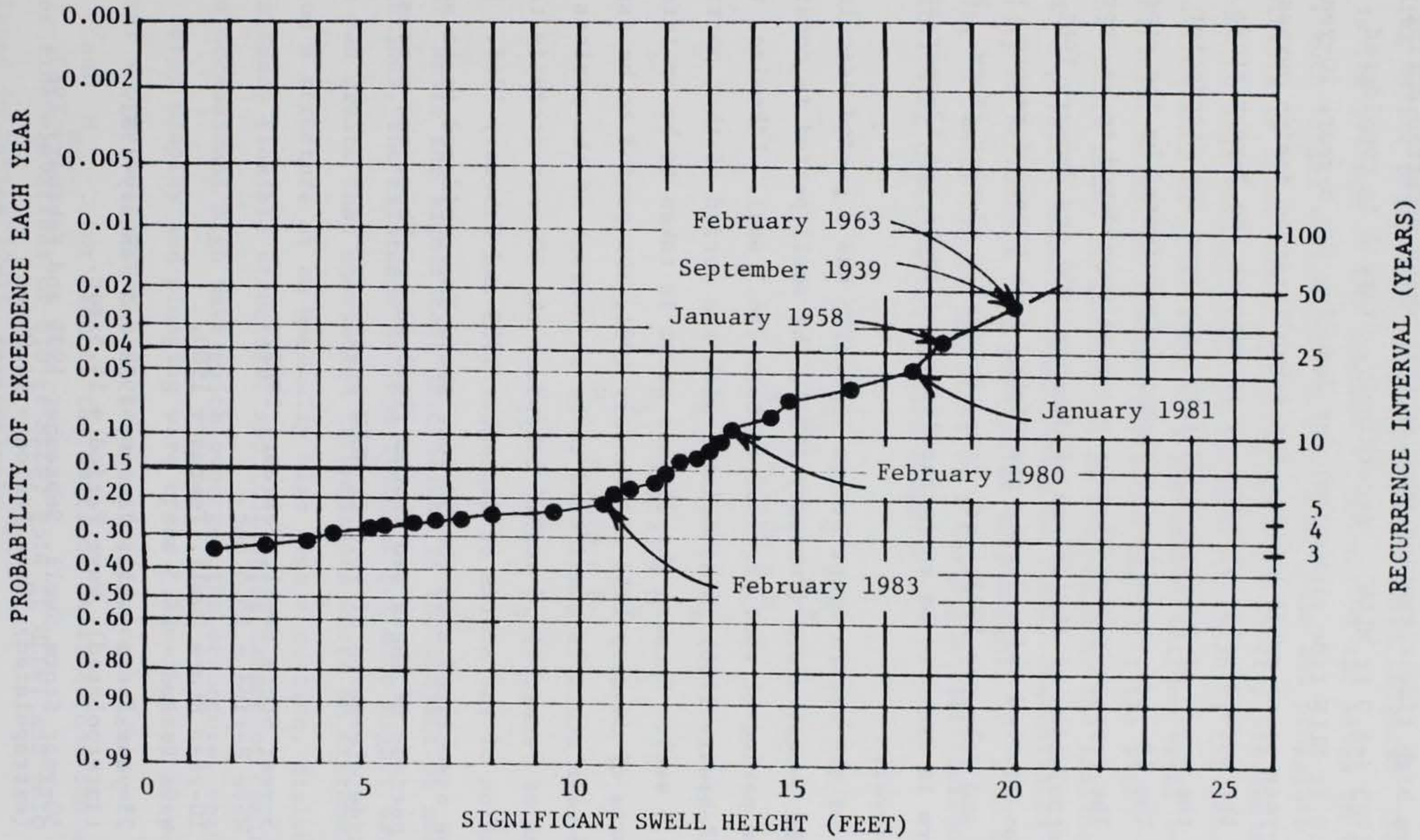
* Long period swell from this deep water unsheltered direction of approach could not reach the structure.



AVERAGE OF STORM SWELL SIGNIFICANT HEIGHTS AT SECTIONS 34-38
REDONDO BEACH KING HARBOR, CALIFORNIA
TIDE ELEVATION = 0.0 FT MLLW



AVERAGE OF STORM SWELL SIGNIFICANT HEIGHTS AT SECTIONS 34-38
REDONDO BEACH KING HARBOR, CALIFORNIA
TIDE ELEVATION = +5.4 FT MLLW



AVERAGE OF STORM SWELL SIGNIFICANT HEIGHTS AT SECTIONS 34-38
REDONDO BEACH KING HARBOR, CALIFORNIA
TIDE ELEVATION = +8.0 FT MLLW

heights for potential rehabilitation purposes, it appears appropriate to consider the swell heights associated with storms which could conceivably arrive at extreme high tide elevation such as that which occurred during the winter of 1982-1983 (+8.0 ft MLLW). Accordingly, Plate 3 is considered appropriate (+8.0 ft MLLW tide elevation) for deducing the 5-year, 10-year, 25-year, and 50-year storm swell heights for rehabilitation design purposes.

87. From the data display of Plate 3, it appears the 5-year storm can be approximated by the storm of February 1983 (strictly from the standpoint of swell height). The 10-year storm can be closely approximated by the storm of February 1980. The representative 25-year storm is considered to be approximated by an interpolation of the storms of January 1958 and January 1981. The largest storm was equaled twice during the eighty four years of record (September 1939 and February 1963) and, thus, becomes a 42-year storm. Hence, the 50-year storm is taken to be an extrapolation of these two 42-year storms to the 50-year level.

88. Each of the return-event storms logically has a period associated with it. For the 5-year storm (February 1983), the swell period is considered to be simply the period of that particular storm (16.5 sec). Likewise, the 10-year storm (February 1980) is associated with the period of that particular storm event (14.5 sec). Because the 25-year storm is taken to be an interpolation of the storms of January 1958 and January 1981, the period to be associated with the 25-year storm is considered to be an average of the periods of these two storms of record (14.5 sec). Likewise, the 50-year storm is taken to be an extrapolation of the storms of September 1939 and February 1963. Hence, the period to be associated with the 50-year storm is considered to be an average of the periods of these two storms (14.0 sec). Thus, the storms of interest at a tide elevation of +8.0 ft MLLW are:

a. 5-year Storm Swell, February 1983,
Wave Period = 16.5 sec.

b. 10-year Storm Swell, February 1980,
Wave Period = 14.5 sec.

c. 25-year Storm Swell, January 1958 and January 1981,
(interpolated), Wave Period = 14.5 sec.

d. 50-year Storm Swell, September 1939 and February 1963,
(extrapolated), Wave Period = 14.0 sec.

89. The swell heights hindcast by Walker, et. al., (1984) for these particular storms (and refracted to the different sections along the Redondo Beach King Harbor breakwater) are significant swell heights. The significant height is the average of the highest 33 percent of the waves in the record. In reality, much larger waves exist on the open ocean and propagate shoreward, and are available to cause damage to structures and overtop breakwaters. Of importance to engineering design is the determination of the return period or expected frequency of occurrence of a particular extreme swell condition (e.g., the significant height of the 50-year storm swell) at the site. The stability design of rubble mound structures may be evaluated by the application of such a wave in a physical model. Longuet-Higgins (1952) demonstrated that the probability of occurrence of a particular wave height, H_i , in a record containing N waves can be specified by a Rayleight distribution, thus leading to the following distribution of wave heights:

$$H_i = C \times H_s$$

$$H_{max} = 2.06 \times H_s$$

$$H_1 = 1.68 \times H_s$$

$$H_5 = 1.37 \times H_s$$

$$H_{10} = 1.28 \times H_s$$

$$H_{33} = 1.00 \times H_s$$

90. While the significant wave height is the subject of most design considerations, the existence of less frequent but much higher waves in the spectrum can create that unexpected circumstance where an extremely high wave impacts on a structure at an unusually high tide elevation, dislodging stone from an already flexible structure, and initiating damage or complete failure. It is the occassional high wave which overtops the structure, resulting in a dramatic spray display and plunging wave crest. The 5-year, 10-year, 25-year, and 50-year storm swell waves have been estimated for heights of H_s , H_{10} , H_5 , H_1 , and H_{max} , for each of the sections 34-41 across the north breakwater, for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, and are displayed in Tables 12-15, respectively.

91. The maximum height of a wave generated and traveling in deep water

Table 12

Redondo Beach King Harbor, California

5-Year Storm Swell Heights at the Structure

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
			Tide Elevation = +8.0 ft MLLW					
H_b (ft)	22.2	27.4	30.6					
H_s (ft)	14.8	11.7	9.8	9.0	8.1	5.9	3.0	1.5
H_{10} (ft)	18.9	15.0	12.5	11.5	10.4	7.6	3.8	1.9
H_5 (ft)	20.3	16.0	13.4	12.3	11.1	8.1	4.1	2.1
H_1 (ft)	22.2**	19.7	16.5	15.1	13.6	9.9	5.0	2.5
H_{max} (ft)	22.2**	24.1	20.2	18.5	16.7	12.2	6.2	3.1
			Tide Elevation = +5.4 ft MLLW					
H_b (ft)	20.0	25.2	28.4					
H_s (ft)	14.6	11.5	9.7	9.0	8.1	5.7	2.8	1.5
H_{10} (ft)	18.7	14.7	12.4	11.5	10.4	7.3	3.6	1.9
H_5 (ft)	20.0**	15.8	13.3	12.3	11.1	7.8	3.8	2.1
H_1 (ft)	20.0**	19.3	16.3	15.1	13.6	9.6	4.7	2.5
H_{max} (ft)	20.0**	23.7	20.0	18.5	16.7	11.7	5.8	3.1

(Table 12 Continued)

** Breaking wave.

(Table 12 Continued)

Redondo Beach King Harbor, California

5-Year Storm Swell Heights at the Structure

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
			Tide Elevation = 0.0 ft MLLW					
H_b (ft)	15.3	20.6	23.7					
H_s (ft)	14.6	11.3	9.6	9.0	8.1	5.5	2.4	1.2
H_{10} (ft)	15.3**	14.5	12.3	11.5	10.4	7.0	3.1	1.5
H_5 (ft)	15.3**	15.5	13.2	12.3	11.1	7.5	3.3	1.6
H_1 (ft)	15.3**	19.0	16.1	15.1	13.6	9.2	4.0	2.0
H_{max} (ft)	15.3**	20.6**	19.8	18.5	16.7	11.3	4.9	2.5

** Breaking wave.

Table 13

Redondo Beach King Harbor, California

10-Year Storm Swell Heights at the Structure

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	22.0	27.1	30.1	32.4	35.0			
H_s (ft)	14.6	13.1	12.9	13.4	13.3	11.1	6.6	3.2
H_{10} (ft)	18.7	16.8	16.5	17.2	17.0	14.2	8.4	4.1
H_5 (ft)	20.0	17.9	17.7	18.4	18.2	15.2	9.0	4.4
H_1 (ft)	22.0**	22.0	21.7	22.5	22.3	18.6	11.1	5.4
H_{max} (ft)	22.0**	27.0	26.6	27.6	27.4	22.9	13.6	6.6
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	19.8	24.9	28.0	30.3	32.9			
H_s (ft)	14.9	13.3	13.0	13.5	13.5	11.0	6.2	3.1
H_{10} (ft)	19.1	17.0	16.6	17.3	17.3	14.1	7.9	4.0
H_5 (ft)	19.8**	18.2	17.8	18.5	18.5	15.1	8.5	4.2
H_1 (ft)	19.8**	22.3	21.8	22.7	22.7	18.5	10.4	5.2
H_{max} (ft)	19.8**	24.9**	26.8	27.8	27.8	22.7	12.8	6.4

(Table 13 Continued)

** Breaking wave.

(Table 13 Continued)

Redondo Beach King Harbor, California

10-Year Storm Swell Heights at the Structure

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = 0.0 ft MLLW				
H_b (ft)	15.2	20.4	23.4	25.9	28.5			
H_s (ft)	15.2**	13.7	13.4	14.1	13.8	10.6	5.4	2.7
H_{10} (ft)	15.2**	17.5	17.2	18.0	17.7	13.6	6.9	3.5
H_5 (ft)	15.2**	18.8	18.4	19.3	18.9	14.5	7.4	3.7
H_1 (ft)	15.2**	20.4**	22.5	23.7	23.2	17.8	9.1	4.5
H_{max} (ft)	15.2**	20.4**	23.4**	25.9*	28.4	21.8	11.1	5.6

** Breaking wave.

Table 14

Redondo Beach King Harbor, California

25-Year Storm Swell Heights at the Structure

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	22.0	27.1	30.1	32.4	35.0	33.7		
H_s (ft)	19.9	18.6	17.6	17.4	17.0	14.9	9.5	4.5
H_{10} (ft)	22.0**	23.8	22.5	22.3	21.8	19.1	12.2	5.8
H_5 (ft)	22.0**	25.5	24.1	23.8	23.3	20.4	13.0	6.2
H_1 (ft)	22.0**	27.1**	29.6	29.2	28.6	25.0	16.0	7.6
H_{max} (ft)	22.0**	27.1**	30.1**	32.4**	35.0**	30.7	19.6	9.3
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	19.8	24.9	28.0	30.3	32.9	31.7		
H_s (ft)	19.2	18.8	17.8	17.6	17.1	14.7	9.0	4.1
H_{10} (ft)	19.8**	24.1	22.8	22.5	21.9	18.8	11.5	5.3
H_5 (ft)	19.8**	24.9**	24.4	24.1	23.4	20.1	12.3	5.6
H_1 (ft)	19.8**	24.9**	28.0**	29.6	28.7	24.7	15.1	6.9
H_{max} (ft)	19.8**	24.9**	28.0**	30.3**	32.9**	30.3	18.5	8.5

(Table 14 Continued)

** Breaking wave.

(Table 14 Continued)

Redondo Beach King Harbor, California

25-Year Storm Swell Heights at the Structure

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = 0.0 ft MLLW				
H_b (ft)	15.2	20.4	23.4	25.9	28.5	27.3		
H_s (ft)	15.2**	19.5	18.3	18.0	17.5	14.2	7.8	3.4
H_{10} (ft)	15.2**	20.4**	23.4**	23.0	22.4	18.2	10.0	4.4
H_5 (ft)	15.2**	20.4**	23.4**	24.7	24.0	19.5	10.7	4.7
H_1 (ft)	15.2**	20.4**	23.4**	25.9**	28.5**	23.9	13.1	5.7
H_{max} (ft)	15.2**	20.4**	23.4**	25.9**	28.5**	27.3**	16.1	7.0

** Breaking wave.

Table 15

Redondo Beach King Harbor, California

50-Year Storm Swell Heights at the Structure

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	21.9	26.9	30.0	32.3	34.8	33.6		
H_s (ft)	20.5	20.4	20.7	21.0	19.9	16.3	10.4	5.2
H_{10} (ft)	21.9**	26.1	26.5	26.9	25.5	20.9	13.3	6.7
H_5 (ft)	21.9**	26.9**	28.4	28.8	27.3	22.3	14.3	7.1
H_1 (ft)	21.9**	26.9**	30.0**	32.3**	33.4	27.4	17.5	8.7
H_{max} (ft)	21.9**	26.9**	30.0**	32.3**	34.8**	33.6**	21.4	10.7
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	19.7	24.8	27.8	30.2	32.7	31.5		
H_s (ft)	19.7**	21.1	21.3	21.4	20.3	16.2	9.4	4.8
H_{10} (ft)	19.7**	24.8**	27.3	27.4	26.0	20.7	12.0	6.1
H_5 (ft)	19.7**	24.8**	27.8**	29.3	27.8	22.2	12.9	6.6
H_1 (ft)	19.7**	24.8**	27.8**	30.2**	32.7**	27.2	15.8	8.1
H_{max} (ft)	19.7**	24.8**	27.8**	30.2**	32.7**	31.5**	19.4	9.9

(Table 15 Continued)

** Breaking wave.

(Table 15 Continued)

Redondo Beach King Harbor, California

50-Year Storm Swell Heights at the Structure

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = 0.0 ft MLLW				
H_b (ft)	15.1	20.3	23.3	25.7	28.4	27.2		
H_s (ft)	15.1**	20.3**	22.4	22.5	21.0	15.9	9.0	4.1
H_{10} (ft)	15.1**	20.3**	23.3**	25.7**	26.9	20.4	11.5	5.3
H_5 (ft)	15.1**	20.3**	23.3**	25.7**	28.4**	21.8	12.3	5.6
H_1 (ft)	15.1**	20.3**	23.3**	25.7**	28.4**	26.7	15.1	6.9
H_{max} (ft)	15.1**	20.3**	23.3**	25.7**	28.4**	27.2**	18.5	8.5

** Breaking wave.

is limited by the maximum steepness for which the wave form can remain stable. Waves reaching the limiting steepness will begin to break, and in so doing, will dissipate a portion of their energy. When a wave moves into shoaling water, the limiting steepness which it can attain decreases, being a function of both the relative depth, d/L, and the underwater bottom slope, m, perpendicular to the direction of wave advance. A wave of given deep water characteristics will move toward a shore until the water becomes shallow enough to initiate breaking. This depth is usually denoted as d_b and termed the breaking depth. The wave height at breaking is usually denoted as H_b. Investigations and observations by Galvin (1969) and Goda (1970) established that H_b is dependent on the depth at breaking, d_b, the underwater bottom slope, m, and the wave period, T. An expression for this relationship has been presented by US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center (1984) as:

$$\frac{d_b}{H_b} = \frac{1}{b - (a\ H_b/g\ T^2)} \tag{22}$$

where

$$a = 43.75\ (1 - e^{-19m}) \tag{23}$$

and

$$b = \frac{1.56}{(1 + e^{-19.5m})} \tag{24}$$

In equations 22-24, g is the gravitational acceleration (32.174 ft/sec^2), and e is the base of the Napierian (natural) logarithm system (2.71828, dimensionless). The other symbols have been previously defined. Equation 22 can be re-arranged to provide for a direct solution of the wave breaking height, H_b, when the water depth, d_b, the approach bottom slope, m, and wave period, T, are known. The resulting expression is:

$$H_b = \frac{d_b\ b}{1 + \frac{d_b\ a}{g\ T^2}} \tag{25}$$

92. The bathymetry in the near-vicinity of the Redondo Beach King Harbor breakwater was determined from the most recent detailed hydrographic surveys of the region. These data were utilized in generating the depth grid for RCPWAVE. All RCPWAVE computations were performed for unity (1.00 ft) wave heights; hence, the model output was in the form of refraction/diffraction/shoaling coefficients only. These coefficients were then applied to the sheltered deep water wave statistics to determine the actual wave height at a particular location. It was necessary to apply Equation 25 to ensure that the computed wave heights never exceeded the maximum possible depth-limited wave heights at any location.

Annual Sea Heights at the Breakwater

93. The annual sea waves of Table 2, obtained from SEAS Station P2 06, were processed through the water wave transformation numerical computer program RCPWAVE, after accounting for island sheltering effects. Sea waves with periods less than 9 sec propagate toward the breakwater and entrance channel essentially unrefracted by bottom topography and the Submarine Canyon. The transformation coefficients for the annual sea waves with periods of 10 sec, 12 sec, and 14 sec, are shown in Table 16. Here is seen that the 10-sec sea feels the effects of the Redondo Submarine Canyon to an extent that the wave energy concentration occurs at the +11.5 ft MLLW crest elevation portion of the structure (sections 39-41). Longer-period sea (12- and 14-sec) increasingly feel the effects of the Canyon and shoal, and are refracted more toward the +20.0 ft MLLW crest elevation section of the structure (sections 34-38). This implies that the longer-period annual sea waves with large heights (14 sec period and up to 15 ft high at the structure) have the potential for causing severe structural damage with overtopping which creates additional damage inside the harbor.

94. When the transformation coefficients at the breakwater for the 10-sec, 12-sec, and 14-sec period sea (Table 16) are applied to the deep water sea data after accounting for island sheltering effects, there results the transformed annual sea wave heights at sections 34-41 along the breakwater (Table 17). Here, again, these are the significant wave heights, and there theoretically exist waves in the spectrum up to 2.06 times as large as these

Table 16

Redondo Beach King Harbor, California

Water Wave Transformation Coefficients

Annual Sea

Wave Period, T (sec)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
10.0	1.05	1.01	0.99	1.00	1.06	1.18	1.24	1.11
12.0	1.13	1.12	1.13	1.19	1.32	1.44	1.30	0.87
14.0	1.39	1.37	1.38	1.40	1.39	1.22	0.77	0.33
				Tide Elevation = +5.4 ft MLLW				
10.0	1.07	1.03	1.01	1.02	1.08	1.21	1.26	1.11
12.0	1.17	1.14	1.15	1.23	1.35	1.47	1.30	0.82
14.0	1.44	1.41	1.40	1.42	1.40	1.20	0.72	0.30
				Tide Elevation = 0.0 ft MLLW				
10.0	1.14	1.07	1.04	1.06	1.13	1.28	1.31	1.09
12.0	1.25	1.21	1.22	1.30	1.44	1.53	1.27	0.70
14.0	1.56	1.49	1.46	1.47	1.42	1.16	0.62	0.24

Table 17

Redondo Beach King Harbor, California

Annual Significant Sea Wave Heights, H_s, at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period, T (sec)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
10.0	9.0	8.6	8.4	8.5	9.0	10.1	10.6	9.5
12.0	9.0	9.0	9.0	9.5	10.6	11.5	10.4	7.0
14.0	14.5	14.3	14.4	14.6	14.5	12.8	8.1	3.5
				Tide Elevation = +5.4 ft MLLW				
10.0	9.1	8.8	8.6	8.7	9.2	10.3	10.8	9.5
12.0	9.4	9.1	9.2	9.8	10.8	11.8	10.4	6.6
14.0	15.1	14.7	14.6	14.9	14.6	12.6	7.5	3.1
				Tide Elevation = 0.0 ft MLLW				
10.0	9.7	9.1	8.9	9.0	9.6	10.9	11.2	9.3
12.0	10.0	9.7	9.8	10.4	11.5	12.2	10.2	5.6
14.0	15.1	15.6	15.3	15.4	14.9	12.1	6.5	2.5

significant sea wave heights (Longuet-Higgins, 1952). The heights of the annual sea with periods of 10 sec, 12 sec, and 14 sec, for tide elevations of 0.0 ft MLLW, +5.4 ft MLLW, and +8.0 ft MLLW, are shown in Tables 18-20, respectively.

95. A comparison of the storm swell heights of the storm of February 1983 with the annual sea wave heights for periods of 10 sec, 12 sec, and 14 sec, for tide elevation of +8.0 ft MLLW, is presented in Table 21. Here is seen that the 14-sec annual sea wave heights at the structure are as large as the 16.5-sec swell component of the storm of February 1983. The 16.5-sec period was the peak of the energy spectrum hindcast for this February 1983 storm. Based on a strictly wave height analysis, the heights of the annual sea waves reaching the breakwater at Redondo Beach King Harbor, California, are as large as the swell height associated with the peak period component of the hindcast open ocean deep water storm of February 1983. From an energy concept analysis, however, the longer-period wave of equal height would possess a larger amount of energy which would be expended on the breakwater. Hence, the potential for structure damage is significantly greater from the longer-period swell than from the shorter-period sea wave of equal height.

Table 18

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 10.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	20.9	25.3						
H_s (ft)	9.0	8.6	8.4	8.5	9.0	10.1	10.6	9.5
H_{10} (ft)	11.5	11.0	10.8	10.9	11.5	12.9	13.6	12.2
H_5 (ft)	12.3	11.8	11.5	11.7	12.3	13.8	14.5	13.0
H_1 (ft)	15.1	14.5	14.1	14.3	15.1	17.0	17.8	16.0
H_{max} (ft)	18.5	17.7	17.3	17.5	18.5	20.8	21.8	19.6
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	18.9	23.4						
H_s (ft)	9.1	8.8	8.6	8.7	9.2	10.3	10.8	9.5
H_{10} (ft)	11.7	11.3	11.0	11.1	11.8	13.2	13.8	12.2
H_5 (ft)	12.5	12.1	11.8	11.9	12.6	14.1	14.8	13.0
H_1 (ft)	15.3	14.8	14.5	14.6	15.5	17.3	18.1	16.0
H_{max} (ft)	18.8	18.1	17.7	17.9	19.0	21.2	22.3	19.6

(Table 18 Continued)

(Table 18 Continued)

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 10.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
Tide Elevation = 0.0 ft MLLW								
H_b (ft)	14.6	19.3						
H_s (ft)	9.7	9.1	8.9	9.0	9.6	10.9	11.2	9.3
H_{10} (ft)	12.4	11.7	11.4	11.5	12.3	14.0	14.3	11.9
H_5 (ft)	13.3	12.5	12.2	12.3	13.2	14.9	15.3	12.7
H_1 (ft)	14.6**	15.3	15.0	15.1	16.1	18.3	18.8	15.6
H_{max} (ft)	14.6**	18.8	18.3	18.5	19.8	22.5	23.1	19.2

** Breaking wave.

Table 19

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 12.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	21.5	26.4	28.7	31.2				
H_s (ft)	9.0	9.0	9.0	9.5	10.6	11.5	10.4	7.0
H_{10} (ft)	11.5	11.5	11.5	12.2	13.6	14.7	13.3	9.0
H_5 (ft)	12.3	12.3	12.3	13.0	14.5	15.8	14.3	9.6
H_1 (ft)	15.1	15.1	15.1	16.0	17.8	19.3	17.5	11.8
H_{max} (ft)	18.5	18.5	18.5	19.6	21.8	23.7	21.4	14.4
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	19.4	23.8	26.7	29.2				
H_s (ft)	9.4	9.1	9.2	9.8	10.8	11.8	10.4	6.6
H_{10} (ft)	12.0	11.7	11.8	12.5	13.8	15.1	13.3	8.5
H_5 (ft)	12.9	12.5	12.6	13.4	14.8	16.2	14.3	9.0
H_1 (ft)	15.8	15.3	15.5	16.5	18.1	19.8	17.5	11.1
H_{max} (ft)	19.4**	18.8	19.0	20.2	22.3	24.3	21.4	13.6

(Table 19 Continued)

** Breaking wave.

(Table 19 Continued)

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 12.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
Tide Elevation = 0.0 ft MLLW								
H_b (ft)	14.9	19.6	22.4	25.0				
H_s (ft)	10.0	9.7	9.8	10.4	11.5	12.2	10.2	5.6
H_{10} (ft)	12.8	12.4	12.5	13.3	14.7	15.6	13.1	7.2
H_5 (ft)	13.7	13.3	13.4	14.3	15.8	16.7	14.0	7.7
H_1 (ft)	14.9**	16.3	16.5	17.5	19.3	20.5	17.1	9.4
H_{max} (ft)	14.9**	19.6**	20.2	21.4	23.7	25.1	21.0	11.5

** Breaking wave.

Table 20

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 14.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_b (ft)	21.9	26.9	30.0	32.3	34.8	33.6		
H_s (ft)	14.5	14.3	14.4	14.6	14.5	12.8	8.1	3.5
H_{10} (ft)	18.6	18.3	18.4	18.7	18.6	16.4	10.4	4.5
H_5 (ft)	19.9	19.6	19.7	20.0	19.9	17.5	11.1	4.8
H_1 (ft)	21.9**	24.0	24.2	24.5	24.4	21.5	13.6	5.9
H_{max} (ft)	21.9**	26.9**	29.7	30.1	29.9	26.4	16.7	7.2
				Tide Elevation = +5.4 ft MLLW				
H_b (ft)	19.7	24.8	27.8	30.2	32.7	31.5		
H_s (ft)	15.1	14.7	14.6	14.9	14.6	12.6	7.5	3.1
H_{10} (ft)	19.3	18.8	18.7	19.1	18.7	16.1	9.6	4.0
H_5 (ft)	19.7**	20.1	20.0	20.4	20.0	17.3	10.3	4.3
H_1 (ft)	19.7**	24.7	24.5	25.0	24.5	21.2	12.6	5.2
H_{max} (ft)	19.7**	24.8**	27.8**	30.2**	30.1	26.0	15.5	6.4

(Table 20 Continued)

** Breaking wave.

(Table 20 Continued)

Redondo Beach King Harbor, California

Annual Sea Wave Heights at the Structure

Sea-State Engineering Analysis System (SEAS)

Wave Period = 14.0 sec

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
Tide Elevation = 0.0 ft MLLW								
H_b (ft)	15.1	20.3	23.3	25.7	28.4	27.2		
H_s (ft)	15.1**	15.6	15.3	15.4	14.9	12.1	6.5	2.5
H_{10} (ft)	15.1**	20.0	19.6	19.7	19.1	15.5	8.3	3.2
H_5 (ft)	15.1**	20.3**	21.0	21.1	20.4	16.6	8.9	3.4
H_1 (ft)	15.1**	20.3**	23.3**	25.7**	25.0	20.3	10.9	4.2
H_{max} (ft)	15.1**	20.3**	23.3**	25.7**	28.4**	24.9	13.4	5.2

** Breaking wave.

Table 21

Redondo Beach King Harbor, California

February 1983 Storm Swell Heights and Annual Sea Heights at the Structure

Tide Elevation = +8.0 ft MLLW

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				February 1983 Storm Swell Heights at the Structure				
H_b (ft)	22.2	27.4						
H_s (ft)	14.8	11.7	9.8	9.0	8.1	5.9	3.0	1.5
H_{10} (ft)	18.9	15.0	12.5	11.5	10.4	7.6	3.8	1.9
H_5 (ft)	20.3	16.0	13.4	12.3	11.1	8.1	4.1	2.1
H_1 (ft)	22.2**	19.7	16.5	15.1	13.6	9.9	5.0	2.5
H_{max} (ft)	22.2**	24.1	20.2	18.5	16.7	12.2	6.2	3.1
				Annual 10.0-second Sea Heights at the Structure				
H_b (ft)	20.9	25.3						
H_s (ft)	9.0	8.6	8.4	8.5	9.0	10.1	10.6	9.5
H_{10} (ft)	11.5	11.0	10.8	10.9	11.5	12.9	13.6	12.2
H_5 (ft)	12.3	11.8	11.5	11.7	12.3	13.8	14.5	13.0
H_1 (ft)	15.1	14.5	14.1	14.3	15.1	17.0	17.8	16.0
H_{max} (ft)	18.5	17.7	17.3	17.5	18.5	20.8	21.8	19.6

(Table 21 Continued)

** Breaking wave.

(Table 21 Continued)

Redondo Beach King Harbor, California

February 1983 Storm Swell Heights and Annual Sea Heights at the Structure

Tide Elevation = +8.0 ft MLLW

Wave Heights (ft)	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Annual 12.0-second Sea Heights at the Structure				
H_b (ft)	21.5	26.4	28.7	31.2				
H_s (ft)	9.0	9.0	9.0	9.0	10.6	11.5	10.4	7.0
H_{10} (ft)	11.5	11.5	11.5	12.2	13.6	14.7	13.3	9.0
H_5 (ft)	12.3	12.3	12.3	13.0	14.5	15.8	14.3	9.6
H_i (ft)	15.1	15.1	15.1	16.0	17.8	19.3	17.5	11.8
H_{max} (ft)	18.5	18.5	18.5	19.6	21.8	23.7	21.4	14.4
				Annual 14.0-second Sea Heights at the Structure				
H_b (ft)	21.9	26.9	30.0	32.3	34.8	33.6		
H_s (ft)	14.5	14.3	14.4	14.6	14.5	12.8	8.1	3.5
H_{10} (ft)	18.6	18.3	18.4	18.7	18.6	16.4	10.4	4.5
H_5 (ft)	19.9	19.6	19.7	20.0	19.9	17.5	11.1	4.8
H_1 (ft)	21.9**	24.0	24.2	24.5	24.4	21.5	13.6	5.9
H_{max} (ft)	21.9**	26.9**	29.7	30.1	29.9	26.4	16.7	7.2

** Breaking wave.

PART VIII: WAVE TRANSMISSION PAST THE REDONDO BEACH KING HARBOR BREAKWATER

96. As a water wave approaches an impermeable breakwater, some of the wave energy is supplied to wave runup, some of the energy is dissipated, and the remaining wave energy returns seaward in the form of a reflected wave. If the runup exceeds the crest elevation of the breakwater, waves will overtop the structure and be regenerated on the landward (harbor) side. As the height of the breakwater is reduced, the magnitude of the wave reflection decreases because more of the wave energy is transmitted past the structure by overtopping.

97. When a wave approaches and interacts with a rough permeable (rubble mound) breakwater, the sequence of wave action is similar to that for an impermeable breakwater, but with important differences. First, some of the wave energy moves through the permeable breakwater, and this flow through the porous medium may dissipate a significant amount of wave energy. Second, because the breakwater absorbs some of the wave energy, the runup and reflection coefficients on a rough permeable rubble mound breakwater are less than for the same wave condition on a similar smooth impermeable structure. If the runup level exceeds the height of the structure, wave transmission by overtopping and penetration through the structure will contribute to the overall transmission past the structure (Seelig, 1980). The overall transmission coefficient, K_T, is the vector sum of the coefficient of penetration, K_P, and coefficient of overtopping, K_O, since wave energy is proportional to the square of the wave heights.

$$K_T = (K_P^2 + K_O^2)^{1/2} \tag{26}$$

98. The wave transmission coefficient, K_T, is primarily a function of wave steepness for a given permeable breakwater design and wave condition where there is no overtopping. As the wave steepness increases, the amount of energy dissipated on the face and inside the breakwater increases (Madsen and White, 1976), and the transmission coefficient decreases. The wave penetration through the structure is a complex function of the wave conditions, structure width, size, permeability, location of various layers of material, structure height, and water depth. Very low steepness waves, such as astronomical

tides, may transmit totally through the breakwater (K_P = 1.00), while wind waves are effectively damped. Locally generated storm waves with high steepness are associated with low penetration coefficients.

99. As soon as the wave runup level exceeds the breakwater crest, wave overtopping occurs and the transmission coefficient increases with increased wave steepness. Figure 25 shows the case of wave transmission for a breakwater armored with tribars. For low wave steepness with no overtopping, the total transmission of the structure, K_T , is the same as the penetration, K_P . As wave steepness increases the coefficient of penetration decreases, as does the total transmission (which is the same thing) until overtopping begins. When overtopping begins, with further increases in wave steepness total transmission rapidly increases since the coefficient of overtopping, K_O , increases.

100. There are several approaches for estimating the transmission of wave energy by a rubble mound breakwater:

a. Use results from previous model studies where penetration coefficients and overtopping coefficients have been determined.

b. Perform site-specific laboratory scale model studies to finalize design. The advantages of a model study are that structural stability, wave transmission, wave overtopping, and wave reflection can all be examined in a single series of model tests.

c. Apply numerical modeling techniques such as the computer program MADSEN (Madsen and White, 1976), available in Seelig (1979). This program calculates penetration coefficients, overtopping coefficients, and determines the total wave transmission past the structure into the harbor.

The advantages of the numerical program by Madsen and White (1976) are that it can be used to make a preliminary evaluation of a large number of alternative structural designs, water levels, and wave conditions quickly and at low cost. The program has been slightly modified by US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, for easier application, and renamed IMADSEN to distinguish from the original version. There is good agreement between this model predictions and physical model results from Keulegan (1973) for rectangular breakwaters composed of one rock

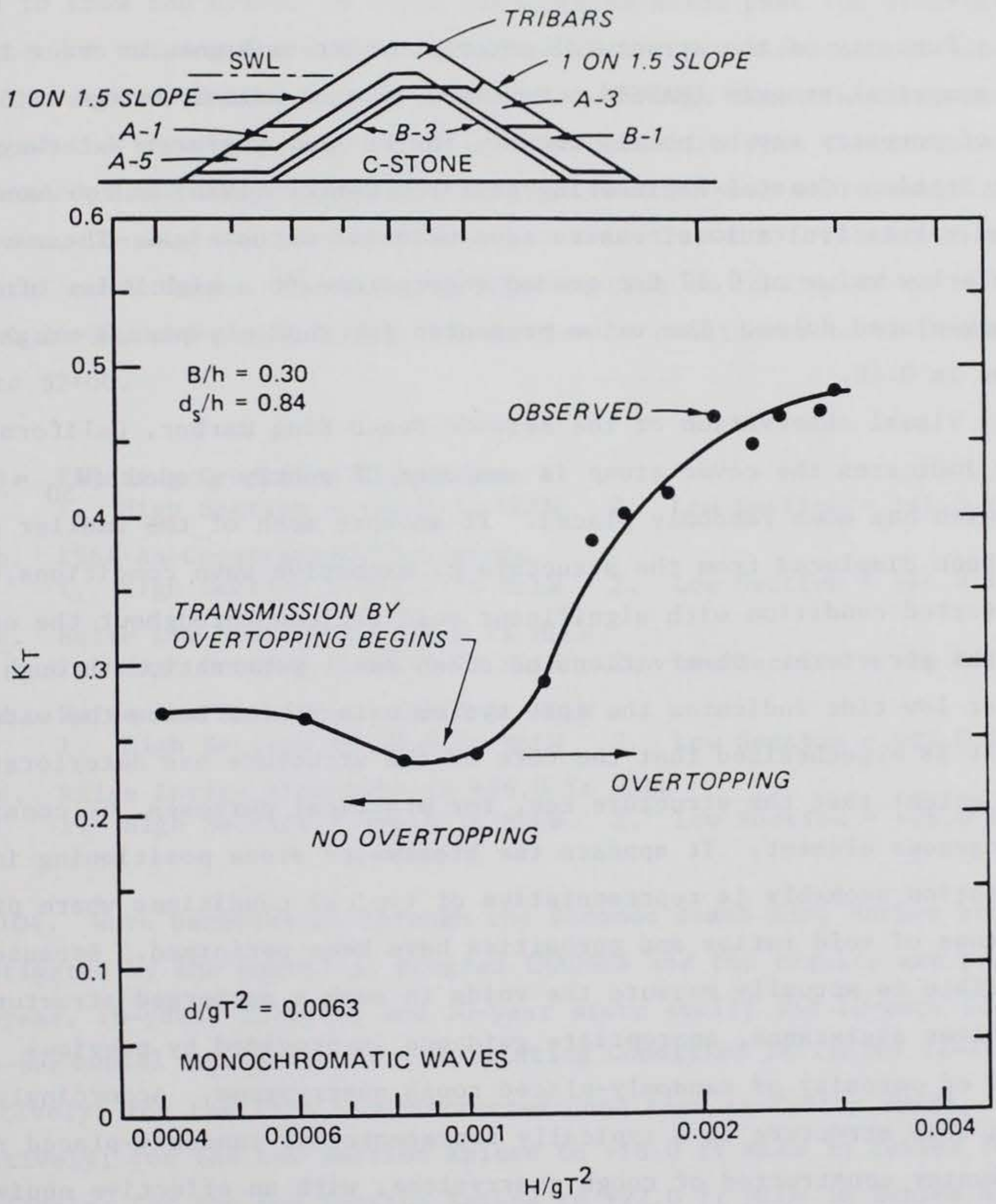


Figure 25. Total wave transmission, K_T, consisting of wave penetration, K_P, and wave overtopping, K_O (Laboratory data from Davidson, 1969) (after US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, 1984)

type, and from Sollitt and Cross (1976) for a multi-layered trapezoidal breakwater made of riprap.

Porosity of the Breakwater

101. Porosity of the structural materials must be known in order to apply the numerical program IMADSEN. However, in many actual design situations, the value of porosity may be poorly known. The US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center (1984) has presented recommended values for various construction material porosities. These values range from a low value of 0.37 for graded quarrystone to a high value of 0.63 for randomly-placed dolos. The value presented for randomly-placed rough quarrystone is 0.40.

102. Visual observation of the Redondo Beach King Harbor, California, breakwater indicates the cover stone is composed of poorly graded (W_{50} = 13-ton) capstone which has been randomly placed. It appears much of the smaller graded stone has been displaced from the structure by excessive wave conditions, leaving a sorted condition with significant void regions throughout the entire extent of the structure. Observations of ocean swell penetration through the structure at low tide indicates the void system extends far below the water surface. It is hypothesized that the core of the structure has deteriorated to such an extent that the structure can, for practical purposes, be considered as one homogenous element. It appears the breakwater stone positioning in its present location probably is representative of typical conditions where precise determinations of void ratios and porosities have been performed. Because it is not possible to actually measure the voids in such a submerged structure even with diver assistance, appropriate guidance is provided by previous estimations of porosity of randomly-placed rough quarrystone. Accordingly, it is believed this structure is a typically representative randomly-placed rubble mound breakwater constructed of rough quarrystone, with an effective equivalent porosity of 0.40.

Conditions Evaluated

103. Local interests desire that the crest elevation of the +11.5 ft MLLW section of the north breakwater be raised at least to the existing crest

elevation of the higher section of this structure (+20.0 ft MLLW). Other alternatives include raising the crest elevation of the +11.5 ft MLLW section in increments of approximately 4 ft above the 1964 as-constructed elevation (+14.0 ft MLLW) to +18.0 ft MLLW, and to +22.0 ft MLLW. Additionally, it is desired to know the effect on total wave transmission past the breakwater into the Harbor of raising the entire structure to a crest elevation of +26.0 ft MLLW. The amount of wave energy penetration through the structure, wave overtopping of the structure, and total wave transmission past the structure, was determined for the 5-year, 10-year, 25-year, and 50-year storm swell and for the 10-sec, 12-sec, and 14-sec annual sea waves, for the following breakwater structural conditions. The existing high section is considered to be Stations 15+50 to 36+00, and the existing low section is considered to be Stations 36+00 to 52+00.

a. Existing Condition Elevations
   1. High Section = +20.0 ft MLLW 2. Low Section = +11.5 ft MLLW

b. 1964 As-Constructed Elevations
   1. High Section = +22.0 ft MLLW 2. Low Section = +14.0 ft MLLW

c. Raise Low Section to +18.0 ft MLLW
   1. High Section = +20.0 ft MLLW 2. Low Section = +18.0 ft MLLW

d. Raise Low Section to +22.0 ft MLLW
   1. High Section = +20.0 ft MLLW 2. Low Section = +22.0 ft MLLW

e. Raise Entire Structure to +26.0 ft MLLW
   1. High Section = +26.0 ft MLLW 2. Low Section = +26.0 ft MLLW

104. Wave penetration through the Redondo Beach King Harbor breakwater was estimated by the numerical program IMADSEN and the results are presented for 5-year, 10-year, 25-year, and 50-year storm swell, and 10-sec, 12-sec, and 14-sec annual sea waves for the Existing Condition in Tables 22-28, respectively; for the 1964 As-Constructed Condition in Tables 29-35, respectively; for the Low Section Raised to +18.0 ft MLLW in Tables 36-42, respectively; for the Low Section Raised to +22.0 ft MLLW in Tables 43-49, respectively; and for the Entire Structure Raised to +26.0 ft MLLW in Tables 50-56, respectively.

105. The results of the computations of wave overtopping of the breakwater are presented for 5-year, 10-year, 25-year, and 50-year storm swell, and 10-sec, 12-sec, and 14-sec annual sea waves for the Existing

Condition in Tables 57-63, respectively; for the 1964 As-Constructed Condition in Tables 64-70, respectively; for the Low Section Raised to +18.0 ft MLLW in Tables 71-77, respectively; for the Low Section Raised to +22.0 ft MLLW in Tables 78-84, respectively; and for the Entire Structure Raised to +26.0 ft MLLW in Tables 85-91, respectively.

106. The total wave transmission past Redondo Beach King Harbor breakwater into the navigation channel and mooring basins was computed by IMADSEN and the results are presented for 5-year, 10-year, 25-year, and 50-year storm swell, and 10-sec, 12-sec, and 14-sec annual sea waves for the Existing Condition in Tables 92-98, respectively; for the 1964 As-Constructed Condition in Tables 99-105, respectively; for the Low Section Raised to +18.0 ft MLLW in Tables 106-112, respectively; for the Low Section Raised to +22.0 ft MLLW in Tables 113-119, respectively; and for the Entire Structure Raised to +26.0 ft MLLW in Tables 120-126, respectively.

Table 22

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.7	1.7	1.6	1.5	1.1	0.7
H_{10} (ft)	2.0	2.1	2.0	1.9	1.8	1.8	1.2	0.8
H_5 (ft)	2.0	2.1	2.0	2.0	1.9	1.8	1.3	0.8
H_1 (ft)	2.1**	2.3	2.2	2.2	2.1	2.0	1.4	0.9
H_{max} (ft)	2.1**	2.3	2.4	2.4	2.3	2.2	1.6	1.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	1.9**	2.1	2.1	2.1	2.0	1.9	1.3	0.9
H_{max} (ft)	1.9**	2.2	2.2	2.2	2.2	2.1	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.2	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 23

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.9	1.9	1.9	2.0	2.0	2.1	1.6	1.1
H_{10} (ft)	2.0	2.1	2.1	2.2	2.2	2.3	1.8	1.3
H_5 (ft)	2.0	2.2	2.2	2.3	2.3	2.4	1.9	1.3
H_1 (ft)	2.1**	2.3	2.4	2.5	2.5	2.6	2.1	1.4
H_{max} (ft)	2.1**	2.4	2.5	2.6	2.7	2.7	2.3	1.6
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.7	1.8	1.8	1.9	1.9	2.0	1.5	1.0
H_{10} (ft)	1.9	2.0	2.0	2.1	2.1	2.2	1.7	1.2
H_5 (ft)	1.9**	2.0	2.1	2.2	2.2	2.3	1.7	1.2
H_1 (ft)	1.9**	2.2	2.3	2.4	2.4	2.5	1.9	1.4
H_{max} (ft)	1.9**	2.2**	2.4	2.5	2.6	2.6	2.1	1.5
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.0	1.3	1.0
H_5 (ft)	1.5**	1.8	1.8	2.0	2.0	2.0	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	2.2	1.6	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3	2.3	1.8	1.2

** Breaking wave.

Table 24

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.2	2.2	2.2	2.4	1.9	1.3
H_{10} (ft)	2.1**	2.3	2.4	2.5	2.5	2.6	2.2	1.5
H_5 (ft)	2.1**	2.4	2.4	2.5	2.6	2.7	2.3	1.5
H_1 (ft)	2.1**	2.4**	2.5	2.6	2.7	2.8	2.5	1.7
H_{max} (ft)	2.1**	2.4**	2.7**	2.6**	2.8**	3.0	2.7	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9	2.1	2.1	2.1	2.1	2.3	1.8	1.2
H_{10} (ft)	1.9**	2.2	2.3	2.4	2.4	2.5	2.0	1.4
H_5 (ft)	1.9**	2.2**	2.3	2.4	2.5	2.5	2.1	1.4
H_1 (ft)	1.9**	2.2**	2.4**	2.5	2.6	2.7	2.3	1.5
H_{max} (ft)	1.9**	2.2**	2.4**	2.5**	2.6**	2.8	2.5	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.8	1.9	1.9	1.9	2.0	1.4	1.0
H_{10} (ft)	1.5**	1.8**	2.0**	2.1	2.2	2.2	1.7	1.1
H_5 (ft)	1.5**	1.8**	2.0**	2.2	2.2	2.3	1.7	1.1
H_1 (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.4	1.9	1.2
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.4**	2.1	1.4

** Breaking wave.

Table 25

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.4	2.4	2.5	2.0	1.4
H_{10} (ft)	2.0**	2.4	2.5	2.6	2.6	2.7	2.3	1.6
H_5 (ft)	2.0**	2.4**	2.5	2.6	2.7	2.7	2.3	1.6
H_1 (ft)	2.0**	2.4**	2.5**	2.6**	2.7	2.8	2.5	1.8
H_{max} (ft)	2.0**	2.4**	2.5**	2.6**	2.8**	3.0**	2.7	2.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.1	2.2	2.3	2.3	2.3	1.8	1.3
H_{10} (ft)	1.9**	2.2**	2.4	2.5	2.5	2.6	2.1	1.4
H_5 (ft)	1.9**	2.2**	2.3**	2.5	2.6	2.6	2.1	1.5
H_1 (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.7	2.3	1.6
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.8**	2.5	1.9
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	2.1	1.5	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.3	1.8	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.8	1.2
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4	2.0	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4**	2.2	1.5

** Breaking wave.

Table 26

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.8	1.8	1.7
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	2.0	2.0	1.9
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	2.0	2.1	2.0
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	2.2	2.2	2.1
H_{max} (ft)	1.7	1.8	1.9	1.9	2.0	2.3	2.3	2.3
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.7	1.7	1.6
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.9	1.9	1.8
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.9	2.0	1.9
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	2.1	2.1	2.0
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.2	2.3	2.2
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.5	1.6	1.5
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.7	1.7	1.6
H_5 (ft)	1.2	1.3	1.4	1.4	1.5	1.7	1.8	1.7
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.9	1.9	1.8
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	2.0	2.0	2.0

** Breaking wave.

Table 27

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.5	1.5	1.6	1.7	2.0	1.9	1.6
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	2.2	2.1	1.8
H_5 (ft)	1.6	1.6	1.7	1.7	1.8	2.3	2.2	1.8
H_1 (ft)	1.8	1.8	1.9	1.9	2.1	2.5	2.4	2.0
H_{max} (ft)	1.9	2.0	2.1	2.2	2.3	2.6	2.6	2.2
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.5	1.6	1.9	1.8	1.4
H_{10} (ft)	1.4	1.5	1.6	1.7	1.7	2.1	2.0	1.6
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	2.2	2.1	1.7
H_1 (ft)	1.7	1.7	1.8	1.9	2.0	2.4	2.3	1.8
H_{max} (ft)	1.8**	1.9	2.0	2.1	2.2	2.5	2.5	2.0
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.7	1.5	1.2
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	1.9	1.7	1.4
H_5 (ft)	1.3	1.4	1.5	1.5	1.7	2.0	1.8	1.4
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	2.2	2.0	1.5
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	2.3	2.2	1.6

** Breaking wave.

Table 28

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	2.0	2.0	2.0	2.2	1.7	1.1
H_{10} (ft)	2.0	2.2	2.2	2.3	2.3	2.5	2.0	1.3
H_5 (ft)	2.0	2.2	2.3	2.3	2.4	2.5	2.1	1.4
H_1 (ft)	2.0**	2.3	2.4	2.5	2.6	2.7	2.3	1.5
H_{max} (ft)	2.0**	2.4**	2.5	2.6	2.7	2.8	2.5	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	2.1	1.6	1.0
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.3	1.8	1.2
H_5 (ft)	1.9**	2.1	2.2	2.2	2.3	2.4	1.9	1.2
H_1 (ft)	1.9**	2.2	2.3	2.4	2.5	2.6	2.1	1.3
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6	2.7	2.3	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.8	1.3	0.8
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	2.1	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.1	1.5	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.3	1.7	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4	1.9	1.2

** Breaking wave.

Table 29

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.8	1.7	1.6	1.5	1.5	1.1	0.7
H_{10} (ft)	2.0	2.1	1.9	1.8	1.8	1.7	1.2	0.8
H_5 (ft)	2.0	2.1	2.0	1.9	1.8	1.8	1.3	0.8
H_1 (ft)	2.0**	2.2	2.2	2.1	2.0	2.0	1.4	0.9
H_{max} (ft)	2.0**	2.3	2.3	2.3	2.3	2.2	1.5	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.6	1.5	1.4	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.7	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	1.9	1.8	1.8	1.7	1.7	1.2	0.8
H_1 (ft)	1.9**	2.2	2.0	2.0	1.9	1.9	1.3	0.9
H_{max} (ft)	1.9**	2.2	2.2	2.2	2.1	2.1	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5	1.4	1.4	1.4	1.3	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.6	1.5	1.5	1.5	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.7	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	1.9	1.9	1.9	1.9	1.2	0.8

** Breaking wave.

Table 30

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.8	1.8	1.9	1.9	2.1	1.6	1.1
H_{10} (ft)	1.9	2.0	2.1	2.1	2.1	2.2	1.7	1.2
H_5 (ft)	2.1	2.1	2.2	2.3	2.3	2.3	1.9	1.3
H_1 (ft)	1.9**	2.2	2.3	2.4	2.4	2.5	2.1	1.5
H_{max} (ft)	1.9**	2.3	2.5	2.5	2.5	2.8	2.3	1.6
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.7	1.8	1.8	1.9	1.5	1.0
H_{10} (ft)	1.9	1.9	2.0	2.0	2.1	2.3	1.6	1.2
H_5 (ft)	1.9**	2.0	2.0	2.1	2.1	2.3	1.7	1.2
H_1 (ft)	1.9**	2.1	2.2	2.2	2.3	2.6	1.9	1.4
H_{max} (ft)	1.9**	2.2**	2.3	2.6	2.4	2.8	2.1	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.5	1.5	1.6	1.7	1.7	1.2	0.8
H_{10} (ft)	1.4**	1.7	1.7	1.8	1.9	2.0	1.4	1.0
H_5 (ft)	1.4**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_1 (ft)	1.4**	1.8**	2.0	2.1	2.1	2.3	1.5	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.3	1.7	1.3

** Breaking wave.

Table 31

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.1	2.2	2.2	2.3	2.0	1.3
H_{10} (ft)	2.0**	2.3	2.3	2.3	2.3	2.4	2.1	1.4
H_5 (ft)	2.0**	2.4	2.4	2.4	2.5	2.6	2.2	1.6
H_1 (ft)	2.0**	2.4**	2.4	2.4	2.5	2.8	2.5	1.7
H_{max} (ft)	2.0**	2.4**	2.4**	2.4**	2.6**	3.0	2.8	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9	2.0	2.0	2.1	2.1	2.3	1.8	1.2
H_{10} (ft)	1.9**	2.1	2.2	2.3	2.3	2.6	2.0	1.4
H_5 (ft)	1.9**	2.2**	2.3	2.3	2.4	2.6	2.2	1.4
H_1 (ft)	1.9**	2.2**	2.3**	2.4	2.5	2.7	2.3	1.6
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.5**	2.8	2.6	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8	1.8	1.8	1.8	2.0	1.4	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.0	2.1	2.2	1.6	1.1
H_5 (ft)	1.4**	1.8**	2.0**	2.1	2.2	2.2	1.7	1.1
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4	1.9	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4**	2.1	1.4

** Breaking wave.

Table 32

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = + 22.0 ft MLLW					Elevation = + 14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.4	2.4	2.3	2.6	2.0	1.4
H_{10} (ft)	2.0**	2.2	2.5	2.5	2.5	2.6	2.1	1.5
H_5 (ft)	2.0**	2.3**	2.6	2.6	2.7	2.7	2.2	1.7
H_1 (ft)	2.0**	2.3**	2.6**	2.7**	2.7	2.9	2.4	1.8
H_{max} (ft)	2.0**	2.3**	2.6**	2.7**	2.7**	3.2**	2.7	2.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.0	2.2	2.2	2.2	2.4	1.8	1.3
H_{10} (ft)	1.9**	2.2**	2.2	2.5	2.5	2.6	2.0	1.5
H_5 (ft)	1.9**	2.2**	2.2**	2.5	2.5	2.7	2.1	1.5
H_1 (ft)	1.9**	2.2**	2.2**	2.5**	2.7**	2.7	2.4	1.7
H_{max} (ft)	1.9**	2.2**	2.2**	2.5**	2.7**	2.8**	2.6	1.8
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	1.9	2.0	2.0	2.1	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.3	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.5	2.0	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.5**	2.3	1.5

** Breaking wave.

Table 33

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.3	1.4	1.4	1.5	1.7	1.7	1.7
H_{10} (ft)	1.4	1.5	1.5	1.6	1.6	1.9	1.8	1.8
H_5 (ft)	1.4	1.5	1.6	1.6	1.7	2.1	1.9	1.9
H_1 (ft)	1.6	1.6	1.7	1.7	1.8	2.2	2.1	2.0
H_{max} (ft)	1.7	1.8	1.8	1.8	1.9	2.4	2.3	2.2
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.2	1.3	1.3	1.3	1.4	1.7	1.7	1.6
H_{10} (ft)	1.3	1.4	1.5	1.5	1.6	1.9	2.0	1.8
H_5 (ft)	1.3	1.5	1.5	1.5	1.6	1.9	2.0	1.8
H_1 (ft)	1.5	1.6	1.6	1.7	1.7	2.0	2.1	2.0
H_{max} (ft)	1.6	1.7	1.7	1.8	1.8	2.2	2.3	2.1
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.1	1.2	1.2	1.3	1.6	1.6	1.5
H_{10} (ft)	1.1	1.3	1.3	1.4	1.4	1.7	1.7	1.6
H_5 (ft)	1.2	1.3	1.3	1.4	1.5	1.8	1.8	1.7
H_1 (ft)	1.2**	1.4	1.4	1.5	1.6	2.0	1.9	1.8
H_{max} (ft)	1.2**	1.5	1.5	1.6	1.7	2.1	2.0	2.0

** Breaking wave.

Table 34

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.5	1.5	1.6	2.0	1.9	1.5
H_{10} (ft)	1.4	1.6	1.6	1.7	1.8	2.0	2.0	1.6
H_5 (ft)	1.5	1.6	1.6	1.7	1.8	2.1	2.2	1.8
H_1 (ft)	1.7	1.8	1.8	1.8	2.0	2.5	2.4	2.0
H_{max} (ft)	1.8	2.0	2.0	2.1	2.2	2.8	2.6	2.4
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.3	1.1	1.4	1.5	1.6	1.8	1.8	1.4
H_{10} (ft)	1.3	1.3	1.5	1.6	1.7	2.2	2.0	1.6
H_5 (ft)	1.4	1.3	1.6	1.7	1.8	2.2	2.0	1.7
H_1 (ft)	1.6	1.4	1.7	1.8	1.9	2.4	2.3	1.8
H_{max} (ft)	1.7**	1.5	1.9	2.0	2.2	2.6	2.3	2.1
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.2	1.3	1.4	1.5	1.7	1.6	1.2
H_{10} (ft)	1.2	1.3	1.4	1.5	1.6	1.9	1.7	1.4
H_5 (ft)	1.2	1.4	1.4	1.5	1.7	2.0	1.8	1.4
H_1 (ft)	1.3**	1.5	1.5	1.6	1.7	2.1	1.9	1.6
H_{max} (ft)	1.3**	1.6**	1.7	1.8	2.0	2.4	2.2	1.7

** Breaking wave.

Table 35

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.9	2.0	1.9	2.2	1.8	1.1
H_{10} (ft)	1.9	2.1	2.2	2.2	2.3	2.4	1.9	1.3
H_5 (ft)	2.0	2.2	2.3	2.3	2.3	2.6	2.0	1.4
H_1 (ft)	2.0**	2.2	2.3	2.4	2.5	2.8	2.2	1.5
H_{max} (ft)	2.0**	2.3**	2.3	2.5	2.7	3.1	2.5	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.8	1.9	2.1	1.6	1.0
H_{10} (ft)	1.8	2.0	2.1	2.1	2.1	2.4	1.8	1.2
H_5 (ft)	1.9**	2.1	2.1	2.2	2.2	2.4	1.8	1.2
H_1 (ft)	1.9**	2.2	2.3	2.3	2.4	2.6	2.1	1.3
H_{max} (ft)	1.9**	2.2**	2.3**	2.4**	2.4	2.8	2.3	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.6	1.7	1.7	1.8	1.1	0.8
H_{10} (ft)	1.4**	1.8	1.8	1.9	1.9	2.1	1.2	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.1	1.2	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.3	1.3	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.4	1.2

** Breaking wave.

Table 36

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.7	1.7	1.6	1.5	1.1	0.7
H_{10} (ft)	2.0	2.1	2.0	1.9	1.8	1.7	1.2	0.8
H_5 (ft)	2.0	2.1	2.0	2.0	1.9	1.7	1.3	0.8
H_1 (ft)	2.1**	2.3	2.2	2.2	2.1	1.9	1.4	0.9
H_{max} (ft)	2.1**	2.3	2.4	2.4	2.3	2.1	1.5	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	1.9**	2.1	2.1	2.1	2.0	1.8	1.3	0.9
H_{max} (ft)	1.9**	2.2	2.2	2.2	2.2	2.0	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 37

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.9	1.9	2.0	2.0	1.9	1.5	1.1
H_{10} (ft)	2.0	2.1	2.1	2.2	2.2	2.1	1.7	1.2
H_5 (ft)	2.0	2.2	2.2	2.3	2.3	2.3	1.7	1.3
H_1 (ft)	2.1**	2.3	2.4	2.5	2.5	2.4	2.0	1.5
H_{max} (ft)	2.1**	2.4	2.5	2.6	2.7	2.6	2.2	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.9	1.9	1.8	1.5	1.0
H_{10} (ft)	1.9	2.0	2.0	2.1	2.1	2.1	1.6	1.2
H_5 (ft)	1.9**	2.0	2.1	2.2	2.2	2.2	1.7	1.2
H_1 (ft)	1.9**	2.2	2.3	2.4	2.4	2.5	1.7	1.4
H_{max} (ft)	1.9**	2.2**	2.4	2.5	2.6	2.5	2.0	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_5 (ft)	1.5**	1.8	1.8	2.0	2.0	2.0	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	2.1	1.5	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3	2.3	1.7	1.3

** Breaking wave.

Table 38

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.2	2.2	2.2	2.3	1.8	1.3
H_{10} (ft)	2.1**	2.3	2.4	2.5	2.5	2.4	2.0	1.4
H_5 (ft)	2.1**	2.4	2.4	2.5	2.6	2.6	2.1	1.5
H_1 (ft)	2.1**	2.4**	2.5	2.6	2.7	2.6	2.4	1.6
H_{max} (ft)	2.1**	2.4**	2.7**	2.6**	2.8**	2.7	2.6	1.8
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9	2.1	2.1	2.1	2.1	2.1	1.6	1.2
H_{10} (ft)	1.9**	2.2	2.3	2.4	2.4	2.4	1.9	1.4
H_5 (ft)	1.9**	2.2**	2.3	2.4	2.5	2.5	1.9	1.4
H_1 (ft)	1.9**	2.2**	2.4**	2.5	2.6	2.7	2.2	1.6
H_{max} (ft)	1.9**	2.2**	2.4**	2.5**	2.6**	2.7	2.4	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.8	1.9	1.9	1.9	2.0	1.4	1.0
H_{10} (ft)	1.5**	1.8**	2.0**	2.1	2.2	2.1	1.6	1.1
H_5 (ft)	1.5**	1.8**	2.0**	2.2	2.2	2.2	1.7	1.1
H_1 (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.4	1.9	1.3
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.4**	2.0	1.4

** Breaking wave.

Table 39

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.4	2.4	2.3	1.8	1.4
H_{10} (ft)	2.0**	2.4	2.5	2.6	2.6	2.4	2.1	1.5
H_5 (ft)	2.0**	2.4**	2.5	2.6	2.7	2.6	2.2	1.5
H_1 (ft)	2.0**	2.4**	2.5**	2.6**	2.7	2.7	2.4	1.7
H_{max} (ft)	2.0**	2.4**	2.5**	2.6**	2.8**	2.9**	2.6	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.1	2.2	2.3	2.3	2.2	1.6	1.3
H_{10} (ft)	1.9**	2.2**	2.4	2.5	2.5	2.4	1.9	1.5
H_5 (ft)	1.9**	2.2**	2.3**	2.5	2.6	2.6	2.0	1.5
H_1 (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.7	2.2	1.7
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.8**	2.4	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.9	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.2	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.9	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4**	2.1	1.5

** Breaking wave.

Table 40

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.7	1.7	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.8	1.9	1.8
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	1.9	2.0	1.9
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	2.0	2.1	2.0
H_{max} (ft)	1.7	1.8	1.9	1.9	2.0	2.4	2.3	2.2
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.6	1.6	1.6
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.8	1.8	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	1.9	2.0	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.1	2.2	2.1
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.5	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.6
H_5 (ft)	1.2	1.3	1.3	1.4	1.5	1.7	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.8	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	2.0	2.0	1.9

** Breaking wave.

Table 41

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.5	1.5	1.6	1.7	1.9	1.8	1.5
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	2.0	2.0	1.7
H_5 (ft)	1.6	1.6	1.7	1.7	1.8	2.1	2.0	1.7
H_1 (ft)	1.8	1.8	1.9	1.9	2.1	2.4	2.1	1.9
H_{max} (ft)	1.9	2.0	2.1	2.2	2.3	2.6	2.3	2.1
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.5	1.6	1.8	1.7	1.4
H_{10} (ft)	1.4	1.5	1.6	1.7	1.7	2.0	1.8	1.6
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	2.0	1.9	1.6
H_1 (ft)	1.7	1.7	1.8	1.9	2.0	2.2	2.1	1.8
H_{max} (ft)	1.8**	1.9	2.0	2.1	2.2	2.5	2.4	1.9
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.6	1.6	1.2
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	1.8	1.7	1.3
H_5 (ft)	1.3	1.4	1.5	1.5	1.7	1.8	1.7	1.4
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	2.0	1.8	1.5
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	2.3	2.1	1.6

** Breaking wave.

Table 42

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	2.0	2.0	2.0	2.1	1.6	1.1
H_{10} (ft)	2.0	2.2	2.2	2.3	2.3	2.3	1.8	1.2
H_5 (ft)	2.0	2.2	2.3	2.3	2.4	2.5	1.9	1.3
H_1 (ft)	2.0**	2.3	2.4	2.5	2.6	2.7	2.1	1.4
H_{max} (ft)	2.0**	2.4**	2.5	2.6	2.7	2.9	2.3	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.9	1.5	0.9
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.2	1.7	1.1
H_5 (ft)	1.9**	2.1	2.2	2.2	2.3	2.3	1.7	1.1
H_1 (ft)	1.9**	2.2	2.3	2.4	2.5	2.4	1.9	1.3
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6	2.6	2.2	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.7	1.3	0.8
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.9	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.0	1.5	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.2	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.8	1.2

** Breaking wave.

Table 43

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.7	1.7	1.6	1.4	1.1	0.7
H_{10} (ft)	2.0	2.1	2.0	1.9	1.8	1.5	1.2	0.8
H_5 (ft)	2.0	2.1	2.0	2.0	1.9	1.6	1.3	0.8
H_1 (ft)	2.1**	2.3	2.2	2.2	2.1	1.8	1.4	0.9
H_{max} (ft)	2.1**	2.3	2.4	2.4	2.3	2.0	1.4	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	1.9**	2.1	2.1	2.1	2.0	1.7	1.3	0.9
H_{max} (ft)	1.9**	2.2	2.2	2.2	2.2	1.9	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 44

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.9	1.9	2.0	2.0	1.8	1.4	1.1
H_{10} (ft)	2.0	2.1	2.1	2.2	2.2	2.1	1.6	1.2
H_5 (ft)	2.0	2.2	2.2	2.3	2.3	2.1	1.6	1.3
H_1 (ft)	2.1**	2.3	2.4	2.5	2.5	2.4	1.8	1.4
H_{max} (ft)	2.1**	2.4	2.5	2.6	2.7	2.6	2.0	1.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.9	1.9	1.7	1.5	1.0
H_{10} (ft)	1.9	2.0	2.0	2.1	2.1	1.9	1.6	1.2
H_5 (ft)	1.9**	2.0	2.1	2.2	2.2	2.0	1.7	1.2
H_1 (ft)	1.9**	2.2	2.3	2.4	2.4	2.3	1.7	1.4
H_{max} (ft)	1.9**	2.2**	2.4	2.5	2.6	2.5	1.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_5 (ft)	1.5**	1.8	1.8	2.0	2.0	2.0	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	2.0	1.5	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3	2.2	1.7	1.3

** Breaking wave.

Table 45

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.2	2.2	2.2	2.1	1.7	1.3
H_{10} (ft)	2.1**	2.3	2.4	2.5	2.5	2.4	1.9	1.3
H_5 (ft)	2.1**	2.4	2.4	2.5	2.6	2.5	2.0	1.4
H_1 (ft)	2.1**	2.4**	2.5	2.6	2.7	2.7	2.2	1.5
H_{max} (ft)	2.1**	2.4**	2.7**	2.6**	2.8**	2.9	2.5	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9	2.1	2.1	2.1	2.1	2.0	1.6	1.2
H_{10} (ft)	1.9**	2.2	2.3	2.4	2.4	2.3	1.7	1.4
H_5 (ft)	1.9**	2.2**	2.3	2.4	2.5	2.3	1.8	1.4
H_1 (ft)	1.9**	2.2**	2.4**	2.5	2.6	2.6	2.0	1.6
H_{max} (ft)	1.9**	2.2**	2.4**	2.5**	2.6**	2.7	2.3	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.8	1.9	1.9	1.9	2.0	1.4	1.0
H_{10} (ft)	1.5**	1.8**	2.0**	2.1	2.2	2.0	1.6	1.1
H_5 (ft)	1.5**	1.8**	2.0**	2.2	2.2	2.1	1.7	1.1
H_1 (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.3	1.9	1.3
H_{max} (ft)	1.5**	1.8**	2.0**	2.2**	2.3**	2.3**	1.9	1.4

** Breaking wave.

Table 46

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.4	2.4	2.2	1.7	1.4
H_{10} (ft)	2.0**	2.4	2.5	2.6	2.6	2.4	1.9	1.4
H_5 (ft)	2.0**	2.4**	2.5	2.6	2.7	2.6	2.0	1.5
H_1 (ft)	2.0**	2.4**	2.5**	2.6**	2.7	2.7	2.2	1.6
H_{max} (ft)	2.0**	2.4**	2.5**	2.6**	2.8**	2.8**	2.4	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.1	2.2	2.3	2.3	2.1	1.6	1.3
H_{10} (ft)	1.9**	2.2**	2.4	2.5	2.5	2.4	1.7	1.5
H_5 (ft)	1.9**	2.2**	2.3**	2.5	2.6	2.4	1.8	1.5
H_1 (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.6	2.0	1.6
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.8**	2.3	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4**	2.0	1.5

** Breaking wave.

Table 47

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.7
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	1.9	2.0	1.9
H_{max} (ft)	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 48

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.5	1.5	1.6	1.7	1.8	1.7	1.4
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.6
H_5 (ft)	1.6	1.6	1.7	1.7	1.8	2.0	1.9	1.7
H_1 (ft)	1.8	1.8	1.9	1.9	2.1	2.2	2.0	1.8
H_{max} (ft)	1.9	2.0	2.1	2.2	2.3	2.5	2.2	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.3
H_{10} (ft)	1.4	1.5	1.6	1.7	1.7	1.9	1.8	1.5
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	1.9	1.9	1.6
H_1 (ft)	1.7	1.7	1.8	1.9	2.0	2.1	2.0	1.7
H_{max} (ft)	1.8**	1.9	2.0	2.1	2.2	2.3	2.1	1.8
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.6	1.5	1.1
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	1.7	1.7	1.3
H_5 (ft)	1.3	1.4	1.5	1.5	1.7	1.8	1.7	1.3
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	1.9	1.8	1.4
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	2.1	1.9	1.6

** Breaking wave.

Table 49

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = + 22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	2.0	2.0	2.0	1.9	1.6	1.0
H_{10} (ft)	2.0	2.2	2.2	2.3	2.3	2.2	1.7	1.2
H_5 (ft)	2.0	2.2	2.3	2.3	2.4	2.2	1.8	1.2
H_1 (ft)	2.0**	2.3	2.4	2.5	2.6	2.4	2.0	1.4
H_{max} (ft)	2.0**	2.4**	2.5	2.6	2.7	2.8	2.2	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.8	1.5	0.9
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.0	1.6	1.1
H_5 (ft)	1.9**	2.1	2.2	2.2	2.3	2.1	1.7	1.1
H_1 (ft)	1.9**	2.2	2.3	2.4	2.5	2.4	1.8	1.2
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6	2.6	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.7	1.1

** Breaking wave.

Table 50

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = + 26.0 ft MLLW					Elevation = + 26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.8	1.7	1.6	1.5	1.4	1.1	0.7
H_{10} (ft)	2.0	2.0	1.9	1.8	1.8	1.5	1.2	0.8
H_5 (ft)	2.1	2.1	2.0	1.9	1.8	1.6	1.3	0.8
H_1 (ft)	2.1**	2.3	2.1	2.1	2.0	1.8	1.4	0.9
H_{max} (ft)	2.1**	2.4	2.4	2.3	2.2	2.0	1.4	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.6	1.5	1.4	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.7	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	1.9	1.8	1.8	1.7	1.7	1.2	0.8
H_1 (ft)	1.9**	2.3	2.0	2.0	1.9	1.7	1.3	0.9
H_{max} (ft)	1.9**	2.3	2.2	2.2	2.1	1.9	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5	1.4	1.4	1.4	1.3	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.6	1.5	1.5	1.5	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.7	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	1.9	1.9	1.9	1.9	1.2	0.8

** Breaking wave.

Table 51

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.8	1.8	1.9	1.9	1.8	1.4	1.1
H_{10} (ft)	2.0	2.0	2.0	2.1	2.1	2.1	1.6	1.2
H_5 (ft)	2.0	2.1	2.1	2.2	2.2	2.1	1.6	1.3
H_1 (ft)	2.1**	2.3	2.3	2.4	2.5	2.2	1.8	1.4
H_{max} (ft)	2.1**	2.4	2.4	2.6	2.6	2.5	2.0	1.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.7	1.8	1.8	1.7	1.5	1.0
H_{10} (ft)	1.8	1.9	2.2	2.0	2.1	1.9	1.6	1.2
H_5 (ft)	1.9**	2.0	2.2	2.1	2.1	2.0	1.7	1.2
H_1 (ft)	1.9**	2.1	2.2	2.3	2.3	2.3	1.7	1.4
H_{max} (ft)	1.9**	2.2	2.4	2.5	2.6	2.3	1.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.5	1.5	1.6	1.7	1.7	1.2	0.8
H_{10} (ft)	1.4**	1.7	1.7	1.8	1.9	2.0	1.4	1.0
H_5 (ft)	1.4**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_1 (ft)	1.4**	1.8**	2.0	2.1	2.1	2.0	1.5	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.2	1.7	1.3

** Breaking wave.

Table 52

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.1	2.1	2.1	2.1	1.7	1.3
H_{10} (ft)	2.1**	2.3	2.3	2.4	2.4	2.3	1.9	1.3
H_5 (ft)	2.1**	2.4	2.5	2.4	2.5	2.4	2.0	1.4
H_1 (ft)	2.1**	2.5**	2.5	2.5	2.6	2.6	2.1	1.5
H_{max} (ft)	2.1**	2.5**	2.6**	2.7**	2.7**	2.7	2.3	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	2.0	2.0	2.1	2.1	2.0	1.6	1.2
H_{10} (ft)	1.9**	2.2	2.2	2.3	2.3	2.1	1.7	1.4
H_5 (ft)	1.9**	2.2**	2.3	2.4	2.4	2.2	1.8	1.4
H_1 (ft)	1.9**	2.2**	2.4**	2.5	2.6	2.5	2.0	1.6
H_{max} (ft)	1.9**	2.2**	2.4**	2.6	2.6**	2.6	2.3	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8	1.8	1.8	1.8	2.0	1.4	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.0	2.1	2.0	1.6	1.1
H_5 (ft)	1.4**	1.8**	2.0**	2.1	2.2	2.1	1.7	1.1
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.9	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3**	1.9	1.4

** Breaking wave.

Table 53

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.3	2.3	2.0	1.7	1.4
H_{10} (ft)	2.0**	2.3	2.5	2.6	2.6	2.3	1.9	1.4
H_5 (ft)	2.0**	2.4**	2.5	2.6	2.6	2.4	2.0	1.5
H_1 (ft)	2.0**	2.4**	2.5**	2.7**	2.7	2.7	2.1	1.6
H_{max} (ft)	2.0**	2.4**	2.5**	2.7**	2.9**	2.8**	2.4	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8**	2.1	2.2	2.2	2.2	2.1	1.6	1.3
H_{10} (ft)	1.8**	2.2**	2.3	2.4	2.4	2.2	1.7	1.5
H_5 (ft)	1.8**	2.2**	2.4**	2.4	2.5	2.3	1.8	1.5
H_1 (ft)	1.8**	2.2**	2.4**	2.5**	2.6**	2.5	2.0	1.6
H_{max} (ft)	1.8**	2.2**	2.4**	2.5**	2.6**	2.6**	2.1	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.2	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.2**	2.0	1.5

** Breaking wave.

Table 54

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = + 26.0 ft MLLW					Elevation = + 26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.3	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.4	1.5	1.5	1.6	1.6	1.8	1.8	1.7
H_5 (ft)	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.6	1.7	1.7	1.8	1.9	2.0	1.9
H_{max} (ft)	1.7	1.8	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.3	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.3	1.5	1.5	1.5	1.6	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.7	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.7	1.8	1.8	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.1	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.1	1.3	1.3	1.4	1.4	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.3	1.5	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.4	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.5	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 55

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.5	1.5	1.6	1.8	1.7	1.4
H_{10} (ft)	1.4	1.6	1.6	1.7	1.8	1.9	1.9	1.6
H_5 (ft)	1.5	1.6	1.6	1.7	1.8	2.0	1.9	1.7
H_1 (ft)	1.7	1.8	1.8	1.8	2.0	2.0	2.0	1.8
H_{max} (ft)	1.8	1.9	1.9	1.9	2.2	2.2	2.1	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.1	1.4	1.5	1.6	1.7	1.7	1.3
H_{10} (ft)	1.3	1.3	1.5	1.6	1.7	1.9	1.8	1.5
H_5 (ft)	1.4	1.3	1.6	1.7	1.8	1.9	1.9	1.6
H_1 (ft)	1.6	1.4	1.7	1.8	1.9	2.1	2.0	1.7
H_{max} (ft)	1.7**	1.5	1.9	2.0	2.1	2.2	2.0	1.8
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.3	1.4	1.5	1.6	1.5	1.1
H_{10} (ft)	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.3
H_5 (ft)	1.2	1.4	1.4	1.5	1.7	1.8	1.7	1.3
H_1 (ft)	1.3**	1.5	1.5	1.6	1.7	1.9	1.8	1.4
H_{max} (ft)	1.3**	1.6**	1.7	1.8	2.0	2.1	1.9	1.6

** Breaking wave.

Table 56

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.9	2.0	1.9	1.9	1.6	1.0
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.0	1.7	1.2
H_5 (ft)	2.0	2.1	2.2	2.3	2.3	2.1	1.8	1.2
H_1 (ft)	2.0**	2.4	2.4	2.5	2.5	2.4	2.0	1.4
H_{max} (ft)	2.0**	2.4**	2.5	2.6	2.7	2.6	2.1	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.8	1.9	1.8	1.5	0.9
H_{10} (ft)	1.8	2.0	2.0	2.1	2.1	2.0	1.6	1.1
H_5 (ft)	1.8**	2.0	2.1	2.2	2.2	2.1	1.7	1.1
H_1 (ft)	1.8**	2.2	2.3	2.4	2.4	2.2	1.8	1.2
H_{max} (ft)	1.8**	2.2**	2.4**	2.5**	2.5	2.4	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.6	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.8	1.9	1.9	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.6	1.0
H_{max} (ft)	1.5**	1.8**	2.0**	2.1**	2.3**	2.3	1.7	1.1

** Breaking wave.

Table 57

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.1	0.0	0.0	0.0	0.0	1.2	0.0	0.0
H_{10} (ft)	2.8	1.3	0.3	0.0	0.0	2.0	0.3	0.0
H_5 (ft)	3.4	1.8	0.7	0.2	0.0	2.2	0.4	0.0
H_1 (ft)	4.1**	3.3	2.0	1.4	0.6	3.0	0.8	0.0
H_{max} (ft)	4.1**	5.2	3.5	2.8	1.9	4.0	1.4	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.4	0.0	0.0	0.0	0.0	0.7	0.0	0.0
H_5 (ft)	1.9**	0.4	0.0	0.0	0.0	0.9	0.0	0.0
H_1 (ft)	1.9**	1.8	0.6	0.1	0.0	1.7	0.0	0.0
H_{max} (ft)	1.9**	3.6	2.1	1.5	0.6	2.6	0.1	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 58

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.8	0.3	0.3	0.5	0.3	3.5	1.5	0.0
H_{10} (ft)	2.4	1.9	1.7	2.0	1.8	4.9	2.3	0.4
H_5 (ft)	3.0	2.3	2.2	2.5	2.3	5.3	2.5	0.5
H_1 (ft)	3.8**	4.0	3.9	4.3	4.0	6.9	3.5	1.0
H_{max} (ft)	3.8**	6.1	6.0	6.4	6.2	8.8	4.6	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.2	0.1	0.0
H_{10} (ft)	1.2	0.6	0.4	0.7	0.5	3.5	0.9	0.0
H_5 (ft)	1.5**	1.1	0.9	1.2	1.0	4.0	1.1	0.0
H_1 (ft)	1.5**	2.7	2.5	2.9	2.8	5.4	1.9	0.0
H_{max} (ft)	1.5**	3.8**	4.6	5.0	4.9	7.3	3.0	0.2
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.3	0.1	2.4	0.0	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1	4.1	0.0	0.0

** Breaking wave.

Table 59

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.9	2.6	2.2	2.1	1.8	5.2	2.8	0.6
H_{10} (ft)	3.8**	4.8	4.2	4.2	3.8	7.1	4.0	1.1
H_5 (ft)	3.8**	5.5	4.9	4.8	4.4	7.7	4.3	1.3
H_1 (ft)	3.8**	6.1**	7.2	7.1	6.7	9.8	5.7	1.9
H_{max} (ft)	3.8**	6.1**	7.4**	8.5**	9.5**	12.3	7.2	2.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.3	0.9	0.8	0.5	3.8	1.3	0.0
H_{10} (ft)	1.5**	3.5	2.9	2.8	2.4	5.6	2.4	0.0
H_5 (ft)	1.5**	3.8**	3.6	3.5	3.0	6.2	2.7	0.0
H_1 (ft)	1.5**	3.8**	5.1**	5.8	5.2	8.2	4.0	0.4
H_{max} (ft)	1.5**	3.8**	5.1**	6.1**	7.0**	10.7	5.5	1.1
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.1**	0.0	0.0	2.6	0.0	0.0
H_5 (ft)	0.0	0.0	0.1**	0.6	0.4	3.1	0.0	0.0
H_1 (ft)	0.0	0.0	0.1**	1.1**	2.1**	5.0	0.5	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1**	6.4**	1.7	0.0

** Breaking wave.

Table 60

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.1	3.2	3.4	3.5	2.9	5.8	3.2	0.9
H_{10} (ft)	3.6**	5.6	5.8	6.0	5.3	7.9	4.5	1.5
H_5 (ft)	3.6**	6.0**	6.6	6.8	6.0	8.5	4.9	1.7
H_1 (ft)	3.6**	6.0**	7.3**	8.3**	8.7	10.8	6.4	2.4
H_{max} (ft)	3.6**	6.0**	7.3**	8.3**	9.3**	13.6**	8.1	3.3
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.4**	2.1	2.2	2.3	1.7	4.4	1.5	0.0
H_{10} (ft)	1.4**	3.6**	4.7	4.7	4.0	6.4	2.6	0.1
H_5 (ft)	1.4**	3.6**	4.9**	5.5	4.7	7.0	3.0	0.3
H_1 (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	9.3	4.2	0.9
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	11.2**	5.1	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.9**	1.4	3.4	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.9**	2.0**	4.0	0.1	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	2.0**	6.1	1.3	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	6.3**	2.7	0.0

** Breaking wave.

Table 61

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.8	3.0	2.6
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	4.0	4.4	3.8
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	4.5	4.8	4.1
H_1 (ft)	0.1	0.1	0.0	0.0	0.1	5.8	6.2	5.4
H_{max} (ft)	1.4	1.3	1.1	1.2	1.4	7.6	8.0	7.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.5	1.7	1.2
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	2.7	3.0	2.3
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	3.1	3.4	2.6
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	4.4	4.8	3.9
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	6.1	6.6	5.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	1.7	1.9	0.7
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	3.4	3.6	2.1

Table 62

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	3.6	3.1	1.6
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	5.0	4.4	2.5
H_5 (ft)	0.0	0.0	0.0	0.0	0.4	5.5	4.8	2.7
H_1 (ft)	0.6	0.8	0.8	1.1	1.7	7.0	6.3	3.7
H_{max} (ft)	1.9	2.1	2.1	2.6	3.3	9.0	7.7	4.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.3	1.8	0.2
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	3.7	3.0	1.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	4.2	3.4	1.2
H_1 (ft)	0.0	0.0	0.0	0.0	0.3	5.8	4.8	2.0
H_{max} (ft)	0.8**	0.8	0.8	1.3	2.0	7.8	6.5	3.1
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	1.1	0.1	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	1.6	0.5	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	3.1	1.7	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	5.0	3.3	0.0

** Breaking wave.

Table 63

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	0.7	0.8	0.8	0.8	0.7	4.2	2.1	0.1
H_{10} (ft)	2.3	2.4	2.5	2.6	2.4	5.8	3.2	0.6
H_5 (ft)	2.8	2.9	3.0	3.1	2.9	6.3	3.5	0.7
H_1 (ft)	3.6**	4.8	4.9	5.0	4.8	8.1	4.6	1.2
H_{max} (ft)	3.6**	6.0**	7.2	7.4	7.2	10.4	6.0	1.8
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.8	0.7	0.0
H_{10} (ft)	1.2	1.2	1.2	1.3	1.0	4.4	1.6	0.0
H_5 (ft)	1.4**	1.7	1.7	1.9	1.5	4.9	1.9	0.0
H_1 (ft)	1.4**	3.6	3.5	3.8	3.4	6.6	2.8	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	5.7	8.7	4.1	0.2
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	0.6	3.4	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	5.3	0.6	0.0

** Breaking wave.

Table 64

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0
H_{10} (ft)	1.8	0.4	0.0	0.0	0.0	1.0	0.0	0.0
H_5 (ft)	2.4	0.8	0.0	0.0	0.0	1.2	0.0	0.0
H_1 (ft)	3.2**	2.3	1.0	0.3	0.0	2.0	0.0	0.0
H_{max} (ft)	3.2**	4.2	2.6	1.7	1.0	3.0	0.4	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.9**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.9**	0.8	0.0	0.0	0.0	0.6	0.0	0.0
H_{max} (ft)	0.9**	2.6	1.1	0.4	0.0	1.5	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 65

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.4	0.5	0.0
H_{10} (ft)	1.4	0.8	0.7	0.8	0.8	3.8	1.2	0.0
H_5 (ft)	1.9	1.3	1.2	1.3	1.3	4.2	1.5	0.0
H_1 (ft)	2.8**	3.0	2.8	3.0	2.9	5.7	2.4	0.0
H_{max} (ft)	2.8**	5.0	4.9	5.1	5.1	7.6	3.5	0.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
H_{10} (ft)	0.2	0.0	0.0	0.0	0.0	2.4	0.0	0.0
H_5 (ft)	0.5**	0.0	0.0	0.0	0.0	2.8	0.0	0.0
H_1 (ft)	0.5**	1.7	1.5	1.7	1.7	4.3	0.8	0.0
H_{max} (ft)	0.5**	2.7	3.5	3.7	3.8	6.1	1.8	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	1.0	2.9	0.0	0.0

** Breaking wave.

Table 66

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.6	1.2	0.9	0.8	4.1	1.7	0.0
H_{10} (ft)	2.8**	3.7	3.2	2.9	2.8	5.9	2.9	0.1
H_5 (ft)	2.8**	4.4	3.8	3.6	3.4	6.5	3.2	0.3
H_1 (ft)	2.8**	5.1**	6.1	5.8	5.6	8.5	4.6	0.9
H_{max} (ft)	2.8**	5.1**	6.4**	7.2**	8.3**	11.1	6.1	1.6
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.3	0.3	0.0	0.0	0.0	2.6	0.3	0.0
H_{10} (ft)	0.5**	2.4	1.9	1.6	1.4	4.4	1.3	0.0
H_5 (ft)	0.5**	2.7**	2.5	2.2	1.9	5.0	1.6	0.0
H_1 (ft)	0.5**	2.7**	4.0**	4.5	4.1	7.0	2.8	0.0
H_{max} (ft)	0.5**	2.7**	4.0**	4.8**	5.9**	9.4	4.3	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	1.0**	3.8	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	1.0**	5.2**	0.6	0.0

** Breaking wave.

Table 67

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.1	2.2	2.3	2.3	1.9	4.6	2.1	0.0
H_{10} (ft)	2.6**	4.5	4.7	4.7	4.2	6.7	3.3	0.5
H_5 (ft)	2.6**	4.9**	5.5	5.5	4.9	7.3	3.8	0.6
H_1 (ft)	2.6**	4.9**	6.2**	7.0**	7.5	9.6	5.2	1.3
H_{max} (ft)	2.6**	4.9**	6.2**	7.0**	8.1**	12.3**	6.9	2.2
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.4**	1.1	1.2	1.0	0.6	3.2	0.4	0.0
H_{10} (ft)	0.4**	2.5**	3.6	3.4	2.9	5.2	1.5	0.0
H_5 (ft)	0.4**	2.5**	3.8**	4.2	3.6	5.8	1.8	0.0
H_1 (ft)	0.4**	2.5**	3.8**	4.6**	5.6**	8.0	3.1	0.0
H_{max} (ft)	0.4**	2.5**	3.8**	4.6**	5.6**	9.9**	4.6	0.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.2	2.2	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.8**	2.8	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.8**	4.8	0.1	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.8**	5.0**	1.4	0.0

** Breaking wave.

Table 68

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.5	1.8	1.4
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	2.6	3.1	2.5
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	2.9	3.5	2.8
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	4.2	4.9	4.1
H_{max} (ft)	0.2	0.1	0.0	0.0	0.2	5.7	6.6	5.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	1.4	1.7	1.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	1.8	2.1	1.4
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	3.1	3.4	2.6
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	4.7	5.2	4.1
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	1.9	2.2	0.7

Table 69

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	0.0	0.0	0.0	0.0	0.0	2.4	1.9	0.5
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	3.8	3.2	1.3
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	4.3	3.6	1.6
H_1 (ft)	0.0	0.0	0.0	0.0	0.6	5.8	5.0	2.5
H_{max} (ft)	0.8	1.0	1.0	1.3	2.2	7.7	6.6	3.6
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.2	0.6	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	2.5	1.8	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	3.0	2.2	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	4.5	3.5	0.9
H_{max} (ft)	0.0	0.0	0.0	0.0	0.8	6.4	5.2	1.9
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	1.8	0.5	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	3.6	2.0	0.0

Table 70

Redondo Beach King Harbor, California

1964-As-Constructed Breakwater Elevations

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	3.1	1.1	0.0
H_{10} (ft)	1.3	1.4	1.4	1.4	1.3	4.7	2.1	0.0
H_5 (ft)	1.8	1.9	1.9	1.9	1.9	5.2	2.4	0.0
H_1 (ft)	2.6**	3.7	3.8	3.7	3.7	6.9	3.5	0.1
H_{max} (ft)	2.6**	4.9**	6.1	6.1	6.0	9.1	4.8	0.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
H_{10} (ft)	0.2	0.2	0.1	0.1	0.0	3.2	0.5	0.0
H_5 (ft)	0.4**	0.7	0.6	0.6	0.5	3.7	0.8	0.0
H_1 (ft)	0.4**	2.5	2.4	2.5	2.3	5.4	1.7	0.0
H_{max} (ft)	0.4**	2.5**	3.8**	4.6**	4.6	7.5	3.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.8**	4.1	0.0	0.0

** Breaking wave.

Table 71

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	2.8	1.3	0.3	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	3.4	1.8	0.7	0.2	0.0	0.0	0.0	0.0
H_1 (ft)	4.1**	3.3	2.0	1.4	0.6	0.2	0.0	0.0
H_{max} (ft)	4.1**	5.2	3.5	2.8	1.9	1.1	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	1.9**	0.4	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	1.9**	1.8	0.6	0.1	0.0	0.0	0.0	0.0
H_{max} (ft)	1.9**	3.6	2.1	1.5	0.6	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 72

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.8	0.3	0.3	0.5	0.3	0.5	0.0	0.0
H_{10} (ft)	2.4	1.9	1.7	2.0	1.8	1.8	0.0	0.0
H_5 (ft)	3.0	2.3	2.2	2.5	2.3	2.2	0.0	0.0
H_1 (ft)	3.8**	4.0	3.9	4.3	4.0	3.7	0.3	0.0
H_{max} (ft)	3.8**	6.1	6.0	6.4	6.2	5.5	1.4	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.2	0.6	0.4	0.7	0.5	0.4	0.0	0.0
H_5 (ft)	1.5**	1.1	0.9	1.2	1.0	0.8	0.0	0.0
H_1 (ft)	1.5**	2.7	2.5	2.9	2.8	2.2	0.0	0.0
H_{max} (ft)	1.5**	3.8**	4.6	5.0	4.9	4.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1	0.8	0.0	0.0

** Breaking wave.

Table 73

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.9	2.6	2.2	2.1	1.8	2.1	0.0	0.0
H_{10} (ft)	3.8**	4.8	4.2	4.2	3.8	3.9	0.8	0.0
H_5 (ft)	3.8**	5.5	4.9	4.8	4.4	4.4	1.1	0.0
H_1 (ft)	3.8**	6.1**	7.2	7.1	6.7	6.4	2.4	0.0
H_{max} (ft)	3.8**	6.1**	7.4**	8.5**	9.5**	8.9	3.9	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.3	0.9	0.8	0.5	0.7	0.0	0.0
H_{10} (ft)	1.5**	3.5	2.9	2.8	2.4	2.4	0.0	0.0
H_5 (ft)	1.5**	3.8**	3.6	3.5	3.0	2.9	0.0	0.0
H_1 (ft)	1.5**	3.8**	5.1**	5.8	5.2	4.8	0.7	0.0
H_{max} (ft)	1.5**	3.8**	5.1**	6.1**	7.0**	7.2	2.1	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.1**	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.1**	0.6	0.4	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.1**	1.1**	2.1**	1.6	0.0	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1**	3.0	0.0	0.0

** Breaking wave.

Table 74

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.1	3.2	3.4	3.5	2.9	2.6	0.0	0.0
H_{10} (ft)	3.6**	5.6	5.8	6.0	5.3	4.6	1.2	0.0
H_5 (ft)	3.6**	6.0**	6.6	6.8	6.0	5.2	1.6	0.0
H_1 (ft)	3.6**	6.0**	7.3**	8.3**	8.7	7.4	3.0	0.0
H_{max} (ft)	3.6**	6.0**	7.3**	8.3**	9.3**	10.1	4.6	0.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.4**	2.1	2.2	2.3	1.7	1.2	0.0	0.0
H_{10} (ft)	1.4**	3.6**	4.7	4.7	4.0	3.1	0.0	0.0
H_5 (ft)	1.4**	3.6**	4.9**	5.5	4.7	3.7	0.0	0.0
H_1 (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	5.8	0.9	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	7.6	2.4	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.9**	1.4	0.1	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.9**	2.0**	0.7	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	2.0**	2.6	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	2.8	0.0	0.0

** Breaking wave.

Table 75

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.1
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.4
H_1 (ft)	0.1	0.1	0.0	0.0	0.1	2.2	2.3	1.6
H_{max} (ft)	1.4	1.3	1.1	1.2	1.4	3.7	4.0	3.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.1
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	2.3	2.5	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 76

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	1.7	0.9	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.4	2.1	1.3	0.0
H_1 (ft)	0.6	0.8	0.8	1.1	1.7	3.6	2.6	0.3
H_{max} (ft)	1.9	2.1	2.1	2.6	3.3	5.4	4.3	1.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.3	2.3	1.2	0.0
H_{max} (ft)	0.8**	0.8	0.8	1.3	2.0	4.1	2.7	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0

** Breaking wave.

Table 77

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.7	0.8	0.8	0.8	0.7	1.2	0.0	0.0
H_{10} (ft)	2.3	2.4	2.5	2.6	2.4	2.7	0.0	0.0
H_5 (ft)	2.8	2.9	3.0	3.1	2.9	3.1	0.3	0.0
H_1 (ft)	3.6**	4.8	4.9	5.0	4.8	4.8	1.3	0.0
H_{max} (ft)	3.6**	6.0**	7.2	7.4	7.2	6.9	2.6	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.2	1.2	1.2	1.3	1.0	1.2	0.0	0.0
H_5 (ft)	1.4**	1.7	1.7	1.9	1.5	1.6	0.0	0.0
H_1 (ft)	1.4**	3.6	3.5	3.8	3.4	3.3	0.0	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	5.7	5.3	0.8	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	0.6	0.1	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	1.9	0.0	0.0

** Breaking wave.

Table 78

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	2.8	1.3	0.3	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	3.4	1.8	0.7	0.2	0.0	0.0	0.0	0.0
H_1 (ft)	4.1**	3.3	2.0	1.4	0.6	0.0	0.0	0.0
H_{max} (ft)	4.1**	5.2	3.5	2.8	1.9	0.0	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	1.9**	0.4	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	1.9**	1.8	0.6	0.1	0.0	0.0	0.0	0.0
H_{max} (ft)	1.9**	3.6	2.1	1.5	0.6	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 79

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.8	0.3	0.3	0.5	0.3	0.0	0.0	0.0
H_{10} (ft)	2.4	1.9	1.7	2.0	1.8	0.0	0.0	0.0
H_5 (ft)	3.0	2.3	2.2	2.5	2.3	0.0	0.0	0.0
H_1 (ft)	3.8**	4.0	3.9	4.3	4.0	1.4	0.0	0.0
H_{max} (ft)	3.8**	6.1	6.0	6.4	6.2	3.2	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.2	0.6	0.4	0.7	0.5	0.0	0.0	0.0
H_5 (ft)	1.5**	1.1	0.9	1.2	1.0	0.0	0.0	0.0
H_1 (ft)	1.5**	2.7	2.5	2.9	2.8	0.0	0.0	0.0
H_{max} (ft)	1.5**	3.8**	4.6	5.0	4.9	1.7	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1	0.0	0.0	0.0

** Breaking wave.

Table 80

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.9	2.6	2.2	2.1	1.8	0.0	0.0	0.0
H_{10} (ft)	3.8**	4.8	4.2	4.2	3.8	1.6	0.0	0.0
H_5 (ft)	3.8**	5.5	4.9	4.8	4.4	2.2	0.0	0.0
H_1 (ft)	3.8**	6.1**	7.2	7.1	6.7	4.1	0.4	0.0
H_{max} (ft)	3.8**	6.1**	7.4**	8.5**	9.5**	6.5	1.8	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.3	0.9	0.8	0.5	0.0	0.0	0.0
H_{10} (ft)	1.5**	3.5	2.9	2.8	2.4	0.1	0.0	0.0
H_5 (ft)	1.5**	3.8**	3.6	3.5	3.0	0.6	0.0	0.0
H_1 (ft)	1.5**	3.8**	5.1**	5.8	5.2	2.5	0.0	0.0
H_{max} (ft)	1.5**	3.8**	5.1**	6.1**	7.0**	4.8	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.1**	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.1**	0.6	0.4	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.1**	1.1**	2.1**	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.1**	1.1**	2.1**	0.6	0.0	0.0

** Breaking wave.

Table 81

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.1	3.2	3.4	3.5	2.9	0.4	0.0	0.0
H_{10} (ft)	3.6**	5.6	5.8	6.0	5.3	2.3	0.0	0.0
H_5 (ft)	3.6**	6.0**	6.6	6.8	6.0	2.8	0.0	0.0
H_1 (ft)	3.6**	6.0**	6.6	6.8	6.0	5.0	0.9	0.0
H_{max} (ft)	3.6**	6.0**	7.3**	8.3**	9.3**	7.6	2.5	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.4**	2.1	2.2	2.3	1.7	0.0	0.0	0.0
H_{10} (ft)	1.4**	3.6**	4.7	4.7	4.0	0.8	0.0	0.0
H_5 (ft)	1.4**	3.6**	4.9**	5.5	4.7	1.4	0.0	0.0
H_1 (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	3.4	0.0	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	5.1	0.2	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.9**	1.4	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.9**	2.0**	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	2.0**	0.2	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	0.4	0.0	0.0

** Breaking wave.

Table 82

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0
H_{max} (ft)	1.4	1.3	1.1	1.2	1.4	1.1	1.5	0.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 83

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
H_1 (ft)	0.6	0.8	0.8	1.1	1.7	1.2	0.5	0.0
H_{max} (ft)	1.9	2.1	2.1	2.6	3.3	2.9	2.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
H_{max} (ft)	0.8**	0.8	0.8	1.3	2.0	1.6	0.5	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 84

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.7	0.8	0.8	0.8	0.7	0.0	0.0	0.0
H_{10} (ft)	2.3	2.4	2.5	2.6	2.4	0.4	0.0	0.0
H_5 (ft)	2.8	2.9	3.0	3.1	2.9	0.9	0.0	0.0
H_1 (ft)	3.6**	4.8	4.9	5.0	4.8	2.5	0.0	0.0
H_{max} (ft)	3.6**	6.0**	7.2	7.4	7.2	4.5	0.6	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.2	1.2	1.2	1.3	1.0	0.0	0.0	0.0
H_5 (ft)	1.4**	1.7	1.7	1.9	1.5	0.0	0.0	0.0
H_1 (ft)	1.4**	3.6	3.5	3.8	3.4	1.0	0.0	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	5.7	2.9	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	0.6	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	0.0	0.0	0.0

** Breaking wave.

Table 85

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	1.2**	0.3	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	1.2**	2.1	0.4	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 86

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by 10-Year Storm Swell

Period Associated with the 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.7**	0.8	0.6	0.9	0.8	0.0	0.0	0.0
H_{max} (ft)	0.7**	2.8	2.5	2.9	2.9	1.0	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.6**	1.1	1.5	1.5	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 87

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by 25-Year Storm Swell

Period Associated with the 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.7**	1.6	0.9	0.8	0.6	0.0	0.0	0.0
H_5 (ft)	0.7**	2.2	1.5	1.4	1.2	0.0	0.0	0.0
H_1 (ft)	0.7**	2.9**	3.7	3.6	3.4	1.9	0.0	0.0
H_{max} (ft)	0.7**	2.9**	3.9**	4.9**	6.0**	4.2	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.6**	0.2	0.1	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.6**	1.6**	2.2	1.9	0.3	0.0	0.0
H_{max} (ft)	0.0	0.6**	1.6**	2.5**	3.6**	2.5	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 88

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0
H_{10} (ft)	0.5**	2.4	2.3	2.5	1.9	0.1	0.0	0.0
H_5 (ft)	0.5**	2.7**	3.1	3.3	2.7	0.7	0.0	0.0
H_1 (ft)	0.5**	2.7**	3.8**	4.7**	5.1	2.7	0.0	0.0
H_{max} (ft)	0.5**	2.7**	3.8**	4.7**	5.7**	5.2**	0.3	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.4**	1.2	1.2	0.7	0.0	0.0	0.0
H_5 (ft)	0.0	0.4**	1.3**	1.9	1.4	0.0	0.0	0.0
H_1 (ft)	0.0	0.4**	1.3**	2.3**	3.3**	1.1	0.0	0.0
H_{max} (ft)	0.0	0.4**	1.3**	2.3**	3.3**	2.8**	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 89

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 90

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 91

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.5**	1.5	1.4	1.5	1.5	0.3	0.0	0.0
H_{max} (ft)	0.5**	2.7**	3.6	3.8	3.7	2.3	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.3	0.1	0.3	0.1	0.0	0.0	0.0
H_{max} (ft)	0.0	0.4**	1.3**	2.3**	2.3	0.7	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 92

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	2.2	1.9	1.7	1.7	1.6	2.0	1.1	0.7
H_{10} (ft)	3.4	2.5	2.0	1.9	1.8	2.7	1.2	0.8
H_5 (ft)	3.9	2.8	2.1	2.0	1.9	2.9	1.3	0.8
H_1 (ft)	4.6**	4.0	3.0	2.6	2.2	3.6	1.6	0.9
H_{max} (ft)	4.6**	5.7	4.3	3.7	3.0	4.6	2.1	1.1
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	2.3	1.9	1.8	1.8	1.7	1.8	1.1	0.8
H_5 (ft)	2.7**	2.0	1.9	1.9	1.8	1.9	1.2	0.8
H_1 (ft)	2.7**	2.8	2.2	2.1	2.0	2.6	1.3	0.9
H_{max} (ft)	2.7**	4.3	3.1	2.7	2.3	3.3	1.5	1.0
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.2	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 93

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by 10-Year Storm Swell

Period Associated with 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	2.0	1.9	1.9	2.0	2.0	4.1	2.2	1.1
H_{10} (ft)	3.2	2.8	2.8	3.0	2.9	5.4	2.9	1.3
H_5 (ft)	3.6	3.2	3.1	3.4	3.3	5.8	3.2	1.4
H_1 (ft)	4.3**	4.2	4.6	4.9	4.7	7.3	4.1	1.7
H_{max} (ft)	4.3**	6.5	6.5	6.9	6.7	9.2	5.2	2.2
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.7	1.8	1.8	1.9	1.9	2.9	1.5	1.0
H_{10} (ft)	2.2	2.1	2.1	2.2	2.2	4.2	1.9	1.2
H_5 (ft)	2.4**	2.3	2.3	2.5	2.4	4.6	2.1	1.2
H_1 (ft)	2.4**	3.5	3.4	3.7	3.7	6.0	2.7	1.3
H_{max} (ft)	2.4**	4.4**	5.2	5.6	5.5	7.8	3.7	1.5
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.1	1.3	1.0
H_5 (ft)	1.5**	1.8	1.9	2.0	2.0	2.3	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	3.3	1.6	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.4**	3.1	4.7	1.8	1.2

** Breaking wave.

Table 94

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by 25-Year Storm Swell

Period Associated with 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.6	3.4	3.1	3.1	2.8	5.7	3.4	1.4
H_{10} (ft)	4.3**	5.3	4.9	4.8	4.6	7.5	4.6	1.9
H_5 (ft)	4.3**	5.9	5.5	5.4	5.1	8.1	4.9	2.0
H_1 (ft)	4.3**	6.6**	7.7	7.6	7.2	10.1	6.2	2.6
H_{max} (ft)	4.3**	6.6**	7.9**	8.9**	9.8**	12.7	7.8	3.3
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3	2.5	2.3	2.3	2.2	4.4	2.2	1.2
H_{10} (ft)	2.4**	4.1	3.7	3.7	3.4	6.1	3.2	1.4
H_5 (ft)	2.4**	4.4**	4.3	4.2	3.9	6.7	3.5	1.4
H_1 (ft)	2.4**	4.4**	5.6**	6.3	5.8	8.6	4.6	1.6
H_{max} (ft)	2.4**	4.4**	5.6**	6.6**	7.5**	11.0	6.0	1.1
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.8	1.8	1.9	1.9	2.2	1.4	1.0
H_{10} (ft)	1.5**	2.0**	2.0**	2.1	2.2	3.4	1.7	1.1
H_5 (ft)	1.5**	2.0**	2.0**	2.2	2.2	3.9	1.7	1.1
H_1 (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	5.5	2.0	1.2
H_{max} (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	6.9**	2.7	1.4

** Breaking wave.

Table 95

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.7	4.0	4.1	4.3	3.8	6.3	3.7	1.7
H_{10} (ft)	4.2**	6.1	6.3	6.6	5.9	8.3	5.0	2.2
H_5 (ft)	4.2**	6.4**	7.1	7.3	6.6	8.9	5.4	2.4
H_1 (ft)	4.2**	6.4**	7.7**	8.7**	9.1	11.2	6.8	3.0
H_{max} (ft)	4.2**	6.4**	7.7**	8.7**	9.5**	14.0**	8.5	3.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3**	3.0	3.1	3.2	2.8	5.0	2.3	1.3
H_{10} (ft)	2.3**	4.2**	5.2	5.3	4.7	6.9	3.3	1.4
H_5 (ft)	2.3**	4.2**	5.4**	6.1	5.4	7.5	3.7	1.5
H_1 (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	9.6	4.8	1.9
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	11.5**	6.3	2.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	2.6	1.5	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.3**	2.6	4.1	1.8	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	4.6	1.8	1.2
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	6.5	2.4	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	6.7**	3.5	1.5

** Breaking wave.

Table 96

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.4	1.5	3.3	3.5	3.1
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	4.5	4.8	4.2
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	4.9	5.2	4.6
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	6.2	6.6	5.8
H_{max} (ft)	2.2	2.3	2.2	2.3	2.4	7.9	8.3	7.4
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.2	1.3	1.3	1.4	1.4	2.3	2.4	2.0
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	3.3	3.5	2.9
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	3.6	3.9	3.2
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	4.9	5.2	4.4
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	6.5	7.0	5.9
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.5	1.6	1.5
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.6
H_5 (ft)	1.2	1.3	1.4	1.4	1.5	1.8	1.9	1.7
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	2.6	2.7	1.9
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	3.9	4.2	2.9

** Breaking wave.

Table 97

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = + 11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.5	1.6	1.7	4.1	3.6	2.2
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	5.4	4.8	3.0
H_5 (ft)	1.6	1.6	1.7	1.7	1.9	5.9	5.3	3.3
H_1 (ft)	1.9	2.0	2.0	2.2	2.7	7.5	6.7	4.2
H_{max} (ft)	2.7	2.9	3.0	3.4	4.0	9.4	8.4	5.3
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.5	1.6	3.0	2.5	1.5
H_{10} (ft)	1.4	1.5	1.6	1.6	1.7	4.3	3.6	1.9
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	4.8	4.0	2.0
H_1 (ft)	1.7	1.7	1.8	1.8	2.0	6.3	5.3	2.7
H_{max} (ft)	1.9**	2.1	2.2	2.5	3.0	8.1	6.9	3.7
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.7	1.4	1.2
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	2.2	1.7	1.4
H_5 (ft)	1.3	1.4	1.5	1.6	1.7	2.5	1.9	1.4
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	3.8	2.7	1.5
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	5.5	4.0	1.6

** Breaking wave.

Table 98

Redondo Beach King Harbor, California

Existing Condition Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = +11.5 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.2	2.2	2.2	4.8	2.8	1.1
H_{10} (ft)	3.1	3.2	3.3	3.4	3.3	6.3	3.7	1.4
H_5 (ft)	3.5	3.7	3.8	3.9	3.8	6.8	4.0	1.5
H_1 (ft)	4.2**	5.3	5.4	5.6	5.5	8.6	5.1	1.9
H_{max} (ft)	4.2**	6.4**	7.6	7.8	7.7	10.7	6.5	2.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	3.5	1.7	1.0
H_{10} (ft)	2.2	2.4	2.4	2.6	2.4	4.9	2.4	1.2
H_5 (ft)	2.3**	2.7	2.8	2.9	2.7	5.4	2.6	1.2
H_1 (ft)	2.3**	4.2	4.2	4.5	4.2	7.1	3.5	1.3
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	6.3	9.1	4.7	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.8	1.3	0.8
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	2.5	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.8	1.5	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	2.3	4.1	1.7	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	5.8	2.0	1.2

** Breaking wave.

Table 99

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.8	1.7	1.6	1.5	1.5	1.1	0.7
H_{10} (ft)	2.7	2.1	1.9	1.8	1.8	2.0	1.2	0.8
H_5 (ft)	3.1	2.2	2.0	1.9	1.8	2.2	1.3	0.8
H_1 (ft)	3.8**	3.2	2.4	2.1	2.0	2.8	1.4	0.9
H_{max} (ft)	3.8**	4.8	3.5	2.9	2.5	3.7	1.6	1.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.6	1.5	1.4	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.7	1.7	1.7	1.1	0.8
H_5 (ft)	2.1**	1.9	1.8	1.8	1.7	1.7	1.2	0.8
H_1 (ft)	2.1**	2.3	2.0	2.0	1.9	2.0	1.3	0.9
H_{max} (ft)	2.1**	3.4	2.5	2.2	2.1	2.6	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5	1.4	1.4	1.4	1.3	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.6	1.5	1.5	1.5	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.7	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	1.9	1.9	1.9	1.9	1.2	0.8

** Breaking wave.

Table 100

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by 10-Year Storm Swell

Period Associated with 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = + 22.0 ft MLLW					Elevation = + 14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.8	1.8	1.9	1.9	3.2	1.7	1.1
H_{10} (ft)	2.4	2.2	2.2	2.3	2.3	4.4	2.2	1.2
H_5 (ft)	2.8	2.5	2.5	2.6	2.6	4.8	2.4	1.3
H_1 (ft)	3.4**	3.7	3.7	3.9	3.8	6.3	3.2	1.5
H_{max} (ft)	3.4**	5.5	5.5	5.7	5.7	8.1	4.2	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.7	1.8	1.8	2.2	1.5	1.0
H_{10} (ft)	1.9	1.9	2.0	2.0	2.1	3.3	1.6	1.2
H_5 (ft)	1.9**	2.0	2.0	2.1	2.1	3.6	1.7	1.2
H_1 (ft)	1.9**	2.7	2.7	2.8	2.9	5.0	2.1	1.4
H_{max} (ft)	1.9**	3.5	4.2	4.5	4.5	6.7	2.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.5	1.5	1.6	1.7	1.7	1.2	0.8
H_{10} (ft)	1.4**	1.7	1.7	1.8	1.9	2.0	1.4	1.0
H_5 (ft)	1.4**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_1 (ft)	1.4**	1.8**	2.0	2.1	2.1	2.6	1.5	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.5	3.7	1.7	1.3

** Breaking wave.

Table 101

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by 25-Year Storm Swell

Period Associated with 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.8	2.7	2.4	2.4	2.3	4.7	2.6	1.3
H_{10} (ft)	3.4**	4.4	4.0	3.8	3.7	6.5	3.6	1.5
H_5 (ft)	3.4**	5.0	4.5	4.3	4.2	7.0	3.9	1.6
H_1 (ft)	3.4**	5.6**	6.6	6.4	6.2	9.0	5.2	1.9
H_{max} (ft)	3.4**	5.6**	6.8**	7.6**	8.7**	11.5	6.7	2.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9	2.0	2.0	2.1	2.1	3.5	1.8	1.2
H_{10} (ft)	1.9**	3.2	2.9	2.8	2.7	5.1	2.4	1.4
H_5 (ft)	1.9**	3.5**	3.4	3.2	3.1	5.6	2.7	1.4
H_1 (ft)	1.9**	3.5**	4.6**	5.1	4.8	7.5	3.6	1.6
H_{max} (ft)	1.9**	3.5**	4.6**	5.4**	6.4**	9.8	5.0	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8	1.8	1.8	1.8	2.0	1.4	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.0	2.1	2.6	1.6	1.1
H_5 (ft)	1.4**	1.8**	2.0**	2.1	2.2	3.0	1.7	1.1
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.5**	4.5	1.9	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.5**	5.7**	2.2	1.4

** Breaking wave.

Table 102

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.9	3.1	3.3	3.3	3.0	5.3	2.9	1.4
H_{10} (ft)	3.3**	5.1	5.3	5.4	4.9	7.2	4.0	1.7
H_5 (ft)	3.3**	5.4**	6.1	6.1	5.6	7.8	4.4	1.8
H_1 (ft)	3.3**	5.4**	6.7**	7.5**	8.0	10.0	5.8	2.2
H_{max} (ft)	3.3**	5.4**	6.7**	7.5**	8.5**	12.7**	7.4	3.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.3	2.5	2.4	2.3	4.0	1.8	1.3
H_{10} (ft)	1.9**	3.3**	4.2	4.2	3.8	5.8	2.5	1.5
H_5 (ft)	1.9**	3.3**	4.4**	4.9	4.4	6.4	2.8	1.5
H_1 (ft)	1.9**	3.3**	4.4**	5.2**	6.2**	8.4	3.9	1.7
H_{max} (ft)	1.9**	3.3**	4.4**	5.2**	6.2**	10.3**	5.3	1.9
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	1.9	2.0	2.0	2.1	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.2	3.2	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.4**	3.7	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.4**	5.4	2.0	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.4**	5.6**	2.7	1.5

** Breaking wave.

Table 103

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.3	1.4	1.4	1.5	2.3	2.5	2.2
H_{10} (ft)	1.4	1.5	1.5	1.6	1.6	3.2	3.7	3.1
H_5 (ft)	1.4	1.5	1.6	1.6	1.7	3.6	4.0	3.4
H_1 (ft)	1.6	1.6	1.7	1.7	1.8	4.8	5.4	4.6
H_{max} (ft)	1.7	1.8	1.8	1.8	1.9	6.2	7.0	6.1
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.2	1.3	1.3	1.3	1.4	1.7	1.8	1.6
H_{10} (ft)	1.3	1.4	1.5	1.5	1.6	2.4	2.6	2.1
H_5 (ft)	1.3	1.5	1.5	1.5	1.6	2.6	2.9	2.3
H_1 (ft)	1.5	1.6	1.6	1.7	1.7	3.7	4.0	3.3
H_{max} (ft)	1.6	1.7	1.7	1.8	1.8	5.2	5.7	4.6
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.1	1.2	1.2	1.3	1.6	1.6	1.5
H_{10} (ft)	1.1	1.3	1.3	1.4	1.4	1.7	1.7	1.6
H_5 (ft)	1.2	1.3	1.3	1.4	1.5	1.8	1.8	1.7
H_1 (ft)	1.2**	1.4	1.4	1.5	1.6	2.0	2.0	1.8
H_{max} (ft)	1.2**	1.5	1.5	1.6	1.7	2.8	3.0	2.1

** Breaking wave.

Table 104

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.5	1.5	1.6	3.1	2.7	1.6
H_{10} (ft)	1.4	1.6	1.6	1.7	1.8	4.4	3.8	2.2
H_5 (ft)	1.5	1.6	1.6	1.7	1.8	4.8	4.2	2.4
H_1 (ft)	1.7	1.8	1.8	1.8	2.1	6.3	5.5	3.2
H_{max} (ft)	2.0	2.2	2.2	2.5	3.1	8.2	7.2	4.3
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.3	1.1	1.4	1.5	1.6	2.2	1.9	1.4
H_{10} (ft)	1.3	1.3	1.5	1.6	1.7	3.3	2.7	1.6
H_5 (ft)	1.4	1.3	1.6	1.7	1.8	3.7	3.0	1.7
H_1 (ft)	1.6	1.4	1.7	1.8	1.9	5.1	4.2	2.0
H_{max} (ft)	1.7**	1.5	1.9	2.0	2.3	6.9	5.7	2.8
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.2	1.3	1.4	1.5	1.7	1.6	1.2
H_{10} (ft)	1.2	1.3	1.4	1.5	1.6	1.9	1.7	1.4
H_5 (ft)	1.2	1.4	1.4	1.5	1.7	2.0	1.8	1.4
H_1 (ft)	1.3**	1.5	1.5	1.6	1.7	2.8	2.0	1.6
H_{max} (ft)	1.3**	1.6**	1.7	1.8	2.0	4.3	3.0	1.7

** Breaking wave.

Table 105

Redondo Beach King Harbor, California

1964 As-Constructed Breakwater Elevations

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +22.0 ft MLLW					Elevation = +14.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.9	2.0	1.9	3.8	2.1	1.1
H_{10} (ft)	2.3	2.5	2.6	2.6	2.6	5.3	2.9	1.3
H_5 (ft)	2.7	2.9	3.0	3.0	3.0	5.8	3.1	1.4
H_1 (ft)	3.3**	4.3	4.5	4.5	4.5	7.4	4.2	1.5
H_{max} (ft)	3.3**	5.4**	6.5	6.6	6.6	9.6	5.4	1.8
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.8	1.9	2.7	1.6	1.0
H_{10} (ft)	1.8	2.0	2.1	2.1	2.1	4.0	1.9	1.2
H_5 (ft)	1.9**	2.2	2.2	2.3	2.3	4.4	2.0	1.2
H_1 (ft)	1.9**	3.3	3.3	3.4	3.3	6.0	2.7	1.3
H_{max} (ft)	1.9**	3.3**	4.4**	5.2**	5.2	8.0	3.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.6	1.7	1.7	1.8	1.1	0.8
H_{10} (ft)	1.4**	1.8	1.8	1.9	1.9	2.1	1.2	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.2	1.2	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	3.2	1.3	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.4**	4.7	1.4	1.2

** Breaking wave.

Table 106

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.2	1.9	1.7	1.7	1.6	1.5	1.1	0.7
H_{10} (ft)	3.4	2.5	2.0	1.9	1.8	1.7	1.2	0.8
H_5 (ft)	3.9	2.8	2.1	2.0	1.9	1.7	1.3	0.8
H_1 (ft)	4.6**	4.0	3.0	2.6	2.2	1.9	1.4	0.9
H_{max} (ft)	4.6**	5.7	2.4	1.5	1.0			
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	2.3	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	2.7**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	2.7**	2.8	2.2	2.1	2.0	1.8	1.3	0.9
H_{max} (ft)	2.7**	4.3	3.1	2.7	2.3	2.0	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 107

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by 10-Year Storm Swell

Period Associated with 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	1.9	1.9	2.0	2.0	2.0	1.5	1.1
H_{10} (ft)	3.2	2.8	2.8	3.0	2.9	2.9	1.7	1.2
H_5 (ft)	3.6	3.2	3.1	3.4	3.3	3.2	1.7	1.3
H_1 (ft)	4.3**	4.2	4.6	4.9	4.7	4.4	2.0	1.5
H_{max} (ft)	4.3**	6.5	6.5	6.9	6.7	6.1	2.6	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.9	1.9	1.8	1.5	1.0
H_{10} (ft)	2.2	2.1	2.1	2.2	2.2	2.1	1.6	1.2
H_5 (ft)	2.4**	2.3	2.3	2.5	2.4	2.3	1.7	1.2
H_1 (ft)	2.4**	3.5	3.4	3.7	3.7	3.3	1.7	1.4
H_{max} (ft)	2.4**	4.4**	5.2	5.6	5.5	4.7	2.0	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_5 (ft)	1.5**	1.8	1.9	2.0	2.0	2.0	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	2.1	1.5	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.4**	3.1	2.4	1.7	1.3

** Breaking wave.

Table 108

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by 25-Year Storm Swell

Period Associated with 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	3.6	3.4	3.1	3.1	2.8	3.1	1.8	1.3
H_{10} (ft)	4.3**	5.3	4.9	4.8	4.6	4.6	2.2	1.4
H_5 (ft)	4.3**	5.9	5.5	5.4	5.1	5.1	2.4	1.5
H_1 (ft)	4.3**	6.6**	7.7	7.6	7.2	7.0	3.4	1.6
H_{max} (ft)	4.3**	6.6**	7.9**	8.9**	9.8**	9.3	4.7	1.8
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	2.3	2.5	2.3	2.3	2.2	2.2	1.6	1.2
H_{10} (ft)	2.4**	4.1	3.7	3.7	3.4	3.4	1.9	1.4
H_5 (ft)	2.4**	4.4**	4.3	4.2	3.9	3.8	1.9	1.4
H_1 (ft)	2.4**	4.4**	5.6**	6.3	5.8	5.5	2.3	1.6
H_{max} (ft)	2.4**	4.4**	5.6**	6.6**	7.5**	7.7	3.2	1.7
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.5**	1.8	1.8	1.9	1.9	2.0	1.4	1.0
H_{10} (ft)	1.5**	2.0**	2.0**	2.1	2.2	2.1	1.6	1.1
H_5 (ft)	1.5**	2.0**	2.0**	2.2	2.2	2.2	1.7	1.1
H_1 (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	2.9	1.9	1.3
H_{max} (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	3.8**	2.0	1.4

** Breaking wave.

Table 109

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.7	4.0	4.1	4.3	3.8	3.5	1.8	1.4
H_{10} (ft)	4.2**	6.1	6.3	6.6	5.9	5.3	2.4	1.5
H_5 (ft)	4.2**	6.4**	7.1	7.3	6.6	5.8	2.7	1.5
H_1 (ft)	4.2**	6.4**	7.7**	8.7**	9.1	7.9	3.8	1.7
H_{max} (ft)	4.2**	6.4**	7.7**	8.7**	9.5**	10.5**	5.3	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3**	3.0	3.1	3.2	2.8	2.5	1.6	1.3
H_{10} (ft)	2.3**	4.2**	5.2	5.3	4.7	3.9	1.9	1.5
H_5 (ft)	2.3**	4.2**	5.4**	6.1	5.4	4.5	2.0	1.5
H_1 (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	6.4	2.4	1.7
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	8.1**	3.4	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.9	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.3**	2.6	2.2	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.4	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	3.5	1.9	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	3.7**	2.1	1.5

** Breaking wave.

Table 110

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.7	1.7	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.9	2.0	1.8
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	2.1	2.2	1.9
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	3.0	3.2	2.6
H_{max} (ft)	2.2	2.3	2.2	2.3	2.4	4.4	4.6	3.8
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.6	1.6	1.6
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.8	1.8	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	2.1	2.2	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	3.1	3.3	2.6
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.5	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.6
H_5 (ft)	1.2	1.3	1.4	1.4	1.5	1.7	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.8	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	2.0	2.0	1.9

** Breaking wave.

Table 111

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.5	1.6	1.7	1.9	1.8	1.5
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	2.6	2.2	1.7
H_5 (ft)	1.6	1.6	1.7	1.7	1.9	3.0	2.4	1.7
H_1 (ft)	1.9	2.0	2.0	2.2	2.7	4.3	3.5	1.9
H_{max} (ft)	2.7	2.9	3.0	3.4	4.0	6.0	4.9	2.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.5	1.6	1.8	1.7	1.4
H_{10} (ft)	1.4	1.5	1.6	1.6	1.7	2.0	1.8	1.6
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	2.2	1.9	1.6
H_1 (ft)	1.7	1.7	1.8	1.8	2.0	3.2	2.4	1.8
H_{max} (ft)	1.9**	2.1	2.2	2.5	3.0	4.8	3.6	1.9
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.6	1.6	1.2
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	1.8	1.7	1.3
H_5 (ft)	1.3	1.4	1.5	1.6	1.7	1.8	1.7	1.4
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	2.0	1.8	1.5
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	2.6	2.1	1.6

** Breaking wave.

Table 112

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +18.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +18.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.2	2.2	2.2	2.4	1.6	1.1
H_{10} (ft)	3.1	3.2	3.3	3.4	3.3	3.6	1.8	1.2
H_5 (ft)	3.5	3.7	3.8	3.9	3.8	4.0	1.9	1.3
H_1 (ft)	4.2**	5.3	5.4	5.6	5.5	5.5	2.5	1.4
H_{max} (ft)	4.2**	6.4**	7.6	7.8	7.7	7.5	3.5	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.9	1.5	0.9
H_{10} (ft)	2.2	2.4	2.4	2.6	2.4	2.5	1.7	1.1
H_5 (ft)	2.3**	2.7	2.8	2.9	2.7	2.8	1.7	1.1
H_1 (ft)	2.3**	4.2	4.2	4.5	4.2	4.1	1.9	1.3
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	6.3	5.9	2.3	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.7	1.3	0.8
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.9	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	2.0	1.5	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	2.3	2.2	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	3.0	1.8	1.2

** Breaking wave.

Table 113

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.2	1.9	1.7	1.7	1.6	1.4	1.1	0.7
H_{10} (ft)	3.4	2.5	2.0	1.9	1.8	1.5	1.2	0.8
H_5 (ft)	3.9	2.8	2.1	2.0	1.9	1.6	1.3	0.8
H_1 (ft)	4.6**	4.0	3.0	2.6	2.2	1.8	1.4	0.9
H_{max} (ft)	4.6**	5.7	4.3	3.7	3.0	2.0	1.4	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	2.3	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	2.7**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	2.7**	2.8	2.2	2.1	2.0	1.7	1.3	0.9
H_{max} (ft)	2.7**	4.3	3.1	2.7	2.3	1.9	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 114

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 10-Year Storm Swell

Period Associated with 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = + 22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	1.9	1.9	2.0	2.0	1.8	1.4	1.1
H_{10} (ft)	3.2	2.8	2.8	3.0	2.9	2.1	1.6	1.2
H_5 (ft)	3.6	3.2	3.1	3.4	3.3	2.1	1.6	1.3
H_1 (ft)	4.3**	4.2	4.6	4.9	4.7	2.8	1.8	1.4
H_{max} (ft)	4.3**	6.5	6.5	6.9	6.7	4.1	2.0	1.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.9	1.9	1.7	1.5	1.0
H_{10} (ft)	2.2	2.1	2.1	2.2	2.2	1.9	1.6	1.2
H_5 (ft)	2.4**	2.3	2.3	2.5	2.4	2.0	1.7	1.2
H_1 (ft)	2.4**	3.5	3.4	3.7	3.7	2.3	1.7	1.4
H_{max} (ft)	2.4**	4.4**	5.2	5.6	5.5	3.0	1.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.5	1.6	1.7	1.7	1.7	1.2	0.8
H_{10} (ft)	1.5**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_5 (ft)	1.5**	1.8	1.9	2.0	2.0	2.0	1.4	1.0
H_1 (ft)	1.5**	1.8**	2.0	2.1	2.2	2.0	1.5	1.1
H_{max} (ft)	1.5**	1.8**	2.0**	2.4**	3.1	2.2	1.7	1.3

** Breaking wave.

Table 115

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 25-Year Storm Swell

Period Associated with 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.6	3.4	3.1	3.1	2.8	2.1	1.7	1.3
H_{10} (ft)	4.3**	5.3	4.9	4.8	4.6	2.9	1.9	1.3
H_5 (ft)	4.3**	5.9	5.5	5.4	5.1	3.3	2.0	1.4
H_1 (ft)	4.3**	6.6**	7.7	7.6	7.2	4.9	2.2	1.5
H_{max} (ft)	4.3**	6.6**	7.9**	8.9**	9.8**	7.1	3.1	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3	2.5	2.3	2.3	2.2	2.0	1.6	1.2
H_{10} (ft)	2.4**	4.1	3.7	3.7	3.4	2.3	1.7	1.4
H_5 (ft)	2.4**	4.4**	4.3	4.2	3.9	2.4	1.8	1.4
H_1 (ft)	2.4**	4.4**	5.6**	6.3	5.8	3.6	2.0	1.6
H_{max} (ft)	2.4**	4.4**	5.6**	6.6**	7.5**	5.5	2.3	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5**	1.8	1.8	1.9	1.9	2.0	1.4	1.0
H_{10} (ft)	1.5**	2.0**	2.0**	2.1	2.2	2.0	1.6	1.1
H_5 (ft)	1.5**	2.0**	2.0**	2.2	2.2	2.1	1.7	1.1
H_1 (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	2.3	1.9	1.3
H_{max} (ft)	1.5**	2.0**	2.0**	2.4**	3.2**	2.4**	1.9	1.4

** Breaking wave.

Table 116

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.7	4.0	4.1	4.3	3.8	2.2	1.7	1.4
H_{10} (ft)	4.2**	6.1	6.3	6.6	5.9	3.4	1.9	1.4
H_5 (ft)	4.2**	6.4**	7.1	7.3	6.6	3.8	2.0	1.5
H_1 (ft)	4.2**	6.4**	7.7**	8.7**	9.1	5.7	2.4	1.6
H_{max} (ft)	4.2**	6.4**	7.7**	8.7**	9.5**	8.1**	3.5	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3**	3.0	3.1	3.2	2.8	2.1	1.6	1.3
H_{10} (ft)	2.3**	4.2**	5.2	5.3	4.7	2.5	1.7	1.5
H_5 (ft)	2.3**	4.2**	5.4**	6.1	5.4	2.8	1.8	1.5
H_1 (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	4.3	2.0	1.6
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	5.8**	2.3	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.3**	2.6	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.3	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.4**	2.0	1.5

** Breaking wave.

Table 117

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.7
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	1.9	2.0	1.9
H_{max} (ft)	2.2	2.3	2.2	2.3	2.4	2.4	2.6	2.2
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 118

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.5	1.6	1.7	1.8	1.7	1.4
H_{10} (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.6
H_5 (ft)	1.6	1.6	1.7	1.7	1.9	2.0	1.9	1.7
H_1 (ft)	1.9	2.0	2.0	2.2	2.7	2.5	2.1	1.8
H_{max} (ft)	2.7	2.9	3.0	3.4	4.0	3.8	3.0	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.3
H_{10} (ft)	1.4	1.5	1.6	1.6	1.7	1.9	1.8	1.5
H_5 (ft)	1.5	1.5	1.6	1.7	1.8	1.9	1.9	1.6
H_1 (ft)	1.7	1.7	1.8	1.8	2.0	2.1	2.0	1.7
H_{max} (ft)	1.9**	2.1	2.2	2.5	3.0	2.8	2.2	1.8
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.3	1.3	1.4	1.5	1.6	1.5	1.1
H_{10} (ft)	1.2	1.4	1.4	1.5	1.6	1.7	1.7	1.3
H_5 (ft)	1.3	1.4	1.5	1.6	1.7	1.8	1.7	1.3
H_1 (ft)	1.3**	1.5	1.6	1.7	1.8	1.9	1.8	1.4
H_{max} (ft)	1.3**	1.7**	1.8	1.9	2.0	2.1	1.9	1.6

** Breaking wave.

Table 119

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.2	2.2	2.2	1.9	1.6	1.0
H_{10} (ft)	3.1	3.2	3.3	3.4	3.3	2.2	1.7	1.2
H_5 (ft)	3.5	3.7	3.8	3.9	3.8	2.4	1.8	1.2
H_1 (ft)	4.2**	5.3	5.4	5.6	5.5	3.5	2.0	1.4
H_{max} (ft)	4.2**	6.4**	7.6	7.8	7.7	5.3	2.3	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.8	1.5	0.9
H_{10} (ft)	2.2	2.4	2.4	2.6	2.4	2.0	1.6	1.1
H_5 (ft)	2.3**	2.7	2.8	2.9	2.7	2.1	1.7	1.1
H_1 (ft)	2.3**	4.2	4.2	4.5	4.2	2.6	1.8	1.2
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	6.3	3.9	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	2.3	2.1	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.3	1.7	1.1

** Breaking wave.

Table 120

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.9	1.8	1.7	1.6	1.5	1.4	1.1	0.7
H_{10} (ft)	2.0	2.0	1.9	1.8	1.8	1.5	1.2	0.8
H_5 (ft)	2.1	2.1	2.0	1.9	1.8	1.6	1.3	0.8
H_1 (ft)	2.4**	2.3	2.1	2.1	2.0	1.8	1.4	0.9
H_{max} (ft)	2.4**	3.2	2.4	2.3	2.2	2.0	1.4	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.6	1.5	1.4	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.7	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	1.9	1.8	1.8	1.7	1.7	1.2	0.8
H_1 (ft)	1.9**	2.3	2.0	2.0	1.9	1.7	1.3	0.9
H_{max} (ft)	1.9**	2.3	2.2	2.2	2.1	1.9	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.5	1.4	1.4	1.4	1.3	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.6	1.5	1.5	1.5	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.7	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	1.9	1.9	1.9	1.9	1.2	0.8

** Breaking wave.

Table 121

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by 10-Year Storm Swell

Period Associated with 10-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.8	1.8	1.9	1.9	1.8	1.4	1.1
H_{10} (ft)	2.0	2.0	2.0	2.1	2.1	2.1	1.6	1.2
H_5 (ft)	2.0	2.1	2.1	2.2	2.2	2.1	1.6	1.3
H_1 (ft)	2.2**	2.4	2.4	2.6	2.6	2.2	1.8	1.4
H_{max} (ft)	2.2**	3.7	3.5	3.9	3.9	2.7	2.0	1.4
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.7	1.7	1.8	1.8	1.7	1.5	1.0
H_{10} (ft)	1.8	1.9	2.2	2.0	2.1	1.9	1.6	1.2
H_5 (ft)	1.9**	2.0	2.2	2.1	2.1	2.0	1.7	1.2
H_1 (ft)	1.9**	2.1	2.2	2.3	2.3	2.3	1.7	1.4
H_{max} (ft)	1.9**	2.3**	2.6	2.9	3.0	2.3	1.8	1.5
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.5	1.5	1.6	1.7	1.7	1.2	0.8
H_{10} (ft)	1.4**	1.7	1.7	1.8	1.9	2.0	1.4	1.0
H_5 (ft)	1.4**	1.7	1.8	1.9	1.9	2.0	1.4	1.0
H_1 (ft)	1.4**	1.8**	2.0	2.1	2.1	2.0	1.5	1.1
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.2	1.7	1.3

** Breaking wave.

Table 122

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by 25-Year Storm Swell

Period Associated with 25-Year Storm = 14.5 sec.

Swell Heights (ft)	Elevation = + 26.0 ft MLLW					Elevation = + 26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.1	2.1	2.1	2.1	1.7	1.3
H_{10} (ft)	2.2**	2.8	2.5	2.5	2.5	2.3	1.9	1.3
H_5 (ft)	2.2**	3.3	2.9	2.8	2.8	2.4	2.0	1.4
H_1 (ft)	2.2**	3.7**	4.5	4.4	4.3	3.2	2.1	1.5
H_{max} (ft)	2.2**	3.7**	4.7**	5.6**	6.6**	5.0	2.3	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	2.0	2.0	2.1	2.1	2.0	1.6	1.2
H_{10} (ft)	1.9**	2.2	2.2	2.3	2.3	2.1	1.7	1.4
H_5 (ft)	1.9**	2.3**	2.3	2.4	2.4	2.2	1.8	1.4
H_1 (ft)	1.9**	2.3**	2.9**	3.3	3.2	2.5	2.0	1.6
H_{max} (ft)	1.9**	2.3**	2.9**	3.6**	4.4**	3.6	2.3	1.7
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8	1.8	1.8	1.8	2.0	1.4	1.0
H_{10} (ft)	1.4**	1.8**	2.0**	2.0	2.1	2.0	1.6	1.1
H_5 (ft)	1.4**	1.8**	2.0**	2.1	2.2	2.1	1.7	1.1
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.9	1.3
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3**	1.9	1.4

** Breaking wave.

Table 123

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.3	2.3	2.0	1.7	1.4
H_{10} (ft)	2.1**	3.3	3.4	3.6	3.2	2.3	1.9	1.4
H_5 (ft)	2.1**	3.6**	4.0	4.2	3.7	2.5	2.0	1.5
H_1 (ft)	2.1**	3.6**	4.5**	5.4**	5.8	3.8	2.1	1.6
H_{max} (ft)	2.1**	3.6**	4.5**	5.4**	6.4**	5.9**	2.4	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8**	2.1	2.2	2.2	2.2	2.1	1.6	1.3
H_{10} (ft)	1.8**	2.2**	2.6	2.7	2.5	2.2	1.7	1.5
H_5 (ft)	1.8**	2.2**	2.7**	3.1	2.9	2.3	1.8	1.5
H_1 (ft)	1.8**	2.2**	2.7**	3.4**	4.2**	2.7	2.0	1.6
H_{max} (ft)	1.8**	2.2**	2.7**	3.4**	4.2**	3.8**	2.1	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.2	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.2**	2.0	1.5

** Breaking wave.

Table 124

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.3	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.4	1.5	1.5	1.6	1.6	1.8	1.8	1.7
H_5 (ft)	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.6	1.7	1.7	1.8	1.9	2.0	1.9
H_{max} (ft)	1.7	1.8	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.3	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.3	1.5	1.5	1.5	1.6	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.7	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.7	1.8	1.8	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.1	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.1	1.3	1.3	1.4	1.4	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.3	1.5	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.4	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.5	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 125

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 12.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.5	1.5	1.6	1.8	1.7	1.4
H_{10} (ft)	1.4	1.6	1.6	1.7	1.8	1.9	1.9	1.6
H_5 (ft)	1.5	1.6	1.6	1.7	1.8	2.0	1.9	1.7
H_1 (ft)	1.7	1.8	1.8	1.8	2.0	2.0	2.0	1.8
H_{max} (ft)	1.8	1.9	1.9	2.0	2.2	2.3	2.1	1.9
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.3	1.1	1.4	1.5	1.6	1.7	1.7	1.3
H_{10} (ft)	1.3	1.3	1.5	1.6	1.7	1.9	1.8	1.5
H_5 (ft)	1.4	1.3	1.6	1.7	1.8	1.9	1.9	1.6
H_1 (ft)	1.6	1.4	1.7	1.8	1.9	2.1	2.0	1.7
H_{max} (ft)	1.7**	1.5	1.9	2.0	2.1	2.2	2.0	1.8
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.3	1.4	1.5	1.6	1.5	1.1
H_{10} (ft)	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.3
H_5 (ft)	1.2	1.4	1.4	1.5	1.7	1.8	1.7	1.3
H_1 (ft)	1.3**	1.5	1.5	1.6	1.7	1.9	1.8	1.4
H_{max} (ft)	1.3**	1.6**	1.7	1.8	2.0	2.1	1.9	1.6

** Breaking wave.

Table 126

Redondo Beach King Harbor, California

Entire Breakwater Raised to +26.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +26.0 ft MLLW					Elevation = +26.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	1.9	2.0	1.9	1.9	1.6	1.0
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.0	1.7	1.2
H_5 (ft)	2.0	2.1	2.2	2.3	2.3	2.1	1.8	1.2
H_1 (ft)	2.1**	2.8	2.8	2.9	2.9	2.4	2.0	1.4
H_{max} (ft)	2.1**	3.6**	4.4	4.6	4.6	3.5	2.1	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.8	1.8	1.9	1.8	1.5	0.9
H_{10} (ft)	1.8	2.0	2.0	2.1	2.1	2.0	1.6	1.1
H_5 (ft)	1.8**	2.0	2.1	2.2	2.2	2.1	1.7	1.1
H_1 (ft)	1.8**	2.2	2.3	2.4	2.4	2.2	1.8	1.2
H_{max} (ft)	1.8**	2.2**	2.7**	3.4**	3.4	2.5	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.6	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.8	1.9	1.9	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.7	1.1

** Breaking wave.

PART IX: ALTERNATIVES TO ALLEVIATE EXCESSIVE WAVE ACTIVITY AND SHOALING IN REDONDO BEACH KING HARBOR, CALIFORNIA

Alternative No. 1

Raise Lower-Elevation Section of North Breakwater

107. Storm waves frequently overtop the +11.5 ft MLLW section of the north breakwater and create undesirable wave action in the Harbor. When combined with extremely high tides, the +20.0 ft MLLW section of the structure is also overtopped. Even when there is no overtopping, wave energy is still transmitted through the breakwater which is permeable throughout its entire length. The effects of raising the crest elevation of the +11.5 ft MLLW elevation section to +18.0 ft MLLW and +22.0 ft MLLW, and of raising the crest elevation of the entire structure to +26.0 ft MLLW, were evaluated by application of the numerical model IMADSEN. These results of penetration, overtopping, and total transmission past the structure are presented in Tables 22-126.

108. An analysis of these data, summarized in Tables 127-134, indicates consideration should be given to raising the elevation of the +11.5 ft MLLW crest section to +22.0 ft MLLW, which was the elevation of the 1964 as-constructed crest of the higher section. The location of this proposed rehabilitation work is shown in Figure 26. Any rehabilitation construction should effectively seal any voids to eliminate wave energy penetration through this section. The rehabilitation construction can blend with the existing higher section so as to be imperceptible. The existing elevation of the higher section is +20.0 ft MLLW, although it was originally constructed to +22.0 ft MLLW. Settlement and adjustment of the flexible structure under years of wave activity have accounted for a decrease of 2 ft in the crest elevation. If the +11.5 ft MLLW section is raised to +22.0 ft MLLW (2 ft higher than the existing elevation of the higher section), settlement will eventually reduce the crest elevation of this rehabilitated section to an elevation approaching that of the existing higher section of the breakwater.

109. A comparison of extreme conditions is presented in Tables 127-134, 5-year and 50-year storm swell, and 10-sec and 14-sec annual sea waves, for overtopping and total wave transmission into the Harbor. It is seen from these data that by raising the crest elevation of the lower section from

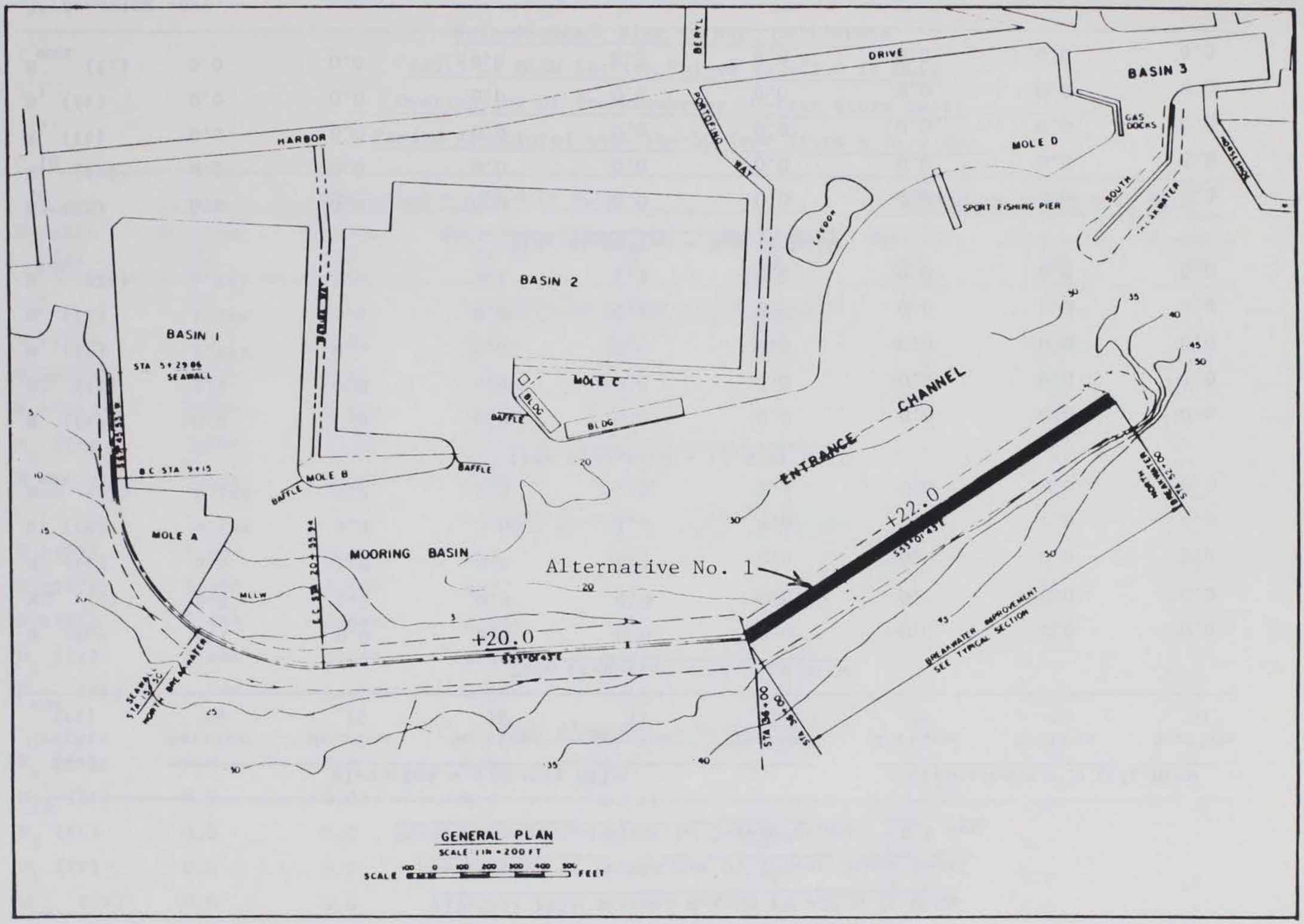


Figure 26. Location of proposed increase in breakwater crest elevation from +11.5 ft MLLW to +22.0 ft MLLW, Redondo Beach King Harbor, California

Table 127

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	2.8	1.3	0.3	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	3.4	1.8	0.7	0.2	0.0	0.0	0.0	0.0
H_1 (ft)	4.1**	3.3	2.0	1.4	0.6	0.0	0.0	0.0
H_{max} (ft)	4.1**	5.2	3.5	2.8	1.9	0.0	0.0	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	1.9**	0.4	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	1.9**	1.8	0.6	0.1	0.0	0.0	0.0	0.0
H_{max} (ft)	1.9**	3.6	2.1	1.5	0.6	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

** Breaking wave.

Table 128

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.1	3.2	3.4	3.5	2.9	0.4	0.0	0.0
H_{10} (ft)	3.6**	5.6	5.8	6.0	5.3	2.3	0.0	0.0
H_5 (ft)	3.6**	6.0**	6.6	6.8	6.0	2.8	0.0	0.0
H_1 (ft)	3.6**	6.0**	6.6	6.8	6.0	5.0	0.9	0.0
H_{max} (ft)	3.6**	6.0**	7.3**	8.3**	9.3**	7.6	2.5	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.4**	2.1	2.2	2.3	1.7	0.0	0.0	0.0
H_{10} (ft)	1.4**	3.6**	4.7	4.7	4.0	0.8	0.0	0.0
H_5 (ft)	1.4**	3.6**	4.9**	5.5	4.7	1.4	0.0	0.0
H_1 (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	3.4	0.0	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	6.8**	5.1	0.2	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.9**	1.4	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.9**	2.0**	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	2.0**	0.2	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	0.4	0.0	0.0

** Breaking wave.

Table 129

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0
H_{max} (ft)	1.4	1.3	1.1	1.2	1.4	1.1	1.5	0.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 130

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Overtopping of Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	0.7	0.8	0.8	0.8	0.7	0.0	0.0	0.0
H_{10} (ft)	2.3	2.4	2.5	2.6	2.4	0.4	0.0	0.0
H_5 (ft)	2.8	2.9	3.0	3.1	2.9	0.9	0.0	0.0
H_1 (ft)	3.6**	4.8	4.9	5.0	4.8	2.5	0.0	0.0
H_{max} (ft)	3.6**	6.0**	7.2	7.4	7.2	4.5	0.6	0.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	1.2	1.2	1.2	1.3	1.0	0.0	0.0	0.0
H_5 (ft)	1.4**	1.7	1.7	1.9	1.5	0.0	0.0	0.0
H_1 (ft)	1.4**	3.6	3.5	3.8	3.4	1.0	0.0	0.0
H_{max} (ft)	1.4**	3.6**	4.9**	5.9**	5.7	2.9	0.0	0.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_{10} (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_5 (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_1 (ft)	0.0	0.0	0.0	0.9**	0.6	0.0	0.0	0.0
H_{max} (ft)	0.0	0.0	0.0	0.9**	2.0**	0.0	0.0	0.0

** Breaking wave.

Table 131

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 5-Year Storm Swell

Period Associated with 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.2	1.9	1.7	1.7	1.6	1.4	1.1	0.7
H_{10} (ft)	3.4	2.5	2.0	1.9	1.8	1.5	1.2	0.8
H_5 (ft)	3.9	2.8	2.1	2.0	1.9	1.6	1.3	0.8
H_1 (ft)	4.6**	4.0	3.0	2.6	2.2	1.8	1.4	0.9
H_{max} (ft)	4.6**	5.7	4.3	3.7	3.0	2.0	1.4	1.0
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	2.3	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	2.7**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	2.7**	2.8	2.2	2.1	2.0	1.7	1.3	0.9
H_{max} (ft)	2.7**	4.3	3.1	2.7	2.3	1.9	1.5	1.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 132

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by 50-Year Storm Swell

Period Associated with 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	3.7	4.0	4.1	4.3	3.8	2.2	1.7	1.4
H_{10} (ft)	4.2**	6.1	6.3	6.6	5.9	3.4	1.9	1.4
H_5 (ft)	4.2**	6.4**	7.1	7.3	6.6	3.8	2.0	1.5
H_1 (ft)	4.2**	6.4**	7.7**	8.7**	9.1	5.7	2.4	1.6
H_{max} (ft)	4.2**	6.4**	7.7**	8.7**	9.5**	8.1**	3.5	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	2.3**	3.0	3.1	3.2	2.8	2.1	1.6	1.3
H_{10} (ft)	2.3**	4.2**	5.2	5.3	4.7	2.5	1.7	1.5
H_5 (ft)	2.3**	4.2**	5.4**	6.1	5.4	2.8	1.8	1.5
H_1 (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	4.3	2.0	1.6
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	7.3**	5.8**	2.3	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.3**	2.6	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.3	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.4**	2.0	1.5

** Breaking wave.

Table 133

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.7
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	1.9	2.0	1.9
H_{max} (ft)	2.2	2.3	2.2	2.3	2.4	2.4	2.6	2.2
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 134

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Total Transmission Past Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.1	2.2	2.2	2.2	1.9	1.6	1.0
H_{10} (ft)	3.1	3.2	3.3	3.4	3.3	2.2	1.7	1.2
H_5 (ft)	3.5	3.7	3.8	3.9	3.8	2.4	1.8	1.2
H_1 (ft)	4.2**	5.3	5.4	5.6	5.5	3.5	2.0	1.4
H_{max} (ft)	4.2**	6.4**	7.6	7.8	7.7	5.3	2.3	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.8	1.5	0.9
H_{10} (ft)	2.2	2.4	2.4	2.6	2.4	2.0	1.6	1.1
H_5 (ft)	2.3**	2.7	2.8	2.9	2.7	2.1	1.7	1.1
H_1 (ft)	2.3**	4.2	4.2	4.5	4.2	2.6	1.8	1.2
H_{max} (ft)	2.3**	4.2**	5.4**	6.4**	6.3	3.9	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.3**	2.3	2.1	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.3**	3.0**	2.3	1.7	1.1

** Breaking wave.

+11.5 ft MLLW to +22.0 ft MLLW, essentially all overtopping of this section of the structure is eliminated for the wave conditions evaluated. The overtopping of the higher section of the breakwater which presently occurs under existing conditions at extreme high tide has not been addressed by this alternative. Raising the crest elevation of the higher section from +20.0 ft MLLW to +26.0 ft MWW1 will indeed eliminate practically all the overtopping which now occurs; however, this does not appear to be a viable alternative when consideration is given to the relationship of cost of rehabilitation versus protection afforded.

Alternative No. 2

Sealing Higher-Elevation Section of North Breakwater

110. The elimination of damaging wave energy in the Harbor can only be accomplished by raising the crest elevation of the lower section of the north breakwater. This section of the structure should be effectively sealed during rehabilitation construction to prevent wave energy penetration through this portion of the structure.

111. A considerable amount of wave energy also enters the Harbor by penetration through the higher section of the structure. This penetration of wave energy into the harbor can be eliminated by effective sealing of the structure by either mechanical or chemical grouting methods, Figure 27. However, sealing of this portion of the breakwater may not be a viable alternative for two reasons: (a) the actual magnitude of the wave energy passing through this portion of the structure is not overwhelmingly devastating; and (b) the Southern California Edison Company maintains at least two cooling water conduit terminal structures on the bottom of the Harbor.

112. Penetration through the structure, as calculated by numerical program IMADSEN, is presented for extreme conditions of 5-year and 50-year storm swell, and 10-sec and 14-sec annual sea waves, in Tables 135-138, respectively. Wave energy penetration for most of these conditions is on the order of 2-ft wave height penetration through the structure into the Harbor. This is the range of wave height magnitudes which are considered tolerable in small boat navigation channels, although wave heights greater than 1 ft are considered excessive in the boat mooring basins. Because of the restricted openings to the mooring basins, much of that wave energy which penetrates through the breakwater will not be able to enter the mooring basins. Hence,

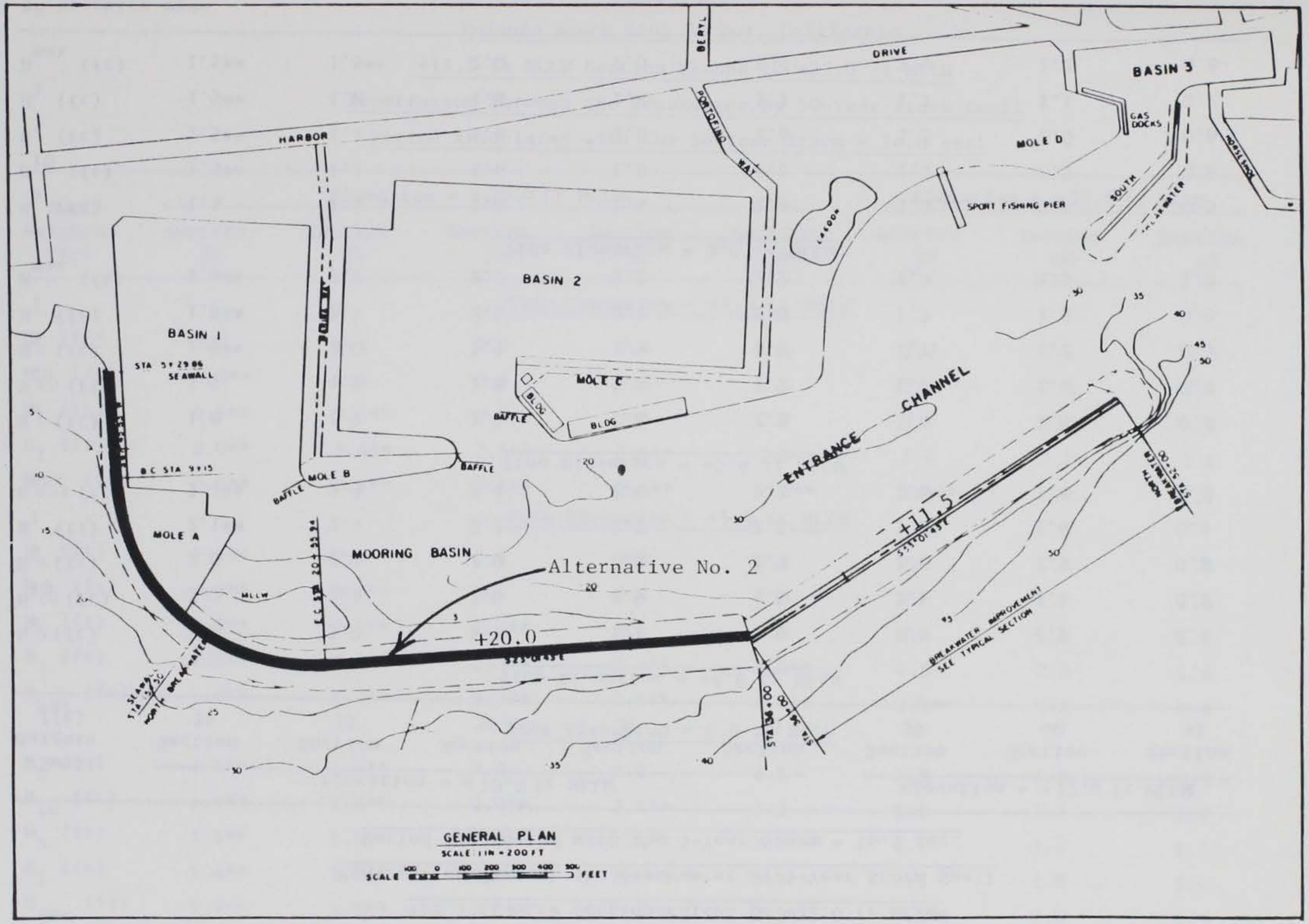


Figure 27. Location of section of breakwater proposed for sealing to eliminate wave energy penetration and shoal material from entering harbor, Redondo Beach King Harbor, California

Table 135

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 5-Year Storm Swell

Period Associated with the 5-Year Storm = 16.5 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
	Tide Elevation = +8.0 ft MLLW							
H_s (ft)	1.8	1.9	1.7	1.7	1.6	1.4	1.1	0.7
H_{10} (ft)	2.0	2.1	2.0	1.9	1.8	1.5	1.2	0.8
H_5 (ft)	2.0	2.1	2.0	2.0	1.9	1.6	1.3	0.8
H_1 (ft)	2.1**	2.3	2.2	2.2	2.1	1.8	1.4	0.9
H_{max} (ft)	2.1**	2.3	2.4	2.4	2.3	2.0	1.4	1.0
	Tide Elevation = +5.4 ft MLLW							
H_s (ft)	1.8	1.7	1.6	1.6	1.5	1.4	1.0	0.7
H_{10} (ft)	1.9	1.9	1.8	1.8	1.7	1.7	1.1	0.8
H_5 (ft)	1.9**	2.0	1.9	1.9	1.8	1.7	1.2	0.8
H_1 (ft)	1.9**	2.1	2.1	2.1	2.0	1.7	1.3	0.9
H_{max} (ft)	1.9**	2.2	2.2	2.2	2.2	1.9	1.5	1.0
	Tide Elevation = 0.0 ft MLLW							
H_s (ft)	1.4	1.5	1.4	1.4	1.4	1.3	0.8	0.5
H_{10} (ft)	1.5**	1.7	1.6	1.6	1.6	1.4	0.9	0.6
H_5 (ft)	1.5**	1.7	1.6	1.6	1.6	1.5	1.0	0.6
H_1 (ft)	1.5**	1.8	1.8	1.8	1.7	1.7	1.1	0.7
H_{max} (ft)	1.5**	1.9**	2.0	2.0	1.9	1.9	1.2	0.8

** Breaking wave.

Table 136

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by 50-Year Storm Swell

Period Associated with the 50-Year Storm = 14.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	2.0	2.2	2.3	2.4	2.4	2.2	1.7	1.4
H_{10} (ft)	2.0**	2.4	2.5	2.6	2.6	2.4	1.9	1.4
H_5 (ft)	2.0**	2.4**	2.5	2.6	2.7	2.6	2.0	1.5
H_1 (ft)	2.0**	2.4**	2.5**	2.6**	2.7	2.7	2.2	1.6
H_{max} (ft)	2.0**	2.4**	2.5**	2.6**	2.8**	2.8**	2.4	1.7
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.9**	2.1	2.2	2.3	2.3	2.1	1.6	1.3
H_{10} (ft)	1.9**	2.2**	2.4	2.5	2.5	2.4	1.7	1.5
H_5 (ft)	1.9**	2.2**	2.3**	2.5	2.6	2.4	1.8	1.5
H_1 (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.6	2.0	1.6
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6**	2.8**	2.3	1.6
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.8**	2.0	2.1	2.1	1.8	1.5	1.1
H_{10} (ft)	1.4**	1.8**	2.0**	2.1**	2.3	2.1	1.7	1.2
H_5 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.1	1.8	1.3
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.8	1.4
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.4**	2.0	1.5

** Breaking wave.

Table 137

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 10.0 sec.

Swell Heights (ft)	Elevation = +20.0 ft MLLW					Elevation = +22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.3	1.4	1.4	1.4	1.5	1.6	1.6	1.6
H_{10} (ft)	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.7
H_5 (ft)	1.5	1.6	1.6	1.6	1.7	1.8	1.9	1.8
H_1 (ft)	1.6	1.7	1.7	1.8	1.8	1.9	2.0	1.9
H_{max} (ft)	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.1
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.5
H_{10} (ft)	1.3	1.5	1.5	1.5	1.6	1.7	1.7	1.7
H_5 (ft)	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.7
H_1 (ft)	1.5	1.6	1.6	1.7	1.8	1.9	1.9	1.9
H_{max} (ft)	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.0
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.1	1.2	1.2	1.2	1.3	1.4	1.5	1.4
H_{10} (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.5
H_5 (ft)	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.6
H_1 (ft)	1.2**	1.4	1.5	1.5	1.6	1.7	1.8	1.7
H_{max} (ft)	1.2**	1.5	1.6	1.6	1.7	1.9	1.9	1.8

** Breaking wave.

Table 138

Redondo Beach King Harbor, California

+11.5 ft MLLW Section Raised to +22.0 ft MLLW

Penetration Through the Breakwater by Annual Sea

Wave Period = 14.0 sec.

Swell Heights (ft)	Elevation = + 20.0 ft MLLW					Elevation = + 22.0 ft MLLW		
	Section 34	Section 35	Section 36	Section 37	Section 38	Section 39	Section 40	Section 41
				Tide Elevation = +8.0 ft MLLW				
H_s (ft)	1.8	1.9	2.0	2.0	2.0	1.9	1.6	1.0
H_{10} (ft)	2.0	2.2	2.2	2.3	2.3	2.2	1.7	1.2
H_5 (ft)	2.0	2.2	2.3	2.3	2.4	2.2	1.8	1.2
H_1 (ft)	2.0**	2.3	2.4	2.5	2.6	2.4	2.0	1.4
H_{max} (ft)	2.0**	2.4**	2.5	2.6	2.7	2.8	2.2	1.5
				Tide Elevation = +5.4 ft MLLW				
H_s (ft)	1.7	1.8	1.9	1.9	1.9	1.8	1.5	0.9
H_{10} (ft)	1.9	2.1	2.1	2.2	2.2	2.0	1.6	1.1
H_5 (ft)	1.9**	2.1	2.2	2.2	2.3	2.1	1.7	1.1
H_1 (ft)	1.9**	2.2	2.3	2.4	2.5	2.4	1.8	1.2
H_{max} (ft)	1.9**	2.2**	2.3**	2.5**	2.6	2.6	2.0	1.4
				Tide Elevation = 0.0 ft MLLW				
H_s (ft)	1.4**	1.6	1.7	1.7	1.7	1.6	1.3	0.7
H_{10} (ft)	1.4**	1.8	1.9	2.0	2.0	1.8	1.4	0.9
H_5 (ft)	1.4**	1.8**	1.9	2.0	2.0	1.8	1.4	0.9
H_1 (ft)	1.4**	1.8**	2.0**	2.1**	2.2	2.1	1.6	1.0
H_{max} (ft)	1.4**	1.8**	2.0**	2.1**	2.3**	2.3	1.7	1.1

** Breaking wave.

if it were not for the fact that the wave energy which now penetrates through the structure combines with wave overtopping of the breakwater, penetration alone would probably be tolerable. The overtopping by the less-frequent storm events (e.g. 50-year storm swell) at extreme high tide elevation (+8.0 ft MLLW) produces about 3 ft of wave height in the Harbor which, when combined with the wave energy penetration through the structure, indicates approximately 4 ft of total wave transmission inside the Harbor. This indeed is excessive. However, overtopping of the high section of the breakwater occurs only during extreme storm events at high-tide elevation while penetration through the structure occurs for all wave conditions. Hence, economic considerations pertaining to cost of sealing the structure versus benefits from eliminating rare events may indicate that sealing is not a viable alternative. The amount of shoaling through the breakwater on an average annual basis appears to be minimal, so there may not be enough economic benefits derived from this aspect to justify sealing expenses.

113. The environmental situation in Redondo Beach King Harbor appears to be in a state of dynamic equilibrium with the coastal region with respect to biological and chemical constituents. The effects of warm water discharge into the Harbor by Southern California Edison Company are dissipated by effective flushing and circulation of the plume. For practical purposes, adverse effects of the discharge appear to be non-existent. This effectively complete dissipation of the warm water effluent occurs because of the ability of tidal flow to transmit through all portions of the breakwater essentially unrestricted because of the great porosity of the structure (estimated to be 0.40). Any sealing of this structure to prevent wave and shoal material penetration will also preclude tidal exchange between the open ocean and the Harbor. Tidal flow would then be restricted to the entrance channel between the north and south breakwaters. The effects of such a tidal exchange restriction on circulation and dissipation of cooling water effluent from the power plant have not been investigated at this time. A thorough evaluation of such effects will be necessary to ensure that no adverse environmental situation is created which will impede continued satisfactory tidal exchange and flushing of the Harbor. Such investigations could be performed by numerical modeling or by physical hydraulic simulation of the three-dimensional aspects of the Harbor complex.

Alternative No. 3

Extension of South Breakwater

114. A portion of the wave energy (especially locally generated sea waves up to 14-sec period) which propagates toward Redondo Beach King Harbor is presently allowed to pass through the relatively wide entrance channel to the Harbor under existing conditions and strike Mole D. Resulting runup and overtopping of the protective revetment has caused extensive damage to the parking lot and facilities situated on the Mole. An extension of the south breakwater for approximately 500 ft along its present alignment would eliminate a large part of the wave energy which is now permitted to propagate almost unrestricted through this opening (Figure 28). This blocking action, combined with the increase of crest elevation of the lower section of the north breakwater from +11.5 ft MLLW to +22.0 ft MLLW, will eliminate the predominant amount of wave energy now permitted to strike Moles C and D. The absolute magnitude of the effectiveness of this alternative can only be ascertained by performing detailed three-dimensional physical model studies. The effects of such a south breakwater extension on circulation and tidal flushing can also be investigated in such a model. Certain aspects of the circulation and flushing ramifications may be researched by numerical simulation modeling of the Harbor.

Alternative No. 4

Baffle Construction at Basin 3

115. In 1975 the US Army Engineer District, Los Angeles, recommended the construction of three prestressed concrete groins (baffles) at the entrance to Basins 1 and 2 to reduce excessive wave activity in those basins. These groins have significantly reduced such wave activity, when consideration is given to the fact that they operate in conjunction with the raised breakwater crest elevation (from +14.0 ft MLLW to +22.0 ft MLLW) which is presently at elevation +20.0 ft MLLW. The combination of these two factors has limited the surge and wave activity in these basins to acceptable levels.

116. During the storms of 1982-1983, significant damage occurred to Moles C and D, and in Basin 3 due to lack of protection by the +11.5 ft MLLW section of breakwater and without the benefit of baffles at the entrance to Basin 3 (Figure 29). Because of the proven effectiveness of the baffles at the

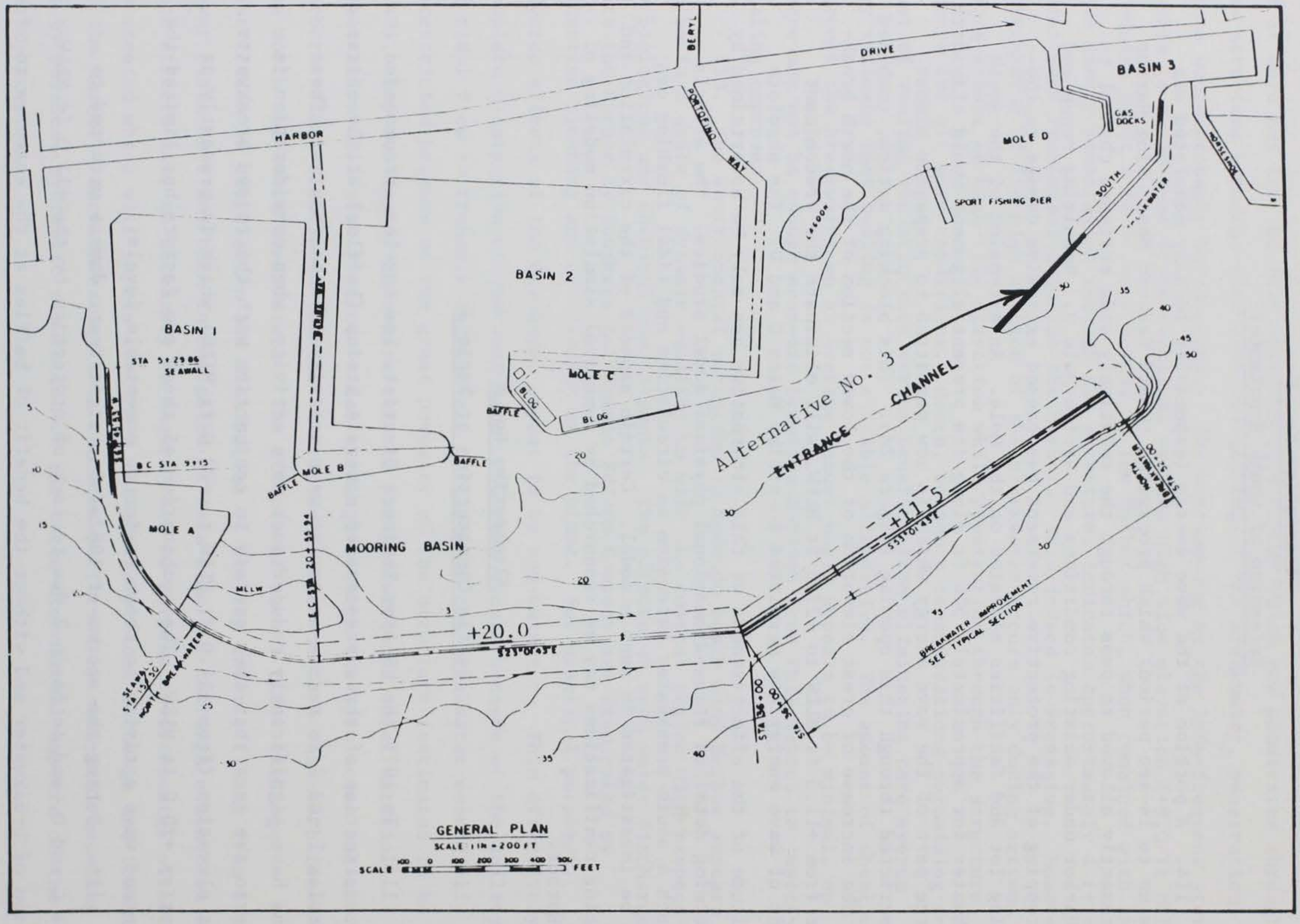


Figure 28. Location of proposed extension of south breakwater, Redondo Beach King Harbor, California

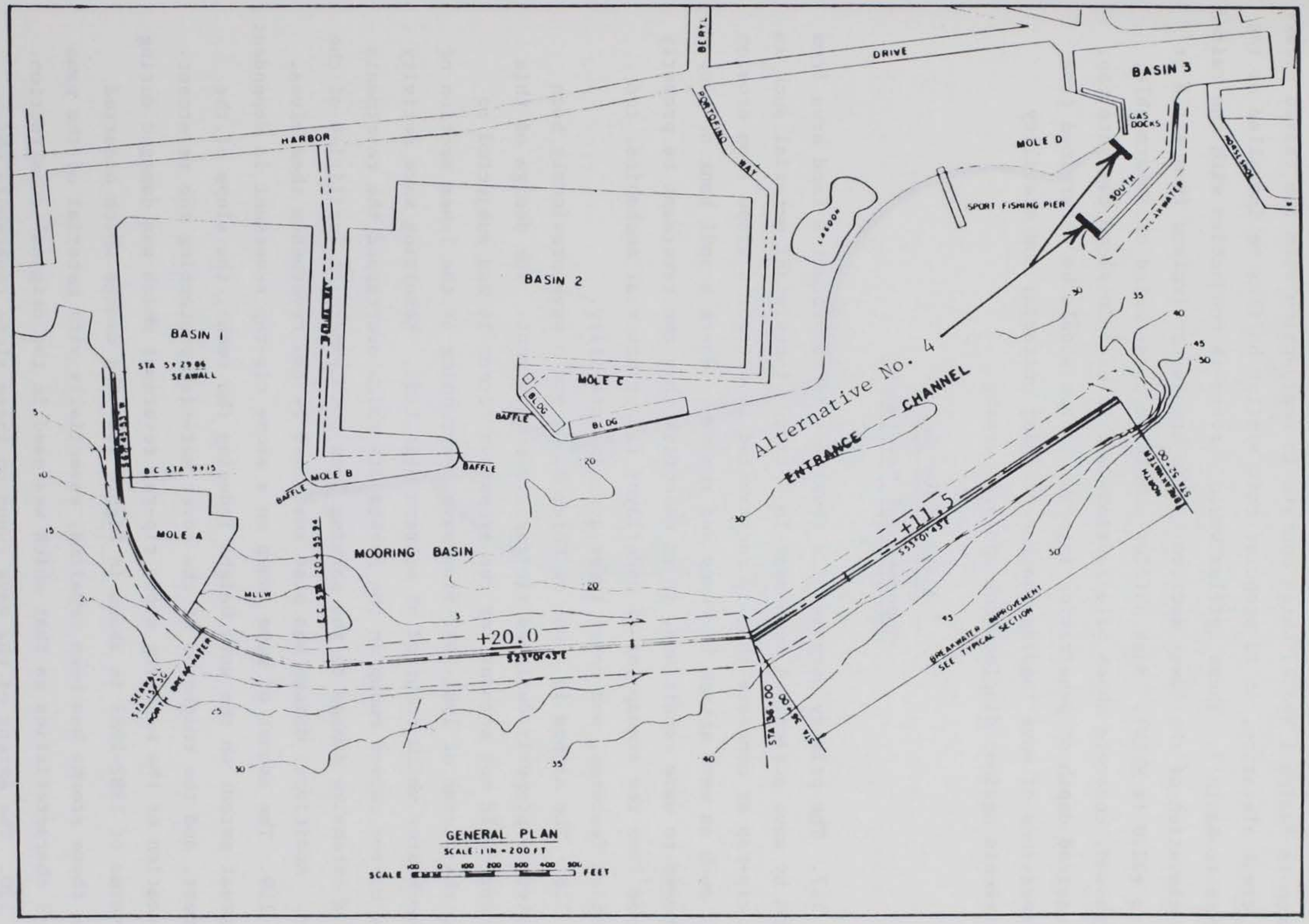


Figure 29. Location of proposed baffles at entrance to Basin 3, Redondo Beach King Harbor, California

entrance to Basins 1 and 2, which operate in conjunction with the raised breakwater crest elevation, it is proposed that similar baffles be installed at the entrance to Basin 3. These baffles would perform in conjuction with the raised crest elevation of the lower section of the breakwater (raised from +11.5 ft MLLW to +22.0 ft MLLW). Such baffles should be constructed of impermeable, prestressed, concrete sheet pile sections with a cast-in-place concrete cap. The required depth of penetration into the bottom should be determined from considerations of wave loading, Harbor dredging criteria, and stability requirements against displacement and overturning.

Alternative No. 5

Supplemental Revetments

117. The primary purpose of a revetment is to protect a land area from erosion by wave action. A revetment is a layer of resistant material such as stone rip-rap or concrete that is constructed to protect a slope from erosion forces such as wave attack by runup and rundown. Where a soil bank or slope is exposed to wave conditions, it is essential that the revetment be properly designed from the standpoint of underlayer filter material mechanics, toe protection features, and cover layer armoring stability.

118. The slopes in front of Moles B, C, and D have previously been protected by properly designed rip-rap stone revetment. The design of this revetment could not account for the excessive forces it was subjected to during the storms of 1982-1983 from wave overtopping of the lower section of the breakwater which occurred at extreme high tide. Resulting wave activity in the Harbor caused runup on the revetments which overtopped the revetments and did extensive damage to the parking lots and commercial facilities of the region. Additional damage was also sustained by the revetments themselves.

119. The amount of wave runup on a stone rip-rap revetment is dependent to a great extent on the wave height inducing the runup, the slope of the revetment, and the roughness of the cover material protecting the revetment. The location of the existing stone rip-rap revetment which was damaged during the storms of 1982-1983 is shown in Figure 30. The damage which occurred during those storms has been repaired, essentially with material of the same general characteristics as that which was used in the original construction.

120. The extent of the wave runup on these slope revetments which

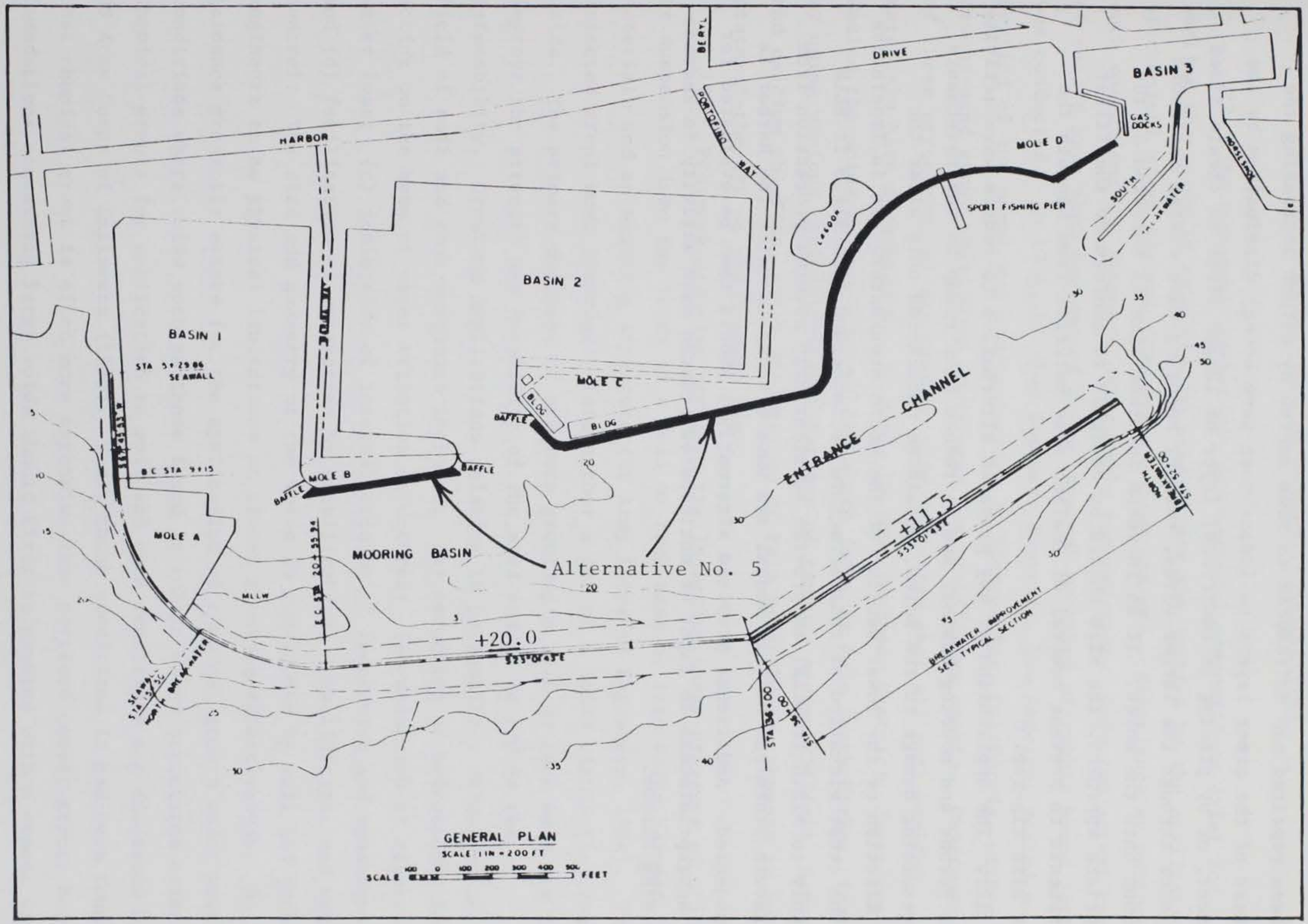


Figure 30. Location of proposed slope revetment modifications, Redondo Beach King Harbor, California

have been repaired can be reduced to some degree by either increasing the thickness of the armor layers to induce more wave energy dissipation by the revetment, or by placing an additional layer of larger stone to create added turbulence through the larger voids, thereby reducing wave energy available for runup onto the moles. If an increase in stone size is selected as the appropriate approach, the size should be designed to conform to the filter requirements to prevent removal of smaller size material from beneath the larger size rip-rap.

121. The application of any proposed alternative to reduce wave activity in the Harbor and mooring basins, and to reduce wave runup on the revetments with resulting damage to the moles, should be considered only after the rehabilitation of the lower section of the north breakwater. It is imperative that the crest elevation of this structure be increased from +11.5 ft MLLW (probably to +22.0 ft MLLW) to provide substantially assured protection from most severe storm and average annual sea wave effects to which the Harbor is now subjected. Additional proposed alternatives should then be evaluated for their appropriateness in light of anticipated reduced wave activity in Redondo Beach King Harbor.

PART X: SEALING PERMEABLE BREAKWATERS

122. The placement technology and material compositions exist for sealing the voids in rubble mound breakwaters and jetties by the application of chemical mixes through pressure grouting systems. Experience at performing such operations is, however, practically non-existent. Only two actual cases of record have been documented where chemical grouting of rubble mound jetties was conducted. In 1958, US Army Engineer District, Los Angeles, sealed a portion of the north and middle jetties at Mission Bay, California, with a cement-sand grout containing admixtures for stabilizing agents. Observations of these structures at the present time indicates that all such sealing materials have disappeared. In 1985, US Army Engineer District, Jacksonville, sealed the voids in a portion of the south jetty at Palm Beach Harbor, Florida, by using various exploratory combinations of cement, sodium silicate, bentonite, and calcium chloride. This application at Palm Beach Harbor appears to be the state-of-the-art at the present time.

123. Pressure grouting involves the injection under pressure of a liquid or suspension into the voids of a soil or rock mass or into voids between these materials and an existing structure (US Army Corps of Engineers, 1984). The injected grout must eventually form either a gel or a solid within the treated voids. The primary purposes of pressure grouting a soil or rock mass are to improve the strength and durability of the mass and/or to reduce the permeability. Grouting applications relating to permeability reduction in the field of soil and rock mechanics includes: (a) reduction of hydrostatic forces acting on the base of water retention structures; (b) reduction of reservoir water loss; (c) inhibition of internal erosion of foundation and embankments; and (d) facilitation of excavation by stabilization, consolidation, and water control. The size and geometry of the voids is considered by soil and rock engineers to be physical limitations on cement grouting effectiveness. No guidance presently exists for the application of chemical grouts under wave conditions where voids such as those found in rubble mound structures exist. Chemical grouts for application to soil and rock conditions are discussed by US Army Corps of Engineers (1973). Under those conditions it has been found that chemical grout is often more expensive than portland cement grout; hence, foundations containing large voids should first be grouted with a cement grout. In a coastal environment, however, a cement grout may not have time to harden

prior to being dispersed by wave action. Under such conditions, a chemical grout may offer the only possibility for successful placement.

Sealing the Mission Bay Jetties

124. Construction of the Mission Bay, California, jetties was completed in 1949. Dredging of the entrance channel was completed in 1955, and the Federal project was completed in January 1959. In December 1954, it was discovered that sand from the littoral zone north of the north jetty was passing through that jetty into the entrance channel. It was apparent that this movement was taking place over the top of the core of the jetty, the core being composed of small stone impenetrable by sand. In design of the jetties, the top of the core was established at the elevation of Mean Lower Low Water (MLLW). Similar design for jetties at similarly sited harbors at Newport Beach and Port Hueneme had not resulted in such a problem after many years of service (US Army Engineer District, Los Angeles, 1958).

125. In March 1955, a contract was awarded for placement of 3,000 tons of sealing stone on the seaward slope of the north jetty within the limits of the littoral zone, allowing the waves to drive the stone into the interstices. Ninety-five percent of the stone was graded in size from 1-1/2 in to 6 inches. This measure succeeded in retarding the movement of sand, but it was later discovered that infiltration was not entirely stopped. During the preparation in 1958 for the final dredging and revetment contract of the project, it was discovered that 70,000 cu yd of shoaling material had intruded into the entrance channel northward through the middle jetty along the littoral zone, and 16,000 cu yd had passed through the north jetty in spite of placement of the sealing stone. Consequently, both jetties had to be sealed by such means as would produce a permanent and completely impervious barrier.

Materials

126. No materials were found which could be combined in a way to provide fluidity required for intrusion through existing voids and still resist erosion of water in motion during the period of solidification. It was therefore decided to drill vertical intrusion holes 14 ft deep from the top of the jetty to the core, through which grout could be introduced through an inserted nozzle. As the drill to be used for this purpose would have to drop through voids and encounter wiggling and sloping surfaces, the success of rotary

drilling was in doubt. Contractors familiar with the use of various drilling systems generally indicated their belief that the holes could be made with percussion drills (Loudon, 1960).

127. After an investigation of the properties of asphalt mixtures, it was decided that cement-sand grout with those admixtures necessary to produce the required characteristics would be the most practical sealing material. The grout would need to be repellant to water and cohesive, with as little internal friction as possible; it would have to migrate freely at low pressures with no tendency to pack, as no pressure other than gravity head could be maintained, and it should pass freely through short runs of pipe or hose less than 2 in in diameter at pressures below 200 psi in order that the rate of intrusion through a small hole should be as great as possible. It was reasoned that large masses of grout placed in short periods of time would suffer the minimal erosion by surging water.

128. P-95 drilling clay, said by the refiner to be the micaceous fraction of illite, mined at Muroc Dry Lake, California, was selected as the stabilizing admixture to be used in the grout because it produced a harder concrete than the other clays. Hardness, more than strength, was desired because the concrete barrier would be exposed to sea action in places and there would be some abrasive effect upon surfaces exposed to sand particles in the attacking waves. Mojave clay, similar to P-95, was also used in the final construction. Both Mojave Clay and P-95 are derived from illite. The illite clays were used only because of availability and suitability. Clays used for this purpose should be highly plastic and should homogenize readily in mixtures.

Construction Techniques

129. In April 1959, a contract was awarded for sealing 880 ft of the middle jetty and 1,000 ft of the north jetty. Specifications were prepared on the basis of what had been learned during an experimental construction effort at the middle jetty where 400 cu yd of grout were placed. Procedures in the final construction differed little from those on the experimental construction, although the equipment used was superior.

130. Equipment and Procedures: A batching and mixing plant expecially for the job was built by the contractor. The mixer consisted of twin 1/2-yd plaster mixers discharging into a shallow hopper, mounted directly underneath, which funneled the grout into a valveless rotary-stator positive action pump. The assembly was mounted on a car which ran on a railway constructed on the

jetty top. Likewise, an endless belt elevator mounted on railway tracks, elevated the dry ingedrients of the grout into the mixer as they were placed at the lower end of the belt by hand. A sand hopper, also mounted on a car, ran back and forth from the beach to the elevator. Rotary gates released sand into a measuring vessel, swung on trunions, which fed the sand onto the belt directly from the bags. The discharge end of the elevator could be continuously charged and discharged. A mine air hoist was rigged at the land end of the rails and, with a closed loop rope through a snatch block placed at the sea end of the rails, moved the mixer and percussion drill as needed, and also shuttled the sand hopper from the stockpile to the mixer. The percussion drill was mounted on a car which ran on the rails, and 2-1/2-in detachable silicon carbide bits were used. Spalls and loose rock, encountered in the drilling, sometimes hampered the work and some holes had to be abandoned and relocated.

131. Mixing and Placing: The grout was mixed at the point of deposition and was not pumped farther than 25 ft to the nozzle. This method allowed the grout to be severely stiffened by reduction water whenever large openings to the outside of the jetty were encountered. The nozzle consisted of 1-1/2-in rigid pipe. The holes were drilled much truer on this effort than was done on the experimental work, so it was never necessary to use a flexible nozzle. Batching measurements were made volumetrically. Sand was measured by a calibrated steel vessel under the hopper, and water by a meter installed at the mixer. Cement and clay were delivered in sacks. In the reaches of the jetties opposite beaches above MLLW, as much as a foot of sand was found to be stacked on top of the jetty core. This sand was removed at each hole by flushing with sea water at high pressure. Drill holes were spaced 8 ft apart along the centerlines of the jetties.

Long Term Evaluation

132. In the few months following the sealing construction at Mission Bay, it was believed the procedure was totally successful. Surveys through November 1959 indicated no further incursion of sand. Surveys as well as visual inspection showed that a shoal of sand along the channel-side toe of the north jetty, much in evidence before sealing, had disappeared since the supply of intruding sand had been cut off. Wave action and tidal currents had carried this surplus sand to the channel slopes in deeper water.

133. In recent years, sand has resumed migration through the north and middle jetties into the navigation channel. Periodic maintenance dredging is

again required because any shoaling in the outer entrance channel results in nuisance and hazards to the navigation of small craft because shoals cause chaotic and breaking waves. It cost approximately $45 per linear foot of structure utilizing approximately 1.06 cu yd of grout per linear foot of structure, and the average spacing of the drill holes was actually 6.3 ft. If the shoaling had been permanently prevented or even reduced to minor quantities, the cost of sealing the jetties would have been justified. Because of the required periodic maintenance dredging at Mission Bay entrance channel at the present time, consideration should again be given to the possibility of sealing the permeable jetties with current state-of-the-art chemical grouts which are believed to be far superior to the cement-sand grout previously utlized at this location.

Sealing the Palm Beach Harbor Jetty

134. A major concern regarding the Palm Beach Harbor Jetties in 1984 was the passage of sand through the south jetty into the navigation channel. Since 1978, a shoal had built up each year inside the south jetty. The shoal was relatively small in quantity, about 25,000 cu yd, but very restrictive to the deep draft vessels using the Harbor. Usually each year the shoal built up to a depth of about 30 ft, about 5 ft less than the authorized 35 ft depth. This resulted in Harbor users being forced to light-load vessels with resulting increased cost. Because of the relatively small volume of dredging involved, the cost of removing the shoal each year was relatively high, about $13.60 per cu yd. The recommended plan provided for making 1,300 ft of the south jetty impervious to the movement of sand, and to restore structural stability to a damaged section of the jetty in the vicinity of Station 55+00. The seaward limit of the work would extend to the vicinity of the toe of the active beach profile in the vicinity of Station 44+50. The landward limit would extend to Station 57+50 which is just west of the section of jetty where settling had occurred. Two alternatives were evaluated for sand sealing the jetty.

Alternative A

135. This alternative provided for sand tightening the considered section of jetty by the provisions of a rubble filter protected with armor stone. Because of the shallower depths and slower velocities, the work would be accomplished on the south side of the structure. The section would be

comprised of blanket stone adjacent to the existing structure, a filter layer overlayed with another layer of blanket stone, then a single layer of armor stone. The work would require the placement of about 7,400 tons of filter stone, 14,300 tons of blanket stone, and 13,000 tons of armor stone. The initial cost of the work would be about $3.1 million.

Alternative B

136. This alternative provided for injecting the jetty with silicate grout between Stations 57+50 and 47+00, and the construction of the previously mentioned rubble section seaward of Station 47+00 to Station 44+50. For the purposes of evaluating the cost effectiveness of this alternative, two types of grout were selected and a ratio of 43.2 lb of sodium silicate to 10.2 lb of sodium aluminate per cu ft of sand-filled voids were used. Variation of the percent of silicate and catalyst to achieve a desired result does not significantly affect cost of the grout.

137. Type 1 was a mixture of sodium silicate and sodium aluminate. Type 2 was a mixture of sodium silicate, sodium aluminate, water, and cement. The grout would be mixed with or injected into the sand. It was not proposed to inject the outer 300 ft with grout because the deeper water in that area permits higher waves to act on the structure. The method of operation would be to bore through the center of the structure to depths as great as -20 ft Mean Low Water (MLW), to allow the placing of a 2.5-in casing. To assure the formation of a barrier of grout, the holes would be bored a maximum of 3 ft apart. The grout would be pumped into the structure by one of two methods:

a. A 1-in pipe would be placed in the casing. Then, as a sand/water solution was pumped in to fill all voids prior to injection of the silicate, the casing would be pulled out. The silicate grout would then be injected into the jetty via the 1-in pipe.

b. Existing sand would be washed from the jetty by water pumped through the casings. If the Type 1 grout were used, a water/sand mixture would be pumped into the jetty where it would be mixed with the silicate grout. As the jetty filled, the casing would be removed. If the Type 2 grout option were used, the silicate grout water/cement mixture would be pumped into the jetty, and the casing removed as the jetty filled.

138. Since the jetty landward of Station 53+50 was at that time mostly filled with sand, method "a" would be applied for grouting this reach of the jetty. Seaward of Station 53+50, method "b" would be applied. In the

calculations, 40 percent voids were assumed for the sand which filled the voids of the jetty. The estimated cost of Alternative B was either $1.8 million or $1.9 million, depending on whether Type 2 or Type 1 grouting was utilized, respectively.

The Recommended Plan

139. The most economically efficient method of sand sealing the considered jetty would be to inject the structure with a chemical grout. However, there were no known examples of using grouts in this type of environment and application. At Mission Bay, California, the jetties were made sand tight using a similar procedure. In that work, however, the jetties were injected with grout only to about mean lower low water, a distance of about 14 feet. Consequently, the success of the grouting of the outer reach of the south jetty at West Palm Beach Harbor, which is exposed to significant wave action and must be injected to elevations of up to -20 ft MLW, could not be assured. Similarly, it was reasonable to expect that the shoreward section of the jetty, which is exposed to relatively minor wave action and must be injected to elevations of only -10 ft MLW or less, could be made sand tight by the use of chemical grouts.

140. Accordingly, based on the lack of performance data, the selected plan provided for injecting the jetty with chemical grout from Station 57+50 to the shoreline at about Station 53+00, thence to Station 49+50, and for the provisions of a rubble filter on the south side of the structure from Station 49+50 to Station 44+50. Injection of grout in the 350-ft section of the jetty seaward of Station 53+00 would provide experience in the use of the procedure in a moderate wave environment with minimal risk. The initial cost of the recommended plan would be about $2.2 million. This was an increase of at least $300,000 over the plan which utilized chemical grouting for all aspects of the rehabilitation, because design guidance did not exist for the application of chemical grouts in such an extreme environment.

141. The estimated chemical grout quantities reflected a 6-ft-wide barrier of grout extending from about MLW to depths up to -10 ft MLW. However, it is important to note that to make the structure impervious to the movement of sand, only a relatively narrow barrier need be provided. By utilizing holes drilled every 3 ft along the considered section of the structure, such a barrier would be assured. To assure success, this type work must be performed by experienced personnel (US Army Engineer District, Jacksonville, 1984).

Contract Specifications

142. After formulation of the recommended plan, but prior to the award of the construction contract, certain modifications were developed regarding the actual placement of the grouting materials. Preliminary investigations revealed that many of the void areas between the rubble stone comprising the jetty had filled with sand, and indeed this sand was continually passing through the jetty into the navigation channel. Hence, the non-stone regions of the jetty below the sand fillet elevation but above the design bottom grade elevation of the jetty were not actually voids but were previous voids which had filled with sand. Therefore, it would be necessary to stabilize that sand which was presently filling many of the voids, and to both fill and stabilize those portions of the jetty which were actually void of all materials.

143. A contract for sealing the permeable south jetty at Palm Beach Harbor, Florida, was awarded to Clarmac Marine Construction Company, Clearwater, Florida, on 5 March 1985. The subcontractor for Clarmac Marine was W. G. Jaques Company, Des Moines, Iowa, who actually performed the drilling and grouting requirements of the contract for: (a) filling the actual void areas of the jetty with cement-sand grout; and (b) chemically grouting the sand which was filling portions of the non-void areas. The cement-sand grout would be composed of cement, sand, water, bentonite, and calcium chloride. The chemical grout would consist of water, sodium silicate, appropriate reactants, and accelerators. The intent of the design was to stabilize a zone through the jetty 6-ft wide extending to prescribed depths down to a much as -10 ft MLW below the upper surface of the jetty.

144. The contract specifications required drilling 3-1/2-in diameter holes vertically, in a single line, at 5-ft centers, until sand was encountered below the bottom elevation of the structure. Approximate elevations for drilling varied from 12 ft to 20 ft deep holes. All voids encountered prior to reaching the bottom of the structure were to be filled with cement-sand grout. An injection pipe was to be inserted into the lower limits of the voids and withdrawn in 1-ft increments as the cement-sand grout was injected. The estimated amount of grout, in order to achieve a 6-ft wide curtain, was 18 cu ft per each rise of 1-ft in the pipe. It was understood that this estimated quantity per linear foot would vary due to various sizes of voids expected to be encountered. The need to adjust the mix design to a quicker set and less flowability would be necessary to construct the 6-ft wide curtain in

certain areas.

145. After cement-sand grouting of the void areas had been completed and the grout had stabilized, chemical grouting of the sands which filled the remaining previously void areas of the jetty would be performed. Redrilling holes through previous cement-sand grout placement would be performed until sand was encountered below the bottom design elevation of the jetty. An injection pipe would be lowered to the specified bottom limits of the hole, and the chemical grout placed. An estimated quantity of chemical grout to be injected was 12 cu ft for each linear foot of sand-filled region surrounding the grout hole. When the chemical grouting had been completed the drilled holes would be backfilled with cement-sand grout to the top elevation of the Palm Beach Harbor, Florida, south jetty.

Construction Operations

146. The contractor initiated construction operations by applying the contract specified cement-sand grout mix in the voids. After pumping 18 cu ft of grout in three holes, apparently no grout remained in place as the water on the inlet side of the jetty was clouded with a plume from grout material dispersion. The amount of bentonite in the cement-sand grout was varied to produce a thicker mix that would have less flowability. After 2,044 cu ft of grout had been pumped, it appeared perhaps only 10 percent effectiveness was being achieved.

147. At this time the contractor suggested a mix using cement and silicate only, which he claimed from experience of past usage would accomplish the desired results. Three holes were tried and results were very effectively achieved. A contract modification was issued, after successful negotiations, which changed the mix of cement-sand grout to a cement-silicate mix.

148. During progress of the work it was found that in some areas where no voids were encountered, the grout that was being placed would not build up. Investigation of this condition revealed that grout was actually flowing into voids which were not shown when drilled, even with variations in the mix. Probing of holes on each side of the apparent unfillable holes found that the grout was flowing in both directions with a small build up in the adjacent holes. Therefore, in order to meet the required criteria of the design, grout was placed in an alternate hole spacing method until the entire area formed a grout curtain sufficient to meet the requirements without filling entire unseen and unknown voids. These areas required more grout than expected; however,

this unexpected over-quantity was balanced by the need for less grout than estimated in other areas. The conclusion was that, providing no grout was entering the waterway and being lost, the apparent over-run in estimated quantity was not being wasted, but was building up in adjacent areas which then required less quantities than expected.

149. Details of the drilling and grouting procedures utilized at Palm Beach Harbor, Florida, have been documented by the US Army Corps of Engineers on-site construction inspector (Ruggeri, 1985). His conclusions include the fact that identifying of voids by drilling may not be the most effective method. Other methods should be developed for discovering such voids, else considerations of large over-runs in grout should be addressed in future contract. Since it is fair and reasonable that this type of contract be awarded as "unit prices items," some imprudent contractors could take financial advantage by gaining more profit in material and placement. However, it should be noted that the contract modification issued to change the cement-sand grout mix basically did not increase the original amount of the contract significantly since the change deleted the need for bentonite and a portion of estimated quantity of sand. It also decreased the placement cost for cement-sand grout for the holes involved. This grouting activity was completed without further problems and exploratory holes drilled with extracted samples showed the intent of the design had been achieved.

PART XI: BREAKWATER ARMOR STONE SIZE

1964 Breakwater Design

Wave Estimate

150. Rehabilitation of the Redondo Beach King Harbor breakwater in 1964 consisted of raising the crest elevation from +14.0 ft MLLW to +22.0 ft MLLW between Station 15+50 and Station 36+00. The crest elevation of this section has since deteriorated to +20.0 ft MLLW. Detailed wave studies resulting in the determination of the design wave at the breakwater were developed from hindcast wave statistics prepared in 1960 from synoptic weather charts for the 3-year period 1956-1958. Based on those data, waves coming through the Santa Barbara channel approach the Harbor site from a 6 deg sector between azimuth 282 deg and azimuth 288 deg. Although the waves from that direction were only 12 ft high, waves from the west (azimuth 260 deg to azimuth 280 deg) reached 18 ft in height. Because the westerly waves were significantly larger and have a line of approach only slightly outside the approach sector, it was believed that those waves could reach the Harbor site with only a slight decrease of wave height. The storm occurring in February 1963 showed this assumption to be good. That storm, which originated about 300 mi west of Redondo Beach, sent 17-ft waves down the Santa Barbara channel to the Harbor site. The deepwater wave from that direction (285 deg azimuth) was accordingly taken as 17 ft high with a period of 13 sec. That wave was significantly higher than any waves considered in Design Memorandum No. 1 when the breakwater was originally constructed.

Physical Model Tests

151. Design for the breakwater which was constructed prior to 1964 required cap stone with 50 percent by weight in pieces larger than 10 tons, with a minimum size of 1 ton, and for quarry-run core stone. The preliminary design criteria for the 1964 rehabilitation called for class A cap stone with 50 percent by weight in pieces larger than 13 tons (US Army Engineer District, Los Angeles, 1964).

152. Two-dimensional physical model tests for stability purposes were desired at two different scales; a fairly comprehensive experimental series at a small scale and a short series of check tests at a larger scale. An undistorted linear scale of 1-to-50 for the small-scale tests and 1-to-5 for

the large-scale tests were decided upon.

153. The gradation of the class A cap stone varied somewhat throughout the test series. In the 1-to-50-scale tests, the class A stone was initially 50 percent by weight in pieces larger than 13 tons with a maximum size of 45 tons and a minimum of 1 ton. This gradation was used for the base section (existing breakwater section) and for the proposed improvements in which the stone would be placed randomly. For proposed additions in which the cap stone would be individually placed and keyed, many more of the larger stones were used. The stone gradation used in these additions was not measured but was estimated to be about 50 percent by weight in pieces larger than 18 tons. While it was recognized by the researchers that variation of stone gradations would affect the stability of the cap stone, it was felt that the overall stability and effectiveness of the breakwater sections would not be significantly affected. In the 1-to-5-scale tests, the cap stone used for the base section was 50 percent by weight in pieces larger than 8.5 tons with a maximum of 21 tons. The class A cap stone used for the proposed additions was 50 percent by weight in pieces larger than 15 tons. The stone gradations used in the 1-to-5-scale tests were relatively close to the proposed specifications and were expected to give reliable results.

154. It was concluded from the results of the physical model tests of a non-overtopping section of breakwater that cap stone of 50 percent by weight in pieces larger than 15 tons with a density of 172 lbs/ft^3 would provide a stable crest.

Construction Specifications

155. Design criteria and construction contract specifications were based on US Army Corps of Engineers (1961). Consideration was given to the proven stability of the existing breakwater and the results of the physical model studies. These investigations determined the crest elevation of the proposed improvements should be +22.0 ft MLLW. For this crest elevation and for a still water level of +5.5 ft MLLW, some overtopping occurred for waves just slightly larger than the design wave (17 ft). This overtopping was very minor and was considered acceptable.

156. The existing cap stone extended from +14.0 ft MLLW down to -20.0 ft MLLW on the seaward slope and to -10.0 ft MLLW on the landward slope. Large cap stone, class A, was specified to be used to extend the breakwater elevation up to +22.0 ft MLLW. This cap stone was specified to have an average size of

13 tons (50 percent by weight in pieces larger than 13 tons), even though the physical model tests had shown that a 15-ton stone was the minimum which would remain stable under the design conditions. While it was realized the 13-ton cap stone was smaller than the average size stone used in the model (50 percent by weight in pieces larger than 15 tons), it was believed the stability of the proposed 1964 improvement should be comparable to that of the model sections because of the flatter seaward slope (1 on 2) to be used in the improvement (US Army Engineer District, Los Angeles, 1964).

Present Analysis

157. Developments in numerical wave hindcasting in recent years make it practical to analyze a significantly greater number of individual storm events and more years of continuous synoptic weather charts than was previously possible. This has not only extended the range of our data base, but it has also removed a large number of possibilities for human error and subjectivity. With increased meteorological and oceanographical competency regarding the physics of air-sea interactions, results of numerical hindcasting efforts now can be accepted with far greater degrees of confidence than in the recent past.

158. Recurring damage to portions of the Redondo Beach King Harbor breakwater indicate the structure is exposed to wave energy in excess of that which it was designed and constructed to withstand. While the structure is intended to be a non-overtopping breakwater, the settled crest elevation of +20.0 ft MLLW and the extreme high tide conditions of the storms of the winter of 1982-1983 permitted considerable overtopping, particularly by the higher although less frequent waves of the spectrum. These waves can be twice as high as the significant wave which the average size cover stone is designed to withstand.

159. The hindcast of the thirty extreme storm events occurring since 1900 off the coast of Southern California provide a far greater understanding of the return period of waves of specific heights than did the 3-year record used in the structure design of 1964. These data by Walker, et. al., (1984) provide the basis for estimating the wave heights associated with various recurrence intervals encompased by the period of record (84 years). From the recurrence interval versus significant wave heights for sections 34-38 (Plates 1-3), for a 50-year useful life of the rehabilitation, it appears the

design wave should be at least 20 ft. Furthermore, these data are believed to be conservative with respect to the amount of wave height reduction associated with island sheltering effects which have not been verified by prototype data at this time. The armor stone size for stability against a 20-ft-high wave attack is given by US Army Corps of Engineers, Coastal Engineering Research Center (1984) as:

$$W = \frac{w_r H^3}{K_D (w_r/w_w - 1) \cot \theta} \tag{27}$$

where

W = 50 percent by weight in pieces larger than, tons
w_r = 165 lb per cu ft, unit weight of rock
H = 20 ft, wave height
K_D = 4, coefficient of stability, dimensionless
w_w = 64 lb per cu ft, unit weight of sea water
$\cot \theta$ = 2, slope of face of rubble mound structure, dimensionless

Considering these conditions, W = 21 tons . When the cover layer is two quarrystones in thickness, the stones comprising the primary cover layer can range from about 0.75 W to 1.25 W . The gradation should be uniform across the face of the structure, with no pockets of smaller stone. The maximum weight of individual stones depends on the size or shape of the unit. The unit should not be of such a size as to extend an appreciable distance above the average level of the slope or crest.

160. The existing cover stone on the structure has an average weight of 13 tons. If the two stone sizes are considered to be shaped as cubes, then the difference in the lengths of their sides is only about 1 ft. The 13-ton stone has a nominal dimension of about 6.2 ft, while the 21-ton stone has a nominal dimension of about 7.3 ft.

PART XII: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

161. The following conclusions have been reached as a result of this study of the Redondo Beach King Harbor, California, region:

a. Extensive wave damage occurs in the Harbor by storm waves overtopping the +11.5 ft MLLW section of the breakwater.

b. Storms of the winter of 1982-1983 occurred at extreme high tide elevation (+8.0 ft MLLW), with unusually long periods (conditions for which the structure was not designed to withstand).

c. Higher waves of the spectrum overtopped the +20.0 ft MLLW section of the breakwater at extreme tide level.

d. Wave energy also penetrates through all sections of the permeable breakwater.

e. Wave energy propagating through the unrestricted entrance channel to the Harbor contributes to the damages of Moles C and D, and to the damages in Basin 3.

f. Structural damage recurs to the breakwater because the structure is under-designed with respect to the storm wave energy that it is required to withstand.

g. The 1964 design wave was based on only 3 years of hindcast wave data, producing a 1964 design wave height of 17 ft.

h. Hindcast storm wave data since 1900 indicates the design wave height for a 50-year recurrence interval should be around 20 ft.

i. Stability testing of the 17-ft design wave indicated the stone size for stability should be approximately 15 tons. The structure was actually constructed with 13-ton stone.

j. Harbor shoaling occurs because of littoral material from upcoast penetrating through the permeable breakwater.

Recommendations

162. To alleviate the extensive damages which periodically occur at Redondo Beach King Harbor, California, the following recommendations are made

which will reduce excessive wave activity and shoaling in the Harbor:

a. Raise the crest elevation of the existing +11.5 ft MLLW section of the breakwater to +22.0 ft MLLW, and effectively seal this portion of the structure during such rehabilitation work.

b. Seal the remainder of the permeable breakwater with chemical grouting materials.

c. Extend the south breakwater at least 500 ft into the Harbor.

d. Install baffles (prestressed concrete sheet pile groins) at the entrance to Basin 3.

e. Provide additional revetment material to the slopes of Moles B, C, D, and E.

163. All alternative proposals are predicated on the assumption that the crest elevation of the +11.5 ft MLLW section of the breakwater will be raised to +22.0 ft MLLW. This is the single most significant item which can be constructed to reduce the excessive wave activity in the Harbor. The armor stone for this rehabilitation work should be large enough to withstand the storm forces to which it will be subjected. After the +11.5 ft MLLW section has been raised to +22.0 ft MLLW, additional alternative measures inside the Harbor may be addressed as appropriate. Only extensive numerical and/or physical model testing will indicate the usefulness of various proposed alternatives which will operate in conjunction with the raised breakwater section.

164. Because Southern California Edison Company discharges cooling water effluents into the Harbor, sealing the breakwater to eliminate sediment intrusion and wave penetration may not be a viable alternative since tidal circulation may be altered. The environmental regime of the Harbor could be adversely affected by an interruption of the flushing action provided by tidal flow through the porous structure. Here again, extensive numerical and/or physical model evaluations will be necessary to provide definitive answers to these environmental questions.

165. Sediment sampling of the shoal material in the Harbor should be performed so petrographic and geomorphological analyses can ascertain the origin of the materials which are filling the Harbor navigation channel and boat mooring areas.

166. Two-dimensional physical model studies of the existing sections of the north breakwater (+11.5 ft MLLW crest elevation section and +20.0 ft MLLW crest elevation section) should be conducted to investigate wave transmission characteristics (penetration and overtopping). Resultant wave activity in the Harbor will be obtained from such studies. Two-dimensional stability tests of the trunk section should be conducted to optimize the cross section which will effectively reduce wave damages, flooding, and shoaling in the Harbor.

167. Three-dimensional undistorted model studies should be performed to investigate wave runup on the moles, and wave effects in the basins and Harbor entrance. This model can realistically evaluate the effects of various alternative proposals for reducing damages in the interior of the Harbor due to excessive wave action. Sediment tracer tests can be conducted to investigate sediment transport within the Harbor. Three-dimensional stability tests for obtaining the most effective cross section design of the breakwater head section should be conducted.

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APPENDIX A

STORM SWELL

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = 0.0 ft MLLW

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				10	12	15									
2 :																			11	10	12	15	15								
3 :	115	111	113	128														11	10	9	10	10	13	2[illegible]							
4 :	108	105	108	114	124	126	163											12	9	8	8	8	11	19							
5 :	102	99	103	109	114	115	126	181	17[illegible]									13	9	7	8	8	11	18	3[illegible]						
6 :	86	83	87	92	103	106	100	130	19[illegible]									13	10	8	8	9	11	13	36						
7 :	78	76	86	92	96	99	93	112	152								20	14	10	9	8	9	11	13	37	7[illegible]					
8 :	78	71	78	83	87	91	90	103	133							35	22	16	11	10	9	10	11	14	34	65	[illegible]				
9 :	73	71	78	82	86	91	89	97	120						68	39	25	18	12	11	10	10	12	16	35	57	89	[illegible]			
10 :	70	68	73	76	80	82	87	92	108	124	124	126	124	106	75	43	28	20	14	12	11	11	13	19	32	51	81	119			
11 :	71	68	69	76	78	81	85	91	102	108	115	120	120	108	81	49	31	22	16	13	12	12	15	20	32	47	75	110	139		
12 :	69	65	69	72	75	79	83	89	97	103	109	114	118	110	86	55	34	25	18	14	13	13	16	21	34	46	73	111	140	119	
13 :	69	65	69	71	73	78	81	87	94	101	105	109	114	110	91	61	38	28	20	15	15	15	17	24	34	47	67	97	126	149	170
14 :	68	63	66	68	72	76	79	84	92	98	102	105	110	108	95	68	42	31	22	17	16	16	18	26	36	47	66	89	111	136	158
15 :	68	63	66	68	71	75	79	84	91	98	99	102	107	108	98	74	47	34	25	19	18	17	20	28	37	49	65	83	103	120	155
16 :	67	62	65	66	68	72	76	81	87	93	99	99	103	105	97	77	53	37	28	22	20	19	21	30	38	49	65	83	96	116	142
17 :	68	63	63	65	68	72	76	80	85	92	97	98	102	104	98	80	57	41	31	24	23	21	23	31	39	50	67	85	96	104	125
18 :	69	63	63	64	68	72	76	79	83	90	94	96	99	102	99	82	59	44	34	27	25	23	25	33	40	50	67	88	99	102	117
19 :	68	62	62	63	66	70	74	76	80	86	92	95	98	101	99	83	60	46	37	29	28	26	28	34	42	51	67	88	100	99	109
20 :	69	63	62	62	65	70	74	76	79	84	89	94	97	100	100	86	63	47	39	32	31	29	30	35	42	53	68	90	102	100	98
21 :	70	64	61	61	63	68	72	74	76	81	88	94	94	96	98	88	67	49	41	35	34	31	31	37	44	53	71	93	102	97	93
22 :	70	64	61	61	63	68	72	73	74	78	85	91	92	93	95	90	72	50	41	38	37	34	33	37	44	55	74	94	102	97	92
23 :	71	64	61	60	62	66	71	73	74	77	84	91	91	91	94	92	76	53	43	41	40	37	35	38	45	57	77	96	100	94	88
24 :	72	65	61	59	61	66	70	72	73	74	81	89	91	89	91	91	79	56	45	44	43	39	37	39	45	60	79	97	100	92	87
25 :	73	66	61	59	60	64	69	73	72	73	80	87	90	88	88	91	82	59	47	47	46	42	39	40	46	61	82	99	100	91	84
26 :	74	66	61	59	60	63	68	72	71	71	77	87	90	86	85	89	83	62	51	51	49	44	41	41	47	63	83	98	99	90	83
27 :	75	67	61	59	59	62	67	71	71	69	75	85	89	85	83	86	84	65	54	54	52	47	43	43	48	65	85	98	99	90	80
28 :	77	69	62	59	59	60	65	70	71	68	72	83	88	84	82	84	82	68	59	57	54	49	45	44	50	66	87	99	97	87	79
29 :	78	71	63	59	59	60	63	68	70	67	70	81	86	84	81	81	80	70	63	60	57	51	47	46	52	69	90	99	95	86	78
30 :	79	73	65	60	60	60	62	67	69	67	69	80	85	84	81	80	79	73	67	63	59	53	49	48	53	71	92	98	92	84	77
31 :	80	75	67	61	61	61	61	65	68	67	69	78	84	85	82	79	78	75	71	66	61	56	51	50	55	73	93	97	90	83	77
32 :	80	76	69	63	63	62	62	64	67	67	70	77	84	86	84	81	79	77	74	69	63	58	53	52	57	76	93	95	89	81	77
33 :	80	77	71	66	65	64	62	63	66	68	70	76	83	87	86	84	82	80	76	71	65	60	56	53	59	78	94	94	86	79	75
34 :	79	77	73	69	69	67	64	64	65	68	71	76	82	86	87	87	86	83	79	73	68	63	58	55	62	80	93	91	84	79	74
35 :	79	77	74	72	71	69	66	65	66	68	72	77	81	86	88	90	88	85	81	76	70	65	60	57	64	82	92	88	83	77	74
36 :	80	76	75	74	73	70	67	66	66	68	72	77	82	87	89	91	90	87	83	78	72	68	63	60	66	83	91	86	81	77	74
37 :	82	76	75	76	75	72	69	67	66	68	72	77	83	88	91	93	92	89	85	80	75	70	66	62	69	83	89	85	81	77	74
38 :	84	78	77	78	77	74	70	68	67	68	71	77	83	89	93	95	94	92	87	82	77	72	68	64	71	84	88	84	79	77	74
39 :	86	80	78	80	78	75	72	69	67	68	71	76	82	88	93	96	96	93	89	84	79	75	71	67	72	83	87	83	78	76	74
40 :	87	83	80	81	80	77	74	70	68	68	70	75	82	88	93	96	97	95	92	87	81	77	73	69	74	83	87	82	78	75	74

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1939, arriving from sheltered approach direction of 224 deg azimuth, period = 14.0 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	5	8									
2 :																			4	4	5	6	6								
3 :	160	167	181	214														4	4	3	4	4	5	7							
4 :	150	157	172	189	211	211	140											5	3	3	3	3	4	7	8						
5 :	143	149	164	182	194	193	195	233	148									5	3	3	3	3	4	7	13						
6 :	119	125	138	153	177	179	158	175	210									5	4	3	3	3	4	5	13	21					
7 :	108	113	138	153	165	169	149	155	172								7	5	4	3	3	3	4	5	13	26					
8 :	108	105	124	138	150	155	145	146	156							14	8	5	5	4	3	4	4	5	13	23	31				
9 :	100	105	123	137	149	156	144	141	145						34	17	10	6	5	4	4	4	4	6	13	21	31				
10 :	95	99	114	128	138	143	143	136	132	119	89	72	64	55	38	19	11	7	5	4	4	4	5	7	12	19	28	41			
11 :	95	99	108	126	136	142	142	135	127	104	83	68	61	55	41	23	13	8	6	5	4	4	5	7	13	17	27	38	50		
12 :	91	94	107	119	131	141	142	135	122	101	79	63	59	55	44	27	15	10	6	5	5	5	6	8	14	17	26	38	48	65	
13 :	91	94	107	118	129	139	140	135	121	99	76	60	55	54	46	30	17	12	7	6	5	5	6	9	14	18	24	33	43	57	85
14 :	88	90	101	113	127	138	139	134	120	98	74	57	52	52	48	34	20	14	8	6	6	6	7	10	15	19	24	30	38	51	78
15 :	88	90	101	112	125	137	143	137	122	99	72	54	49	50	48	37	23	16	10	7	7	6	7	12	15	20	23	28	35	46	77
16 :	86	87	99	107	120	133	140	135	119	95	71	52	46	47	47	39	26	18	12	8	7	7	8	13	16	20	23	28	33	48	71
17 :	86	86	95	106	120	134	141	137	120	95	70	51	45	46	46	40	28	20	14	9	8	8	9	14	17	21	24	28	34	45	67
18 :	86	86	94	105	119	135	143	139	121	95	68	49	42	43	45	40	30	21	16	11	10	9	10	15	18	21	24	29	37	42	73
19 :	84	84	90	100	115	132	141	137	118	92	67	48	41	42	44	40	30	22	17	13	11	10	11	16	19	22	24	29	39	44	72
20 :	84	83	89	99	114	132	143	139	120	92	64	47	39	40	43	40	31	23	19	14	12	11	13	16	20	23	24	31	41	48	64
21 :	84	83	86	95	111	129	142	139	119	89	63	46	37	37	41	40	33	24	19	16	14	12	13	18	21	23	25	33	41	49	62
22 :	84	83	85	94	110	129	144	139	118	87	60	44	36	35	38	40	35	24	20	17	15	14	15	18	22	24	27	34	42	51	63
23 :	82	80	84	91	106	127	143	142	120	87	58	42	35	34	37	40	36	26	20	18	17	15	16	19	22	25	28	35	43	53	65
24 :	82	80	81	89	105	126	142	143	120	84	55	40	35	32	34	38	36	27	21	19	19	17	17	19	23	26	29	36	45	56	67
25 :	81	79	79	86	102	123	143	147	123	84	53	39	33	31	32	37	37	28	21	21	20	18	18	20	23	27	30	37	48	58	68
26 :	80	77	77	84	99	121	142	148	123	82	51	38	33	30	30	35	36	28	22	22	22	20	19	21	24	28	31	38	52	61	68
27 :	79	76	75	81	97	118	141	149	124	80	48	36	32	29	29	33	35	29	24	24	23	21	21	22	25	28	31	41	56	63	66
28 :	79	76	74	78	94	114	139	149	125	78	45	35	31	29	28	31	33	29	25	25	25	23	22	23	26	29	33	45	58	63	67
29 :	78	75	71	75	90	112	136	147	125	77	42	34	30	28	27	29	31	29	27	27	26	24	23	24	26	29	36	48	59	64	67
30 :	77	74	70	72	87	109	135	146	124	77	41	32	29	28	27	28	30	29	28	28	28	25	24	25	27	30	39	50	60	65	67
31 :	76	74	68	69	84	108	133	143	123	77	41	31	28	27	26	26	28	29	30	30	29	27	25	26	28	31	41	53	61	66	67
32 :	75	73	67	67	82	106	132	143	122	78	41	29	27	27	26	26	28	30	31	31	30	28	26	28	29	32	43	55	62	65	67
33 :	74	72	66	65	80	105	132	143	123	79	42	29	26	26	27	26	28	30	32	32	31	29	28	29	29	34	47	56	61	65	67
34 :	73	71	64	64	79	104	132	143	124	81	44	28	25	26	27	27	29	31	33	34	33	31	29	30	30	37	49	56	62	66	66
35 :	71	70	63	64	77	102	132	146	127	84	45	28	25	26	27	28	29	32	33	35	34	32	31	31	31	40	50	57	63	66	66
36 :	71	68	62	64	75	99	131	148	131	87	47	29	25	26	27	28	30	33	34	36	35	34	33	32	33	42	51	57	63	67	66
37 :	71	66	62	64	74	96	128	149	135	91	49	29	25	26	27	29	31	33	35	37	37	35	34	34	35	44	51	58	65	67	65
38 :	70	66	62	64	72	92	125	150	141	96	51	30	26	26	28	30	32	34	36	38	38	37	36	35	37	45	52	59	65	67	64
39 :	70	66	63	65	71	88	120	150	145	103	53	30	26	27	28	30	33	35	37	39	40	38	38	37	38	45	53	60	65	66	63
40 :	69	66	64	65	71	85	115	148	150	110	57	31	26	27	29	31	33	36	39	41	41	40	40	39	40	47	55	61	64	65	63

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1958, arriving from sheltered approach direction of 268 deg azimuth, period = 17.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	4	5									
2 :																			4	3	4	5	5								
3 :	154	126	103	93														4	3	3	3	3	4	8							
4 :	144	118	97	81	71	60	70											4	3	3	3	3	4	6							
5 :	137	111	92	77	64	54	51	76	110									5	3	2	2	3	4	6	12						
6 :	115	93	77	64	58	49	40	50	78									5	3	3	3	3	3	5	12						
7 :	105	84	76	64	53	45	37	42	59								6	5	4	3	3	3	3	5	12	23					
8 :	105	78	69	57	47	41	35	38	51							12	7	5	4	3	3	3	3	5	12	21					
9 :	98	78	68	56	47	40	35	36	45						29	14	8	6	4	3	3	3	4	5	12	19	28				
10 :	94	75	63	52	43	36	34	34	40	48	51	57	59	51	34	16	10	6	5	4	3	4	4	6	11	17	26	38			
11 :	95	75	60	51	42	36	33	33	37	40	46	53	56	53	38	19	11	7	6	4	4	4	5	6	11	16	25	35	46		
12 :	93	72	60	48	40	35	32	32	35	38	43	49	54	53	41	23	13	9	6	5	4	4	5	7	12	16	24	35	45	62	
13 :	93	72	60	48	39	34	31	31	33	36	40	45	52	53	44	27	15	10	7	5	5	5	6	8	13	17	22	31	40	54	81
14 :	92	70	57	46	38	33	30	30	32	35	38	43	49	51	46	32	18	12	8	6	5	5	6	9	13	17	22	28	36	48	74
15 :	93	71	57	45	37	32	30	30	31	34	36	40	46	50	48	36	21	14	9	7	6	6	7	11	14	18	21	26	33	44	73
16 :	92	69	57	44	35	31	29	29	30	32	35	38	43	48	46	37	25	16	11	8	7	6	7	12	15	19	22	26	31	46	68
17 :	94	71	55	43	35	31	29	28	29	31	34	37	42	47	46	39	27	19	13	9	8	7	8	12	16	19	22	26	32	43	65
18 :	96	72	56	43	35	31	29	28	28	31	33	35	40	44	46	40	28	20	15	10	9	8	9	14	17	20	23	27	35	40	70
19 :	96	71	54	42	34	30	28	27	27	29	32	34	38	43	45	40	29	22	17	12	10	9	10	14	18	20	23	27	38	42	69
20 :	98	73	55	42	34	30	28	27	26	28	30	34	37	42	45	41	30	22	18	13	11	10	11	15	19	21	23	29	39	46	61
21 :	100	75	54	41	33	29	27	26	25	27	30	33	35	39	43	41	32	23	19	15	12	11	12	16	20	22	24	31	40	48	60
22 :	102	76	55	41	33	29	28	25	25	25	28	32	34	37	41	42	35	24	19	16	14	13	13	17	20	22	25	32	41	50	61
23 :	103	76	56	41	33	29	27	25	24	25	28	31	33	35	39	42	36	25	19	17	16	14	15	17	21	23	26	33	42	52	62
24 :	107	79	56	41	33	29	26	25	24	24	26	30	33	33	37	41	37	26	20	18	17	15	16	18	21	25	27	35	44	54	63
25 :	109	80	56	41	33	28	26	25	24	23	26	29	32	32	35	40	38	28	21	20	19	17	17	19	22	25	29	36	47	56	64
26 :	112	83	57	41	33	28	26	25	23	22	25	29	32	31	33	38	38	29	22	22	20	18	18	19	22	26	29	37	51	59	64
27 :	116	86	59	42	33	28	25	25	23	22	24	28	31	31	31	35	37	30	23	23	22	19	19	20	23	27	30	40	55	61	62
28 :	121	90	61	43	33	27	25	24	23	21	22	27	30	30	30	33	35	30	25	25	23	21	20	21	24	27	32	44	56	61	62
29 :	125	95	64	44	34	27	24	23	23	21	21	26	29	29	29	31	33	30	27	26	25	22	21	22	25	28	34	47	58	61	61
30 :	129	102	68	45	35	27	23	23	22	20	21	25	29	29	29	30	32	30	28	28	26	23	22	24	26	29	37	49	59	62	60
31 :	131	108	73	48	37	28	23	22	22	20	20	24	27	28	28	28	30	31	30	29	27	25	23	25	27	30	40	52	59	62	60
32 :	133	114	80	52	39	29	22	21	21	20	20	23	26	28	28	27	29	31	31	30	29	26	24	26	27	31	42	54	60	60	60
33 :	133	119	88	57	43	30	23	21	21	20	20	22	25	28	28	28	29	31	32	32	30	27	26	27	28	33	46	55	59	60	58
34 :	132	122	95	64	48	32	23	21	20	20	21	22	25	27	28	28	30	32	33	33	31	29	27	28	29	36	48	55	59	60	57
35 :	131	123	100	73	53	35	25	21	20	20	21	22	24	27	28	29	31	33	34	34	32	30	29	29	30	39	49	55	59	59	56
36 :	130	122	104	81	59	39	26	22	20	20	21	22	24	26	28	30	31	33	35	35	34	31	30	31	32	41	50	55	59	59	55
37 :	130	120	105	89	66	43	28	23	21	20	21	22	24	26	28	30	32	34	36	36	35	33	32	32	34	43	50	56	59	58	54
38 :	128	120	108	96	74	48	31	24	21	21	21	22	24	27	29	31	33	35	37	37	37	34	34	33	36	43	51	56	59	57	51
39 :	127	120	111	102	81	54	34	25	22	21	21	23	25	27	29	32	34	36	38	39	38	36	35	35	37	44	52	56	58	55	50
40 :	124	120	113	108	89	61	38	27	23	21	21	23	25	27	30	32	34	37	39	40	39	37	37	37	38	45	53	57	56	53	49

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1983, arriving from sheltered approach direction of 253 deg azimuth, period = 18.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				7	9	10									
2 :																			8	7	9	10	10								
3 :	166	165	172	199														8	7	6	7	7	9	14							
4 :	156	156	163	175	194	198	146											8	6	6	5	6	8	13							
5 :	148	148	156	168	178	180	190	242	120									8	6	5	5	6	8	12	25						
6 :	125	124	131	141	162	167	153	182	235									9	7	6	5	6	8	10	24						
7 :	113	113	131	141	150	157	144	161	192								15	10	7	6	6	6	7	9	25	46					
8 :	114	105	118	127	136	143	140	151	174							29	17	11	8	7	6	7	8	10	23	42					
9 :	106	105	117	126	135	144	139	145	162						62	34	19	13	8	7	7	7	8	11	24	37	54				
10 :	101	100	109	117	125	131	138	140	148	146	120	104	96	87	66	38	21	15	9	8	7	8	9	13	22	34	49	70			
11 :	102	100	103	116	123	130	136	139	142	129	113	98	91	85	69	43	24	17	11	9	8	8	10	14	22	31	46	65	83		
12 :	98	96	103	109	118	128	135	139	137	125	109	93	87	84	72	48	28	19	13	10	9	9	11	14	24	31	45	65	80	106	
13 :	99	96	102	108	115	126	133	138	135	123	105	89	83	81	73	53	31	22	15	11	10	10	12	17	24	32	42	56	73	92	127
14 :	96	93	98	103	113	124	132	137	134	122	103	86	79	78	73	57	35	24	17	12	11	11	13	19	26	32	41	51	64	84	118
15 :	97	93	98	102	111	123	134	139	136	124	101	84	76	75	73	60	40	26	19	14	13	12	14	21	27	34	40	47	60	76	115
16 :	95	91	97	98	107	119	130	136	132	120	102	81	72	71	70	61	44	29	21	16	14	13	15	22	28	34	40	47	56	78	106
17 :	95	91	93	97	106	119	131	137	133	120	101	81	71	69	69	62	47	32	24	18	16	15	17	24	30	35	41	48	57	72	99
18 :	96	91	93	96	105	119	132	138	134	121	99	79	68	66	67	62	48	35	26	20	18	16	19	25	31	36	41	49	61	69	101
19 :	94	90	90	93	101	115	129	136	132	117	98	79	67	64	64	60	48	36	28	22	20	18	21	27	32	36	40	50	64	70	98
20 :	95	90	90	92	100	115	130	138	133	118	95	78	66	62	63	60	49	37	30	24	22	21	23	28	34	38	41	52	66	74	87
21 :	95	90	87	89	97	112	128	137	132	115	95	78	64	58	60	59	50	38	31	26	25	23	24	30	35	38	42	55	67	75	84
22 :	95	91	87	88	96	111	129	136	131	113	92	76	62	56	56	58	52	39	31	28	27	25	26	31	35	39	44	57	69	76	84
23 :	94	89	87	86	93	108	126	138	133	114	91	75	62	54	54	57	53	40	32	30	30	28	28	31	36	40	46	58	69	77	84
24 :	95	90	85	85	93	107	125	138	133	112	89	73	62	52	51	55	53	41	33	32	32	30	30	32	37	42	48	60	71	78	84
25 :	94	89	84	83	90	105	125	140	135	112	88	72	61	52	48	53	53	42	34	34	35	32	32	33	37	43	49	62	74	80	82
26 :	93	88	83	82	88	102	123	140	136	111	86	71	61	50	46	50	52	42	36	37	37	35	33	34	38	43	50	63	77	81	81
27 :	93	88	82	81	87	101	121	139	136	110	84	70	60	49	44	48	51	43	38	39	40	37	35	36	39	44	51	66	81	82	78
28 :	92	88	81	79	85	97	118	139	137	109	81	68	58	48	43	45	48	43	40	42	42	39	37	37	40	45	54	71	81	81	77
29 :	92	88	80	78	84	96	116	135	136	109	79	67	56	47	42	43	45	43	42	44	44	41	38	39	41	46	58	73	82	80	76
30 :	91	88	80	76	83	95	114	133	135	109	79	66	55	46	41	41	44	44	44	46	46	43	40	40	42	47	61	75	81	80	74
31 :	90	88	80	75	82	95	112	130	132	109	81	64	53	45	41	40	42	44	46	48	48	45	42	42	43	49	64	77	80	78	73
32 :	89	87	79	75	82	95	112	128	131	111	83	64	52	45	41	40	42	45	48	50	50	47	44	44	44	51	66	78	80	76	72
33 :	88	86	79	76	83	96	112	127	130	113	85	63	51	44	41	41	42	46	49	52	51	49	46	45	45	53	69	77	78	74	70
34 :	87	86	79	77	85	98	113	127	130	115	88	64	50	44	41	41	44	47	51	53	53	51	48	47	46	56	71	76	77	74	68
35 :	86	85	79	78	86	98	114	128	131	117	91	66	50	43	41	42	45	49	52	54	55	53	50	48	48	60	71	75	76	72	67
36 :	86	83	78	80	87	98	113	128	132	119	93	67	50	43	42	43	46	50	53	56	56	55	53	50	50	62	71	75	75	72	66
37 :	86	82	78	81	88	98	113	128	134	121	95	69	51	44	42	44	47	51	54	57	58	57	55	51	53	63	71	74	74	70	64
38 :	86	82	79	82	88	98	112	128	135	124	98	70	52	45	43	45	48	52	55	59	60	59	57	53	55	64	71	74	73	69	62
39 :	85	83	81	83	88	97	111	127	136	127	100	72	53	45	44	45	49	53	57	60	62	61	59	56	56	64	71	73	71	67	61
40 :	85	83	82	84	89	97	110	125	136	129	104	74	54	46	44	46	49	54	58	62	63	63	61	58	57	65	72	73	69	65	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 257 deg azimuth, period = 15.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	3									
2 :																			2	2	2	3	3								
3 :	140	106	80	65														2	1	1	2	2	2	3							
4 :	131	99	74	56	45	35	41											2	1	1	1	1	2	3							
5 :	123	92	69	52	40	31	30	45	67									2	1	1	1	1	2	3	5						
6 :	103	76	57	43	35	28	23	30	47									2	1	1	1	1	2	2	5	[illegible]					
7 :	93	68	56	42	31	25	21	25	36								3	2	1	1	1	1	2	2	5	10					
8 :	93	63	50	37	28	23	20	22	30							4	3	2	1	1	1	1	2	2	5	9	[illegible]				
9 :	86	63	49	36	27	22	19	21	27						12	5	3	3	2	2	1	1	2	2	5	8	13	[illegible]			
10 :	82	59	45	32	24	20	19	20	23	28	29	31	31	24	15	6	4	3	2	2	1	2	2	3	5	8	12	17			
11 :	83	59	42	31	23	19	18	19	22	24	27	29	30	26	17	8	4	4	2	2	2	2	2	3	5	7	11	16	22		
12 :	80	56	41	29	21	18	18	18	20	22	25	27	29	26	19	10	5	4	3	2	2	2	2	3	5	7	11	16	21	30	
13 :	80	55	40	28	20	18	17	18	19	21	23	25	28	27	21	12	6	4	4	2	2	2	2	4	5	7	10	14	18	25	42
14 :	79	53	38	26	19	17	16	17	19	20	22	24	26	26	22	14	7	5	4	2	2	2	3	4	6	8	10	12	16	23	38
15 :	80	53	37	25	19	17	16	17	18	20	21	23	25	26	23	16	9	6	4	3	2	3	3	4	6	8	10	12	15	21	38
16 :	79	52	36	24	17	16	16	16	17	19	20	21	24	25	23	17	11	7	5	4	3	3	3	5	7	8	10	12	14	22	35
17 :	80	52	35	23	17	15	15	16	17	18	20	21	23	24	23	18	12	8	5	4	3	3	3	5	7	9	10	12	15	20	33
18 :	81	52	34	22	17	15	15	16	16	18	19	20	22	23	23	19	13	9	6	4	4	3	4	6	8	9	10	12	16	18	38
19 :	81	51	33	21	16	15	15	15	15	17	18	19	21	23	23	19	13	10	7	5	4	4	4	6	8	9	10	12	18	20	38
20 :	83	52	32	20	15	15	15	15	15	16	17	19	20	22	23	20	14	10	8	6	5	4	5	7	9	9	10	13	18	22	34
21 :	84	53	31	19	15	14	14	14	14	15	17	18	19	21	22	20	15	11	9	7	5	5	5	7	9	10	11	14	19	24	33
22 :	86	53	31	19	14	14	14	14	14	15	16	18	18	19	21	20	16	11	9	7	6	5	6	8	9	10	12	15	19	25	35
23 :	87	53	30	18	14	13	14	14	14	14	16	17	18	18	20	21	17	12	9	8	7	6	6	8	9	11	12	15	20	27	37
24 :	91	54	29	17	13	13	14	14	13	14	15	17	18	17	19	20	18	12	9	8	7	7	7	8	10	11	13	16	21	29	38
25 :	94	55	29	17	13	13	13	14	13	13	15	16	17	17	18	20	18	13	10	9	8	7	7	8	10	12	13	16	23	30	40
26 :	98	56	29	16	13	12	13	14	13	13	14	16	17	16	17	19	19	13	10	10	9	8	8	9	10	12	14	17	25	33	40
27 :	103	58	29	16	13	12	13	14	13	12	14	16	17	16	16	18	18	14	11	10	10	8	8	9	11	13	14	18	28	35	40
28 :	110	62	30	16	13	12	12	13	13	12	13	15	16	16	15	16	17	14	12	11	10	9	9	10	11	13	15	21	30	36	41
29 :	118	67	31	16	13	11	12	13	13	12	12	15	16	15	15	15	16	14	12	12	11	10	9	10	12	13	16	23	31	37	42
30 :	126	75	33	16	13	11	11	13	13	12	12	14	16	15	15	15	16	15	13	12	12	10	10	11	12	14	18	24	33	39	42
31 :	134	84	36	17	13	11	11	12	12	12	11	14	15	15	14	14	14	14	14	13	12	11	10	12	13	14	19	26	34	40	43
32 :	141	94	42	18	14	11	10	11	12	12	11	13	14	15	14	13	14	14	14	14	13	12	11	12	13	15	20	29	35	40	44
33 :	147	105	51	20	16	11	10	11	12	12	11	13	14	15	14	13	14	14	15	14	14	12	12	13	14	16	23	30	36	41	44
34 :	151	115	62	24	18	11	10	11	11	12	12	12	14	15	15	14	14	15	15	15	14	13	12	14	14	17	25	31	37	42	45
35 :	154	123	73	31	19	11	11	11	11	12	12	12	13	14	15	14	14	15	15	15	15	13	13	14	15	19	26	31	38	43	45
36 :	157	130	83	40	21	12	11	11	11	12	12	13	13	14	14	15	15	15	16	16	15	14	14	15	16	21	27	32	39	44	45
37 :	160	136	91	52	24	14	11	11	11	11	12	13	13	14	15	15	15	16	16	17	16	15	15	16	17	22	27	34	41	45	45
38 :	159	143	102	63	28	15	12	11	11	11	12	13	14	14	15	15	16	16	17	17	17	16	16	16	18	23	28	35	42	45	44
39 :	155	149	115	76	35	17	13	12	11	11	12	13	14	14	15	16	16	17	17	18	18	16	17	17	19	24	30	37	42	45	44
40 :	148	152	128	91	43	19	14	12	12	11	12	13	14	15	15	16	17	17	18	19	19	17	18	18	20	25	31	38	42	44	44

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1983, arriving from sheltered approach direction of 264 deg azimuth, period = 20.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				42	45	47									
2 :																			64	42	45	49	46								
3 :	148	145	145	158														84	52	37	35	33	39	5[illegible]							
4 :	140	137	138	140	144	136	158											82	47	33	29	29	34	56							
5 :	133	131	132	134	132	124	121	153	17[illegible]									86	48	32	29	28	33	52	8[illegible]						
6 :	113	112	114	115	121	114	98	114	148									88	50	35	31	30	33	41	86	[illegible]					
7 :	104	103	114	115	112	106	92	101	123								127	90	53	38	33	32	32	39	86	134					
8 :	104	98	105	105	102	98	90	95	112							137	126	92	57	41	36	34	34	40	79	119	[illegible]				
9 :	98	98	105	105	102	98	88	91	105						122	132	125	96	61	44	38	36	36	44	77	106	129	[illegible]			
10 :	95	94	99	99	95	90	87	87	97	106	100	98	98	104	117	128	125	99	65	46	41	38	39	49	70	93	117	142	[illegible]		
11 :	95	94	96	99	94	89	86	86	93	95	98	96	95	101	113	125	123	101	68	49	44	40	42	51	70	85	106	129	149		
12 :	92	92	96	94	91	88	85	85	89	93	95	94	94	98	110	122	122	102	71	51	47	43	45	53	71	83	101	128	140	162	
13 :	93	92	96	94	90	87	84	85	88	92	93	92	92	96	107	119	120	103	74	55	50	45	47	57	72	82	93	110	126	141	161
14 :	91	91	93	91	89	86	83	84	87	91	92	91	91	95	105	116	118	103	76	58	53	49	50	61	73	81	89	99	110	128	152
15 :	91	91	93	91	87	85	84	84	88	92	91	90	91	95	104	114	116	103	78	61	56	52	53	64	75	82	87	92	101	114	151
16 :	90	90	93	89	85	83	82	83	86	90	92	89	90	93	101	112	114	103	80	63	59	56	56	67	75	81	86	90	94	111	137
17 :	90	90	91	88	85	82	82	83	86	90	91	90	90	92	99	109	112	102	81	66	63	60	61	69	77	81	85	90	94	102	123
18 :	90	90	91	88	85	82	82	83	86	90	90	89	89	91	98	107	111	102	82	67	66	65	66	71	77	81	84	91	97	98	121
19 :	90	89	89	87	83	81	80	82	85	89	91	90	90	91	95	104	108	101	82	69	70	69	70	73	78	80	83	91	98	97	114
20 :	90	89	89	86	83	81	80	82	86	89	90	90	90	91	94	101	106	99	81	71	73	73	74	74	79	80	83	92	99	98	103
21 :	90	90	88	85	82	80	79	81	85	89	90	90	89	90	93	100	106	98	80	73	77	78	77	76	79	80	83	93	98	97	99
22 :	90	90	88	85	81	79	79	81	86	89	89	89	89	89	91	100	104	95	79	76	81	82	81	77	79	80	84	93	98	98	98
23 :	89	89	88	84	81	79	79	82	87	89	89	89	89	90	91	98	103	93	80	79	85	86	84	78	78	80	85	93	97	97	97
24 :	89	89	87	84	81	79	79	83	87	89	88	88	90	90	90	97	101	92	82	83	88	89	86	78	78	81	85	94	97	97	97
25 :	88	89	87	83	80	78	79	84	88	90	88	87	90	90	90	96	99	90	84	87	91	92	88	79	78	80	86	94	98	97	95
26 :	88	88	86	83	80	78	80	84	89	89	87	87	90	90	90	95	97	90	87	90	94	94	90	80	78	80	86	94	99	97	94
27 :	88	88	86	83	80	79	80	85	90	89	86	87	90	91	90	94	95	91	90	93	96	95	91	82	78	80	86	95	100	96	91
28 :	88	88	86	82	80	79	81	86	90	89	86	88	91	91	91	93	93	92	93	96	98	97	92	83	79	80	88	97	99	94	91
29 :	88	88	86	82	80	81	83	87	90	89	87	89	91	92	91	93	93	94	96	98	99	97	93	84	79	80	89	97	98	93	90
30 :	88	88	86	83	82	83	85	88	90	90	90	90	91	92	92	93	93	96	98	99	100	98	94	85	79	81	91	97	96	93	89
31 :	88	89	86	85	84	87	88	90	91	92	93	92	93	94	95	96	96	98	100	100	100	98	94	86	80	82	92	97	95	92	88
32 :	88	89	87	87	87	90	91	92	92	93	95	94	96	97	98	99	99	99	101	100	100	98	95	87	80	83	92	96	94	90	88
33 :	89	89	88	89	90	93	93	94	94	95	97	96	97	98	99	100	100	101	101	100	100	98	95	88	81	85	93	95	92	89	87
34 :	89	89	89	91	93	95	95	96	96	97	98	98	98	98	99	101	101	101	101	100	100	98	96	89	83	87	93	93	91	89	87
35 :	90	89	90	93	95	96	97	97	97	98	98	99	99	99	100	101	101	101	101	100	99	98	96	89	84	88	92	92	91	89	87
36 :	91	89	92	94	96	97	97	98	98	98	99	99	100	100	100	101	101	101	101	100	99	98	96	90	86	89	92	91	90	89	86
37 :	91	92	94	95	96	97	98	98	98	99	99	100	100	101	101	101	101	101	101	100	99	98	97	91	88	89	91	91	90	89	86
38 :	92	94	95	96	97	98	98	98	99	99	99	100	100	101	101	101	101	101	100	100	99	98	97	92	89	89	91	91	90	88	85
39 :	93	95	96	97	97	98	98	99	99	99	99	100	100	101	101	101	101	101	100	100	99	98	97	93	91	90	91	91	89	88	85
40 :	94	97	97	97	98	98	99	99	99	99	100	100	101	101	101	101	101	101	100	99	99	98	97	94	92	90	91	91	89	87	86

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of November 1982, arriving from sheltered approach direction of 268 deg azimuth, period = 10.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				13	16	18									
2 :																			15	13	16	18	19								
3 :	156	150	148	161														16	13	11	12	12	16	25							
4 :	147	142	141	142	150	149	190											16	12	10	10	11	14	24							
5 :	140	135	135	136	138	136	145	202	14[illegible]									18	12	10	10	10	14	22	43						
6 :	119	114	114	115	125	125	116	149	212									19	13	10	10	11	14	17	42						
7 :	108	104	114	115	115	117	109	131	173								30	20	14	11	11	12	13	16	43	75					
8 :	109	98	104	104	104	106	105	122	156							76	35	22	15	13	12	12	14	17	40	68					
9 :	102	98	103	103	103	106	104	116	144						128	83	40	24	17	14	13	13	15	19	40	61	83				
10 :	98	94	97	96	95	96	102	111	132	148	143	142	146	147	130	89	46	27	19	15	14	14	16	23	37	54	76	101			
11 :	98	94	92	95	94	95	100	109	125	131	136	136	138	142	129	95	53	30	21	16	16	15	18	24	37	50	70	94	115		
12 :	95	91	92	90	90	93	99	108	120	127	131	130	134	138	129	100	59	34	23	18	17	17	20	25	39	49	68	93	111	139	
13 :	96	91	92	90	88	92	97	107	118	125	127	126	129	133	128	103	65	38	26	20	19	18	21	29	40	50	62	81	100	121	151
14 :	94	89	89	86	86	90	95	105	116	123	125	123	125	128	126	106	70	42	29	22	21	20	22	31	41	50	60	73	88	109	145
15 :	94	90	89	86	85	88	96	106	116	124	123	121	121	125	125	108	75	46	32	24	23	22	24	34	43	51	59	68	82	99	136
16 :	93	88	89	83	82	86	93	103	113	120	123	118	117	120	120	107	80	50	35	27	26	24	26	36	44	51	59	67	76	98	126
17 :	93	88	86	83	82	85	93	103	112	120	122	118	117	118	117	107	82	55	38	30	28	26	29	38	46	52	59	68	77	90	115
18 :	94	89	86	82	81	85	93	103	112	119	119	116	114	114	115	105	83	58	41	33	31	30	32	40	47	52	59	69	81	87	113
19 :	93	88	84	80	79	83	91	100	110	116	119	116	114	112	111	103	82	59	43	35	35	33	35	42	48	53	58	70	83	87	107
20 :	93	88	84	80	79	82	91	101	110	116	116	117	114	110	109	100	82	60	45	38	38	36	37	43	49	54	58	72	85	89	96
21 :	93	89	83	78	77	81	89	99	108	113	116	117	112	107	105	98	83	61	46	41	41	40	39	45	50	54	60	74	85	88	92
22 :	94	89	83	78	77	80	89	98	107	111	113	114	110	105	101	97	85	61	47	44	45	43	42	46	51	55	62	76	86	89	91
23 :	93	88	83	77	75	79	87	99	108	111	112	114	111	104	98	95	85	62	48	46	48	46	45	46	51	56	64	77	86	88	89
24 :	93	89	82	77	75	79	86	98	108	110	110	112	112	103	95	92	83	63	49	49	52	49	47	47	51	57	65	79	87	88	88
25 :	93	88	82	76	74	77	86	99	108	110	109	111	111	102	92	90	83	64	51	53	55	52	49	48	51	58	67	80	89	88	86
26 :	92	88	81	75	74	77	85	99	108	108	107	111	111	101	90	87	80	64	54	56	58	55	51	49	52	58	68	81	90	89	85
27 :	92	88	81	75	74	76	85	98	108	107	105	110	110	100	88	83	78	64	57	59	61	58	53	51	53	59	69	83	92	89	81
28 :	91	88	81	74	73	76	84	97	107	106	103	108	109	99	86	80	75	64	60	62	63	60	55	52	54	60	72	86	91	86	80
29 :	91	88	80	74	73	76	83	95	106	104	102	108	107	97	85	77	72	65	63	65	65	62	57	54	55	61	75	87	90	85	78
30 :	90	88	80	74	74	77	83	94	104	104	103	107	106	97	85	75	70	66	65	67	67	64	59	56	56	62	78	88	88	84	77
31 :	90	87	80	74	75	79	84	93	102	104	105	107	104	96	84	74	69	67	68	69	69	66	61	57	56	64	80	88	87	82	76
32 :	89	87	80	75	76	81	86	93	101	105	107	107	104	96	85	75	69	68	69	71	70	68	63	59	58	66	81	88	85	79	75
33 :	88	87	80	77	79	84	87	93	100	106	109	108	104	96	85	76	71	70	71	72	72	70	65	61	59	68	83	87	83	77	73
34 :	88	86	81	79	82	87	90	94	100	107	111	110	104	95	85	77	72	71	72	73	73	72	68	62	60	71	83	85	81	76	71
35 :	87	86	81	81	85	88	92	96	102	108	113	112	105	94	85	78	73	72	72	74	75	73	70	64	62	73	83	83	80	75	70
36 :	87	85	82	83	86	90	93	97	102	109	114	113	106	96	85	78	74	72	73	75	76	75	72	65	65	75	82	81	79	74	69
37 :	88	85	83	85	88	91	94	98	103	110	114	114	107	96	86	78	74	73	74	76	77	77	74	67	67	76	81	80	78	73	68
38 :	88	86	85	86	89	92	95	98	104	110	115	115	108	97	86	79	74	73	75	77	79	78	76	70	69	76	80	79	76	72	67
39 :	88	87	86	88	90	92	95	99	104	111	116	116	108	97	86	78	74	74	75	78	80	80	78	72	70	76	80	79	74	70	66
40 :	88	88	88	89	91	93	96	99	104	111	116	116	108	96	85	78	74	74	76	79	81	82	80	74	72	76	80	78	73	69	65

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1963, arriving from sheltered approach direction of 257 deg azimuth, period = 13.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	7									
2 :																			6	5	6	7	7								
3 :	153	154	164	194														6	5	4	5	5	6	9							
4 :	143	145	155	171	195	204	133											6	4	4	4	4	5	9							
5 :	136	137	147	163	179	186	200	258	120									6	5	4	4	4	5	8	17						
6 :	114	115	124	137	162	172	161	195	252									6	5	4	4	4	5	7	17						
7 :	103	104	123	136	150	161	152	172	207								10	7	5	4	4	4	5	6	17	33					
8 :	103	97	111	123	136	147	148	162	187							20	11	7	6	5	4	5	5	7	17	30					
9 :	97	96	110	121	134	148	146	155	174						46	23	13	8	6	5	5	5	6	8	17	26	39				
10 :	92	91	102	112	124	135	145	150	160	156	124	101	87	72	50	26	15	10	6	6	5	5	6	9	15	24	36	52			
11 :	92	91	98	111	121	133	143	149	153	138	118	96	82	71	54	31	17	11	7	6	6	6	7	10	16	22	34	48	62		
12 :	89	87	95	104	116	131	142	148	148	134	113	92	80	71	56	35	20	13	8	7	6	6	8	10	17	22	33	48	60	82	
13 :	89	87	94	102	113	129	140	148	146	132	110	88	76	69	58	39	22	16	10	7	7	7	8	12	18	23	30	42	54	71	104
14 :	87	84	90	97	111	127	138	146	145	131	108	85	73	66	59	43	25	18	12	8	8	8	9	13	18	23	30	37	48	64	96
15 :	87	84	89	96	108	124	140	149	147	133	106	83	70	65	59	46	29	20	14	9	9	8	10	15	19	25	29	35	44	58	93
16 :	85	81	88	92	103	120	136	146	144	130	107	81	66	61	57	48	33	22	15	11	10	9	11	16	20	25	29	35	41	60	87
17 :	85	81	84	90	102	120	137	147	145	130	106	80	65	59	56	48	35	24	17	12	11	10	12	17	22	26	30	35	42	56	82
18 :	86	82	84	89	101	119	138	148	146	131	104	78	63	56	55	49	36	26	19	14	12	11	13	18	23	26	30	36	47	53	86
19 :	84	80	81	85	97	116	135	146	144	127	103	78	62	55	53	48	37	27	21	16	14	13	15	20	24	27	30	37	49	55	85
20 :	84	80	80	84	95	115	135	148	145	128	100	78	61	53	52	48	37	28	23	18	16	14	16	20	25	28	30	39	51	59	76
21 :	85	80	78	80	92	111	133	147	144	125	100	77	58	50	49	47	39	29	23	19	17	16	17	22	26	28	32	41	52	61	73
22 :	85	80	77	79	90	110	133	146	144	124	97	75	57	47	46	47	41	29	24	21	19	18	19	23	27	29	33	43	53	63	74
23 :	84	79	77	77	87	106	130	149	147	124	96	74	56	46	44	46	42	31	24	22	21	20	20	23	27	31	35	44	54	64	76
24 :	84	79	75	76	85	104	128	148	147	123	93	71	56	44	41	44	42	32	25	24	23	21	22	24	28	32	36	45	56	67	77
25 :	84	78	73	74	82	101	128	151	149	123	92	70	54	43	39	43	42	33	26	26	25	23	23	25	28	33	37	47	59	69	77
26 :	83	78	72	72	80	98	125	150	150	122	90	69	54	42	37	40	41	33	27	27	27	25	25	26	29	34	38	48	63	72	77
27 :	83	78	72	71	78	95	123	150	151	121	87	67	53	41	35	38	40	34	29	29	29	27	26	27	30	34	39	51	68	73	75
28 :	82	77	71	69	76	91	119	149	152	120	84	65	51	39	34	36	38	34	30	31	31	29	27	28	31	35	41	56	69	73	75
29 :	82	77	70	67	74	89	115	145	151	120	82	64	49	38	33	34	36	34	32	33	33	30	28	30	32	36	44	59	70	74	75
30 :	81	77	69	66	72	87	112	142	150	120	81	62	48	37	33	32	35	34	34	35	34	32	30	31	33	37	47	61	71	75	74
31 :	80	77	69	64	71	86	110	138	147	120	82	60	45	36	32	31	33	34	35	36	36	34	31	32	34	38	50	63	72	74	74
32 :	80	77	68	64	70	85	108	135	145	122	84	59	43	35	32	31	32	35	37	38	37	35	33	34	35	39	53	66	72	73	74
33 :	79	76	68	64	71	85	107	133	144	124	87	58	42	35	32	31	33	35	38	39	39	37	35	35	35	42	56	66	71	73	73
34 :	78	76	68	65	71	85	107	132	143	126	90	58	41	34	32	32	34	36	39	40	40	38	37	37	36	45	58	66	71	73	72
35 :	77	75	68	66	72	85	106	132	144	129	93	59	40	34	32	33	35	37	40	42	42	40	38	38	38	48	60	66	71	73	71
36 :	76	73	67	67	73	84	105	131	145	132	96	60	40	34	32	34	36	38	41	43	43	42	40	39	40	50	60	66	72	73	71
37 :	76	72	67	68	73	84	103	129	146	134	98	61	41	34	33	34	37	39	42	44	45	43	42	41	43	52	61	67	72	73	70
38 :	76	71	68	69	74	83	101	128	147	137	102	63	41	34	34	35	37	40	43	45	46	45	44	43	45	53	61	68	72	72	68
39 :	75	72	69	71	74	83	99	125	147	141	105	65	42	35	34	36	38	41	44	47	48	47	46	45	46	54	63	69	71	71	67
40 :	75	72	70	72	75	82	97	122	146	144	109	67	42	35	34	36	39	42	45	48	49	49	48	47	47	55	64	69	71	69	66

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1978, arriving from sheltered approach direction of 264 deg azimuth, period = 16.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	4	5									
2 :																			3	3	4	5	5								
3 :	196	199	202	219														3	3	3	3	3	4	8							
4 :	185	188	193	194	195	173	193											3	3	2	2	3	3	5	9						
5 :	176	180	186	187	179	158	141	154	161									4	3	2	2	2	3	5	10	19					
6 :	149	152	158	159	163	146	113	111	125									4	3	2	2	2	3	4	10	20	29				
7 :	135	138	159	160	153	137	106	98	101								5	4	3	2	2	3	3	4	10	20	26				
8 :	136	130	144	146	139	126	103	91	90							10	6	4	4	3	2	3	3	4	10	18	24	29			
9 :	127	130	145	146	140	127	102	87	82						26	12	7	5	4	3	3	3	3	4	10	16	24				
10 :	121	124	136	137	130	117	101	84	74	64	52	51	51	45	30	14	8	5	4	3	3	3	4	5	9	15	22	32			
11 :	122	125	129	137	130	117	100	83	70	55	48	47	49	45	33	17	10	6	5	4	3	3	4	5	10	13	21	30	40		
12 :	117	120	130	131	126	116	100	82	67	52	45	44	47	46	36	20	12	7	5	4	4	4	5	6	11	14	21	30	38	52	
13 :	118	121	131	132	125	116	99	82	65	51	42	41	44	45	38	24	13	9	6	5	4	4	5	7	11	14	19	26	34	45	69
14 :	115	117	126	127	124	115	98	81	64	49	40	38	42	44	40	27	15	10	7	5	4	5	5	8	11	15	19	24	30	40	64
15 :	115	118	127	128	123	115	101	82	64	49	38	36	39	43	41	30	18	12	8	6	5	5	6	9	12	15	18	22	28	37	63
16 :	112	115	127	124	121	113	99	80	61	46	37	34	37	41	40	32	21	14	9	6	6	5	6	10	13	16	19	22	26	38	58
17 :	113	116	123	125	122	114	100	81	61	45	36	33	36	39	40	33	23	16	11	7	7	6	7	11	14	16	19	22	27	36	55
18 :	113	116	124	126	123	116	102	81	60	44	34	31	33	37	39	34	24	18	13	8	7	6	8	12	14	17	19	23	30	33	60
19 :	110	114	121	123	121	115	101	80	58	42	33	30	32	36	38	34	25	18	14	10	8	7	9	12	15	17	19	23	31	35	60
20 :	110	115	121	124	123	117	102	81	58	40	31	29	31	35	38	34	26	19	15	11	9	8	10	13	16	18	19	24	33	38	53
21 :	110	115	119	122	121	116	102	80	56	38	30	29	29	32	36	34	27	20	16	12	11	10	10	14	17	18	20	26	33	40	52
22 :	109	115	120	123	123	118	104	80	55	36	28	27	28	30	34	35	29	20	16	14	12	11	11	15	17	19	21	27	34	42	53
23 :	107	113	120	121	122	118	104	81	55	35	27	27	27	29	32	35	31	21	16	14	13	12	12	15	18	20	22	28	35	43	55
24 :	106	113	118	122	124	120	104	81	54	33	25	26	27	28	31	34	31	22	17	16	15	13	13	15	18	21	23	29	36	46	57
25 :	104	110	116	121	124	120	106	83	54	32	24	25	27	27	29	33	32	23	18	17	16	14	14	16	18	22	24	29	39	48	58
26 :	101	108	114	121	124	121	107	83	53	30	23	25	27	26	27	31	31	24	18	18	17	15	15	17	19	22	25	30	42	51	58
27 :	99	106	113	120	125	122	108	83	52	28	22	24	26	26	26	29	31	25	20	19	18	17	16	17	20	23	25	33	46	53	57
28 :	96	104	111	119	125	121	107	83	51	26	20	23	25	25	25	27	29	25	21	21	20	18	17	18	21	23	27	36	48	54	58
29 :	93	101	108	117	125	122	107	80	49	25	19	23	25	25	24	26	27	25	22	22	21	19	18	19	21	24	29	39	49	55	59
30 :	90	99	105	115	126	124	108	80	47	24	18	22	24	25	24	24	26	25	23	23	22	20	19	20	22	24	31	41	50	56	58
31 :	86	95	102	111	126	127	109	78	45	23	18	21	23	24	23	23	25	25	25	24	23	21	20	21	23	25	33	43	52	57	59
32 :	83	91	97	109	126	130	112	78	44	23	18	20	22	23	23	23	24	25	26	25	24	22	21	22	23	26	35	46	52	56	59
33 :	80	86	93	106	127	135	116	78	43	23	18	19	22	23	24	23	24	26	26	27	25	23	22	23	24	28	38	47	52	56	59
34 :	77	82	87	102	128	140	122	80	42	23	19	19	21	23	24	23	24	26	27	27	26	24	23	24	24	30	40	47	53	57	59
35 :	74	78	81	97	127	145	129	85	43	24	19	19	21	23	24	24	25	27	28	28	27	25	25	25	25	33	41	48	54	58	59
36 :	73	74	76	93	124	147	137	92	45	24	20	20	21	22	24	25	26	28	29	29	29	27	26	26	27	35	42	48	55	59	59
37 :	72	69	71	88	119	148	144	100	48	25	20	20	21	22	24	25	27	28	30	30	30	28	27	27	29	36	43	49	56	59	59
38 :	71	68	68	83	114	147	151	110	53	26	21	20	21	23	24	26	27	29	30	31	31	29	29	28	30	37	43	51	57	59	57
39 :	70	67	67	79	107	144	156	121	60	28	21	20	21	23	25	26	28	30	31	32	32	30	30	30	31	38	45	52	57	59	57
40 :	70	67	66	75	100	139	160	132	69	29	22	21	21	23	25	27	29	31	32	34	33	32	32	31	33	39	46	53	57	58	56

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1960, arriving from sheltered approach direction of 269 deg azimuth, period = 18.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				13	16	18									
2 :																			15	13	16	18	18								
3 :	155	149	147	159														16	12	11	12	12	16	25							
4 :	147	141	139	140	148	145	193											16	12	10	10	11	14	24							
5 :	140	134	133	134	135	132	141	197	150									18	12	10	10	10	14	22	43						
6 :	118	114	113	114	122	122	113	145	208									19	13	10	10	11	14	17	42						
7 :	108	103	113	113	113	114	106	127	169								31	20	14	11	11	11	13	16	42	75					
8 :	108	97	103	103	102	104	102	118	152							80	36	22	15	12	12	12	14	17	40	68					
9 :	102	98	103	102	101	103	101	113	141						134	88	41	24	17	14	13	13	15	19	40	60	82				
10 :	98	93	96	95	94	94	99	108	128	146	142	143	149	152	135	94	48	27	19	15	14	14	16	23	36	54	75	100			
11 :	98	94	92	94	92	93	97	106	122	129	135	137	141	146	135	100	55	30	21	16	16	15	18	24	37	49	69	93	114		
12 :	95	91	92	89	88	91	96	105	117	125	130	131	137	142	134	104	61	34	23	18	17	17	20	25	39	49	67	92	110	138	
13 :	95	91	92	89	87	89	94	103	115	123	126	127	131	137	133	108	67	38	26	20	19	18	21	28	40	49	62	80	99	121	150
14 :	93	89	88	85	85	88	92	102	113	121	124	124	127	132	131	110	73	43	29	22	21	20	22	31	41	50	60	72	88	109	145
15 :	94	89	88	85	83	86	93	102	113	122	122	121	124	129	130	112	78	47	32	24	23	22	24	34	43	51	58	67	81	99	137
16 :	92	87	88	82	81	84	90	99	110	118	122	119	120	124	124	112	83	51	35	27	26	24	26	36	44	51	58	66	76	98	127
17 :	93	88	86	82	80	83	90	99	109	118	121	119	119	122	122	111	85	56	38	30	28	26	29	38	46	52	59	67	76	90	116
18 :	93	88	86	81	80	83	90	99	109	117	118	117	117	117	119	110	86	59	41	32	31	29	31	40	47	52	58	69	81	87	114
19 :	92	87	84	79	78	81	88	97	107	114	118	117	116	116	115	107	85	61	44	35	34	33	34	41	48	52	58	69	83	87	109
20 :	93	88	84	79	77	80	88	98	107	113	115	117	116	114	113	104	85	62	46	38	38	36	37	42	49	53	58	72	85	89	97
21 :	93	88	83	77	75	79	86	96	105	111	115	117	114	111	109	102	86	63	47	41	41	39	39	44	50	53	60	74	85	89	93
22 :	93	89	83	77	75	78	86	95	105	109	112	115	113	108	105	101	87	62	47	44	45	43	42	46	51	54	61	76	86	90	92
23 :	92	88	83	76	74	77	85	96	105	109	111	114	113	108	102	99	88	64	48	46	48	46	44	46	51	56	63	77	86	89	91
24 :	93	88	82	76	74	77	84	95	105	108	109	113	114	106	99	96	86	64	50	49	52	49	47	47	51	57	65	79	87	89	90
25 :	92	88	81	75	73	76	84	96	106	108	108	111	113	106	96	94	85	65	52	53	55	52	49	48	51	58	66	80	89	89	88
26 :	91	87	81	75	73	75	83	96	105	106	106	111	114	105	94	90	83	65	54	56	58	55	51	49	52	58	67	81	91	90	86
27 :	91	87	80	74	73	75	83	95	105	105	104	110	113	104	92	87	81	65	57	59	60	57	53	51	53	59	69	83	93	90	83
28 :	90	87	80	73	72	74	82	95	104	103	102	109	111	102	91	83	77	66	60	62	63	60	55	52	54	59	71	86	92	87	81
29 :	90	87	80	73	72	75	81	93	103	102	101	108	109	101	89	80	74	66	63	65	65	62	57	54	54	60	74	88	92	86	80
30 :	90	87	79	73	73	76	82	92	101	102	102	108	108	101	89	79	72	67	66	67	67	64	59	55	55	62	77	88	90	85	78
31 :	89	87	79	73	74	77	82	91	99	102	104	107	107	99	88	77	71	68	68	69	68	66	61	57	56	64	80	89	88	83	77
32 :	88	87	79	74	75	79	84	91	98	102	106	108	107	100	89	78	71	69	69	70	70	67	63	59	57	66	81	89	87	81	76
33 :	88	86	80	76	78	82	86	91	97	104	108	109	107	100	89	79	73	71	71	71	71	69	65	60	58	68	83	88	84	79	74
34 :	87	86	80	78	81	86	88	92	98	105	110	111	107	99	89	80	74	72	71	72	72	71	67	62	60	71	83	86	83	78	73
35 :	87	85	80	80	84	87	91	94	99	106	112	113	108	98	88	81	75	72	72	73	74	73	69	64	62	73	83	84	81	77	72
36 :	87	84	81	83	85	89	92	95	100	107	113	114	109	100	89	81	75	73	73	74	75	74	72	65	65	75	83	83	80	76	71
37 :	87	84	82	84	87	90	93	96	101	107	113	115	110	100	90	81	76	73	73	75	76	76	74	67	67	76	82	82	79	75	70
38 :	87	85	84	86	88	91	93	97	102	108	114	116	111	101	90	81	76	74	74	76	78	78	76	69	69	76	81	81	78	74	68
39 :	87	86	86	87	89	92	94	97	102	109	115	117	111	101	89	81	76	74	75	77	79	79	78	72	70	77	81	80	76	72	67
40 :	87	88	87	88	90	92	95	98	102	109	115	117	111	100	89	80	75	74	75	78	80	81	80	74	72	77	81	79	75	70	67

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1958, arriving from sheltered approach direction of 258 deg azimuth, period = 13.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				16	20	24									
2 :																			19	16	20	24	24								
3 :	150	146	146	15[illegible]														20	16	15	16	16	20	3[illegible]							
4 :	142	138	139	142	148	143	17[illegible]											20	15	13	13	14	18	31							
5 :	135	131	133	136	136	131	133	181	23[illegible]									22	16	13	13	13	18	29	5[illegible]						
6 :	114	111	113	116	124	121	108	128	17[illegible]									22	17	14	14	14	18	22	57						
7 :	105	101	113	116	116	114	101	112	142								33	24	18	15	15	15	17	22	57	10[illegible]					
8 :	105	96	103	105	106	105	98	105	126							59	37	25	19	17	16	16	18	23	53	90	[illegible]				
9 :	99	96	103	105	105	105	97	100	115						94	64	40	28	21	18	17	18	19	26	52	80	110	[illegible]			
10 :	95	92	97	98	98	96	96	96	105	114	110	113	118	115	98	69	44	31	23	19	19	19	21	30	48	71	100	131			
11 :	96	93	93	98	97	96	95	95	100	100	103	107	113	113	100	73	49	34	25	21	21	20	23	31	47	65	91	120	145		
12 :	93	90	93	93	94	94	94	94	96	97	99	102	109	112	102	78	53	37	27	23	23	22	25	32	48	63	86	121	139	162	
13 :	94	90	93	93	92	93	92	93	94	95	95	98	105	109	103	82	57	41	30	25	25	24	26	35	49	63	80	105	126	140	158
14 :	92	88	90	90	91	92	91	91	92	93	93	94	101	106	104	86	61	44	33	27	27	26	28	38	50	62	78	96	110	126	146
15 :	93	88	90	90	90	91	92	92	92	93	91	92	97	104	104	89	66	47	36	30	30	28	30	40	51	63	77	88	101	111	134
16 :	92	87	90	88	88	89	90	89	89	90	90	89	94	100	101	90	70	51	39	33	32	30	32	42	51	62	76	87	93	105	126
17 :	92	88	88	87	88	89	90	89	88	89	89	88	92	98	100	91	72	54	42	36	35	33	34	43	52	63	77	88	92	94	110
18 :	93	88	88	87	88	89	90	89	88	88	87	86	90	95	99	91	74	57	45	39	39	37	37	44	52	63	77	90	94	92	103
19 :	92	87	86	85	86	88	89	87	85	84	86	86	88	94	97	91	74	59	48	42	42	40	40	45	53	63	76	90	93	89	96
20 :	93	88	86	85	86	88	89	88	85	84	83	85	87	91	96	91	75	60	50	45	45	43	42	45	53	64	77	90	94	90	87
21 :	93	89	85	84	84	87	88	87	83	81	82	85	85	88	93	91	78	61	51	48	48	46	43	46	54	64	78	91	94	87	83
22 :	94	89	86	84	84	87	89	86	82	80	80	83	84	85	90	92	81	62	52	51	52	49	46	47	54	66	80	92	94	87	82
23 :	93	89	86	83	83	86	88	87	83	79	79	83	83	84	88	91	83	64	54	55	55	52	48	47	54	67	82	92	92	85	80
24 :	94	90	85	83	83	86	87	87	82	78	78	81	83	82	85	90	83	66	57	58	58	54	50	48	55	69	83	93	91	83	80
25 :	94	90	85	83	83	85	87	87	83	77	77	80	82	81	83	88	84	68	60	62	61	56	52	49	55	70	84	93	91	83	78
26 :	94	90	85	83	83	84	87	87	83	76	75	80	82	80	81	86	84	70	63	65	64	59	54	51	56	70	84	92	90	82	77
27 :	95	90	86	83	83	84	86	87	83	76	74	79	81	79	79	84	84	73	67	69	66	61	56	52	58	72	86	91	89	83	75
28 :	95	91	86	83	83	83	85	87	83	75	73	78	80	79	78	81	81	75	71	71	68	63	57	54	59	72	86	92	88	80	75
29 :	95	92	87	84	84	84	85	86	83	76	73	77	79	78	78	79	80	77	75	74	70	65	59	56	60	74	87	91	87	80	75
30 :	95	93	88	84	85	85	85	85	83	77	74	77	79	78	78	78	79	79	78	76	72	67	62	58	62	75	88	90	85	79	75
31 :	95	93	89	86	87	88	86	85	83	78	76	77	79	79	79	79	79	81	80	78	74	69	64	60	63	77	89	90	84	78	75
32 :	94	93	90	88	90	90	88	86	83	80	78	78	80	81	82	82	82	82	82	80	76	71	66	62	65	78	88	88	82	77	75
33 :	94	93	90	91	93	94	90	87	84	81	80	78	80	82	83	84	84	84	83	81	77	73	68	64	67	79	88	87	81	76	74
34 :	93	92	91	93	96	96	93	90	86	83	81	80	81	82	83	85	86	86	85	82	79	75	70	66	69	80	87	85	80	76	74
35 :	93	92	92	95	98	98	95	92	88	85	83	82	81	82	84	86	87	87	86	84	81	77	72	68	71	82	87	83	79	76	74
36 :	94	91	93	97	99	98	96	93	89	86	84	83	83	84	85	87	87	87	86	85	82	79	75	70	73	82	86	82	78	76	74
37 :	94	93	94	97	99	99	97	94	90	87	84	83	83	84	86	87	88	88	87	86	83	80	77	72	75	83	85	81	78	76	74
38 :	95	94	95	98	100	100	98	95	92	88	85	84	84	85	87	88	88	89	88	87	85	82	79	74	77	83	85	81	78	77	74
39 :	96	96	97	99	100	100	99	96	93	89	86	84	84	85	87	88	89	89	89	88	86	84	81	77	78	83	85	81	78	76	75
40 :	96	97	97	99	101	101	100	97	94	90	87	85	84	85	87	88	89	89	89	88	87	85	83	79	80	83	85	81	78	76	75

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1904, arriving from sheltered approach direction of 235 deg azimuth, period = 12.0 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				25	30	34									
2 :																			32	25	30	34	34								
3 :	155	150	149	161														38	26	22	23	23	29	43							
4 :	146	142	142	142	147	140	170											37	24	20	19	21	25	43							
5 :	140	136	136	136	135	128	130	174	21[illegible]									40	25	19	19	20	25	40	74						
6 :	118	116	116	116	122	118	104	127	172									42	27	21	20	21	25	31	72	[illegible]					
7 :	108	106	116	116	114	110	98	112	142								84	45	28	23	22	22	24	30	72	117					
8 :	109	100	106	106	103	101	95	105	129							133	91	49	31	25	24	24	25	31	67	105	[illegible]				
9 :	103	100	106	105	103	101	94	100	120						149	134	96	55	34	27	26	26	27	35	66	93	117	[illegible]			
10 :	99	96	100	99	95	92	93	96	110	121	116	116	122	136	145	134	101	61	37	30	28	27	30	40	60	82	106	134	[illegible]		
11 :	99	97	96	98	94	92	91	95	105	108	112	111	116	129	140	134	105	66	40	32	31	29	32	42	59	75	97	122	145		
12 :	96	94	96	94	91	90	90	94	101	106	108	108	113	124	136	133	108	71	44	34	33	32	35	43	61	73	92	121	137	162	
13 :	97	94	96	93	90	89	89	93	99	104	105	105	109	120	132	131	110	76	48	37	36	34	37	48	61	72	84	104	124	141	162
14 :	95	92	93	90	88	88	88	92	98	103	104	103	106	115	128	129	111	80	52	40	39	37	39	51	63	71	81	94	108	128	151
15 :	95	93	93	90	87	86	89	93	99	103	102	102	105	114	126	128	112	83	56	44	43	40	42	54	64	72	79	87	100	113	150
16 :	94	91	93	88	84	84	86	91	96	101	102	100	102	110	120	125	113	85	59	47	46	44	45	56	64	71	78	86	93	111	136
17 :	94	91	91	87	84	84	86	91	96	100	102	100	102	108	118	123	112	88	62	50	50	47	48	58	65	71	78	87	92	101	122
18 :	94	92	91	87	84	84	86	91	96	100	100	99	100	105	115	120	111	89	65	53	54	52	53	59	66	70	78	88	95	97	117
19 :	93	91	89	85	82	82	85	90	94	98	99	99	100	104	111	116	109	89	67	56	58	56	56	61	66	70	76	88	96	96	110
20 :	93	91	89	85	82	82	85	90	95	98	98	99	100	103	109	113	107	89	68	59	62	60	59	61	66	71	76	89	97	97	100
21 :	94	92	88	83	81	81	84	89	94	96	98	99	99	100	106	111	106	89	69	62	66	64	62	63	67	70	78	90	97	95	95
22 :	94	92	88	83	80	81	84	89	94	95	96	97	98	99	103	109	106	87	69	66	70	68	65	63	67	71	79	91	97	96	94
23 :	93	91	88	82	79	80	83	89	94	95	95	97	98	99	101	107	105	87	70	70	74	72	68	64	66	72	80	92	96	94	92
24 :	93	91	87	82	80	80	83	89	94	95	93	95	99	98	99	104	103	86	72	73	77	75	70	64	66	72	81	93	96	93	92
25 :	92	91	86	82	79	79	83	90	95	95	93	94	98	98	97	102	101	86	75	77	81	78	72	65	66	73	83	94	97	93	90
26 :	92	90	86	81	79	79	83	90	95	94	91	94	99	98	96	100	98	85	78	81	83	80	74	66	67	73	83	94	97	93	88
27 :	92	90	86	81	79	79	83	90	95	93	90	94	98	97	95	97	96	86	81	84	85	82	76	68	67	74	84	94	98	93	86
28 :	91	90	86	81	79	79	83	90	95	92	89	94	98	97	95	95	93	87	85	87	87	84	77	69	68	74	86	96	97	90	85
29 :	91	90	85	80	79	81	84	90	94	92	90	94	97	97	94	93	91	88	88	89	89	85	79	71	69	75	88	96	95	89	84
30 :	91	90	85	81	80	82	85	90	93	92	92	94	97	96	94	92	90	89	90	90	90	86	80	72	70	76	89	96	93	88	83
31 :	91	90	85	82	82	85	87	91	93	93	94	95	97	98	96	94	91	91	92	91	90	87	82	74	71	78	91	95	92	87	83
32 :	90	90	86	84	85	88	90	92	93	95	96	97	99	100	99	97	94	92	93	92	91	88	83	75	72	79	91	94	91	85	82
33 :	90	89	86	86	88	91	92	93	94	96	98	98	100	101	100	98	96	94	93	92	91	89	85	77	73	81	92	93	88	84	81
34 :	90	89	87	88	91	94	94	95	96	98	100	101	101	101	100	99	96	94	93	92	92	90	86	78	75	83	91	91	87	84	81
35 :	90	89	88	90	93	95	96	97	98	99	101	102	102	101	100	99	97	95	93	93	92	91	88	80	77	85	91	89	86	83	80
36 :	91	89	90	92	94	96	97	98	98	100	102	103	103	103	101	99	97	94	93	93	93	92	89	82	79	86	90	88	85	83	80
37 :	91	91	92	94	95	96	97	98	99	100	102	103	104	103	101	99	96	94	93	93	93	92	90	83	81	86	89	87	85	83	80
38 :	92	92	93	95	96	97	98	99	99	101	102	104	104	104	102	99	96	94	93	93	93	93	92	85	83	86	88	87	84	82	79
39 :	92	94	95	95	96	97	98	99	100	101	103	104	104	103	101	99	96	94	93	93	94	94	93	87	85	86	88	86	83	81	79
40 :	93	95	95	96	97	98	98	99	100	101	103	104	104	103	101	98	96	94	93	93	94	94	94	89	87	87	88	86	83	81	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1912, arriving from sheltered approach direction of 258 deg azimuth, period = 11.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	8									
2 :																			6	5	6	8	8								
3 :	175	179	189	219														6	5	5	5	5	6	16							
4 :	165	169	180	194	212	210	143											6	5	4	4	4	6	10							
5 :	156	160	172	186	195	192	192	231	14[illegible]									6	5	4	4	4	6	9	18						
6 :	131	135	145	157	178	178	156	173	210									6	5	4	4	4	5	7	17	[illegible]					
7 :	119	122	145	157	166	167	147	153	172								10	7	5	4	4	5	5	7	18	34					
8 :	119	114	131	142	150	153	143	144	155							20	12	7	6	5	4	5	5	7	17	31					
9 :	111	114	130	141	150	155	142	139	144	[illegible]					45	23	13	9	6	5	5	5	6	8	18	27	41				
10 :	106	108	121	132	139	142	141	134	132	121	93	79	74	67	49	27	16	10	7	6	5	5	6	10	16	25	37	54			
11 :	106	108	115	130	137	141	140	133	126	106	88	75	70	66	52	31	18	12	7	6	6	6	7	10	17	23	35	50	65		
12 :	102	103	115	123	132	140	139	133	122	103	83	70	67	66	55	35	20	14	9	7	7	6	8	11	18	23	35	50	63	85	
13 :	102	103	114	123	130	138	138	133	120	101	80	66	63	64	57	40	23	16	10	8	7	7	9	12	18	24	32	44	57	74	108
14 :	100	100	109	117	128	137	137	132	119	99	78	63	60	61	58	44	26	18	12	8	8	8	9	14	19	24	31	39	50	67	100
15 :	100	99	108	116	126	136	140	135	121	101	76	61	57	59	58	47	30	20	14	10	9	9	10	15	20	26	30	37	46	61	97
16 :	97	97	108	112	122	132	137	132	118	97	76	58	53	56	56	48	34	23	16	11	10	10	11	17	21	26	31	36	43	63	91
17 :	98	97	103	111	122	133	139	134	119	97	75	57	52	54	55	49	36	25	18	13	11	10	12	18	22	27	31	37	45	59	85
18 :	98	97	102	110	121	134	140	136	119	97	72	55	49	51	54	49	38	27	20	15	13	12	14	19	24	27	31	38	49	56	89
19 :	96	94	99	106	118	131	138	134	117	94	71	54	48	49	52	49	38	28	22	16	15	13	15	20	25	28	31	38	51	58	87
20 :	96	95	98	105	117	131	140	136	119	94	69	53	46	47	51	49	39	29	23	18	16	15	17	21	26	29	32	41	54	62	78
21 :	96	95	96	102	114	129	139	136	117	91	68	53	44	44	48	48	40	30	24	20	18	17	18	23	27	30	33	43	54	63	75
22 :	96	94	95	101	113	129	141	136	117	89	65	50	43	41	45	48	42	30	25	22	20	19	19	24	28	30	34	45	56	65	76
23 :	95	93	94	98	110	126	139	139	119	89	63	49	42	40	43	47	44	32	25	23	22	20	21	24	28	32	36	46	56	67	77
24 :	95	93	92	97	109	126	138	139	119	87	61	47	42	38	41	45	44	33	26	25	24	22	23	25	29	33	37	48	59	69	78
25 :	94	91	90	95	107	124	140	142	121	86	59	46	40	37	38	44	44	34	27	27	26	24	24	26	29	34	39	49	62	71	78
26 :	93	90	88	93	105	122	139	143	121	85	57	45	40	36	36	42	43	35	28	29	28	26	25	27	30	35	40	51	66	74	77
27 :	92	89	87	91	103	120	138	143	122	83	55	44	39	35	35	39	42	35	30	31	30	28	27	28	31	36	41	54	70	75	75
28 :	92	89	86	88	100	116	136	144	123	82	52	43	38	34	33	37	39	35	32	32	32	30	28	29	32	36	43	58	71	75	75
29 :	91	88	84	86	98	115	134	141	122	81	50	41	37	34	33	35	37	35	34	34	34	31	29	31	33	37	46	61	72	75	74
30 :	90	88	82	83	96	113	132	140	122	81	49	40	36	33	32	33	36	36	35	36	36	33	31	32	34	38	50	63	73	75	73
31 :	89	87	81	81	94	113	131	138	120	81	50	39	34	32	31	32	34	36	37	38	37	35	32	33	35	39	52	66	73	75	73
32 :	87	86	80	80	93	113	131	137	120	83	51	38	33	32	32	31	34	36	38	39	39	36	34	35	36	41	55	68	73	74	73
33 :	86	85	79	79	92	113	132	137	120	84	52	37	32	32	32	32	34	37	39	41	40	38	36	36	36	43	58	68	72	73	71
34 :	85	84	78	79	93	114	133	138	121	87	54	37	32	32	32	33	35	38	41	42	42	40	38	38	38	46	61	68	72	73	70
35 :	84	82	77	79	92	113	134	141	123	89	56	38	31	31	32	34	36	39	42	43	43	41	40	39	39	50	62	68	72	72	69
36 :	83	81	76	79	91	111	134	143	127	92	58	39	32	31	32	34	37	40	43	45	45	43	42	40	41	52	62	68	72	72	68
37 :	83	78	75	79	90	109	132	145	131	96	60	39	32	31	33	35	38	41	44	46	46	45	44	42	44	54	62	69	72	71	67
38 :	82	78	76	80	89	107	131	146	135	100	63	40	33	32	34	36	39	42	45	47	48	46	46	44	46	55	63	69	72	70	65
39 :	82	79	76	80	89	105	128	146	139	105	66	42	33	32	34	37	40	43	46	49	50	48	48	46	47	55	64	70	71	69	64
40 :	81	79	77	81	88	103	125	145	142	111	69	43	34	33	34	37	40	44	47	50	51	50	50	48	49	57	65	70	70	67	62

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1983, arriving from sheltered approach direction of 260 deg azimuth, period = 16.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				21	25	29									
2 :																			26	21	25	29	28								
3 :	154	149	146	158														31	21	18	19	19	24	3[illegible]							
4 :	145	141	139	138	141	134	161											30	20	17	15	17	21	36							
5 :	139	134	133	132	129	122	122	165	20[illegible]									33	21	16	16	16	21	33	62						
6 :	117	114	114	113	117	112	98	120	165									34	22	17	16	17	21	26	60						
7 :	107	104	114	112	109	104	92	106	135								80	37	24	19	18	18	20	25	61	101					
8 :	107	98	104	102	99	95	89	99	123							144	89	40	26	21	19	19	21	26	57	91	[illegible]				
9 :	101	99	104	102	98	95	88	94	114						166	146	97	47	28	23	21	21	23	29	56	81	104				
10 :	97	95	98	95	91	87	87	90	104	117	114	116	127	147	161	147	104	54	31	24	23	22	25	33	51	72	95	120			
11 :	98	95	93	95	90	86	85	89	99	104	109	111	120	139	155	147	110	61	34	26	25	24	27	35	52	66	87	110	129		
12 :	95	92	94	90	86	85	84	88	95	101	106	108	116	133	150	147	114	68	38	29	27	26	29	37	53	64	83	109	125	151	
13 :	95	92	94	90	85	83	83	87	94	100	103	105	112	127	145	145	118	74	42	31	30	28	31	41	54	64	76	94	112	132	156
14 :	93	90	91	87	83	82	82	86	92	98	101	102	108	122	141	143	120	79	47	34	33	31	33	44	56	64	73	85	98	119	148
15 :	93	91	91	86	82	81	82	87	93	99	99	101	106	120	138	142	122	84	51	38	36	33	36	47	57	65	71	78	91	106	148
16 :	92	89	91	84	80	78	80	85	91	97	100	99	103	115	131	139	123	88	55	41	39	37	38	50	58	65	70	77	84	106	135
17 :	92	89	88	83	79	78	80	85	91	96	99	99	103	113	127	136	123	91	59	45	43	40	42	52	60	65	70	77	84	97	122
18 :	93	90	88	83	79	78	80	85	91	96	97	97	101	109	124	132	122	93	63	48	47	44	46	54	61	65	70	78	88	93	120
19 :	91	89	86	81	77	76	79	83	89	94	97	98	101	108	119	128	119	94	66	51	51	48	49	56	61	65	68	78	90	93	114
20 :	92	89	86	81	77	76	79	84	90	94	95	98	101	107	117	124	117	94	67	54	55	53	52	56	62	65	68	80	92	95	103
21 :	92	89	85	79	75	75	78	83	89	93	95	98	99	104	113	121	116	94	68	58	59	57	55	58	63	64	69	82	92	94	98
22 :	92	90	85	79	75	75	78	82	89	92	93	96	99	102	109	119	116	92	68	61	63	61	58	59	63	65	70	83	92	95	98
23 :	91	89	85	78	74	74	77	83	90	92	93	95	99	102	107	117	115	92	69	65	67	65	61	59	62	66	72	84	92	94	96
24 :	91	89	84	78	74	74	76	83	90	92	91	94	100	101	105	113	112	91	71	69	71	68	63	60	62	66	73	85	93	94	96
25 :	90	88	83	77	73	73	77	84	91	92	90	93	99	102	103	111	110	90	73	73	75	71	65	60	61	66	74	86	95	95	94
26 :	90	88	83	77	73	73	77	84	91	91	89	93	100	101	101	108	107	89	76	77	78	74	67	61	62	66	74	87	96	95	92
27 :	89	87	82	76	73	73	77	85	91	90	88	92	99	101	100	105	104	89	80	80	81	76	69	62	62	67	76	89	98	95	89
28 :	89	87	82	75	73	73	77	85	91	89	86	92	98	100	100	102	100	89	83	83	83	77	70	63	62	66	78	91	97	93	88
29 :	88	87	81	75	73	74	78	85	90	88	86	92	97	100	99	99	97	90	86	86	84	79	71	65	63	67	80	93	97	92	87
30 :	88	87	81	75	74	75	79	85	90	88	87	92	97	100	99	98	95	91	89	88	85	80	73	66	63	68	83	93	95	91	86
31 :	87	87	81	76	75	78	81	85	89	89	90	93	97	100	100	98	95	93	91	89	86	81	74	67	64	70	85	94	94	90	85
32 :	87	86	81	77	77	80	83	86	89	90	92	94	98	102	103	101	97	94	92	89	86	81	75	68	65	72	86	94	92	88	84
33 :	87	86	81	79	80	84	86	87	89	92	94	96	100	103	104	103	99	96	93	89	86	82	77	69	66	74	88	93	90	86	83
34 :	86	86	82	81	84	87	88	90	91	93	96	98	101	103	104	103	100	96	93	89	86	83	78	71	67	77	88	91	89	86	82
35 :	86	85	82	83	86	89	90	92	93	95	98	101	103	104	104	104	101	96	92	89	86	83	80	72	69	79	88	90	88	85	81
36 :	87	85	84	86	88	90	92	93	94	96	99	102	104	106	105	104	100	96	92	89	86	84	81	74	72	80	88	88	87	85	80
37 :	87	86	86	87	89	91	93	94	95	97	99	103	106	107	107	104	100	95	91	88	86	85	82	75	74	81	87	88	87	84	79
38 :	87	87	87	89	90	92	93	95	96	98	100	103	106	108	107	104	100	95	91	88	87	85	84	77	76	82	87	88	86	83	78
39 :	88	88	89	90	91	93	94	95	97	98	101	104	107	108	107	103	99	94	90	88	87	86	85	79	78	83	87	87	85	82	78
40 :	88	90	90	91	92	94	95	96	97	99	101	105	107	108	106	103	98	93	90	88	87	87	86	81	80	83	87	87	83	80	77

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1915, arriving from sheltered approach direction of 263 deg azimuth, period = 12.4 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				14	18	21									
2 :																			16	14	18	21	21								
3 :	132	131	135	151														17	14	13	14	14	18	30							
4 :	124	124	128	134	144	141	177											17	13	12	11	13	16	28							
5 :	118	118	123	129	132	130	135	190	253									18	14	11	11	12	16	26	58						
6 :	100	100	104	110	121	120	109	133	186									19	15	12	12	13	16	20	56						
7 :	92	91	104	110	113	113	103	116	148								27	20	15	13	13	14	16	20	56	101					
8 :	92	86	95	100	103	104	100	107	131							43	29	21	17	15	14	15	17	21	52	90					
9 :	87	86	94	99	102	104	99	103	120						68	46	32	24	18	16	15	16	18	24	51	80	109				
10 :	83	82	89	93	95	96	97	99	109	118	111	109	105	92	72	49	35	26	20	17	17	17	19	28	47	71	100	126			
11 :	84	82	85	92	94	95	96	98	104	104	105	105	102	93	75	53	38	28	22	18	18	18	21	29	47	65	90	116	131		
12 :	82	80	85	88	91	94	95	97	100	101	101	100	100	94	78	57	40	31	24	20	20	20	23	30	47	64	85	116	127	142	
13 :	82	80	85	88	89	92	93	95	98	99	98	97	98	94	81	61	43	33	26	22	22	21	24	33	47	63	79	100	115	122	136
14 :	81	78	82	84	88	91	91	94	96	98	96	94	95	93	83	65	46	36	28	24	24	23	25	35	48	62	77	91	99	109	119
15 :	81	78	82	84	86	89	92	94	96	98	95	93	93	92	85	69	50	39	31	26	26	25	27	37	49	63	76	83	91	95	110
16 :	80	77	81	82	84	87	89	91	93	95	95	91	91	91	84	70	54	41	33	29	28	27	29	39	50	63	76	82	83	89	104
17 :	81	77	79	81	84	87	89	90	92	94	94	91	90	90	85	72	56	44	36	31	31	29	31	39	50	64	76	83	81	79	89
18 :	82	78	79	81	84	87	89	90	91	93	92	89	89	89	85	73	58	47	38	34	34	32	33	40	51	63	76	84	82	77	83
19 :	81	77	77	79	82	86	88	88	88	90	91	89	88	89	86	74	59	48	41	36	36	35	35	41	51	64	75	83	81	75	77
20 :	82	78	78	79	82	86	88	88	87	89	89	89	88	88	87	76	60	49	43	39	39	38	37	42	52	65	75	82	81	75	71
21 :	82	78	77	77	80	84	87	87	86	86	89	89	86	85	86	78	63	50	44	42	42	40	39	43	53	65	76	83	81	72	67
22 :	83	79	77	77	80	84	87	86	84	85	87	88	85	84	84	80	67	51	45	45	45	43	41	43	53	66	77	83	80	72	67
23 :	83	79	77	76	78	83	86	86	84	84	86	88	85	83	83	81	69	54	47	48	48	45	43	44	53	67	78	83	78	70	65
24 :	84	80	76	76	78	82	86	86	84	82	85	87	85	82	82	81	71	56	50	51	51	47	45	45	54	68	79	82	77	69	65
25 :	84	80	76	75	77	81	85	87	84	82	84	86	85	81	80	81	74	58	52	54	53	50	47	46	55	69	79	82	77	68	64
26 :	85	80	76	75	76	80	84	87	84	81	83	86	85	80	78	80	75	61	56	57	56	52	49	48	56	69	79	81	75	68	64
27 :	86	81	77	75	76	79	83	87	84	80	82	86	85	80	78	79	76	64	59	60	58	54	50	50	57	70	79	79	75	68	62
28 :	87	82	78	76	76	78	82	86	85	80	80	85	85	80	77	77	75	67	63	63	60	56	52	51	58	70	79	79	74	67	62
29 :	88	84	79	76	77	78	81	85	85	81	80	85	85	80	77	77	75	70	66	65	62	58	54	53	59	71	79	78	73	66	63
30 :	88	85	80	77	78	79	81	84	85	82	81	84	85	81	78	76	75	72	70	67	64	60	56	55	61	71	79	77	71	66	63
31 :	89	86	82	79	80	81	82	84	85	83	84	85	86	83	80	78	76	75	72	70	66	62	59	57	62	72	79	77	70	66	63
32 :	89	87	83	81	82	83	83	84	85	85	86	87	88	86	84	81	79	76	75	72	68	64	61	59	63	73	78	75	69	65	63
33 :	88	87	85	84	85	86	85	85	85	87	88	88	89	88	86	84	82	79	77	73	70	66	63	61	65	74	78	74	68	65	63
34 :	88	87	86	86	89	88	87	86	87	88	89	90	90	89	87	86	84	81	78	75	72	69	65	63	66	74	77	72	67	65	63
35 :	88	86	87	88	90	89	88	88	88	89	91	91	91	89	89	88	86	83	80	77	74	71	67	65	68	75	77	71	67	65	63
36 :	89	86	88	90	91	90	89	89	89	90	91	92	92	92	90	89	87	84	81	79	76	73	70	67	70	75	76	71	67	65	64
37 :	91	88	89	91	91	91	90	89	89	90	91	93	93	93	92	90	88	86	83	80	78	75	72	69	71	76	75	70	67	66	64
38 :	92	90	91	92	92	91	90	90	90	90	91	93	94	94	94	92	90	87	84	82	79	77	74	71	73	76	75	70	67	66	64
39 :	93	92	92	93	93	92	91	90	90	90	91	93	95	95	94	93	91	88	86	83	81	79	76	73	74	76	75	70	67	66	65
40 :	94	94	93	94	94	93	91	91	90	90	92	93	95	95	95	94	92	90	87	85	82	80	78	75	76	77	76	71	68	66	65

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1915, arriving from sheltered approach direction of 224 deg azimuth, period = 11.8 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				15	19	23									
2 :																			17	15	19	23	23								
3 :	123	123	126	139														17	15	14	15	16	20	35							
4 :	116	116	121	124	130	124	153											18	14	13	12	14	17	33							
5 :	110	111	116	120	120	115	117	164	238									19	15	12	13	13	17	32	67						
6 :	94	94	99	102	110	107	95	112	154									20	16	14	14	14	17	25	64	[illegible]					
7 :	86	86	99	103	103	101	89	97	122								26	20	16	15	15	15	17	25	64	104					
8 :	87	82	91	94	95	93	87	91	108							37	28	22	18	16	16	16	18	26	57	92	[illegible]				
9 :	82	82	90	94	94	94	87	87	99						52	39	30	23	19	17	17	18	20	29	55	82	100	[illegible]			
10 :	79	79	85	89	89	87	86	85	90	95	88	84	78	68	54	41	32	25	20	18	19	19	22	32	51	71	91	105	[illegible]		
11 :	80	79	82	88	88	86	85	84	88	85	84	82	77	69	57	43	34	27	22	20	20	20	23	33	50	65	80	96	101	[illegible]	
12 :	78	77	82	85	85	85	84	84	85	83	81	79	77	71	59	46	36	29	24	21	22	21	25	34	49	63	75	95	98	106	[illegible]
13 :	78	77	82	84	84	84	83	83	84	82	79	77	76	71	61	48	38	31	26	23	24	23	26	36	50	61	70	81	88	90	99
14 :	77	76	80	82	83	83	81	82	83	82	78	75	74	71	63	51	40	33	27	25	25	25	27	38	50	60	67	74	75	80	86
15 :	78	76	80	82	82	82	82	82	83	83	78	74	73	71	65	54	43	35	30	27	27	26	29	39	50	61	67	67	69	69	79
16 :	77	75	80	80	81	81	80	80	80	81	79	74	72	70	64	55	45	37	32	29	29	29	30	40	51	59	66	66	62	64	75
17 :	78	75	78	80	81	81	80	79	80	80	79	74	72	71	65	56	47	40	34	31	32	31	32	40	51	60	66	66	61	57	64
18 :	78	76	78	80	81	81	80	79	79	80	78	74	72	71	66	57	48	41	36	33	34	33	34	41	50	59	65	66	62	56	60
19 :	78	75	77	78	80	80	79	77	77	78	77	74	72	72	67	58	48	43	38	36	36	35	36	41	51	59	64	65	60	55	56
20 :	79	76	77	78	80	81	80	77	76	77	76	74	72	71	69	60	49	43	40	38	39	37	37	41	50	59	63	64	60	55	52
21 :	79	77	76	77	79	80	79	77	75	75	76	75	71	70	69	62	51	44	41	40	41	40	39	42	51	59	63	64	60	54	50
22 :	80	77	76	77	79	81	80	77	74	74	75	74	71	70	69	64	55	45	42	43	43	42	40	43	51	59	64	64	60	54	51
23 :	80	77	76	76	78	80	80	77	74	74	75	74	71	69	69	66	57	47	44	46	46	43	42	43	51	60	64	63	58	53	50
24 :	81	78	76	76	78	80	80	78	74	73	74	74	71	69	69	67	59	49	46	48	48	45	44	44	51	60	64	63	58	52	50
25 :	82	79	76	76	77	79	81	79	74	73	74	74	71	69	68	68	62	51	49	51	50	47	45	45	51	60	64	63	58	52	50
26 :	83	80	77	76	77	79	81	79	75	72	73	74	72	68	68	68	63	54	52	53	51	49	47	46	52	60	63	62	57	52	50
27 :	85	81	78	77	77	78	80	80	76	72	73	74	72	69	67	68	64	57	55	56	53	51	49	48	53	60	63	61	57	53	49
28 :	86	82	79	78	78	78	80	81	78	73	73	74	72	69	68	67	65	60	58	58	55	52	51	49	54	60	62	60	56	52	50
29 :	88	84	80	79	79	79	80	81	79	75	73	75	73	70	68	68	66	63	61	60	57	54	52	51	54	60	62	60	56	53	50
30 :	88	86	82	80	81	81	81	82	80	77	76	75	74	71	69	68	67	66	64	62	59	56	54	53	55	60	62	60	55	53	51
31 :	89	88	84	83	84	84	83	83	82	80	79	78	77	74	72	71	69	68	66	64	61	58	56	54	56	61	62	59	55	53	51
32 :	89	89	87	86	86	86	85	84	83	82	82	80	80	78	76	74	72	70	69	66	63	60	58	56	57	61	62	59	55	53	52
33 :	89	89	88	88	89	89	88	86	85	85	84	82	81	80	78	77	75	73	70	68	65	62	60	58	59	61	62	58	55	53	52
34 :	89	89	90	90	92	91	90	89	87	87	86	84	83	81	80	79	77	75	72	70	67	64	62	59	60	62	61	58	55	54	52
35 :	89	89	91	92	93	92	91	90	89	88	87	86	84	82	81	80	78	76	74	72	69	66	64	61	62	63	61	57	55	54	53
36 :	90	89	93	94	94	93	92	91	90	90	89	87	86	84	83	82	80	78	76	74	71	68	66	63	63	63	61	57	55	54	54
37 :	92	91	94	95	94	93	93	92	91	90	90	89	87	86	84	83	81	79	77	75	73	71	68	65	65	64	62	58	56	55	54
38 :	93	93	95	96	95	94	93	93	92	91	91	90	88	87	86	84	82	81	79	77	75	73	70	67	66	65	62	58	56	56	54
39 :	94	95	96	96	96	95	94	93	93	92	91	91	89	88	87	85	84	82	81	79	77	75	72	70	68	66	63	59	57	56	55
40 :	95	96	96	97	96	95	95	94	93	93	92	91	90	89	88	86	85	84	82	80	79	77	75	72	70	67	64	60	57	56	56

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1943, arriving from sheltered approach direction of 214 deg azimuth, period = 10.8 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	4	5									
2 :																			3	3	4	5	5								
3 :	117	90	71	65														3	3	3	3	3	4	5							
4 :	109	83	67	56	52	48	63											3	3	2	2	3	3	5	8						
5 :	102	78	62	53	47	43	46	72	108									4	3	2	2	2	3	5	10						
6 :	85	64	52	44	42	40	36	48	76									4	3	2	2	2	3	4	10	2[illegible]					
7 :	77	58	51	43	39	37	33	40	58								5	4	3	2	2	3	3	4	10	20					
8 :	76	53	45	39	35	33	32	36	49							10	6	5	3	3	2	3	3	4	10	18	2[illegible]				
9 :	71	53	45	38	34	33	31	34	44						25	12	7	5	4	3	3	3	3	4	11	16	25				
10 :	67	50	41	35	31	30	30	32	39	47	50	54	55	46	29	14	8	5	4	3	3	3	4	5	9	15	22	33			
11 :	67	49	38	34	30	29	29	31	36	40	45	51	53	48	33	16	9	6	5	4	3	3	4	5	10	14	21	30	40		
12 :	65	47	38	32	29	28	29	30	34	37	42	47	51	49	36	20	11	7	5	4	4	4	5	6	11	14	21	30	39	53	
13 :	65	47	37	31	28	28	28	30	32	36	39	44	49	49	40	23	13	9	6	4	4	4	5	7	11	14	19	27	35	46	70
14 :	64	45	36	29	27	27	27	28	31	34	37	41	46	48	42	28	15	10	7	5	4	5	5	8	12	15	19	24	31	42	65
15 :	64	45	35	29	26	26	27	28	31	34	36	39	44	47	43	31	18	12	8	6	5	5	6	9	12	16	19	22	28	38	64
16 :	63	43	35	28	25	25	26	27	29	32	35	37	41	45	42	33	22	14	9	7	6	5	6	10	13	16	19	22	27	40	59
17 :	64	44	33	27	25	25	26	27	28	31	34	36	40	44	43	35	24	16	11	8	7	6	7	11	14	17	19	23	27	37	57
18 :	65	44	33	27	25	25	26	26	28	30	32	34	38	42	43	36	25	18	13	9	7	6	8	12	15	17	20	23	31	35	61
19 :	64	43	32	26	24	24	25	25	26	28	31	33	37	41	42	36	26	19	15	10	8	7	9	13	16	18	20	24	32	36	61
20 :	65	44	32	25	24	24	25	25	26	28	30	33	36	39	42	37	27	20	16	11	9	8	10	13	17	19	20	25	34	40	54
21 :	66	44	31	25	23	23	24	24	25	26	29	32	34	37	40	38	29	20	17	13	11	10	11	14	17	19	21	27	34	42	53
22 :	67	45	31	24	23	23	24	24	24	25	28	31	32	35	38	39	31	21	17	14	12	11	11	15	18	20	22	28	35	43	54
23 :	68	44	31	24	22	23	24	24	24	24	27	31	32	33	37	39	33	22	17	15	13	12	13	15	18	21	23	29	36	45	56
24 :	70	46	31	24	22	23	23	24	23	24	26	30	32	32	35	38	34	24	18	16	15	13	14	16	19	21	24	30	38	47	57
25 :	72	46	30	24	22	22	23	24	23	23	26	29	31	31	33	37	35	25	19	18	16	14	15	16	19	22	25	31	41	50	58
26 :	75	47	31	24	21	21	23	24	23	22	25	29	31	30	31	35	35	26	20	19	18	15	16	17	20	23	26	32	44	52	58
27 :	78	49	31	24	21	21	22	24	23	22	24	28	30	30	30	33	35	27	21	20	19	17	16	18	20	24	26	34	48	54	56
28 :	83	52	32	24	21	20	21	23	23	21	22	27	30	29	28	31	33	27	22	22	20	18	17	19	21	24	28	38	50	54	56
29 :	88	55	34	24	21	20	21	22	22	21	21	26	29	28	28	29	31	28	24	23	22	19	18	20	22	25	30	41	51	55	56
30 :	93	60	36	25	22	20	20	22	22	20	21	25	28	28	27	28	30	28	25	24	23	20	19	21	23	25	33	43	52	56	55
31 :	98	66	39	26	22	20	19	21	21	20	20	24	27	27	26	26	28	28	27	26	24	21	20	22	23	26	35	46	53	56	55
32 :	103	72	43	27	23	20	19	20	21	20	20	23	26	27	26	25	27	28	28	27	25	23	21	23	24	27	37	48	53	55	55
33 :	107	78	49	30	25	20	19	19	20	20	20	22	25	27	27	26	27	28	29	28	26	24	22	24	25	29	40	49	53	54	53
34 :	110	84	56	34	27	21	19	19	20	20	20	22	24	27	27	26	27	29	29	29	27	25	24	25	25	31	42	49	53	54	52
35 :	114	88	61	39	30	23	20	19	20	20	21	22	24	26	27	27	28	30	30	30	29	26	25	26	26	34	44	49	53	54	52
36 :	118	91	66	45	33	24	21	19	19	20	21	22	24	26	27	28	29	30	31	31	30	27	27	27	28	36	44	49	53	54	51
37 :	123	94	70	52	36	26	22	20	20	20	21	22	24	26	27	28	30	31	32	32	31	28	28	28	30	38	45	50	54	53	49
38 :	127	100	75	59	41	29	23	21	20	20	21	22	24	26	28	29	31	32	33	33	32	30	29	29	32	39	45	50	53	52	47
39 :	129	106	81	66	46	32	25	22	20	20	21	22	24	26	28	30	31	33	34	34	33	31	31	31	32	39	46	51	52	50	46
40 :	130	111	88	73	52	36	27	23	21	20	21	22	24	27	28	30	32	34	35	36	35	32	33	32	34	40	47	51	51	49	44

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1953, arriving from sheltered approach direction of 251 deg azimuth, period = 19.2 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				9	11	13									
2 :																			10	9	11	13	13								
3 :	146	139	135	144														11	8	8	9	9	11	18							
4 :	138	131	128	127	133	131	170											11	8	7	7	8	10	17							
5 :	131	125	122	122	121	119	128	186	158									12	8	7	7	7	10	16	30						
6 :	111	105	104	103	110	109	102	136	202									14	8	7	7	8	10	12	30						
7 :	101	96	104	102	101	102	95	118	163								21	15	9	8	8	8	9	12	30	54					
8 :	101	90	94	92	91	92	92	109	146							65	23	17	10	9	8	8	10	12	29	49					
9 :	95	90	94	92	90	92	90	104	134						133	75	27	19	11	9	9	9	11	14	29	44	62				
10 :	91	86	88	85	83	83	89	98	122	144	147	154	164	163	137	83	33	20	13	10	10	10	12	16	26	39	56	77			
11 :	91	86	83	85	82	82	87	97	115	127	139	146	155	158	139	91	40	22	15	11	11	11	13	17	27	36	52	71	89		
12 :	88	84	83	80	78	80	85	95	110	123	133	140	150	155	140	98	47	25	17	12	12	12	14	18	28	36	51	71	86	112	
13 :	89	84	83	80	77	79	83	94	107	120	129	135	144	150	140	103	54	28	19	14	13	13	15	20	29	37	47	62	78	98	133
14 :	87	82	80	76	75	77	82	92	105	118	126	132	139	144	139	108	61	31	22	15	15	14	16	23	30	37	45	55	69	89	123
15 :	87	82	80	76	74	76	82	92	106	119	124	129	135	142	139	112	68	35	24	18	16	16	17	25	32	39	44	52	64	81	121
16 :	86	80	80	73	71	73	79	89	102	114	123	125	131	136	133	112	74	40	26	20	18	17	19	27	33	39	44	51	59	82	113
17 :	86	81	78	73	71	73	79	89	101	114	123	125	130	134	131	112	77	44	29	22	20	19	21	28	34	40	45	52	60	76	104
18 :	87	81	78	73	70	72	79	89	101	113	119	123	127	130	129	112	79	48	32	24	23	21	23	30	36	40	45	53	65	72	107
19 :	86	80	76	70	68	70	77	87	98	109	119	123	127	128	125	109	80	51	34	27	25	23	25	31	37	41	44	54	67	74	103
20 :	86	81	76	70	68	70	77	87	98	109	116	124	127	127	123	108	80	52	36	29	28	26	27	32	38	42	45	56	70	77	92
21 :	86	81	75	69	66	68	75	86	97	106	115	124	125	123	119	106	82	53	37	31	30	29	29	34	39	42	46	58	71	78	89
22 :	87	82	75	69	66	68	75	84	96	104	112	121	123	120	115	105	84	54	38	34	33	31	31	35	40	43	48	60	72	80	89
23 :	86	81	75	67	65	67	74	85	96	104	111	121	124	120	112	103	85	56	39	36	36	34	33	36	40	44	49	61	72	81	90
24 :	86	81	74	67	65	67	73	84	96	102	109	119	125	118	109	100	84	57	40	38	39	36	35	36	40	45	51	63	74	83	90
25 :	85	80	73	67	64	66	73	85	96	102	108	117	124	119	105	98	83	57	42	41	42	39	37	37	41	46	52	65	78	84	89
26 :	85	80	73	66	63	65	72	84	96	101	105	117	125	117	103	94	81	58	44	44	44	41	39	38	41	46	53	66	81	87	89
27 :	84	80	72	65	63	65	71	84	96	99	104	116	124	116	101	90	79	58	47	47	47	43	40	40	42	47	54	69	85	88	86
28 :	84	80	72	65	63	64	71	83	95	97	101	114	122	115	99	86	75	58	50	49	49	45	42	41	43	47	57	74	85	87	85
29 :	83	80	71	64	62	64	70	82	93	96	99	114	120	113	98	83	71	59	52	51	51	47	43	42	44	48	60	76	86	87	84
30 :	83	80	71	64	63	65	70	81	92	95	99	113	119	112	96	80	69	59	54	53	52	49	45	44	45	50	64	78	86	87	83
31 :	82	80	71	64	63	66	71	79	89	95	101	112	117	110	95	78	66	60	56	55	54	51	47	46	46	51	67	80	86	86	83
32 :	82	79	71	64	65	68	72	79	88	95	103	112	116	110	95	78	66	60	58	56	55	52	49	47	47	53	69	82	85	84	82
33 :	81	79	71	66	67	71	74	79	87	95	105	113	116	110	95	78	67	61	59	57	56	54	51	49	48	56	72	82	84	83	81
34 :	80	78	71	67	70	73	76	80	87	96	107	115	116	109	94	79	68	62	59	58	57	55	53	50	49	59	74	81	83	83	80
35 :	79	78	71	69	72	75	78	82	88	97	109	117	117	107	93	79	68	62	60	59	58	57	55	52	51	63	75	81	83	82	79
36 :	79	77	72	72	74	77	80	83	88	98	110	119	118	108	92	79	68	63	60	60	60	59	57	53	54	65	75	80	83	82	78
37 :	79	76	73	73	75	78	81	84	89	99	111	121	120	109	93	78	68	63	61	60	61	60	59	55	56	67	75	80	83	81	77
38 :	79	76	74	75	77	79	82	85	90	100	112	122	121	109	93	78	68	63	61	61	62	62	61	58	59	68	76	81	82	80	75
39 :	79	77	76	76	78	80	83	86	91	100	113	123	121	108	92	77	68	63	61	62	63	64	64	60	60	69	77	81	81	79	74
40 :	79	78	77	77	79	81	84	87	92	101	114	124	121	108	90	76	67	63	62	63	65	65	66	62	62	70	78	81	80	77	73

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1969, arriving from sheltered approach direction of 264 deg azimuth, period = 14.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				9	12	14									
2 :																			11	9	12	14	14								
3 :	174	170	172	191														11	9	9	9	9	12	19							
4 :	164	161	164	169	179	173	179											11	8	8	7	8	11	18							
5 :	156	153	157	162	165	159	159	203	24									12	8	7	7	7	11	16	33						
6 :	132	129	133	138	150	147	128	147	189									13	9	8	7	8	10	13	32						
7 :	120	117	133	138	140	138	121	129	153								20	14	10	8	8	8	10	12	32	58					
8 :	120	110	121	125	127	126	117	121	137							40	23	15	11	9	9	9	10	13	31	53					
9 :	113	110	120	124	126	127	116	116	127						79	46	25	18	12	10	9	10	11	15	31	47	65				
10 :	108	105	112	116	117	117	115	112	116	115	102	100	105	103	84	52	29	20	13	11	10	10	12	17	28	42	60	80			
11 :	109	106	107	115	116	116	114	111	110	101	96	94	98	101	87	58	33	22	15	12	11	11	14	18	29	39	55	74	90		
12 :	105	102	107	109	112	115	113	110	106	98	91	89	94	99	89	63	37	25	17	13	13	12	15	19	30	38	54	74	87	108	
13 :	106	102	107	109	110	113	112	110	104	96	87	84	89	95	90	69	41	28	20	14	14	14	16	22	31	39	49	64	79	94	121
14 :	103	99	103	104	108	112	111	108	103	94	85	80	85	91	91	73	46	31	22	16	15	15	17	24	32	39	47	57	69	85	110
15 :	104	99	103	104	107	111	113	110	104	95	83	77	81	88	91	77	52	34	25	18	17	16	18	26	33	41	46	53	64	77	106
16 :	102	97	102	101	104	108	110	108	101	91	82	75	77	84	87	78	57	38	27	21	19	18	20	28	35	40	46	52	59	76	99
17 :	103	98	99	100	104	109	111	108	101	91	81	74	75	81	85	79	60	42	30	23	21	20	22	30	36	41	46	53	59	70	90
18 :	103	98	99	100	104	109	112	109	101	91	79	71	72	77	84	79	62	45	33	26	24	22	24	31	37	41	46	54	63	67	89
19 :	102	97	96	97	101	107	110	108	99	88	78	71	70	75	81	78	62	47	36	28	26	25	26	33	38	42	45	54	64	67	84
20 :	102	97	96	97	101	107	111	109	99	87	76	70	69	73	79	77	63	48	38	31	29	27	28	33	39	42	46	56	65	68	75
21 :	103	98	95	94	98	105	110	108	98	85	75	70	67	69	76	76	65	49	39	34	32	30	30	35	40	42	47	57	65	68	71
22 :	103	98	95	94	98	105	111	108	97	83	73	68	65	66	72	76	68	50	40	36	35	33	32	36	40	43	48	58	66	68	70
23 :	102	97	95	93	96	104	110	109	99	83	71	67	64	64	69	75	70	52	41	39	38	36	34	36	40	44	49	59	65	67	69
24 :	103	98	93	92	96	104	109	109	98	81	70	66	64	62	66	73	70	54	43	42	42	38	36	37	40	45	50	60	66	67	69
25 :	102	97	92	91	95	102	110	111	99	81	69	64	63	61	63	70	70	55	45	45	44	41	38	38	40	45	51	61	67	67	67
26 :	102	97	91	90	94	101	109	111	100	80	67	64	63	60	60	67	69	56	47	48	47	43	40	39	41	45	52	61	68	67	66
27 :	101	96	91	90	94	100	108	111	100	79	65	63	62	59	58	64	68	57	50	51	50	45	41	40	41	46	53	63	69	67	63
28 :	101	96	91	89	93	99	107	111	100	78	63	62	61	58	57	61	64	58	53	54	52	47	42	41	42	46	54	65	69	65	62
29 :	101	97	90	88	92	98	105	109	100	78	62	61	59	57	56	58	62	59	56	56	55	49	44	42	42	46	56	65	68	64	62
30 :	100	97	90	87	92	98	105	108	99	79	62	60	59	57	55	57	60	60	59	59	57	51	45	43	42	47	58	65	66	63	61
31 :	99	96	90	87	92	100	105	106	98	79	64	59	57	56	55	55	58	61	62	61	58	53	47	44	43	48	59	66	65	62	60
32 :	98	96	90	87	94	101	106	106	98	81	65	59	56	56	56	56	59	61	64	63	60	55	48	45	43	49	60	65	64	60	60
33 :	97	95	90	88	95	104	107	106	98	83	67	59	56	56	56	58	60	64	65	65	61	56	50	46	44	51	61	64	61	59	59
34 :	96	94	89	90	98	106	110	108	99	85	70	60	56	56	57	59	62	65	67	66	63	58	52	47	45	52	61	62	60	58	58
35 :	95	93	89	91	99	108	112	110	101	87	72	61	56	55	57	60	64	67	68	68	65	59	53	47	46	54	61	61	59	58	58
36 :	95	92	89	93	100	108	113	112	103	89	74	63	57	56	57	61	65	68	70	69	66	61	55	48	47	54	60	59	58	57	58
37 :	95	91	89	93	101	108	113	113	105	91	76	64	58	57	59	62	66	69	71	70	67	62	56	49	48	55	59	58	57	57	58
38 :	95	91	90	94	101	108	114	114	107	93	78	65	59	58	60	63	67	70	72	72	69	63	58	51	49	54	58	57	56	56	58
39 :	95	92	91	95	101	108	114	115	109	96	80	67	60	58	60	64	68	71	73	73	70	65	59	52	50	54	57	56	55	56	58
40 :	95	94	92	95	101	107	114	116	111	98	82	68	61	59	61	64	69	72	74	74	71	66	60	53	51	54	57	56	54	55	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1980, arriving from sheltered approach direction of 248 deg azimuth, period = 14.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	5	6									
2 :																			5	4	5	6	6								
3 :	198	182	167	165														5	4	4	4	4	5	8							
4 :	187	172	159	146	136	114	118											5	4	3	3	4	5	8							
5 :	179	164	153	140	124	103	90	106	130									6	4	3	3	3	5	7	15						
6 :	151	139	130	119	112	95	71	74	96									6	4	3	3	4	4	6	15						
7 :	138	126	130	119	104	88	66	64	75								8	6	5	4	3	4	4	5	15	29					
8 :	139	119	118	108	95	80	64	59	65							16	9	6	5	4	4	4	4	6	15	26					
9 :	131	120	119	108	95	81	63	55	58						37	18	11	7	5	4	4	4	5	6	15	23	35				
10 :	126	115	112	101	88	73	62	53	52	55	55	61	65	59	41	21	13	8	6	5	4	5	5	8	14	21	32	47			
11 :	127	116	107	101	87	73	61	52	49	47	50	56	62	60	45	25	15	9	6	5	5	5	6	8	14	19	30	43	57		
12 :	124	112	107	97	84	72	60	51	46	44	46	52	59	60	49	29	17	11	7	6	5	5	7	9	15	20	30	43	55	75	
13 :	125	113	108	97	83	71	59	50	44	42	43	48	56	59	51	33	19	13	8	7	6	6	7	10	16	20	27	38	50	65	96
14 :	123	111	105	93	82	71	58	49	43	40	41	45	52	57	53	38	22	16	10	7	7	7	8	12	16	21	27	34	44	59	88
15 :	124	112	105	94	81	70	59	49	42	40	39	42	49	55	54	42	26	18	12	8	7	7	8	13	17	22	26	32	41	54	87
16 :	123	110	106	92	79	68	57	47	40	37	38	40	46	52	52	44	30	20	14	9	8	8	9	14	18	22	27	32	38	56	81
17 :	125	112	104	92	80	69	58	47	40	36	37	39	44	50	52	45	32	22	16	11	10	9	10	15	19	23	27	32	39	52	76
18 :	126	113	105	93	81	69	58	47	39	35	35	37	42	48	51	46	33	24	18	12	11	10	12	17	20	24	27	33	43	49	81
19 :	125	113	103	91	79	68	57	46	37	33	34	36	40	46	50	46	34	25	20	14	12	11	13	18	21	24	27	33	45	51	79
20 :	127	115	105	92	80	69	58	46	37	32	32	35	39	44	49	46	35	26	21	16	14	12	14	18	23	25	28	36	47	55	71
21 :	128	117	104	91	79	68	57	45	35	31	31	34	37	41	47	46	37	27	22	18	15	14	15	20	23	26	29	38	48	56	68
22 :	130	119	105	92	80	69	58	44	34	29	30	33	35	39	44	46	39	28	22	19	17	16	16	21	24	27	30	39	49	59	69
23 :	129	119	107	92	80	69	57	45	34	28	29	32	34	37	42	46	41	29	23	20	19	17	18	21	25	28	32	40	50	60	70
24 :	131	121	107	94	82	70	57	44	33	27	28	31	34	35	39	44	42	31	23	22	21	19	19	22	25	29	33	42	52	62	71
25 :	131	122	108	94	82	70	57	45	33	26	27	30	33	34	37	43	42	32	24	24	23	20	21	22	26	30	34	43	55	64	71
26 :	131	123	109	95	83	70	57	44	32	25	26	30	33	33	35	41	42	32	26	26	25	22	22	23	27	31	35	45	59	67	71
27 :	131	124	110	97	84	71	57	44	32	25	25	29	32	32	33	38	41	33	27	27	26	24	23	24	27	32	36	48	64	68	68
28 :	131	125	112	98	86	71	56	44	32	24	23	28	31	31	32	36	39	34	29	29	28	25	24	26	29	32	38	52	65	68	68
29 :	130	127	114	99	87	72	56	42	31	23	22	27	30	31	31	34	36	34	31	31	30	27	25	27	29	33	41	55	66	68	68
30 :	128	128	116	101	90	73	56	41	30	23	22	26	30	31	31	32	35	34	33	32	31	29	27	28	30	34	44	57	66	69	66
31 :	126	129	118	104	93	76	56	40	29	23	22	25	28	30	30	30	33	34	34	34	33	30	28	30	31	35	47	60	67	68	66
32 :	122	128	120	107	98	80	57	39	29	23	22	24	27	29	30	30	32	34	35	36	34	31	29	31	32	36	50	62	67	67	65
33 :	118	125	121	111	103	84	59	39	29	24	22	23	26	29	30	30	32	35	37	37	36	33	31	32	33	39	53	63	66	66	64
34 :	114	122	120	115	110	91	63	40	28	24	22	23	26	29	30	31	33	36	38	38	37	34	33	33	34	42	55	62	66	66	62
35 :	110	117	118	118	116	98	67	42	29	24	23	23	25	28	30	32	34	37	39	40	38	36	35	35	35	45	56	62	65	65	61
36 :	107	112	114	120	121	104	73	45	30	25	23	24	25	28	30	32	35	38	40	41	40	38	36	36	37	47	57	62	65	65	60
37 :	106	106	110	121	125	111	79	48	31	25	24	24	26	28	30	33	36	38	41	42	41	39	38	37	39	49	57	62	65	64	58
38 :	104	103	107	120	128	117	87	53	34	26	24	24	26	28	31	34	37	39	42	43	43	41	40	39	41	50	57	63	65	62	56
39 :	102	101	106	119	129	122	94	58	36	27	24	24	26	28	31	34	37	40	43	45	45	42	42	41	42	51	58	63	63	60	55
40 :	100	100	104	117	129	127	102	65	40	29	25	25	26	29	31	35	38	41	44	46	46	44	44	43	44	52	59	63	62	58	53

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 255 deg azimuth, period = 17.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	3									
2 :																			2	2	2	3	3								
3 :	123	91	67	55														2	2	1	2	2	2	3							
4 :	115	84	62	47	39	33	41											2	1	1	1	1	2	3							
5 :	108	78	58	44	35	29	30	47	69									2	1	1	1	1	2	3	5						
6 :	89	64	48	36	31	26	23	31	49									2	1	1	1	1	2	3	5						
7 :	80	57	46	35	28	24	21	26	37								3	2	1	1	1	1	2	2	5	11					
8 :	80	53	41	31	24	22	20	23	31							5	3	3	2	1	1	1	2	2	5	10					
9 :	74	52	40	30	24	21	20	22	28						13	6	3	3	2	2	1	2	2	2	6	9	13				
10 :	70	49	36	27	21	19	19	20	24	29	31	33	32	26	15	7	4	3	2	2	2	2	2	3	5	8	12	18			
11 :	70	48	34	26	20	18	18	20	23	25	28	31	31	27	17	8	4	4	3	2	2	2	2	3	5	7	12	17	23		
12 :	68	45	33	24	19	18	18	19	21	23	26	29	30	28	20	10	5	4	3	2	2	2	3	3	6	7	12	17	22	32	
13 :	68	45	32	23	18	17	17	19	20	22	24	27	29	28	22	12	6	4	4	2	2	2	3	4	6	8	11	15	20	27	44
14 :	66	43	30	21	17	17	17	18	19	21	23	25	28	27	23	15	8	5	4	3	2	2	3	4	6	8	10	13	17	24	41
15 :	66	42	29	21	17	16	17	18	19	21	22	24	26	27	24	17	10	6	4	3	3	3	3	5	7	9	10	12	16	22	40
16 :	65	41	28	19	16	16	16	17	18	20	21	22	25	26	24	18	12	7	5	4	3	3	3	5	7	9	10	12	15	23	37
17 :	66	41	27	18	15	15	16	16	17	19	21	22	24	26	24	19	13	9	6	4	3	3	4	6	8	9	11	12	15	21	36
18 :	67	40	26	18	15	15	16	16	17	19	20	21	23	24	24	20	14	10	7	5	4	3	4	6	8	9	11	13	17	20	40
19 :	66	39	25	17	14	15	15	16	16	17	19	20	22	24	24	20	14	10	8	5	4	4	5	7	9	10	11	13	19	21	41
20 :	67	40	24	16	14	15	15	15	16	17	18	20	21	23	24	21	15	11	9	6	5	4	5	7	9	10	11	14	19	24	36
21 :	68	40	23	15	13	14	15	15	15	16	18	19	20	22	23	21	16	11	9	7	6	5	5	8	9	10	11	15	20	25	35
22 :	69	40	23	15	13	14	15	15	15	15	17	19	19	20	22	21	17	12	9	8	6	6	6	8	10	11	12	16	20	27	37
23 :	69	39	22	14	13	13	14	15	14	15	16	18	19	19	21	22	18	12	9	8	7	6	7	8	10	11	13	16	21	28	39
24 :	71	40	21	14	12	13	14	14	14	14	16	18	18	18	20	21	19	13	10	9	8	7	7	9	10	12	13	17	22	31	41
25 :	74	40	21	13	12	13	14	14	14	14	15	17	18	18	19	21	19	14	10	9	9	8	8	9	10	13	14	17	24	32	42
26 :	76	40	20	13	12	12	13	14	14	13	15	17	18	17	17	20	20	14	11	10	9	8	8	9	11	13	14	18	27	35	43
27 :	81	42	20	13	12	12	13	14	14	13	14	17	18	17	17	19	19	15	11	11	10	9	9	10	11	13	15	19	30	37	43
28 :	86	44	21	13	12	11	13	14	14	13	13	16	17	16	16	17	18	15	12	12	11	10	9	10	12	14	16	22	32	38	44
29 :	93	47	21	13	11	11	12	13	14	12	13	16	17	16	15	16	17	15	13	12	12	10	10	11	12	14	17	24	33	40	45
30 :	100	52	22	13	12	11	12	13	13	12	12	15	17	16	15	15	17	15	14	13	12	11	10	12	13	14	19	26	35	41	45
31 :	108	59	24	13	12	11	11	12	13	12	12	14	16	16	15	14	15	15	14	14	13	12	11	12	14	15	20	28	36	42	46
32 :	116	67	28	14	12	11	11	12	13	12	12	14	15	16	15	14	15	15	15	15	14	12	12	13	14	16	22	31	37	42	47
33 :	123	76	33	16	13	11	11	12	12	12	12	13	15	16	15	14	14	15	15	15	14	13	12	14	14	17	24	32	38	43	47
34 :	130	85	41	18	14	11	11	11	12	12	12	13	14	15	15	14	15	16	16	16	15	14	13	14	15	18	26	33	39	44	47
35 :	136	92	48	22	16	12	11	11	12	12	12	13	14	15	15	15	15	16	16	16	16	14	14	15	15	21	27	34	40	45	47
36 :	144	100	55	28	17	12	11	11	12	12	13	13	14	15	15	15	16	16	17	17	16	15	15	16	17	22	28	34	42	46	48
37 :	152	108	61	36	18	13	12	11	11	12	13	13	14	15	15	16	16	17	17	18	17	16	16	16	18	24	29	36	43	47	47
38 :	157	120	71	43	20	14	12	12	12	12	13	13	14	15	16	16	17	17	18	18	18	17	17	17	19	24	30	37	44	47	46
39 :	159	131	83	53	24	16	13	12	12	12	13	13	14	15	16	16	17	18	18	19	19	17	18	19	20	25	32	39	44	47	46
40 :	157	141	97	63	29	18	14	13	12	12	13	13	14	15	16	17	17	18	19	20	20	18	19	20	21	27	33	40	45	46	46

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1969, arriving from sheltered approach direction of 261 deg azimuth, period = 20.5 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				38	45	51									
2 :																			46	38	45	51	50								
3 :	145	143	144	158														51	39	34	35	35	42	69							
4 :	137	135	137	140	147	143	173											50	36	32	30	31	37	66	1[illegible]						
5 :	131	129	132	135	136	131	133	176	212									53	38	31	31	31	36	62	109						
6 :	111	110	113	115	124	121	109	129	171									55	40	34	33	33	36	50	103	1[illegible]					
7 :	103	101	113	115	116	114	103	114	141								82	57	42	37	36	35	36	49	99	151					
8 :	103	98	104	106	106	105	100	107	127							111	85	60	45	40	39	38	39	50	88	128	1[illegible]				
9 :	98	97	104	105	105	105	99	103	119						123	111	88	64	48	42	42	41	42	53	83	113	133	[illegible]			
10 :	95	94	98	100	99	98	98	100	109	117	109	108	112	119	121	111	91	67	51	45	45	43	45	56	76	98	121	140	[illegible]		
11 :	95	94	95	99	98	97	97	99	105	105	105	104	107	115	118	111	93	71	54	48	48	46	48	58	74	89	107	128	139	[illegible]	
12 :	93	92	95	95	95	96	96	98	102	103	102	101	105	112	116	111	95	74	57	50	51	48	50	59	73	85	100	127	135	150	[illegible]
13 :	93	92	95	95	94	95	95	98	100	101	100	99	102	109	114	111	96	77	60	54	54	51	53	62	73	83	93	109	122	128	146
14 :	92	90	93	92	93	94	94	96	99	100	98	97	99	105	112	110	97	79	63	57	57	54	55	63	73	82	90	99	105	116	128
15 :	92	91	93	92	92	93	95	97	99	101	97	95	97	104	111	110	98	81	66	61	60	57	57	65	73	82	89	92	97	101	119
16 :	91	90	92	90	90	91	93	95	97	98	97	94	95	101	107	109	99	83	68	64	63	61	59	66	73	80	88	90	90	95	112
17 :	92	90	91	90	90	91	93	95	97	98	97	94	95	99	105	107	99	84	71	67	67	64	63	66	73	80	88	91	88	86	98
18 :	92	90	91	90	90	91	93	95	96	97	95	94	94	97	103	105	99	86	73	69	70	68	66	66	72	79	87	92	90	85	92
19 :	91	90	90	88	88	90	92	94	95	95	95	94	94	96	101	103	98	86	75	72	74	71	68	67	72	79	86	91	89	83	87
20 :	92	90	90	88	88	90	92	94	95	95	94	94	93	95	100	102	97	86	76	75	77	74	70	67	72	80	86	90	89	83	80
21 :	92	91	89	87	87	89	91	93	94	93	93	94	93	93	97	101	97	86	77	78	80	77	72	68	72	79	86	91	89	82	78
22 :	92	91	89	88	87	89	91	93	94	93	92	93	92	92	95	100	98	86	78	82	83	80	74	68	73	80	87	91	89	82	78
23 :	91	90	89	87	87	88	91	93	94	92	92	93	93	92	94	99	97	87	81	85	86	82	76	69	72	81	88	91	87	81	77
24 :	92	91	89	87	87	88	91	93	94	92	91	92	93	91	92	97	97	88	84	88	88	84	78	70	73	81	88	91	87	80	77
25 :	91	90	89	87	87	88	91	94	94	91	90	92	93	91	91	96	96	88	87	90	90	85	80	72	74	81	88	91	87	80	76
26 :	91	91	89	87	87	88	91	94	94	91	90	91	93	91	91	94	95	90	90	93	92	87	81	74	75	82	88	90	86	80	76
27 :	92	91	89	87	87	88	91	94	94	91	89	91	92	91	91	93	94	92	93	94	93	88	83	76	76	82	88	89	86	80	75
28 :	92	91	89	88	88	89	91	94	94	91	90	92	92	91	91	92	93	94	95	96	94	90	84	78	77	82	88	89	85	79	75
29 :	92	92	90	89	89	91	92	94	94	92	91	92	93	92	92	93	93	95	97	97	95	91	86	79	78	83	89	89	84	79	75
30 :	92	92	91	90	91	93	93	94	95	94	94	93	93	92	92	92	93	97	98	97	95	92	87	81	80	84	89	88	83	79	75
31 :	92	92	92	92	93	95	96	96	96	96	97	95	95	95	95	96	96	98	98	98	96	93	89	83	81	85	89	88	83	79	76
32 :	93	93	93	94	96	97	97	97	97	98	98	97	97	98	98	98	98	98	99	98	97	94	90	85	82	86	89	87	82	79	76
33 :	93	93	94	96	98	99	99	99	98	99	99	98	98	98	98	99	99	99	99	99	97	95	91	86	84	87	89	86	82	79	76
34 :	93	93	95	97	99	100	100	100	100	100	100	99	98	98	98	99	99	99	99	99	98	96	92	88	86	88	88	85	82	79	76
35 :	94	93	96	98	99	100	100	100	100	100	100	100	99	98	98	99	99	99	99	99	98	96	94	89	88	88	88	85	82	79	77
36 :	95	94	97	99	99	100	100	100	100	100	100	100	99	99	99	99	99	99	99	99	98	97	95	91	89	89	88	85	82	80	77
37 :	96	96	98	99	100	100	100	100	101	100	100	100	99	99	99	99	99	99	99	99	99	98	96	92	91	89	88	85	82	80	77
38 :	96	98	99	99	100	100	100	100	101	101	100	100	99	99	99	99	99	99	99	99	99	98	96	94	92	89	89	85	83	80	78
39 :	97	99	99	99	100	100	100	100	101	101	100	100	99	99	99	99	99	99	100	99	99	98	97	95	93	90	89	86	83	81	78
40 :	97	99	99	100	100	100	100	100	101	101	100	100	99	99	99	99	99	99	100	100	99	99	98	96	95	91	90	87	84	81	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1916, arriving from sheltered approach direction of 245 deg azimuth, period = 9.6 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				19	24	29									
2 :																			22	19	24	29	30								
3 :	124	124	127	139														21	19	18	19	20	25	45							
4 :	117	118	122	125	130	123	150											22	18	17	16	18	22	43							
5 :	111	112	117	120	120	114	115	158	208									23	18	16	17	17	21	41	79						
6 :	95	98	100	103	110	107	94	110	150									24	20	18	18	19	22	34	74	1[illegible]					
7 :	88	88	100	104	104	101	89	96	120								30	25	20	19	19	20	22	34	72	108					
8 :	88	84	92	96	96	94	87	90	106							41	32	26	22	21	21	21	24	34	63	94	1[illegible]				
9 :	84	84	92	95	95	94	87	87	97						54	43	34	28	23	22	22	23	26	36	60	83	96	[illegible]			
10 :	81	81	87	90	90	88	87	85	90	93	87	82	77	68	56	45	36	29	25	23	24	24	28	39	55	72	87	96	[illegible]		
11 :	82	82	84	89	89	88	86	85	87	84	82	80	76	69	58	47	38	31	26	25	26	26	29	40	54	66	75	87	90		
12 :	80	80	84	86	86	87	86	85	85	83	80	78	76	70	60	49	40	33	28	26	27	27	31	40	52	63	70	86	87	93	
13 :	80	80	84	86	85	85	84	84	85	82	78	76	75	71	62	51	42	35	30	28	29	29	32	42	53	61	65	73	78	79	88
14 :	80	79	83	84	84	84	83	83	84	82	78	75	74	71	64	54	44	37	32	30	31	30	33	43	53	60	63	66	67	71	76
15 :	80	79	83	84	84	83	83	83	84	83	78	74	73	71	65	56	46	39	34	33	33	32	34	43	53	60	63	61	61	61	70
16 :	80	78	82	83	83	82	82	81	82	82	79	74	72	71	65	57	49	41	36	35	35	34	36	44	53	59	62	60	56	57	67
17 :	81	78	81	82	83	82	81	81	82	82	79	75	73	71	66	58	50	43	38	37	37	37	38	44	52	59	62	60	55	51	58
18 :	81	79	81	82	83	83	81	80	81	81	79	75	73	71	67	59	51	45	40	39	39	39	39	44	52	58	61	60	55	51	54
19 :	81	79	80	81	82	82	81	79	79	80	79	75	73	72	68	60	51	46	42	41	42	41	41	44	52	58	60	59	55	50	51
20 :	82	79	80	81	82	83	81	79	79	79	78	76	73	72	70	62	52	47	44	44	44	43	42	44	52	58	59	58	55	50	48
21 :	82	80	80	80	82	83	81	79	78	78	78	76	73	72	71	64	54	48	45	46	46	44	43	45	52	58	60	59	55	50	47
22 :	82	80	80	80	82	83	82	79	77	77	78	76	73	71	71	66	57	49	47	49	48	46	45	45	52	58	60	58	55	50	47
23 :	83	80	80	80	81	83	82	79	77	77	77	76	73	71	71	68	60	51	49	51	50	48	47	46	52	58	60	58	54	49	47
24 :	83	81	80	80	81	83	83	80	77	76	77	76	74	71	71	69	62	53	52	53	52	50	48	47	52	58	60	58	54	49	47
25 :	85	82	80	80	80	82	83	81	77	76	77	77	74	71	71	70	64	55	55	56	54	51	50	48	52	58	60	58	54	49	47
26 :	86	83	81	80	81	82	83	82	78	76	77	77	75	72	71	70	66	59	57	58	56	53	51	50	53	58	59	57	53	50	47
27 :	87	84	82	81	81	82	83	83	79	76	77	77	75	72	71	70	67	62	60	60	57	55	53	51	54	58	59	57	54	51	47
28 :	88	86	83	82	82	82	83	84	81	77	77	78	76	73	72	71	68	65	63	62	59	57	55	53	54	58	59	57	54	50	48
29 :	90	87	85	83	84	84	84	85	83	80	79	79	78	75	73	72	70	68	66	64	61	58	56	54	55	58	59	57	54	51	49
30 :	91	89	86	85	86	86	85	86	84	82	82	80	79	76	74	73	71	71	68	66	63	60	58	56	56	58	59	57	53	51	49
31 :	91	90	88	88	89	89	88	88	86	86	85	83	82	80	78	77	74	73	71	68	65	62	60	58	57	59	59	57	53	52	50
32 :	91	91	90	91	91	92	90	89	88	88	88	86	85	84	82	80	78	75	73	70	67	64	62	59	59	60	59	56	54	52	50
33 :	91	92	92	93	94	94	92	91	90	90	89	88	87	85	84	82	80	78	75	72	69	66	64	61	60	60	59	56	54	52	51
34 :	91	91	94	94	95	95	94	93	92	92	91	89	88	86	85	84	82	79	77	74	71	68	66	63	62	61	60	56	54	53	51
35 :	92	91	95	95	96	95	95	94	93	93	92	91	89	88	86	85	83	81	79	76	73	71	68	65	63	62	60	57	54	53	52
36 :	93	92	96	96	96	96	95	95	94	94	93	92	91	89	88	86	85	83	81	78	75	73	70	67	65	63	60	57	55	54	53
37 :	94	95	97	97	97	96	96	95	95	94	93	93	92	90	89	88	86	84	82	80	78	75	72	69	67	64	61	57	56	55	53
38 :	96	96	97	98	97	97	96	96	95	95	94	93	92	91	90	89	87	86	84	82	80	77	74	71	69	65	62	58	56	55	54
39 :	96	98	98	98	97	97	96	96	96	95	95	94	93	92	91	90	88	87	85	83	81	79	77	74	71	67	64	60	57	56	55
40 :	97	98	98	98	98	97	97	96	96	96	95	95	94	93	92	91	90	88	87	85	83	81	79	76	73	68	65	61	58	57	55

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1914, arriving from sheltered approach direction of 214 deg azimuth, period = 9.9 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																															
2 :																				7	9	10									
3 :																			6	6	7	7	9								
4 :	179	174	174	173														7	6	6	5	6	8	13							
5 :	171	166	167	167	161	146	137	165	192									8	6	5	5	5	8	12	24						
6 :	144	140	141	141	147	135	111	118	147									8	7	5	5	6	7	9	23						
7 :	131	128	142	142	137	127	104	103	118								14	9	7	6	6	6	7	9	24	45					
8 :	132	120	129	129	125	116	101	97	105							27	16	10	7	7	6	6	7	9	23	40					
9 :	124	120	129	129	125	117	100	92	96						58	31	18	12	8	7	7	7	8	11	23	36	52				
10 :	119	115	121	121	116	107	99	89	87	85	77	81	87	83	63	35	21	14	9	8	7	7	9	13	21	32	48	67			
11 :	119	116	115	120	115	107	98	88	82	73	71	75	81	82	67	41	23	16	10	8	8	8	10	13	22	30	45	62	78		
12 :	116	111	116	115	111	106	97	87	78	70	66	69	78	81	71	46	26	19	12	9	9	9	11	14	23	30	44	62	76	98	
13 :	116	112	116	115	110	105	96	87	77	68	63	65	73	79	73	52	30	21	14	10	10	10	11	16	24	31	40	54	68	85	114
14 :	114	109	112	110	109	105	95	86	75	66	60	61	69	76	74	57	34	24	16	11	11	11	12	18	25	31	39	48	60	77	105
15 :	114	109	112	111	108	104	97	87	76	66	58	58	65	73	75	61	39	26	19	13	12	12	13	20	26	33	38	45	56	70	102
16 :	113	107	112	107	105	102	95	85	73	63	57	55	61	69	72	63	44	29	21	15	14	13	15	22	27	33	38	45	52	71	95
17 :	113	108	109	107	106	103	96	85	73	62	56	54	59	67	71	64	47	32	24	17	15	14	16	23	29	34	39	45	53	66	88
18 :	114	109	109	108	106	104	97	86	72	61	53	51	56	63	69	64	49	35	26	19	17	16	18	25	30	35	39	46	57	62	89
19 :	113	107	107	105	104	102	96	85	70	59	52	50	54	61	67	64	50	37	29	22	19	18	20	26	31	35	39	47	59	63	86
20 :	113	108	107	105	105	103	98	86	71	58	50	49	52	59	66	64	51	38	31	24	22	20	22	27	33	36	39	49	61	66	76
21 :	114	109	105	103	103	102	97	85	69	56	49	49	50	55	63	63	53	39	32	26	24	22	23	29	34	37	40	51	61	66	73
22 :	114	110	106	104	104	103	98	85	68	54	47	47	48	52	59	63	56	40	32	28	27	25	25	30	34	37	42	53	62	67	72
23 :	113	108	106	103	103	102	98	86	69	53	46	46	47	50	57	62	57	42	33	30	29	27	27	30	35	39	44	54	62	68	72
24 :	114	109	105	103	104	104	98	86	68	51	44	44	47	48	53	60	58	44	34	33	32	29	29	31	35	40	45	55	64	68	71
25 :	113	108	104	102	103	103	99	88	69	51	43	43	45	47	50	58	58	45	36	35	34	31	31	32	36	41	46	56	66	69	70
26 :	112	108	103	102	103	103	99	88	69	49	41	43	45	45	48	55	57	46	37	38	37	34	32	33	37	41	47	58	68	70	68
27 :	111	108	103	102	103	103	99	89	69	48	40	42	44	44	46	52	56	47	40	40	39	36	34	34	37	42	48	60	71	70	65
28 :	111	108	103	101	103	102	99	89	69	47	38	41	43	43	44	49	53	47	42	43	42	38	35	36	38	42	50	63	71	68	64
29 :	110	108	102	100	103	102	98	87	68	47	37	40	42	43	43	47	50	48	45	45	44	40	37	37	39	43	53	65	71	68	62
30 :	109	107	102	99	103	103	98	87	68	47	36	39	41	42	43	45	49	48	47	48	46	42	38	38	40	44	56	66	69	67	61
31 :	107	107	101	99	104	105	99	86	67	47	37	37	40	41	42	43	46	49	49	50	48	44	40	40	40	45	58	67	69	65	59
32 :	105	106	101	99	105	108	100	86	67	48	37	36	39	41	42	43	46	49	51	52	50	46	42	41	41	46	60	68	67	63	58
33 :	103	104	100	100	108	111	103	87	67	49	38	36	38	41	42	44	47	50	53	53	51	47	43	42	41	49	62	67	65	61	56
34 :	101	102	98	100	111	115	107	89	68	50	39	36	37	40	43	45	48	52	54	55	53	49	45	43	42	51	62	66	64	60	54
35 :	99	99	97	101	112	118	111	92	70	52	41	37	37	40	42	46	49	53	56	57	55	51	47	44	44	53	62	64	62	58	53
36 :	98	97	95	101	113	120	114	96	73	54	42	37	37	40	42	46	50	54	57	58	56	53	49	46	45	55	62	62	61	57	52
37 :	98	94	93	101	113	121	117	100	76	56	43	38	38	40	43	47	51	55	58	60	58	54	51	47	47	55	61	61	60	55	50
38 :	98	94	93	101	112	121	120	105	80	58	44	39	38	41	44	48	53	57	60	61	60	56	53	48	49	56	60	61	58	54	48
39 :	97	94	93	100	111	121	122	109	85	61	46	39	39	41	44	49	53	58	61	63	61	58	54	50	49	56	60	60	56	52	47
40 :	96	94	94	100	110	120	124	112	90	65	48	40	39	41	45	49	54	59	62	64	63	60	56	51	50	56	60	59	55	50	46

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1926, arriving from sheltered approach direction of 251 deg azimuth, period = 16.0 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				11	14	17									
2 :																			13	11	14	17	17								
3 :	154	147	145	157														14	11	10	11	11	14	22							
4 :	145	139	138	139	146	145	193											14	10	9	9	10	13	21							
5 :	138	133	132	133	134	132	141	199	147									16	10	9	9	9	13	20	39						
6 :	117	112	112	112	121	121	113	147	212									17	11	9	9	10	13	15	38						
7 :	107	102	112	112	112	113	106	128	172								27	19	12	10	10	10	12	15	38	68					
8 :	107	96	101	101	101	103	102	119	154							73	31	20	14	11	11	11	13	15	36	62					
9 :	100	96	101	100	100	102	100	113	143						130	81	36	22	15	12	12	12	14	17	37	55	76				
10 :	96	92	95	93	92	93	99	108	130	149	146	147	152	152	132	88	42	25	17	13	13	13	15	21	33	50	70	94			
11 :	97	92	90	93	91	92	97	107	124	132	139	140	144	147	132	94	49	27	19	15	14	14	16	22	34	45	65	87	108		
12 :	94	89	90	88	87	90	95	105	118	128	133	135	140	143	133	99	55	31	21	16	15	15	18	23	36	45	63	87	104	133	
13 :	94	90	90	87	85	88	93	104	116	126	129	130	134	138	131	103	61	34	24	18	17	17	19	26	36	46	57	75	94	116	147
14 :	92	87	87	84	83	87	92	102	114	123	127	127	130	133	130	106	67	39	26	20	19	18	20	29	38	46	56	68	83	104	142
15 :	93	88	87	83	82	85	93	103	115	124	125	125	127	131	129	109	73	43	29	22	21	20	22	31	39	48	54	63	77	95	134
16 :	91	86	87	81	79	82	90	100	111	120	125	122	123	125	124	109	78	47	32	25	23	22	24	33	41	47	54	62	72	95	125
17 :	92	87	84	80	79	82	89	100	110	120	124	122	122	123	121	108	80	51	35	27	26	24	26	35	42	49	55	64	73	87	114
18 :	92	87	84	80	78	82	89	100	110	119	121	120	119	119	119	107	82	55	38	30	28	27	29	37	43	49	55	65	77	84	114
19 :	91	86	82	78	76	79	87	97	108	116	121	120	119	118	115	104	81	57	40	32	31	29	32	38	45	49	54	66	79	85	108
20 :	91	86	82	77	76	79	87	98	108	115	118	120	119	116	113	102	81	58	42	35	34	33	34	39	46	50	54	68	82	87	97
21 :	92	87	81	76	74	77	85	96	106	113	118	120	117	112	109	100	82	59	43	38	38	36	36	41	47	50	56	70	82	87	93
22 :	92	87	81	76	74	77	85	95	105	111	115	118	115	110	105	99	84	59	44	40	41	39	38	43	48	51	58	72	83	88	92
23 :	91	86	81	74	72	75	34	96	106	111	114	118	116	109	102	97	84	60	45	43	44	42	41	43	48	53	60	73	83	88	91
24 :	92	87	80	74	72	75	83	95	106	109	111	116	117	108	99	94	83	61	46	46	48	45	43	44	48	54	61	75	85	89	91
25 :	91	86	79	74	72	74	83	96	106	109	111	114	116	108	96	92	82	61	48	49	51	48	45	45	48	55	63	77	87	89	89
26 :	90	86	79	73	71	74	82	95	106	108	108	114	116	106	94	89	80	61	51	52	54	51	47	46	49	55	64	78	89	90	87
27 :	90	86	79	72	71	73	81	95	105	107	107	113	115	105	92	85	78	62	53	55	56	53	49	48	50	56	65	81	92	90	84
28 :	89	86	78	72	70	72	80	94	105	105	104	112	114	104	90	82	74	62	56	58	59	55	51	49	51	56	68	84	92	88	83
29 :	89	86	78	71	70	73	80	92	103	104	103	111	112	103	89	78	71	63	59	60	61	58	53	51	52	57	71	86	91	87	81
30 :	88	86	78	71	71	74	80	91	102	103	104	111	111	102	88	76	69	63	62	63	63	60	55	53	53	59	75	87	90	86	80
31 :	88	86	78	71	72	75	81	90	100	103	105	110	109	100	87	75	67	64	64	64	64	62	57	54	54	61	77	88	89	85	78
32 :	87	85	78	72	73	77	82	89	98	103	108	110	109	101	88	75	68	65	65	66	66	63	59	56	55	63	79	88	87	82	78
33 :	86	85	78	74	76	80	84	90	97	104	110	111	109	100	88	77	69	67	67	67	67	65	61	57	56	66	81	87	85	80	76
34 :	86	84	78	76	79	83	86	91	98	106	112	113	109	100	87	77	71	68	67	68	68	67	63	59	58	68	82	86	83	79	74
35 :	85	84	79	78	81	85	89	93	99	107	114	115	109	99	87	78	71	69	68	69	70	69	66	61	60	71	82	84	82	78	73
36 :	85	83	79	80	83	86	90	94	99	108	115	117	111	100	87	78	72	69	69	70	71	70	68	62	62	73	82	83	81	77	72
37 :	85	83	80	82	85	87	91	94	100	108	115	118	112	100	88	78	72	69	69	71	72	72	70	64	65	74	81	82	81	76	70
38 :	85	83	82	83	86	89	91	95	101	109	116	119	113	101	88	78	72	70	70	72	74	74	72	67	67	75	81	82	79	75	69
39 :	86	84	84	85	87	90	92	96	101	109	117	119	113	100	87	78	72	70	71	73	75	75	75	69	68	75	81	81	77	73	68
40 :	86	86	85	86	88	90	93	96	102	110	118	120	113	100	87	77	72	70	72	74	76	77	77	71	70	76	81	80	76	71	67

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1926, arriving from sheltered approach direction of 259 deg azimuth, period = 13.8 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				20	25	27									
2 :																			24	20	25	29	29								
3 :	156	152	152	168														26	20	18	19	20	24	37							
4 :	147	143	145	149	158	154	189											26	19	17	16	17	21	37							
5 :	140	137	139	143	145	141	146	197	242									28	20	16	16	17	21	35	67						
6 :	119	116	118	121	132	130	118	142	192									29	21	17	17	18	21	27	65	1[illegible]					
7 :	109	106	118	121	123	123	111	125	157								47	31	22	19	18	19	21	27	65	108					
8 :	109	100	108	110	112	112	108	117	141							87	52	33	24	21	20	20	22	28	60	96	1[illegible]				
9 :	103	100	108	109	111	113	107	112	131						122	92	57	37	26	23	22	22	23	31	59	85	111				
10 :	99	96	101	103	103	103	106	108	120	127	119	119	125	130	122	96	63	40	29	24	24	23	25	35	53	75	101	129			
11 :	99	96	97	102	102	103	104	107	114	113	113	113	118	126	121	89	68	44	32	26	26	25	28	37	53	69	91	118	142		
12 :	97	94	97	97	98	101	103	106	110	110	109	108	114	122	121	103	73	48	34	28	28	27	30	38	54	66	86	118	135	159	
13 :	97	94	97	97	97	100	102	105	108	108	105	104	109	118	119	105	77	53	38	31	31	29	32	41	54	66	80	102	122	137	158
14 :	95	92	94	93	95	98	100	104	106	106	103	101	105	113	118	106	81	57	41	34	33	31	34	44	55	65	77	92	106	124	148
15 :	96	92	94	93	94	97	101	105	107	107	102	99	102	110	116	108	85	61	44	37	37	34	36	46	56	65	76	85	98	109	136
16 :	94	90	93	90	91	95	99	102	104	104	101	97	98	106	111	107	88	64	48	40	40	37	38	48	56	64	75	84	91	105	127
17 :	95	91	91	90	91	95	99	102	104	103	101	96	97	103	109	106	90	68	51	43	43	41	41	49	57	65	75	85	90	95	112
18 :	95	91	91	90	91	94	99	102	103	103	98	95	95	100	107	105	90	70	54	47	47	44	44	50	57	64	75	87	92	92	107
19 :	94	90	89	88	89	93	97	101	101	100	98	95	94	98	104	103	90	72	57	50	50	48	47	51	57	64	74	86	92	90	99
20 :	95	91	89	87	88	93	98	101	101	99	96	94	93	96	102	101	90	73	59	53	54	52	50	52	57	64	74	87	93	91	91
21 :	95	91	88	86	87	91	96	100	100	97	95	94	92	93	98	100	91	74	60	56	58	55	52	53	58	64	75	88	93	89	87
22 :	95	92	88	86	87	91	97	99	99	96	93	93	91	90	95	99	93	74	61	60	62	58	54	53	58	65	77	89	93	89	86
23 :	94	91	88	85	85	89	95	100	100	95	92	92	91	89	92	98	93	75	63	64	65	61	56	53	57	66	78	89	91	87	84
24 :	95	92	87	85	85	89	95	100	99	94	91	91	91	88	89	95	92	76	66	68	69	64	58	54	57	67	79	90	91	86	84
25 :	94	91	87	84	85	88	95	100	100	94	90	90	90	87	87	93	92	77	69	71	72	66	60	55	58	68	81	91	92	85	82
26 :	94	91	87	84	84	88	94	100	100	93	88	90	90	86	85	91	90	78	72	75	74	69	62	56	58	69	81	90	91	85	81
27 :	94	91	87	84	84	87	93	100	100	92	87	89	89	86	84	88	89	80	76	78	77	71	64	57	59	69	82	90	91	85	79
28 :	94	91	87	83	84	87	93	99	100	92	86	88	88	85	83	86	86	81	80	81	79	73	65	59	60	70	83	90	90	83	79
29 :	94	91	87	83	85	88	92	98	99	92	87	88	88	85	83	84	85	83	83	84	81	74	67	60	61	71	85	90	88	82	78
30 :	93	92	87	84	86	89	93	97	98	93	88	88	87	85	83	83	84	85	86	85	82	76	69	62	62	73	86	90	86	82	78
31 :	93	92	87	85	87	91	94	97	98	94	91	88	87	86	84	84	84	87	88	87	83	78	70	64	64	74	86	89	85	81	78
32 :	93	92	88	87	90	94	96	97	98	96	93	90	89	88	87	86	87	88	90	88	85	79	72	65	65	75	86	88	84	80	78
33 :	92	91	89	89	93	97	98	98	98	97	95	91	89	88	88	89	89	90	90	89	86	81	74	67	67	77	87	87	83	79	78
34 :	92	91	90	91	96	99	100	100	100	99	97	93	90	88	88	89	91	91	91	90	87	82	76	69	69	78	86	85	81	79	77
35 :	92	90	90	93	97	100	101	102	102	100	98	95	91	88	89	90	91	92	92	91	88	83	78	70	70	79	86	84	81	79	77
36 :	93	90	92	95	98	100	102	103	102	101	99	95	92	90	89	91	92	92	92	91	89	85	79	72	72	80	85	83	81	79	78
37 :	93	92	93	96	98	100	102	103	103	102	99	96	93	91	90	91	92	93	93	92	89	86	81	74	74	81	84	82	81	79	78
38 :	94	94	94	97	99	100	102	103	103	102	100	97	93	91	91	92	93	93	93	92	90	87	83	76	76	81	83	82	80	79	78
39 :	94	95	96	97	99	101	102	103	104	103	100	97	94	92	91	92	93	94	94	93	91	88	84	78	78	81	83	82	80	79	78
40 :	94	96	96	98	99	101	102	103	104	103	101	97	94	92	91	92	93	94	94	93	91	89	85	80	79	81	83	82	80	79	78

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1952, arriving from sheltered approach direction of 245 deg azimuth, period = 11.7 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	7	8									
2 :																			6	5	7	8	8								
3 :	183	185	194	220														6	5	5	5	5	7	11							
4 :	172	175	184	195	209	202	157											6	5	4	4	5	6	10							
5 :	163	166	176	187	192	185	181	219	241									6	5	4	4	4	6	9	19						
6 :	138	140	149	159	175	171	147	159	191									7	5	4	4	5	6	8	18						
7 :	125	127	149	159	164	161	138	141	156								11	7	6	5	4	5	5	7	19	38					
8 :	125	119	135	144	149	148	135	133	141							21	13	8	6	5	5	5	6	8	18	33					
9 :	117	119	135	143	149	149	134	128	130						46	25	14	9	6	6	5	5	6	8	19	29	43				
10 :	112	113	126	134	138	137	133	123	119	108	85	76	74	68	51	28	16	11	7	6	6	6	7	10	17	26	39	57			
11 :	112	113	119	133	137	137	132	122	114	95	80	71	70	68	54	33	19	12	8	7	6	6	8	11	17	24	37	52	69		
12 :	108	108	119	126	132	135	131	122	109	92	75	66	67	67	57	37	21	15	9	7	7	7	9	11	19	24	36	53	66	89	
13 :	108	108	119	126	130	134	130	122	108	90	72	62	63	65	59	41	24	17	11	8	8	8	9	13	19	25	33	46	60	78	112
14 :	105	105	114	120	128	133	129	121	107	88	70	59	59	62	60	46	27	19	13	9	9	8	10	15	20	26	33	41	53	70	103
15 :	105	105	113	120	127	132	132	124	108	89	68	56	56	60	60	49	32	21	15	10	10	9	11	16	21	27	32	39	49	64	100
16 :	103	102	113	116	123	129	130	121	105	86	67	54	52	57	58	50	36	24	17	12	11	10	12	18	22	27	32	38	46	66	94
17 :	103	102	109	115	123	130	131	123	106	85	66	53	51	55	57	51	38	26	19	14	12	11	13	19	24	28	33	39	47	61	88
18 :	104	102	108	114	123	131	133	124	106	85	64	51	48	51	56	51	39	28	21	16	14	12	14	20	25	29	33	40	51	58	92
19 :	102	100	105	111	120	129	131	123	104	82	63	50	47	50	54	51	40	30	23	17	15	14	16	21	26	29	33	41	54	60	89
20 :	102	100	104	110	119	130	133	125	105	82	60	49	45	48	53	51	40	31	25	19	17	16	18	22	27	31	33	43	56	64	80
21 :	102	101	102	107	117	127	132	124	104	79	59	48	43	45	50	50	42	32	26	21	19	18	19	24	28	31	35	45	57	65	77
22 :	102	101	101	106	116	128	134	124	103	77	57	46	41	42	47	50	44	32	26	23	21	20	20	25	29	32	36	47	58	68	78
23 :	100	99	101	104	114	126	133	127	105	77	55	45	41	40	45	49	45	34	26	24	23	22	22	25	30	33	38	48	59	69	78
24 :	101	99	98	103	114	126	133	127	105	75	53	44	40	39	42	47	46	35	27	26	26	23	24	26	30	35	39	50	61	71	79
25 :	99	97	97	101	111	125	134	130	106	74	52	42	39	38	39	46	46	36	28	28	28	25	25	27	31	36	41	52	65	73	79
26 :	98	96	95	99	110	123	134	131	107	72	49	42	39	37	37	43	45	36	30	30	30	27	27	28	32	36	42	53	68	75	78
27 :	97	95	93	98	109	122	134	132	107	71	47	40	38	36	36	41	44	37	31	32	32	29	28	29	32	37	43	56	72	77	75
28 :	97	94	92	95	107	119	132	132	108	70	45	39	37	35	34	38	41	37	33	34	34	31	30	31	34	38	45	61	73	76	75
29 :	96	94	90	93	105	118	130	130	107	69	43	38	36	34	34	36	39	37	35	36	36	33	31	32	35	38	48	64	74	76	74
30 :	94	93	89	91	103	117	130	129	107	69	43	37	35	34	33	35	38	37	37	38	37	35	32	33	36	40	52	66	74	76	73
31 :	93	92	88	88	102	117	129	127	105	69	43	36	34	33	33	33	36	38	39	40	39	37	34	35	36	41	55	68	75	75	72
32 :	92	91	86	87	101	118	130	127	105	70	44	35	33	33	33	33	35	38	40	41	41	38	36	36	37	43	57	70	75	74	72
33 :	90	90	85	86	101	119	131	128	105	71	45	34	32	33	33	33	36	39	41	43	42	40	38	38	38	45	61	70	73	72	70
34 :	89	88	83	86	101	121	133	130	106	73	47	34	31	32	33	34	37	40	43	44	44	42	40	39	39	48	63	70	73	72	68
35 :	87	86	82	85	101	121	136	133	109	76	49	35	31	32	33	35	38	41	44	46	45	43	42	41	41	52	64	70	72	71	67
36 :	86	85	81	85	100	120	136	136	113	79	50	36	31	32	33	36	39	42	45	47	47	45	44	42	43	54	64	69	72	71	66
37 :	86	82	80	85	98	118	137	139	117	82	52	37	32	32	34	36	40	43	46	48	49	47	46	44	45	56	64	70	72	70	65
38 :	86	82	80	85	97	116	136	141	122	86	54	38	33	33	35	37	41	44	47	50	50	49	48	46	47	56	65	70	71	69	62
39 :	85	82	81	85	96	114	134	143	126	91	57	39	33	33	35	38	41	45	48	51	52	51	50	48	49	57	66	70	70	67	61
40 :	85	83	81	86	95	111	132	144	131	96	60	40	34	33	35	38	42	46	50	53	54	52	52	50	50	59	66	70	69	65	60

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1937, arriving from sheltered approach direction of 258 deg azimuth, period = 16.4 sec, tide elevation = 0.0 ft MLLW.

Swell from storm of August 1972 (deep water approach azimuth = 156 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				6	8	7									
2 :																			7	6	8	9	10								
3 :	94	93	96	107														7	6	6	6	6	8	13							
4 :	88	87	92	97	104	102	130											7	6	5	5	5	7	12							
5 :	83	83	88	93	96	94	98	143	205									8	6	5	5	5	7	11	27						
6 :	70	70	74	79	87	87	79	97	138									8	6	5	5	5	7	8	26						
7 :	63	63	74	79	81	82	74	83	108								12	9	6	6	5	6	7	8	26	57					
8 :	63	59	67	72	74	75	71	77	95							20	14	10	7	6	6	6	7	9	24	51					
9 :	59	59	67	71	74	75	70	73	86						35	22	15	11	8	7	6	6	8	10	25	45	77				
10 :	57	56	62	66	68	69	69	70	77	84	80	77	71	58	39	24	17	12	9	7	7	7	8	12	22	41	71	107			
11 :	57	56	59	66	67	68	68	69	74	74	75	74	70	60	43	27	19	14	10	8	8	8	10	13	23	37	66	101	129		
12 :	55	54	59	62	65	67	67	68	70	71	71	71	70	62	46	30	21	16	11	9	8	8	10	14	24	37	65	102	127	154	
13 :	55	54	59	62	64	66	66	67	69	69	69	68	68	63	50	33	23	18	12	10	9	9	11	16	25	38	60	90	116	133	156
14 :	54	52	57	60	63	65	64	65	67	68	67	66	66	62	52	37	25	20	14	11	10	10	12	18	26	39	59	82	102	121	138
15 :	54	52	56	59	62	64	65	65	67	68	66	64	64	62	54	41	28	21	16	12	11	11	13	19	27	41	59	77	95	107	129
16 :	53	51	56	58	60	62	63	63	64	66	66	63	63	61	54	43	31	23	18	14	13	12	14	21	28	41	60	77	87	102	121
17 :	54	51	54	57	60	62	63	62	63	65	65	62	62	61	55	44	33	25	20	15	14	13	15	22	30	42	62	79	87	91	105
18 :	54	51	54	57	60	62	63	62	62	64	63	61	61	60	56	46	34	27	22	17	16	15	17	23	31	43	62	82	89	88	97
19 :	54	51	52	55	58	61	62	61	60	61	62	61	60	61	57	47	35	28	24	19	18	17	19	24	32	44	63	82	89	85	89
20 :	54	51	52	55	58	61	62	61	60	61	61	60	59	60	58	49	36	29	25	21	20	19	20	25	33	46	64	83	90	85	80
21 :	55	51	51	53	57	60	61	60	58	59	60	60	58	58	58	50	38	30	26	23	22	21	21	27	34	47	67	85	90	82	76
22 :	55	52	51	53	56	60	62	59	57	57	59	59	57	56	57	52	41	30	27	25	24	23	23	27	36	49	70	86	89	81	74
23 :	55	51	51	52	55	59	61	60	57	56	58	59	56	55	56	54	44	32	27	26	26	24	25	28	36	52	72	87	87	79	71
24 :	57	52	50	51	55	59	60	59	56	55	57	58	56	53	54	54	46	34	29	28	28	26	26	29	37	55	75	88	87	76	70
25 :	58	52	50	51	53	57	61	60	56	55	57	58	55	53	53	54	48	35	30	30	30	28	28	30	38	57	77	89	86	75	68
26 :	59	53	50	50	53	56	60	60	56	53	56	58	56	52	51	53	50	37	32	33	32	30	29	32	40	59	78	88	84	74	67
27 :	61	54	50	50	52	55	59	61	57	53	55	58	56	51	50	52	50	40	34	35	34	32	31	33	42	61	79	87	83	74	64
28 :	64	56	51	50	52	54	58	61	58	52	53	57	55	50	48	50	49	41	36	37	36	34	33	35	44	62	81	87	81	71	63
29 :	66	58	52	50	52	53	57	60	58	52	52	57	55	50	48	48	49	43	39	39	38	36	35	37	45	64	82	86	79	69	63
30 :	69	61	53	50	52	53	56	59	58	53	52	56	56	51	48	47	48	45	42	41	40	38	36	39	47	66	83	85	76	68	62
31 :	71	64	56	51	52	53	55	58	58	54	53	56	56	52	48	46	47	46	44	43	41	40	38	41	49	68	84	84	74	67	62
32 :	73	68	59	53	54	54	55	58	58	55	54	56	56	54	50	48	47	47	46	45	43	42	40	43	52	70	83	81	73	65	62
33 :	74	70	62	56	56	56	56	58	58	57	55	55	56	55	52	50	49	49	48	47	45	44	43	44	54	72	83	79	70	64	61
34 :	74	72	66	59	59	58	58	58	59	58	57	56	56	56	54	52	51	51	49	48	47	46	45	46	56	73	81	76	68	64	60
35 :	75	72	68	62	62	60	60	60	60	60	59	58	57	56	55	54	53	52	51	50	49	48	47	48	58	74	81	74	67	63	60
36 :	78	73	71	65	63	62	61	61	61	61	61	60	59	58	56	56	54	54	52	51	50	50	49	50	60	75	79	72	66	63	61
37 :	83	75	72	69	65	63	62	62	62	62	62	62	61	60	58	57	56	55	54	53	52	52	52	52	62	75	77	71	66	63	61
38 :	88	78	75	73	68	65	63	63	63	63	63	64	63	62	61	59	58	56	55	54	54	54	54	55	63	75	76	70	65	63	60
39 :	93	83	79	76	71	67	65	64	64	64	64	65	64	63	62	61	59	58	57	56	55	56	56	57	64	74	75	69	64	62	61
40 :	99	89	83	80	74	70	67	65	65	65	66	66	66	65	64	62	61	59	58	57	57	57	58	59	65	74	75	68	64	62	61

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1963, arriving from sheltered approach direction of 208 deg azimuth, period = 14.5 sec, tide elevation = 0.0 ft MLLW.

Swell from storm of September 1982 (deep water approach azimuth = 158 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

APPENDIX B

STORM SWELL

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = +5.4 ft MLLW

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				10	11	12									
2 :																			11	10	11	12	13								
3 :	95	93	96	103														12	10	9	10	10	12	18							
4 :	92	90	93	98	105	107	125											12	9	9	8	9	12	18							
5 :	90	88	91	96	100	103	110	142	17[illegible]									14	10	8	8	9	12	18	31						
6 :	81	79	82	87	95	98	96	117	154									15	11	9	9	9	11	16	32						
7 :	76	74	82	86	90	94	91	105	133								21	16	11	10	9	10	11	16	33	56					
8 :	76	70	76	80	84	88	88	99	121							37	24	17	12	10	10	10	12	17	33	56					
9 :	72	70	76	80	84	88	87	94	113						69	42	26	19	14	11	11	11	13	18	34	54	78				
10 :	70	67	72	75	79	81	86	91	104	116	117	119	117	102	75	46	29	21	15	12	12	12	14	20	33	51	76	101			
11 :	70	67	69	75	77	80	84	89	99	104	110	114	114	104	80	51	33	23	17	13	13	13	15	21	33	49	73	100	118		
12 :	69	65	69	71	75	79	83	88	95	101	106	110	112	105	84	56	36	26	19	15	14	14	17	22	34	49	71	101	118	130	
13 :	69	65	68	71	73	78	81	86	93	98	102	106	109	105	88	62	39	29	21	16	15	15	18	25	35	49	69	94	114	125	133
14 :	68	64	66	68	72	76	79	84	91	96	100	102	106	104	91	67	43	32	23	18	17	17	19	27	37	49	67	89	106	121	128
15 :	68	64	66	68	71	75	79	84	90	96	97	100	103	103	94	72	48	35	26	20	19	18	20	29	38	51	67	84	102	113	124
16 :	68	63	66	66	69	73	77	81	86	92	97	97	100	101	93	75	53	38	28	22	21	20	22	31	39	51	68	84	96	109	122
17 :	68	63	64	66	69	73	76	80	85	91	95	96	99	101	94	78	56	41	31	25	23	22	24	32	41	52	69	86	95	101	112
18 :	69	64	64	65	68	73	76	79	83	89	93	94	97	99	95	80	59	44	34	27	26	24	26	34	41	53	70	89	98	99	105
19 :	69	63	63	63	67	71	75	77	80	86	91	94	96	98	95	81	60	46	37	30	28	27	28	35	43	54	70	89	98	97	99
20 :	70	64	63	63	66	71	74	77	79	84	89	93	95	97	96	83	62	47	39	33	31	29	30	36	43	55	71	91	99	96	92
21 :	70	65	62	62	65	69	73	75	77	81	88	93	92	94	95	85	66	49	41	36	34	32	32	37	45	56	74	93	99	94	88
22 :	71	65	62	62	64	69	73	74	75	79	85	91	91	91	93	88	71	50	42	38	37	35	34	38	46	58	77	94	99	93	87
23 :	71	65	62	61	63	67	72	74	75	78	84	90	90	90	91	89	74	53	43	41	40	37	36	39	46	60	79	95	97	91	84
24 :	72	66	62	61	63	67	71	74	74	75	82	88	90	88	89	89	77	56	45	44	43	40	38	40	47	62	81	96	97	89	83
25 :	73	67	62	60	62	65	71	74	73	74	81	87	89	87	86	89	80	58	48	47	46	42	40	41	48	64	83	97	97	88	81
26 :	74	67	62	60	61	64	69	73	73	72	78	87	90	86	84	87	81	61	51	51	49	45	42	42	49	65	84	97	96	87	80
27 :	76	69	63	60	61	63	68	73	72	71	76	85	89	85	83	85	82	65	54	54	52	47	43	44	50	67	86	96	95	87	77
28 :	77	70	64	61	61	62	66	72	72	70	74	84	88	84	81	83	80	67	59	57	54	49	45	45	52	69	88	97	94	84	77
29 :	79	72	65	61	61	61	65	70	72	69	72	82	86	84	81	80	79	70	63	60	57	51	47	47	53	71	90	97	92	83	76
30 :	80	74	66	62	62	62	64	68	71	69	71	81	86	84	81	79	78	72	66	63	59	54	49	49	55	73	91	96	89	82	75
31 :	80	76	68	63	63	63	63	67	69	69	71	79	85	85	82	79	77	74	70	66	61	56	51	51	57	75	92	95	88	81	75
32 :	81	77	71	65	65	64	64	66	69	69	72	78	85	87	84	81	79	76	73	68	63	58	54	53	59	77	92	93	86	79	75
33 :	80	78	72	68	67	66	64	65	68	70	72	77	84	87	86	84	82	79	75	71	65	61	56	54	61	79	92	91	84	77	74
34 :	80	78	74	71	71	69	66	66	68	70	74	78	83	87	88	87	85	82	78	73	68	63	58	56	63	80	91	89	82	77	73
35 :	80	77	75	73	73	71	68	67	68	70	74	79	83	87	89	90	88	85	80	75	70	65	61	58	65	82	91	87	81	76	73
36 :	81	77	76	76	75	72	69	68	68	71	74	79	84	88	90	92	90	87	82	77	72	68	63	61	68	83	89	85	80	76	74
37 :	83	78	77	78	77	74	71	69	68	70	74	79	84	89	92	93	92	89	84	79	74	70	66	63	70	83	88	84	79	76	74
38 :	85	79	78	80	78	75	72	70	69	70	73	79	85	90	94	95	94	91	86	81	76	72	68	65	71	83	87	83	78	76	73
39 :	86	81	80	81	80	77	74	71	70	70	73	78	84	90	94	96	95	93	89	84	79	74	71	68	73	83	86	82	78	75	73
40 :	88	84	81	82	81	79	75	72	71	70	73	77	84	90	94	97	97	95	91	86	81	77	73	70	74	83	86	81	77	75	73

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1939, arriving from sheltered approach direction of 224 deg azimuth, period = 14.0 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	4	5									
2 :																			4	4	4	5	5								
3 :	127	132	144	163														5	4	4	4	4	5	8							
4 :	123	128	140	155	171	174	188											5	4	3	3	4	4	7							
5 :	119	124	136	151	164	168	171	191	19									5	4	3	3	3	4	7	11						
6 :	107	111	122	136	156	161	152	164	180									5	4	3	3	3	4	6	11						
7 :	99	103	122	136	149	156	146	152	162								8	6	4	3	3	4	4	6	12	19					
8 :	99	97	113	126	138	147	143	145	152							16	9	6	5	4	4	4	4	6	12	19					
9 :	94	97	112	125	138	147	142	142	144						36	19	11	7	5	4	4	4	4	7	13	19	26				
10 :	90	92	105	118	129	138	142	138	135	121	93	74	64	55	40	22	12	8	6	5	4	4	5	8	12	18	26	34			
11 :	90	92	100	116	128	137	141	138	131	110	88	70	61	55	42	25	14	9	6	5	5	5	6	8	13	18	25	33	41		
12 :	87	88	99	110	124	136	141	138	127	107	85	67	59	54	45	29	16	11	7	6	5	5	6	8	14	18	25	33	41	52	
13 :	86	88	98	109	121	134	140	138	127	106	82	64	56	53	46	32	19	13	8	6	6	6	7	10	14	18	24	31	39	50	67
14 :	84	85	94	105	119	133	139	138	126	105	80	61	53	51	47	35	21	15	9	7	6	6	7	11	15	19	23	29	37	49	67
15 :	84	84	93	103	117	132	141	141	128	106	79	59	51	50	47	38	25	16	11	8	7	7	8	12	16	20	23	28	35	47	67
16 :	82	82	92	99	113	129	139	138	126	104	79	57	48	47	46	39	28	18	13	9	8	7	9	13	17	20	24	28	34	48	68
17 :	82	81	88	98	113	129	140	140	127	104	78	56	47	46	45	40	29	20	14	10	9	8	9	14	18	21	24	28	34	46	66
18 :	82	81	87	96	112	129	142	142	128	104	76	54	45	43	45	40	31	22	16	12	10	9	11	15	19	22	24	29	37	45	67
19 :	81	79	84	93	108	126	140	141	126	101	75	54	43	42	43	40	31	23	18	13	11	10	12	16	19	22	24	30	39	47	66
20 :	81	79	83	91	107	126	142	143	128	101	72	53	42	40	42	40	32	24	19	15	13	11	13	17	20	23	25	31	41	49	63
21 :	81	79	80	88	103	123	140	143	127	99	71	52	40	38	40	40	33	25	20	16	14	13	14	18	21	23	26	33	42	50	62
22 :	81	78	79	86	102	123	142	143	127	97	69	50	39	36	38	40	35	25	20	17	16	14	15	19	22	24	27	35	43	52	63
23 :	80	77	78	83	98	120	140	146	130	97	67	48	38	35	37	39	36	26	20	19	17	16	16	19	22	25	29	36	44	54	65
24 :	80	77	76	82	97	119	139	147	130	96	65	46	38	33	34	38	36	27	21	20	19	17	18	20	23	26	30	37	46	56	66
25 :	79	76	74	79	93	116	140	150	133	96	63	45	36	32	32	37	36	28	22	21	21	19	19	21	23	27	31	38	49	58	67
26 :	78	75	72	77	91	113	139	151	134	94	60	44	36	31	31	35	36	29	23	23	22	20	20	21	24	28	31	39	53	61	67
27 :	78	74	71	75	88	110	137	152	135	93	58	42	35	30	30	33	35	29	24	24	24	22	21	22	25	29	32	42	56	63	66
28 :	77	73	70	72	85	106	134	153	136	92	55	41	34	30	28	31	33	29	26	26	25	23	22	23	26	29	34	46	58	63	67
29 :	77	73	68	70	82	103	131	150	136	91	52	39	32	29	28	29	31	29	27	27	27	25	23	25	27	30	37	49	59	64	67
30 :	76	73	67	67	80	101	129	149	136	91	51	38	32	29	27	28	30	30	29	29	28	26	24	26	28	31	39	51	60	65	66
31 :	75	72	66	65	77	99	127	146	135	91	51	36	30	28	27	27	29	30	30	30	30	27	26	27	29	32	42	53	61	65	67
32 :	74	72	65	63	75	97	125	145	134	93	52	35	29	27	27	26	28	30	31	32	31	29	27	28	29	33	44	55	62	65	67
33 :	73	71	64	62	74	96	124	144	134	95	53	34	28	27	27	27	28	30	32	33	32	30	29	30	30	35	47	56	62	65	67
34 :	72	70	63	62	73	95	124	144	135	97	55	33	27	27	27	27	29	31	33	34	33	31	30	31	31	38	49	57	62	66	66
35 :	71	69	63	62	72	93	123	145	137	100	57	33	27	26	27	28	30	32	34	35	35	33	32	32	32	41	51	57	63	66	66
36 :	71	68	62	62	71	90	121	146	141	104	59	34	27	26	27	29	31	33	35	36	36	34	34	33	34	43	51	58	64	67	66
37 :	70	66	62	63	70	88	118	146	144	108	62	35	27	27	28	29	32	34	36	37	37	36	35	34	36	44	52	59	65	67	65
38 :	70	66	62	64	70	85	114	145	148	113	64	35	27	27	28	30	32	35	37	39	39	37	37	36	38	45	53	60	65	67	64
39 :	70	66	63	64	69	82	110	143	151	118	68	36	28	27	29	31	33	36	38	40	40	39	39	38	39	46	54	61	65	66	63
40 :	69	66	64	65	69	80	105	140	154	125	72	37	28	28	29	31	34	37	39	41	42	41	41	40	41	47	55	62	65	65	62

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1958, arriving from sheltered approach direction of 268 deg azimuth, period = 17.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	4	4									
2 :																			4	3	4	4	4								
3 :	129	107	89	77														4	3	3	3	4	4	8							
4 :	125	103	86	72	62	52	52											4	3	3	3	3	4	6							
5 :	122	100	84	70	59	49	46	56	7[illegible]									5	3	3	3	3	4	6	10						
6 :	110	90	75	63	55	46	39	45	61									5	4	3	3	3	4	6	10						
7 :	103	84	75	63	52	44	37	40	52								7	5	4	3	3	3	3	6	11	18					
8 :	104	80	70	58	48	41	36	37	46							14	8	5	4	3	3	3	4	6	11	18	[illegible]				
9 :	99	80	69	57	47	40	35	35	42						31	16	9	6	5	4	3	4	4	6	12	17	24				
10 :	96	77	66	54	44	37	34	33	38	44	48	54	57	51	36	19	11	7	5	4	4	4	5	7	11	17	24	32			
11 :	97	77	63	53	43	37	33	33	36	39	44	50	54	52	39	22	13	8	6	5	4	4	5	7	12	16	23	31	39		
12 :	95	75	63	51	42	36	33	32	34	37	41	47	52	52	42	25	14	10	6	5	4	5	6	8	12	16	23	32	39	49	
13 :	96	76	63	51	41	35	32	31	33	35	39	44	50	52	44	29	17	11	7	6	5	5	6	9	13	17	22	29	37	48	64
14 :	95	74	61	49	40	35	31	30	31	34	37	41	47	50	46	33	19	13	8	6	6	6	7	10	14	18	22	27	35	47	64
15 :	96	75	61	49	39	34	31	30	31	34	35	39	45	49	47	36	22	15	10	7	6	6	7	11	15	18	22	26	33	45	65
16 :	96	74	61	47	38	33	30	29	29	32	35	37	42	47	46	38	26	17	12	8	7	7	8	12	15	19	22	26	32	46	65
17 :	98	75	60	47	38	33	30	28	29	31	34	36	41	46	46	39	28	19	13	9	8	7	9	13	16	20	23	27	33	45	64
18 :	100	76	60	47	38	33	30	28	28	30	32	35	39	44	46	40	29	21	15	11	9	8	10	14	17	20	23	27	36	44	64
19 :	100	76	59	46	37	32	29	27	27	28	31	34	38	43	45	40	30	22	17	12	10	9	11	15	18	21	23	28	38	45	64
20 :	102	78	60	46	37	32	29	27	26	28	30	33	36	41	44	41	31	23	18	14	12	10	12	16	19	22	23	30	40	47	60
21 :	104	80	59	45	36	32	29	27	25	26	29	33	35	38	43	41	33	24	19	15	13	12	13	17	20	22	24	32	41	48	60
22 :	107	82	60	46	37	32	29	26	25	25	28	31	33	36	41	42	35	24	20	17	14	13	14	18	21	23	26	33	42	50	60
23 :	108	82	61	45	36	31	28	26	25	25	27	31	33	35	39	41	37	26	20	18	16	14	15	18	21	24	27	34	43	52	61
24 :	111	85	62	46	37	31	28	26	24	24	26	30	32	33	37	40	37	27	21	19	18	16	16	19	22	25	28	36	45	54	62
25 :	114	87	62	46	37	31	28	26	24	23	26	29	32	32	35	39	38	28	22	21	19	17	17	19	22	26	29	37	48	56	63
26 :	117	89	64	47	37	31	27	26	24	22	25	29	31	31	33	37	38	29	23	22	21	19	18	20	23	27	30	38	51	59	63
27 :	121	92	65	48	37	31	27	25	23	22	24	28	31	31	31	35	37	30	24	24	22	20	19	21	24	27	31	41	55	60	61
28 :	125	97	68	48	38	30	26	25	23	21	23	27	30	30	30	33	35	30	26	25	24	21	20	22	25	28	33	45	56	60	61
29 :	128	102	71	50	39	30	26	24	23	21	21	26	29	29	29	31	34	31	27	27	25	23	21	23	25	28	35	47	58	61	61
30 :	131	108	76	52	40	30	25	24	23	21	21	26	29	29	29	30	32	31	29	28	27	24	23	24	26	29	38	50	58	61	60
31 :	133	114	81	55	42	31	25	23	22	21	21	24	28	29	28	28	30	31	30	30	28	25	24	25	27	31	41	52	59	61	59
32 :	134	119	88	59	45	32	24	22	22	21	20	23	27	28	28	28	29	31	31	31	29	27	25	27	28	32	43	54	59	60	59
33 :	133	123	95	65	49	34	25	22	21	21	20	23	26	28	29	28	29	31	32	32	30	28	26	28	29	34	46	55	59	59	58
34 :	131	125	101	73	55	37	26	22	21	21	21	22	25	28	29	29	30	32	33	33	32	29	28	29	29	36	48	55	59	59	56
35 :	129	125	106	81	61	40	27	22	21	21	21	22	25	27	29	29	31	33	34	34	33	31	30	30	31	39	49	55	59	58	55
36 :	128	123	108	89	67	44	29	23	21	21	21	23	24	27	28	30	32	34	35	36	34	32	31	31	33	42	50	55	59	58	54
37 :	127	120	109	96	74	49	32	24	22	21	22	23	25	27	29	31	33	35	36	37	36	33	33	32	35	43	50	56	59	57	53
38 :	126	120	111	102	82	55	35	25	22	21	22	23	25	27	29	31	34	36	37	38	37	35	34	34	36	44	51	56	58	56	51
39 :	124	119	113	107	89	61	38	27	23	22	22	23	25	27	30	32	34	36	38	39	39	36	36	36	37	45	52	56	57	55	49
40 :	121	119	115	112	96	69	43	30	25	22	22	23	25	27	30	32	35	37	39	41	40	38	38	37	39	46	53	57	56	53	48

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1983, arriving from sheltered approach direction of 253 deg azimuth, period = 18.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				7	8	9									
2 :																			8	7	8	9	9								
3 :	134	134	139	152														8	7	7	7	7	9	12							
4 :	131	130	135	145	157	161	179											9	7	6	6	7	8	13							
5 :	127	126	132	141	150	155	162	192	212									10	7	6	6	6	8	13	20						
6 :	115	114	119	127	142	148	144	164	193									10	7	6	6	7	8	12	21						
7 :	107	106	119	127	135	143	137	151	173								17	11	8	7	6	7	8	12	22	35					
8 :	107	101	110	118	126	134	134	145	162							34	19	13	8	7	7	7	8	12	22	35					
9 :	102	100	109	116	125	134	133	140	154						66	39	21	14	9	8	7	8	9	13	23	34	46				
10 :	98	97	103	110	117	125	132	136	144	141	119	104	96	87	69	43	24	16	11	9	8	8	10	14	22	33	45	59			
11 :	99	96	99	109	115	124	131	136	140	129	114	100	91	86	71	48	27	18	12	9	9	9	11	15	23	32	44	58	70		
12 :	96	93	99	104	112	122	130	135	136	126	111	96	88	84	73	52	31	20	14	10	10	10	12	16	24	32	43	58	69	84	
13 :	96	93	98	103	109	120	129	135	134	125	108	92	84	81	74	56	34	23	16	11	11	11	13	18	25	32	41	54	67	82	100
14 :	94	91	94	98	107	119	127	134	133	123	106	90	81	78	74	59	38	26	18	13	12	12	14	20	26	33	41	51	63	80	99
15 :	95	91	94	98	105	117	129	136	135	125	105	88	78	76	74	62	42	28	20	15	13	13	15	21	28	34	40	48	60	76	99
16 :	93	89	93	94	102	114	126	133	132	122	105	85	75	72	70	62	46	31	22	17	15	14	16	23	29	35	41	48	58	76	99
17 :	94	89	90	93	101	114	127	134	133	122	105	85	74	70	69	62	48	34	25	19	17	16	18	24	30	36	41	49	58	73	95
18 :	94	89	90	92	100	114	127	135	134	123	102	83	72	67	67	62	49	36	27	21	19	17	20	26	32	36	42	50	62	72	93
19 :	93	88	88	89	97	111	125	134	132	120	102	83	71	66	65	61	49	38	29	23	21	19	22	28	33	37	42	51	64	73	90
20 :	93	88	87	88	96	110	126	135	133	120	100	83	70	64	64	60	50	39	31	25	23	22	23	29	34	38	42	54	67	74	85
21 :	93	89	85	86	93	108	124	134	132	118	100	83	68	61	61	59	51	39	32	27	26	24	25	30	35	39	44	56	68	75	83
22 :	94	89	85	85	92	107	124	134	132	117	97	81	66	58	57	59	53	40	32	29	28	26	27	32	36	40	45	58	69	76	82
23 :	93	88	85	83	90	104	122	136	134	117	96	80	66	57	55	58	54	41	33	31	31	29	29	32	37	41	47	59	70	77	82
24 :	93	89	83	83	89	103	121	135	134	116	94	78	66	55	52	55	53	42	34	33	33	31	31	33	37	43	49	61	72	78	82
25 :	93	88	82	81	87	101	121	137	136	116	94	77	65	54	50	54	53	43	35	35	36	34	33	34	38	44	50	63	74	79	81
26 :	92	87	82	80	86	99	119	137	136	115	91	77	65	53	48	51	52	43	37	38	38	36	34	35	39	44	51	64	77	81	80
27 :	92	87	81	79	84	97	117	137	137	115	90	76	64	52	46	49	51	44	39	40	41	38	36	37	40	45	53	67	80	81	77
28 :	92	87	81	78	83	94	114	136	138	114	87	74	62	51	45	46	48	44	41	43	43	40	38	38	41	46	56	71	81	80	76
29 :	91	87	80	77	82	93	112	133	137	113	86	73	61	50	44	44	46	44	43	45	45	42	40	40	42	47	59	73	81	79	75
30 :	91	87	79	76	81	92	110	131	136	114	86	72	60	49	43	42	45	45	45	47	47	44	41	41	43	48	62	75	80	79	73
31 :	90	87	79	75	81	92	109	128	133	114	87	70	57	48	43	41	43	45	47	49	49	46	43	43	44	50	65	76	80	77	72
32 :	89	87	79	75	81	93	108	126	132	116	90	70	56	48	43	41	43	46	49	51	51	48	45	45	45	52	67	77	79	75	71
33 :	88	86	79	76	82	94	109	125	131	117	92	70	55	47	43	42	43	47	50	52	52	50	47	46	46	55	70	77	77	74	69
34 :	87	86	79	77	84	96	109	124	130	119	95	71	55	47	43	43	45	48	52	54	54	52	49	48	47	57	71	76	76	73	68
35 :	86	84	79	78	85	96	110	125	131	121	98	72	55	46	43	44	46	49	53	55	56	54	52	49	49	60	72	75	75	72	66
36 :	86	83	79	80	86	96	110	125	132	124	100	74	55	46	43	45	47	51	54	57	57	56	54	51	51	62	72	74	74	71	65
37 :	86	82	79	81	87	96	109	125	133	125	102	75	56	47	44	45	48	52	55	58	59	58	56	53	54	64	71	74	74	70	64
38 :	86	82	80	82	88	96	109	124	134	128	105	77	57	48	45	46	49	53	56	60	61	60	58	55	56	64	71	74	73	68	61
39 :	86	83	81	83	88	96	108	123	134	129	107	79	58	48	46	47	50	54	58	61	63	62	60	57	57	65	72	73	71	66	60
40 :	85	84	82	84	89	96	107	122	134	131	110	81	59	49	46	47	51	55	59	63	64	64	63	59	59	66	72	73	69	64	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 257 deg azimuth, period = 15.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	2									
2 :																			2	2	2	2	2								
3 :	118	90	69	54														2	2	1	2	2	2	3							
4 :	114	87	66	50	39	30	30											2	1	1	1	1	2	3							
5 :	111	84	63	48	36	28	26	34	43									2	1	1	1	1	2	3	4						
6 :	99	75	56	42	33	26	22	27	37									2	2	1	1	1	2	2	5						
7 :	93	69	55	41	31	25	21	23	31								3	2	2	1	1	1	2	2	5	8					
8 :	93	65	51	38	28	22	20	21	27							5	3	3	2	2	1	2	2	2	5	8	11				
9 :	88	65	50	37	27	22	19	20	25						13	6	3	3	2	2	1	2	2	3	5	8	11				
10 :	85	62	47	34	25	20	19	19	22	26	28	30	30	25	16	8	4	3	2	2	2	2	2	3	5	7	11	15			
11 :	86	62	44	33	24	19	18	19	21	23	26	28	29	25	17	9	5	4	3	2	2	2	2	3	5	7	10	14	18		
12 :	84	59	44	31	23	19	18	18	20	21	24	26	28	26	19	11	6	4	3	2	2	2	3	3	5	7	10	14	18	24	
13 :	84	59	43	30	22	18	17	18	19	21	22	25	27	26	21	13	7	4	4	2	2	2	3	4	6	8	10	13	17	23	33
14 :	83	57	41	28	21	18	16	17	18	20	21	23	26	26	22	15	8	5	4	3	2	2	3	4	6	8	10	12	16	22	33
15 :	84	57	41	28	20	17	16	17	18	20	20	22	24	25	23	17	10	6	4	3	3	3	3	5	6	8	10	12	15	21	34
16 :	84	56	40	26	19	16	16	16	17	18	20	21	23	24	23	18	12	7	5	4	3	3	3	5	7	9	10	12	15	22	34
17 :	85	57	38	26	18	16	16	16	17	18	19	20	22	24	23	18	13	9	6	4	3	3	4	6	7	9	10	12	15	21	34
18 :	87	57	38	25	18	16	15	15	16	17	18	19	21	23	23	19	13	10	7	5	4	3	4	6	8	9	10	12	16	21	35
19 :	87	57	37	24	17	15	15	15	15	16	18	19	21	22	23	19	14	10	8	5	4	4	5	7	8	9	10	13	17	22	35
20 :	89	58	37	23	17	15	15	15	15	16	17	19	20	22	23	20	14	11	8	6	5	4	5	7	9	10	11	14	18	23	34
21 :	91	59	36	22	16	15	14	14	14	15	17	18	19	20	22	20	15	11	9	7	6	5	5	8	9	10	11	14	19	24	34
22 :	94	60	36	22	16	14	14	14	14	15	16	18	18	19	21	20	17	11	9	7	6	6	6	8	9	10	12	15	20	26	35
23 :	95	60	35	21	15	14	14	14	14	14	16	17	18	18	20	21	17	12	9	8	7	6	7	8	10	11	12	16	20	27	36
24 :	99	62	35	21	15	14	14	14	13	14	15	17	18	17	19	20	18	13	10	9	8	7	7	8	10	12	13	16	21	29	38
25 :	103	63	35	20	15	13	14	14	13	13	15	16	17	17	18	20	19	13	10	9	8	7	8	9	10	12	14	17	23	31	39
26 :	107	65	35	20	14	13	13	14	13	13	14	16	17	17	17	19	19	14	10	10	9	8	8	9	11	12	14	17	26	33	40
27 :	113	68	35	20	14	13	13	14	13	13	14	16	17	16	16	18	18	14	11	11	10	9	9	10	11	13	14	19	29	35	40
28 :	120	72	37	20	14	12	13	14	13	12	13	15	17	16	15	17	17	14	12	11	11	9	9	10	12	13	15	21	30	36	41
29 :	128	79	38	20	15	12	12	13	13	12	12	15	16	16	15	15	16	15	13	12	11	10	10	11	12	14	16	23	31	37	42
30 :	135	87	41	20	15	12	12	13	13	12	12	14	16	16	15	15	16	15	13	13	12	11	10	11	13	14	18	25	33	39	42
31 :	143	97	46	21	16	12	11	12	13	12	12	14	15	15	14	14	15	15	14	13	13	11	11	12	13	15	19	27	34	40	43
32 :	149	108	54	23	17	12	11	12	12	12	12	13	15	15	14	13	14	15	14	14	13	12	11	13	14	15	21	29	35	40	44
33 :	153	119	64	27	19	12	11	11	12	12	12	13	14	15	15	14	14	15	15	15	14	12	12	13	14	16	23	30	36	41	44
34 :	155	128	76	32	21	12	11	11	12	12	12	12	14	15	15	14	14	15	15	15	14	13	13	14	14	18	25	31	37	42	44
35 :	156	135	87	40	24	13	11	11	11	12	12	13	14	15	15	14	15	15	16	16	15	14	14	15	15	20	26	32	38	43	45
36 :	157	141	97	51	27	14	12	11	11	12	12	13	14	14	15	15	15	16	16	16	16	15	15	15	16	21	27	33	39	44	45
37 :	158	144	105	64	31	15	12	11	11	12	12	13	14	14	15	15	16	16	17	17	17	15	15	16	17	23	28	34	41	44	45
38 :	154	148	116	77	37	17	13	11	11	12	12	13	14	15	15	16	16	17	17	18	17	16	16	17	19	23	29	35	42	45	44
39 :	149	150	127	91	45	19	14	12	12	12	12	13	14	15	15	16	16	17	18	18	18	17	17	18	19	24	30	37	42	45	44
40 :	141	150	137	106	56	23	15	12	12	12	12	13	14	15	16	16	17	18	18	19	19	18	18	19	20	25	32	38	42	44	43

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1983, arriving from sheltered approach direction of 264 deg azimuth, period = 20.5 sec, tide elevation = +5.4 ft MLLW.

J/I:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1	:																														
2	:																			46	43	41									
3	:	122	120	120	125														68	46	43	41	41								
4	:	119	117	118	119	120	114	116										93	60	42	37	36	39	50							
5	:	116	115	116	117	115	109	105	118	130								92	56	39	33	33	37	51							
6	:	106	105	106	107	110	104	94	103	120								95	57	38	34	31	36	51	72						
7	:	100	99	107	107	105	100	90	95	109								96	60	41	36	34	35	47	73						
8	:	100	95	101	101	98	94	88	91	103							126	97	62	44	38	35	35	46	75	100					
9	:	96	96	101	100	98	94	87	89	99						129	124	98	66	47	40	37	37	46	74	99					
10	:	93	93	97	96	93	89	86	86	93	100	97	95	95	100	114	125	123	100	69	50	43	40	39	49	73	95	108			
11	:	94	93	94	96	92	88	85	85	90	92	95	93	93	97	111	122	122	102	72	52	46	42	42	52	70	89	104	116		
12	:	91	91	94	93	90	87	84	84	88	91	93	92	92	96	107	119	120	103	75	54	48	44	45	54	70	84	99	113	119	
13	:	92	92	94	93	89	86	83	84	87	90	92	91	91	94	105	116	119	104	77	57	51	46	48	56	71	83	95	112	117	124
14	:	90	90	92	90	88	85	83	83	86	89	91	90	90	93	103	114	117	104	79	60	54	49	50	60	72	82	90	102	112	119
15	:	91	90	92	90	87	84	83	84	87	90	90	90	90	93	101	111	115	104	81	62	57	52	53	63	74	81	88	96	104	115
16	:	90	90	92	88	85	83	82	82	85	89	90	89	89	91	101	110	113	104	82	65	60	55	56	66	75	82	86	90	99	109
17	:	90	90	90	88	85	83	82	82	85	89	90	89	89	91	98	108	112	103	83	67	62	59	59	68	76	81	85	89	94	106
18	:	90	90	90	88	85	82	82	83	86	89	89	89	89	91	97	106	110	102	83	69	66	63	63	70	77	81	85	89	93	100
19	:	89	89	89	87	84	81	81	82	85	88	90	89	89	90	96	104	108	101	84	70	69	67	68	72	78	81	84	90	95	98
20	:	89	89	89	86	83	81	81	82	85	88	89	90	89	90	94	101	106	100	83	72	72	71	72	74	78	80	83	90	96	97
21	:	90	90	88	85	82	80	80	82	85	88	90	90	89	89	93	99	105	99	83	73	75	75	76	75	79	81	83	91	97	97
22	:	90	90	88	85	82	80	80	82	86	89	89	89	89	89	92	99	104	97	82	75	79	79	79	77	79	80	84	92	97	96
23	:	89	89	88	85	82	80	80	83	87	89	89	88	89	90	91	98	103	95	81	78	82	83	82	78	79	80	85	93	97	96
24	:	89	89	88	85	82	80	80	83	87	89	88	88	90	90	90	97	102	93	82	81	86	87	85	79	79	81	85	93	96	96
25	:	89	89	87	84	81	79	80	84	88	90	88	87	90	90	90	96	100	92	83	84	89	90	87	79	79	81	86	93	96	96
26	:	88	89	87	84	81	79	81	85	89	89	87	88	90	90	90	95	98	91	85	88	92	92	89	81	79	81	86	94	97	96
27	:	88	89	87	83	81	80	81	86	90	89	87	88	90	91	90	94	96	90	88	91	95	94	91	82	79	81	86	94	98	96
28	:	88	89	87	83	81	81	82	87	90	89	87	88	91	91	91	94	95	91	91	94	97	96	92	83	79	81	87	95	99	95
29	:	89	89	87	83	82	82	84	88	91	89	88	89	91	92	92	93	93	94	96	98	99	98	94	85	80	82	90	96	97	93
30	:	89	89	87	84	83	85	86	89	91	90	91	91	92	92	92	93	93	96	98	99	100	98	94	86	81	82	91	96	96	92
31	:	89	89	87	86	86	88	89	91	92	92	93	93	94	95	95	96	96	98	100	100	100	98	95	87	81	83	92	96	95	91
32	:	89	89	88	88	89	91	92	92	93	94	95	95	96	97	98	99	99	99	100	100	100	98	95	88	82	85	92	95	93	90
33	:	89	89	89	90	91	94	94	94	94	96	97	96	97	98	99	100	100	101	101	100	100	98	96	89	83	86	93	94	92	89
34	:	90	89	90	92	94	96	96	96	96	97	98	98	98	99	99	101	101	101	101	100	100	98	96	90	84	88	93	93	91	89
35	:	90	90	91	94	95	96	97	98	98	98	99	99	99	99	100	101	101	101	101	100	99	98	96	90	86	89	92	92	91	89
36	:	91	90	93	95	96	97	98	98	98	99	99	99	100	100	100	101	101	101	101	100	99	98	97	91	87	89	92	91	90	89
37	:	92	93	95	96	97	98	98	98	99	99	99	100	100	101	101	101	101	101	101	100	99	98	97	92	89	90	91	91	90	89
38	:	93	95	96	97	97	98	98	99	99	99	99	100	100	101	101	101	101	101	100	100	99	98	97	93	91	90	91	91	90	88
39	:	94	96	97	97	98	98	99	99	99	99	100	100	100	101	101	101	101	101	100	100	99	98	97	94	92	90	92	91	90	88
40	:	94	97	97	98	98	99	99	99	99	99	100	100	101	101	101	101	101	101	100	99	99	98	98	95	93	91	92	91	89	88

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of November 1982, arriving from sheltered approach direction of 268 deg azimuth, period = 10.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				13	14	15									
2 :																			15	13	14	15	16								
3 :	129	124	123	126														18	14	12	13	13	16	2[illegible]							
4 :	126	121	120	120	123	122	137											18	13	11	11	12	15	22							
5 :	123	118	117	117	118	117	123	154	18[illegible]									20	14	11	11	11	15	22	3[illegible]						
6 :	111	107	106	106	111	112	108	131	167									21	15	12	11	12	15	21	37						
7 :	104	100	106	106	106	107	103	120	149								38	23	16	13	12	13	14	21	38	58					
8 :	104	96	99	99	99	100	100	114	139							86	43	24	17	14	13	14	15	21	39	58					
9 :	100	96	99	98	98	100	99	110	132						130	92	49	27	19	15	14	15	16	23	39	56	71				
10 :	97	93	94	93	92	93	98	106	123	137	135	136	140	143	131	97	55	30	21	17	16	16	18	25	38	53	70	85			
11 :	97	93	91	92	91	92	96	105	118	125	129	130	133	138	130	101	61	34	23	18	17	17	20	26	38	51	67	84	96		
12 :	95	90	91	89	88	90	95	104	114	122	126	126	130	134	129	104	67	38	25	20	19	18	21	28	40	51	65	84	95	108	
13 :	95	91	91	88	86	89	94	102	113	120	123	123	125	130	127	107	71	43	28	22	21	20	23	30	41	51	62	77	92	105	119
14 :	93	89	88	85	85	88	92	101	111	119	121	120	122	126	125	108	76	47	31	24	23	22	24	33	43	51	61	72	85	102	117
15 :	94	89	88	85	83	86	93	102	112	119	119	118	119	123	124	109	80	51	34	26	25	24	26	35	44	52	60	68	82	97	115
16 :	93	88	88	82	81	84	91	99	109	116	119	116	116	119	119	109	83	55	37	29	27	26	28	38	46	52	60	68	78	95	114
17 :	93	88	86	82	81	84	91	99	109	116	119	116	115	117	117	108	85	58	40	32	30	28	30	40	47	53	60	69	78	90	108
18 :	94	89	86	82	80	83	90	99	108	115	116	114	113	113	115	106	86	61	43	35	33	31	33	41	48	54	60	71	81	88	104
19 :	92	88	84	80	78	82	89	98	106	113	116	114	113	112	111	104	85	62	46	37	36	35	36	43	49	54	60	71	83	88	100
20 :	93	88	84	80	78	81	89	98	107	112	113	114	113	110	109	102	84	63	48	40	40	38	39	44	50	55	60	73	85	88	93
21 :	93	89	83	78	77	80	87	97	105	110	113	114	111	107	105	100	85	64	49	43	43	42	41	46	51	55	62	75	85	88	90
22 :	94	89	83	78	76	80	87	96	105	109	111	112	110	105	101	98	86	64	49	46	47	45	44	47	52	56	63	77	86	88	89
23 :	93	89	84	77	75	78	86	97	106	109	110	112	110	104	99	97	86	65	50	48	50	48	46	48	52	57	65	78	86	88	88
24 :	93	89	83	77	75	78	85	96	105	108	108	110	111	103	96	94	85	65	52	51	54	51	49	49	53	58	67	80	87	87	87
25 :	93	88	82	76	75	77	85	97	106	107	107	109	110	103	93	91	84	66	54	55	57	54	51	50	53	59	68	81	88	87	85
26 :	92	88	82	76	74	77	85	97	106	106	105	109	111	102	91	88	82	66	56	58	60	57	53	51	54	60	69	82	89	88	83
27 :	92	88	81	76	74	77	84	96	105	105	104	108	110	101	90	85	80	66	59	61	62	59	55	52	54	61	71	83	91	87	80
28 :	91	88	81	75	74	76	83	96	105	104	102	107	108	100	88	82	76	66	62	64	65	62	57	54	55	61	73	86	90	85	79
29 :	91	88	81	75	74	76	83	94	104	103	101	107	107	99	87	79	74	67	65	67	67	64	59	55	56	62	76	87	89	84	78
30 :	91	88	81	75	74	77	83	93	102	103	102	107	106	98	87	78	72	68	67	69	69	66	61	57	57	64	78	87	88	83	76
31 :	90	88	81	75	76	79	84	92	101	103	104	106	105	97	86	77	71	69	70	71	71	68	63	59	58	65	80	88	86	81	75
32 :	90	88	81	76	77	81	86	92	100	103	106	107	105	98	88	78	72	70	71	72	72	70	65	60	59	67	81	87	85	79	75
33 :	89	87	81	78	80	84	88	93	99	105	108	108	105	98	88	79	73	72	72	73	73	71	67	62	60	70	83	86	83	77	73
34 :	88	87	82	80	83	88	90	94	100	106	110	110	105	97	87	80	75	73	73	75	75	73	69	64	62	72	83	85	81	76	72
35 :	88	86	82	82	86	89	92	96	101	107	112	112	106	96	87	80	76	74	74	75	76	75	71	65	64	74	83	83	80	75	71
36 :	88	86	83	85	87	90	93	97	102	108	113	113	107	98	87	81	76	74	75	76	77	76	73	67	66	76	82	82	79	75	70
37 :	88	86	84	86	89	91	94	98	102	108	113	114	108	98	88	81	76	75	76	77	79	78	76	69	68	76	81	81	78	74	69
38 :	88	87	86	87	90	92	95	98	103	109	114	115	109	99	89	81	77	75	76	78	80	80	78	71	70	77	81	80	76	72	68
39 :	89	88	88	89	91	93	96	99	103	109	114	115	109	99	88	81	77	76	77	79	81	81	79	73	71	77	81	79	75	71	67
40 :	89	89	89	90	92	94	96	99	104	110	115	116	109	98	88	80	76	76	78	80	82	83	81	75	73	77	80	78	73	70	67

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1963, arriving from sheltered approach direction of 257 deg azimuth, period = 13.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	5	6									
2 :																			5	5	5	6	6								
3 :	123	123	130	148														6	5	5	5	5	6	6							
4 :	119	119	126	139	155	164	188											6	5	4	4	5	6	9							
5 :	116	116	123	135	148	157	169	205	22[illegible]									6	5	4	4	4	6	9	14						
6 :	104	104	110	121	140	150	150	175	208									7	5	4	4	5	5	8	15	[illegible]					
7 :	97	96	110	120	133	145	143	161	186								11	7	6	5	4	5	5	8	16	25					
8 :	97	91	101	111	123	135	140	154	174							23	13	8	6	5	5	5	5	8	16	25	[illegible]				
9 :	92	91	101	110	122	135	139	150	166						50	26	14	9	6	6	5	5	6	9	16	24	33				
10 :	89	87	95	103	114	126	138	145	156	153	126	104	89	74	53	30	17	11	7	6	6	6	7	10	16	23	33	43			
11 :	89	87	90	102	112	124	136	144	151	139	121	100	85	73	56	34	19	13	8	7	6	6	8	11	16	23	32	43	52		
12 :	86	84	90	98	108	122	135	144	147	136	117	97	83	72	58	38	22	15	9	7	7	7	8	11	17	23	31	43	52	65	
13 :	86	84	89	95	105	120	133	144	146	135	115	93	79	71	59	41	24	17	11	8	7	7	9	13	18	23	30	40	50	63	81
14 :	84	81	85	91	103	118	132	143	144	134	113	91	77	68	60	45	27	19	13	9	8	8	10	14	19	24	30	37	47	61	81
15 :	85	81	84	90	100	117	133	145	147	136	112	89	74	67	60	47	31	21	15	10	9	9	10	15	20	25	29	35	44	59	82
16 :	83	79	84	86	97	113	130	142	144	133	112	87	71	63	58	48	34	23	16	12	10	10	11	17	21	25	30	35	43	59	82
17 :	83	79	80	85	95	112	130	143	145	134	112	87	70	62	57	49	36	25	18	13	12	11	12	18	22	26	30	36	43	57	80
18 :	84	79	80	83	94	111	131	144	146	134	110	85	68	59	56	49	37	27	20	15	13	12	14	19	23	27	31	37	47	57	79
19 :	83	78	77	80	90	108	128	142	144	131	110	85	67	57	54	48	38	28	22	16	15	13	15	20	24	28	31	38	49	58	78
20 :	83	78	77	79	89	107	128	144	146	132	107	85	66	56	52	48	38	29	23	18	16	15	17	21	25	29	31	40	51	60	74
21 :	83	79	75	76	86	104	126	143	145	130	107	84	64	53	50	47	40	30	24	20	18	17	18	22	26	29	32	42	52	61	73
22 :	84	79	75	75	84	102	126	142	144	129	105	82	63	51	47	47	41	30	24	21	20	19	19	23	27	30	34	43	54	63	74
23 :	83	78	74	73	81	99	123	144	147	129	104	81	62	50	45	46	42	31	25	23	22	20	21	24	28	31	35	45	55	65	75
24 :	83	78	73	72	80	97	121	144	147	128	102	79	62	48	43	44	42	32	26	24	24	22	22	25	28	32	37	46	57	67	76
25 :	83	77	72	71	77	94	120	145	149	129	101	78	61	47	41	43	42	33	27	26	26	24	24	26	29	33	38	48	60	69	76
26 :	82	77	71	69	75	91	118	145	150	128	98	77	61	46	39	41	41	34	28	28	28	26	25	27	30	34	39	49	64	72	76
27 :	82	77	70	68	74	89	115	144	151	128	97	76	59	44	37	39	40	34	29	30	30	28	27	28	31	35	40	52	67	73	74
28 :	82	77	70	67	72	85	112	143	152	127	93	74	58	43	36	36	38	34	31	32	32	29	28	29	32	36	42	56	69	73	74
29 :	81	77	69	65	70	83	108	139	151	126	92	73	55	42	35	34	36	34	33	34	33	31	29	30	33	36	45	59	70	74	74
30 :	81	77	69	64	69	82	105	136	150	127	91	71	54	41	34	33	35	35	34	35	35	33	31	32	34	38	48	61	71	74	73
31 :	80	77	68	63	68	81	103	132	147	127	93	69	51	39	34	32	33	35	36	37	37	34	32	33	35	39	51	64	71	74	73
32 :	79	76	68	63	68	80	101	129	145	129	95	68	49	39	34	32	33	35	37	38	38	36	34	35	36	41	54	66	72	73	73
33 :	78	76	68	64	69	81	100	127	143	131	98	67	48	38	34	32	33	36	38	40	39	38	36	36	36	43	57	67	71	73	72
34 :	77	75	68	64	70	81	100	125	142	133	101	67	47	38	34	33	34	37	39	41	41	39	37	37	38	46	59	67	71	73	71
35 :	77	74	68	66	71	82	100	125	142	135	104	69	46	37	34	34	36	38	40	42	42	41	39	39	39	49	60	67	71	73	71
36 :	76	73	67	67	72	81	99	124	142	137	107	70	46	37	34	35	36	39	42	44	44	42	41	40	41	51	61	67	72	73	70
37 :	76	72	68	68	73	81	97	122	143	139	109	72	47	37	34	35	37	40	43	45	45	44	43	42	44	53	61	68	72	73	69
38 :	76	72	68	70	73	81	96	120	143	142	112	73	48	37	35	36	38	41	44	46	47	46	45	44	45	54	62	68	72	72	67
39 :	75	72	69	71	74	81	94	118	142	144	115	75	48	38	36	37	39	42	45	48	49	48	47	46	47	55	63	69	72	71	67
40 :	75	73	71	72	75	81	93	115	141	146	119	77	49	38	36	37	40	43	46	49	50	50	49	48	48	56	64	70	71	69	66

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1978, arriving from sheltered approach direction of 264 deg azimuth, period = 16.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	3	4									
2 :																			3	3	3	4	4								
3 :	156	161	167	175														4	3	3	3	3	4	5							
4 :	152	157	164	167	166	151	143											4	3	3	2	3	3	5							
5 :	148	153	161	165	161	146	130	128	12[illegible]									4	3	2	2	3	3	5	9						
6 :	134	139	146	150	153	140	115	109	11[illegible]									4	3	2	2	3	3	5	9						
7 :	125	129	146	151	147	135	110	100	97								6	4	3	3	3	3	3	5	9	15					
8 :	125	123	137	141	138	129	108	96	90							12	7	5	4	3	3	3	3	5	10	15	2[illegible]				
9 :	119	123	137	141	138	129	108	93	85						28	14	8	5	4	3	3	3	3	5	10	15	21				
10 :	114	119	130	135	131	121	107	90	78	66	52	49	49	44	31	17	9	6	5	4	3	3	4	6	10	14	20	27			
11 :	114	119	125	135	131	121	107	89	75	58	49	46	47	45	34	19	11	7	5	4	4	4	4	6	10	14	20	27	33		
12 :	111	115	126	130	128	121	107	89	72	56	46	43	45	45	36	22	13	8	5	4	4	4	5	6	11	14	20	27	32	42	
13 :	111	115	126	130	127	121	106	89	71	55	43	40	43	44	38	25	14	10	6	5	4	4	5	7	11	14	19	25	31	40	55
14 :	108	112	122	126	127	121	106	89	70	53	42	38	40	43	39	29	17	11	7	5	5	5	6	8	12	15	19	23	29	39	55
15 :	108	112	122	127	126	121	108	90	70	53	40	36	38	42	40	31	20	13	9	6	5	5	6	9	12	16	18	22	28	38	56
16 :	106	110	123	124	124	119	107	89	68	51	39	34	36	40	39	33	22	15	10	7	6	6	7	10	13	16	19	22	27	38	56
17 :	106	110	119	124	125	121	109	89	68	50	38	33	35	38	39	33	24	17	12	8	7	6	7	11	14	17	19	23	27	37	55
18 :	106	110	119	124	126	123	110	90	68	49	36	31	33	37	39	34	25	18	13	9	8	7	8	12	15	17	20	23	30	36	56
19 :	103	108	116	122	124	122	110	89	66	47	35	31	32	36	38	34	26	19	15	10	9	8	9	13	16	18	20	24	31	38	56
20 :	103	108	116	122	125	124	112	91	66	46	33	30	31	34	37	34	26	20	16	12	10	9	10	13	16	18	20	25	33	39	53
21 :	102	108	114	120	124	123	112	90	65	44	32	29	29	32	36	35	28	20	16	13	11	10	11	14	17	19	21	26	34	41	53
22 :	102	107	114	120	125	125	114	91	64	42	30	28	28	30	34	35	30	21	17	14	12	11	12	15	18	19	22	28	35	43	54
23 :	99	105	114	119	124	125	114	92	64	40	29	27	28	29	33	35	31	22	17	15	14	12	13	15	18	20	23	28	36	44	55
24 :	98	105	111	119	126	127	115	93	63	38	27	26	27	28	31	34	31	23	18	16	15	13	14	16	19	21	24	30	37	47	57
25 :	96	102	109	118	125	127	118	95	63	37	26	26	27	27	29	33	32	24	18	17	16	15	15	17	19	22	25	30	40	49	58
26 :	94	100	107	116	125	127	118	95	63	35	25	25	27	26	27	31	32	24	19	19	18	16	16	17	20	23	25	32	43	52	58
27 :	92	99	105	115	125	128	120	96	62	33	23	25	26	26	26	30	31	25	20	20	19	17	17	18	20	23	26	34	47	53	57
28 :	90	96	103	113	125	127	119	96	61	31	22	24	26	25	25	28	29	25	22	21	20	18	18	19	21	24	27	37	48	54	58
29 :	87	93	100	111	124	128	119	95	60	30	20	23	25	25	24	26	28	25	23	23	22	20	18	20	22	24	30	40	50	55	59
30 :	85	91	96	108	123	129	120	95	59	29	20	22	24	25	24	25	27	26	24	24	23	21	19	21	23	25	32	42	51	56	58
31 :	82	88	93	104	122	131	122	93	57	28	19	21	23	24	24	23	25	26	25	25	24	22	20	22	23	26	34	44	52	57	59
32 :	79	84	89	100	122	134	124	94	56	28	19	21	23	24	24	23	24	26	26	26	25	23	22	23	24	27	36	46	53	57	59
33 :	77	81	84	97	121	137	128	95	55	28	20	20	22	24	24	23	24	26	27	27	26	24	23	24	25	29	39	47	53	57	59
34 :	75	77	80	93	120	141	134	98	55	29	20	20	21	23	24	24	25	27	28	28	27	25	24	25	25	31	41	48	54	58	59
35 :	73	74	75	88	117	143	140	103	57	29	21	20	21	23	24	25	26	27	29	29	28	26	25	26	26	34	42	48	54	58	59
36 :	72	71	71	84	114	143	146	111	60	30	21	20	21	23	24	25	27	28	29	30	29	27	27	27	28	36	43	49	55	59	59
37 :	71	68	67	80	109	142	151	119	64	31	22	21	21	23	24	26	27	29	30	31	31	29	28	28	30	37	43	50	57	59	59
38 :	70	67	66	77	103	139	155	128	71	32	22	21	22	23	25	26	28	30	31	32	32	30	30	29	31	38	44	51	57	59	57
39 :	70	66	65	74	97	134	158	137	79	34	23	21	22	23	25	27	29	30	32	33	33	31	31	31	32	39	46	53	57	59	57
40 :	69	66	65	71	91	128	158	146	90	37	24	22	22	24	26	27	29	31	33	34	34	33	33	32	34	40	47	54	57	58	56

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1960, arriving from sheltered approach direction of 269 deg azimuth, period = 18.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				13	14	15									
2 :																			15	13	14	15	16								
3 :	128	123	121	125														18	14	12	13	13	16	22							
4 :	125	120	119	119	121	120	133											19	13	11	11	12	15	22							
5 :	122	117	116	116	116	115	120	150	181									20	14	11	11	11	15	22	36						
6 :	111	106	105	105	110	109	105	127	163									22	15	12	11	12	15	21	37						
7 :	104	100	105	105	104	104	100	116	146								39	23	16	13	12	13	14	21	38	58					
8 :	104	95	99	98	97	98	98	111	136							91	45	25	17	14	13	14	15	21	38	58					
9 :	99	95	98	97	96	97	96	107	128						136	97	51	27	19	15	14	15	16	23	39	56	71				
10 :	96	92	94	92	90	91	95	103	120	135	133	136	143	147	136	102	58	31	21	17	16	16	18	25	38	53	69	85			
11 :	96	92	90	91	89	90	94	102	115	123	128	131	136	142	135	106	64	34	23	18	17	17	20	26	38	51	66	83	95		
12 :	94	90	90	88	86	88	92	101	111	120	125	126	132	138	134	109	70	39	25	20	19	18	21	27	40	50	64	83	94	108	
13 :	94	90	90	87	85	87	91	99	110	118	121	123	127	133	132	111	75	43	28	22	21	20	23	30	41	50	61	77	91	104	119
14 :	93	88	88	84	83	86	90	98	108	116	120	120	124	129	130	112	79	48	31	24	23	22	24	33	42	51	60	72	85	102	117
15 :	93	89	88	84	82	84	90	99	109	117	118	118	121	127	129	114	83	52	34	26	25	24	26	35	44	52	59	68	81	97	116
16 :	92	87	88	82	80	82	88	96	106	114	118	116	118	122	123	113	87	56	37	29	27	26	28	38	45	52	59	67	77	95	115
17 :	93	88	85	81	79	82	88	96	106	113	117	116	117	120	121	112	88	60	41	32	30	28	30	39	47	53	60	68	77	90	109
18 :	93	88	85	81	79	82	88	97	106	113	115	114	115	116	119	111	89	62	44	34	33	31	33	41	48	53	60	70	81	89	105
19 :	92	87	84	79	77	80	86	95	104	110	114	115	115	115	115	108	88	64	46	37	36	34	36	43	49	54	59	71	82	88	101
20 :	92	88	84	79	77	80	86	95	104	110	112	115	114	113	113	106	87	65	48	40	40	38	39	44	50	55	60	73	85	89	94
21 :	93	88	83	78	75	78	85	94	103	108	112	115	113	110	109	103	88	66	49	43	43	41	41	46	51	55	61	75	85	88	91
22 :	93	89	83	78	75	78	85	93	102	107	110	113	112	108	105	102	89	65	49	46	47	45	43	47	52	56	63	76	86	89	90
23 :	92	88	83	77	74	77	84	94	103	107	109	112	112	108	103	100	89	66	50	48	50	48	46	48	52	57	65	78	86	88	89
24 :	93	89	82	77	74	77	83	94	103	105	107	111	113	106	100	97	88	67	52	51	53	51	49	48	52	58	66	79	87	88	88
25 :	92	88	82	76	74	76	83	94	103	105	106	109	112	106	97	95	87	67	54	55	57	54	51	49	52	59	68	81	89	88	86
26 :	91	88	81	75	73	75	83	94	103	104	104	109	112	105	95	92	85	67	57	58	60	57	53	51	53	59	69	82	90	89	85
27 :	91	88	81	75	73	75	82	94	103	103	103	109	112	104	94	89	83	67	59	61	62	59	55	52	54	60	70	83	92	89	82
28 :	91	88	81	74	73	75	82	93	102	102	101	108	110	103	92	85	79	68	62	64	65	61	57	54	55	61	73	86	91	86	81
29 :	90	88	80	74	73	75	81	92	101	101	100	107	109	102	91	83	76	68	65	66	67	63	58	55	56	62	75	87	90	85	79
30 :	90	88	80	74	73	76	82	91	100	100	101	107	108	101	91	81	74	69	68	69	69	65	60	57	57	63	78	88	89	84	78
31 :	89	87	80	74	75	78	83	90	98	101	103	106	107	101	90	80	73	70	70	70	70	67	62	58	58	65	80	88	88	83	77
32 :	89	87	80	76	76	80	84	90	97	101	105	107	107	101	91	81	74	71	71	72	71	69	64	60	59	67	81	88	86	81	76
33 :	88	87	81	77	79	83	86	91	97	102	107	108	107	101	92	82	75	73	73	73	73	71	66	62	60	69	83	87	84	79	74
34 :	88	86	81	79	83	86	89	92	97	104	109	110	107	101	91	83	77	74	73	74	74	72	69	63	62	72	84	86	82	78	73
35 :	87	86	81	81	85	88	91	94	99	105	111	112	108	100	91	83	77	75	74	75	75	74	71	65	64	74	84	84	81	77	72
36 :	87	85	82	84	86	89	92	95	100	106	111	114	109	101	91	84	78	75	75	76	76	76	73	67	66	76	83	83	80	76	71
37 :	88	85	84	85	88	90	93	96	100	106	112	114	111	102	92	83	78	75	75	77	78	77	75	69	68	77	82	82	79	75	70
38 :	88	86	85	87	89	91	94	97	101	107	113	115	111	103	92	84	78	76	76	77	79	79	77	71	70	77	82	81	78	74	69
39 :	88	87	87	88	90	92	94	97	102	107	113	116	111	102	92	83	78	76	76	78	80	80	79	73	72	77	82	80	76	72	68
40 :	88	89	88	89	91	93	95	98	102	108	114	116	112	102	91	83	78	76	77	79	81	82	81	75	74	78	81	79	75	71	68

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1958, arriving from sheltered approach direction of 258 deg azimuth, period = 13.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				17	18	20									
2 :																			19	17	18	20	21								
3 :	123	120	121	128														21	17	16	16	17	20	29							
4 :	120	117	118	120	123	120	129											22	17	15	14	16	19	30							
5 :	117	114	116	118	118	115	116	138	162									24	17	14	14	15	19	30	50						
6 :	106	104	105	107	113	111	103	116	143									25	18	15	15	16	19	28	51						
7 :	100	97	105	107	108	107	98	106	126								37	26	20	17	16	17	18	28	53	77					
8 :	101	93	99	101	101	101	96	101	116							63	41	28	21	18	18	18	20	28	52	78					
9 :	96	94	99	100	101	101	95	97	109						95	68	44	31	23	20	19	19	21	30	51	75	95				
10 :	94	91	94	96	96	95	94	95	102	108	106	110	114	112	98	72	48	34	25	21	21	21	23	32	50	70	92	110			
11 :	94	91	91	95	95	94	93	94	98	98	101	105	109	111	99	76	52	37	27	23	23	22	25	34	49	67	87	107	117		
12 :	92	89	91	92	92	93	93	93	95	95	97	100	107	109	101	80	56	40	30	25	24	24	27	35	50	65	84	108	116	122	
13 :	92	89	91	92	91	92	91	92	93	94	94	97	103	107	102	83	60	43	32	27	27	26	29	38	51	65	80	99	112	116	119
14 :	91	87	89	89	90	91	90	91	92	92	92	94	99	104	102	86	64	47	35	29	29	28	30	40	52	64	78	93	103	112	114
15 :	92	88	89	89	89	90	91	91	91	92	90	91	97	102	102	89	68	50	38	32	32	30	32	42	53	65	78	88	98	103	110
16 :	91	87	89	87	87	89	89	89	89	89	90	89	93	99	100	90	71	53	41	35	34	32	34	44	53	65	78	87	92	99	108
17 :	92	87	87	87	87	89	90	89	88	89	89	89	92	98	99	91	73	56	44	38	37	35	36	45	54	65	79	88	91	91	99
18 :	92	88	87	87	87	89	90	89	88	88	87	87	90	95	98	91	75	59	47	41	41	39	39	46	54	65	78	90	92	90	93
19 :	92	87	86	85	86	88	89	88	86	85	86	86	89	94	97	91	75	60	50	44	44	42	41	47	55	66	78	89	91	87	88
20 :	92	88	86	85	86	88	89	88	85	84	84	86	88	92	96	91	76	62	52	47	47	45	44	47	55	67	78	89	92	87	83
21 :	93	89	86	84	85	87	88	87	84	82	83	86	86	89	93	91	79	63	53	50	50	48	45	48	56	67	80	90	92	85	80
22 :	93	89	86	84	85	87	89	87	83	81	82	84	85	86	91	92	82	64	54	53	54	51	47	49	57	68	81	91	91	85	79
23 :	93	89	86	83	84	86	88	87	84	80	81	84	84	85	89	91	83	66	56	57	57	53	50	49	57	70	83	91	90	83	78
24 :	94	90	86	84	84	86	88	87	83	79	79	82	84	83	86	90	84	68	59	60	60	56	52	50	57	71	84	92	89	82	77
25 :	94	90	86	83	83	85	88	88	84	78	79	82	83	82	84	89	85	70	62	64	63	58	54	51	58	72	85	92	89	81	76
26 :	94	90	86	83	83	85	87	88	84	78	77	81	83	82	82	87	85	72	65	67	65	60	55	53	59	72	85	91	88	81	75
27 :	94	90	86	84	84	85	87	88	84	77	76	81	83	81	81	85	84	74	69	70	68	62	57	54	60	73	86	90	87	81	74
28 :	94	91	87	84	84	84	86	88	85	77	75	80	82	80	80	83	83	76	73	73	70	65	59	56	61	74	86	90	86	79	74
29 :	95	92	87	84	85	85	86	87	84	78	75	79	81	80	80	81	81	78	76	75	72	67	61	58	63	75	87	90	85	78	74
30 :	95	92	88	85	86	87	86	87	84	79	76	79	81	80	80	80	81	80	79	78	74	69	63	60	64	76	88	89	83	78	74
31 :	94	93	89	87	88	89	88	87	84	80	78	79	81	81	81	81	81	82	82	79	76	71	65	62	66	78	88	88	82	77	74
32 :	94	93	90	89	91	91	89	87	85	82	80	80	82	84	84	84	84	84	84	81	77	73	67	64	67	79	88	87	81	76	74
33 :	93	93	91	91	94	95	92	89	86	83	82	81	82	84	85	86	86	86	85	83	79	75	70	66	69	80	88	86	80	76	74
34 :	93	92	92	93	97	97	94	91	88	85	84	83	83	84	85	87	88	87	86	84	80	76	72	68	71	81	87	84	79	76	73
35 :	93	92	92	95	98	98	96	93	90	87	85	84	84	84	86	88	89	88	87	85	82	78	74	70	73	82	86	83	79	76	74
36 :	94	91	93	97	99	99	97	95	91	88	86	85	85	86	87	89	89	89	88	86	83	80	76	72	75	83	86	82	78	76	74
37 :	94	93	94	98	100	100	98	95	92	89	86	85	86	87	88	89	90	90	89	87	85	82	78	74	76	83	85	81	78	76	74
38 :	95	94	96	98	100	100	99	96	93	90	87	86	86	87	89	90	90	90	89	88	86	83	80	76	78	83	85	81	78	76	74
39 :	96	96	97	99	101	101	100	97	94	91	88	87	86	88	89	90	91	91	90	89	87	85	82	78	79	83	85	81	78	76	75
40 :	96	97	98	99	101	101	100	98	95	92	89	87	87	88	89	90	91	91	91	90	88	86	84	80	81	84	85	81	78	76	75

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1904, arriving from sheltered approach direction of 235 deg azimuth, period = 12.0 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				26	27	28									
2 :																			33	26	27	28	29								
3 :	128	124	123	126														44	30	24	24	25	28	37							
4 :	124	121	121	120	121	117	123											44	28	23	21	23	27	40							
5 :	121	118	118	118	116	112	111	131	151									48	29	22	21	22	27	40	60						
6 :	110	108	108	108	110	106	99	113	138									50	31	24	23	23	26	37	62						
7 :	104	102	108	107	105	102	94	104	124								94	54	33	26	24	25	26	37	64	89					
8 :	104	97	102	101	99	96	92	99	117							133	98	58	36	28	26	26	27	37	63	87	110				
9 :	100	98	102	100	98	96	91	96	111						142	133	102	63	39	31	28	28	30	40	63	84	99				
10 :	97	95	97	96	93	90	90	93	104	113	110	110	116	128	138	132	106	68	42	33	31	30	32	42	60	79	96	110			
11 :	97	95	94	95	92	89	89	92	101	104	107	107	111	122	133	131	108	73	46	35	33	32	35	44	60	75	90	107	117		
12 :	95	93	94	92	89	88	88	92	98	102	104	104	108	119	130	130	110	77	49	37	36	34	37	46	61	73	87	107	116	125	
13 :	95	93	94	92	88	87	87	91	97	101	102	102	106	115	126	128	111	81	53	40	39	37	40	50	62	72	83	98	111	120	129
14 :	94	92	92	89	87	86	86	90	96	100	101	101	103	111	123	126	112	84	57	44	42	39	42	53	63	72	81	92	103	116	126
15 :	94	92	92	89	86	85	87	91	96	101	100	99	102	110	121	124	112	86	60	47	45	42	45	55	65	72	79	87	98	109	123
16 :	93	91	92	87	84	83	85	89	94	98	100	98	100	107	117	122	112	88	63	50	49	46	47	58	65	71	79	86	93	106	121
17 :	93	91	90	87	84	83	85	89	94	98	100	98	100	105	114	119	111	90	66	53	52	50	51	59	66	72	79	87	92	99	113
18 :	94	91	90	86	84	83	86	90	94	98	98	97	98	103	112	117	110	90	68	56	56	54	55	61	67	71	78	88	95	98	108
19 :	93	91	89	85	82	82	84	88	93	96	98	97	98	102	108	114	108	91	70	59	60	58	58	62	67	71	78	88	95	96	103
20 :	93	91	89	85	82	82	84	89	93	96	96	97	98	101	107	111	106	90	71	62	64	63	61	63	67	72	78	89	97	96	97
21 :	93	91	88	84	81	81	84	88	93	95	96	97	97	99	104	109	106	90	71	65	68	67	64	64	68	72	79	91	97	95	94
22 :	93	91	88	84	81	81	84	88	93	94	95	96	97	98	101	107	105	88	71	68	72	70	67	65	68	72	80	91	97	95	93
23 :	93	91	88	83	80	80	83	89	94	95	94	95	97	98	100	105	104	88	72	72	76	74	69	65	68	73	82	92	96	94	91
24 :	93	91	87	83	80	80	83	89	94	94	93	94	98	97	98	103	102	87	74	75	79	77	72	66	68	74	83	93	96	93	90
25 :	92	91	87	82	80	80	83	90	94	94	92	94	97	97	96	101	100	86	77	79	82	79	74	67	68	74	84	94	96	92	89
26 :	92	90	86	82	79	80	83	90	94	93	91	94	98	97	95	99	98	86	80	83	85	81	76	68	68	75	84	94	96	92	88
27 :	91	90	86	82	79	80	84	90	94	93	90	93	97	96	95	97	96	87	83	86	87	83	77	70	69	75	85	94	97	92	85
28 :	91	90	86	81	79	80	84	90	94	92	89	93	97	96	94	95	93	87	86	88	88	85	79	71	70	76	87	95	96	90	85
29 :	91	90	86	81	80	81	85	90	94	92	90	93	96	96	94	93	92	89	89	90	90	86	80	72	71	77	88	95	95	89	84
30 :	91	90	86	82	81	83	86	90	93	92	92	94	96	96	94	93	91	90	91	91	91	87	82	74	71	78	90	95	93	88	83
31 :	91	90	86	83	83	86	88	91	93	93	94	95	97	98	96	94	92	92	93	92	91	89	83	75	72	79	91	95	92	87	83
32 :	91	90	87	85	86	89	90	92	94	95	96	97	99	100	99	97	94	93	93	93	92	89	85	77	74	81	91	94	90	86	83
33 :	91	90	87	87	89	92	93	93	94	96	98	98	100	100	100	99	96	95	94	93	92	90	86	79	75	82	92	93	89	85	82
34 :	90	90	88	89	92	94	95	96	96	98	100	100	101	100	100	99	97	95	94	93	93	91	87	80	77	84	91	91	87	84	81
35 :	91	89	89	91	94	95	97	97	98	99	101	102	102	101	100	99	97	95	94	94	93	92	89	82	79	86	91	90	87	84	81
36 :	91	89	91	93	95	96	97	98	99	100	101	103	103	102	101	99	97	95	94	94	94	93	90	83	81	86	90	88	86	84	81
37 :	92	91	92	94	96	97	98	98	99	100	102	103	103	103	101	99	97	95	94	94	94	93	91	85	83	87	89	88	86	83	81
38 :	92	93	94	95	96	97	98	99	100	101	102	103	104	103	101	99	97	95	94	94	94	94	92	86	85	87	89	87	85	83	80
39 :	93	94	95	96	97	98	98	99	100	101	102	104	104	103	101	99	97	95	94	94	94	95	93	88	86	87	89	87	84	82	80
40 :	93	96	96	97	97	98	99	99	100	101	102	104	104	103	101	99	96	95	94	94	95	95	94	90	88	88	89	87	84	82	81

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1912, arriving from sheltered approach direction of 258 deg azimuth, period = 11.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	8									
2 :																			6	5	6	6	6								
3 :	140	144	152	168														6	5	5	5	5	6	9							
4 :	136	139	149	160	173	174	185											6	5	4	4	5	6	9							
5 :	132	135	145	157	166	167	168	187	19									7	5	4	4	4	6	9	15						
6 :	119	122	131	142	158	161	149	160	178									7	5	4	4	5	6	8	15						
7 :	111	113	130	142	151	155	143	148	159								12	8	6	5	4	5	5	8	16	26					
8 :	111	107	121	132	141	146	140	142	149							23	13	8	6	5	5	5	6	8	17	26					
9 :	105	107	120	131	140	147	140	138	142						47	27	15	10	7	6	5	5	6	9	17	25	35				
10 :	101	103	114	123	132	137	139	135	133	121	95	80	74	67	51	30	17	11	7	6	6	6	7	10	17	24	34	45			
11 :	101	102	108	122	130	137	138	134	129	110	91	76	70	66	54	34	20	13	8	7	6	6	8	11	17	23	33	45	55		
12 :	98	99	108	117	126	136	138	135	125	107	87	72	67	65	56	38	22	15	10	7	7	7	9	12	18	24	33	45	54	68	
13 :	98	98	107	116	124	134	137	135	124	106	85	69	64	63	57	41	25	17	11	8	8	8	9	13	19	24	32	41	52	66	84
14 :	96	95	103	111	122	133	136	134	123	104	83	66	61	60	57	45	28	19	13	9	9	8	10	15	20	25	31	39	49	64	84
15 :	96	95	103	110	121	132	139	137	125	106	81	64	58	59	58	47	32	21	15	10	10	9	11	16	21	26	31	37	47	62	85
16 :	94	93	102	107	117	129	136	135	122	103	81	62	55	55	55	49	35	24	17	12	11	10	12	17	22	26	31	37	45	62	85
17 :	95	93	98	105	117	130	138	136	123	103	80	61	53	54	54	49	37	26	19	14	12	11	13	18	23	27	32	38	46	60	82
18 :	95	93	97	104	116	130	139	138	124	103	78	59	51	51	53	49	38	28	21	15	14	12	14	20	24	28	32	39	49	59	82
19 :	93	91	94	101	113	127	138	137	123	100	77	59	50	49	51	49	39	29	23	17	15	14	16	21	25	29	32	39	51	60	81
20 :	93	91	94	100	112	127	139	139	124	100	75	58	49	47	50	48	39	30	24	19	17	16	17	22	26	30	32	42	54	62	76
21 :	93	91	91	97	109	125	138	139	123	98	74	57	47	45	48	48	41	31	25	21	19	18	19	23	27	30	34	44	55	64	75
22 :	94	91	91	96	108	125	139	139	123	97	72	55	45	42	45	48	43	31	25	22	21	19	20	24	28	31	35	45	56	66	75
23 :	92	89	90	93	105	122	138	141	125	97	70	54	45	41	43	47	44	33	26	24	23	21	22	25	29	32	37	47	57	67	76
24 :	93	90	88	92	104	122	137	142	126	95	68	52	44	39	41	45	44	34	27	26	25	23	23	26	29	34	38	49	59	69	77
25 :	92	89	86	90	101	119	138	145	128	95	67	51	43	39	38	44	44	35	28	27	27	25	25	27	30	35	40	50	63	71	77
26 :	91	88	85	88	99	117	137	146	129	93	64	50	43	37	37	41	43	35	29	29	29	27	26	27	31	35	41	52	66	73	76
27 :	91	87	84	86	98	115	136	146	130	92	62	49	42	37	35	39	42	36	31	31	31	29	28	29	32	36	42	55	70	75	74
28 :	90	87	83	84	95	112	134	147	131	91	59	48	41	36	34	37	40	36	33	33	33	31	29	30	33	37	44	59	71	74	74
29 :	89	86	81	82	93	110	131	144	130	91	58	46	39	35	33	35	38	36	34	35	35	32	30	31	34	38	47	62	72	74	73
30 :	89	86	80	80	91	108	130	143	130	91	57	45	39	35	33	34	36	36	36	37	36	34	32	33	35	39	51	64	72	75	73
31 :	88	86	79	78	90	108	128	140	129	92	58	44	37	34	32	32	35	37	38	39	38	36	33	34	36	40	53	66	73	74	72
32 :	86	85	78	77	89	107	128	140	128	93	59	43	36	33	32	32	34	37	39	40	40	37	35	36	37	42	56	68	73	73	72
33 :	85	84	78	77	88	107	128	139	128	95	61	42	35	33	33	33	35	38	40	42	41	39	37	37	37	44	59	69	72	72	70
34 :	84	83	77	77	89	108	129	140	129	98	63	42	34	33	33	34	36	39	41	43	42	41	39	38	39	47	61	69	72	72	69
35 :	83	82	76	77	89	107	129	141	131	100	66	43	34	32	33	34	37	40	42	44	44	42	41	40	40	51	62	68	72	72	68
36 :	83	80	75	78	88	106	128	143	134	103	68	44	34	32	33	35	38	41	43	46	46	44	43	41	42	53	63	68	72	72	67
37 :	82	78	75	78	88	104	127	143	137	107	70	45	35	33	34	36	39	42	45	47	47	46	45	43	45	54	63	69	72	71	66
38 :	82	78	76	79	87	102	125	144	140	111	73	46	36	33	35	37	40	43	46	48	49	47	47	45	47	55	64	69	72	70	64
39 :	82	79	76	79	87	101	122	143	143	116	76	48	36	34	35	37	40	44	47	50	50	49	49	47	48	56	65	70	71	68	63
40 :	81	79	77	80	87	99	120	142	146	120	80	49	37	34	35	38	41	45	48	51	52	51	51	49	50	58	66	70	69	66	62

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1983, arriving from sheltered approach direction of 260 deg azimuth, period = 16.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				22	23	24									
2 :																			28	22	23	24	25								
3 :	128	124	122	124														37	24	20	20	21	24	32							
4 :	124	121	119	118	117	112	117											37	23	19	17	19	23	33							
5 :	121	118	117	115	112	107	106	125	14									40	24	18	18	18	22	33	51						
6 :	110	107	106	105	107	102	93	107	132									43	25	19	18	19	22	31	52						
7 :	103	101	107	105	101	97	89	98	119								94	46	27	21	20	20	21	31	54	77					
8 :	104	96	100	98	95	91	87	94	111							146	101	51	30	23	21	21	23	31	54	77					
9 :	99	97	100	98	94	91	86	91	106						157	146	107	58	32	25	23	23	25	33	54	74	88				
10 :	96	94	95	93	89	85	85	88	99	109	108	110	119	137	152	146	112	64	36	27	25	25	27	36	52	70	86	100			
11 :	96	94	92	93	88	84	84	87	96	100	105	107	113	130	146	145	116	71	39	29	27	26	29	38	53	66	82	98	107		
12 :	94	92	92	89	85	83	83	86	93	98	102	104	111	126	142	144	119	76	43	32	30	28	32	39	54	66	79	97	106	117	
13 :	94	92	92	89	84	82	82	85	91	97	100	102	107	121	138	141	120	82	48	34	32	31	33	43	55	65	75	89	102	113	127
14 :	93	90	90	86	83	81	81	84	90	96	99	100	105	117	134	139	122	86	52	38	35	33	36	46	57	65	73	83	94	110	124
15 :	93	90	90	86	82	80	81	85	91	97	97	98	103	115	131	137	122	89	56	41	39	36	38	49	58	66	71	78	90	104	123
16 :	92	89	90	84	80	78	80	84	89	95	97	97	101	111	126	134	123	92	60	44	42	39	41	52	60	65	71	77	86	102	122
17 :	92	89	88	84	79	78	80	84	89	95	97	97	101	109	123	131	122	94	64	48	45	42	44	54	61	66	71	78	85	96	115
18 :	92	90	88	83	79	78	80	84	90	94	95	96	99	106	120	128	120	95	67	51	49	47	48	56	62	66	71	79	88	95	111
19 :	91	89	87	82	78	76	78	83	88	93	96	96	99	105	116	124	118	96	69	54	53	51	52	57	63	66	70	80	90	94	106
20 :	92	89	87	81	77	76	79	83	89	93	94	96	99	104	113	121	116	96	70	57	57	55	55	58	63	66	70	81	91	94	100
21 :	92	90	85	80	76	75	78	83	88	92	94	96	98	102	110	118	115	95	70	60	61	59	57	60	64	66	71	83	92	94	97
22 :	92	90	86	80	76	75	78	82	88	91	93	95	97	101	107	116	115	93	70	63	65	63	60	61	64	66	72	84	92	94	96
23 :	91	89	86	79	75	74	77	83	89	92	92	94	98	101	105	114	113	93	71	67	70	67	63	61	64	67	73	85	92	94	95
24 :	91	89	85	79	75	74	77	83	89	91	90	93	98	100	103	111	110	92	73	71	73	70	66	62	63	68	74	86	93	94	94
25 :	90	89	84	78	75	74	77	84	90	91	90	92	98	100	101	109	109	91	75	75	77	73	68	62	63	68	75	87	94	94	93
26 :	90	88	84	78	74	74	77	85	91	91	89	92	98	100	100	106	105	90	78	79	80	76	69	63	63	68	76	88	96	95	91
27 :	90	88	83	77	74	74	78	85	91	90	88	92	98	100	99	104	103	89	81	82	82	78	71	64	64	68	77	89	97	94	88
28 :	89	88	83	77	74	74	78	85	91	89	86	91	97	99	99	101	99	90	85	85	84	79	72	65	64	68	79	92	96	92	88
29 :	89	88	82	76	74	75	78	85	91	89	87	92	97	99	99	99	97	91	88	87	86	81	73	66	65	69	81	93	96	92	87
30 :	89	88	82	76	75	77	80	85	90	89	88	92	97	99	99	98	95	92	90	89	87	82	75	68	65	70	84	93	94	91	85
31 :	88	87	82	77	77	79	82	86	89	90	90	93	97	100	100	98	95	93	92	90	87	83	76	69	66	72	86	94	93	89	85
32 :	88	87	82	79	79	82	84	87	90	91	92	94	98	102	103	101	97	94	93	91	87	83	77	70	67	74	87	93	92	88	84
33 :	88	87	83	81	82	85	87	88	90	92	95	96	99	103	103	103	99	96	94	91	88	84	79	71	68	76	88	93	90	86	83
34 :	87	87	83	83	85	88	89	91	92	94	97	98	101	103	103	103	100	97	94	91	88	84	80	73	69	78	89	91	89	86	82
35 :	87	86	84	85	88	90	92	93	94	95	98	100	102	103	104	104	101	97	93	90	88	85	81	74	71	80	89	90	88	85	81
36 :	88	86	85	87	89	91	93	94	95	97	99	102	104	105	105	104	101	97	93	90	88	86	83	76	74	82	88	89	87	85	81
37 :	88	87	87	89	90	92	93	95	96	97	99	102	105	106	106	104	100	96	93	90	88	86	84	77	76	83	88	88	87	84	80
38 :	88	88	89	90	92	93	94	95	96	98	100	103	106	107	107	104	100	96	92	90	88	87	85	79	78	83	88	88	86	83	79
39 :	89	90	90	91	93	94	95	96	97	99	101	104	106	107	106	103	99	95	92	89	88	87	86	81	79	84	88	87	85	82	78
40 :	89	91	91	92	93	94	96	97	98	99	101	104	107	107	106	103	99	94	91	89	88	88	88	83	81	84	88	87	84	81	78

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1915, arriving from sheltered approach direction of 263 deg azimuth, period = 12.4 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				15	16	18									
2 :																			17	15	16	18	19								
3 :	109	109	112	120														18	15	14	15	15	18	28							
4 :	106	106	110	114	119	118	131											19	15	13	13	14	17	29							
5 :	104	103	107	112	115	114	117	142	16									20	15	13	13	13	17	29	51						
6 :	94	94	98	102	109	109	104	119	148									21	16	14	14	15	17	27	52						
7 :	89	88	97	102	105	105	99	108	130								29	22	17	15	15	15	17	27	53	81					
8 :	89	84	91	96	98	100	97	102	119							46	32	24	19	16	16	16	18	27	52	80					
9 :	85	84	91	95	98	100	96	99	111						69	49	34	26	20	18	17	18	20	29	52	77	95				
10 :	83	81	87	91	93	94	95	96	104	110	106	104	100	90	72	52	37	28	22	19	19	19	21	31	50	72	93	106			
11 :	83	82	84	90	92	93	94	95	101	100	101	101	98	91	75	55	40	30	23	20	20	20	23	33	50	68	87	103	107		
12 :	81	79	84	87	89	92	93	95	97	98	98	97	97	92	78	59	43	33	25	22	22	22	25	34	50	67	83	103	106	106	
13 :	82	79	84	86	88	90	91	93	96	97	95	95	95	91	80	62	46	36	28	24	24	23	26	36	51	66	80	94	101	100	100
14 :	81	78	81	84	87	89	90	92	94	95	94	92	93	91	82	66	49	38	30	26	26	25	28	38	52	65	78	89	93	96	95
15 :	81	78	81	84	86	88	90	92	94	96	93	91	91	90	83	69	52	41	33	28	28	27	29	40	53	66	78	83	87	88	91
16 :	81	77	81	82	84	87	88	89	91	93	93	90	89	89	83	70	55	43	35	31	30	29	31	41	53	66	77	81	81	83	89
17 :	81	78	79	81	84	87	88	89	90	92	92	89	89	89	83	72	57	46	38	33	33	32	33	42	54	66	78	82	80	76	81
18 :	82	78	79	81	83	87	88	88	89	91	91	88	88	87	84	73	59	48	40	36	36	35	36	43	54	66	77	83	80	75	76
19 :	82	78	78	79	82	85	87	87	87	89	90	88	87	88	85	74	60	50	43	38	38	37	38	44	55	67	76	82	79	73	72
20 :	82	78	78	79	82	85	87	87	87	88	88	88	87	87	86	76	61	51	44	41	41	40	39	44	55	67	76	81	79	72	68
21 :	83	79	77	78	80	84	87	86	85	86	88	88	85	85	85	78	64	52	46	44	44	42	41	45	56	67	77	82	79	71	66
22 :	83	79	77	77	80	84	87	86	84	84	86	87	85	83	84	79	67	53	47	47	47	45	43	46	56	68	78	82	78	70	65
23 :	83	79	78	77	79	83	86	86	84	84	86	87	85	82	83	81	70	55	49	50	50	47	45	47	56	69	78	81	76	69	64
24 :	84	80	77	77	79	83	86	86	84	82	85	86	85	81	81	81	72	57	51	53	53	49	47	48	57	70	79	81	76	68	64
25 :	85	80	77	76	78	81	85	87	84	82	84	86	84	81	80	81	74	60	54	56	55	51	49	49	57	71	79	81	75	67	63
26 :	86	81	77	76	77	80	85	87	84	81	83	86	85	80	79	80	75	62	57	59	57	54	51	50	58	71	79	79	74	67	63
27 :	87	82	78	76	77	80	84	87	84	80	82	86	85	80	78	79	76	65	61	62	59	56	53	52	59	71	79	78	73	67	62
28 :	88	83	79	77	78	79	82	86	85	80	81	85	84	80	78	78	75	68	64	64	61	58	55	54	61	72	79	78	73	66	62
29 :	88	85	80	78	78	79	82	85	85	81	81	85	85	80	78	77	75	71	68	67	63	60	57	56	62	72	79	77	72	66	62
30 :	89	86	81	79	79	80	82	85	85	82	82	85	85	81	78	77	75	73	71	69	65	62	59	57	63	73	79	77	70	66	63
31 :	89	87	83	81	81	82	83	85	85	84	84	86	86	84	81	79	76	76	74	71	67	64	61	59	64	73	79	76	70	66	63
32 :	89	88	85	83	84	84	84	85	86	86	86	87	88	87	84	82	80	78	76	73	69	66	63	61	65	74	78	74	69	65	64
33 :	89	88	86	85	87	87	86	86	86	87	88	88	89	88	86	85	82	80	78	75	71	68	65	63	67	74	78	74	68	65	64
34 :	89	88	88	88	90	89	88	87	88	89	90	90	90	89	88	87	85	82	80	77	73	70	67	65	68	75	77	72	68	65	64
35 :	89	87	88	90	91	90	89	89	89	90	91	92	91	90	89	88	86	84	81	78	75	72	69	67	70	76	77	72	68	65	64
36 :	90	87	90	92	92	91	90	90	90	91	92	93	93	92	91	90	87	85	83	80	77	74	72	69	71	76	76	71	68	66	65
37 :	91	89	91	93	93	92	91	90	90	91	92	93	94	93	92	91	89	86	84	81	79	76	74	71	73	76	76	71	68	66	65
38 :	93	91	92	94	93	92	91	91	90	91	92	93	94	95	94	92	90	88	85	83	81	78	76	73	74	77	76	71	68	67	65
39 :	94	93	93	94	94	93	92	91	91	91	92	94	95	95	95	93	91	89	87	84	82	80	78	75	76	77	76	71	68	67	66
40 :	94	95	94	95	95	94	93	92	91	91	92	94	95	96	95	94	92	90	88	86	84	82	80	77	78	78	76	72	69	67	66

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1915, arriving from sheltered approach direction of 224 deg azimuth, period = 11.8 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				16	18	20									
2 :																			18	16	18	20	22								
3 :	102	103	106	111														19	16	15	16	17	21	34							
4 :	99	100	104	106	108	105	114											19	16	15	14	16	20	35							
5 :	97	98	102	105	105	101	102	121	140									21	16	14	15	15	20	35	59						
6 :	88	89	93	96	100	98	90	101	123									22	17	15	16	17	20	33	59						
7 :	84	84	93	96	96	95	87	92	108								28	23	18	17	17	18	20	33	60	82					
8 :	84	81	87	91	91	90	85	88	99							39	30	24	20	18	18	19	21	33	58	80					
9 :	80	81	87	90	91	90	85	85	93						53	41	32	26	21	19	19	20	23	34	56	76	86				
10 :	79	79	84	87	87	85	84	83	87	90	85	81	76	67	55	43	34	27	22	21	21	21	25	36	54	70	82	87			
11 :	79	79	81	86	86	85	84	83	85	83	81	79	76	68	57	45	36	29	24	22	23	23	27	38	53	66	76	83	82		
12 :	78	77	81	84	84	84	83	83	84	82	79	78	75	70	59	48	38	31	26	23	24	24	28	39	52	64	72	83	81	78	
13 :	78	77	81	83	83	83	82	82	83	81	78	76	75	70	61	50	40	33	28	25	26	25	29	40	53	63	69	75	77	74	73
14 :	77	76	80	81	82	82	81	81	82	81	78	75	74	70	63	52	42	35	30	27	28	27	31	41	53	62	67	71	70	70	69
15 :	78	76	80	82	82	82	81	81	82	82	78	74	73	70	64	55	45	37	32	29	30	29	32	42	53	62	67	66	66	64	66
16 :	77	75	80	80	81	81	80	79	80	80	78	74	72	70	64	56	47	39	34	31	32	31	33	43	54	61	66	65	61	60	65
17 :	78	76	78	80	81	81	80	79	79	80	78	74	72	71	65	57	48	41	36	34	34	33	35	43	53	61	66	65	60	56	60
18 :	79	76	78	80	81	81	80	78	79	80	78	74	72	71	66	58	49	43	38	36	36	36	37	44	53	61	65	65	60	55	56
19 :	79	76	77	79	80	81	79	77	77	78	77	74	73	72	68	59	50	44	40	38	39	38	39	44	53	61	64	64	59	54	53
20 :	79	77	77	79	80	81	80	77	77	77	76	74	72	72	69	61	51	45	42	40	41	40	40	44	53	61	64	63	59	54	51
21 :	79	77	77	78	80	81	80	77	76	76	76	75	72	71	70	63	53	46	43	43	43	42	42	45	53	61	64	63	59	53	50
22 :	80	78	77	78	79	81	80	77	75	75	76	75	72	70	70	65	56	47	44	45	45	44	43	45	53	61	64	63	59	53	50
23 :	80	78	77	77	79	81	80	78	75	75	75	75	72	70	70	67	58	49	46	48	48	46	45	46	53	61	64	63	58	53	50
24 :	81	79	77	77	79	81	81	78	75	74	75	74	72	70	70	68	60	51	49	50	50	48	46	47	53	61	64	63	58	52	50
25 :	82	79	77	77	78	80	81	79	75	74	75	75	72	70	69	69	63	53	51	53	52	49	48	48	54	61	64	62	58	52	50
26 :	84	80	78	77	78	80	81	80	76	73	74	75	73	70	69	69	64	56	54	55	53	51	50	49	54	61	63	61	57	53	50
27 :	85	81	79	78	78	79	81	81	77	73	74	75	73	70	69	69	66	59	57	58	55	53	51	51	55	61	63	61	57	53	50
28 :	87	83	80	79	79	80	81	82	79	74	74	76	74	70	69	69	66	62	60	60	57	55	53	52	56	61	63	60	57	53	51
29 :	88	85	81	80	80	81	81	82	80	76	75	76	75	71	70	69	68	65	63	62	59	56	55	53	56	61	63	60	56	53	51
30 :	89	86	83	81	82	83	82	83	81	78	77	77	76	72	71	69	68	68	66	64	61	58	56	55	57	61	63	60	56	54	52
31 :	89	88	85	84	85	85	84	84	83	81	81	80	78	76	74	73	71	70	68	66	63	60	58	57	58	62	63	60	56	54	52
32 :	89	89	87	87	88	88	86	86	85	84	83	82	81	80	78	76	74	72	70	68	65	62	60	58	59	62	62	59	56	54	53
33 :	89	90	89	89	90	90	89	88	86	86	85	84	83	81	80	79	77	75	72	70	67	64	62	60	61	63	62	59	56	54	53
34 :	89	89	91	91	93	92	91	90	89	88	87	86	84	83	81	80	79	77	74	72	69	66	64	62	62	63	62	59	56	55	54
35 :	89	89	92	93	94	93	92	92	90	90	89	87	86	84	83	82	80	78	76	74	71	68	66	63	63	64	62	59	56	55	54
36 :	90	89	93	94	94	94	93	92	92	91	90	89	87	86	84	83	82	80	78	75	73	71	68	65	65	65	63	59	57	56	55
37 :	92	92	94	95	95	94	94	93	92	92	91	90	89	87	86	84	83	81	79	77	75	73	70	67	66	65	63	59	57	56	56
38 :	93	94	95	96	95	95	94	94	93	92	92	91	90	88	87	86	84	83	81	79	77	75	72	69	68	66	64	60	58	57	56
39 :	94	95	96	97	96	95	95	94	94	93	92	92	91	89	88	87	85	84	82	81	79	77	75	72	70	67	65	61	58	57	57
40 :	95	96	96	97	97	96	95	95	94	94	93	93	92	90	89	88	87	85	84	82	81	79	77	74	72	68	66	62	59	58	57

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1943, arriving from sheltered approach direction of 214 deg azimuth, period = 10.8 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	3	4									
2 :																			3	3	3	4	4								
3 :	98	76	61	53														3	3	3	3	3	4	5							
4 :	94	73	59	49	45	41	46											4	3	3	2	3	3	5							
5 :	91	70	57	48	42	39	40	53	70									4	3	2	2	2	3	5	9						
6 :	82	63	50	42	39	37	34	43	60									4	3	2	2	3	3	5	9	[illegible]					
7 :	76	58	50	42	37	35	32	38	50								6	5	3	3	2	3	3	5	9	15					
8 :	76	54	46	38	34	32	31	35	45							12	7	5	4	3	3	3	3	5	10	15	[illegible]				
9 :	72	54	45	38	34	32	30	33	41						27	13	8	5	4	3	3	3	3	5	10	15	21	[illegible]			
10 :	69	52	42	35	31	29	30	31	37	43	47	52	53	46	31	16	9	6	5	3	3	3	4	6	10	14	21	28	[illegible]		
11 :	69	51	40	35	30	29	29	30	35	38	43	48	51	47	34	18	11	7	5	4	3	4	4	6	10	14	20	27	34		
12 :	67	49	40	33	29	28	28	30	33	36	40	45	50	48	37	22	12	8	6	4	4	4	5	6	11	14	20	27	33	43	[illegible]
13 :	68	49	39	32	28	28	28	29	32	35	38	42	47	48	40	25	14	10	6	5	4	4	5	7	11	15	19	25	32	41	56
14 :	67	48	38	31	28	27	27	28	30	33	36	40	45	47	42	29	16	11	7	5	5	5	6	8	12	15	19	24	30	40	56
15 :	67	48	37	30	27	26	27	28	30	33	35	38	43	46	43	32	19	13	9	6	5	5	6	9	13	16	19	23	29	39	57
16 :	67	47	37	29	26	26	26	27	28	31	34	36	41	44	42	34	23	15	10	7	6	6	7	10	13	16	19	23	28	40	57
17 :	68	47	36	29	26	25	26	26	28	30	33	35	39	43	42	35	24	17	12	8	7	6	7	11	14	17	20	23	28	38	56
18 :	69	47	35	28	26	25	26	26	27	30	32	34	37	41	42	36	26	19	13	9	8	7	8	12	15	18	20	24	31	38	56
19 :	68	47	34	28	25	25	25	25	26	28	31	33	36	40	42	36	26	20	15	10	9	8	9	13	16	18	20	24	32	39	56
20 :	70	47	34	27	25	25	25	25	26	27	30	32	35	39	41	37	27	20	16	12	10	9	10	13	17	19	20	26	34	41	53
21 :	71	48	34	27	24	24	24	24	25	26	29	32	34	37	40	38	29	21	17	13	11	10	11	15	17	19	21	27	35	42	53
22 :	73	49	34	26	24	24	24	24	24	25	28	31	32	35	38	38	32	22	17	14	12	11	12	15	18	20	22	28	36	44	54
23 :	73	49	34	26	23	23	24	24	24	24	27	30	32	33	37	38	33	23	18	15	14	12	13	16	18	21	23	29	37	46	55
24 :	76	50	34	26	23	23	24	24	23	23	26	29	31	32	35	37	34	24	18	17	15	13	14	16	19	22	24	31	38	48	56
25 :	78	51	34	26	23	23	24	24	23	23	26	29	31	31	33	37	35	25	19	18	17	15	15	17	19	23	25	32	41	50	57
26 :	81	53	34	26	23	22	23	24	23	22	25	29	31	30	31	35	35	26	20	19	18	16	16	17	20	23	26	33	45	52	57
27 :	85	55	35	26	23	22	23	24	23	22	24	28	30	30	30	33	35	27	21	21	19	17	17	18	21	24	27	35	48	54	55
28 :	90	58	37	26	23	21	22	23	23	21	22	27	29	29	28	31	33	28	23	22	21	18	18	19	22	24	28	39	50	54	55
29 :	95	62	38	27	23	21	21	22	22	21	21	26	29	28	28	29	31	28	24	23	22	20	19	20	22	25	31	41	51	54	55
30 :	100	67	41	28	24	21	20	22	22	20	21	25	28	28	27	28	30	28	26	25	23	21	20	21	23	26	33	43	52	55	54
31 :	105	73	44	29	24	21	20	21	22	20	20	24	27	28	27	26	28	28	27	26	24	22	21	22	24	27	35	46	53	55	54
32 :	109	80	49	31	26	21	20	20	21	20	20	23	26	27	27	26	27	28	28	27	26	23	22	23	25	28	38	48	53	54	53
33 :	113	86	55	34	27	22	20	20	21	20	20	22	25	27	27	26	27	29	29	28	27	24	23	24	25	30	41	49	53	53	52
34 :	115	91	62	39	30	23	20	20	20	20	21	22	25	27	27	27	28	29	30	30	28	25	24	25	26	32	43	49	53	53	51
35 :	118	95	68	44	33	25	21	20	20	20	21	22	24	26	27	28	29	30	31	31	29	26	26	26	27	35	44	49	53	53	50
36 :	121	97	73	51	37	26	22	20	20	20	21	22	24	26	27	28	29	31	32	32	30	28	27	27	29	37	44	49	53	53	49
37 :	125	100	76	58	41	29	23	21	20	20	21	23	24	26	27	29	30	31	32	33	31	29	29	29	30	38	45	50	53	52	48
38 :	128	104	81	65	46	32	24	21	20	20	21	23	24	26	28	30	31	32	33	34	33	30	30	30	32	39	45	50	53	51	46
39 :	129	109	87	72	51	35	26	22	21	20	21	23	24	27	28	30	32	33	34	35	34	32	31	31	33	40	46	51	52	50	45
40 :	129	113	93	79	58	40	29	24	22	21	21	23	25	27	29	31	32	34	35	36	35	33	33	33	34	41	47	51	51	48	43

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1953, arriving from sheltered approach direction of 251 deg azimuth, period = 19.2 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				9	10	11									
2 :																			11	9	10	11	12								
3 :	121	115	112	114														13	10	9	9	9	11	14							
4 :	118	112	109	108	109	108	121											13	9	8	8	9	11	16							
5 :	115	110	107	106	105	103	108	139	17									15	9	8	8	8	11	16	26						
6 :	104	99	97	96	99	98	95	117	156									16	10	8	8	9	11	15	27						
7 :	98	93	97	95	94	93	90	107	138								27	17	11	9	9	9	10	15	28	43					
8 :	98	88	91	88	87	87	87	101	128							80	31	19	12	10	9	10	11	15	28	43					
9 :	93	89	90	88	86	87	86	97	121						140	89	37	21	14	11	10	10	12	16	29	41	53				
10 :	90	86	86	83	81	80	85	93	113	131	136	145	157	161	143	96	44	23	15	12	11	11	13	18	28	39	52	65			
11 :	91	86	83	83	79	79	83	92	108	119	130	139	149	156	143	102	51	25	17	13	12	12	14	19	28	38	50	64	75		
12 :	88	83	83	79	77	78	82	91	103	116	126	134	144	152	143	107	58	28	19	14	13	13	15	20	29	38	49	64	75	89	
13 :	89	84	83	79	75	77	80	89	102	113	122	130	139	147	142	111	64	32	21	15	15	14	16	22	30	38	47	59	72	86	105
14 :	87	82	80	76	74	75	79	88	100	112	120	126	135	143	141	114	70	37	24	17	16	16	18	24	32	39	46	55	67	84	104
15 :	87	82	80	76	73	74	80	88	100	112	118	124	132	141	140	117	76	41	26	19	18	17	19	26	33	40	45	53	64	81	104
16 :	86	81	80	73	71	72	77	86	97	109	118	121	128	135	135	117	81	45	29	22	20	19	20	28	34	40	46	52	62	80	104
17 :	87	81	78	73	70	72	77	86	97	108	117	121	127	133	133	117	84	50	32	24	22	20	22	30	36	41	46	53	62	77	100
18 :	87	82	78	73	70	71	77	86	97	108	114	119	125	129	131	116	86	53	35	26	24	23	25	31	37	41	46	54	66	76	98
19 :	86	81	76	71	68	70	75	84	94	105	114	119	125	128	127	114	85	56	37	29	27	25	27	33	38	42	46	55	68	77	96
20 :	86	81	76	71	68	69	75	84	95	104	111	120	124	126	125	112	86	57	39	31	30	28	29	34	39	43	46	57	70	78	90
21 :	87	82	75	69	66	68	74	83	93	102	111	119	122	123	121	110	87	58	40	34	32	31	31	36	40	43	48	59	71	79	88
22 :	87	82	75	69	66	68	74	82	93	101	108	117	121	121	117	109	89	58	41	36	35	33	33	37	41	44	49	61	73	81	88
23 :	86	81	76	68	65	67	73	83	93	101	107	117	122	120	115	107	89	60	42	38	38	36	35	37	41	45	51	62	73	82	88
24 :	87	82	75	68	65	67	72	83	93	99	105	115	123	119	111	104	88	61	43	41	41	39	37	38	42	46	52	64	75	83	89
25 :	86	81	74	68	65	66	72	83	94	99	104	113	122	119	108	102	87	61	45	44	44	41	39	39	42	47	54	66	78	84	88
26 :	85	81	74	67	64	65	72	83	94	98	102	114	123	118	106	98	85	62	47	47	47	43	41	40	43	48	55	68	81	86	87
27 :	85	81	73	67	64	65	71	83	93	97	100	113	122	117	104	95	83	62	50	49	49	46	42	41	44	49	56	71	84	87	85
28 :	84	81	73	66	64	65	71	83	93	95	98	111	120	116	102	91	79	62	53	52	51	48	44	43	45	49	59	74	85	86	85
29 :	84	81	73	65	64	65	71	81	92	94	97	111	118	114	101	87	75	62	55	54	53	49	45	44	46	50	62	77	86	86	84
30 :	84	81	72	65	64	66	71	80	90	93	97	110	118	114	100	85	73	63	57	56	55	51	47	46	46	51	65	79	86	86	83
31 :	83	80	72	65	65	67	72	79	88	93	99	109	116	112	99	82	71	63	59	58	56	53	49	47	47	53	68	80	86	85	82
32 :	82	80	72	66	66	69	73	79	87	93	100	110	115	112	99	82	70	64	61	59	57	54	50	49	48	55	70	82	85	84	82
33 :	82	80	72	67	68	72	75	80	86	94	103	111	115	112	99	83	71	65	62	60	58	56	52	50	49	58	73	82	84	83	80
34 :	81	79	73	69	71	75	77	81	86	95	105	113	116	111	98	83	72	66	62	61	59	57	54	52	51	61	75	81	83	83	79
35 :	80	79	73	71	73	76	79	83	87	96	107	115	117	110	97	84	73	66	63	61	60	59	56	53	53	64	76	81	83	82	78
36 :	80	78	73	73	75	78	81	84	88	97	108	117	118	110	96	83	73	66	63	62	62	60	59	55	55	66	76	81	83	82	78
37 :	80	77	74	75	77	79	82	85	89	97	109	118	120	111	97	83	73	66	63	63	63	62	61	57	58	68	76	81	83	81	76
38 :	80	78	75	76	78	80	83	86	90	98	110	120	121	112	97	83	72	66	64	63	64	64	63	59	60	69	77	81	82	80	75
39 :	80	78	77	78	79	82	84	87	91	99	111	121	121	111	96	82	72	66	64	64	65	65	65	61	62	70	78	81	81	79	74
40 :	80	79	78	79	81	82	85	88	92	100	112	122	122	111	95	80	71	66	64	65	66	67	67	64	64	71	78	81	80	77	73

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1969, arriving from sheltered approach direction of 264 deg azimuth, period = 14.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				10	11	11									
2 :																			11	10	11	11	12								
3 :	142	139	141	149														12	10	9	9	10	12	18							
4 :	138	135	138	142	147	144	152											12	9	8	8	9	11	17							
5 :	134	132	135	139	142	138	137	156	17									14	9	8	8	8	11	17	27						
6 :	122	119	122	126	134	133	122	133	154									15	10	8	8	9	11	16	28						
7 :	114	111	122	126	128	129	117	122	137								23	16	11	9	9	9	11	16	29	45					
8 :	114	106	114	118	120	120	114	117	127							46	26	17	12	10	9	10	11	16	29	45					
9 :	109	106	113	117	120	121	113	113	120						82	52	29	19	13	11	10	11	12	17	30	44	56				
10 :	105	102	108	111	113	113	113	110	112	111	99	97	101	101	85	57	32	22	15	12	11	11	13	19	29	41	55	68			
11 :	105	102	104	110	112	113	112	109	108	100	94	92	96	98	87	62	37	24	17	13	12	12	15	20	29	40	53	66	76		
12 :	103	99	104	106	108	112	111	109	105	97	90	87	92	96	89	67	41	27	19	14	14	13	16	21	31	40	51	66	75	86	
13 :	103	100	103	105	107	111	110	109	104	96	87	83	87	93	90	71	46	30	21	16	15	15	17	23	32	40	49	61	73	83	95
14 :	101	97	100	102	106	110	109	108	103	94	85	80	84	89	90	75	50	33	24	18	16	16	18	25	33	40	48	57	67	81	93
15 :	102	97	100	101	104	109	111	109	103	95	83	78	80	87	89	78	55	37	26	20	18	18	20	27	34	41	47	54	64	76	92
16 :	100	96	100	99	102	106	109	107	101	92	83	75	77	83	86	78	59	40	29	22	20	19	21	29	36	41	47	53	61	75	91
17 :	101	96	97	98	102	107	110	108	101	92	82	75	75	80	84	79	62	44	32	25	23	21	23	31	37	42	47	54	61	71	86
18 :	101	96	97	98	101	107	111	109	101	91	80	73	72	77	83	79	63	47	35	27	25	23	25	32	38	42	47	55	63	69	83
19 :	100	95	95	95	99	105	109	107	100	89	79	72	71	75	80	78	64	48	37	30	28	26	28	34	39	43	47	56	65	69	79
20 :	101	96	95	95	99	106	110	109	100	89	77	72	70	73	79	77	64	50	39	32	31	29	30	35	40	43	47	57	66	69	74
21 :	101	96	93	93	97	104	109	108	99	87	77	71	68	69	75	76	66	51	41	35	34	32	31	36	41	43	48	58	66	68	71
22 :	102	97	93	93	97	104	110	108	99	85	75	70	66	66	72	76	69	52	41	38	37	34	33	37	41	44	49	60	67	69	71
23 :	101	96	93	91	95	102	109	109	100	85	74	69	66	65	69	75	70	53	42	40	40	37	35	37	41	45	51	60	66	68	69
24 :	101	96	92	91	95	103	109	110	100	84	72	67	65	63	66	72	70	55	44	43	43	40	37	38	41	46	52	61	67	68	69
25 :	101	96	91	90	94	101	109	111	101	83	71	66	65	62	63	70	70	56	46	46	46	42	39	39	41	46	53	62	68	68	68
26 :	100	95	90	89	93	100	108	111	101	82	69	66	65	61	61	68	69	57	48	49	49	44	41	40	42	46	53	63	69	68	67
27 :	100	95	90	89	93	99	108	111	102	82	68	65	64	60	59	65	68	58	51	52	51	47	42	41	42	47	54	64	70	68	64
28 :	100	95	90	88	92	98	106	111	102	81	66	64	62	59	58	62	65	59	54	55	54	49	44	42	43	47	56	65	69	66	64
29 :	100	96	89	87	91	98	105	109	102	81	65	63	61	58	57	59	62	60	57	58	56	51	45	43	43	48	57	66	68	65	63
30 :	99	96	89	86	91	98	105	109	101	82	66	62	60	58	57	58	61	61	60	60	58	53	47	44	44	48	59	66	67	65	62
31 :	98	96	89	86	92	99	105	107	100	83	67	61	59	57	56	57	59	62	63	62	60	54	48	45	44	49	60	66	66	63	62
32 :	97	95	89	87	93	101	106	107	100	84	69	61	58	58	57	57	60	63	65	64	61	56	50	46	45	50	61	66	65	62	62
33 :	96	94	89	88	95	103	107	107	100	86	71	62	58	58	58	59	61	65	67	66	63	57	51	47	45	52	62	65	63	61	61
34 :	95	94	89	89	97	106	109	108	101	88	73	63	58	57	58	60	63	67	68	68	64	59	53	48	46	53	62	63	61	60	61
35 :	95	93	89	91	99	107	112	111	103	90	76	64	58	57	58	61	65	68	69	69	66	61	54	49	47	55	62	62	61	60	61
36 :	94	91	89	92	99	107	112	112	105	92	78	66	59	58	59	63	66	69	71	70	67	62	56	50	48	56	61	60	60	60	61
37 :	95	91	89	93	100	107	113	113	107	94	79	67	61	59	60	63	67	70	72	72	68	63	58	51	50	56	60	60	59	59	61
38 :	95	91	90	94	100	107	113	114	109	96	81	69	62	60	61	65	68	71	73	73	70	65	59	52	51	56	59	59	58	59	61
39 :	95	92	91	95	100	107	113	115	111	99	83	70	62	60	62	65	69	72	74	74	71	66	60	53	51	56	59	58	57	58	62
40 :	95	94	92	95	100	106	112	115	112	101	86	72	63	61	62	66	70	73	75	75	72	67	62	55	52	56	58	58	56	58	62

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1980, arriving from sheltered approach direction of 248 deg azimuth, period = 14.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	5	5									
2 :																			5	4	5	5	5								
3 :	163	152	142	135														5	4	4	4	4	5	7							
4 :	159	148	139	129	117	99	91											5	4	4	3	4	5	7							
5 :	156	145	137	126	112	95	81	83	89									6	4	3	3	4	5	7	12						
6 :	141	131	124	115	106	91	71	69	78									6	5	4	4	4	5	7	13						
7 :	133	123	124	115	102	87	68	62	67								9	6	5	4	4	4	4	7	14	22					
8 :	134	118	117	108	95	81	66	59	61							18	10	7	5	4	4	4	5	7	14	22					
9 :	128	119	117	108	95	82	65	56	56						39	21	12	8	6	5	4	5	5	8	14	22	30				
10 :	124	115	112	103	90	76	64	54	51	51	51	57	61	58	43	24	14	9	6	5	5	5	6	9	14	21	29	39			
11 :	125	116	108	103	90	76	64	53	49	45	47	53	58	58	46	28	16	10	7	6	5	5	6	9	14	20	28	38	47		
12 :	122	113	109	99	87	76	63	53	46	43	44	49	56	58	49	32	18	12	8	6	6	6	7	10	15	20	28	38	47	59	
13 :	123	114	109	99	87	75	62	52	45	41	42	46	53	56	51	35	21	14	9	7	6	6	8	11	16	21	27	36	45	58	75
14 :	122	112	107	97	86	75	62	51	44	40	40	43	50	54	52	39	24	16	11	8	7	7	8	12	17	21	27	33	42	56	75
15 :	123	113	108	97	86	74	63	52	44	40	38	41	47	53	53	42	27	18	13	9	8	8	9	14	18	22	26	32	41	54	76
16 :	122	111	108	95	84	73	62	50	42	38	37	39	44	50	51	44	31	21	14	10	9	8	10	15	19	23	27	32	39	55	76
17 :	123	113	106	96	85	74	62	50	41	37	36	38	43	49	51	45	33	23	16	12	10	9	11	16	20	24	27	33	40	53	74
18 :	125	115	107	97	86	75	63	50	41	36	35	36	41	46	50	45	34	25	18	13	11	10	12	17	21	24	28	33	43	53	74
19 :	124	114	106	95	85	74	62	49	39	34	34	35	39	45	49	45	35	26	20	15	13	12	13	18	22	25	28	34	45	54	73
20 :	125	116	107	96	86	75	63	50	39	33	32	34	38	43	48	46	36	27	22	17	14	13	15	19	23	26	28	36	48	56	69
21 :	127	118	107	96	85	75	62	49	38	32	31	34	36	40	46	46	38	28	23	18	16	15	16	20	24	26	30	38	49	57	68
22 :	128	119	108	97	86	76	63	49	37	30	30	33	35	38	44	46	40	28	23	20	18	16	17	21	25	27	31	40	50	59	69
23 :	127	119	110	97	86	76	63	49	37	30	29	32	34	37	42	45	41	30	23	21	20	18	19	22	25	29	32	41	51	61	69
24 :	129	121	110	99	88	77	63	49	36	28	28	31	34	35	39	44	42	31	24	23	22	19	20	22	26	30	34	43	53	63	70
25 :	129	122	110	99	88	77	64	50	36	28	27	30	33	34	37	43	42	32	25	24	23	21	21	23	26	31	35	44	56	64	70
26 :	128	122	111	100	90	77	64	49	35	27	26	30	33	33	35	41	42	33	26	26	25	23	22	24	27	31	36	46	60	67	70
27 :	128	123	113	102	91	78	64	49	35	26	25	29	32	32	33	38	41	34	28	28	27	24	24	25	28	32	37	49	63	68	67
28 :	127	124	114	103	93	78	64	49	35	25	24	28	31	32	32	36	39	34	30	30	29	26	25	26	29	33	39	53	65	68	67
29 :	126	125	115	104	94	80	63	48	34	25	23	27	30	31	31	34	37	34	32	31	30	28	26	28	30	34	42	56	66	68	67
30 :	124	126	117	106	97	82	63	47	33	24	22	27	30	31	31	32	35	35	33	33	32	29	27	29	31	35	45	58	66	68	66
31 :	121	126	118	107	100	84	64	46	33	24	22	25	29	30	30	31	33	35	35	35	34	31	29	30	32	36	48	60	67	68	65
32 :	118	124	119	110	104	88	65	45	32	25	22	25	28	30	30	30	33	35	36	36	35	32	30	32	33	37	50	62	67	66	64
33 :	114	121	119	114	109	93	68	46	32	25	23	24	27	30	31	31	33	36	37	38	36	34	32	33	33	40	54	63	66	65	63
34 :	111	118	118	116	115	99	72	47	32	25	23	24	26	29	31	32	34	36	38	39	38	35	34	34	34	43	56	63	65	65	61
35 :	107	113	115	118	120	106	77	49	33	26	24	24	26	29	31	32	35	37	39	40	39	37	35	35	36	46	57	62	65	64	60
36 :	105	108	111	119	124	112	83	52	34	27	24	24	26	28	30	33	35	38	40	42	41	38	37	37	38	48	57	62	65	64	59
37 :	103	103	107	119	127	118	90	57	36	27	25	25	26	28	31	33	36	39	41	43	42	40	39	38	40	50	58	63	65	63	58
38 :	101	101	105	118	129	123	97	62	38	28	25	25	26	29	32	34	37	40	43	44	44	42	41	40	42	50	58	63	64	62	55
39 :	100	99	103	116	129	127	104	68	42	30	25	25	27	29	32	35	38	41	44	46	45	43	43	42	43	51	59	63	63	60	54
40 :	98	98	102	114	128	131	111	75	46	32	26	25	27	29	32	35	39	42	45	47	47	45	45	43	45	52	60	63	62	58	53

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 255 deg azimuth, period = 17.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	2									
2 :																			2	2	2	2	2								
3 :	103	77	57	45														2	2	2	2	2	2	3							
4 :	99	73	55	41	33	28	30											2	1	1	1	2	2	3							
5 :	96	70	52	39	31	26	26	34	45									2	1	1	1	1	2	3	5						
6 :	86	62	46	35	28	24	22	27	38									2	2	1	1	1	2	3	5						
7 :	79	57	45	34	26	23	20	24	32								3	3	2	1	1	2	2	3	5	8					
8 :	79	54	41	31	24	21	20	22	28							6	3	3	2	2	1	2	2	3	5	8					
9 :	75	53	40	30	23	21	19	21	26						14	7	4	3	2	2	2	2	2	3	5	8	11				
10 :	72	50	37	27	21	19	19	20	23	27	29	31	31	26	16	8	4	3	2	2	2	2	2	3	5	8	11	15			
11 :	72	50	35	26	21	18	18	19	22	24	27	29	30	27	18	10	5	4	3	2	2	2	2	3	5	8	11	15	19		
12 :	70	48	34	25	19	18	18	19	20	22	25	27	29	27	20	11	6	4	3	2	2	2	3	3	6	8	11	15	19	25	
13 :	70	47	34	24	19	17	17	18	20	21	23	26	28	27	22	13	7	5	4	2	2	2	3	4	6	8	10	14	18	25	36
14 :	69	46	32	22	18	17	17	17	19	21	22	24	27	27	23	16	9	6	4	3	2	3	3	4	6	8	10	13	17	24	36
15 :	70	45	31	22	17	16	16	17	19	20	21	23	25	27	24	17	10	7	5	3	3	3	3	5	7	9	10	12	16	23	36
16 :	69	44	30	21	16	16	16	16	18	19	21	22	24	26	24	18	12	8	5	4	3	3	4	5	7	9	10	12	15	23	36
17 :	70	44	29	20	16	15	16	16	17	19	20	21	23	25	24	19	13	9	6	4	4	3	4	6	8	9	11	13	16	23	36
18 :	71	44	28	19	16	15	16	16	17	18	19	20	22	24	24	20	14	10	7	5	4	4	4	6	8	10	11	13	17	22	37
19 :	70	43	27	18	15	15	15	15	16	17	19	20	21	23	24	20	14	11	8	6	5	4	5	7	9	10	11	13	19	23	37
20 :	72	44	27	18	15	15	15	15	16	17	18	19	21	23	24	21	15	11	9	6	5	5	5	7	9	10	11	14	20	25	36
21 :	73	44	26	17	14	14	15	15	15	16	18	19	20	21	23	21	16	12	9	7	6	5	6	8	10	10	12	15	20	26	36
22 :	75	45	26	16	14	14	15	15	15	15	17	18	19	20	22	21	17	12	9	8	7	6	6	8	10	11	12	16	21	27	37
23 :	76	44	25	16	13	14	14	15	14	15	16	18	19	19	21	22	18	13	10	8	7	6	7	9	10	12	13	16	22	29	39
24 :	78	45	25	16	13	13	14	14	14	14	16	18	18	18	20	21	19	13	10	9	8	7	8	9	10	12	14	17	23	31	40
25 :	81	46	24	15	13	13	14	14	14	14	15	17	18	18	19	21	19	14	11	10	9	8	8	9	11	13	14	18	25	33	42
26 :	84	47	24	15	13	13	14	14	14	13	15	17	18	17	18	20	19	14	11	10	10	8	9	10	11	13	15	18	27	35	43
27 :	89	48	24	15	12	12	13	14	14	13	14	17	18	17	17	19	19	15	12	11	10	9	9	10	12	14	15	20	30	37	42
28 :	96	51	25	15	12	12	13	14	14	13	14	16	17	17	16	18	18	15	12	12	11	10	10	11	12	14	16	23	32	38	44
29 :	102	56	26	15	12	12	12	13	14	12	13	16	17	16	16	16	17	15	13	13	12	11	10	11	13	14	17	25	34	40	44
30 :	110	61	27	15	13	11	12	13	13	12	12	15	17	16	15	16	17	15	14	13	13	11	11	12	13	15	19	26	35	41	45
31 :	118	69	30	16	13	11	11	12	13	12	12	14	16	16	15	14	15	15	15	14	13	12	11	13	14	15	21	28	36	42	45
32 :	125	78	35	17	14	11	11	12	13	12	12	14	15	16	15	14	15	15	15	15	14	12	12	13	14	16	22	31	37	42	46
33 :	132	87	41	19	15	11	11	12	12	12	12	13	15	16	15	14	15	15	16	15	15	13	13	14	15	17	25	32	38	43	46
34 :	138	97	50	21	16	12	11	11	12	12	12	13	14	15	15	15	15	16	16	16	15	14	14	15	15	19	26	33	39	44	47
35 :	143	104	59	26	18	12	11	11	12	12	12	13	14	15	15	15	15	16	17	17	16	15	14	15	16	21	28	34	40	45	47
36 :	148	112	67	34	19	13	12	11	12	12	13	13	14	15	15	15	16	17	17	17	17	15	15	16	17	23	29	35	42	46	47
37 :	155	119	73	43	21	14	12	12	12	12	13	13	14	15	15	16	16	17	18	18	17	16	16	17	18	24	30	36	43	47	47
38 :	157	129	84	52	25	16	13	12	12	12	13	13	14	15	16	16	17	17	18	19	18	17	17	18	20	25	31	38	44	47	46
39 :	157	138	96	62	30	17	13	12	12	12	13	14	14	15	16	17	17	18	19	19	19	18	18	19	21	26	32	39	44	47	46
40 :	153	144	109	74	36	20	15	13	12	12	13	14	15	16	16	17	18	18	19	20	20	19	19	20	22	27	34	41	45	46	45

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1969, arriving from sheltered approach direction of 261 deg azimuth, period = 20.5 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				39	41	42									
2 :																			46	39	41	42	45								
3 :	119	118	119	124														55	42	36	36	37	43	60							
4 :	116	115	117	119	122	119	127											55	41	35	33	34	41	61							
5 :	114	112	114	117	117	114	115	134	151									58	42	35	34	34	40	61	87						
6 :	104	103	105	107	112	110	103	115	138									60	44	38	37	36	40	57	87	1[illegible]					
7 :	99	97	105	107	107	106	99	107	124								86	62	47	41	40	39	40	56	87	111					
8 :	99	94	99	101	101	100	97	103	116							109	88	65	49	44	42	41	43	55	83	107	1[illegible]				
9 :	95	94	99	100	101	101	96	100	111						118	110	91	68	52	46	45	44	46	57	80	101	112				
10 :	93	92	95	96	96	95	96	97	105	110	105	104	107	113	116	109	93	72	55	49	48	47	49	59	77	93	108	116			
11 :	93	92	93	96	95	95	95	97	102	102	102	101	104	110	114	109	94	74	58	51	51	49	52	61	75	88	100	111	113		
12 :	92	91	93	93	93	94	94	96	99	100	99	99	102	108	112	109	96	77	61	54	54	52	54	62	74	85	95	111	112	113	
13 :	92	91	93	93	92	93	94	96	98	99	98	97	99	105	111	108	97	79	64	57	57	54	56	64	75	84	91	102	107	107	108
14 :	91	90	91	91	91	92	93	95	97	98	97	95	97	103	109	108	97	81	66	61	60	57	58	66	75	82	89	96	99	103	104
15 :	91	90	91	91	90	92	93	95	97	98	96	94	96	101	108	107	98	83	69	64	63	60	60	67	75	82	89	91	94	95	100
16 :	91	89	91	90	89	90	92	94	96	97	96	93	94	99	105	106	99	84	71	67	66	64	62	68	75	81	88	90	89	91	99
17 :	91	90	90	89	89	90	92	94	95	96	96	93	94	98	103	105	98	86	73	69	69	67	65	68	74	81	88	90	87	85	91
18 :	91	90	90	89	89	90	92	94	95	96	94	93	93	96	101	103	98	87	75	72	73	70	68	68	74	81	87	91	88	84	86
19 :	91	90	89	88	88	89	91	93	94	94	94	93	93	95	100	102	97	87	77	75	76	73	71	69	74	81	87	90	88	82	82
20 :	91	90	89	88	88	89	91	93	94	94	93	93	93	94	98	101	97	87	78	77	79	76	73	69	74	81	86	90	88	83	79
21 :	91	90	89	88	87	89	91	93	93	93	93	93	92	93	96	100	97	87	79	80	82	79	74	70	74	81	87	90	88	81	77
22 :	91	90	89	88	87	89	91	93	93	92	92	93	92	92	95	99	97	87	80	83	85	81	76	71	74	81	87	90	88	81	77
23 :	91	90	89	87	87	88	91	93	93	92	91	92	92	92	93	98	97	88	82	86	87	83	78	72	75	82	88	90	87	81	76
24 :	91	90	89	87	87	88	91	93	93	92	91	92	93	91	92	97	96	88	85	89	89	85	80	73	75	82	88	90	87	80	76
25 :	91	91	89	87	87	88	91	93	94	91	90	92	93	91	91	95	95	89	88	91	91	87	82	74	76	83	88	90	86	80	76
26 :	91	91	89	88	87	88	91	93	94	91	90	92	93	91	91	94	94	91	91	93	92	88	83	76	77	83	88	89	86	80	76
27 :	92	91	89	88	88	88	91	94	94	91	90	91	92	91	91	93	93	92	94	95	94	89	84	78	78	83	88	89	86	80	75
28 :	92	91	90	88	88	90	91	94	94	92	90	92	93	92	92	93	93	94	96	96	94	91	86	80	79	84	89	89	85	80	76
29 :	92	92	90	89	90	91	92	94	94	93	92	92	93	92	92	93	93	96	97	97	95	92	87	81	80	84	89	89	85	80	76
30 :	92	92	91	91	92	93	94	94	95	94	95	93	93	93	93	93	93	97	98	98	96	93	89	83	82	85	89	88	84	80	76
31 :	93	93	92	93	94	96	96	96	96	96	97	96	96	96	96	96	96	98	99	98	97	94	90	85	83	86	89	88	83	80	77
32 :	93	93	93	95	96	98	98	97	97	98	98	97	98	98	98	98	98	99	99	98	97	95	91	87	84	87	89	87	83	80	77
33 :	93	93	94	96	98	99	99	99	98	99	99	98	98	98	98	99	99	99	99	99	98	96	92	88	86	88	89	87	83	80	78
34 :	94	93	96	98	99	100	100	100	100	100	100	99	99	98	99	99	99	99	99	99	98	96	93	89	88	89	89	86	83	80	78
35 :	94	93	96	98	99	100	100	100	100	100	100	100	99	98	99	99	99	99	99	99	98	97	94	91	89	89	89	86	83	81	78
36 :	95	94	98	99	99	100	100	100	100	100	100	100	99	99	99	99	99	99	99	99	99	97	95	92	91	90	89	86	83	81	79
37 :	96	97	98	99	100	100	100	100	100	100	100	100	99	99	99	99	99	99	100	99	99	98	96	93	92	90	89	86	83	81	79
38 :	97	98	99	99	100	100	100	100	100	100	100	100	99	99	99	99	99	99	100	99	99	98	97	94	93	90	89	87	84	82	79
39 :	97	99	99	99	100	100	100	100	100	100	100	100	99	99	99	99	99	100	100	100	99	99	97	95	94	91	90	87	84	82	80
40 :	97	99	99	100	100	100	100	100	100	100	100	100	100	99	99	99	99	100	100	100	99	99	98	96	95	92	91	88	85	83	80

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1916, arriving from sheltered approach direction of 245 deg azimuth, period = 9.6 sec, tide elevation = +5.4 ft MLLW.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				20	23	25									
2 :																			22	20	23	25	29								
3 :	103	104	107	111														23	20	19	21	22	28	43							
4 :	100	102	105	107	108	104	113											24	20	19	18	20	26	44							
5 :	98	99	103	105	105	101	101	119	137									25	21	19	19	20	26	44	67						
6 :	90	91	94	97	100	98	90	100	121									26	22	20	21	22	26	41	66						
7 :	86	86	94	97	97	95	87	91	106								33	27	23	22	22	23	26	40	66	83					
8 :	86	83	89	92	92	91	85	87	98							43	35	28	24	23	24	25	28	40	62	79					
9 :	83	83	89	92	92	91	86	85	92						55	45	36	30	26	25	25	26	30	41	60	76	80				
10 :	81	81	86	88	88	87	85	84	87	89	84	80	75	67	57	47	38	32	27	26	27	28	32	43	57	69	77	78			
11 :	81	81	84	88	87	86	85	84	85	83	80	78	75	69	59	48	40	34	29	27	29	29	33	44	56	65	71	75	72		
12 :	80	80	84	85	85	85	85	84	84	81	79	77	75	70	61	50	42	36	31	29	30	31	35	44	55	63	67	74	72	69	
13 :	80	80	84	85	85	85	84	84	84	81	78	75	74	70	63	53	44	38	33	31	32	32	36	45	55	62	64	68	68	65	65
14 :	80	79	82	84	84	84	83	83	83	82	78	75	73	70	64	55	46	40	35	33	34	34	37	46	55	61	63	64	62	62	62
15 :	81	79	82	84	83	83	83	83	83	83	78	74	73	71	65	57	48	41	37	35	36	35	38	46	55	61	63	60	59	57	60
16 :	81	79	82	83	83	82	82	81	82	81	79	75	73	71	65	58	50	43	38	37	38	37	39	47	55	60	62	59	55	54	59
17 :	81	79	81	83	83	82	81	81	81	81	79	75	73	71	66	59	52	45	41	39	40	39	41	47	55	60	62	59	54	50	54
18 :	82	79	81	82	83	83	81	80	81	81	79	75	73	71	67	60	53	47	43	42	42	42	43	47	54	59	61	59	55	50	51
19 :	82	80	81	82	83	83	81	80	80	80	79	76	74	73	69	61	53	48	45	44	44	43	44	47	54	59	60	59	54	50	49
20 :	82	80	81	82	83	83	82	80	79	80	79	76	74	73	70	63	54	49	46	46	46	45	45	47	54	59	60	58	54	50	47
21 :	82	81	81	81	82	83	82	79	78	79	79	77	74	72	71	65	56	50	48	48	48	47	46	48	54	59	60	58	55	50	47
22 :	83	81	81	81	82	83	82	80	78	78	78	77	74	72	71	67	59	52	49	51	51	49	48	48	54	59	60	58	55	50	47
23 :	83	81	81	81	82	83	82	80	78	78	78	77	74	72	72	69	61	54	51	53	53	51	49	49	54	59	60	58	54	50	47
24 :	84	82	81	81	82	83	83	81	78	78	78	77	75	73	72	70	63	55	54	56	54	52	51	50	54	59	60	58	54	50	47
25 :	85	83	81	81	82	83	84	82	78	77	78	78	75	73	72	71	65	58	57	58	56	54	52	51	54	59	60	58	54	50	47
26 :	86	84	82	81	82	83	84	83	79	77	78	78	76	73	72	72	67	61	60	60	58	55	54	52	55	59	60	58	54	50	48
27 :	88	85	83	82	82	83	84	84	81	78	78	79	77	74	72	72	69	64	62	62	60	57	56	54	56	59	60	57	54	51	48
28 :	89	86	84	83	83	84	84	85	82	79	79	79	78	75	74	72	70	67	65	64	61	59	57	55	57	59	60	57	54	51	49
29 :	90	88	86	85	85	85	85	86	84	81	80	80	79	76	75	74	72	70	68	66	63	61	59	57	57	59	60	57	54	52	49
30 :	91	90	87	87	87	88	87	87	86	84	83	81	80	78	76	74	73	73	70	68	65	63	60	58	58	60	60	58	54	52	50
31 :	92	91	89	89	90	90	89	89	87	87	87	85	84	82	80	79	76	75	73	70	67	64	62	60	59	60	60	58	55	53	51
32 :	92	92	91	92	93	93	92	91	89	89	89	87	87	85	83	82	79	77	75	72	69	66	64	62	61	61	60	58	55	53	51
33 :	92	92	93	94	95	95	93	92	91	91	91	89	88	87	85	84	82	79	77	74	71	68	66	64	62	62	60	58	55	54	52
34 :	92	92	95	95	96	96	95	94	93	93	92	91	89	88	87	85	83	81	79	76	73	70	68	65	64	63	61	58	56	54	53
35 :	93	92	95	96	97	96	96	95	94	94	93	92	91	89	88	87	85	83	81	78	75	73	70	67	65	64	61	58	56	55	53
36 :	94	92	97	97	97	96	96	96	95	94	94	93	92	91	89	88	86	84	82	80	77	75	72	69	67	65	62	59	57	56	54
37 :	95	95	97	98	97	97	96	96	96	95	94	94	93	92	90	89	88	86	84	82	79	77	74	71	69	66	63	59	57	56	55
38 :	96	97	98	98	98	97	97	96	96	96	95	94	93	92	91	90	89	87	85	84	81	79	76	73	71	67	64	60	58	57	56
39 :	97	98	98	98	98	97	97	97	96	96	96	95	94	93	92	91	90	88	87	85	83	81	79	76	73	69	65	62	59	58	56
40 :	97	99	99	99	98	98	97	97	97	96	96	96	95	94	93	92	91	90	88	87	85	83	81	78	75	70	67	63	60	59	57

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1914, arriving from sheltered approach direction of 214 deg azimuth, period = 9.9 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																															
2 :																				7	8	8									
3 :	155	151	151	155															8	7	8	8	9								
4 :	151	147	148	148	146	135	134											8	7	6	7	7	8	12							
5 :	147	144	145	145	141	130	121	129	138									8	6	6	6	6	8	12							
6 :	133	130	131	132	134	125	107	109	121									9	7	5	5	6	8	12	20						
7 :	125	122	131	132	128	121	103	100	107									10	7	6	6	6	8	11	20						
8 :	125	116	123	123	120	114	100	95	99								15	11	7	6	6	7	7	11	21	34					
9 :	119	116	123	123	120	114	100	92	93							31	18	12	8	7	6	7	8	11	22	34					
10 :	115	112	117	117	114	107	99	90	86	82	75	77	83	81	60	35	20	13	9	8	7	7	8	12	22	33	44				
11 :	116	113	113	117	113	107	99	89	83	73	69	72	78	80	65	39	23	15	10	8	8	8	9	14	22	32	44	56			
12 :	113	109	113	113	110	107	98	89	79	70	66	67	75	79	71	49	29	20	13	10	9	9	12	15	23	31	42	55	65	77	
13 :	113	110	113	113	109	106	98	88	78	69	63	63	70	77	72	54	33	22	15	11	10	10	12	17	24	31	40	51	62	74	89
14 :	111	107	110	109	108	106	97	88	77	67	60	60	67	73	73	58	37	25	17	12	11	11	13	19	25	32	39	48	58	73	88
15 :	112	108	110	109	108	105	99	89	77	67	59	57	63	71	73	61	41	28	20	14	13	12	14	21	27	33	39	45	56	69	88
16 :	110	106	110	107	105	103	97	87	75	65	58	55	60	67	70	63	46	30	22	16	14	14	15	22	28	34	39	45	53	69	87
17 :	111	106	107	107	106	104	99	88	75	64	57	54	58	65	69	64	48	34	25	18	16	15	17	24	29	35	40	46	54	66	84
18 :	112	107	107	107	106	105	100	89	75	63	54	51	55	62	68	64	50	36	27	20	18	17	19	25	31	35	40	47	57	65	81
19 :	110	106	105	105	105	104	99	88	73	61	53	51	53	60	66	63	51	38	29	22	20	19	21	27	32	36	40	48	59	65	79
20 :	111	106	106	105	105	105	100	89	74	60	51	50	52	58	65	63	51	39	31	25	22	21	23	28	33	37	40	50	61	66	74
21 :	111	107	104	103	104	104	100	88	73	58	50	49	50	54	62	63	53	40	32	27	25	23	24	29	34	37	41	52	61	66	71
22 :	112	108	105	103	104	105	101	89	72	56	48	47	48	51	58	62	56	41	33	29	27	25	26	31	35	38	43	53	62	67	71
23 :	111	107	105	102	103	104	101	90	73	56	47	47	47	50	56	62	57	43	34	31	30	28	28	31	35	39	45	54	62	67	70
24 :	111	107	103	102	104	105	101	90	72	54	46	45	47	48	53	59	57	45	35	33	33	30	30	32	36	41	46	56	64	68	69
25 :	110	107	103	102	103	105	103	92	73	54	45	44	46	47	50	58	58	46	37	36	35	32	31	33	36	41	47	57	66	68	68
26 :	110	106	102	101	103	105	103	93	73	53	43	44	46	45	48	55	57	46	38	39	38	35	33	34	37	42	48	58	68	69	67
27 :	109	106	102	101	103	105	103	93	73	52	42	43	45	45	46	52	56	47	41	41	40	37	35	35	38	43	49	60	70	69	64
28 :	109	106	101	100	103	104	102	94	74	51	40	42	44	44	44	49	53	48	43	44	43	39	36	36	39	43	51	63	70	67	63
29 :	108	106	101	99	103	104	102	92	73	50	39	41	43	43	43	47	51	48	46	46	45	41	38	38	40	44	54	65	70	66	61
30 :	107	105	100	99	103	105	102	92	73	50	39	40	42	43	43	45	49	49	48	48	47	43	39	39	40	45	56	66	68	65	60
31 :	105	105	100	98	104	107	103	91	72	51	39	39	41	42	42	43	47	49	50	50	49	45	41	40	41	46	58	67	68	64	58
32 :	103	104	99	98	105	109	104	91	72	52	40	38	40	42	43	43	46	50	52	52	50	47	43	42	42	47	60	67	66	62	57
33 :	102	102	98	99	107	112	107	92	72	53	41	37	39	41	43	44	47	51	54	54	52	48	44	43	42	50	62	66	64	60	55
34 :	100	100	97	99	110	116	110	94	73	55	42	38	38	41	43	45	49	53	55	56	54	50	46	44	43	52	62	65	63	59	54
35 :	98	98	95	100	111	118	114	98	76	56	44	38	38	40	43	46	50	54	56	57	56	52	48	45	45	54	62	64	62	57	53
36 :	97	96	94	100	111	120	117	102	79	58	45	39	38	40	43	47	51	55	58	59	57	54	50	46	46	55	62	62	60	56	51
37 :	97	93	92	100	111	120	120	105	82	61	46	40	39	41	44	48	52	56	59	60	59	55	52	48	48	56	61	61	60	55	50
38 :	97	93	92	100	111	120	122	109	86	63	48	41	40	42	45	49	53	57	60	62	61	57	54	49	49	56	60	61	58	54	48
39 :	96	93	93	99	110	120	123	113	91	67	50	42	40	42	45	50	54	58	62	63	62	59	55	51	50	56	60	60	56	52	47
40 :	96	94	93	99	108	119	124	116	95	71	52	43	41	42	46	50	55	60	63	65	64	61	57	52	51	56	60	59	54	50	46

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1926, arriving from sheltered approach direction of 251 deg azimuth, period = 16.0 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				12	13	14									
2 :																			14	12	13	14	15								
3 :	127	122	120	123														16	12	11	11	12	14	20							
4 :	123	119	117	117	120	119	133											17	12	10	10	11	14	20							
5 :	120	116	114	114	114	114	119	151	184									18	12	10	10	10	13	20	32						
6 :	109	105	104	103	108	108	105	128	166									19	13	10	10	11	13	19	33						
7 :	102	98	104	103	103	103	100	117	148								34	21	14	11	11	12	13	19	35	53					
8 :	103	94	97	96	95	97	97	111	137							84	39	22	16	12	12	12	14	19	35	53					
9 :	98	94	97	95	95	96	96	107	130						133	91	45	25	17	14	13	13	15	20	36	51	66				
10 :	95	91	92	90	89	90	95	103	121	137	137	140	146	148	134	96	52	28	19	15	14	14	16	22	34	49	64	80			
11 :	95	91	89	90	88	89	93	102	117	125	131	134	139	144	133	101	58	31	21	16	15	15	18	24	35	47	61	78	90		
12 :	93	89	89	86	85	87	92	101	112	122	127	130	135	140	133	105	64	35	23	18	17	17	19	25	36	46	60	78	90	104	
13 :	93	89	89	86	83	86	90	100	111	120	124	126	130	135	131	108	69	39	26	19	18	18	20	28	38	47	57	72	86	100	117
14 :	92	87	86	83	82	84	89	98	109	118	122	123	127	131	130	109	74	43	29	22	20	20	22	30	39	47	56	67	81	98	115
15 :	92	87	86	82	80	83	89	99	110	119	120	121	124	129	129	111	79	48	32	24	23	21	24	32	41	48	55	64	77	93	114
16 :	91	86	86	80	78	81	87	96	106	116	120	119	121	124	123	111	82	52	34	27	25	23	25	35	42	49	55	63	74	92	113
17 :	91	86	84	80	78	80	87	96	106	115	120	119	120	122	121	110	84	56	37	29	27	26	28	36	44	50	56	65	74	88	108
18 :	92	87	84	79	77	80	87	96	106	115	117	117	118	118	119	109	85	58	40	32	30	28	30	38	45	50	56	66	77	86	104
19 :	91	86	82	77	76	78	85	95	104	112	117	117	117	117	115	106	84	60	43	34	33	31	33	40	46	50	56	67	79	86	100
20 :	91	86	82	77	75	78	85	95	104	112	115	118	117	115	113	104	84	61	45	37	36	35	36	41	47	51	56	69	82	87	94
21 :	91	87	81	76	74	77	84	94	103	110	114	118	115	112	110	102	85	62	46	40	39	38	38	43	48	52	58	71	83	87	91
22 :	92	87	81	76	74	76	84	93	102	108	112	116	114	110	106	101	87	62	46	42	43	41	40	44	49	52	59	73	84	88	90
23 :	91	87	81	75	72	75	82	94	103	108	111	115	115	110	104	99	87	63	47	45	46	44	43	45	49	54	61	74	84	88	89
24 :	91	87	80	75	73	75	82	93	103	107	109	113	116	108	100	96	85	64	49	48	49	47	45	45	49	55	63	76	85	88	89
25 :	91	87	80	74	72	74	82	94	104	107	108	112	115	108	98	94	84	64	51	51	53	50	47	46	50	56	64	78	87	88	87
26 :	90	86	79	74	71	74	81	93	103	105	106	112	115	107	95	91	82	64	53	54	55	52	49	48	51	56	65	79	89	89	86
27 :	90	86	79	73	71	73	81	93	103	104	105	111	115	106	94	87	80	64	56	57	58	55	51	49	51	57	67	81	91	89	83
28 :	89	86	79	72	71	73	80	93	103	103	102	110	113	105	92	84	76	65	59	60	60	57	53	51	52	58	69	84	91	87	82
29 :	89	86	79	72	71	73	80	91	101	102	102	110	111	104	91	81	74	65	61	62	63	59	55	52	53	59	73	86	90	86	80
30 :	89	86	78	72	71	74	80	90	100	101	102	109	111	103	90	79	72	66	64	64	64	61	57	54	54	61	76	87	89	85	79
31 :	88	86	79	72	72	76	81	89	98	101	104	109	109	102	90	78	70	67	66	66	66	63	59	56	55	62	78	87	88	84	78
32 :	87	86	79	73	74	78	82	89	97	102	106	109	109	102	91	78	71	67	67	68	67	65	61	57	56	64	79	87	87	81	77
33 :	87	85	79	75	77	81	84	89	96	103	108	110	109	102	91	80	72	69	69	69	68	67	63	59	58	67	82	87	84	80	75
34 :	86	85	79	77	80	84	87	91	97	104	110	112	109	101	90	80	73	70	69	70	70	68	65	60	59	70	82	85	83	79	74
35 :	86	84	79	79	82	86	89	93	98	105	112	114	110	100	90	81	74	71	70	71	71	70	67	62	61	72	82	84	82	78	73
36 :	86	83	80	81	84	87	90	94	99	106	113	116	111	101	90	81	74	71	71	72	72	72	69	64	64	74	82	83	81	77	72
37 :	86	83	81	83	85	88	91	94	99	107	114	117	112	102	91	81	75	72	71	73	74	73	72	66	66	75	82	82	80	76	71
38 :	86	84	83	84	87	89	92	95	100	107	114	118	113	103	91	81	75	72	72	74	75	75	74	68	68	76	81	82	79	75	69
39 :	86	85	85	86	88	90	93	96	101	108	115	118	113	102	90	80	74	72	73	74	76	77	76	70	70	76	81	81	77	73	68
40 :	86	86	86	87	89	91	94	96	101	108	116	119	113	102	89	80	74	72	73	75	78	78	78	72	71	77	81	80	76	71	67

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1926, arriving from sheltered approach direction of 259 deg azimuth, period = 13.8 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				21	23	24									
2 :																			24	21	23	24	25								
3 :	127	125	125	131														28	22	20	20	21	25	35							
4 :	124	121	123	125	129	128	139											29	21	19	17	19	23	35							
5 :	121	119	120	123	124	123	125	149	17									31	22	18	18	18	23	35	56						
6 :	110	108	109	111	118	117	111	127	154									33	24	19	19	20	23	33	57						
7 :	104	101	109	111	113	113	106	117	137								54	35	25	21	20	21	22	33	59	84					
8 :	104	97	102	104	105	106	104	111	128							92	59	37	27	23	22	22	24	33	58	82					
9 :	100	97	102	104	105	107	103	108	121						120	96	64	41	29	25	24	24	26	35	57	79	96				
10 :	97	94	98	99	99	100	102	105	114	120	114	114	120	125	120	99	69	45	32	27	26	26	28	38	55	74	93	109			
11 :	97	94	94	98	98	99	101	104	110	109	109	109	114	121	119	101	73	49	35	29	28	27	30	40	55	70	87	106	115		
12 :	95	92	94	95	95	98	100	103	107	107	106	105	111	118	118	103	77	53	38	31	30	29	33	41	55	68	84	106	115	122	
13 :	95	92	94	94	94	97	99	103	105	105	103	102	107	114	117	105	81	57	41	34	33	31	34	44	56	67	80	97	110	117	123
14 :	94	91	92	91	93	96	98	101	104	104	101	100	103	110	115	106	84	61	44	37	36	34	36	46	57	67	78	92	102	113	118
15 :	94	91	92	91	92	95	99	102	104	105	100	98	101	108	114	107	87	64	48	40	39	37	39	48	58	67	77	86	97	105	115
16 :	93	90	92	89	90	93	97	100	102	102	100	96	98	104	110	106	90	67	51	43	42	40	41	50	58	66	77	85	91	101	113
17 :	94	90	90	89	90	93	97	100	102	101	99	95	97	102	108	105	91	70	54	46	46	43	44	51	59	67	77	86	90	94	104
18 :	94	91	90	88	89	93	97	100	101	101	97	94	95	99	106	104	91	73	57	49	49	47	47	52	59	66	77	88	92	92	98
19 :	93	90	88	87	88	91	96	99	100	98	97	94	94	97	103	102	91	74	59	52	53	51	50	53	59	67	76	88	92	90	94
20 :	94	90	88	87	87	91	96	99	100	98	95	94	93	95	101	101	91	75	61	56	57	54	52	54	59	67	77	88	93	90	88
21 :	94	91	88	85	86	90	95	99	99	96	94	94	92	93	98	100	92	76	63	59	60	58	54	55	60	67	78	89	93	88	85
22 :	94	91	88	85	86	90	95	98	98	95	93	92	91	90	94	99	93	76	64	63	64	61	56	55	60	68	79	90	93	88	84
23 :	94	91	88	85	85	89	94	99	99	95	92	92	91	89	92	97	93	77	65	66	68	64	58	56	60	69	81	90	91	87	83
24 :	94	91	87	85	85	89	94	99	98	94	91	91	91	88	90	95	93	78	68	70	71	66	60	56	60	70	82	91	91	86	82
25 :	94	91	87	84	84	88	94	99	99	94	90	90	90	88	87	93	92	79	71	74	74	69	62	57	60	71	83	91	91	85	81
26 :	94	91	87	84	84	87	93	99	99	93	89	90	90	87	86	91	91	80	75	77	77	71	64	58	61	71	83	91	90	85	80
27 :	93	91	87	84	84	87	93	99	99	92	88	89	90	86	85	88	89	82	78	80	79	73	66	60	62	72	84	90	90	85	79
28 :	93	91	87	84	84	87	92	98	99	92	87	89	89	86	84	86	87	83	82	83	81	75	68	61	63	73	85	91	89	83	79
29 :	93	91	87	84	85	88	92	97	98	92	87	89	88	86	84	85	86	85	85	85	82	76	69	63	64	74	86	91	88	83	78
30 :	93	91	87	84	86	89	92	97	98	93	89	89	88	86	84	84	85	86	88	87	84	78	71	65	65	75	87	90	86	82	78
31 :	93	91	88	86	88	91	94	97	97	95	91	89	88	87	85	85	86	88	90	89	85	80	73	66	67	76	88	90	86	81	78
32 :	93	91	88	88	90	94	96	97	98	96	94	91	90	89	88	88	88	89	91	90	86	81	75	68	68	78	87	88	85	80	79
33 :	92	91	89	90	93	97	98	98	98	98	96	92	90	89	89	90	91	92	92	91	87	83	77	70	70	79	88	87	83	80	78
34 :	92	91	90	92	96	99	100	100	100	99	97	94	91	89	89	91	92	93	93	91	89	84	78	71	71	80	87	86	82	80	78
35 :	92	91	91	94	97	99	101	102	101	100	99	96	92	90	90	92	93	93	93	92	90	86	80	73	73	82	87	85	82	80	78
36 :	93	91	92	95	98	100	101	102	102	101	99	96	93	91	91	92	93	94	94	93	90	87	82	75	75	82	86	84	81	80	78
37 :	93	92	93	96	98	100	102	102	103	102	100	97	94	92	92	92	93	94	94	93	91	88	84	77	77	83	85	83	81	80	79
38 :	94	94	95	97	99	100	102	103	103	102	100	97	95	93	92	93	94	94	95	94	92	89	85	79	79	83	85	83	81	80	78
39 :	94	95	96	97	99	100	102	103	103	103	101	98	95	93	92	93	94	95	95	94	93	90	86	81	80	83	85	83	81	80	79
40 :	95	97	97	98	99	100	102	103	103	103	101	98	95	93	92	93	94	95	95	95	93	91	88	83	82	83	85	83	81	80	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1952, arriving from sheltered approach direction of 245 deg azimuth, period = 11.7 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	8									
2 :																			6	5	6	6	7								
3 :	147	150	157	171														6	5	5	5	6	7								
4 :	142	145	153	163	172	169	178											6	5	5	4	5	6	10							
5 :	139	141	150	160	166	163	160	174	17									7	5	4	4	5	6	10	16						
6 :	125	127	135	144	157	156	142	149	162									7	6	5	5	5	6	9	16						
7 :	117	118	135	144	151	151	136	137	145								12	8	6	5	5	5	6	9	17	28					
8 :	117	113	126	135	141	142	133	132	135							24	14	9	6	6	5	5	6	9	17	28					
9 :	111	112	125	134	140	143	133	128	128						49	28	16	10	7	6	6	6	7	10	18	27	37				
10 :	107	108	119	127	132	134	132	125	120	108	86	75	73	68	53	32	18	12	8	7	6	6	7	11	17	26	36	48			
11 :	107	108	113	126	131	134	132	124	116	98	82	71	69	67	56	36	21	14	9	7	7	7	8	12	18	25	35	47	58		
12 :	104	104	113	120	127	133	132	125	113	95	78	67	66	66	58	40	23	16	10	8	7	7	9	12	19	25	35	47	57	71	
13 :	104	104	113	120	126	132	131	125	112	94	76	64	62	64	59	43	26	18	12	9	8	8	10	14	20	26	33	44	55	69	88
14 :	101	101	109	115	124	131	130	124	111	93	74	61	59	61	59	47	30	20	14	10	9	9	11	15	21	26	33	41	52	67	87
15 :	101	101	108	115	123	130	133	127	113	94	72	59	56	59	59	50	33	23	16	11	10	10	11	17	22	27	32	39	49	65	88
16 :	100	98	108	111	119	128	131	125	110	91	72	57	53	56	57	51	37	25	18	13	11	11	12	18	23	28	33	39	47	65	88
17 :	100	98	104	110	119	128	132	126	111	91	71	56	51	54	56	51	39	27	20	15	13	12	14	19	24	29	33	40	48	63	85
18 :	100	99	103	110	119	129	134	128	112	90	69	54	49	51	55	51	40	29	22	16	14	13	15	21	25	29	34	41	52	62	84
19 :	98	97	101	106	116	127	132	127	110	88	68	53	48	50	53	51	41	31	24	18	16	15	17	22	27	30	34	42	54	63	83
20 :	99	97	100	106	116	128	134	129	111	88	65	52	46	48	52	50	41	32	25	20	18	17	18	23	28	31	34	44	57	65	78
21 :	99	97	98	103	113	126	133	128	110	86	64	51	45	45	49	50	43	33	26	22	20	19	20	25	29	32	36	46	58	66	76
22 :	99	97	97	102	112	126	135	129	110	84	62	50	43	42	47	50	45	33	27	24	22	21	21	26	30	33	37	48	59	68	77
23 :	98	95	97	100	110	124	134	131	112	84	61	49	43	41	45	49	46	34	27	25	24	22	23	26	30	34	39	49	60	69	77
24 :	98	95	94	99	110	124	134	132	112	82	59	47	42	39	42	47	46	36	28	27	26	24	25	27	31	35	40	51	62	71	78
25 :	97	94	93	97	107	122	135	135	114	82	57	46	41	39	40	46	46	36	29	29	29	26	26	28	31	36	42	53	65	73	77
26 :	96	93	91	95	106	120	134	135	114	80	55	45	41	38	38	43	45	37	31	31	31	28	28	29	32	37	43	55	69	75	77
27 :	95	93	90	94	104	119	134	136	115	79	53	44	40	37	36	41	44	37	32	33	33	30	29	30	33	38	44	57	72	76	74
28 :	95	92	89	91	102	116	132	137	116	78	51	43	39	36	35	39	41	38	34	35	35	32	30	31	34	38	46	62	73	75	74
29 :	94	92	87	89	100	115	130	135	115	77	49	42	38	35	34	36	40	38	36	37	37	34	32	33	35	39	50	64	74	75	73
30 :	93	91	86	87	99	114	130	134	115	77	49	41	37	35	34	35	38	38	38	39	38	36	33	34	36	41	53	66	74	75	72
31 :	92	90	85	85	97	114	129	132	114	78	49	40	36	34	33	34	36	38	40	41	40	38	35	36	37	42	56	68	74	75	71
32 :	90	89	84	84	97	114	129	132	114	79	50	39	35	34	34	34	36	39	41	42	42	39	37	37	38	44	58	70	74	73	71
33 :	89	88	83	83	96	115	130	132	114	81	52	38	34	34	34	34	36	40	42	44	43	41	39	39	39	47	61	71	73	72	69
34 :	88	87	82	83	97	116	132	133	115	83	54	38	33	33	34	35	37	41	43	45	45	43	41	40	40	49	63	70	73	72	68
35 :	87	86	81	83	97	116	133	136	118	86	56	39	33	33	34	36	39	42	45	47	46	44	43	42	42	53	64	70	72	71	67
36 :	86	84	80	84	96	115	133	139	121	89	58	40	34	33	34	37	39	43	46	48	48	46	45	43	44	55	65	70	72	70	66
37 :	86	82	79	84	95	113	133	140	125	92	60	41	34	33	35	37	40	44	47	49	50	48	47	45	46	56	65	70	72	69	64
38 :	85	82	80	84	94	111	132	142	129	96	63	42	35	34	36	38	41	45	48	51	51	50	49	47	48	57	65	70	71	68	62
39 :	85	82	80	84	94	109	130	142	133	101	65	43	35	34	36	39	42	46	49	52	53	52	51	49	50	58	66	70	70	66	61
40 :	85	83	81	85	93	107	128	142	136	106	69	45	36	35	36	39	43	47	51	54	55	54	53	51	51	59	67	70	68	64	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1937, arriving from sheltered approach direction of 258 deg azimuth, period = 16.4 sec, tide elevation = +5.4 ft MLLW.

Swell from storm of August 1972 (deep water approach azimuth = 156 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				7	7	8									
2 :																			7	7	7	8	9								
3 :	77	77	80	88														8	7	6	6	7	8	12							
4 :	74	75	78	83	86	86	98											8	6	6	5	6	8	12							
5 :	72	72	77	81	83	82	85	105	12									9	6	5	5	6	8	12	24						
6 :	65	65	69	73	79	79	75	87	110									9	7	6	6	6	8	11	24						
7 :	61	61	69	73	76	76	71	78	95								14	10	7	6	6	6	8	11	25	48					
8 :	61	58	64	68	71	71	69	73	86							22	15	11	8	7	6	7	8	11	25	47					
9 :	58	58	64	68	70	72	68	70	80						37	24	17	12	9	7	7	7	9	12	26	46	71				
10 :	56	56	61	64	66	67	67	68	74	79	76	74	69	57	41	26	19	13	10	8	8	8	10	14	25	44	70	95			
11 :	56	55	58	64	66	66	66	67	71	71	72	72	68	59	44	29	20	15	11	9	8	9	11	15	25	42	67	93	109		
12 :	54	54	58	61	63	65	66	67	69	69	69	69	68	61	47	32	22	17	12	10	9	9	11	16	26	42	66	95	109	117	
13 :	54	54	58	61	63	64	64	65	67	68	67	67	66	61	50	35	24	19	14	11	10	10	12	17	27	42	64	88	105	112	114
14 :	54	52	56	59	62	64	63	64	66	67	66	65	65	61	52	38	27	21	15	12	11	11	13	19	29	43	63	84	98	108	109
15 :	54	52	56	59	61	63	63	64	66	67	65	63	63	61	54	42	29	23	17	13	12	12	14	21	30	45	63	79	93	100	105
16 :	53	51	56	57	60	61	62	62	63	64	64	62	62	61	54	43	32	24	19	15	14	13	15	22	31	45	64	79	87	95	103
17 :	54	51	54	57	60	61	62	62	62	64	64	62	62	61	55	45	34	27	21	17	15	15	16	23	32	47	66	81	86	87	93
18 :	54	51	54	56	59	62	62	61	62	63	62	60	60	60	56	46	35	28	23	18	17	16	18	25	34	47	66	83	88	85	87
19 :	54	51	52	55	58	61	61	60	60	61	62	60	60	60	57	47	36	30	25	20	19	18	20	26	35	49	67	83	87	82	81
20 :	54	51	52	55	58	61	61	60	59	60	60	60	59	59	58	49	37	30	26	22	21	20	21	27	36	50	68	84	88	82	75
21 :	55	52	51	53	57	60	61	59	58	58	60	60	58	58	58	51	39	31	27	24	23	22	23	28	37	52	71	85	87	79	72
22 :	55	52	51	53	56	60	61	59	57	57	59	59	56	56	57	53	42	32	28	26	25	24	24	29	39	54	73	86	87	78	70
23 :	56	52	51	52	55	59	61	59	57	56	58	59	56	55	56	54	45	33	29	28	27	26	26	30	40	56	75	87	84	75	68
24 :	57	52	51	52	55	59	61	59	56	55	57	58	56	54	55	54	47	35	30	30	29	28	28	31	41	59	77	87	84	73	67
25 :	58	53	50	51	54	58	61	60	56	55	57	58	56	53	53	55	49	37	31	32	32	30	30	32	42	61	79	87	83	72	65
26 :	59	53	51	51	53	57	60	60	57	54	56	58	56	52	51	54	50	38	33	34	34	32	31	34	43	62	79	86	81	71	64
27 :	61	55	51	51	53	56	60	61	57	53	55	58	56	51	50	52	51	41	35	36	36	34	33	36	45	64	80	85	80	71	62
28 :	64	56	52	51	52	54	58	61	58	53	54	57	56	51	49	51	50	42	38	38	37	35	35	37	47	65	81	85	78	68	62
29 :	66	59	53	51	52	54	57	60	58	53	53	57	56	51	49	49	49	44	40	40	39	37	36	39	49	67	82	84	77	67	61
30 :	69	62	54	51	53	54	56	59	58	54	53	57	56	52	48	48	49	46	43	42	41	39	38	41	51	69	83	83	74	66	61
31 :	71	65	57	52	53	54	56	59	58	55	53	56	56	53	49	47	48	47	45	44	43	41	40	43	53	70	83	81	72	66	61
32 :	73	68	59	54	55	55	56	58	59	56	55	56	57	55	51	49	48	48	47	46	45	43	42	45	54	71	82	79	71	64	61
33 :	74	70	63	57	57	57	57	58	59	58	56	56	57	56	53	51	50	50	49	48	46	45	45	47	56	73	82	77	69	63	60
34 :	75	72	66	60	60	59	59	59	60	59	58	57	57	57	55	53	52	52	51	50	48	47	47	49	58	73	80	75	67	63	60
35 :	76	72	69	63	62	61	61	61	61	61	60	59	58	57	56	55	54	53	52	51	50	50	49	50	60	74	79	73	66	62	60
36 :	78	73	71	66	64	63	62	62	62	62	62	61	60	59	57	57	56	55	54	53	52	52	51	52	62	75	78	71	65	62	60
37 :	83	75	73	70	66	64	63	63	63	63	63	63	62	61	59	58	57	56	55	54	54	54	54	54	63	75	77	70	65	62	61
38 :	88	78	76	73	69	66	64	64	64	64	64	64	64	63	62	60	59	58	57	56	55	55	56	57	64	75	75	69	64	62	60
39 :	93	83	79	77	71	68	66	65	65	65	65	66	65	64	63	62	60	59	58	57	57	57	58	59	65	74	75	68	64	62	61
40 :	98	89	83	81	75	71	68	66	66	66	67	67	67	66	65	63	62	61	60	59	59	59	60	61	67	74	74	68	63	62	61

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1963, arriving from sheltered approach direction of 208 deg azimuth, period = 14.5 sec, tide elevation = +5.4 ft MLLW.

Swell from storm of September 1982 (deep water approach azimuth = 158 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

APPENDIX C

STORM SWELL

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = +8.0 ft MLLW

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																			10	11	11									
2																		11	10	11	11	13								
3	91	89	92	98													12	10	9	10	10	12	17							
4	89	87	90	94	100	103	117										13	10	9	8	9	12	18							
5	87	85	88	93	97	99	106	133	16								14	10	8	8	9	12	18	31						
6	80	78	81	85	93	96	95	113	144								15	11	9	9	10	12	17	32						
7	75	73	80	85	89	92	90	103	128							22	16	12	10	9	10	12	17	33	55					
8	75	70	76	80	84	87	88	97	117						39	25	17	13	11	10	11	12	18	33	55					
9	72	70	75	79	83	87	87	94	110					69	43	27	19	14	12	11	11	13	19	34	54	76				
10	70	68	72	75	78	81	85	90	102	113	114	116	114	100	75	47	30	21	16	13	12	12	14	21	33	52	75	98		
11	70	68	69	74	77	80	84	89	98	103	108	112	111	102	79	52	33	24	17	14	13	13	16	22	34	50	73	98	113	
12	69	66	69	72	75	79	83	88	94	100	104	108	110	103	84	57	37	26	19	15	14	15	17	23	35	50	72	99	114	123
13	69	66	69	71	74	78	81	86	92	97	101	104	107	103	87	62	40	29	21	17	16	16	18	25	36	50	70	93	111	120	124
14	68	64	67	69	72	76	79	84	90	95	98	101	104	102	90	67	44	32	24	18	18	17	20	27	37	51	69	89	105	117	120
15	69	64	66	68	71	75	79	84	89	95	97	98	102	102	92	72	49	35	26	20	19	19	21	29	39	52	69	85	101	110	117
16	68	63	66	67	69	73	77	81	86	92	96	96	99	100	92	74	53	38	29	23	21	20	22	31	40	52	69	85	96	106	116
17	69	64	64	66	69	73	77	80	85	90	95	95	98	99	93	77	56	41	32	25	24	22	24	33	41	54	71	87	95	99	108
18	70	64	64	66	69	73	77	79	83	89	92	93	96	97	94	79	59	44	34	28	26	25	26	34	42	54	71	89	97	98	101
19	69	64	63	64	67	72	75	77	81	86	91	93	95	97	94	80	60	46	37	30	29	27	29	35	43	55	72	90	97	95	96
20	70	65	63	64	67	71	75	77	79	84	89	92	94	96	95	82	62	47	39	33	32	30	31	36	44	56	73	91	98	95	90
21	71	65	63	63	65	70	74	76	77	81	88	92	92	93	94	84	65	49	41	36	34	33	32	38	45	57	75	93	98	92	87
22	72	66	63	62	65	70	74	75	76	79	85	90	90	90	92	87	70	50	42	39	38	35	34	39	46	59	78	94	98	92	85
23	72	66	63	62	64	68	73	75	75	78	84	90	90	89	90	88	74	53	43	41	41	38	36	39	47	61	80	95	97	90	83
24	73	67	63	62	63	68	72	74	74	76	82	88	90	87	88	88	76	56	46	44	44	40	38	40	48	64	82	96	96	88	82
25	74	67	63	61	62	66	71	75	74	75	81	87	89	86	86	88	79	58	48	48	47	43	40	41	49	65	84	97	96	87	80
26	75	68	63	61	62	65	70	74	73	73	79	87	89	85	84	86	80	61	51	51	49	45	42	43	50	67	85	96	95	86	79
27	76	69	64	61	62	64	69	73	73	72	77	86	89	85	82	84	81	64	55	54	52	47	44	44	51	68	87	96	94	86	76
28	78	71	65	62	62	63	67	73	73	70	74	84	88	84	81	82	79	67	59	57	54	50	46	46	53	70	88	96	93	83	76
29	79	73	66	62	62	63	66	71	72	70	73	83	87	84	81	80	78	70	63	60	57	52	48	48	55	72	90	96	91	82	75
30	80	75	67	63	63	63	65	69	72	70	72	81	86	84	81	79	78	72	66	63	59	54	50	50	56	74	91	95	88	81	75
31	81	77	69	64	64	64	64	68	70	70	72	80	85	85	82	79	77	74	70	66	61	56	52	51	58	76	92	94	87	80	75
32	81	78	71	66	66	65	65	67	70	70	73	79	85	87	84	81	79	76	73	68	63	58	54	53	60	77	92	92	85	78	75
33	81	79	73	69	68	67	66	67	69	71	73	78	84	88	87	84	82	79	75	71	65	61	56	55	62	79	92	91	83	77	74
34	81	79	75	72	72	70	67	67	69	71	74	79	84	87	88	87	85	82	78	73	68	63	59	57	64	81	91	88	81	77	73
35	81	78	76	74	74	72	69	68	69	71	75	79	84	87	89	89	88	84	80	75	70	65	61	59	66	82	90	86	81	76	73
36	82	78	77	77	76	73	71	69	69	72	75	80	85	88	90	92	90	87	82	77	72	68	64	61	68	83	89	84	79	76	73
37	84	78	78	79	78	75	72	70	70	71	75	80	85	90	92	93	92	88	84	79	74	70	66	63	70	83	88	83	79	76	73
38	86	80	79	81	79	77	73	71	70	71	75	80	85	91	94	95	94	91	86	81	76	72	69	66	72	83	87	82	78	76	73
39	87	82	81	82	81	78	75	72	71	71	74	79	85	91	95	96	95	92	88	83	79	75	71	68	73	83	86	82	77	75	73
40	88	84	82	83	82	80	77	74	72	72	74	79	85	90	95	97	97	94	90	86	81	77	74	70	75	83	86	81	77	75	73

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1939, arriving from sheltered approach direction of 224 deg azimuth, period = 14.0 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	4	4									
2 :																			4	4	4	4	5								
3 :	118	123	133	150														5	4	4	4	4	5	8							
4 :	115	119	130	144	159	165	177											5	4	3	3	4	4	7							
5 :	112	116	127	141	154	160	164	182	18									5	4	3	3	3	4	7	11						
6 :	102	106	116	130	148	155	149	160	174									5	4	3	3	4	4	6	11						
7 :	96	99	115	129	142	150	144	150	159								9	6	5	4	3	4	4	6	12	19					
8 :	96	94	108	120	133	142	141	145	151							18	10	6	5	4	4	4	4	7	12	19					
9 :	91	93	107	119	132	143	141	142	145						38	20	11	7	5	4	4	4	5	7	13	19	25				
10 :	88	89	101	113	125	134	140	138	137	123	95	76	65	56	41	23	13	8	6	5	4	5	5	8	13	18	25	33			
11 :	87	89	96	111	123	134	139	138	133	113	91	72	62	55	43	27	15	10	6	5	5	5	6	8	13	18	25	32	40		
12 :	85	86	95	106	119	133	139	139	130	111	88	69	60	55	45	30	17	11	7	6	5	5	7	9	14	18	25	33	39	50	
13 :	84	85	94	105	117	131	138	139	129	109	86	66	57	53	47	33	20	13	9	6	6	6	7	10	14	19	24	31	38	49	64
14 :	82	82	91	101	115	130	137	138	128	109	84	64	55	52	47	36	22	15	10	7	6	6	8	11	15	19	24	29	37	48	64
15 :	82	82	90	99	113	129	140	141	131	110	83	62	52	50	48	38	25	17	12	8	7	7	8	12	16	20	23	28	35	47	66
16 :	81	80	88	96	110	126	138	139	128	107	83	60	50	48	46	39	28	19	13	9	8	8	9	13	17	20	24	28	34	48	66
17 :	81	79	85	94	109	126	139	141	130	108	82	59	48	46	45	40	30	21	15	11	9	8	10	14	18	21	24	29	35	47	65
18 :	81	79	84	93	108	126	140	143	131	108	80	57	46	44	45	40	31	23	17	12	10	9	11	15	19	22	25	29	37	46	66
19 :	80	77	81	89	104	123	138	142	129	106	79	57	45	43	43	40	31	24	18	13	12	10	12	16	20	22	25	30	39	48	66
20 :	80	77	80	88	103	123	140	144	131	106	77	56	44	41	43	40	32	24	19	15	13	12	13	17	21	23	25	32	42	49	63
21 :	80	77	78	84	99	120	138	144	130	104	76	55	42	39	41	40	33	25	20	16	14	13	14	18	22	24	26	34	43	51	63
22 :	80	77	77	83	97	119	139	144	131	102	73	53	41	37	38	40	35	26	21	18	16	15	15	19	22	25	28	35	44	53	64
23 :	79	75	76	80	94	116	138	147	133	102	72	52	40	35	37	39	36	27	21	19	18	16	17	20	23	26	29	36	45	54	65
24 :	79	76	74	79	92	115	137	148	134	101	69	50	39	34	35	38	36	28	22	20	19	18	18	20	23	27	30	38	47	57	66
25 :	78	74	72	76	89	111	137	151	136	101	68	48	38	33	33	37	37	28	22	22	21	19	19	21	24	28	31	39	50	59	67
26 :	78	74	71	74	87	108	136	151	137	100	65	47	38	32	31	35	36	29	24	23	23	21	20	22	25	28	32	40	53	62	67
27 :	77	73	69	72	84	106	134	152	139	99	63	46	37	31	30	33	35	29	25	25	24	22	22	23	25	29	33	43	57	63	66
28 :	77	73	68	70	81	102	131	153	141	98	60	44	36	30	29	31	33	30	26	26	26	24	23	24	27	30	35	46	58	64	67
29 :	76	73	67	67	79	99	128	150	140	97	57	43	34	30	28	29	32	30	28	28	27	25	24	25	27	30	37	49	60	64	67
30 :	76	72	66	65	76	96	125	149	140	97	56	41	33	29	28	28	31	30	29	29	29	27	25	26	28	31	40	51	61	66	67
31 :	75	72	65	63	74	94	123	146	139	98	57	39	32	28	27	27	29	30	30	31	30	28	26	28	29	33	42	54	62	66	67
32 :	74	71	64	62	72	93	121	144	138	100	58	38	30	28	27	27	28	30	32	32	31	29	28	29	30	34	45	56	62	65	67
33 :	73	71	64	61	71	91	120	143	138	102	59	37	29	28	28	27	29	31	33	33	33	31	29	30	31	36	48	57	62	65	67
34 :	72	70	63	61	70	91	119	142	139	104	62	37	28	28	28	28	29	32	34	35	34	32	31	31	32	38	50	57	63	66	66
35 :	71	69	63	61	70	89	118	143	141	107	64	37	28	27	28	29	30	33	34	36	35	33	32	32	33	41	51	58	63	66	66
36 :	71	68	62	62	69	87	116	143	143	111	66	37	28	27	28	29	31	33	35	37	37	35	34	34	35	43	52	58	64	67	66
37 :	71	66	62	63	69	84	113	142	146	115	69	38	28	27	28	30	32	34	36	38	38	36	36	35	37	45	52	59	65	67	65
38 :	70	66	62	63	69	82	109	141	149	120	72	39	29	28	29	31	33	35	37	39	39	38	37	37	39	46	53	60	66	67	64
39 :	70	66	63	64	69	80	105	138	152	125	75	40	29	28	29	31	34	36	38	40	41	39	39	38	40	47	55	61	65	66	63
40 :	69	66	64	65	69	78	101	135	153	131	80	41	29	28	30	32	34	37	39	42	42	41	41	40	41	48	56	62	65	65	63

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1958, arriving from sheltered approach direction of 268 deg azimuth, period = 17.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	4	4									
2 :																			4	3	4	4	4								
3 :	124	103	86	74														4	4	3	3	4	4	6							
4 :	121	101	84	71	60	51	50											4	3	3	3	3	4	6							
5 :	119	98	82	69	58	49	45	53	64									5	3	3	3	3	4	6	10						
6 :	110	90	76	63	55	46	39	44	57									5	4	3	3	3	4	6	10						
7 :	103	85	75	63	52	44	37	40	50								7	5	4	3	3	3	4	6	11	17					
8 :	104	81	70	59	49	41	36	37	45							15	8	6	5	4	3	4	4	6	11	17					
9 :	100	81	70	58	48	41	35	35	41						33	17	10	6	5	4	4	4	4	6	12	17	23				
10 :	97	79	67	55	45	38	34	34	38	43	47	53	56	51	36	20	11	7	5	4	4	4	5	7	11	17	23	31			
11 :	98	79	65	55	45	38	34	33	36	38	43	49	54	52	40	23	13	8	6	5	4	4	5	8	12	16	23	31	38		
12 :	96	77	65	53	43	37	33	32	34	36	41	46	52	52	42	26	15	10	7	5	5	5	6	8	13	17	23	31	38	48	
13 :	97	78	65	52	42	36	32	31	33	35	38	43	49	51	45	30	17	12	8	6	5	5	6	9	13	17	22	29	37	47	61
14 :	97	76	63	51	41	36	32	30	31	34	37	41	47	50	46	34	20	14	9	6	6	6	7	10	14	18	22	28	35	46	62
15 :	98	77	63	50	41	35	32	30	31	33	35	39	44	49	47	37	23	16	10	7	6	6	7	11	15	19	22	26	34	45	63
16 :	98	76	63	49	40	34	31	29	29	32	34	37	42	47	46	38	26	17	12	8	7	7	8	12	16	19	22	26	33	46	64
17 :	100	77	62	49	40	34	31	29	29	31	34	36	41	45	46	39	28	20	14	10	8	8	9	13	17	20	23	27	33	45	63
18 :	102	79	62	49	40	34	31	28	28	30	32	35	39	43	46	40	30	21	16	11	9	8	10	14	18	20	23	28	36	45	63
19 :	102	79	62	48	39	34	30	28	27	28	31	34	38	42	45	40	30	23	17	12	10	9	11	15	18	21	23	29	38	46	63
20 :	104	80	62	48	39	34	30	27	27	28	30	33	36	41	44	41	31	23	19	14	12	11	12	16	19	22	24	30	40	48	60
21 :	106	83	62	48	38	33	30	27	26	26	29	33	35	38	43	41	33	24	20	15	13	12	13	17	20	22	25	32	41	49	60
22 :	109	84	63	48	39	33	30	27	25	25	28	31	33	36	41	42	35	25	20	17	15	13	14	18	21	23	26	33	42	51	60
23 :	110	85	64	48	38	33	29	27	25	25	27	31	33	35	39	41	37	26	20	18	16	15	15	18	21	24	27	35	43	53	61
24 :	114	88	65	49	39	33	29	26	24	24	26	30	32	33	37	40	37	27	21	19	18	16	17	19	22	25	28	36	45	55	62
25 :	116	90	66	49	39	32	29	26	24	23	26	29	32	32	35	39	38	29	22	21	20	17	18	20	22	26	30	37	48	56	63
26 :	119	92	67	50	39	32	28	26	24	23	25	29	32	31	33	38	38	29	23	22	21	19	19	20	23	27	30	39	52	59	62
27 :	123	96	69	51	40	32	28	26	24	22	24	28	31	31	31	36	37	30	24	24	23	20	20	21	24	28	31	41	55	60	61
28 :	126	100	72	52	40	32	27	26	24	21	23	27	30	30	30	33	35	31	26	26	24	22	21	22	25	28	33	45	56	60	61
29 :	130	105	75	53	41	32	27	25	23	21	22	27	29	30	29	31	34	31	28	27	26	23	22	23	26	29	36	48	58	61	60
30 :	132	111	79	55	43	32	26	24	23	21	21	26	29	30	29	30	33	31	29	29	27	24	23	25	27	30	39	50	58	61	59
31 :	134	116	85	58	45	33	26	23	23	21	21	24	28	29	28	28	31	31	31	30	28	26	24	26	27	31	41	52	59	61	59
32 :	134	121	92	63	48	35	26	23	22	21	21	24	27	28	28	28	30	31	32	31	30	27	25	27	28	32	43	54	59	60	59
33 :	133	124	98	69	52	37	26	22	22	21	21	23	26	28	29	28	30	32	33	33	31	28	27	28	29	34	47	55	59	59	57
34 :	131	126	104	77	58	39	27	22	21	21	21	22	25	28	29	29	31	33	34	34	32	30	28	29	30	37	49	55	59	59	56
35 :	129	125	108	84	64	43	29	23	21	21	21	23	25	27	29	30	31	33	35	35	34	31	30	30	31	40	50	55	59	58	55
36 :	127	124	110	92	71	48	31	24	22	21	22	23	25	27	29	30	32	34	36	36	35	32	32	32	33	42	50	55	59	58	54
37 :	126	120	111	99	78	53	33	25	22	21	22	23	25	27	29	31	33	35	37	37	36	34	33	33	35	44	51	56	59	57	53
38 :	124	119	112	105	86	59	37	26	23	22	22	23	25	27	30	32	34	36	38	39	38	35	35	34	37	44	51	56	58	56	51
39 :	122	119	114	110	93	65	41	28	24	22	22	23	25	27	30	32	35	37	39	40	39	37	37	36	38	45	52	57	57	54	49
40 :	119	118	115	113	99	73	46	31	25	23	22	23	25	28	30	33	35	38	40	41	41	38	38	38	39	46	53	57	56	53	48

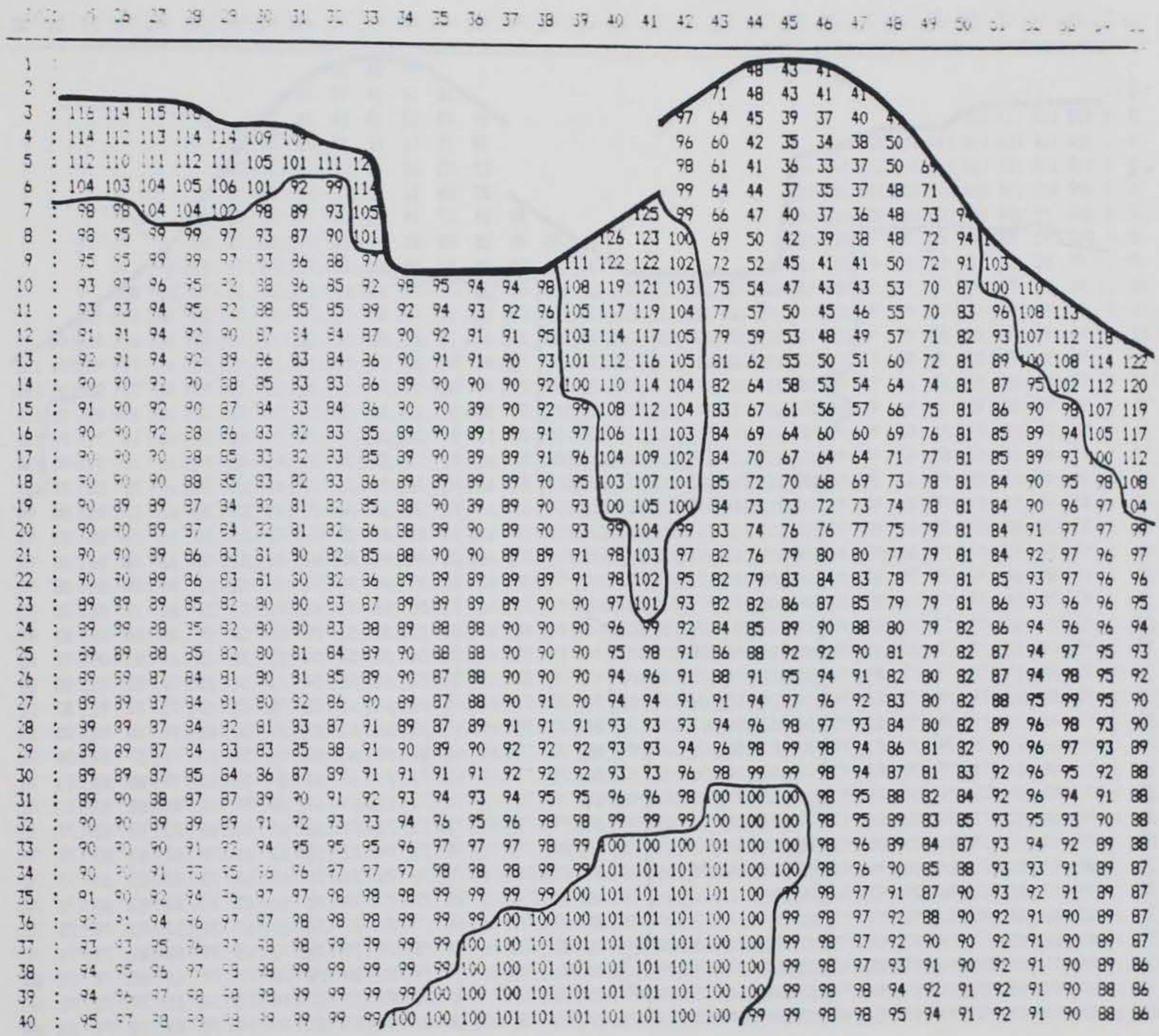
Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1983, arriving from sheltered approach direction of 253 deg azimuth, period = 18.5 sec, tide elevation = +8.0 ft MLLW.

J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
2 :																				7	8	8									
3 :	127	126	131	142															8	7	8	8	9								
4 :	124	123	128	136	147	152	167											9	7	7	7	7	9	12							
5 :	121	120	125	133	142	147	155	180	19									9	7	6	6	7	8	12							
6 :	111	110	115	122	136	142	140	158	183									10	7	6	6	6	8	13	20						
7 :	105	103	114	122	130	137	134	148	167									11	8	6	6	7	8	12	21						
8 :	105	99	107	114	122	130	132	142	158								18	12	8	7	7	7	8	12	22	34					
9 :	100	99	106	113	121	130	131	138	151							37	20	13	9	8	7	8	9	12	23	34					
10 :	97	95	101	107	114	122	130	135	143	140	119	105			68	41	22	15	10	8	8	8	9	13	23	34	45				
11 :	98	95	97	106	112	121	129	134	139	129	115	100	96	88	71	46	26	17	11	9	8	9	10	15	23	33	44	57			
12 :	95	92	97	101	109	119	128	134	135	126	112	97	92	86	73	50	29	19	13	10	9	9	11	16	23	32	43	56	67		
13 :	95	92	96	100	107	118	126	133	134	125	109	94	89	84	74	54	33	21	14	11	10	10	12	16	25	32	43	56	67	80	
14 :	94	90	93	98	105	116	125	132	133	124	108	91	85	82	74	57	36	24	16	12	11	11	13	18	26	33	42	53	66	79	95
15 :	94	90	92	96	103	115	127	134	135	126	106	89	82	79	74	60	40	27	19	14	12	12	14	20	27	34	41	51	62	78	95
16 :	93	88	92	92	100	112	124	132	132	123	107	87	80	77	74	62	44	29	21	15	14	13	15	22	28	35	41	48	60	76	96
17 :	93	89	89	91	99	111	124	133	133	123	106	87	77	73	71	63	47	32	23	17	16	15	17	24	30	35	41	48	58	76	96
18 :	94	89	89	91	98	111	125	134	133	123	104	85	76	72	70	63	49	35	25	19	17	16	18	25	31	37	42	50	59	74	93
19 :	92	88	87	88	95	108	123	132	132	121	104	85	74	69	68	63	50	37	28	21	19	18	20	27	32	37	42	51	62	73	91
20 :	93	88	86	87	94	108	123	134	133	121	102	85	73	67	66	62	51	39	30	23	22	20	22	28	34	38	42	52	65	74	89
21 :	93	89	85	85	92	105	122	133	132	119	103	85	72	65	65	61	51	40	32	26	24	22	24	29	35	39	43	54	67	75	85
22 :	94	89	85	84	91	104	122	132	132	118	99	83	70	62	62	60	52	40	33	28	26	25	26	31	36	39	45	57	69	75	83
23 :	93	88	84	82	88	102	120	134	134	119	99	83	69	60	59	60	54	41	33	30	29	27	28	32	37	41	46	59	70	77	82
24 :	93	88	83	82	88	101	118	134	134	117	97	81	69	59	56	58	55	42	34	32	32	30	30	33	38	42	48	60	71	78	92
25 :	93	88	82	80	86	99	118	135	136	118	96	80	68	57	54	56	54	43	35	34	34	32	32	34	38	43	50	62	72	78	82
26 :	92	87	81	79	84	97	116	135	136	117	94	80	68	56	51	55	54	44	36	36	37	34	34	35	39	44	51	64	75	79	81
27 :	92	87	81	79	83	95	115	135	137	116	92	78	67	55	49	52	53	44	38	39	39	37	35	36	40	45	53	66	78	81	80
28 :	92	87	81	77	82	92	112	134	137	115	90	77	65	54	48	50	52	45	40	41	42	39	37	38	41	46	54	68	80	81	77
29 :	91	87	80	76	81	91	110	131	136	115	89	76	63	52	45	45	47	45	42	44	44	41	39	39	42	47	57	72	81	80	76
30 :	91	87	80	75	80	91	108	129	135	115	89	75	62	51	45	44	46	46	46	48	48	45	42	42	44	49	63	75	80	79	75
31 :	90	87	79	75	80	91	107	126	133	116	90	73	60	50	44	42	44	46	48	50	50	47	44	44	45	51	66	77	80	78	73
32 :	89	87	79	75	80	91	107	124	131	117	93	73	59	50	45	42	44	47	50	52	52	49	46	45	46	53	68	78	79	76	71
33 :	88	86	79	76	82	93	107	123	130	119	95	73	58	50	45	43	45	48	51	54	53	51	48	47	47	56	70	78	77	74	70
34 :	87	86	79	77	84	94	108	122	130	121	98	74	58	49	45	44	46	49	53	55	55	53	50	49	48	58	72	77	76	73	68
35 :	87	85	79	78	85	95	109	123	130	122	102	76	58	48	45	45	47	51	54	56	57	55	53	50	50	61	72	76	76	72	67
36 :	86	84	79	80	86	95	108	123	131	125	103	77	58	49	45	46	48	52	55	58	59	57	55	52	52	63	72	75	75	71	66
37 :	86	82	79	81	87	95	108	123	132	126	105	79	59	49	46	47	49	53	56	59	60	59	57	54	55	65	72	75	74	70	64
38 :	86	82	80	82	87	95	107	122	132	128	107	81	60	50	47	48	50	54	58	61	62	61	59	56	57	65	72	74	73	69	62
39 :	86	83	82	84	88	95	106	121	133	130	110	82	61	50	47	48	51	55	59	62	64	63	61	58	58	66	73	74	71	67	61
40 :	86	84	83	85	89	95	106	120	132	132	112	84	62	51	48	49	52	56	60	64	65	65	64	60	59	67	73	73	70	65	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 257 deg azimuth, period = 15.5 sec, tide elevation = +8.0 ft MLLW.

Y/X:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	2									
2 :																			2	2	2	2	2								
3 :	114	88	68	53														2	2	2	2	2	2	3							
4 :	111	86	65	50	38	30	29											2	1	1	1	1	2	3							
5 :	109	83	63	48	36	28	25	31	40									2	1	1	1	1	2	3	4						
6 :	100	75	57	43	34	26	22	26	34									2	2	1	1	1	2	2	5						
7 :	94	70	56	42	31	25	21	23	30								3	3	2	1	1	2	2	3	5	7					
8 :	94	67	52	39	29	23	20	21	26							6	3	3	2	2	1	2	2	3	5	8	11				
9 :	90	67	52	38	28	22	19	20	24						14	7	4	3	2	2	2	2	2	3	5	8	11	14			
10 :	87	64	49	35	26	20	19	19	22	26	27	29	29	25	16	8	4	3	2	2	2	2	2	3	5	7	10	14			
11 :	88	64	46	35	25	20	18	19	21	22	25	28	29	26	18	10	5	4	3	2	2	2	2	3	5	7	10	14	18		
12 :	86	62	46	33	24	19	18	18	20	21	24	26	28	26	20	11	6	4	3	2	2	2	3	3	5	7	10	14	17	23	
13 :	87	62	45	32	23	19	17	18	19	20	22	24	27	26	21	13	7	5	4	2	2	2	3	4	6	8	10	13	17	23	32
14 :	86	60	43	30	22	18	17	17	18	20	21	23	26	26	22	15	9	5	4	3	2	3	3	4	6	8	10	12	16	22	33
15 :	87	60	43	29	21	18	17	17	18	19	20	22	24	25	23	17	10	6	4	3	3	3	3	5	7	8	10	12	15	22	33
16 :	87	59	43	28	20	17	16	16	17	18	20	21	23	24	23	18	12	8	5	4	3	3	3	5	7	9	10	12	15	22	34
17 :	89	60	41	27	20	17	16	16	17	18	19	20	22	24	23	18	13	9	6	4	3	3	4	6	7	9	10	12	15	22	34
18 :	91	61	41	27	19	16	16	16	16	17	18	19	21	23	23	19	14	10	7	5	4	4	4	6	8	9	10	13	17	21	34
19 :	91	60	40	26	18	16	15	15	15	16	18	19	21	22	23	19	14	10	8	5	5	4	5	7	8	9	11	13	18	22	35
20 :	93	61	40	25	18	16	15	15	15	16	17	19	20	22	23	20	15	11	8	6	5	5	5	7	9	10	11	14	19	24	34
21 :	95	63	39	24	17	15	15	14	14	15	17	18	19	20	22	20	15	11	9	7	6	5	6	8	9	10	11	15	19	25	34
22 :	98	64	39	24	17	15	15	14	14	15	16	18	18	19	21	21	17	12	9	7	6	6	6	8	9	11	12	15	20	26	35
23 :	100	65	39	23	16	15	14	14	14	14	16	17	18	18	20	21	18	12	9	8	7	6	7	8	10	11	13	16	21	28	37
24 :	104	67	38	23	16	14	14	14	14	14	15	17	18	18	19	20	18	13	10	9	8	7	7	9	10	12	13	17	22	29	38
25 :	108	68	38	22	16	14	14	14	13	13	15	16	17	17	18	20	19	13	10	9	9	8	8	9	10	12	14	17	24	31	40
26 :	112	70	39	22	16	14	14	14	13	13	14	16	17	17	17	19	19	14	11	10	9	8	8	9	11	13	14	18	26	34	40
27 :	118	74	40	22	16	13	13	14	13	13	14	16	17	16	16	18	19	14	11	11	10	9	9	10	11	13	15	19	29	35	40
28 :	126	79	41	22	16	13	13	14	13	12	13	16	17	16	15	17	17	15	12	12	11	10	9	10	12	13	15	22	30	36	41
29 :	133	86	43	22	16	13	12	13	13	12	12	15	16	16	15	16	17	15	13	12	11	10	10	11	12	14	17	23	32	38	42
30 :	140	94	47	23	16	12	12	13	13	12	12	15	16	16	15	15	16	15	13	13	12	11	10	11	13	14	18	25	33	39	42
31 :	147	104	52	24	17	12	11	12	13	12	12	14	15	15	14	14	15	15	14	14	13	11	11	12	13	15	20	27	34	40	43
32 :	152	115	60	27	19	12	11	12	12	12	12	13	15	15	14	14	14	15	15	14	13	12	12	13	14	16	21	29	35	40	44
33 :	155	125	71	31	21	12	11	11	12	12	12	13	14	15	15	14	14	15	15	15	14	13	12	13	14	17	23	30	36	41	44
34 :	157	134	83	37	24	13	11	11	12	12	12	13	14	15	15	14	14	15	16	15	15	13	13	14	15	18	25	31	37	42	44
35 :	156	140	95	46	27	14	11	11	12	12	12	13	14	15	15	15	15	16	16	16	15	14	14	15	15	20	26	32	38	43	45
36 :	156	145	105	58	30	15	12	11	11	12	12	13	14	14	15	15	15	16	16	17	16	15	15	15	16	22	27	33	39	44	45
37 :	155	146	112	72	35	16	12	11	11	12	12	13	14	15	15	15	16	16	17	17	17	15	16	16	18	23	28	34	41	45	45
38 :	151	149	122	85	42	18	13	12	12	12	12	13	14	15	15	16	16	17	17	18	17	16	17	17	19	24	29	36	42	45	44
39 :	145	150	132	99	52	21	14	12	12	12	12	13	14	15	16	16	17	17	18	19	18	17	18	18	20	25	31	37	42	45	44
40 :	137	148	140	113	63	26	16	13	12	12	12	13	14	15	16	16	17	18	19	19	19	18	19	19	21	26	32	39	43	44	43

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1983, arriving from sheltered approach direction of 264 deg azimuth, period = 20.5 sec, tide elevation = +8.0 ft MLLW.



Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of November 1982, arriving from sheltered approach direction of 268 deg azimuth, period = 10.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				14	14	15									
2 :																			16	14	14	15	16								
3 :	123	118	117	119														19	15	13	13	14	16	2[illegible]							
4 :	120	116	114	115	117	116	127	[illegible]										20	14	12	11	13	16	22	[illegible]						
5 :	118	114	112	112	113	112	117	142	16[illegible]									22	15	12	11	12	15	23	35						
6 :	109	105	104	104	107	107	105	125	155									23	16	12	12	13	15	22	37	[illegible]					
7 :	103	99	104	103	103	104	101	116	141								42	24	17	14	13	14	15	22	38	56					
8 :	103	95	98	97	97	98	98	111	133							90	48	26	18	15	14	14	16	22	39	57	[illegible]				
9 :	99	95	98	96	96	97	97	107	127	[illegible]					131	96	53	29	20	16	15	15	17	24	40	55	69				
10 :	96	92	93	92	91	91	96	104	120	133	131	132	138	141	131	100	60	33	22	18	16	17	19	26	39	53	68	83			
11 :	97	93	90	91	89	91	95	103	116	122	127	128	131	136	130	104	65	36	24	19	18	18	21	27	39	52	66	82	93		
12 :	94	90	90	88	87	89	94	102	112	119	123	124	128	133	129	107	70	41	27	21	20	19	22	29	41	51	65	82	92	104	
13 :	95	91	90	88	85	88	92	101	110	118	120	121	124	129	127	108	75	45	30	23	21	21	24	31	42	52	62	77	90	101	113
14 :	93	89	88	85	84	87	91	99	109	116	119	118	121	124	125	109	79	49	33	25	24	23	25	34	44	52	61	73	85	100	112
15 :	94	89	88	85	83	86	92	100	110	117	117	116	118	122	124	110	83	53	36	27	26	25	27	36	45	53	60	69	82	96	111
16 :	93	88	88	82	81	83	90	98	107	114	117	114	115	118	119	110	85	57	39	30	28	27	29	39	46	53	60	69	79	94	111
17 :	93	88	86	82	80	83	90	98	107	114	117	114	114	116	117	108	87	60	42	33	31	29	31	40	48	54	61	70	79	90	106
18 :	94	89	86	82	80	83	89	98	107	113	114	113	112	113	114	107	87	63	45	36	34	33	34	42	49	54	61	71	82	89	102
19 :	93	88	84	80	78	81	88	97	105	111	114	113	112	111	111	104	86	64	47	38	37	36	37	44	50	55	61	72	83	88	98
20 :	93	89	85	80	78	81	88	97	105	111	112	113	112	110	109	102	86	65	49	41	41	39	40	45	51	56	61	74	85	89	93
21 :	93	89	83	78	77	80	87	96	104	109	112	113	110	107	105	100	87	66	50	44	44	43	42	47	52	56	63	76	86	88	90
22 :	94	89	84	78	76	79	87	95	104	108	110	111	109	105	102	99	88	65	50	47	48	46	45	48	53	57	64	78	86	88	89
23 :	93	89	84	77	75	78	85	96	104	108	109	111	110	104	100	97	87	66	51	50	51	49	47	49	53	58	66	79	86	88	87
24 :	93	89	83	78	76	78	85	96	104	106	107	109	110	103	97	94	86	67	53	53	55	52	50	50	53	59	68	80	87	87	87
25 :	93	89	82	77	75	77	85	96	105	106	106	108	110	103	94	92	85	67	55	56	58	55	52	51	54	60	69	82	89	87	85
26 :	92	88	82	76	74	77	84	96	105	105	104	108	110	102	92	89	83	67	58	59	61	58	54	52	54	61	70	82	90	88	83
27 :	92	88	82	76	74	77	84	96	104	104	103	108	109	101	91	86	81	67	60	62	64	61	56	53	55	62	72	84	91	87	80
28 :	92	88	82	76	74	76	83	95	104	103	101	107	108	100	89	83	78	68	63	65	66	63	58	55	56	62	74	86	90	85	79
29 :	91	88	81	75	74	77	83	94	103	102	100	106	106	99	88	80	75	68	66	68	68	65	60	56	57	63	76	87	89	84	78
30 :	91	88	81	75	75	78	83	93	102	102	101	106	106	98	88	79	73	69	69	70	70	67	62	58	58	65	79	88	88	83	77
31 :	90	88	81	76	76	80	84	92	100	102	103	106	104	98	87	78	72	70	71	72	72	69	64	60	59	66	81	88	87	81	76
32 :	90	88	82	77	78	82	86	92	99	103	105	106	105	99	89	79	73	71	72	73	73	71	66	61	60	68	82	88	85	79	75
33 :	89	88	82	79	81	85	88	93	98	104	107	107	105	98	89	80	75	73	74	75	74	72	68	63	61	70	83	87	83	78	74
34 :	89	87	82	81	84	88	90	94	99	105	109	109	105	98	89	81	76	74	75	76	76	74	70	64	63	73	83	85	81	77	72
35 :	88	87	83	83	86	89	93	96	100	106	111	111	106	97	88	82	77	75	75	77	77	76	72	66	65	75	83	83	80	76	72
36 :	88	86	84	85	88	91	93	97	101	107	112	112	107	98	88	82	77	76	76	77	78	77	74	68	67	76	83	82	79	75	71
37 :	89	86	85	87	89	92	94	97	102	108	112	113	108	99	90	82	78	76	77	78	79	79	76	70	69	77	82	81	78	74	70
38 :	89	87	86	88	90	93	95	98	103	108	113	114	109	100	90	82	78	76	77	79	81	80	78	72	71	77	81	80	77	73	69
39 :	89	88	88	89	91	93	96	99	103	109	114	115	109	99	89	82	78	77	78	80	82	82	80	74	72	77	81	79	75	72	68
40 :	89	90	89	90	92	94	96	99	103	109	114	115	109	99	89	81	78	77	78	81	83	83	82	76	74	78	81	78	74	70	68

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1963, arriving from sheltered approach direction of 257 deg azimuth, period = 13.5 sec, tide elevation = +8.0 ft MLLW.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																															
2																				5	5	6									
3	116	116	122	135															6	5	5	6	8								
4	113	113	119	129	144	153	174											6	5	5	5	5	6	8							
5	110	110	116	126	139	149	161	192	21[illegible]									6	5	4	4	5	6	9							
6	101	100	106	116	132	143	145	169	19[illegible]									7	5	4	4	4	6	9	14						
7	95	94	105	115	127	138	139	157	180								12	7	5	4	4	5	6	8	15						
8	95	89	96	107	118	130	136	151	170							25	13	8	6	5	5	5	5	8	15	24					
9	91	89	97	105	117	130	135	147	163						52	28	15	9	6	5	5	5	6	9	16	24					
10	87	86	92	100	110	122	134	143	154	152	127	106	90	75	55	32	18	10	7	6	5	6	9	16	24	32					
11	88	85	88	99	108	121	133	143	150	140	123	102	87	74	57	36	20	11	8	6	6	6	7	10	16	23	32	41			
12	85	83	87	93	104	119	132	142	146	137	120	99	84	74	59	40	23	13	9	7	6	6	8	11	17	23	31	41	50		
13	85	82	87	92	102	117	130	142	145	136	117	96	81	72	60	43	26	15	11	8	8	8	9	13	18	24	30	39	49	61	78
14	84	80	83	88	99	115	128	141	144	135	116	94	79	69	61	46	29	17	13	9	9	8	10	14	19	24	30	37	46	60	78
15	84	80	83	87	97	113	130	143	146	138	115	92	77	68	61	48	32	21	15	10	10	9	11	16	20	25	30	35	45	59	79
16	83	78	82	84	94	109	127	140	143	135	115	90	74	65	59	49	35	23	17	12	11	10	12	17	21	26	30	35	43	59	80
17	83	79	79	83	92	109	127	141	144	135	115	90	73	64	58	49	37	26	19	14	12	11	13	18	23	27	31	36	44	58	78
18	84	79	79	81	91	108	127	142	146	136	113	89	71	61	57	50	38	28	21	15	13	12	14	19	24	27	31	37	47	58	78
19	82	78	76	78	88	105	125	140	144	133	113	89	70	60	55	49	38	29	22	17	15	14	16	21	25	28	31	38	49	59	77
20	83	78	76	77	86	104	125	141	145	134	111	88	69	58	54	48	39	30	24	19	17	15	17	21	26	29	32	40	52	60	74
21	83	78	74	75	83	100	122	140	144	132	111	88	68	55	51	48	40	30	24	20	19	17	18	23	27	29	33	42	53	62	73
22	84	78	74	74	82	99	122	139	144	131	108	86	66	53	49	48	42	31	25	22	20	19	20	24	28	30	34	44	54	64	74
23	83	77	74	72	79	96	120	141	146	132	108	86	66	52	47	47	43	32	25	23	23	21	21	24	28	32	36	45	56	65	75
24	83	78	72	71	78	94	117	141	147	131	106	84	66	50	44	45	43	33	26	25	25	23	23	25	29	33	37	47	58	67	76
25	83	77	71	70	75	91	117	142	149	131	105	82	64	49	42	44	43	34	27	27	27	25	24	26	29	34	39	48	61	69	76
26	82	77	71	68	74	88	114	142	150	131	103	82	64	48	40	41	42	34	28	29	28	26	26	27	30	35	40	50	64	72	76
27	82	77	70	67	72	86	111	141	150	130	101	81	63	47	38	39	41	34	30	30	30	28	27	28	31	36	41	53	68	73	74
28	82	77	70	66	71	83	108	140	151	130	98	79	61	45	37	37	39	35	32	32	32	30	28	29	32	36	43	57	69	73	74
29	81	77	69	65	69	81	105	136	150	129	96	77	59	44	36	35	37	35	33	34	34	32	30	31	33	37	46	60	70	74	74
30	81	77	69	64	68	79	102	133	149	130	96	76	57	43	36	34	36	35	35	36	36	33	31	32	34	38	49	62	71	74	73
31	80	77	69	63	67	79	100	129	146	130	98	74	55	41	35	32	34	35	36	37	37	35	33	34	35	40	52	64	72	74	73
32	79	77	68	63	68	79	98	126	144	132	100	73	53	41	35	32	34	36	38	39	39	37	34	35	36	41	54	66	72	73	73
33	79	76	68	64	68	79	98	124	142	133	103	72	52	40	35	33	34	37	39	40	40	38	36	37	37	44	57	67	71	73	72
34	79	76	68	65	70	80	97	122	141	135	106	72	51	40	35	34	35	38	40	42	41	40	38	38	38	46	59	67	71	73	71
35	77	75	68	66	71	80	97	121	141	137	109	74	50	39	35	35	36	39	41	43	43	41	40	39	40	50	61	67	72	73	71
36	76	74	68	67	72	80	96	120	141	139	112	75	50	39	35	35	37	40	42	44	45	43	42	41	42	52	61	67	72	73	70
37	76	72	68	69	73	80	95	119	141	141	114	77	50	39	36	36	38	40	43	45	46	45	44	42	44	53	62	68	73	73	69
38	76	72	69	70	73	80	94	117	140	143	117	79	51	39	36	37	39	42	44	47	48	47	46	44	46	54	62	69	73	72	68
39	76	72	70	71	74	80	92	115	140	145	120	81	51	39	37	37	40	42	45	48	49	48	48	46	47	55	64	70	72	71	67
40	75	73	71	72	75	80	91	112	139	147	124	83	52	40	37	38	40	43	47	49	51	50	50	48	49	57	65	70	71	69	66

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1978, arriving from sheltered approach direction of 264 deg azimuth, period = 16.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	3	4									
2 :																			3	3	3	4	4								
3 :	146	152	158	166														4	3	3	3	3	4	5							
4 :	143	148	156	161	160	148	139											4	3	3	2	3	3	5							
5 :	140	146	154	159	156	144	129	125	118									4	3	2	2	3	3	5	8						
6 :	128	134	142	147	150	140	117	110	109									4	3	3	3	3	3	5	9						
7 :	121	126	142	147	145	136	113	103	98								6	5	4	3	3	3	3	5	9	15					
8 :	121	120	134	139	138	129	111	99	92							13	7	5	4	3	3	3	3	5	10	15					
9 :	115	120	134	139	138	131	111	96	87						29	15	8	5	4	3	3	3	4	6	10	15	20				
10 :	111	116	128	133	132	123	111	94	81	68	53	49	49	44	32	18	10	6	5	4	3	4	4	6	10	14	20	26			
11 :	111	116	123	133	132	124	110	93	79	61	50	46	47	45	35	20	12	7	5	4	4	4	5	6	10	14	20	26	32		
12 :	108	112	124	129	129	124	110	93	76	59	47	43	45	45	37	23	13	9	6	5	4	4	5	7	11	14	20	26	32	40	
13 :	107	112	124	129	128	123	110	93	75	57	45	41	43	44	39	26	15	10	7	5	4	5	5	8	11	15	19	25	31	39	53
14 :	105	109	120	125	127	124	110	93	74	56	43	38	40	42	40	29	18	12	8	6	5	5	6	9	12	15	19	23	29	39	53
15 :	105	109	120	126	127	124	113	95	75	56	42	36	38	41	40	32	20	13	9	6	6	5	6	10	13	16	19	22	28	38	54
16 :	102	107	120	123	125	122	111	93	72	54	41	35	36	39	39	33	23	15	10	7	6	6	7	10	13	16	19	22	27	39	55
17 :	102	107	116	123	126	124	113	94	72	53	40	34	35	38	39	34	24	17	12	8	7	6	8	11	14	17	20	23	28	38	54
18 :	102	107	116	123	127	126	115	96	72	52	38	32	33	37	39	34	26	18	13	9	8	7	9	12	15	18	20	23	30	37	55
19 :	100	105	114	120	125	125	114	95	71	50	37	31	32	36	38	34	26	19	15	11	9	8	10	13	16	18	20	24	32	39	55
20 :	99	104	113	121	126	127	117	96	71	49	35	30	31	34	37	35	27	20	16	12	10	9	10	14	17	19	20	25	33	40	53
21 :	99	104	111	118	125	126	117	96	70	47	34	30	30	32	36	35	28	21	17	13	11	10	11	15	17	19	21	27	34	41	53
22 :	98	104	111	119	126	128	119	96	69	45	32	29	28	30	34	35	30	21	17	14	13	11	12	15	18	20	22	28	35	43	54
23 :	96	101	110	117	124	128	119	98	69	44	31	28	28	29	33	35	31	22	17	15	14	13	13	16	18	21	23	29	36	45	55
24 :	95	101	108	117	126	130	120	99	69	42	29	27	28	28	31	34	32	23	18	16	15	14	14	16	19	22	24	30	38	47	57
25 :	93	98	105	115	125	129	123	101	69	40	28	26	27	27	29	33	32	24	19	18	17	15	15	17	19	22	25	31	40	49	58
26 :	91	96	103	114	124	130	124	102	68	38	26	26	27	27	27	31	32	25	20	19	18	16	16	18	20	23	26	32	44	52	58
27 :	89	94	101	112	124	131	125	103	68	37	24	25	27	26	26	30	31	25	21	20	19	18	17	18	21	24	27	34	47	54	58
28 :	87	92	99	110	123	129	125	104	68	35	23	24	26	25	25	28	30	26	22	22	21	19	18	19	22	24	28	38	49	54	58
29 :	85	90	95	107	122	130	125	102	66	33	21	23	25	25	25	26	28	26	23	23	22	20	19	20	22	25	30	40	50	55	59
30 :	83	87	92	103	121	131	126	102	65	32	21	23	25	25	24	25	27	26	25	24	23	21	20	21	23	26	32	42	51	57	59
31 :	80	85	89	99	119	132	127	101	63	31	20	22	24	24	24	24	25	26	26	25	24	22	21	22	24	27	35	44	52	57	59
32 :	78	82	85	96	118	134	130	102	63	31	20	21	23	24	24	23	25	26	27	27	25	23	22	23	24	28	37	47	53	57	60
33 :	76	79	81	92	117	137	134	104	62	32	21	20	22	24	24	24	25	27	28	28	26	24	23	24	25	29	39	48	53	57	60
34 :	74	76	77	88	115	139	138	107	62	32	21	20	22	24	24	24	25	27	28	29	28	26	25	25	26	31	41	48	54	58	59
35 :	72	73	73	84	112	141	144	112	65	33	22	20	22	23	24	25	26	28	29	30	29	27	26	26	27	34	43	49	55	59	59
36 :	71	70	69	80	108	140	149	119	68	34	22	21	22	23	24	26	27	29	30	31	30	28	27	27	29	36	43	49	56	60	59
37 :	71	67	66	77	103	138	153	127	74	35	23	21	22	23	25	26	28	29	31	32	31	29	29	29	30	37	44	51	57	60	59
38 :	70	66	65	74	98	134	156	136	81	37	24	22	22	24	25	27	29	30	32	33	32	31	30	30	32	38	45	52	58	60	58
39 :	70	66	64	72	92	128	157	144	90	40	24	22	22	24	26	27	29	31	33	34	34	32	32	32	33	39	46	53	58	59	57
40 :	69	66	65	70	87	122	156	152	100	43	25	22	23	24	26	28	30	32	34	35	35	33	33	33	34	40	48	54	58	58	57

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1960, arriving from sheltered approach direction of 269 deg azimuth, period = 18.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				14	14	15									
2 :																			16	14	14	15	16								
3 :	122	118	116	118														19	15	13	13	14	16	22							
4 :	120	115	114	113	115	114	124											20	14	12	11	13	15	22							
5 :	117	113	112	111	111	110	114	139	163									22	15	12	11	12	15	23	35						
6 :	108	104	103	102	106	105	102	121	152									23	16	12	12	13	15	22	36						
7 :	102	99	103	102	101	101	98	112	138								44	24	17	14	13	14	15	22	38	58					
8 :	103	95	97	96	95	96	96	108	130							95	50	26	19	15	14	14	16	22	39	56					
9 :	99	95	97	95	94	95	95	104	124						137	101	56	30	20	16	15	15	17	24	39	55	69				
10 :	96	92	93	91	89	89	93	101	117	130	130	133	140	145	136	105	62	33	22	18	16	17	19	26	38	53	68	82			
11 :	96	92	90	91	88	89	92	100	113	120	126	128	133	140	135	109	68	37	24	19	18	18	20	27	39	51	66	81	92		
12 :	94	90	90	87	86	87	91	99	109	117	122	124	130	136	134	111	74	42	27	21	20	19	22	29	40	51	64	81	92	103	
13 :	94	90	90	87	84	86	90	98	108	116	119	121	125	132	131	113	78	46	30	23	21	21	24	31	42	51	62	76	89	101	113
14 :	93	89	87	84	83	85	89	97	106	114	118	119	122	128	129	114	82	51	33	25	24	23	25	34	43	52	61	72	84	100	112
15 :	93	89	88	84	82	84	89	97	107	115	116	117	120	126	128	115	86	55	36	27	26	25	27	36	45	53	60	69	81	96	112
16 :	92	88	87	82	80	82	87	95	104	112	116	114	117	121	123	114	89	58	39	30	28	27	29	38	46	53	60	68	78	94	111
17 :	93	88	85	81	79	81	87	95	104	112	116	114	116	119	121	113	90	62	42	33	31	29	31	40	48	54	61	69	78	90	106
18 :	93	89	86	81	79	81	87	95	104	111	113	113	114	116	118	111	90	65	45	36	34	32	34	42	49	54	61	71	81	89	102
19 :	92	88	84	79	77	80	86	94	102	109	113	113	114	114	115	108	89	66	48	38	37	36	37	44	50	54	60	72	83	88	99
20 :	92	88	84	79	77	79	86	94	103	108	111	113	113	113	113	106	89	67	49	41	41	39	40	45	51	55	61	74	85	89	94
21 :	93	89	83	78	76	78	84	93	101	107	110	113	112	110	109	104	90	67	50	44	44	43	42	47	52	56	62	76	86	88	91
22 :	93	89	83	78	76	78	84	93	101	105	108	111	111	108	106	103	91	67	51	47	48	46	45	48	53	56	64	77	86	89	90
23 :	92	88	84	77	75	77	83	93	102	105	107	111	111	108	103	102	90	68	52	50	51	49	47	48	53	58	66	78	86	89	88
24 :	93	89	83	77	75	77	83	93	102	104	106	109	112	106	100	98	89	68	53	53	55	52	50	49	53	59	67	80	87	88	88
25 :	92	88	82	76	74	76	83	94	102	104	105	108	111	106	98	96	88	68	55	56	58	55	52	50	53	60	69	81	89	88	86
26 :	92	88	82	76	74	75	82	94	102	103	103	108	112	105	96	93	86	68	58	59	61	58	54	52	54	60	70	82	90	89	85
27 :	91	88	81	76	74	75	82	93	102	102	102	108	111	104	94	90	84	69	61	62	63	60	56	53	55	61	71	84	92	89	82
28 :	91	88	81	75	73	75	82	93	102	101	100	107	110	103	93	86	80	69	64	65	66	62	58	55	56	62	73	86	91	86	81
29 :	91	88	81	75	73	76	81	92	101	100	99	106	108	102	92	84	77	70	67	68	68	65	60	56	57	63	76	88	90	85	79
30 :	90	88	81	75	74	77	82	91	99	100	100	106	108	102	91	82	76	70	69	70	70	67	61	58	58	64	79	88	89	84	78
31 :	90	88	81	75	75	79	83	90	98	100	102	106	106	101	91	81	74	71	71	72	71	68	63	59	59	66	81	89	88	83	77
32 :	89	87	81	76	77	81	85	90	97	101	104	106	107	102	92	82	75	72	73	73	72	70	65	61	60	68	82	88	86	81	76
33 :	89	87	81	78	80	84	87	91	96	102	106	107	107	102	93	83	77	74	74	74	74	72	68	63	61	70	84	87	84	79	75
34 :	88	87	82	80	83	87	89	92	97	103	108	109	107	101	92	84	78	75	75	75	75	73	70	64	63	73	84	86	83	78	74
35 :	88	86	82	82	85	89	91	95	98	104	110	112	108	100	92	85	79	76	75	76	76	75	72	66	65	75	84	84	82	77	73
36 :	88	86	83	85	87	90	92	95	99	105	111	113	109	102	92	85	79	76	76	77	77	77	74	68	67	76	83	83	80	76	72
37 :	88	86	84	86	88	91	93	96	100	106	111	114	111	103	93	85	79	77	76	77	79	78	76	70	69	77	83	82	80	75	71
38 :	88	87	86	87	90	92	94	97	101	106	112	115	111	103	93	85	79	77	77	78	80	80	78	72	71	78	82	81	78	74	70
39 :	88	98	87	89	91	93	95	97	101	107	112	115	111	103	93	84	79	77	77	79	81	81	80	74	72	78	82	81	77	73	69
40 :	88	89	89	90	92	93	96	98	102	107	113	116	111	102	92	84	79	77	78	80	82	83	82	76	74	78	82	80	75	72	69

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1958, arriving from sheltered approach direction of 258 deg azimuth, period = 13.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				17	18	19									
2 :																			19	17	18	19	21								
3 :	117	115	115	119														22	18	16	17	17	21	29							
4 :	115	112	113	115	117	115	122											23	17	16	15	16	20	30							
5 :	112	110	111	113	114	111	112	130	15[illegible]									25	18	15	15	16	20	31	50						
6 :	104	102	103	105	109	108	101	113	136									26	19	16	16	17	20	29	51						
7 :	99	96	103	105	105	104	98	105	122								39	27	21	18	17	18	19	29	53	77					
8 :	99	93	97	99	100	99	96	100	114							65	43	29	22	19	18	19	21	30	53	77					
9 :	95	93	97	99	99	100	95	97	107						95	70	46	32	24	21	20	20	22	32	52	75	93				
10 :	93	90	93	95	95	94	94	94	101	107	105	108	113	111	98	74	50	35	26	22	22	22	24	34	51	71	91	107			
11 :	93	90	91	94	94	94	93	94	98	98	100	104	109	110	99	77	54	38	28	24	24	23	26	35	51	68	87	105	112		
12 :	92	88	91	91	92	93	93	93	95	95	97	100	106	109	101	81	58	41	31	26	25	25	28	37	51	67	84	105	112	115	
13 :	92	89	91	91	91	92	91	92	93	94	94	97	102	106	101	84	61	45	34	28	28	27	30	39	52	66	81	98	108	111	111
14 :	91	87	89	89	90	91	91	91	92	92	92	94	99	104	102	87	65	48	37	31	30	29	31	41	53	66	80	93	102	107	108
15 :	92	88	89	89	89	90	91	91	92	92	91	92	97	102	102	89	69	51	40	33	33	31	33	43	54	67	80	89	97	101	105
16 :	91	87	89	87	87	89	90	89	89	90	90	90	94	99	100	90	72	54	42	36	35	34	35	45	55	66	79	88	92	96	103
17 :	91	87	87	87	87	89	90	89	89	89	90	89	92	98	99	91	74	57	45	39	38	36	38	46	55	67	80	89	90	90	96
18 :	92	88	87	87	87	89	90	89	88	88	88	87	90	95	98	91	76	60	48	42	42	40	40	47	56	67	80	90	91	89	90
19 :	92	87	86	85	86	88	89	88	86	86	87	87	89	94	97	91	76	61	51	45	45	43	43	48	56	68	80	90	91	86	86
20 :	92	88	86	85	86	88	90	86	86	85	85	87	88	92	96	91	77	63	53	48	48	46	45	48	57	68	80	90	91	86	82
21 :	92	89	86	84	85	87	89	88	85	83	84	86	87	89	94	92	79	64	54	51	51	49	47	49	58	69	81	90	91	84	79
22 :	93	89	86	84	85	87	89	88	84	82	82	85	85	87	91	92	82	65	55	54	55	52	49	50	58	70	82	91	91	84	79
23 :	93	89	86	84	84	87	89	88	84	81	82	85	85	86	89	92	84	67	57	58	58	55	51	51	58	71	84	91	89	82	77
24 :	93	90	86	84	84	87	88	88	84	80	80	83	85	84	87	91	85	69	60	61	61	57	53	51	59	72	84	91	89	81	77
25 :	93	90	86	84	84	86	88	89	85	79	80	83	84	83	85	89	86	71	63	65	64	59	55	53	59	73	85	91	88	80	75
26 :	94	90	86	84	84	85	88	89	85	79	78	82	84	82	83	87	95	72	67	68	66	61	57	54	60	74	85	90	87	80	75
27 :	94	90	86	84	84	85	88	89	85	78	77	82	84	82	82	85	85	75	70	71	69	63	58	56	62	75	86	90	87	80	74
28 :	94	91	87	84	84	85	87	89	85	78	76	81	83	81	81	83	83	77	74	74	71	66	60	57	63	75	86	90	86	79	74
29 :	94	92	87	85	85	86	87	89	85	79	76	80	82	81	81	82	82	79	77	76	73	68	62	59	64	76	87	89	85	78	74
30 :	94	92	88	86	87	87	87	87	85	80	77	80	82	81	81	81	82	81	80	79	75	70	64	61	65	77	88	89	83	79	74
31 :	94	93	89	87	89	90	88	88	85	81	79	80	82	83	82	82	82	83	83	80	76	72	66	63	67	78	88	88	82	77	74
32 :	94	93	90	89	91	92	90	88	86	83	81	81	83	85	85	85	85	85	85	82	78	74	69	65	68	79	88	86	81	77	74
33 :	93	93	91	92	94	95	93	90	87	85	83	82	84	85	86	87	87	87	86	83	80	75	71	67	70	81	88	85	80	76	74
34 :	93	92	92	94	97	98	95	92	89	86	85	84	84	85	87	88	89	88	87	85	81	77	73	69	72	82	87	84	79	76	74
35 :	93	92	92	96	98	99	97	94	91	88	86	85	85	85	87	89	90	89	88	86	83	79	75	71	74	82	86	83	79	76	74
36 :	93	91	94	97	99	99	98	95	92	89	87	86	86	87	88	90	90	90	89	87	84	81	77	73	76	83	86	82	78	76	75
37 :	94	93	95	98	100	100	99	96	93	90	88	87	87	88	89	90	91	91	90	88	86	83	79	75	77	83	85	81	79	77	75
38 :	95	94	96	99	100	100	99	97	94	91	89	87	88	89	90	91	91	91	90	89	87	84	81	77	79	84	85	81	78	77	75
39 :	95	96	97	99	101	101	100	98	95	92	89	88	88	89	90	91	92	92	91	90	88	86	83	79	80	84	85	81	78	77	75
40 :	96	97	98	99	101	101	101	99	96	93	90	88	88	89	90	91	92	92	92	91	89	87	85	81	82	84	85	81	78	77	76

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1904, arriving from sheltered approach direction of 235 deg azimuth, period = 12.0 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1 :																			
2 :																			
3 :	121	118	117	119															
4 :	119	116	115	115	115	111	115	130											
5 :	117	114	113	113	111	107	107	123	139										
6 :	108	105	105	105	107	103	97	109	129										
7 :	102	100	106	105	103	100	93	101	119										
8 :	102	97	100	99	97	95	91	98	113								131	133	101
9 :	99	97	100	99	96	94	90	95	108	112	107	107	113	127	139	132	105		
10 :	96	94	96	95	92	89	89	92	102	110	108	108	113	124	135	131	108		
11 :	96	94	93	94	91	89	88	92	99	103	105	105	109	120	130	130	110		
12 :	94	93	94	91	89	88	88	91	96	101	103	103	107	116	127	128	111		
13 :	95	93	94	91	88	87	87	90	96	100	101	101	104	113	124	126	111		
14 :	93	91	92	89	87	86	86	90	95	99	100	100	102	110	121	124	112		
15 :	94	92	92	89	86	85	87	90	95	99	99	98	101	108	119	123	112		
16 :	93	91	92	87	84	83	85	89	93	98	99	97	99	105	115	120	112		
17 :	93	91	90	87	84	83	85	89	93	97	99	97	99	104	112	118	111		
18 :	93	91	90	86	83	83	85	89	94	97	97	96	98	102	110	116	109		
19 :	93	91	89	85	82	82	84	88	93	96	97	97	98	101	107	112	107		
20 :	93	91	89	85	82	82	84	89	93	96	96	97	98	100	105	110	106		
21 :	93	91	88	84	81	81	84	88	92	95	96	97	97	98	103	108	105		
22 :	93	91	88	84	81	81	84	88	92	94	94	95	96	97	100	106	105		
23 :	92	91	88	83	80	80	83	89	93	94	94	95	97	97	99	105	103		
24 :	93	91	87	83	80	80	83	89	93	94	92	94	97	97	97	102	101		
25 :	92	91	87	83	80	80	83	89	94	94	92	93	97	97	96	101	100		
26 :	92	90	87	82	80	80	83	90	94	93	91	93	97	96	95	98	98		
27 :	91	90	86	82	80	80	84	90	94	92	90	93	97	96	94	96	96		
28 :	91	90	86	82	80	81	84	90	94	92	89	93	96	96	94	95	93		
29 :	91	90	86	82	81	82	85	90	94	92	90	93	96	96	94	93	92		
30 :	91	90	86	82	82	84	86	90	93	92	92	94	96	96	94	93	91		
31 :	91	90	87	84	84	86	88	91	93	94	94	95	97	97	96	94	92		
32 :	91	90	87	86	86	89	91	92	94	95	96	97	99	100	99	97	94		
33 :	91	90	88	88	89	92	93	94	94	96	98	98	100	100	99	99	96		
34 :	91	90	89	90	92	95	95	96	96	98	100	100	101	100	100	99	97		
35 :	91	90	89	92	94	96	97	97	98	99	101	102	102	100	100	99	97		
36 :	91	90	91	94	95	96	97	98	99	100	101	102	103	102	100	99	97		
37 :	92	92	93	94	96	97	98	98	99	100	101	103	103	103	101	99	97		
38 :	93	93	94	95	96	97	98	99	100	101	102	103	104	103	101	99	97		
39 :	93	95	95	96	97	98	98	99	100	101	102	103	104	103	101	99	97		
40 :	93	96	96	97	97	98	99	99	100	101	102	103	104	103	101	99	97		

I/J:	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
1 :																			
2 :																			
3 :																			
4 :																			
5 :																			
6 :																			
7 :																			
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33 :																			
34 :																			
35 :																			
36 :																			
37 :																			
38 :																			
39 :																			
40 :																			

I/J:	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
1 :																			
2 :			85	27	27	28	30												
3 :			46	35	27	27	28	30	38										
4 :			48	32	25	25	25	29	39										
5 :			48	30	24	22	24	28	40	58									
6 :			52	31	23	23	23	28	40	59									
7 :			55	33	25	24	24	27	38	61	82								
8 :			58	35	28	26	26	27	38	63	85								
9 :			62	38	30	28	27	29	39	63	84	98							
10 :			67	41	32	30	29	31	41	63	82	95	108						
11 :			72	45	34	32	31	34	44	61	78	93	106	115					
12 :			76	48	37	35	33	36	46	61	75	89	104	112	118				
13 :			80	52	39	37	36	39	48	62	74	86	104	111	118	121			
14 :			83	55	42	40	38	41	51	63	73	83	97	108	115	122			
15 :			86	59	45	43	41	43	54	64	72	81	92	102	113	119			
16 :			88	62	49	47	44	46	56	65	73	80	87	98	107	118			
17 :			89	65	52	50	47	49	58	66	72	79	86	93	104	117			
18 :			91	67	55	54	51	52	60	67	73	80	87	93	99	110			
19 :			91	69	58	57	56	56	62	67	72	79	88	95	97	105			
20 :			91	71	60	61	60	60	63	68	72	78	89	95	96	101			
21 :			91	72	63	65	64	62	64	68	73	79	90	96	96	96			
22 :			90	72	66	69	68	65	65	69	72	80	91	96	94	93			
23 :			88	72	69	73	71	68	66	69	73	81	92	96	94	92			
24 :			88	73	73	77	75	70	66	69	74	82	92	95	93	91			
25 :			87	75	76	80	78	73	67	69	75	83	93	96	93	90			
26 :			87	78	80	83	80	75	68	69	75	84	94	96	92	88			
27 :			87	80	83	85	82	77	69	69	75	85	94	96	92	87			
28 :			87	84	86	87	84	78	70	70	76	86	94	97	92	85			
29 :			88	87	89	89	86	80	72	71	76	87	95	96	90	85			
30 :			89	89	91	90	87	81	73	72	78	89	95	94	89	84			
31 :			91	91	92	92	91	88	83	75	72	79	90	95	93	88	83		
32 :			94	93	94	93	92	90	85	78	75	82	91	94	92	87	83		
33 :			96	95	94	94	93	91	87	79	76	83	92	93	89	85	82		
34 :			97	96	94	94	93	92	88	81	78	85	92	91	88	85	82		
35 :			97	96	95	94	94	93	89	82	80	86	91	90	87	84	82		
36 :			97	96	95	94	94	93	91	84	82	87	90	89	86	84	82		
37 :			97	95	94	94	94	94	92	85	84	87	90	88	86	84	81		
38 :			97	95	94	94	95	94	93	87	85	87	89	88	85	83	81		
39 :			97	95	94	95	95	95	94	89	87	88	89	87	85	83	81		
40 :			97	95	95	95	95	95	95	90	88	88	89	87	84	83	81		

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1912, arriving from sheltered approach direction of 258 deg azimuth, period = 11.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	6									
2 :																			6	5	6	6	6								
3 :	131	134	143	157														6	5	5	5	5	6								
4 :	128	131	140	151	163	165	174											6	5	5	4	5	6	9							
5 :	125	128	137	148	158	160	162	178	18									7	5	4	4	5	6	9	14						
6 :	115	117	125	136	151	155	147	157	171									7	6	5	4	5	6	9	15						
7 :	108	110	125	136	145	150	142	147	156								12	8	6	5	5	5	6	9	16	25					
8 :	108	104	117	127	136	143	139	142	148							25	14	9	6	6	5	5	6	9	17	25					
9 :	103	104	116	126	136	144	139	139	141						49	28	16	10	7	6	5	6	7	10	17	25	33				
10 :	99	100	110	120	129	135	138	135	134	122	97	81	74	67	52	32	18	12	8	7	6	6	7	11	17	24	33	43			
11 :	99	100	106	119	127	135	137	135	130	112	93	77	70	66	54	36	21	13	9	7	7	7	8	11	17	24	33	43	52		
12 :	96	97	105	113	123	133	137	135	127	109	90	74	68	65	56	39	23	15	10	8	7	7	9	12	18	24	32	43	52	63	
13 :	96	96	104	112	121	132	136	135	126	108	87	71	64	63	57	43	26	18	12	9	8	8	10	13	19	25	31	41	51	64	81
14 :	94	94	101	108	120	131	136	135	125	107	86	68	62	60	58	46	29	20	14	10	9	9	10	15	20	25	31	39	49	63	81
15 :	95	93	100	107	118	130	138	137	127	109	84	66	59	59	58	48	33	22	16	11	10	10	11	16	21	26	31	37	47	62	82
16 :	93	91	99	104	114	127	136	135	125	106	84	64	56	56	55	49	36	24	17	13	11	11	12	18	22	27	31	37	46	62	83
17 :	93	91	96	103	114	127	137	137	126	106	84	64	55	54	54	49	38	27	19	14	12	12	13	19	24	28	32	38	46	61	81
18 :	94	91	95	102	113	128	138	139	127	106	81	62	53	52	53	50	39	29	21	16	14	13	15	20	25	28	32	39	50	60	80
19 :	92	90	92	98	110	125	137	138	125	104	81	61	52	50	52	49	39	30	23	18	16	14	16	21	26	29	32	40	52	61	79
20 :	92	90	92	97	109	125	138	140	127	104	78	61	50	48	51	49	40	31	25	19	17	16	18	22	27	30	33	42	55	63	76
21 :	92	90	89	94	106	123	137	139	126	102	78	60	49	46	48	48	41	32	26	21	19	18	19	24	28	31	34	44	56	64	75
22 :	93	90	89	93	105	122	138	140	126	100	75	58	47	43	46	48	43	32	26	23	21	20	20	25	29	32	36	46	57	66	75
23 :	92	88	88	91	102	120	137	142	128	101	74	57	47	42	44	47	44	33	26	24	23	22	22	25	29	33	38	47	58	68	76
24 :	92	89	86	90	101	119	136	143	129	99	72	55	46	41	41	45	44	34	27	26	26	24	24	26	30	34	39	49	60	70	77
25 :	91	87	85	88	98	116	136	145	131	99	71	54	45	40	39	44	44	35	28	28	28	26	25	27	30	35	40	51	63	71	77
26 :	90	87	84	86	96	114	135	146	132	98	68	53	45	39	37	42	43	36	30	30	30	27	27	28	31	36	41	53	67	73	76
27 :	90	86	82	84	95	112	134	147	133	97	66	52	44	38	36	40	42	36	31	32	32	29	28	29	32	37	43	56	70	75	74
28 :	89	86	82	82	93	109	132	147	134	96	64	51	43	37	35	37	40	36	33	34	33	31	29	31	33	37	45	60	71	74	74
29 :	89	86	80	80	90	107	129	144	134	96	62	50	41	36	34	35	38	36	35	36	35	33	31	32	34	38	48	62	72	75	73
30 :	88	85	79	79	89	105	128	143	133	96	61	48	41	36	34	34	37	37	36	37	37	35	32	33	35	40	51	64	73	75	72
31 :	87	85	79	77	87	105	126	141	132	97	62	47	39	35	33	33	35	37	38	39	39	36	34	35	36	41	54	67	73	74	72
32 :	86	84	78	76	86	104	125	140	131	98	64	46	38	34	33	33	35	37	39	41	40	38	36	36	37	43	56	68	73	73	72
33 :	85	83	77	76	86	105	125	139	131	100	66	45	37	34	33	33	35	38	41	42	42	40	37	38	38	45	60	69	72	72	70
34 :	84	83	77	76	87	105	126	139	132	103	68	45	36	34	34	34	36	39	42	44	43	41	39	39	39	48	61	69	72	72	69
35 :	83	82	76	76	87	105	126	141	134	106	71	46	36	33	34	35	37	40	43	45	45	43	41	40	41	51	63	69	72	72	68
36 :	82	80	75	77	87	103	125	142	136	109	73	47	36	33	34	36	38	41	44	46	46	45	43	42	43	53	63	69	72	72	67
37 :	82	79	75	78	86	102	124	142	139	112	75	49	37	34	34	36	39	42	45	47	48	46	45	44	45	55	64	69	72	71	66
38 :	82	78	76	79	86	100	122	142	142	116	78	50	37	34	35	37	40	43	46	49	49	48	47	45	47	56	64	70	72	70	64
39 :	82	79	77	79	86	99	119	141	144	120	81	51	38	35	36	38	41	44	47	50	51	50	49	48	49	57	65	70	71	68	63
40 :	81	79	78	80	86	97	117	139	146	125	85	53	39	35	36	38	42	45	49	52	53	52	51	49	50	58	66	70	70	66	62

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1983, arriving from sheltered approach direction of 260 deg azimuth, period = 16.5 sec, tide elevation = +8.0 ft MLLW.

J/I:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																															
2 :																				22	23	24									
3 :	121	118	116	117															29	22	23	24	25								
4 :	119	116	114	113	112	107	110											41	26	21	21	21	24	32							
5 :	117	114	112	111	108	103	102	117	13[illegible]									42	25	20	18	20	23	33							
6 :	108	105	104	103	104	99	92	103	124									45	26	19	19	19	23	33	49						
7 :	102	100	104	103	99	95	88	96	114									48	27	21	19	20	23	32	51						
8 :	102	96	99	97	94	90	86	92	108								99	52	29	23	21	21	23	32	53	74					
9 :	98	96	99	96	93	90	85	90	103							146	105	56	32	25	22	22	24	32	54	74					
10 :	96	93	95	92	88	85	84	87	98	107	106	108	116	132	153	145	110	63	35	27	24	24	26	35	54	72	85				
11 :	96	93	92	92	87	84	83	86	94	99	103	105	111	126	143	143	118	69	38	29	26	26	28	37	53	69	84	96			
12 :	94	92	92	89	85	83	82	85	92	97	101	102	108	122	139	142	120	75	42	31	29	27	30	39	53	67	81	95	103		
13 :	94	92	92	89	84	82	81	85	91	96	99	100	105	118	134	139	121	80	46	33	31	29	33	41	55	66	79	94	103	112	
14 :	93	90	90	86	83	81	81	84	90	95	98	99	103	114	131	137	122	85	51	36	34	32	35	44	56	66	75	88	99	109	121
15 :	93	91	90	86	82	80	81	85	90	96	96	98	102	112	128	135	122	89	55	39	37	34	37	47	58	66	73	83	94	107	119
16 :	92	89	90	84	80	78	80	83	89	94	97	96	100	109	123	132	122	92	59	43	40	37	39	50	59	67	72	79	90	103	118
17 :	92	90	88	84	80	78	80	83	89	94	96	96	100	107	120	129	121	94	62	46	43	40	42	52	60	66	72	78	86	101	118
18 :	92	90	88	84	79	78	80	84	89	94	95	95	98	105	118	126	120	95	66	49	47	44	45	54	62	67	72	79	86	96	112
19 :	91	89	87	82	78	77	78	83	88	92	95	96	98	104	114	122	117	97	68	52	51	48	49	56	63	67	72	80	89	95	108
20 :	92	89	87	82	78	77	79	83	89	92	94	96	98	103	112	119	115	97	70	55	54	52	53	58	63	67	71	80	90	94	104
21 :	92	90	86	81	77	76	78	83	88	92	94	96	97	101	108	117	114	96	71	58	58	56	56	59	64	67	71	82	92	95	99
22 :	92	90	86	81	76	76	78	82	88	91	92	94	96	100	106	115	114	95	72	61	62	60	58	61	64	67	72	83	92	94	96
23 :	91	89	86	80	76	75	77	83	89	91	92	94	97	100	104	113	112	93	72	68	71	68	64	62	64	68	74	85	92	94	94
24 :	91	90	85	80	76	75	77	83	89	91	90	93	97	99	102	110	110	92	74	72	74	71	67	62	64	68	75	87	93	94	94
25 :	91	89	84	79	75	74	78	84	90	91	90	92	97	99	100	108	108	91	76	76	78	74	69	63	64	69	76	88	94	94	92
26 :	90	89	84	78	75	74	79	85	91	91	89	92	98	99	99	105	105	90	79	79	81	77	70	64	64	69	77	88	96	94	91
27 :	90	88	84	78	75	75	78	85	91	90	88	91	97	99	99	103	102	90	82	83	83	79	72	65	65	69	78	90	97	94	88
28 :	89	88	83	77	75	75	79	86	91	89	87	91	97	99	98	100	99	90	85	86	85	80	73	66	65	69	80	92	96	92	88
29 :	89	88	83	77	75	76	79	85	91	89	87	92	96	99	98	98	96	91	88	88	87	82	74	67	66	70	82	93	96	91	87
30 :	89	88	83	77	76	77	80	86	90	89	88	92	96	98	98	97	95	92	91	90	87	83	76	69	66	71	85	93	94	91	85
31 :	89	88	83	78	77	80	82	86	90	90	90	93	96	99	100	98	95	94	93	91	88	83	77	70	67	73	86	94	93	89	85
32 :	88	88	83	79	80	82	85	87	90	91	93	94	98	101	102	100	97	95	94	91	88	84	78	71	68	75	87	94	92	88	84
33 :	88	87	83	81	83	86	87	89	90	92	95	96	99	102	103	102	99	97	94	91	88	85	80	72	69	77	89	93	90	86	83
34 :	88	87	84	84	86	89	90	91	92	94	97	98	100	102	103	103	100	97	94	91	89	85	81	74	70	79	89	91	89	86	82
35 :	88	87	84	86	88	90	92	93	94	95	98	100	102	103	103	104	101	97	94	91	89	86	82	75	72	81	89	90	88	85	82
36 :	88	86	86	88	90	92	93	94	95	97	99	101	103	105	104	104	101	97	93	91	89	86	84	76	75	82	89	89	87	85	81
37 :	88	87	88	89	91	93	94	95	96	97	99	102	105	106	106	104	100	97	93	90	89	87	85	78	77	83	88	88	87	84	80
38 :	89	89	89	90	92	93	95	96	97	98	100	103	105	107	106	104	100	96	93	90	89	87	86	80	79	83	88	88	86	83	79
39 :	89	90	91	92	93	94	95	96	97	99	101	104	106	107	106	103	99	95	92	90	89	88	87	82	80	84	88	88	85	82	79
40 :	90	92	92	93	94	95	96	97	98	99	101	104	106	107	106	103	99	95	92	90	89	89	88	83	82	85	88	87	84	81	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1915, arriving from sheltered approach direction of 263 deg azimuth, period = 12.4 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				15	16	17									
2 :																			17	15	16	17	20								
3 :	104	104	107	113														19	16	14	15	16	19	29							
4 :	102	102	105	109	113	113	123											19	15	14	13	15	18	30							
5 :	100	99	103	107	110	109	112	133	151									21	16	13	14	14	18	30	51						
6 :	92	92	95	99	106	106	101	115	138									22	17	14	14	15	18	29	53						
7 :	88	87	95	99	102	103	97	106	124								31	23	18	16	15	16	18	29	54	79					
8 :	88	84	90	94	97	98	95	101	115							47	33	25	19	17	17	17	19	29	53	78					
9 :	84	83	90	93	96	98	95	98	109						69	50	36	27	21	18	18	19	21	31	53	77	93				
10 :	82	81	86	90	92	93	94	95	102	107	104	102	99	89	72	53	38	29	22	20	19	20	23	33	52	72	91	101			
11 :	83	81	83	89	91	92	93	94	99	99	99	99	97	90	75	56	41	31	24	21	21	21	24	35	52	70	86	99	101		
12 :	81	79	83	86	88	91	92	94	96	97	96	96	96	90	77	59	44	34	26	23	23	23	26	36	52	68	83	99	101	99	
13 :	81	79	83	86	87	90	91	93	95	95	94	94	94	90	79	62	47	37	29	25	25	24	28	38	53	67	80	92	97	95	92
14 :	81	78	81	83	86	89	89	91	94	94	93	92	92	90	81	66	50	39	31	27	27	26	29	40	53	67	78	88	90	91	89
15 :	81	78	81	83	85	88	90	91	93	95	92	90	90	89	83	69	53	42	34	29	29	28	31	41	54	68	78	82	86	85	86
16 :	81	77	81	82	84	86	88	89	91	92	92	89	89	88	82	70	56	44	36	32	31	30	32	43	55	67	78	81	80	81	85
17 :	81	78	79	81	84	86	88	88	90	92	92	89	88	88	83	72	58	47	38	34	34	33	34	44	55	68	78	82	79	75	78
18 :	82	78	79	81	83	86	88	88	89	91	90	88	87	87	84	73	59	49	41	37	37	36	37	44	56	67	78	83	79	74	74
19 :	82	78	78	79	82	85	87	87	87	88	90	88	87	87	84	74	60	50	43	39	39	38	39	45	56	68	77	82	78	72	70
20 :	82	78	78	79	82	85	87	87	86	88	88	88	86	86	85	76	61	51	45	42	42	41	41	46	56	69	77	81	78	71	67
21 :	83	79	77	78	81	84	86	86	85	86	88	88	85	85	85	78	64	52	47	45	45	43	42	47	57	69	78	81	78	70	65
22 :	83	80	78	78	80	84	87	86	84	84	86	87	84	83	83	79	67	54	48	48	48	46	44	47	58	70	78	81	77	70	65
23 :	84	80	78	77	79	83	86	86	84	84	86	87	84	82	83	81	70	56	50	50	51	48	46	48	58	71	79	81	76	68	64
24 :	84	81	77	77	79	83	86	86	84	82	85	86	85	81	81	81	72	58	52	53	53	50	48	49	58	71	79	81	75	67	63
25 :	85	81	78	77	78	81	85	87	84	82	84	86	84	81	80	81	74	60	55	57	56	52	50	50	59	72	79	80	75	67	63
26 :	86	82	78	77	78	81	85	87	84	81	83	86	85	80	79	80	75	63	58	60	58	55	52	52	60	72	79	79	73	67	63
27 :	87	83	79	77	78	80	84	87	84	81	82	86	85	80	78	79	76	66	62	63	60	57	54	53	61	72	79	78	73	67	62
28 :	88	84	79	77	78	79	83	86	85	81	81	85	85	80	78	78	76	69	65	65	62	59	56	55	62	72	79	78	72	66	62
29 :	89	85	80	78	79	80	82	85	85	81	81	85	85	81	78	77	76	71	69	67	64	61	58	57	63	73	79	77	71	66	63
30 :	89	86	82	79	80	81	82	85	85	83	82	85	85	81	79	77	76	74	72	70	66	63	60	59	64	73	79	76	70	66	63
31 :	90	87	83	81	82	83	83	85	86	85	85	86	86	84	81	79	77	76	74	72	68	65	62	60	65	74	79	76	70	66	63
32 :	90	88	85	83	84	85	84	85	86	86	87	87	88	87	85	82	80	78	77	74	70	67	64	62	66	74	78	74	69	65	64
33 :	89	88	87	86	87	88	86	86	86	88	89	88	89	89	87	85	83	81	78	75	72	69	66	64	68	75	78	74	68	65	64
34 :	89	88	88	88	90	90	88	88	88	89	90	90	90	89	88	87	85	83	80	77	74	71	68	66	69	75	77	72	68	66	64
35 :	89	88	89	90	91	91	90	89	89	90	91	92	91	90	89	89	87	84	82	79	76	73	70	68	71	76	77	72	68	66	64
36 :	90	88	90	92	92	91	90	90	90	91	92	93	93	92	91	90	88	86	83	81	78	75	72	70	72	76	76	71	68	66	65
37 :	92	90	91	93	93	92	91	90	90	91	92	93	94	94	93	91	89	87	84	82	80	77	75	72	74	77	76	71	68	67	65
38 :	93	92	92	94	94	93	92	91	91	91	92	94	95	95	94	92	90	88	86	84	81	79	77	74	75	77	76	71	68	67	66
39 :	94	94	94	95	94	93	92	91	91	91	92	94	95	95	95	93	91	89	87	85	83	81	79	76	76	78	76	72	69	67	66
40 :	95	95	95	95	95	94	93	92	91	92	92	94	95	96	95	94	92	90	88	86	84	83	81	78	78	78	77	72	69	68	67

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1915, arriving from sheltered approach direction of 224 deg azimuth, period = 11.8 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				17	18	20									
2 :																			18	17	18	20	23								
3 :	97	98	101	105														20	17	16	17	18	23	35							
4 :	95	96	99	102	103	100	107											20	17	15	15	17	22	36							
5 :	93	94	98	100	100	97	98	113	128									22	17	15	16	17	21	37	59						
6 :	87	87	91	94	97	95	89	98	115									22	18	16	17	18	22	35	59						
7 :	83	83	91	94	94	92	86	90	103								29	23	19	18	18	19	22	35	60	79					
8 :	83	80	86	89	90	88	84	86	96							40	31	25	21	19	19	20	23	35	58	77					
9 :	80	80	86	89	89	89	84	84	91						53	42	33	26	22	20	21	21	25	37	57	75	82				
10 :	78	78	83	86	86	85	84	83	86	88	84	80	75	67	55	44	35	28	23	22	22	23	27	38	55	70	80	82			
11 :	79	79	81	85	85	84	83	83	84	82	80	79	75	68	57	46	37	30	25	23	24	24	28	40	54	67	75	79	77		
12 :	78	77	81	83	83	83	83	83	83	81	79	77	75	69	59	48	39	32	27	24	25	25	30	40	54	65	71	79	76	73	
13 :	78	77	81	83	82	83	82	82	82	81	78	75	74	70	61	50	41	34	29	26	27	27	31	42	54	64	69	73	73	70	68
14 :	77	76	80	81	82	82	81	81	82	80	77	74	73	70	63	53	43	36	31	28	29	29	32	43	54	63	67	69	68	67	65
15 :	78	76	80	81	81	81	81	81	81	81	77	74	73	70	64	55	45	38	33	30	31	30	33	44	55	63	67	65	64	62	63
16 :	78	76	79	80	80	80	79	79	80	80	78	74	72	70	64	56	48	40	35	32	33	32	35	44	55	62	66	64	60	59	62
17 :	78	76	78	80	81	81	79	79	79	80	78	74	72	70	65	57	49	42	37	35	35	35	37	45	54	62	66	64	59	55	58
18 :	79	76	78	80	81	81	80	78	78	79	77	74	72	71	66	58	50	44	39	37	37	37	38	45	54	61	65	64	59	55	55
19 :	79	76	77	79	80	81	79	77	77	78	77	74	73	72	68	59	50	45	41	39	40	39	40	45	54	61	64	63	59	54	53
20 :	79	77	77	79	80	81	80	77	77	77	76	74	72	72	69	61	51	46	43	41	42	41	41	46	54	61	64	63	59	54	51
21 :	79	78	77	78	80	81	80	77	76	76	76	75	72	71	70	63	53	47	44	44	44	43	43	46	54	61	64	63	59	53	50
22 :	80	78	77	78	80	81	80	77	75	75	76	75	72	71	70	65	56	48	45	46	46	45	44	46	54	61	64	62	58	53	50
23 :	81	78	77	78	79	81	80	78	75	75	76	75	72	70	70	67	59	50	47	49	49	47	46	47	54	61	64	62	58	53	50
24 :	81	79	77	77	79	81	81	78	75	74	75	75	72	70	70	68	61	52	49	51	51	49	48	48	54	62	64	62	57	52	50
25 :	83	79	77	77	78	80	81	79	76	74	75	75	72	70	69	69	63	54	52	54	52	50	49	49	55	61	64	62	57	52	50
26 :	84	81	78	77	78	80	81	80	76	74	75	75	73	70	69	69	65	56	55	56	54	52	51	50	55	61	63	61	57	53	50
27 :	85	82	79	78	79	80	81	81	77	74	74	76	73	70	69	69	66	60	58	58	56	54	52	52	56	61	63	60	57	53	50
28 :	87	83	80	79	79	80	81	82	79	75	75	76	74	71	70	69	67	63	61	60	58	55	54	53	56	61	63	60	57	53	51
29 :	88	85	82	80	81	81	82	83	80	77	76	77	75	72	71	70	68	65	64	62	60	57	56	54	57	61	63	60	56	53	51
30 :	89	87	83	82	83	83	83	83	82	79	78	77	76	73	71	70	69	68	66	64	62	59	57	56	58	61	63	60	56	54	52
31 :	89	88	85	85	85	86	85	85	83	82	81	80	79	77	75	73	71	71	69	66	64	61	59	57	59	62	63	60	56	54	53
32 :	90	89	88	87	88	88	87	86	85	84	84	82	82	80	78	77	75	73	71	68	66	63	61	59	60	62	62	59	56	54	53
33 :	89	90	89	90	91	91	89	88	87	87	86	84	83	82	80	79	77	75	73	70	68	65	63	61	61	63	62	59	56	55	53
34 :	89	90	91	91	93	92	91	90	89	88	88	86	85	83	82	81	79	77	75	72	70	67	65	62	63	64	62	59	56	55	54
35 :	90	89	92	93	94	93	93	92	91	90	89	88	86	84	83	82	81	79	77	74	72	69	67	64	64	64	63	59	57	56	55
36 :	91	89	94	95	95	94	93	93	92	91	90	89	88	86	85	84	82	80	78	76	74	71	69	66	66	65	63	59	57	56	55
37 :	92	92	94	95	95	94	94	93	93	92	91	90	89	88	86	85	83	82	80	78	76	73	71	68	67	66	63	59	58	57	56
38 :	93	94	95	96	96	95	94	94	93	93	92	91	90	89	88	86	85	83	81	80	78	75	73	70	69	67	64	60	58	58	56
39 :	94	95	96	97	96	95	95	94	94	93	93	92	91	90	89	87	86	84	83	81	79	77	75	72	70	68	65	61	59	58	57
40 :	95	97	97	97	97	96	95	95	94	94	93	93	92	91	90	88	87	86	84	83	81	79	77	75	73	69	66	62	60	59	58

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1943, arriving from sheltered approach direction of 214 deg azimuth, period = 10.8 sec, tide elevation = +8.0 ft MLLW.

IAJ:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				3	3	4									
2 :																			3	3	3	4	4								
3 :	94	73	59	51														4	3	3	3	3	4	5							
4 :	91	71	57	48	43	40	43											4	3	3	2	3	3	5							
5 :	89	69	55	47	41	38	39	50	64									4	3	2	2	3	3	5	8						
6 :	81	62	50	42	39	36	34	41	56									4	3	3	2	3	3	5	9						
7 :	76	58	49	42	37	34	32	37	48								6	5	3	3	3	3	3	5	9	15					
8 :	76	55	46	39	34	32	31	34	43							12	7	5	4	3	3	3	3	5	10	15					
9 :	72	53	45	38	34	32	30	33	40						28	14	8	5	4	3	3	3	4	6	10	15	20				
10 :	70	52	43	36	31	29	30	31	36	42	46	51	52	46	32	17	10	6	5	4	3	3	4	6	10	14	20	27			
11 :	70	52	41	35	31	29	29	30	34	38	43	48	51	47	35	19	11	7	5	4	4	4	5	6	10	14	20	26	33		
12 :	69	50	41	33	30	28	28	30	33	36	40	45	49	48	38	23	13	8	6	4	4	4	5	7	11	14	20	27	32	41	
13 :	69	50	40	33	29	28	28	29	31	34	38	42	47	48	40	26	15	10	7	5	4	5	5	8	11	15	19	25	32	41	53
14 :	68	49	39	32	28	27	27	28	30	33	36	40	45	46	42	29	17	12	8	6	5	5	6	9	12	15	19	24	30	40	54
15 :	69	49	38	31	28	27	27	28	30	33	35	38	43	46	43	32	20	13	9	6	5	5	6	10	13	16	19	23	29	39	55
16 :	68	48	38	30	27	26	26	27	28	31	34	36	40	44	42	34	23	15	10	7	6	6	7	10	14	17	19	23	28	40	56
17 :	69	48	37	30	27	26	26	26	28	30	33	35	39	43	42	35	25	17	12	8	7	6	7	11	14	17	20	23	29	39	55
18 :	70	49	37	29	26	26	26	26	27	30	32	34	37	41	42	36	26	19	14	9	8	7	8	12	15	18	20	24	31	39	55
19 :	70	48	36	28	26	25	25	25	26	28	31	33	36	40	42	37	27	20	15	11	9	8	10	13	16	18	20	25	33	40	55
20 :	72	49	36	28	25	25	25	25	26	27	30	32	35	39	41	37	28	21	17	12	10	9	10	14	17	19	21	26	35	41	53
21 :	73	50	35	28	25	24	25	25	25	26	29	32	34	37	40	38	30	21	17	14	11	10	11	15	18	19	22	28	35	43	53
22 :	75	51	36	28	25	24	25	24	24	25	28	31	32	35	38	38	32	22	18	15	13	11	12	16	18	20	23	29	36	44	54
23 :	78	51	36	27	24	24	24	24	24	25	27	30	32	33	37	38	33	23	18	16	14	13	13	16	19	21	24	30	37	46	55
24 :	78	53	36	27	24	24	24	24	23	24	26	30	31	32	35	38	34	25	19	17	16	14	14	16	19	22	25	31	39	48	56
25 :	81	54	36	27	24	23	24	24	23	23	26	29	31	31	33	37	35	26	19	18	17	15	15	17	20	23	26	32	42	50	56
26 :	84	55	36	27	24	23	23	24	23	22	25	29	31	30	31	35	35	27	20	20	18	16	16	18	20	24	26	33	45	52	56
27 :	88	57	37	27	24	22	23	24	23	22	24	28	30	30	30	33	35	27	22	21	20	17	17	19	21	24	27	36	48	54	55
28 :	93	61	39	28	24	22	22	23	23	21	23	27	30	29	29	31	33	28	23	22	21	19	18	19	22	25	29	39	50	54	55
29 :	98	65	40	28	24	21	21	23	23	21	22	26	29	29	28	29	31	28	25	24	22	20	19	20	23	25	31	42	51	55	55
30 :	103	70	43	29	25	21	21	22	22	21	21	26	28	29	28	28	30	28	26	25	24	21	20	21	23	26	34	44	52	55	54
31 :	107	76	47	31	25	22	20	21	22	20	21	24	27	28	27	26	28	29	27	26	25	22	21	23	24	27	36	46	53	55	54
32 :	112	83	52	33	27	22	20	21	21	20	20	23	26	28	27	26	27	29	28	28	26	23	22	24	25	28	38	48	53	54	53
33 :	115	89	58	36	29	23	20	20	21	21	20	23	25	27	27	26	27	29	29	29	27	24	23	25	25	30	41	49	53	53	52
34 :	117	94	65	41	32	24	20	20	20	21	21	22	25	27	28	27	28	30	30	30	28	26	25	26	26	32	43	49	53	53	51
35 :	119	97	71	47	35	26	21	20	20	21	21	22	24	27	28	28	29	30	31	31	29	27	26	27	27	35	44	49	53	53	50
36 :	122	100	76	54	39	28	22	20	20	21	21	23	24	26	27	28	30	31	32	32	31	28	27	28	29	37	45	50	53	53	49
37 :	126	102	79	61	43	30	24	21	20	21	21	23	24	26	28	29	30	32	33	33	32	29	29	29	31	39	45	50	53	52	48
38 :	128	106	84	68	48	33	25	22	21	21	21	23	25	27	28	30	31	33	34	34	33	31	30	30	32	39	46	51	53	51	46
39 :	129	110	89	75	54	37	27	23	21	21	21	23	25	27	29	30	32	34	35	35	34	32	32	32	33	40	47	51	52	49	45
40 :	128	114	95	81	61	42	30	25	22	21	21	23	25	27	29	31	33	34	36	37	36	33	33	33	35	41	48	51	51	48	43

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1953, arriving from sheltered approach direction of 251 deg azimuth, period = 19.2 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				10	10	11									
2 :																			11	10	10	11	12								
3 :	116	110	107	106														14	10	9	9	10	12	14							
4 :	113	108	105	103	104	102	112											14	10	9	8	9	11	16							
5 :	111	106	103	101	100	98	103	128	15									16	10	8	8	9	11	16	25						
6 :	102	97	95	93	95	94	92	111	14									17	11	9	9	9	11	16	27						
7 :	97	92	95	93	91	91	88	103	131								31	18	12	10	9	10	11	16	28	41					
8 :	97	88	90	87	85	85	86	98	122							87	37	19	13	10	10	10	11	16	28	42					
9 :	93	88	89	87	85	85	84	95	116						143	95	42	22	15	11	11	11	12	17	29	41	52				
10 :	90	86	85	83	80	79	83	91	109	126	132	141	153	160	145	101	50	24	16	12	12	12	14	19	28	40	52	64			
11 :	91	86	83	82	79	79	82	90	105	115	127	135	146	155	144	107	57	27	18	14	13	13	15	20	29	38	50	63	73		
12 :	88	84	83	79	76	77	81	89	101	113	123	131	142	151	144	111	63	31	20	15	14	14	16	21	30	39	49	63	73	88	
13 :	89	84	83	79	75	76	79	88	99	111	120	127	137	146	142	115	69	35	23	16	15	15	17	23	31	39	48	59	71	84	101
14 :	87	82	80	76	74	75	78	87	98	109	117	124	133	141	141	117	75	40	25	18	17	16	18	25	33	39	47	56	67	83	100
15 :	88	83	80	76	73	74	79	87	98	110	115	122	130	139	140	119	80	44	28	20	19	18	20	27	34	41	46	53	65	81	101
16 :	86	81	80	74	71	72	77	85	95	107	115	119	126	134	135	119	85	48	30	23	21	19	21	29	35	41	47	53	63	80	101
17 :	87	82	78	73	70	72	77	85	95	106	115	119	126	132	133	119	87	53	33	25	23	21	23	31	37	42	47	54	63	78	98
18 :	87	82	78	73	70	71	77	85	95	105	112	117	123	128	131	118	88	56	36	27	25	24	25	32	38	42	47	55	66	77	96
19 :	86	81	77	71	68	70	75	83	93	103	112	117	123	127	127	115	88	58	39	30	28	26	28	34	39	43	47	56	69	78	94
20 :	87	82	77	71	68	69	75	84	93	102	109	118	123	125	125	113	88	60	41	32	31	29	30	35	40	44	47	58	71	79	90
21 :	87	82	76	70	67	68	74	83	92	101	109	117	121	122	121	111	90	61	42	35	34	32	32	37	41	44	49	60	72	79	88
22 :	87	83	76	70	67	68	74	82	92	99	107	115	120	120	117	110	91	61	42	37	37	35	34	38	42	45	50	62	73	81	88
23 :	86	82	76	69	66	67	73	83	93	99	106	115	120	120	115	109	91	62	43	40	40	37	36	38	42	46	52	63	74	82	88
24 :	87	82	75	69	66	67	72	82	92	98	103	113	121	118	112	105	90	63	45	42	43	40	38	39	43	47	53	65	76	83	88
25 :	86	82	75	68	65	66	72	83	93	98	103	112	121	119	109	103	89	63	47	45	45	42	40	40	43	48	55	67	79	85	88
26 :	86	82	74	68	65	66	72	83	93	97	101	112	121	117	107	100	87	64	49	48	48	45	42	41	44	49	56	69	82	86	87
27 :	85	81	74	67	65	66	72	83	93	96	99	111	121	117	105	96	85	64	52	51	50	47	43	42	45	50	57	71	85	87	85
28 :	85	81	74	67	64	65	71	82	92	94	97	110	119	116	103	92	81	64	54	53	52	49	45	44	46	50	60	75	85	86	84
29 :	85	81	73	66	64	66	71	81	91	93	96	109	117	114	102	89	77	64	57	56	54	51	46	45	46	51	63	77	86	86	84
30 :	84	81	73	66	65	67	71	80	90	92	96	109	117	114	101	87	75	65	59	58	56	52	48	46	47	52	66	79	86	86	83
31 :	83	81	73	66	65	68	72	80	88	92	98	108	115	112	100	84	73	65	61	59	57	54	50	48	48	54	69	81	86	85	82
32 :	83	81	73	67	67	70	74	80	87	92	100	109	115	112	100	84	72	65	62	60	58	55	51	50	49	56	71	82	85	84	82
33 :	82	80	73	68	69	72	76	80	86	93	102	109	115	112	100	85	73	67	63	61	59	57	53	51	50	59	74	82	84	83	80
34 :	82	80	73	70	72	75	78	81	87	94	104	112	115	111	99	85	74	68	64	62	60	58	55	53	52	61	75	82	84	83	79
35 :	81	79	73	72	74	77	80	83	88	95	106	114	116	110	98	86	75	68	64	63	62	60	57	54	54	65	76	81	83	82	78
36 :	81	78	74	74	76	79	81	84	88	96	107	116	118	111	98	85	75	68	64	63	63	61	60	56	56	67	77	81	83	82	78
37 :	81	78	75	75	77	80	82	85	89	97	108	117	119	112	99	85	74	68	65	64	64	63	62	58	59	68	77	81	83	81	76
38 :	81	78	76	77	79	81	83	86	90	98	109	119	121	113	99	85	74	68	65	64	65	64	64	60	61	69	77	81	82	80	75
39 :	81	79	78	78	80	82	84	87	91	99	110	120	121	112	98	84	73	67	65	65	66	66	66	62	62	70	78	82	81	79	74
40 :	81	80	79	80	81	83	86	88	92	99	111	121	121	112	96	82	73	67	65	66	67	68	68	64	64	71	79	82	80	77	73

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1969, arriving from sheltered approach direction of 264 deg azimuth, period = 14.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				10	10	11									
2 :																			11	10	10	11	12								
3 :	134	131	133	140														12	10	9	9	10	12	18							
4 :	131	128	131	135	139	137	143											13	10	9	8	9	11	17							
5 :	128	126	128	132	135	133	132	147	15									14	10	8	8	9	11	17	28						
6 :	118	116	118	122	129	128	120	129	146									15	11	9	9	9	11	16	28						
7 :	111	109	118	122	124	124	115	120	132								24	16	12	10	9	10	11	16	29	43					
8 :	112	104	111	115	117	118	113	115	124							49	27	18	13	10	10	10	12	17	29	43					
9 :	107	104	111	114	117	119	112	112	118						83	54	31	20	14	11	11	11	12	18	30	43	54				
10 :	104	101	106	109	111	112	112	109	111	109	98	96	100	99	86	59	35	22	16	12	12	12	14	19	29	41	53	65			
11 :	104	101	102	108	110	111	111	109	108	100	94	91	95	97	88	64	39	25	17	14	13	13	15	21	30	40	52	64	73		
12 :	102	98	102	104	107	110	111	109	105	97	90	87	91	95	89	68	43	28	19	15	14	14	16	22	31	40	51	64	73	82	
13 :	102	98	102	104	106	109	110	108	104	96	87	83	87	92	89	72	48	31	22	16	15	15	18	24	32	40	49	60	71	80	91
14 :	100	96	99	100	104	109	109	108	103	95	86	81	83	89	89	75	52	35	24	18	17	17	19	26	34	40	48	57	67	79	90
15 :	101	96	99	100	103	108	110	109	104	95	84	78	80	86	89	78	56	38	27	20	19	18	20	28	35	42	47	54	64	76	89
16 :	99	95	98	97	101	106	109	107	101	93	84	76	77	82	85	79	60	41	30	23	21	20	22	30	36	42	47	54	62	75	89
17 :	100	95	96	97	101	106	109	108	102	92	83	75	75	80	84	79	63	45	33	25	23	22	24	31	38	43	48	55	62	71	85
18 :	101	96	96	96	100	106	110	109	102	92	81	73	73	77	83	79	64	48	35	28	26	24	26	33	38	43	48	56	64	70	81
19 :	99	95	94	94	98	104	109	108	100	90	80	73	71	75	80	78	64	49	38	30	28	27	28	34	39	43	47	56	65	70	78
20 :	100	95	94	94	98	105	110	109	101	90	78	73	70	73	79	77	65	51	40	33	31	29	30	35	40	44	48	58	67	70	74
21 :	100	96	92	92	96	103	109	108	100	88	78	72	68	70	75	76	67	52	41	36	34	32	32	37	41	44	49	59	67	69	72
22 :	101	96	92	92	96	103	110	108	100	86	76	71	67	67	72	76	69	52	42	38	37	35	34	38	42	45	50	60	67	70	71
23 :	100	95	92	90	94	102	109	110	101	86	75	70	67	66	70	75	70	54	43	41	41	38	36	38	42	46	51	61	67	69	70
24 :	101	96	91	90	94	102	108	110	101	85	73	69	67	64	67	73	70	56	45	44	44	40	38	39	42	46	52	62	68	69	70
25 :	100	95	90	89	93	100	109	111	102	85	73	68	66	63	64	71	70	57	47	47	47	43	40	39	42	47	54	63	69	69	68
26 :	100	95	90	89	92	99	108	112	102	84	71	68	66	62	62	68	69	58	49	50	49	45	41	40	42	47	54	64	69	69	67
27 :	100	95	90	88	92	99	107	112	103	84	70	67	65	61	60	65	68	59	52	53	52	47	43	41	43	48	55	64	70	69	65
28 :	99	95	89	87	91	97	106	112	103	83	68	66	64	60	59	62	65	59	55	56	54	50	44	42	43	48	56	66	70	67	65
29 :	99	95	89	87	91	97	105	110	103	83	67	65	62	59	58	60	63	60	58	59	57	52	46	43	44	48	58	67	69	66	64
30 :	99	95	89	86	91	97	104	109	102	84	68	64	62	59	57	59	62	61	61	61	59	53	47	44	44	49	60	67	67	65	64
31 :	98	95	89	86	91	98	104	107	101	84	69	63	60	58	57	57	60	62	64	63	60	55	49	46	45	50	61	67	66	64	63
32 :	97	95	89	86	92	100	105	107	101	86	71	63	60	59	58	58	60	63	66	65	62	57	50	47	45	51	62	66	65	63	63
33 :	96	94	89	88	94	102	107	107	101	88	73	63	60	59	59	60	62	65	67	67	63	58	52	47	46	53	63	65	64	62	63
34 :	95	93	89	89	97	105	109	109	102	90	76	64	59	58	59	61	64	67	69	68	65	60	54	48	47	54	63	64	62	62	62
35 :	95	92	88	90	98	106	111	111	104	92	78	66	60	58	59	62	66	69	70	70	66	61	55	49	48	56	62	63	62	61	62
36 :	94	91	89	92	99	106	112	112	106	94	80	68	61	59	60	63	67	70	71	71	68	63	57	50	49	56	61	61	61	61	63
37 :	95	91	89	93	99	106	112	113	108	96	81	69	62	60	61	64	68	71	73	72	69	64	58	52	51	57	61	61	60	61	63
38 :	95	91	90	94	100	106	112	114	110	98	83	71	63	61	62	66	69	72	74	73	71	66	60	53	52	57	60	60	60	61	63
39 :	95	92	91	94	100	106	112	115	111	100	85	72	64	61	63	66	70	73	75	75	72	67	61	54	52	57	60	59	59	60	63
40 :	94	94	92	95	100	106	112	115	112	102	88	74	65	62	63	67	71	74	76	76	73	68	63	55	53	57	59	59	58	59	64

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1980, arriving from sheltered approach direction of 248 deg azimuth, period = 14.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				4	5	5									
2 :																			5	4	5	5	5								
3 :	155	146	137	130														5	4	4	4	4	5	7							
4 :	152	143	135	125	114	97	88											5	4	4	4	4	5	7							
5 :	150	141	133	123	110	94	81	80	83									6	4	4	4	4	5	8	12						
6 :	138	130	123	114	106	91	72	69	74									6	5	4	4	4	5	7	13						
7 :	131	122	123	115	102	88	69	63	66								10	7	5	4	4	4	5	7	14	21					
8 :	132	118	116	108	96	83	68	60	60							19	11	7	5	4	4	4	5	7	14	21					
9 :	127	118	117	108	96	83	67	58	56						40	22	13	8	6	5	4	5	5	8	14	21	29				
10 :	123	115	112	104	92	78	66	56	52	51	51	56	60	58	44	25	15	9	6	5	5	5	6	9	14	21	29	37			
11 :	124	116	109	104	91	78	66	55	50	46	47	52	57	58	47	29	17	11	7	6	5	6	7	9	15	20	28	37	48		
12 :	122	113	110	101	89	78	65	55	47	43	44	49	55	57	49	33	19	13	8	6	6	6	7	10	16	21	28	37	46	57	
13 :	123	114	110	101	89	78	65	54	46	42	42	46	52	56	51	36	22	15	10	7	7	7	8	11	16	21	27	35	45	56	72
14 :	121	112	108	99	88	77	64	53	45	41	40	43	49	54	52	40	25	17	11	8	7	7	9	13	17	22	27	34	42	56	72
15 :	123	113	109	99	88	77	65	54	45	40	38	41	47	53	53	43	28	19	13	9	8	8	9	14	18	23	27	32	41	55	74
16 :	121	112	109	98	87	76	64	53	43	38	37	39	44	50	51	44	31	21	15	10	9	9	10	15	19	23	27	32	40	55	74
17 :	123	114	108	98	87	77	65	53	43	37	36	38	43	48	51	45	34	23	17	12	10	9	11	16	20	24	28	33	41	54	73
18 :	124	115	109	99	88	78	65	53	42	37	35	36	40	46	50	46	35	25	19	14	12	11	12	17	21	25	28	34	44	54	73
19 :	123	115	107	98	87	77	65	52	41	35	34	35	39	45	49	46	35	27	21	15	13	12	14	18	22	25	28	35	46	55	72
20 :	125	116	109	99	89	78	66	52	41	34	32	35	38	43	48	46	36	28	22	17	15	13	15	19	23	26	29	37	48	56	69
21 :	126	118	108	98	88	78	65	52	39	33	32	34	36	40	46	46	38	28	23	19	16	15	16	21	24	27	30	39	49	58	68
22 :	127	120	110	99	89	79	66	51	39	31	30	33	35	38	43	46	40	29	23	20	18	17	17	21	25	28	31	41	51	60	69
23 :	126	119	111	99	89	79	66	52	39	31	30	32	34	37	42	45	41	30	24	22	20	18	19	22	26	29	33	42	52	61	69
24 :	127	121	111	101	91	80	66	52	38	29	28	31	34	35	39	44	42	32	25	23	22	20	20	23	26	30	34	44	54	63	70
25 :	127	121	111	101	92	80	67	52	38	29	28	30	33	34	37	43	42	33	26	25	24	22	22	24	27	31	36	45	57	65	70
26 :	127	122	112	102	93	81	68	52	37	28	27	30	33	33	35	41	42	33	27	27	26	23	23	24	28	32	36	47	60	67	69
27 :	126	122	113	104	94	82	68	52	37	27	26	29	32	33	34	38	41	34	28	28	27	25	24	26	28	33	38	50	64	68	67
28 :	125	123	115	105	96	82	67	52	37	26	24	28	31	32	32	36	39	34	30	30	29	27	25	27	30	33	40	53	65	68	67
29 :	124	124	116	106	97	84	67	51	36	25	23	28	30	31	32	34	37	35	32	32	31	28	27	28	31	34	43	56	66	68	66
30 :	122	124	117	107	100	86	67	50	35	25	23	27	30	31	31	33	36	35	34	34	33	30	28	29	31	35	46	58	66	68	65
31 :	119	124	118	109	103	88	68	49	34	25	23	26	29	30	30	31	34	35	35	35	34	31	29	31	32	37	48	60	67	68	65
32 :	116	122	118	111	107	92	70	49	34	25	23	25	28	30	31	31	33	35	37	37	35	33	31	32	33	38	51	62	67	66	64
33 :	113	119	118	114	111	97	73	49	34	26	23	24	27	30	31	31	33	36	38	38	37	34	32	33	34	40	54	63	66	65	63
34 :	109	116	116	116	117	104	77	50	34	26	24	24	27	29	31	32	34	37	39	40	38	36	34	35	35	43	56	63	65	65	61
35 :	106	111	113	118	122	110	82	53	35	27	24	24	26	29	31	33	35	38	40	41	40	37	36	36	37	46	57	63	65	64	60
36 :	103	107	109	118	125	116	88	57	36	28	25	25	26	29	31	33	36	39	41	42	41	39	38	37	39	48	58	63	65	64	59
37 :	102	102	106	118	127	121	95	61	38	28	25	25	27	29	31	34	37	40	42	43	43	41	40	39	41	50	58	63	65	63	57
38 :	100	99	103	117	128	126	101	67	41	30	26	25	27	29	32	35	38	41	43	45	44	42	42	40	42	51	58	63	64	62	55
39 :	99	98	102	115	128	129	108	73	45	31	26	26	27	29	32	35	38	42	44	46	46	44	43	42	44	52	59	63	63	60	54
40 :	97	97	100	113	127	132	115	80	49	33	27	26	27	30	32	36	39	42	46	48	48	46	45	44	45	53	60	63	62	58	53

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1981, arriving from sheltered approach direction of 255 deg azimuth, period = 17.5 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				2	2	2									
2 :																			2	2	2	2	2								
3 :	99	75	56	43														2	2	2	2	2	2	3							
4 :	97	72	54	41	32	27	28											2	2	1	1	2	2	3							
5 :	94	70	52	39	30	25	25	32	41									2	2	1	1	1	2	3	5						
6 :	86	63	47	35	28	24	22	26	35									2	2	1	1	2	2	3	5						
7 :	80	58	46	34	26	23	20	23	30								3	3	2	2	1	2	2	3	5	8					
8 :	80	55	42	31	24	21	19	22	27							6	3	3	2	2	1	2	2	3	5	8					
9 :	76	55	41	30	24	21	19	20	25						15	7	4	3	2	2	2	2	2	3	5	8	11				
10 :	74	52	39	28	22	19	19	19	23	26	28	31	31	26	17	8	5	3	3	2	2	2	2	3	5	8	11	15			
11 :	74	52	36	27	21	18	18	19	21	23	26	29	30	27	19	10	5	4	3	2	2	2	3	3	5	8	11	15	19		
12 :	72	50	36	26	20	18	18	18	20	22	24	27	29	27	20	12	6	4	3	2	2	2	3	4	6	8	11	15	18	24	
13 :	73	49	35	25	19	17	17	18	19	21	23	25	28	27	22	14	8	5	4	3	2	2	3	4	6	8	10	14	18	24	34
14 :	72	48	33	23	18	17	17	17	19	20	22	24	26	27	23	16	9	6	4	3	3	3	3	5	6	8	10	13	17	24	34
15 :	72	48	33	23	18	16	16	17	18	20	21	23	25	26	24	18	11	7	5	3	3	3	3	5	7	9	10	12	16	23	35
16 :	72	46	32	22	17	16	16	16	17	19	21	22	24	25	24	19	12	8	5	4	3	3	4	5	7	9	11	12	16	23	36
17 :	73	47	31	21	17	16	16	16	17	18	20	21	23	25	24	19	14	9	6	4	4	3	4	6	8	9	11	13	16	23	36
18 :	74	47	30	20	16	15	16	16	17	18	19	20	22	24	24	20	14	10	7	5	4	4	4	6	8	10	11	13	18	23	36
19 :	74	46	29	19	15	15	15	15	16	17	19	20	21	23	24	20	15	11	8	6	5	4	5	7	9	10	11	14	19	24	37
20 :	75	47	29	19	15	15	15	15	16	17	18	19	21	23	24	21	15	11	9	6	5	5	5	7	9	10	11	14	20	25	36
21 :	77	47	28	18	15	14	15	15	15	16	17	19	20	21	23	21	16	12	9	7	6	5	6	8	10	11	12	15	20	26	36
22 :	79	48	28	18	14	14	15	15	14	15	17	18	19	20	22	21	17	12	10	8	7	6	6	8	10	11	13	16	21	28	37
23 :	80	48	28	17	14	14	14	15	14	15	16	18	19	19	21	21	18	13	10	8	7	7	7	9	10	12	13	17	22	29	39
24 :	83	49	27	17	14	14	14	14	14	14	16	17	18	18	20	21	19	14	10	9	8	7	8	9	11	12	14	17	23	31	40
25 :	86	50	27	16	13	13	14	14	14	14	15	17	18	18	19	21	20	14	11	10	9	8	8	9	11	13	14	18	25	33	42
26 :	90	51	27	16	13	13	14	14	14	13	15	17	18	17	18	20	19	15	11	11	10	9	9	10	11	13	15	19	28	36	43
27 :	95	53	27	16	13	13	13	14	14	13	14	17	18	17	17	19	19	15	12	11	11	9	9	10	12	14	15	20	31	37	43
28 :	101	56	28	16	13	12	13	14	14	13	13	16	17	17	16	17	18	15	13	12	11	10	10	11	12	14	16	23	32	38	44
29 :	108	61	29	16	13	12	12	14	14	12	13	16	17	16	16	16	17	16	13	13	12	11	10	11	13	15	18	25	34	40	44
30 :	116	67	31	16	13	12	12	13	13	12	12	15	17	16	15	16	17	16	14	14	13	11	11	12	13	15	19	27	35	41	45
31 :	123	75	34	17	14	12	12	13	13	12	12	14	16	16	15	15	16	16	15	14	13	12	11	13	14	16	21	29	37	42	45
32 :	131	85	39	18	14	12	11	12	13	12	12	14	15	16	15	14	15	16	15	15	14	13	12	13	14	16	22	31	38	43	46
33 :	137	94	46	21	16	12	11	12	12	12	12	13	15	16	15	14	15	16	16	16	15	13	13	14	15	18	25	32	38	43	46
34 :	141	104	56	24	18	12	11	11	12	12	12	13	14	16	16	15	15	16	16	16	15	14	14	15	15	19	27	33	39	44	46
35 :	146	111	65	30	19	13	12	11	12	12	13	13	14	15	16	15	16	16	17	17	16	15	15	16	16	21	28	34	41	45	47
36 :	150	118	73	38	21	13	12	12	12	12	13	13	14	15	15	16	16	17	17	17	17	15	16	16	17	23	29	35	42	46	47
37 :	155	124	80	47	24	15	12	12	12	12	13	13	14	15	16	16	17	17	18	18	18	16	17	17	19	24	30	37	43	47	47
38 :	156	133	91	57	28	16	13	12	12	12	13	14	14	15	16	16	17	18	18	19	18	17	17	18	20	25	31	38	44	47	46
39 :	155	140	102	68	33	18	14	12	12	12	13	14	15	15	16	17	17	18	19	19	19	18	18	19	21	26	33	39	45	47	45
40 :	151	145	114	80	41	21	15	13	12	12	13	14	15	16	16	17	18	19	19	20	20	19	20	20	22	27	34	41	45	46	45

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1969, arriving from sheltered approach direction of 261 deg azimuth, period = 20.5 sec, tide elevation = +8.0 ft MLLW.

J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				39	40	42									
2 :																			47	39	40	42	45								
3 :	113	112	113	117														57	44	38	37	38	44	6[illegible]							
4 :	111	110	111	113	115	113	117											58	43	36	34	36	42	61							
5 :	109	108	110	112	112	110	110	125	13[illegible]									61	44	37	36	35	42	61	84						
6 :	102	101	102	104	108	106	101	111	130									62	47	40	38	38	42	58	85	1[illegible]					
7 :	97	96	102	104	104	103	97	104	119								87	65	49	43	41	40	42	57	85	105					
8 :	97	93	98	99	99	99	96	101	113							109	90	67	52	45	44	43	45	57	82	102	1[illegible]				
9 :	94	93	98	99	99	99	95	98	108						116	109	91	70	54	48	47	46	48	59	80	98	107	1[illegible]			
10 :	92	91	94	95	95	94	95	96	103	107	103	102	106	111	115	109	93	73	57	51	50	48	51	61	77	92	104	110			
11 :	93	92	92	95	94	94	94	96	100	101	100	100	102	109	113	108	95	76	60	53	53	51	53	62	76	88	98	107	108		
12 :	91	90	92	93	92	93	94	96	98	99	98	98	101	106	111	108	96	78	63	56	55	53	55	63	75	85	94	107	107	107	
13 :	91	90	92	92	92	92	93	95	97	98	97	96	98	104	109	108	97	80	65	59	58	56	57	65	75	84	91	100	104	103	102
14 :	91	90	91	91	91	92	92	94	96	97	96	95	97	102	108	107	97	82	68	62	61	59	59	67	75	83	89	95	97	99	99
15 :	91	90	91	90	90	91	93	95	96	98	95	94	95	101	106	106	98	84	70	65	64	62	61	68	76	83	89	90	93	93	96
16 :	91	89	91	89	89	90	92	93	95	96	95	93	94	98	104	105	98	85	72	68	68	65	64	69	76	82	88	90	88	90	95
17 :	91	90	90	89	89	90	92	93	95	96	95	93	94	97	102	104	98	86	74	71	71	68	67	69	75	82	88	90	88	85	89
18 :	91	90	90	89	89	90	92	93	94	95	94	93	93	96	101	103	98	87	76	73	74	72	70	69	75	82	88	91	88	84	85
19 :	91	90	89	88	88	89	91	93	93	94	94	93	93	95	99	101	97	87	78	76	77	75	72	70	75	82	87	90	88	83	82
20 :	91	90	89	88	88	89	91	93	93	93	93	93	93	94	98	100	97	88	79	79	80	77	74	70	75	82	87	90	88	83	79
21 :	91	90	89	88	87	89	91	92	93	92	93	93	92	93	96	99	97	87	80	81	83	80	76	71	75	82	88	90	88	82	77
22 :	91	90	89	88	87	89	91	92	93	92	92	92	92	92	95	99	97	88	81	84	85	82	77	72	76	82	88	90	88	82	77
23 :	91	90	89	87	87	88	91	93	93	92	91	92	92	92	93	97	97	88	83	87	88	84	79	73	76	83	88	90	87	81	77
24 :	91	90	89	88	87	88	91	93	93	92	91	92	93	92	92	96	96	89	86	89	90	86	81	74	76	83	89	90	87	81	77
25 :	91	91	89	88	87	88	91	93	93	91	90	92	93	91	92	95	95	89	89	92	92	88	83	76	77	83	89	90	87	81	77
26 :	91	91	89	88	87	88	91	93	94	91	90	92	93	91	91	94	94	91	92	94	93	89	84	77	78	84	89	90	86	81	77
27 :	92	91	90	88	88	89	91	93	94	91	90	92	93	92	91	93	93	93	94	95	94	90	85	79	79	84	89	89	86	81	76
28 :	92	92	90	89	89	90	91	94	94	92	91	92	93	92	92	93	93	95	96	97	95	91	87	81	80	85	89	89	86	81	77
29 :	92	92	91	90	90	91	92	94	94	93	92	93	94	93	93	93	94	96	97	97	96	92	88	83	81	85	89	89	85	81	77
30 :	93	92	92	91	92	94	94	94	95	94	95	93	94	93	93	93	94	97	98	98	96	93	89	84	83	86	90	89	85	81	78
31 :	93	93	92	93	94	96	96	96	96	97	97	96	96	96	96	97	96	98	99	98	97	94	91	86	84	87	90	88	84	81	78
32 :	93	93	94	95	96	98	98	97	97	98	98	97	98	98	98	98	98	99	99	99	97	95	92	88	85	88	90	88	84	81	79
33 :	93	93	95	97	98	99	99	99	98	99	99	98	98	98	99	99	99	99	99	99	98	96	93	89	87	88	89	87	84	81	79
34 :	94	93	96	98	99	100	100	100	100	100	100	99	99	98	99	99	99	99	99	99	98	97	94	90	88	89	89	87	84	81	79
35 :	95	94	97	98	99	100	100	100	100	100	100	100	99	99	99	99	99	99	99	99	99	97	95	92	90	90	89	86	84	82	80
36 :	95	94	98	99	100	100	100	100	100	100	100	100	99	99	99	99	99	99	100	99	99	98	96	93	91	90	89	87	84	82	80
37 :	96	97	98	99	100	100	100	100	100	100	100	100	100	99	99	99	99	100	100	99	99	98	97	94	93	90	89	87	84	83	80
38 :	97	98	99	99	100	100	100	100	100	100	100	100	100	99	99	99	99	100	100	100	99	98	97	95	94	91	90	87	85	83	81
39 :	97	99	99	100	100	100	100	100	100	100	100	100	100	99	99	99	99	100	100	100	99	99	98	96	95	92	91	88	85	83	81
40 :	98	99	99	100	100	100	100	100	100	100	100	100	100	99	99	99	99	100	100	100	99	99	98	97	96	92	91	89	86	84	82

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of January 1916, arriving from sheltered approach direction of 245 deg azimuth, period = 9.6 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				21	23	26									
2 :																			23	21	23	26	30								
3 :	98	100	102	105														24	21	20	21	23	30	45							
4 :	97	98	101	102	103	100	106											25	21	20	20	22	28	45							
5 :	95	96	99	101	101	97	97	111	12									26	22	20	21	22	28	46	65						
6 :	88	89	93	95	97	95	89	97	113									27	23	21	22	23	28	44	65						
7 :	85	85	92	95	95	93	86	90	102								34	28	24	23	24	25	28	43	65	79					
8 :	85	83	88	91	91	89	85	86	95							44	36	29	25	24	25	26	30	42	62	76					
9 :	82	83	88	90	90	90	85	84	90						55	46	38	31	27	26	27	28	32	43	60	74	77				
10 :	81	81	85	88	87	86	85	83	86	87	82	79	75	67	57	47	39	33	28	27	28	29	34	44	58	68	74	74			
11 :	81	81	83	87	87	86	85	84	85	82	80	78	74	68	59	49	41	35	30	29	30	31	35	45	57	65	69	71	69		
12 :	80	80	84	85	85	85	84	84	84	81	78	76	74	69	61	51	43	37	32	30	32	32	37	46	56	63	66	71	68	65	
13 :	80	80	84	85	84	84	83	83	83	81	77	75	74	70	63	53	45	39	34	32	33	33	38	47	56	62	64	66	65	62	61
14 :	80	79	82	84	84	84	83	83	83	81	77	74	73	70	64	56	47	41	36	34	35	35	39	47	56	61	62	63	61	60	59
15 :	81	79	82	84	83	83	82	83	83	82	78	74	73	70	65	58	49	42	38	37	37	37	40	48	56	61	62	59	58	56	57
16 :	81	79	82	83	83	82	82	81	82	81	79	75	73	71	66	59	51	44	40	39	39	39	41	48	56	60	62	59	55	53	57
17 :	81	80	81	83	83	83	81	81	81	81	79	75	73	71	66	60	52	46	42	41	41	41	42	48	56	60	62	59	54	50	53
18 :	82	80	81	83	83	83	81	81	81	81	79	75	73	72	67	60	53	48	44	43	43	43	44	48	55	60	61	59	54	50	50
19 :	82	80	81	82	83	83	81	80	80	80	79	76	74	73	69	61	54	49	46	45	45	45	45	48	55	60	60	58	54	50	49
20 :	82	81	81	82	83	83	82	80	79	80	79	76	74	73	71	63	55	50	47	47	48	46	46	48	55	60	60	58	54	50	47
21 :	83	81	81	81	83	83	82	80	79	79	79	77	74	73	71	65	57	51	49	50	50	48	48	49	55	59	60	58	54	50	47
22 :	83	81	81	81	83	83	83	80	78	79	79	77	74	73	72	67	60	53	50	52	52	50	49	49	55	59	60	58	55	50	47
23 :	84	82	81	81	82	84	83	80	79	78	79	78	75	73	72	69	62	55	52	54	54	52	51	50	55	59	60	58	54	50	47
24 :	84	83	81	81	82	84	84	81	79	78	79	78	75	73	72	71	64	56	55	57	56	53	52	51	55	60	60	58	54	50	48
25 :	86	83	82	81	82	83	84	82	79	78	79	78	76	73	72	71	66	59	58	59	57	55	54	52	55	59	60	58	55	50	48
26 :	87	84	82	82	82	83	84	83	80	78	78	79	77	74	73	72	68	62	61	61	59	57	55	53	56	59	60	58	54	51	48
27 :	88	86	83	83	83	83	85	84	81	78	79	79	77	75	73	72	69	65	64	63	61	58	57	55	57	60	60	58	55	52	49
28 :	89	87	85	84	84	84	85	85	83	80	79	80	78	76	74	73	71	68	66	65	62	60	58	56	58	60	60	58	55	52	49
29 :	91	88	86	85	86	86	86	86	85	82	81	81	80	77	76	75	72	71	69	67	64	62	60	58	58	60	60	58	55	52	50
30 :	91	90	88	87	88	88	87	87	86	85	84	82	81	78	77	75	74	74	71	69	66	64	62	59	59	60	60	58	55	53	51
31 :	92	91	90	90	91	91	90	89	88	88	87	85	84	83	81	79	77	76	74	71	68	65	63	61	60	61	61	58	55	53	51
32 :	92	92	92	92	93	93	92	91	90	90	90	88	87	86	84	82	80	78	76	73	70	67	65	63	62	62	61	58	56	54	52
33 :	92	93	93	94	95	95	94	93	92	92	91	90	89	87	86	84	82	80	78	75	72	69	67	65	63	62	61	58	56	54	53
34 :	92	92	95	95	97	96	95	95	94	93	92	91	90	88	87	86	84	82	80	77	74	71	69	66	65	64	61	58	56	55	53
35 :	93	92	96	97	97	96	96	96	95	94	93	92	91	90	89	87	86	84	81	79	76	74	71	68	66	64	62	59	57	56	54
36 :	94	93	97	97	97	97	96	96	95	95	94	93	92	91	90	89	87	85	83	81	78	76	73	70	68	65	63	59	58	56	55
37 :	95	96	97	98	98	97	97	96	96	95	95	94	93	92	91	90	88	87	85	83	80	78	75	72	70	66	64	60	58	57	56
38 :	96	97	98	98	98	97	97	97	96	96	95	95	94	93	92	91	89	88	86	84	82	80	77	74	72	68	65	61	59	58	56
39 :	97	98	98	99	98	98	97	97	97	96	96	95	95	94	93	92	90	89	88	86	84	82	79	77	74	69	66	63	60	59	57
40 :	97	99	99	99	98	98	98	97	97	97	96	96	95	94	94	93	91	90	89	87	86	84	82	79	76	71	68	64	61	60	58

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1914, arriving from sheltered approach direction of 214 deg azimuth, period = 9.9 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				7	7	8									
2 :																			8	7	7	8	8								
3 :	146	143	143	148														8	7	6	7	7	8	12							
4 :	143	140	141	141	140	130	128											9	7	6	6	6	8	12							
5 :	140	138	139	139	136	127	118	123	12									9	7	6	6	6	8	12	19						
6 :	129	127	128	129	131	123	107	107	116									10	7	6	6	6	8	11	20						
7 :	122	119	128	129	126	119	103	100	104								16	11	8	7	6	7	8	12	21	32					
8 :	122	114	121	122	119	113	101	96	97							33	18	12	9	7	7	7	8	12	22	33					
9 :	117	115	121	121	119	114	101	93	92						62	37	21	14	9	8	7	8	9	13	22	33	43				
10 :	114	111	115	116	113	108	100	91	86	81	74	76	81	80	66	42	24	16	11	9	8	8	10	14	22	32	42	53			
11 :	114	111	111	116	113	108	100	90	83	74	69	71	77	79	68	46	27	18	12	9	9	9	11	15	22	31	41	53	63		
12 :	111	108	112	112	110	107	100	90	81	71	66	67	74	78	71	51	31	20	14	10	10	10	12	16	24	31	41	53	62	73	
13 :	112	108	112	112	109	107	99	90	80	70	63	63	70	75	72	55	34	23	16	11	11	11	13	18	25	31	40	50	61	72	84
14 :	110	106	109	109	108	106	99	89	79	68	61	60	66	73	72	59	38	26	18	13	12	12	14	19	26	32	39	48	58	71	84
15 :	110	106	109	109	108	106	100	91	79	68	59	57	63	70	72	62	43	29	20	15	13	13	15	21	27	34	39	45	56	69	85
16 :	109	105	109	106	106	104	99	89	77	66	58	55	59	67	70	63	47	32	23	17	15	14	16	23	29	34	39	45	54	69	85
17 :	110	105	106	106	106	105	100	90	77	65	58	54	58	65	69	64	49	35	25	19	17	15	17	24	30	35	40	46	54	66	82
18 :	110	106	106	106	107	106	101	91	77	65	55	52	55	62	68	64	51	37	28	21	19	17	19	26	31	36	40	48	57	65	80
19 :	109	105	104	104	105	105	101	90	76	63	55	51	54	60	66	63	51	39	30	23	21	19	21	27	32	36	40	48	59	66	77
20 :	109	105	105	104	105	106	102	91	76	62	53	50	52	58	64	63	52	40	32	25	23	21	23	28	34	37	41	50	61	66	73
21 :	110	106	103	103	104	105	102	91	75	60	52	50	50	54	62	63	54	41	33	28	25	24	25	30	35	38	42	52	62	66	71
22 :	110	106	104	103	105	106	103	91	75	59	50	48	48	52	59	63	56	42	34	30	28	26	26	31	35	39	44	54	63	67	71
23 :	109	105	104	102	103	106	103	93	75	58	49	48	48	50	56	62	58	44	34	32	31	28	28	32	36	40	45	55	63	68	70
24 :	110	106	102	102	104	106	103	93	75	57	47	46	47	48	53	60	58	45	36	34	33	31	30	32	37	41	46	57	64	68	69
25 :	109	105	102	101	103	106	105	95	76	56	46	45	47	47	50	58	58	46	37	37	36	33	32	33	37	42	48	58	66	68	68
26 :	108	105	101	101	103	106	105	96	76	55	45	45	46	46	48	55	57	47	39	39	39	35	34	34	38	43	49	59	68	69	66
27 :	108	105	101	100	103	106	105	96	76	54	43	44	46	45	46	53	56	48	41	42	41	37	35	36	39	43	50	61	70	69	64
28 :	107	104	100	99	103	105	104	97	77	53	42	43	44	44	45	50	53	48	44	44	43	40	37	37	39	44	52	64	70	67	63
29 :	107	104	99	99	103	105	104	95	76	53	41	42	43	44	44	47	51	49	46	47	46	42	38	38	40	44	54	65	70	66	61
30 :	105	104	99	98	103	106	104	95	76	53	40	41	43	43	44	46	50	49	49	49	48	44	40	40	41	46	57	66	69	65	60
31 :	104	104	99	97	103	107	105	94	75	54	41	40	41	42	43	44	47	50	51	51	49	45	41	41	42	47	59	67	68	64	58
32 :	102	102	98	97	105	110	106	94	75	55	42	39	40	42	43	44	47	50	53	53	51	47	43	42	42	48	60	67	67	62	57
33 :	101	101	97	98	106	113	109	95	76	56	43	39	40	42	44	45	48	52	54	55	53	49	45	44	43	50	62	67	65	60	56
34 :	99	99	96	98	109	116	112	97	77	58	44	39	39	42	44	46	49	53	56	57	55	51	47	45	44	52	63	65	63	59	54
35 :	98	97	94	99	110	118	116	101	79	59	46	40	39	41	44	47	51	55	57	58	56	53	49	46	45	55	63	64	62	58	53
36 :	97	95	93	99	110	119	118	105	82	62	47	41	39	41	44	48	52	56	58	60	58	54	51	47	47	56	62	63	61	57	52
37 :	97	93	92	99	110	120	121	108	86	64	49	41	40	42	45	49	53	57	60	61	60	56	52	48	49	56	61	62	60	55	50
38 :	96	93	92	99	109	119	122	112	90	67	50	42	41	42	46	50	54	58	61	63	61	58	54	50	50	57	61	61	58	54	49
39 :	96	93	92	98	108	119	123	115	94	70	52	43	41	43	46	50	55	59	63	64	63	60	56	52	51	57	61	60	57	52	48
40 :	95	94	93	98	107	118	124	118	99	74	55	44	42	43	47	51	56	60	64	66	65	61	58	53	52	57	60	59	55	50	47

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of February 1926, arriving from sheltered approach direction of 251 deg azimuth, period = 16.0 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				12	13	14									
2 :																			14	12	13	14	15								
3 :	121	116	114	116														17	13	12	12	12	15	20							
4 :	118	114	112	112	113	112	123											18	13	11	10	11	14	20							
5 :	116	111	110	109	109	108	113	139	16									20	13	10	10	11	14	21	32						
6 :	107	103	101	101	104	104	102	122	154									21	14	11	11	12	14	20	33						
7 :	101	97	101	100	100	100	97	113	140								39	22	15	12	12	12	14	20	35	51					
8 :	101	93	96	94	94	95	95	108	131							89	44	24	17	13	12	13	14	20	35	52					
9 :	97	93	95	94	93	94	94	104	125						135	95	50	26	18	14	13	14	15	22	36	51	64				
10 :	94	90	91	89	88	88	93	101	118	132	133	136	143	147	135	100	56	30	20	16	15	15	17	23	35	49	63	77			
11 :	95	91	88	89	87	87	91	100	114	122	128	131	136	142	134	104	62	33	22	17	16	16	19	25	36	47	61	76	87		
12 :	93	88	88	85	84	86	90	99	110	119	125	127	133	138	133	108	68	37	24	19	18	17	20	26	37	47	60	76	87	99	
13 :	93	89	88	85	83	85	89	98	108	117	122	124	128	134	131	110	73	42	27	20	19	19	21	29	38	47	58	72	85	98	111
14 :	91	87	86	82	81	83	88	96	107	116	120	121	125	130	129	111	77	46	30	23	21	20	23	31	40	48	57	68	80	96	110
15 :	92	87	86	82	80	82	88	97	107	116	118	120	123	128	128	112	81	50	33	25	23	22	25	33	42	49	56	65	78	93	110
16 :	91	86	86	80	78	80	86	95	105	113	118	117	119	123	123	112	85	54	36	28	26	24	26	35	43	49	56	64	75	92	110
17 :	91	87	84	80	78	80	86	95	105	113	118	117	119	121	121	111	86	58	39	30	28	27	29	37	44	51	57	65	75	88	105
18 :	92	87	84	79	77	80	86	95	104	113	115	116	117	118	119	110	87	61	42	33	31	30	31	39	46	51	57	67	78	87	102
19 :	91	86	82	78	76	78	84	93	103	110	115	116	117	117	115	107	86	62	44	35	34	32	34	41	47	51	57	68	80	86	99
20 :	91	87	82	77	75	78	85	94	103	110	113	116	116	115	114	105	86	63	46	38	37	36	37	42	48	52	57	70	82	87	93
21 :	91	87	81	76	74	76	83	93	102	108	113	116	115	112	110	103	87	64	47	41	41	39	39	44	49	52	59	72	83	87	91
22 :	92	88	82	76	74	76	83	92	101	107	110	114	114	110	106	102	88	64	48	43	44	42	41	45	50	53	60	74	84	88	90
23 :	91	87	82	75	73	75	82	93	102	107	110	114	114	110	104	100	88	65	48	46	47	45	44	45	50	55	62	75	84	88	89
24 :	91	87	81	75	73	75	81	92	102	105	108	112	115	108	101	97	86	65	50	49	51	48	46	46	50	56	64	77	85	88	88
25 :	91	87	80	74	72	74	82	93	102	105	107	111	114	108	98	95	86	65	52	52	54	51	48	47	51	57	65	78	87	88	87
26 :	90	87	80	74	72	74	81	93	102	104	105	111	115	107	96	92	83	65	54	55	57	54	50	49	51	57	66	80	89	89	85
27 :	90	86	80	74	72	74	81	92	102	103	104	110	114	106	95	88	81	66	57	58	59	56	52	50	52	58	68	82	91	89	82
28 :	90	86	80	73	71	73	80	92	102	102	102	109	112	105	93	85	78	66	60	61	62	58	54	52	53	59	70	84	91	87	81
29 :	89	86	79	73	71	74	80	91	101	101	101	109	111	104	92	82	75	66	63	64	64	60	56	53	54	60	73	86	90	86	80
30 :	89	86	79	73	72	75	80	90	99	100	101	109	110	103	91	80	73	67	65	66	65	62	58	55	55	62	76	87	89	85	79
31 :	88	86	79	73	73	76	81	89	97	101	103	108	109	102	91	79	72	68	67	68	67	64	60	56	56	63	78	88	88	84	78
32 :	88	86	79	74	75	79	83	89	96	101	105	108	109	103	92	80	72	69	69	69	68	66	62	58	57	65	80	88	87	81	77
33 :	87	86	79	76	77	81	85	89	96	102	107	109	109	103	92	81	73	71	70	70	70	68	64	60	58	68	82	87	85	80	75
34 :	87	85	80	78	81	85	87	91	96	103	110	111	109	102	91	82	75	72	71	71	71	69	66	61	60	70	83	86	83	79	74
35 :	86	85	80	80	83	86	89	93	98	104	111	114	110	101	91	82	76	72	71	72	72	71	68	63	62	73	83	84	82	78	73
36 :	86	84	81	82	84	87	90	94	98	105	112	115	111	102	91	82	76	73	72	73	73	73	70	65	65	75	82	83	81	77	72
37 :	86	84	82	83	86	89	91	94	99	106	113	116	112	103	92	82	76	73	72	74	75	74	72	67	67	76	82	82	80	76	71
38 :	87	85	84	85	87	90	92	95	100	107	114	117	113	104	92	82	76	73	73	74	76	76	74	69	69	76	81	82	79	75	69
39 :	87	86	85	86	88	91	93	96	100	107	114	118	113	103	91	82	76	73	74	75	77	77	76	71	70	77	82	81	78	73	69
40 :	87	87	86	87	89	91	94	96	101	108	115	118	113	103	91	81	76	73	74	76	78	79	78	73	72	77	82	80	76	72	68

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of April 1926, arriving from sheltered approach direction of 259 deg azimuth, period = 13.8 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				21	23	24									
2 :																			25	21	23	24	26								
3 :	121	118	119	123														30	23	20	21	22	25	35							
4 :	118	116	117	119	122	121	129											31	22	20	18	20	24	36							
5 :	116	114	115	117	119	117	120	139	157									33	23	19	19	19	24	36	55						
6 :	107	105	106	108	114	113	108	122	144									35	25	21	20	21	24	34	57						
7 :	102	99	106	108	109	110	104	114	131								58	37	27	22	21	22	24	35	59	81					
8 :	102	96	100	102	103	104	102	109	124							94	62	40	29	24	23	23	25	35	58	80					
9 :	98	96	100	102	103	104	102	106	118						120	97	67	43	31	26	25	25	27	37	58	78	93				
10 :	96	93	96	97	98	99	101	103	112	117	112	112	118	124	120	100	71	47	33	28	27	27	29	39	56	74	91	105			
11 :	96	93	93	97	97	98	100	103	108	108	108	108	113	120	118	102	76	51	36	30	29	29	32	41	56	71	87	103	111		
12 :	94	91	93	94	94	97	99	102	105	106	105	104	109	117	117	104	79	55	39	32	32	31	34	43	56	69	84	103	111	116	
13 :	95	92	93	93	93	96	98	101	104	104	102	101	106	113	116	105	82	59	43	35	34	33	36	45	57	68	81	97	108	112	116
14 :	93	90	91	91	92	95	97	100	103	103	101	99	103	109	114	106	85	63	46	38	37	35	38	48	58	68	79	92	101	109	112
15 :	94	90	91	91	91	94	98	101	103	104	99	97	100	107	113	107	88	66	49	41	40	38	40	50	59	68	79	87	97	103	110
16 :	93	89	91	89	89	92	96	99	101	101	99	96	97	103	109	106	90	69	52	44	43	41	42	51	60	68	78	86	92	99	108
17 :	93	90	89	88	89	92	96	99	101	101	99	95	96	101	107	105	91	72	55	48	47	44	45	52	60	68	79	87	91	93	101
18 :	94	90	89	88	89	92	96	99	101	100	97	94	94	99	105	104	92	74	58	51	51	48	48	53	60	68	78	89	92	92	96
19 :	93	90	88	87	87	91	95	98	99	98	96	94	94	97	102	102	91	75	61	54	54	52	51	54	61	68	78	88	92	90	92
20 :	93	90	88	86	87	91	95	99	99	97	95	94	93	95	101	101	91	76	63	57	58	55	53	55	61	69	78	89	93	90	87
21 :	94	91	87	85	86	90	95	98	98	96	94	94	92	93	98	100	92	77	64	60	62	59	55	56	61	69	79	90	93	88	85
22 :	94	91	88	85	86	89	95	98	98	95	93	92	91	91	95	99	93	77	65	64	65	62	57	56	61	70	81	91	93	88	84
23 :	93	90	88	85	85	89	94	98	98	95	92	92	91	90	92	97	94	78	67	67	69	65	60	57	61	71	82	91	91	87	82
24 :	94	91	87	85	85	88	93	98	98	94	91	91	91	89	90	95	93	79	69	71	72	68	62	58	62	72	83	91	91	85	82
25 :	93	91	87	84	84	88	93	99	98	93	90	90	91	88	88	93	93	80	72	75	75	70	64	59	62	72	84	92	91	85	81
26 :	93	91	87	84	84	87	93	98	98	93	89	90	91	87	86	91	91	81	76	78	78	72	65	60	63	73	84	91	90	85	80
27 :	93	91	87	84	84	87	92	98	98	92	88	90	90	87	85	89	90	82	79	81	80	74	67	61	64	74	85	91	90	85	79
28 :	93	91	87	84	84	87	92	98	98	92	87	89	89	86	85	87	88	84	83	84	82	76	69	63	65	74	86	91	89	83	79
29 :	93	91	87	84	85	88	92	97	98	92	88	89	89	86	85	86	87	86	86	86	83	78	71	64	66	75	87	91	88	83	79
30 :	93	91	87	85	86	89	92	96	97	93	89	89	89	86	85	85	86	87	89	88	85	79	72	66	67	77	88	91	87	82	78
31 :	93	91	88	86	88	92	94	97	97	95	92	90	89	88	86	86	86	89	91	89	86	81	74	68	68	78	88	90	86	82	79
32 :	93	91	89	88	90	94	96	97	97	96	94	91	90	90	89	89	89	90	92	91	87	82	76	69	70	79	88	89	85	81	79
33 :	92	91	89	90	93	97	98	98	98	98	96	92	91	90	90	91	91	92	93	91	88	84	78	71	71	80	88	88	83	80	78
34 :	92	91	90	92	96	99	99	100	100	99	98	94	92	90	90	92	93	93	93	92	89	85	80	73	73	82	88	86	83	80	78
35 :	92	91	91	94	97	99	101	102	101	100	99	96	93	90	91	92	93	94	94	93	90	87	81	75	75	83	87	85	82	80	78
36 :	93	91	92	95	98	100	101	102	102	101	99	97	94	92	91	93	94	94	94	93	91	88	83	77	77	83	87	84	82	80	79
37 :	93	92	94	96	98	100	101	102	103	102	100	97	95	93	92	93	94	95	95	94	92	89	85	78	79	84	86	84	82	80	79
38 :	94	94	95	97	99	100	101	103	103	102	100	98	95	93	93	93	94	95	95	94	93	90	86	80	80	84	86	84	82	80	79
39 :	94	96	96	97	99	100	102	103	103	103	101	98	95	93	93	93	94	95	96	95	93	91	87	82	81	84	86	84	81	80	79
40 :	95	97	97	98	99	100	102	103	103	103	101	98	96	94	93	94	95	96	96	95	94	92	89	84	83	84	86	84	81	80	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of March 1952, arriving from sheltered approach direction of 245 deg azimuth, period = 11.7 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				5	6	8									
2 :																			6	5	6	6	7								
3 :	138	140	148	160														7	6	5	5	6	7								
4 :	135	137	145	154	163	161	168											7	5	5	5	5	6	9							
5 :	132	134	142	152	158	157	155	166	16									7	6	5	5	5	6	10	15						
6 :	121	123	130	139	152	152	140	146	156									8	6	5	5	5	6	9	16						
7 :	114	115	130	139	146	148	135	137	142								13	9	6	5	5	5	6	9	17	28					
8 :	114	110	122	131	137	140	133	132	134							26	15	10	7	6	5	6	6	9	17	27					
9 :	108	110	121	130	137	141	133	129	129						50	30	17	11	7	6	6	6	7	10	18	26	35				
10 :	105	106	116	124	130	133	132	126	121	109	87	76	72	67	54	33	19	12	8	7	6	7	8	11	18	26	35	46			
11 :	105	105	111	123	129	133	132	126	118	100	83	72	68	66	56	37	22	14	10	7	7	7	9	12	18	25	34	45	55		
12 :	102	102	111	118	125	132	132	126	115	97	80	68	66	65	58	41	25	16	11	8	8	8	9	13	19	25	34	46	55	68	
13 :	102	102	110	117	124	131	131	126	114	96	78	65	62	63	59	45	28	19	13	9	8	9	10	14	20	26	33	43	54	67	83
14 :	100	99	106	113	122	130	130	125	113	95	76	62	59	61	59	48	31	21	14	10	9	9	11	16	21	27	33	41	51	66	84
15 :	100	99	106	112	121	129	133	128	115	96	74	60	57	59	59	50	35	23	16	12	10	10	12	17	22	28	33	39	50	65	85
16 :	98	97	105	109	118	127	131	126	113	94	74	58	54	56	57	51	38	26	18	13	12	11	13	19	23	28	33	39	48	65	85
17 :	99	97	102	108	117	127	132	128	113	94	73	58	52	54	56	51	40	28	20	15	13	12	14	20	25	29	34	40	49	63	84
18 :	99	97	101	107	117	128	134	129	114	93	71	56	50	52	55	52	41	30	22	17	15	14	16	21	26	30	34	41	52	63	83
19 :	97	95	99	104	114	126	132	128	113	91	71	55	49	50	53	51	41	31	24	19	17	15	17	23	27	31	34	42	55	64	81
20 :	97	95	98	103	114	126	134	130	114	91	68	54	48	48	52	51	42	32	26	20	18	17	19	23	28	32	35	45	57	66	78
21 :	98	96	96	101	111	124	133	130	113	89	67	54	46	45	50	50	43	33	27	22	20	19	20	25	29	32	36	47	58	67	76
22 :	98	95	95	100	110	124	135	131	113	88	65	52	45	43	47	50	45	34	27	24	23	21	22	26	30	33	38	49	60	69	77
23 :	97	94	95	98	108	122	134	133	115	87	64	51	44	42	45	49	46	35	28	26	25	23	23	27	31	35	40	50	61	70	77
24 :	97	94	93	97	107	122	133	134	115	86	62	49	44	40	42	47	46	36	29	27	27	25	25	27	31	36	41	52	63	71	77
25 :	96	93	91	95	105	120	135	137	117	86	61	48	43	39	40	46	46	37	30	29	29	27	27	28	32	37	42	54	66	73	77
26 :	95	92	90	93	103	119	134	137	118	84	59	48	43	38	38	44	45	37	31	32	31	29	28	29	33	38	44	55	69	75	76
27 :	95	92	89	92	102	117	133	138	119	83	57	47	42	38	37	41	44	38	33	34	33	31	30	31	34	39	45	58	72	76	74
28 :	94	91	88	89	100	114	132	139	120	82	54	45	41	37	36	39	42	38	35	36	35	33	31	32	35	39	47	62	73	75	74
29 :	93	91	86	88	98	113	130	137	119	82	53	44	39	36	35	37	40	38	37	38	37	35	32	33	36	40	50	65	74	75	73
30 :	92	90	85	86	97	112	129	136	119	82	52	43	39	36	35	36	39	39	38	39	39	36	34	35	37	41	54	67	74	75	72
31 :	91	90	84	84	95	112	128	134	118	83	53	42	37	35	34	34	37	39	40	41	41	38	36	36	38	43	56	69	75	75	71
32 :	90	89	83	83	95	112	128	133	118	84	54	41	36	35	34	34	36	39	42	43	42	40	37	38	39	45	59	70	74	73	71
33 :	89	88	82	82	94	113	129	133	118	86	56	41	35	35	35	35	37	40	43	44	44	42	39	39	40	47	62	71	73	72	69
34 :	88	87	81	82	95	114	130	135	119	88	58	41	35	34	35	36	38	41	44	46	45	43	41	41	41	50	64	71	73	72	68
35 :	87	85	80	82	95	114	132	137	121	91	60	42	35	34	35	36	39	42	45	47	47	45	43	42	43	53	65	70	72	71	67
36 :	86	84	80	83	94	112	131	139	125	94	62	43	35	34	35	37	40	43	46	49	49	47	45	44	45	55	65	70	72	70	66
37 :	86	82	79	83	94	111	131	140	128	97	64	44	36	34	35	38	41	44	48	50	50	49	47	45	47	57	65	70	72	70	64
38 :	85	82	80	84	93	109	129	141	132	101	67	45	36	35	36	39	42	45	49	51	52	50	49	47	49	58	66	70	71	68	62
39 :	85	82	80	84	93	107	127	141	135	106	70	46	37	35	37	39	43	46	50	53	54	52	52	49	50	59	67	71	70	67	61
40 :	85	83	81	85	92	105	125	141	138	110	73	48	37	36	37	40	43	47	51	54	55	54	54	51	52	60	67	70	69	65	59

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of December 1937, arriving from sheltered approach direction of 258 deg azimuth, period = 16.4 sec, tide elevation = +8.0 ft MLLW.

Swell from storm of August 1972 (deep water approach azimuth = 156 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				7	7	8									
2 :																			7	7	7	8	8								
3 :	72	72	76	81														8	7	6	6	7	8	12							
4 :	70	71	74	78	81	81	89											8	6	6	6	6	8	12							
5 :	68	69	73	77	79	79	81	97	114									9	7	6	6	6	8	12	24						
6 :	63	63	67	71	76	76	73	83	102									10	7	6	6	6	8	12	25						
7 :	59	59	67	71	73	74	69	76	90								14	10	8	7	6	7	8	12	26	47					
8 :	59	57	63	67	69	70	68	72	83							23	16	11	8	7	7	7	8	12	26	47					
9 :	57	57	63	66	69	70	67	69	78						38	25	17	12	9	8	7	8	9	13	27	46	70				
10 :	55	55	60	63	65	66	66	67	72	77	74	72	68	57	41	27	19	14	10	8	8	8	10	15	26	45	69	92			
11 :	55	55	58	63	65	65	65	66	70	70	71	70	67	58	44	30	21	16	11	9	9	9	11	16	27	43	67	91	104		
12 :	54	53	58	61	63	64	65	66	68	68	68	68	66	60	47	33	23	17	13	10	10	10	12	16	28	44	67	93	105	110	
13 :	54	53	57	60	62	64	64	65	66	67	66	66	65	61	50	36	25	19	14	11	11	11	13	18	29	44	65	88	102	106	106
14 :	53	52	56	59	61	63	63	63	65	66	65	64	64	61	52	39	28	21	16	12	12	12	14	20	30	45	64	84	96	103	102
15 :	53	52	56	58	61	62	63	63	65	66	64	63	63	61	54	42	30	23	18	14	13	13	15	22	31	47	65	80	92	96	99
16 :	53	51	55	57	59	61	61	62	63	64	64	62	61	60	54	44	33	25	19	15	14	14	16	23	33	47	66	80	87	92	97
17 :	53	51	54	57	59	61	61	61	62	63	63	61	61	60	55	45	35	27	21	17	16	15	17	24	34	49	67	81	85	85	89
18 :	54	51	53	56	59	61	62	61	61	63	62	60	60	59	56	46	36	29	23	19	18	17	19	26	35	49	68	83	87	84	83
19 :	54	51	52	55	58	61	61	60	59	61	61	60	60	60	57	47	36	30	25	21	20	19	21	27	36	51	69	84	86	81	78
20 :	54	51	52	55	58	61	61	60	59	60	60	60	59	59	58	49	37	31	27	23	21	21	22	28	37	53	70	84	87	80	73
21 :	54	52	52	54	57	60	61	59	58	58	60	60	58	58	58	51	40	32	28	24	24	23	24	29	39	54	72	85	86	77	70
22 :	55	52	51	53	57	60	61	59	57	57	59	59	56	56	57	53	43	32	28	26	26	25	25	30	40	56	74	86	86	76	69
23 :	56	52	51	52	55	59	61	59	57	57	58	59	56	55	56	54	45	34	29	28	28	27	27	31	41	58	76	86	83	74	67
24 :	57	52	51	52	55	59	61	59	56	55	57	58	56	54	55	55	47	35	31	30	30	29	29	32	42	61	78	87	83	72	66
25 :	58	53	51	51	54	58	61	60	57	55	57	58	56	53	53	55	49	37	32	32	32	31	30	34	43	62	79	87	82	71	64
26 :	59	54	51	51	53	57	60	61	57	54	56	58	56	52	52	54	51	39	34	35	34	32	32	35	45	64	80	85	80	70	63
27 :	61	55	51	51	53	56	60	61	57	53	55	58	56	52	50	53	51	41	36	37	36	34	34	37	47	65	81	84	79	70	61
28 :	64	56	52	51	53	55	59	61	58	53	54	57	56	51	49	51	51	43	39	39	38	36	36	39	49	67	81	84	77	67	61
29 :	66	59	53	51	53	54	58	60	58	53	53	57	56	51	49	50	50	45	41	41	40	38	37	40	50	68	82	83	75	66	61
30 :	69	62	55	52	53	54	57	60	59	54	53	57	56	52	49	49	49	46	44	43	42	40	39	42	52	69	82	82	73	66	61
31 :	71	65	57	53	54	55	57	59	59	55	54	57	57	53	49	48	48	48	46	45	44	42	41	44	54	71	82	80	71	65	61
32 :	73	68	60	55	55	56	57	59	59	56	55	57	57	55	52	49	49	49	48	47	46	44	43	46	56	72	81	78	70	63	61
33 :	74	70	63	57	58	57	57	59	59	58	56	57	58	56	54	52	51	51	50	49	47	46	46	48	57	73	81	76	68	62	60
34 :	74	72	66	60	61	60	59	60	60	60	58	58	58	57	55	54	53	53	51	50	49	48	48	50	59	74	80	74	66	62	60
35 :	76	72	69	63	63	62	61	61	61	61	61	60	59	57	56	56	55	54	53	52	51	50	50	52	61	74	79	72	66	62	60
36 :	78	73	71	67	65	63	62	62	62	63	62	62	60	59	58	57	56	55	54	54	53	52	52	53	63	75	77	70	65	62	60
37 :	83	75	73	70	67	65	63	63	63	64	64	63	63	61	60	59	58	57	56	55	55	54	54	55	64	75	76	69	64	62	60
38 :	88	78	76	73	69	66	65	64	64	65	65	65	64	63	62	61	60	58	57	57	56	56	57	57	65	75	75	68	64	62	60
39 :	93	83	79	77	72	68	66	65	65	66	66	66	66	65	64	62	61	60	59	58	58	58	59	59	66	74	74	68	63	62	61
40 :	98	89	83	81	75	71	68	67	66	66	67	68	67	66	65	64	62	61	60	60	59	60	61	61	67	74	74	68	63	61	61

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for storm swell of September 1963, arriving from sheltered approach direction of 208 deg azimuth, period = 14.5 sec, tide elevation = +8.0 ft MLLW.

Swell from storm of September 1982 (deep water approach azimuth = 158 deg), period = 17.5 sec, could not reach Redondo Beach King Harbor, California, breakwater.

APPENDIX D

ANNUAL SEA

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = 0.0 ft MLLW

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				40	46	51									
2 :																			55	40	46	51	49								
3 :	148	145	145	158														67	45	36	35	34	41	6[illegible]							
4 :	140	137	138	140	146	139	163											66	42	33	30	31	36	61							
5 :	133	131	133	135	134	127	127	165	19[illegible]									70	43	32	31	30	35	58	100						
6 :	114	112	114	115	122	117	103	122	160									71	45	35	33	32	35	46	95	[illegible]					
7 :	104	103	114	115	114	110	97	108	133								109	74	48	38	35	34	35	45	94	143					
8 :	105	98	105	105	104	101	95	102	122							131	110	77	51	41	38	36	37	46	85	126	[illegible]				
9 :	99	98	105	105	103	101	94	98	114						128	128	111	81	54	43	41	39	40	49	82	111	133	[illegible]			
10 :	96	95	99	99	97	93	93	94	105	114	107	104	106	113	123	125	112	84	58	46	44	42	43	54	75	97	120	144			
11 :	96	95	96	99	96	93	91	93	100	102	104	101	102	109	119	123	112	87	61	49	47	44	46	56	74	88	108	131	150		
12 :	94	93	96	95	93	92	91	93	97	100	101	99	100	106	116	121	112	90	64	51	50	47	49	58	74	85	101	129	142	164	
13 :	94	93	96	95	91	90	89	92	96	99	99	97	98	104	113	119	112	91	67	55	53	49	52	61	74	83	93	111	128	141	161
14 :	92	91	93	92	90	89	88	91	95	98	98	96	96	101	111	117	111	93	70	58	56	53	54	64	74	82	90	101	112	127	151
15 :	93	92	93	92	89	88	89	92	95	98	96	95	95	101	110	115	110	94	72	61	60	56	57	66	75	82	88	94	103	113	139
16 :	92	91	93	90	87	87	87	90	93	96	97	94	94	98	106	113	110	94	74	64	63	60	60	68	75	80	87	92	96	108	130
17 :	92	91	91	89	87	86	87	90	93	96	96	94	94	97	104	111	108	94	76	66	66	64	64	69	75	80	87	93	95	98	115
18 :	92	91	91	89	87	86	88	90	93	96	95	93	93	96	103	109	107	94	77	69	70	69	68	70	75	79	86	94	97	96	110
19 :	91	90	90	88	86	85	86	89	92	94	95	94	93	95	100	106	105	94	78	71	73	72	72	71	75	79	85	93	97	94	103
20 :	91	91	90	88	85	85	86	89	92	94	93	94	93	94	99	103	103	93	78	74	77	76	75	71	75	79	85	94	98	95	95
21 :	92	91	89	87	84	84	86	89	92	93	93	94	93	93	96	102	103	92	78	76	80	90	77	73	75	79	86	95	98	93	91
22 :	92	91	89	86	84	84	86	88	92	93	92	93	93	93	95	101	102	91	78	79	84	83	79	73	75	79	87	95	97	93	91
23 :	91	90	89	86	84	83	85	89	92	93	92	92	93	93	94	100	101	90	80	83	87	86	82	74	75	80	88	95	96	92	89
24 :	91	91	89	86	84	84	85	89	92	92	91	91	93	93	93	98	99	90	82	86	90	88	84	75	75	80	88	96	96	91	89
25 :	91	90	88	86	84	83	86	90	93	92	90	91	93	93	92	97	98	89	85	89	92	90	85	76	75	81	89	96	96	91	87
26 :	91	90	88	85	83	83	86	90	93	92	89	91	93	93	92	96	96	90	88	92	94	92	87	77	76	81	89	95	96	91	86
27 :	91	90	88	85	84	84	86	91	93	91	89	91	93	93	92	94	94	91	91	94	95	93	88	79	77	82	90	95	96	90	85
28 :	91	90	88	85	84	85	87	91	93	91	89	91	93	93	92	93	93	92	94	96	96	94	89	80	77	82	91	96	95	89	84
29 :	91	91	88	86	85	87	88	91	93	92	91	92	94	94	93	93	93	94	96	97	97	95	90	82	78	83	92	96	94	88	84
30 :	91	91	89	87	87	89	90	92	93	93	93	93	94	94	93	93	93	96	97	98	97	95	91	83	79	84	93	95	92	88	84
31 :	91	91	89	89	90	92	93	94	94	95	96	95	96	97	97	97	95	97	98	98	97	96	92	85	81	85	93	95	91	87	83
32 :	91	91	91	91	92	94	95	95	95	96	98	97	98	99	99	99	98	98	98	98	98	96	93	86	82	86	93	94	90	86	84
33 :	91	91	91	93	95	97	97	97	96	98	99	98	99	100	100	100	99	99	98	98	98	97	94	88	83	88	93	93	89	85	83
34 :	92	91	93	95	97	98	98	98	98	99	100	100	100	100	100	100	99	99	98	98	98	97	95	89	85	89	93	91	88	85	83
35 :	92	91	94	96	97	98	99	99	99	100	100	100	100	100	100	100	99	99	98	98	98	97	96	90	87	90	92	90	88	85	83
36 :	93	92	95	97	98	99	99	99	100	100	100	101	101	101	100	100	99	99	98	98	98	98	96	92	89	90	92	90	88	86	83
37 :	94	95	97	98	98	99	99	99	100	100	100	101	101	101	101	100	99	99	98	98	98	98	97	93	91	91	91	89	87	86	83
38 :	95	97	98	98	99	99	99	100	100	100	101	101	101	101	101	100	99	99	98	98	98	98	97	94	92	91	91	90	87	85	83
39 :	96	98	98	99	99	99	99	100	100	100	101	101	101	101	101	100	99	99	98	98	98	98	98	95	93	91	92	90	87	85	83
40 :	96	98	99	99	99	99	100	100	100	100	101	101	101	101	100	100	99	99	98	98	99	99	98	96	95	92	92	90	87	85	83

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 10 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				21	26	30									
2 :																			26	21	26	30	27								
3 :	156	151	149	161														30	22	19	20	20	25	3[illegible]							
4 :	148	143	142	142	147	141	172											30	20	17	16	18	22	37							
5 :	141	136	136	136	134	128	131	178	22[illegible]									32	21	16	16	17	22	35	6[illegible]						
6 :	119	116	116	116	122	118	105	129	17[illegible]									34	23	18	17	18	22	27	64	[illegible]					
7 :	109	106	116	116	113	110	99	114	146								70	36	24	20	19	19	21	26	64	10[illegible]					
8 :	109	100	106	105	103	101	96	107	132							127	78	39	26	22	20	20	22	27	60	9[illegible]	[illegible]				
9 :	103	100	106	105	102	101	94	102	123						153	130	84	45	28	23	22	22	24	31	59	85	110				
10 :	99	96	100	98	95	92	93	97	113	125	121	122	130	144	150	131	91	50	31	25	24	24	26	35	54	75	99	127			
11 :	99	97	95	98	93	91	92	96	107	112	116	117	123	137	145	132	96	56	34	27	26	25	28	37	54	69	91	116	140		
12 :	97	94	96	93	90	90	91	95	103	109	112	113	119	132	141	133	101	62	38	29	29	27	31	39	55	67	87	115	132	158	
13 :	97	94	96	93	89	88	89	94	101	107	109	110	115	127	137	132	104	67	42	32	31	30	33	43	56	67	80	100	119	138	160
14 :	95	92	93	89	87	87	88	93	100	105	107	107	112	122	134	130	106	72	45	35	34	32	35	46	57	66	77	90	104	125	150
15 :	95	92	93	89	86	86	89	94	101	106	105	105	109	120	132	130	109	76	49	38	37	35	37	49	59	67	75	83	97	111	149
16 :	94	91	93	86	83	83	86	92	98	103	105	103	106	115	125	128	110	79	53	42	41	38	40	51	60	67	74	82	90	109	136
17 :	94	91	90	86	83	83	86	92	98	103	105	103	106	113	122	125	110	82	56	45	44	42	43	53	61	67	74	83	89	99	121
18 :	95	92	90	86	83	83	87	92	98	102	102	102	104	109	120	123	109	84	60	48	48	46	47	55	62	66	73	84	93	96	118
19 :	93	91	88	84	81	81	85	90	96	100	102	102	104	108	115	118	107	85	62	51	52	50	51	56	62	66	72	84	94	95	111
20 :	94	91	88	84	81	81	85	91	96	100	100	102	104	107	113	115	106	85	63	54	56	54	54	57	63	67	72	85	95	96	100
21 :	94	91	87	82	79	80	84	90	95	98	100	102	102	104	109	113	106	85	64	57	60	58	56	59	63	66	74	87	95	95	95
22 :	94	92	87	82	79	80	84	89	95	97	98	100	101	102	106	111	106	83	64	61	64	62	59	59	63	67	75	88	95	95	94
23 :	93	91	87	81	78	79	83	90	96	97	97	100	102	102	104	109	105	84	65	64	68	66	62	60	63	68	77	89	94	94	92
24 :	94	91	86	81	78	79	82	90	96	96	95	98	102	101	101	106	102	83	67	68	72	69	64	60	63	69	78	90	95	93	92
25 :	93	90	86	80	77	78	83	91	96	96	95	97	102	101	99	104	101	83	70	72	75	72	67	61	63	69	79	91	96	93	90
26 :	92	90	85	80	77	78	83	91	96	95	93	97	102	100	98	101	98	82	73	76	78	74	69	62	63	70	80	91	96	93	88
27 :	92	90	85	79	77	78	83	91	96	94	92	96	101	100	97	98	96	83	77	79	80	76	70	64	64	70	81	92	97	92	85
28 :	91	90	85	79	77	78	83	91	96	93	91	96	100	99	96	95	92	83	80	82	82	78	72	65	65	70	83	94	96	90	84
29 :	91	90	84	79	77	79	83	90	95	93	91	96	100	99	96	93	90	84	83	84	84	80	74	67	65	72	85	95	95	89	83
30 :	91	90	84	79	78	80	84	90	94	93	92	96	99	99	95	92	88	86	86	86	85	81	75	68	66	73	87	94	93	88	82
31 :	90	89	84	80	80	83	86	90	93	94	95	97	99	99	97	93	88	87	88	87	86	83	77	70	67	75	88	94	91	86	81
32 :	90	89	84	81	82	86	88	91	93	95	97	98	101	101	99	95	91	88	89	88	87	84	79	71	68	76	89	93	90	84	81
33 :	90	89	85	84	85	89	90	92	94	96	99	100	102	102	100	97	93	90	89	88	87	85	80	73	70	78	90	92	87	83	80
34 :	90	89	86	86	89	92	93	94	96	98	101	102	103	102	100	97	94	91	89	89	88	86	82	74	71	80	90	90	86	82	79
35 :	90	88	86	88	91	93	95	96	97	99	102	104	104	102	100	98	94	91	90	89	89	87	84	76	73	82	89	88	85	81	78
36 :	90	88	88	90	92	94	96	97	98	100	103	105	105	104	100	98	94	91	90	89	89	88	85	78	76	83	88	87	84	81	78
37 :	90	89	90	92	93	95	96	97	99	101	103	105	106	104	101	98	94	91	90	89	90	89	87	80	78	84	87	86	84	81	78
38 :	91	91	91	93	94	96	97	98	99	101	104	106	106	105	102	97	94	91	90	90	90	90	88	81	80	84	87	85	83	80	77
39 :	91	92	93	94	95	96	97	98	100	102	104	106	106	105	101	97	93	91	90	90	91	91	90	83	81	84	87	85	81	79	77
40 :	92	94	94	95	96	97	98	99	100	102	104	106	107	104	101	97	93	91	90	90	91	92	91	85	83	84	86	84	81	78	77

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 12 sec, tide elevation = 0.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				11	13	18									
2 :																			12	11	13	16	16								
3 :	155	149	147	161														13	10	10	10	10	14	2[illegible]							
4 :	146	140	139	142	151	152	186											13	9	9	8	9	12	20							
5 :	139	133	133	136	138	138	150	210	13[illegible]									15	10	8	8	9	12	19	37						
6 :	117	113	113	115	125	127	120	156	223									16	10	9	9	9	12	14	36						
7 :	107	103	113	114	116	119	112	136	182								24	17	11	10	9	10	11	14	36	68					
8 :	107	96	102	103	105	108	108	127	163							62	28	19	12	10	10	10	12	15	34	60	[illegible]				
9 :	101	97	102	102	103	108	107	121	151						116	69	31	21	14	11	11	11	13	17	35	53	74	[illegible]			
10 :	97	92	95	95	95	98	105	115	138	156	149	146	147	142	119	76	37	23	16	12	12	12	14	20	32	48	67	92	[illegible]		
11 :	97	93	91	94	94	97	103	114	131	138	142	140	139	138	120	82	43	25	18	14	13	13	15	21	32	44	63	85	108		
12 :	94	90	91	89	90	95	102	112	126	134	137	134	135	134	121	88	48	28	20	15	14	14	17	22	34	43	61	85	102	130	
13 :	95	90	91	89	88	93	99	111	123	132	133	130	130	130	120	92	54	32	22	17	16	16	18	25	35	44	56	74	92	114	145
14 :	92	88	87	85	86	91	98	109	121	129	130	127	126	125	119	95	59	36	25	19	18	17	19	27	36	44	54	66	82	103	140
15 :	93	88	87	85	84	89	98	110	122	131	128	124	123	123	119	98	65	39	28	21	20	19	21	29	38	46	53	62	76	93	132
16 :	91	86	87	82	81	86	95	107	118	126	128	122	119	118	114	98	70	43	30	23	22	20	23	32	39	46	53	61	71	94	123
17 :	92	87	84	81	81	86	95	106	118	126	128	122	118	116	111	98	72	47	33	26	24	22	25	33	41	47	53	62	71	86	113
18 :	93	87	84	81	80	85	95	106	118	126	125	120	116	112	109	97	74	50	36	28	27	25	27	35	42	47	53	64	76	83	112
19 :	91	86	82	78	78	83	93	104	115	122	124	120	115	111	106	95	73	52	38	31	30	28	30	37	43	48	53	64	78	83	107
20 :	92	87	83	78	77	83	92	104	115	122	122	121	115	109	104	93	73	53	40	33	33	31	32	38	44	49	53	67	81	86	96
21 :	92	87	81	76	76	81	90	103	113	119	121	121	113	105	100	91	75	54	41	36	36	34	34	40	45	49	55	69	81	86	91
22 :	93	88	81	76	75	80	90	102	112	117	119	118	112	103	96	90	76	54	42	39	39	37	37	41	46	50	57	71	82	87	91
23 :	92	87	81	75	74	78	88	102	113	117	118	118	112	102	93	88	77	56	42	41	42	40	39	42	47	51	59	72	82	87	90
24 :	92	87	80	75	74	78	87	101	113	116	115	116	113	101	90	85	76	56	44	44	45	43	42	42	47	53	60	74	84	87	89
25 :	91	87	80	74	73	77	87	102	113	115	115	115	112	100	87	83	75	57	46	47	48	46	44	44	47	54	62	76	86	88	87
26 :	91	86	79	73	72	76	86	101	113	114	112	115	113	99	85	80	73	57	48	50	51	49	46	45	48	54	63	77	88	89	86
27 :	90	86	79	73	72	75	85	101	112	113	111	114	112	98	83	77	72	58	50	53	54	51	48	46	49	55	64	79	91	89	82
28 :	90	86	79	72	71	74	84	100	112	111	108	112	110	96	81	73	68	58	53	55	56	54	50	48	50	55	67	83	90	87	81
29 :	90	86	78	72	71	74	83	97	110	110	107	112	108	95	80	70	65	58	56	58	59	56	51	50	51	56	70	85	90	85	79
30 :	89	86	78	71	71	75	83	96	108	109	107	111	107	94	79	68	63	59	58	60	61	58	53	51	52	58	74	86	88	84	78
31 :	88	86	78	71	72	77	83	94	106	109	109	110	104	92	78	67	61	60	61	62	62	60	55	53	53	60	76	87	87	83	76
32 :	88	86	78	72	74	78	84	93	104	110	111	110	104	92	79	67	62	61	62	64	64	62	58	55	54	62	78	87	86	80	76
33 :	87	85	78	74	76	81	86	93	103	110	114	111	103	92	79	68	63	62	64	65	65	64	60	56	55	64	80	86	83	78	74
34 :	86	85	78	76	79	84	88	94	103	112	116	112	103	91	78	69	64	64	65	66	67	65	62	58	56	67	81	84	82	77	72
35 :	86	84	79	78	82	86	90	96	104	112	118	115	104	90	78	70	66	65	66	68	68	67	64	59	58	70	81	83	81	76	71
36 :	86	83	79	80	83	87	91	97	104	114	119	116	105	91	78	70	66	65	67	69	70	69	67	61	61	72	80	81	79	75	70
37 :	86	83	80	82	85	88	92	97	105	114	119	117	106	92	79	70	67	66	67	70	71	71	69	63	63	73	80	80	79	74	68
38 :	86	83	82	83	86	89	93	98	105	115	120	118	107	92	79	71	67	67	68	71	73	73	71	65	65	73	79	80	77	73	66
39 :	86	84	83	85	87	90	94	98	106	115	121	119	107	92	79	71	67	67	69	72	74	75	73	68	67	74	79	79	75	71	65
40 :	86	86	85	86	88	91	94	99	106	115	122	119	107	92	78	70	67	68	70	73	76	76	75	70	69	75	79	78	74	69	64

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 14 sec, tide elevation = 0.0 ft MLLW.

APPENDIX E

ANNUAL SEA

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = +5.4 ft MLLW

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				42	42	42									
2 :																			57	42	42	42	43								
3 :	122	120	120	124														74	51	39	37	36	41	55							
4 :	119	117	118	119	120	116	121											74	48	37	33	34	39	56							
5 :	116	114	115	117	116	111	110	126	14[illegible]									77	49	36	34	33	38	56	80						
6 :	106	105	106	107	110	106	98	109	130									79	52	39	36	35	38	52	81	[illegible]					
7 :	100	99	106	107	105	102	94	101	118								111	81	54	43	39	37	38	51	82	106					
8 :	100	95	100	101	99	97	92	97	111							126	111	83	57	45	42	40	40	51	79	104	[illegible]				
9 :	96	96	100	100	99	97	91	95	106						121	123	112	86	60	48	45	42	43	54	78	99	111				
10 :	94	93	96	96	94	91	91	92	100	107	103	101	102	108	117	121	112	89	63	51	47	45	46	57	74	92	107	118			
11 :	94	93	94	96	93	91	90	91	97	99	100	99	99	105	114	119	112	91	66	53	50	47	49	59	74	87	100	114	120		
12 :	92	92	94	93	91	90	89	91	95	98	98	97	98	103	112	117	111	92	69	56	53	50	52	60	74	84	96	113	119	124	
13 :	93	92	94	93	90	89	88	90	94	97	97	95	96	101	109	115	110	93	71	59	56	53	55	63	74	83	91	104	114	118	124
14 :	92	91	92	91	89	88	88	90	93	96	96	94	95	99	107	113	110	94	73	62	59	56	57	66	75	82	89	98	105	114	120
15 :	92	91	92	90	88	87	88	90	93	96	95	94	94	98	106	112	109	95	75	65	62	59	60	68	75	82	87	93	100	107	116
16 :	91	90	92	89	87	86	87	89	92	95	95	93	93	96	103	110	108	95	77	67	66	63	63	70	76	81	87	91	95	103	115
17 :	91	90	91	89	87	86	87	89	92	95	95	93	93	96	102	108	106	95	78	69	69	67	67	71	76	81	87	92	94	96	107
18 :	91	91	91	89	87	86	87	89	92	94	94	92	93	95	100	106	105	95	79	72	72	71	71	72	76	80	86	93	96	95	101
19 :	91	90	90	88	86	85	86	88	91	93	94	93	93	94	98	103	103	94	80	74	75	75	74	73	76	80	85	93	96	93	97
20 :	91	90	90	87	85	85	86	89	91	93	93	93	93	93	97	102	102	94	80	76	79	78	77	73	76	80	86	93	96	93	92
21 :	91	91	89	87	85	84	86	88	91	92	93	93	92	93	95	101	102	92	80	78	82	82	79	74	76	80	86	94	96	92	89
22 :	91	91	89	87	85	84	86	88	91	92	92	92	92	92	94	100	101	91	80	81	85	85	81	75	76	80	87	95	96	92	89
23 :	91	90	89	86	84	84	86	89	92	92	91	92	92	92	93	98	100	91	82	84	88	87	83	75	76	81	88	95	95	91	88
24 :	91	90	89	86	84	84	86	89	92	92	90	91	93	92	92	97	98	90	84	87	91	89	85	76	76	82	89	95	95	91	87
25 :	91	90	88	86	84	84	86	90	93	92	90	91	93	92	92	96	97	90	87	90	93	91	87	78	77	82	89	95	95	90	86
26 :	91	90	88	86	84	84	86	90	93	92	89	91	93	92	92	95	96	90	89	93	94	92	88	79	78	82	89	95	95	90	86
27 :	91	90	88	86	84	85	87	91	93	91	89	91	93	93	92	94	94	91	92	95	96	94	89	80	78	83	90	95	95	90	84
28 :	91	91	89	86	85	86	88	91	93	91	90	91	93	93	92	93	93	93	94	96	97	94	90	82	79	83	91	95	94	88	84
29 :	91	91	89	87	86	87	89	92	93	92	91	92	94	94	93	94	93	95	96	97	97	95	91	83	80	84	92	95	93	88	84
30 :	91	91	89	88	88	90	91	92	93	93	94	93	94	94	93	93	93	96	97	98	98	96	92	85	81	85	92	95	92	87	84
31 :	91	91	90	90	91	93	93	94	94	95	96	95	96	97	97	97	96	98	98	98	98	96	93	86	82	86	93	94	91	87	84
32 :	92	92	91	92	93	95	95	96	96	97	98	97	98	99	99	99	98	98	99	98	98	97	94	88	84	87	93	93	90	86	84
33 :	92	92	92	94	95	97	97	97	97	98	99	99	99	100	100	100	99	99	99	98	98	97	95	89	85	89	93	92	89	86	84
34 :	92	92	93	95	97	98	98	98	98	99	100	100	100	100	100	100	99	99	99	99	98	98	95	90	87	90	93	91	88	86	84
35 :	93	92	94	97	98	99	99	99	99	100	100	100	100	100	100	100	100	99	99	99	98	98	96	91	89	91	92	90	88	86	84
36 :	94	93	96	98	98	99	99	99	100	100	100	101	101	101	100	100	99	99	99	99	98	98	97	92	90	91	92	90	88	86	84
37 :	95	95	97	98	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	98	97	94	92	91	91	90	88	86	84
38 :	96	97	98	98	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	95	93	91	92	90	88	86	84
39 :	96	98	98	99	99	99	100	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	96	94	92	92	90	88	86	84
40 :	96	99	99	99	99	99	100	100	100	100	101	101	101	101	100	100	99	99	99	99	99	99	99	96	95	92	92	90	88	86	84

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 10 sec, tide elevation = +5.4 ft MLLW.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																															
2																				22	24	25									
3	129	125	123	128															28	22	24	25	26								
4	125	122	121	120	121	117	124											35	25	21	21	21	25	34							
5	122	119	118	118	116	112	112	134	15									36	23	19	18	20	24	35							
6	111	108	108	107	110	106	99	115	142									39	24	19	18	19	23	35	54						
7	105	102	108	107	105	102	95	106	127									41	26	20	19	20	23	32	55						
8	105	97	101	100	98	96	92	101	119								82	44	27	22	21	21	22	32	57	81					
9	100	98	101	100	97	96	91	97	113							130	88	47	30	24	22	23	24	33	57	80					
10	97	95	97	95	92	90	90	94	107	117	114	115	123	135	147	131	93	53	32	26	24	24	26	35	57	77	93				
11	98	95	94	95	91	89	89	93	103	107	111	112	117	130	143	131	98	58	35	28	26	26	28	38	55	73	90	105			
12	95	93	94	91	88	88	88	93	99	105	108	109	114	125	139	131	102	64	39	30	29	28	31	40	55	69	85	103	113		
13	96	93	94	91	87	87	87	92	98	103	105	106	111	121	136	131	105	69	42	32	31	30	33	41	56	68	83	102	112	122	
14	94	91	91	88	86	85	86	91	97	102	104	104	108	117	132	129	107	73	46	35	34	32	35	45	57	67	78	94	108	118	129
15	94	92	91	88	85	85	87	92	98	103	102	103	106	115	129	128	108	77	50	38	37	35	37	48	59	67	76	88	100	114	125
16	93	90	91	86	83	83	85	90	95	101	103	101	104	111	127	127	110	80	54	41	40	37	40	51	60	68	75	83	95	107	123
17	94	91	89	86	83	82	85	90	96	100	102	101	103	110	121	125	110	83	57	45	43	41	42	53	61	67	75	82	90	105	121
18	94	91	89	85	82	82	85	90	96	100	100	100	102	107	119	122	110	85	60	48	47	44	46	55	62	68	75	83	90	98	114
19	93	90	88	84	81	81	84	89	94	98	100	100	102	106	116	120	109	86	63	51	50	49	49	56	63	68	74	84	92	97	108
20	93	91	88	84	81	81	84	89	95	98	98	100	102	104	112	116	107	87	65	54	54	52	53	58	63	68	74	85	93	95	104
21	94	91	87	82	79	80	83	89	94	97	98	100	100	102	110	113	105	87	66	57	58	57	56	59	64	68	74	86	95	95	97
22	94	91	87	82	79	80	83	88	94	96	97	99	100	101	107	111	105	86	67	60	62	61	58	60	64	68	75	88	95	94	94
23	93	91	87	81	78	79	83	89	95	96	96	98	100	101	104	109	105	85	67	63	66	64	61	61	65	69	77	89	95	94	93
24	93	91	86	82	79	79	82	89	95	95	94	97	101	100	102	107	104	85	68	66	70	68	64	61	64	70	78	89	94	93	91
25	92	90	86	81	78	78	83	90	95	95	94	96	100	100	100	105	102	85	70	70	74	71	66	62	64	70	79	91	95	92	90
26	92	90	86	80	78	78	83	90	95	94	92	96	100	98	97	103	100	84	72	74	77	74	69	63	64	71	80	91	96	92	89
27	92	90	85	80	78	78	83	90	95	94	91	95	100	99	96	100	98	84	75	78	80	76	71	64	65	71	81	92	96	92	87
28	91	90	85	80	78	79	83	90	95	93	90	95	99	98	96	97	95	84	78	81	82	78	72	66	66	72	82	92	96	92	85
29	91	90	85	80	78	80	83	90	95	92	91	95	99	98	95	95	92	85	82	84	84	80	74	67	66	72	84	94	95	90	84
30	91	90	85	80	79	81	85	90	94	93	92	96	98	98	95	93	90	86	85	86	85	82	75	68	67	73	86	94	94	88	83
31	91	90	85	81	81	84	86	90	93	94	94	96	99	99	96	92	89	87	87	87	87	83	77	70	68	75	88	94	92	88	82
32	90	90	85	83	83	86	89	91	93	95	97	98	100	101	99	93	89	89	89	89	87	84	79	72	69	76	89	94	91	86	82
33	90	89	86	85	86	90	91	92	94	96	99	99	101	101	100	95	92	90	90	89	88	86	80	73	70	78	89	93	90	85	82
34	90	89	87	87	90	93	93	94	96	98	100	102	102	101	100	97	94	92	90	90	89	87	82	75	72	80	90	92	88	83	81
35	90	89	87	89	92	94	95	96	97	99	102	103	103	101	100	98	95	92	91	90	89	88	84	76	73	82	90	90	86	83	80
36	90	89	89	91	93	95	96	97	98	100	102	104	104	103	100	98	95	92	91	90	89	88	85	78	75	83	90	89	86	82	80
37	91	90	90	92	94	96	97	98	99	101	103	105	105	104	101	98	95	92	91	90	90	89	87	79	77	84	89	87	85	82	79
38	91	91	92	93	95	96	97	98	99	101	103	105	106	104	102	98	95	92	91	91	91	91	90	88	81	79	85	88	87	84	82	79
39	92	93	94	94	96	97	98	99	100	101	103	105	106	104	101	98	94	92	91	91	91	91	90	83	81	85	87	86	83	81	78
40	92	94	94	95	96	97	98	99	100	102	104	106	106	104	101	97	94	92	91	92	92	93	92	86	84	85	87	85	82	80	78

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 12 sec, tide elevation = +5.4 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				11	12	13									
2 :																			13	11	12	13	14								
3 :	127	123	121	126														15	11	10	11	11	13	17							
4 :	124	119	118	119	123	124	141											15	11	10	9	10	13	19							
5 :	121	116	116	116	118	119	126	160	19									17	11	9	9	10	13	19	31						
6 :	110	105	105	105	111	113	111	136	176									18	12	10	10	10	12	18	32						
7 :	103	99	105	105	106	108	105	124	156								30	19	13	11	10	11	12	18	33	51					
8 :	103	94	98	98	98	101	103	118	146							72	34	21	14	12	11	11	13	18	33	51					
9 :	98	94	97	97	97	101	101	114	138						120	79	39	23	16	13	12	12	14	19	34	49	64				
10 :	95	91	93	92	91	94	100	110	129	144	141	140	142	140	122	84	44	25	18	14	13	13	15	21	33	47	62	78			
11 :	96	91	89	91	90	92	98	108	124	131	135	135	136	136	122	89	50	28	20	15	14	14	17	22	33	45	60	76	89		
12 :	93	89	89	87	87	91	97	107	119	128	131	130	132	133	122	93	56	32	22	17	16	16	18	24	35	45	58	76	88	102	
13 :	94	89	89	87	85	89	95	106	118	126	128	127	128	129	121	96	61	36	24	18	17	17	19	26	36	45	56	70	85	99	115
14 :	92	87	86	84	84	88	94	104	116	124	126	124	124	124	120	99	65	40	27	20	19	18	21	29	37	46	55	66	79	96	113
15 :	92	87	86	83	82	87	95	105	116	125	124	122	121	123	119	101	70	43	30	22	21	20	22	31	39	47	54	62	76	92	113
16 :	91	86	86	81	80	84	92	102	113	122	124	120	118	118	114	101	74	47	32	25	23	22	24	33	40	47	54	62	72	91	112
17 :	92	87	84	80	80	84	92	102	113	121	124	120	117	116	112	100	76	51	35	27	26	24	26	35	42	48	55	63	73	86	106
18 :	92	87	84	80	79	83	92	102	113	121	121	118	115	112	110	99	77	53	38	30	29	27	29	37	43	48	55	65	76	85	103
19 :	91	86	82	78	77	81	90	101	111	118	121	119	115	111	107	97	76	55	40	32	31	30	32	38	44	49	54	66	78	85	99
20 :	92	87	82	78	77	81	90	101	111	118	119	119	115	109	105	95	76	56	42	35	34	33	34	39	46	50	55	68	81	86	93
21 :	92	87	81	76	75	79	88	100	110	116	119	119	113	106	101	93	77	57	43	38	37	36	36	41	47	50	57	70	81	85	90
22 :	92	88	81	76	75	79	88	99	109	114	116	117	112	104	98	92	79	57	44	40	41	39	38	42	47	51	58	72	82	86	89
23 :	91	87	82	75	74	77	87	99	110	114	115	117	112	104	95	90	79	58	44	43	44	42	41	43	48	53	60	73	82	86	88
24 :	92	87	81	75	74	77	85	99	109	113	113	115	113	102	92	87	78	59	46	45	47	45	43	44	48	54	62	75	84	86	87
25 :	91	87	80	74	73	76	86	99	110	112	112	114	112	102	89	85	77	59	48	48	50	48	45	45	49	55	63	77	86	87	86
26 :	91	86	80	74	72	75	85	99	110	111	110	114	113	101	87	82	75	59	50	52	53	50	47	46	49	55	64	78	88	88	84
27 :	90	86	79	73	72	75	84	98	109	110	109	113	112	100	86	79	74	60	53	54	56	53	49	48	50	56	66	80	90	88	81
28 :	90	86	79	73	72	74	83	98	109	109	107	112	110	98	84	76	70	60	55	57	58	55	51	49	51	57	68	83	89	86	80
29 :	90	86	79	72	72	75	82	96	107	107	106	111	108	97	83	73	67	61	58	60	60	57	53	51	52	58	71	84	89	84	79
30 :	89	86	79	72	72	76	82	94	106	107	106	111	108	96	82	71	66	61	60	62	62	59	55	53	53	60	74	85	87	84	77
31 :	89	86	79	72	73	77	83	93	104	107	108	110	106	95	81	70	64	62	63	64	64	61	57	54	54	61	77	86	86	82	76
32 :	88	86	79	73	75	79	84	93	102	108	110	110	105	95	82	70	64	63	64	66	65	63	59	56	55	63	78	86	85	80	75
33 :	87	86	79	75	77	82	86	93	101	108	112	111	105	95	82	72	66	65	66	67	67	65	61	58	56	66	80	85	83	78	73
34 :	87	85	79	77	80	85	88	94	101	110	115	113	105	94	82	72	67	66	67	68	68	67	64	59	58	68	81	84	81	77	72
35 :	86	85	80	79	83	86	90	95	102	110	116	115	106	93	81	73	68	67	68	69	70	69	66	61	60	71	81	83	80	76	71
36 :	86	84	80	81	84	88	91	96	103	112	117	116	107	94	81	73	69	68	68	70	71	71	68	63	62	73	81	81	79	75	70
37 :	86	84	81	83	86	89	92	97	103	112	118	117	108	95	82	74	69	68	69	71	73	72	70	65	65	74	80	81	79	74	68
38 :	86	84	83	84	87	90	93	97	104	112	119	118	109	95	83	74	70	69	70	72	74	74	72	67	67	74	80	80	77	73	67
39 :	87	85	84	86	88	91	94	98	104	113	119	119	109	95	82	74	70	69	71	73	75	76	75	69	68	75	80	79	75	71	66
40 :	86	86	86	87	89	91	95	98	105	113	120	119	109	95	82	73	70	70	72	74	77	77	77	71	70	75	80	78	74	69	65

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 14 sec, tide elevation = +5.4 ft MLLW.

APPENDIX F

ANNUAL SEA

WATER WAVE TRANSFORMATION COEFFICIENTS

REDONDO BEACH KING HARBOR, CALIFORNIA

TIDE ELEVATION = +8.0 ft MLLW

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1																				44	42	42									
2																			59	44	42	42	43								
3	116	114	114	117														78	54	41	38	38	42								
4	114	112	112	113	114	110	113											77	51	39	35	35	40	56							
5	111	110	111	112	111	107	105	118	13									81	52	39	36	35	40	56	77						
6	104	102	103	104	107	103	96	105	122									82	55	42	38	37	40	53	79						
7	99	98	104	104	103	100	93	99	113								111	83	57	45	41	39	40	53	80	101					
8	99	95	99	99	98	95	91	96	108							124	111	85	60	48	44	42	42	53	79	99					
9	96	95	99	99	97	95	90	94	104						118	121	111	88	63	50	47	44	45	56	77	96	106				
10	93	93	96	95	93	91	90	91	99	105	101	99	100	106	115	119	111	90	66	53	49	47	48	58	75	90	104	113			
11	94	93	93	95	92	90	89	91	96	98	99	97	98	103	112	117	111	92	69	55	52	49	51	60	74	86	98	110	114		
12	92	91	93	92	91	89	89	90	94	97	97	96	96	101	110	115	110	93	71	58	55	52	54	62	74	84	95	109	114	117	
13	92	92	93	92	90	89	88	90	93	96	96	95	95	100	108	113	110	94	73	61	58	54	56	65	75	83	91	102	110	113	117
14	91	91	92	90	89	88	87	89	93	95	95	94	94	98	106	111	109	95	75	64	61	58	59	67	76	82	89	97	103	110	114
15	92	91	92	90	88	87	88	90	93	95	94	93	93	97	105	110	108	95	77	66	64	61	61	69	76	82	88	92	99	104	111
16	91	90	92	89	87	86	87	89	92	94	95	92	93	96	102	108	107	95	78	69	67	65	64	70	76	81	87	91	95	101	110
17	91	90	91	89	87	86	87	89	92	94	94	93	93	95	101	106	106	95	79	71	70	68	68	71	77	81	87	92	94	96	104
18	91	91	91	89	87	86	87	89	92	94	93	92	92	94	99	105	104	95	80	73	73	72	72	73	77	81	87	93	95	95	99
19	91	90	90	88	86	85	86	88	91	93	93	93	92	94	97	102	103	94	81	75	76	76	75	73	77	81	86	93	95	93	95
20	91	90	90	87	86	85	86	89	91	93	93	93	92	93	96	101	102	94	81	77	80	79	77	74	77	81	86	93	96	93	91
21	91	91	89	87	85	85	86	88	91	92	92	93	92	92	95	100	101	93	81	79	83	83	80	75	77	81	87	94	96	92	89
22	91	91	89	87	85	85	86	88	91	92	92	92	92	92	94	99	100	91	81	82	86	85	82	76	77	81	88	95	96	92	88
23	91	90	89	86	85	84	86	89	92	92	91	91	92	92	93	98	99	91	82	85	89	88	84	76	77	82	89	95	95	91	88
24	91	90	89	86	85	84	86	89	92	92	90	91	93	92	92	97	98	90	85	88	91	90	86	77	77	82	89	95	95	90	87
25	91	90	89	86	85	84	86	90	92	92	90	91	93	92	92	96	97	90	87	91	93	92	87	79	78	83	90	95	95	90	86
26	91	90	89	86	85	85	87	90	93	92	90	91	93	92	92	95	95	91	90	93	95	93	89	80	79	83	90	95	95	90	86
27	91	91	89	86	85	85	87	91	93	91	89	91	93	93	92	94	94	92	93	95	96	94	90	81	79	84	90	95	94	90	85
28	91	91	89	87	86	86	88	91	93	91	90	91	93	93	92	93	93	93	95	96	97	95	91	83	80	84	91	95	94	88	85
29	91	91	89	87	87	88	89	92	93	92	91	92	94	94	93	94	93	95	96	97	97	96	92	84	81	85	92	95	93	88	84
30	91	91	90	88	89	90	91	93	94	93	94	93	94	94	94	93	93	96	98	98	98	96	93	86	82	86	93	94	91	88	84
31	92	92	91	90	91	93	94	94	95	95	96	96	96	97	97	97	96	98	98	98	98	97	93	87	83	87	93	94	91	87	84
32	92	92	92	93	94	95	96	96	96	97	98	97	98	99	99	99	98	98	99	99	98	97	94	89	85	88	93	93	90	86	84
33	92	92	93	94	96	97	97	97	97	98	99	99	99	99	100	100	99	99	99	99	98	98	95	90	86	89	93	92	89	86	84
34	92	92	94	96	97	98	98	99	99	99	100	100	100	100	100	100	99	99	99	99	99	98	96	91	88	90	93	91	89	86	84
35	93	92	95	97	98	99	99	99	99	100	100	100	100	100	100	100	100	99	99	99	99	98	96	92	89	91	92	91	88	86	84
36	94	93	96	98	98	99	99	99	100	100	100	100	101	100	100	100	100	99	99	99	99	98	97	93	91	91	92	90	88	87	84
37	95	96	97	98	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	94	92	91	92	90	88	87	84
38	96	97	98	99	99	99	99	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	95	94	92	92	90	88	86	84
39	96	98	99	99	99	99	100	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	98	96	94	92	92	90	88	87	84
40	97	99	99	99	99	99	100	100	100	100	100	101	101	101	100	100	99	99	99	99	99	99	99	97	96	93	92	91	88	87	85

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 10 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				23	24	24									
2 :																			29	23	24	24	28								
3 :	122	119	117	119														39	26	22	21	22	25	3[illegible]							
4 :	120	117	115	115	115	111	118											39	25	21	19	21	24	35							
5 :	118	114	114	113	111	107	107	125	14[illegible]									42	26	20	19	20	24	35	5[illegible]						
6 :	109	106	105	105	106	103	97	110	13[illegible]									45	28	21	20	21	24	34	54						
7 :	103	100	105	104	102	100	93	103	122								87	48	29	23	22	22	24	34	57	7[illegible]					
8 :	103	97	100	99	96	94	91	99	115							130	92	52	32	25	24	24	25	34	57	78					
9 :	99	97	100	98	96	94	90	96	110						144	131	97	57	35	27	25	25	27	37	57	76	90				
10 :	97	94	96	94	91	89	90	93	104	113	112	113	119	132	140	131	101	62	38	29	28	27	29	39	55	72	88	101			
11 :	97	94	93	94	90	88	88	92	101	105	108	109	114	126	136	131	104	67	41	32	30	29	32	41	56	70	84	100	109		
12 :	95	92	93	91	88	87	88	92	98	103	106	107	112	123	133	130	106	72	45	34	32	31	34	43	57	69	82	99	108	118	
13 :	95	93	93	90	87	86	87	91	97	102	104	105	109	119	129	128	108	76	49	37	35	33	36	46	58	68	79	93	105	114	122
14 :	94	91	91	88	86	85	86	90	96	101	103	103	106	115	126	126	109	79	52	40	38	36	38	49	59	68	77	88	99	111	119
15 :	94	92	91	88	85	84	86	91	97	102	101	102	105	113	124	125	110	82	56	43	41	39	41	52	61	69	76	84	95	106	118
16 :	93	90	91	86	83	82	85	89	95	99	101	100	103	110	119	123	111	84	59	46	44	42	44	54	62	68	75	83	91	103	117
17 :	93	91	89	86	83	82	85	89	95	99	101	100	102	108	117	121	110	86	62	49	48	45	47	56	63	69	76	84	90	98	111
18 :	94	91	89	85	82	82	85	90	95	99	99	99	101	106	115	118	109	87	64	52	52	50	51	57	63	68	75	85	93	97	106
19 :	93	90	88	84	81	81	84	89	94	97	99	99	101	105	111	115	107	88	66	55	55	54	54	59	64	68	75	85	93	95	102
20 :	93	91	88	84	81	81	84	89	94	97	98	99	101	103	109	112	105	88	67	58	59	58	57	59	65	69	75	87	95	95	96
21 :	93	91	87	83	80	80	83	88	93	96	98	99	100	101	106	110	105	87	68	61	63	62	60	61	65	69	76	88	95	94	93
22 :	94	91	87	83	80	80	83	88	93	95	96	98	99	100	103	109	105	86	68	64	67	66	62	62	65	69	78	89	95	94	92
23 :	93	91	87	82	79	79	83	89	94	95	95	97	99	100	102	107	104	86	69	68	71	69	65	62	65	70	79	90	94	93	91
24 :	93	91	87	82	79	79	82	89	94	95	94	96	100	99	99	104	102	85	71	71	75	72	67	63	65	71	80	91	95	92	90
25 :	92	90	86	81	78	79	83	90	95	95	93	95	99	99	98	102	100	85	73	75	78	75	70	64	65	72	81	92	95	92	88
26 :	92	90	86	81	78	79	83	90	95	94	92	95	100	99	96	100	97	84	76	79	81	77	72	65	66	72	82	92	96	92	87
27 :	92	90	86	81	78	79	83	90	95	93	91	95	99	98	96	97	95	84	79	82	83	79	73	67	67	73	83	93	96	92	85
28 :	91	90	85	80	78	79	83	90	95	93	90	95	99	98	95	95	92	85	83	84	85	81	75	68	67	73	85	94	95	89	84
29 :	91	90	85	80	79	80	84	90	94	92	91	95	98	98	95	93	91	86	85	87	86	83	76	69	68	74	86	94	94	88	84
30 :	91	90	85	80	80	82	85	90	94	93	92	95	98	97	95	92	89	87	88	88	87	84	78	71	69	76	88	94	92	88	83
31 :	91	90	85	82	82	84	87	90	93	94	94	96	98	99	96	93	90	89	90	89	88	85	80	72	70	77	89	94	91	86	82
32 :	91	90	86	83	84	87	89	91	93	95	97	97	100	101	99	96	92	90	91	90	89	86	81	74	71	79	90	93	90	85	82
33 :	90	90	86	85	87	90	91	93	94	96	99	99	101	101	99	97	94	92	91	90	90	87	83	75	73	81	91	92	88	84	81
34 :	90	89	87	87	90	93	94	95	96	98	100	101	102	101	99	98	95	93	91	91	90	88	84	77	74	82	90	90	87	83	80
35 :	90	89	88	90	92	94	96	97	97	99	102	103	103	101	100	98	95	93	91	91	91	89	86	79	76	84	90	89	86	83	80
36 :	91	89	89	92	93	95	96	97	98	100	102	104	104	103	100	98	95	93	92	91	91	90	87	80	78	85	89	88	85	83	80
37 :	91	90	91	93	94	96	97	98	99	100	102	104	105	104	101	98	95	93	92	91	92	91	89	82	80	85	88	87	85	82	80
38 :	92	92	92	94	95	96	97	98	99	101	103	105	105	104	101	98	95	93	92	92	92	92	90	84	82	85	88	86	84	82	79
39 :	92	93	94	95	96	97	98	99	100	101	103	105	105	104	101	98	95	92	92	92	92	93	91	85	83	86	88	86	83	81	79
40 :	92	95	95	95	96	97	98	99	100	102	104	105	105	104	101	97	94	92	92	92	93	93	92	87	85	86	87	85	82	80	79

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 12 sec, tide elevation = +8.0 ft MLLW.

I/J:	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1 :																				11	12	13									
2 :																			13	11	12	13	14								
3 :	121	117	115	116														16	12	11	11	12	14	17							
4 :	119	114	113	114	117	117	130											16	12	10	10	11	13	19							
5 :	117	112	111	111	112	113	120	148	17									18	12	10	10	10	13	19	30						
6 :	107	103	102	102	107	109	107	129	163									19	13	10	10	11	13	19	31						
7 :	101	97	102	102	103	104	103	120	148								33	20	14	11	11	11	13	19	33	49					
8 :	102	93	96	96	96	99	100	114	139							77	38	22	15	12	12	12	14	19	33	50					
9 :	98	94	96	95	95	98	99	111	133						122	83	43	24	17	13	13	13	15	20	34	49	62				
10 :	95	91	92	91	90	92	98	107	125	139	137	138	140	139	124	88	49	27	19	15	14	14	16	22	34	47	61	75			
11 :	95	91	89	90	89	91	96	106	120	128	132	133	134	135	123	93	54	30	21	16	15	15	18	23	34	46	59	74	86		
12 :	93	89	89	86	86	89	95	105	117	125	129	129	131	132	123	96	59	34	23	17	16	16	19	25	36	46	58	75	86	98	
13 :	93	89	89	86	85	88	94	104	115	123	126	125	126	128	122	99	64	38	25	19	18	18	20	27	37	46	56	70	83	96	110
14 :	92	87	86	83	83	87	92	102	113	122	124	123	123	124	120	101	69	42	28	21	20	19	22	30	38	46	55	66	79	95	109
15 :	92	88	86	83	82	85	93	103	114	123	122	121	121	122	120	102	73	46	31	23	22	21	23	32	40	48	54	63	76	91	109
16 :	91	86	86	81	80	83	91	101	111	119	122	119	117	118	115	102	76	49	33	26	24	23	25	34	41	48	55	63	73	90	108
17 :	92	87	84	80	79	83	91	101	111	119	122	119	117	116	113	101	78	53	36	28	27	25	27	36	43	49	56	64	74	87	104
18 :	92	87	84	80	79	83	91	101	111	119	120	117	115	113	111	100	79	55	39	31	29	28	30	38	44	49	56	66	77	86	100
19 :	91	86	82	78	77	81	89	99	109	116	119	117	115	111	108	98	78	57	42	34	32	31	32	39	45	50	55	67	79	85	97
20 :	92	87	83	78	77	80	89	99	109	116	117	118	114	110	106	96	78	58	43	36	35	34	35	40	46	51	56	69	81	86	92
21 :	92	87	81	76	75	79	87	98	108	114	117	118	113	107	102	94	79	59	45	39	38	37	37	42	47	51	58	71	82	86	89
22 :	92	88	82	76	75	79	87	97	107	112	115	116	112	105	99	93	80	59	45	41	42	40	39	43	48	52	59	73	83	87	89
23 :	92	87	82	75	74	77	86	98	108	112	114	116	112	104	96	92	81	60	46	44	45	43	42	44	49	54	61	74	83	86	87
24 :	92	88	81	75	74	77	85	98	108	111	112	114	113	103	93	89	79	60	47	47	48	46	44	45	49	55	63	76	84	87	87
25 :	91	87	80	75	73	76	85	98	108	111	111	113	112	103	91	87	79	61	49	50	51	49	46	46	49	56	64	77	86	87	85
26 :	91	87	80	74	73	75	84	98	108	110	109	113	113	101	89	84	77	61	51	53	54	51	48	47	50	56	65	79	88	87	84
27 :	91	87	80	74	72	75	84	97	108	109	108	112	112	101	87	81	75	61	54	56	57	54	50	49	51	57	67	81	90	87	81
28 :	90	87	80	73	72	75	83	97	108	107	106	111	110	99	85	77	71	61	57	58	59	56	52	50	52	58	69	83	89	85	80
29 :	90	87	79	73	72	75	82	95	106	106	105	110	109	98	84	75	69	62	59	61	61	58	54	52	53	59	72	85	89	84	79
30 :	89	87	79	73	73	76	82	94	105	106	105	110	108	97	84	73	67	63	62	63	63	61	56	54	54	61	75	86	87	83	77
31 :	89	87	79	73	74	77	83	93	103	106	107	109	106	96	83	72	66	64	64	65	65	62	58	55	55	62	77	86	86	82	76
32 :	88	86	79	74	75	79	84	92	101	106	109	109	106	96	84	72	66	64	66	67	67	64	60	57	56	64	79	86	85	80	75
33 :	88	86	80	76	78	82	86	92	100	107	111	110	106	96	84	73	67	66	67	68	68	66	62	58	57	67	81	86	83	78	74
34 :	87	86	80	78	81	85	88	93	101	108	114	112	106	95	83	74	69	67	68	69	69	68	64	60	59	69	81	84	82	77	72
35 :	87	85	80	80	83	87	91	95	102	109	115	114	106	94	83	75	70	68	69	70	71	70	67	62	61	72	82	83	81	76	71
36 :	87	84	81	82	85	88	92	96	102	110	116	116	107	95	83	75	70	69	70	71	72	72	69	64	63	73	81	82	79	75	70
37 :	87	84	82	83	86	89	92	97	103	111	117	117	109	96	84	75	71	69	70	72	74	73	71	65	66	74	81	81	79	74	69
38 :	87	85	83	85	87	90	93	97	103	112	118	118	109	97	84	76	71	70	71	73	75	75	73	68	67	75	80	80	77	73	67
39 :	87	86	85	86	88	91	94	98	104	112	118	118	109	96	84	75	71	70	72	74	76	77	75	70	69	75	80	79	76	71	66
40 :	87	87	86	87	89	92	95	98	104	112	119	119	110	96	83	75	71	71	73	75	78	78	77	72	71	76	80	79	74	69	66

Redondo Beach King Harbor, California, water wave transformation coefficients (x 100), for annual sea, arriving from sheltered approach direction of 258 deg azimuth, period = 14 sec, tide elevation = +8.0 ft MLLW.

APPENDIX G

ISLAND SHELTERING PROGRAM*

* Program developed by US Army Engineer District, Los Angeles.

APPENDIX G

ISLAND SHELTERING PROGRAM

Prepared by

U. S. Army Engineer District, Los Angeles

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C        PROGRAM NAME                                                    DATE
C        ISLAND SHELTERING COEFFICIENT                                   AUG. 1972
C        (SITE VS. STATISTICAL STATION)
C
C
C
C
C        U.S. ARMY ENGINEER DISTRICT                                PROGRAM NUMBER
C        LOS ANGELES, CORPS OF ENGINEERS                               720-L1-004
C        300 NORTH LOS ANGELES STREET
C        LOS ANGELES, CALIFORNIA
C
C
C
C                 AUTHORS                                                FORTRAN
C        DAN MUSLIN,AL RAMIREZ                                  CETOS-GE 225
C
C
C
C        * * * * * * * * * * * * * * * * * *
C
C
C
C                 DIMENSION A(4,14), S(4,14), C(4,14), JNAME(40)
                  DIMENSION SD(4,6), SSUM(6), CD(4,6), Y(8), X(8), D(8)
C
C      A(2,9) IS THE INPUT DATA, COMPRISING PREDOMINATE WAVE DIRECTION
C      AND PERIOD LOCATED IN ROW(1),COLUMN(1) AND ROW(2),COLUMN(1)
C      RESPECTIVELY. ROW(1),COLUMNS(2) TO (9) ARE ALLOCATED FOR LIMITS
C      OF ISLAND SHELTERING WINDOWS FOR THE PROPOSED SITE LOCATION AND
C      ROW(2),COLUMNS(2) TO (9) ARE ALLOCATED FOR THE OFFSHORE
C      STATISTICAL STATION
C
C      S(2,8) AND C(2,8) ARE COMPUTED VALUES AND ARE EXPLAINED LATER IN
C      THE PROGRAM.
C
C      JNAME(40) IS INPUT DATA AND INDICATES NAME OF STATISTICAL STATION
C      ADJUSTED FOR PROPOSED SITE.
C
C
C      CONVERSION FACTOR FOR DEGREES TO RADIANS
                  RADIAN=3.1416/180.
C
            5 READ 10,JNAME
           15 PRINT 11,JNAME
           10 FORMAT (40A2)
           11 FORMAT (1H1,40A2)
              PRINT 17
           17 FORMAT (/,46H ALL DIRECTIONS IN AZIMUTH-DEGREES FROM NORTH )
            1 DO 12 M=1,8
              D(M)=0
```

```
   12 CONTINUE
      DO 20 I=1,4
         DO 20 J=1,14
      A(I,J) = 0.0
      S(I,J) = 0.0
   20 C(I,J) = 0.0
C
C     READ FIRST DATA CARD
         READ 30, (A(1,J),J=1,13),FLAGA
   30   FORMAT (14F5.1)
      IF (A(1,1))1050,1050,35
C
C     READ SECOND DATA CARD ** WILL ALWAYS BE AT LEAST TWO DATA CARDS
   35   READ 30, (A(2,J),J=1,13),FLAGB
C
C     CHECK FLAGB FOR MORE DATA (VALUE SHOULD BE POSITIVE FOR YES)
      IF (FLAGB)50,50,40
   40   READ 30, (A(3,J),J=1,13),FC
         READ 30, (A(4,J),J=1,13),FD
      LIM = 4
      GO TO 60
C
   50 LIM = 2
C
C
C     LOOP TO COMPUTE S AND C FOR ALL DATA CARDS AND PUT THEM IN ARRAYS
C
C
   60 PRINT 55
   55 FORMAT (///,48X,12H*INPUT DATA*)
      DO 70 I=1,LIM
         PRINT 80, I, (A(I,J),J=1,13)
   80   FORMAT (5X,2HA(,I1,3H,J),14F8.2)
   70 CONTINUE
 1015 PRINT 1025
 1025 FORMAT (//7H PERIOD,3X,11HPREDOMINANT,28X,8HCENTROID,25X,
     18HADJUSTED,3X,6HFACTOR,5X,11HIS. COEFF. ,/7H (SEC),4X,9HDIR. DEG.,
     229X,9HDIR. DEG.,24X,9HDIR. DEG.,/,25X,2HD1,5X,2HD2,5X,2HD3,5X,
     32HD4,5X,2HD5,5X,2HD6,5X,2HD7,5X,2HD8,/)
      DO 440 I=1,LIM
C     XL IS THE LEFT LIMIT OF EXPOSURE  1+COS(2THETA) CURVE
C     XR IS THE RIGHT LIMIT OF EXPOSURE 1+COS(2THETA) CURVE
      XL = A(1,1) + 45
      XR = A(1,1) - 45
C
  260   DO 430 J=2,13
  270 K=J-1
C     ZERO WILL BE USED WHEN AZIMUTH OF WINDOW IS CLOSED
C                          (WINDOW CHECK)
C
  300 IF (A(I,J))310,410,310
  310 IF (A(I,J)-XL)330,320,320
  320 A(I,J)=XL
  330 IF (A(I,J)-XR)340,340,350
  340 A(I,J)=XR
C
C     LIMITS HAVE BEEN RESET NOW COMPUTE DIFFERENCE BETWEEN PRED. DIR.AND
C
  350 B= A(I,J)-A(1,1)
C
C     THE PREDOMINANT WAVE DIRECTION IS SET AT 90 DEGREES-LIMITS=45 TO 13
C                          ALL DISTANCES ARE FROM XR (B+90-45=B+45)
C
  360 E=B+180
C
```

```
C     Z IS EQUAL TO E IN RADIANS
C
  370 Z=E*RADIAN
  380   S(I,K)=Z+.5*SIN(2*Z)
C
C     LOOP TO COMPUTE S AND C FOR ALL DATA CARDS AND PUT THEM IN ARRAYS
C
C
C
C     C IS USED TO COMPUTE MOMENTS UNDER THE INTENSITY CURVE. THE DIFFERE
C                    OF THE CIS IS THE MOMENT UNDER THE CURVE.
C
  390   C(I,K)=.5*Z**2+.5*Z*SIN(2*Z)+.25*COS(2*Z)
  400 GO TO 430
  410 S(I,K)=0.0
  420 C(I,K)=0.0
  430 CONTINUE
  440 CONTINUE
C
C     S IS USED TO COMPUTE AREA UNDER INTENSITY CURVE(1+COS(2THETA)).THE
C                    DIFFERENCE OF THE S#S GIVES THE AREA UNDER CURVE.
C
C
C                    COMPUTE AREAS UNDER INTENSITY CURVE
C
  450 DO 540 I=1,LIM
  455 SSUM(I)=0
  460 L=0
  470   DO 530 K=1,12,2
  480 N=K+1
  490 L=L+1
  500 SD(I,L)=(S(I,N)-S(I,K))
  520 SSUM(I)=SSUM(I)+SD(I,L)
  530 CONTINUE
  540 CONTINUE
C                    AREAS ARE EQUAL TO INTENSITY
C                    AREAS FOR STATION ARE SDEVN
C                    AREAS FOR SITE ARE SDODD
C
  545 SDODD=0
  546 SDEVN=0
  550 DO 590 I=1,LIM,2
  560 M=I+1
  570 SDODD=SDODD+SSUM(I)
  580 SDEVN=SDEVN+SSUM(M)
  590 CONTINUE
C
C     XK IS THE ISLAND SHELTERING COEFFICIENT AT THE SITE. IT IS THE SQRT
C     OF THE INTENSITY(SDODD) OF SITE TO INTENSITY OF WINDOW(45 TO 135 DE
C
      XK=0
  600 IF (SDODD)1065,530,510
  510   XK=SQRT(SDODD/2.571)
  620 GO TO 635
  630 XK=0
C
C                    COMPUTE MOMENTS UNDER CURVE AND SUM
C
C
  635 CSUM=0
  640 DO 720 I=1,LIM,2
  650 L=0
  660   DO 710 K=1,12,2
  670 N=K+1
  680 L=L+1
  690 CD(I,L)=C(I,N)-C(I,K)
  700 CSUM=CSUM+CD(I,L)
  710 CONTINUE
  720 CONTINUE
```

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C
C     W IS THE SHELTERED INTENSITY OF THE SITE DIVIDED BY THE SHELTERED
C                                   INTENSITY OF WAVE STATION
C
  730 IF (SDEVN) 740,770,740
  740 W=SDODD/SDEVN
C
C     F IS THE FACTOR TO EQUATE THE WAVE STATION DATA TO THE SITE,CONSIDE
C                          THE ISLAND SHELTERING CHARACTERISTICS OF THE TWO.
C
        F=0
 750    F=SQRT(W)
  760 GO TO 775
  770 F=0
C
C     D IS THE AZIMUTH FROM NORTH (ZERO DEGREES) TO CENTER OF OPEN WINDOW
C
  775 M=0
  780 DO 860 I=1,LIM,2
  800   DO 850 L=1,6
  810 M=M+1
  820 IF (SD(I,L)) 1065,840,830
  830 D(M)=(CD(I,L)/SD(I,L))/RADIAN +XR-135
  835 GO TO 850
  840 D(M)=0
  850 CONTINUE
  860 CONTINUE
C
C     DR IS USED TO DENOTE THE RESULT AZIMUTH
C
C
  945 IF (CSUM) 1065,946,950
  946 DR=0
      GO TO 1000
  950 DR=0
      DR=(CSUM/SDODD)/RADIAN+XR-135
 1000 PRINT 1030,A(2,1),A(1,1),D(1),D(2),D(3),D(4),D(5),D(6),D(7),D(8),
     1DR,F,KK
 1030 FORMAT (1X,F4.1,7X,F5.1,6X,F5.1,2X,F5.1,2X,F5.1,2X,F5.1,2X,F5.1,
     12X,F5.1,2X,F5.1,2X,F5.1,5X,F5.1,4X,F6.4,8X,F5.3,//1X,118(1H-))
 1040 GO TO 1
 1050 PRINT 1060
 1060 FORMAT(/,11HEND OF DATA,)
C
C     A -1 CARD INDICATES A NEW SET OF DATA
C
 1064 GO TO 1070
 1065 PRINT 1066
 1066 FORMAT(/,12H DATA ERROR ,)
 1067 GO TO 1
 1070 IF (A(1,1)) 5,1080,1080
 1080 STOP
      END
```

APPENDIX H: NOTATION

$A_{I,J}$	Location of RCPWAVE variables which vary in space, ft
a	Wave amplitude, ft
c	Wave celerity, ft/sec
c_g	Group celerity, ft/sec
c_o	Deep water wave celerity, ft/sec
d	Arbitrary water depth, ft
d_b	Water depth at wave breaking, ft
e	Base of the Napierian (natureal) logarithm system, 2.71828, dimensionless
g	Gravitational acceleration, 32.174 ft/sec^2
H	Arbitrary wave height, ft
H_b	Wave height at wave breaking, ft
H_i	Incident wave height, ft
H_{max}	Maximum wave height, ft
H_o	Deep water wave height, ft
H_s	Significant wave height, ft
H_1	Average of highest 1 percent of waves in a record, ft
H_5	Average of highest 5 percent of waves in a record, ft
H_{10}	Average of highest 10 percent of waves in a record, ft
H_{33}	Average of highest 33 percent of waves in a record (H_s), ft
h	Arbitrary water depth, ft
i	Subscript denoting x-direction , dimensionless
i	$(-1)^{1/2}$, dimensionless
J	Probability of occurrence in any series of N years, dimensionless
j	Subscript denoting y-direction , dimensionless
K_D	Rubble mound breakwater or jetty stability coefficient, dimensionless
K_O	Coefficient of overtopping, dimensionless
K_P	Coefficient of penetration, dimensionless
K_r	Coefficient of refraction, dimensionless
K_s	Coefficient of shoaling, dimensionless
K_T	Coefficient of total transmission, dimensionless
k	Wave number, $2\pi/L$, 1/ft
L	Wave length, ft
L_i	Incident wave height, ft
M	Number of grid lines in x-direction , dimensionless

MLLW	Mean Lower Low Water, ft
MLW	Mean Low Water, ft
m	Underwater slope, dimensionless
N	Number of grid lines in y-direction , dimensionless
N	Period of record, years
n	Parameter relating wave celerity to group celerity
P	Probability of occurrence in any 1 year, dimensionless
RI_i	Return interval, years
S	Interval of time, years
s	Wave vector phase function, dimensionless
T	Wave period, sec
W	Weight of armor unit of rubble mound breakwater or jetty, 50 percent of stones weigh more than W_{50}, lbs
w_r	Unit weight of stone, lb/ft^3
w_w	Unit weight of water, lb/ft^3
x	Horizontal coordinate direction, dimensionless
x	Grid size in the x-direction , ft
y	Horizontal coordinate direction, dimensionless
y	Grid size in the y-direction , ft
ϕ	Velocity potential function, ft^2/sec
σ	Angular wave frequency, $2\pi/T$, 1/sec
θ	Wave angle, deg
θ	Angle of rubble mound structure slope, deg
θ_o	Deep water wave direction of approach, deg
∂	Partial derivative symbol, dimensionless
∇	Horizontal gradient operator, 1/ft
π	3.14159