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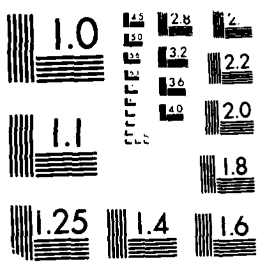

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BUHNE POINT SHORELINE EROSION DEMONSTRATION PROJECT

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FINAL

APPENDICES VOL. II
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Native plants

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

This report provides detailed information on the rebuilding of the Buhne Point marine beach, the construction of retaining structures, and the establishment of native dune vegetation to prevent wind erosion. The various appendices which are part of the report thoroughly document physical and numerical model studies done at the Waterways Experimentation Station (WES) in Vicksburg Mississippi for the structures and beach, as well as the post-construction and post-planting monitoring programs.
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20. Abstract, continued.

Buhne Point is located about 250 air miles north of San Francisco, on the east shore of Humboldt Bay, ~~Humboldt County,~~ California. A natural sand spit was located on the western face of the point, but the area lies directly in line with wind and waves entering Humboldt Bay from the Pacific Ocean. Reports of erosion there have been recorded since the mid-19th century. By the late 1970s, erosion had become so severe that the beach had disappeared, and the shoreline had eroded back to the roadway, threatening the road and underground water, gas and sanitary sewer lines. Storm waves 10' in height are common, and were sending rock flying across the road and against adjacent homes of the community of King Salmon. The appendix [illegible] (U)

In 1982, Congress included the area in an authorization to the Federal Highway Administration to undertake a demonstration project to apply "state-of-the-art methods for repairing damage to highways and preventing damage to highways resulting from shoreline erosion." A four-year, four-phase program was implemented, and is described in this final report.

The First Phase consisted of designing and constructing a 1,250' timber groin and a 200' long rubble-mound head to prevent sand from being transported south, downcoast.

Phase II consisted of placing 600,000 yds^3 of fine-to-medium grain sand to reform the almost-24-acre beach.

In Phase III, a 1,050' shore-connected, rubble-mound breakwater was constructed on the northerly face of the beach. The Phase I timber groin and breakwater was given an additional 425' arched extension.

Phase IV consisted of vegetating the sandfill with native plants. The vegetation program included experimental collecting and growing of 20 different native and naturalized species for a two-year period, and then extensive plantings and monitoring.

APPENDIX E

SECTION 1 BUHNE SPIT/KING SALMON SHORE PROTECTION PROJECT (PHASE I)

SECTION 2 PHASE II BASIS FOR DESIGN

SECTION 3 PHASE II FOUNDATION REPORT

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SECTION 1

BUHNE SPIT/KING SALMON SHORE PROTECTION PROJECT (PHASE I)

BOATING FACILITIES DIVISION

DESIGN STUDY

for

BUHNE SPIT/KING SALMON
SHORE PROTECTION PROJECT

at

HUMBOLDT BAY

in the

COUNTY of HUMBOLDT

May 1983

STATE of CALIFORNIA

RESOURCES AGENCY

DEPARTMENT of BOATING and WATERWAYS

PREFACE

The Buhne Spit/King Salmon area, located within Humboldt Bay easterly of the entrance channel jetties of the bay, has had a serious erosion problem for the last decade. The Department of Boating and Waterways, Beach Erosion Branch, was asked by Humboldt Bay Harbor, Recreation and Conservation District to design a project to mitigate shoreline erosion and reduce the shoaling of Fishermans Channel.

We have reviewed all prior reports written by the U. S. Army Corps of Engineers, historical literature, maps, and other data collected in the vicinity of Buhne Spit. We have compiled a data and information base that would give us insight into the environmental and climatological factors that have a direct affect on the shoreline erosion within the area of study.

Presented in this design study is a compilation of the data and information applicable to the Buhne Spit erosion area which aided our staff in the development of numerous conceptual designs. These alternative designs were evaluated by a numerical process to pick what we feel is the best, most efficient and least costly project to provide shoreline protection to the Buhne Spit area for several decades.

Excellent assistance and technical information was obtained from the Humboldt County Department of Natural Resources and the U. S. Army Corps of Engineers. Without their help, it would have been necessary to collect additional engineering and environmentaldata which would have resulted in additional design time and increased time to the project. We have also received keen cooperation from the U. S. Army Corps of Engineers who have agreed to place their channel maintenance dredge spoils within our project area to rebuild the spit to its 1955 area.

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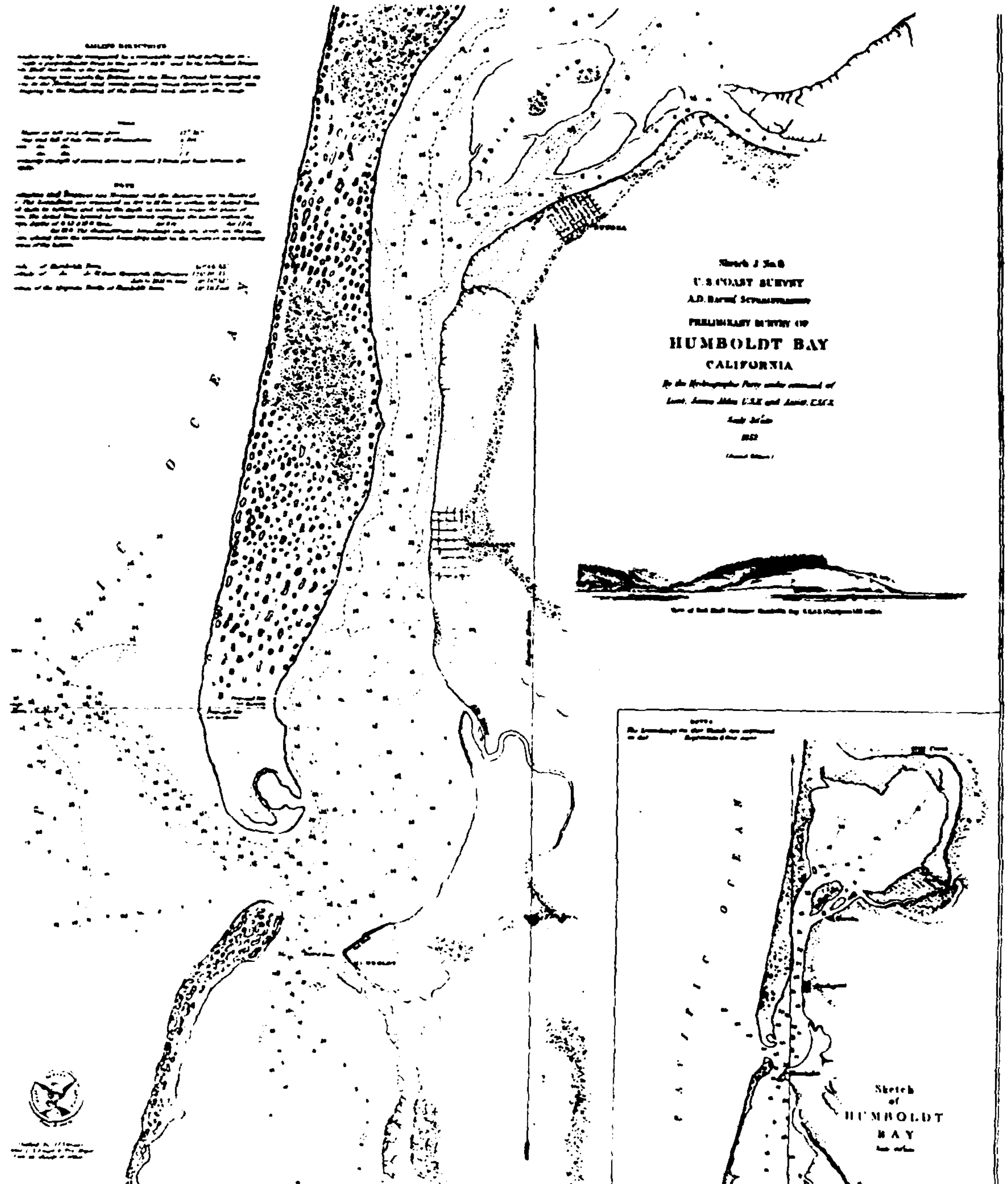

U.S. COAST SURVEY
HUMBOLDT BAY
CALIFORNIA
PACIFIC OCEAN
Sketch
of
HUMBOLDT
BAY

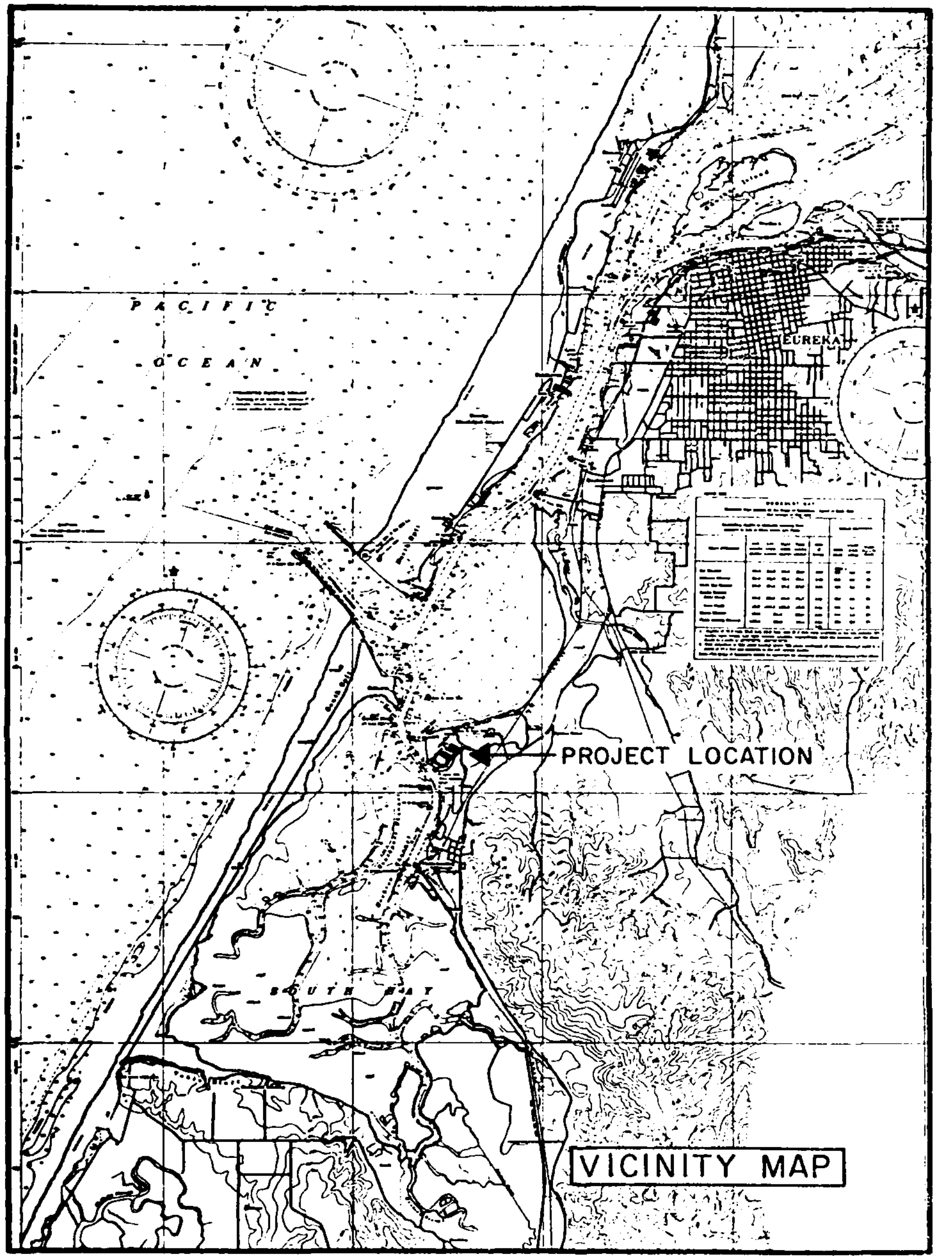
ABSTRACT

The Department of Boating and Waterways along with the U. S. Army Corps of Engineers have been studying the shoreline problems along Buhne Spit in Humboldt Bay since the early 1960's. The results of our combined studies indicate that there is a severe erosion problem on the spit with continuing shoreline retreat. Without the construction of some type of groin system or other shore protection configuration continued erosion is inevitable. Erosion has already progressed to a point where Buhne Point Drive and extensive underground public utilities are in immediate danger. A permanent shore protection project must be constructed soon if these facilities are to be preserved.

This design study investigates several combinations of shore protection configurations that can be utilized to prevent continuing erosion of Buhne Spit and recreate the spit to its area in 1955.

A 1000-1400 foot groin constructed of H-Beam Pile with timber lagging between the piles, a rock reveted bayward end and a 400 foot rock rubble-mound offshore breakwater with a sand filled pocket is the least expensive and most cost effective solution to the problem. This project, exclusive of sand fill, will cost about $640,000. The project including sand fill to form the protective beach is estimated to cost about $1,700,000.

The proposed project with groin and offshore breakwater is considered to be Phase I of the project. Phase II of the project, the filling of the groin pocket with sand would be accomplished during the periodic maintenance dredging of Humboldt Bay's navigation channels by the U. S. Army Corps of Engineers. Subsequent lengthening of the groin after monitoring the project through several winter storms would be Phase III. Construction funding for the project would be by a combination of State-Local or State-Local-Federal funds.



PACIFIC
OCEAN
EUREKA
PROJECT LOCATION
SOUTH BAY
VICINITY MAP

Figure 1

BUHNE SPIT/KING SALMON SHORE PROTECTION PROJECT

PURPOSE AND APPROACH

The purpose of the Buhne Point/King Salmon Design Study was to devise a method for long-term control of erosion problems which have eliminated Buhne Spit and which now threaten Buhne Point Drive and the residences shoreward of the road in the King Salmon area located on Humboldt Bay in Humboldt County.

As an initial phase of this design study, an analysis of the alternative erosion control methods was conducted. The approach to alternative design analysis included the following steps:

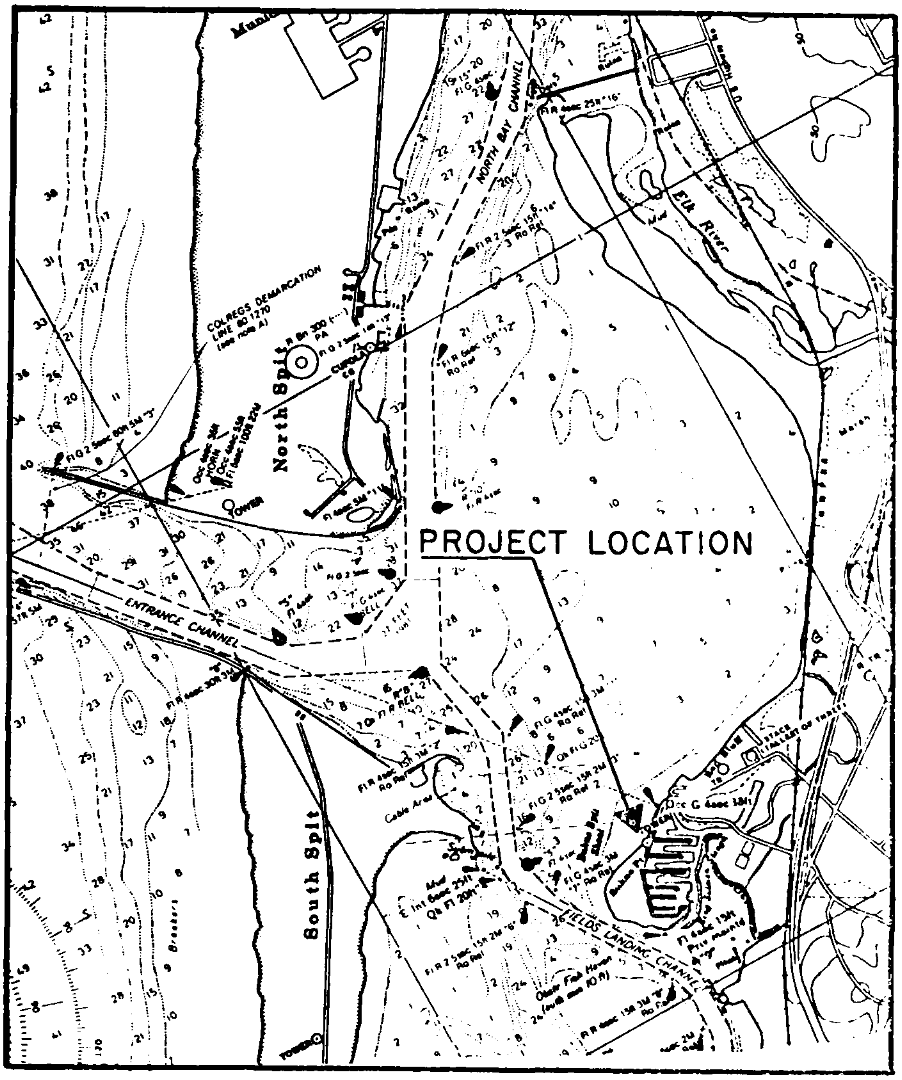
a. Define the erosional problem on Buhne Spit by review and analysis of existing data and past reports.
b. Develop specific goals and constraints as a basis for analyzing and comparing alternative designs for erosion protection.
c. Determine the functional effectiveness, advantages, disdvantages and estimated cost for each alternative.
d. Compare the alternatives against the specific project needs and select the best method for long-term erosion control.

DESIGN STUDY SCOPE

A total of twelve alternative beach erosion control plans were analyzed to determine their effectiveness and acceptability in reducing erosion in the Buhne Spit/King Salmon area. Preliminary screening was used to eliminate less practical and costly plans. Four of the alternatives met the functional, economic and environmental criteria when compared against specific project design goals and constraints. This final selection analysis determined the alternative recommended for detailed engineering, final design and future construction.

DESCRIPTION OF AREA

Buhne Point is located about 3 miles south of the City of Eureka and is opposite the jettied entrance to Humboldt Bay. King Salmon Harbor (Fisherman's Channel) was developed shoreward of Buhne Spit on what was previously a dredge spoil area. The area is now a small fishing village, camping/recreation site and a home for retired persons. The highest point on Buhne Spit Shoal is about 8-10 feet above the mean lower low water datum (MLLW).



LOCATION MAP

Figure 2

The spit has a length of about 2,000 feet measured from the juncture of the shoal and the Fields Landing Channel bayside to Buhne Point. The shoreline between Buhne Point and the Elk River Spit is protected by stone revetment. Buhne Point Drive, the bayside boundary between the shoal and King Salmon, is the main transportation link to the area. The road also carries all the underground utilities including the main sanitary sewer line. The road has been protected by emergency placement of rock along its entire length from Buhne Point to the Fields Landing Channel. The existing rock protection is inadequate and erosion and undermining of the roadway continues.

The entrance to PG&E's cooling water intake channel (Fisherman's Channel) is located southeasterly of King Salmon Harbor where it confluences with the Fields Landing Channel. The cooling water intake channel also serves as the harbor entrance to King Salmon and is the berthing area for the deeper draft boats moored within/along the channel. Shoaling caused by sand transport off Buhne Spit shoal has closed the channel entrance numerous times during the past few years blocking the channel for boat entrance/exit and safe mooring. This severe shoaling situation has also reduced the capacity of the cooling water intake channel supplying PG&E's steam power plant. Continuous dredging at the entrance and along the channel has been the short-term solution to provide adequate cooling water and access to King Salmon Harbor.

STATEMENT OF PROBLEM

During the past decade the Buhne Spit shoal has eroded away at an accelerated rate due to a redirection of the waves that enter Humboldt Bay through the entrance channel. Modifications on the bayside of the south channel jetty have generated an additional refracted wave train that commingles with the main waves that are transmitted through the entrance channel. Local observers believe that this modification has shifted the focus of the waves southwesterly toward Buhne Point from its previous location northeast of PG&E's steam power plant and along the Northwestern Pacific Railroad, thus accelerating sand transport along the shoal and into Fields Landing Channel as well as into PG&E's cooling water intake/Fisherman's Channel. The Department's assessment of the present sand transport system at Buhne Spit shoal is that the previous unrefracted wave pattern within the bay carried sediment along the spit which formed a point bar shoal along the navigation channel. The sediment eventually was deposited within the channel. The modification of the south jetty within the bay generated an additional wave pattern that passes through the main wave with a slight change in direction, rounds off the shoal and transports sand directly into the navigation channel, then down the edge of the channel into Fisherman's Channel creating a shoal.

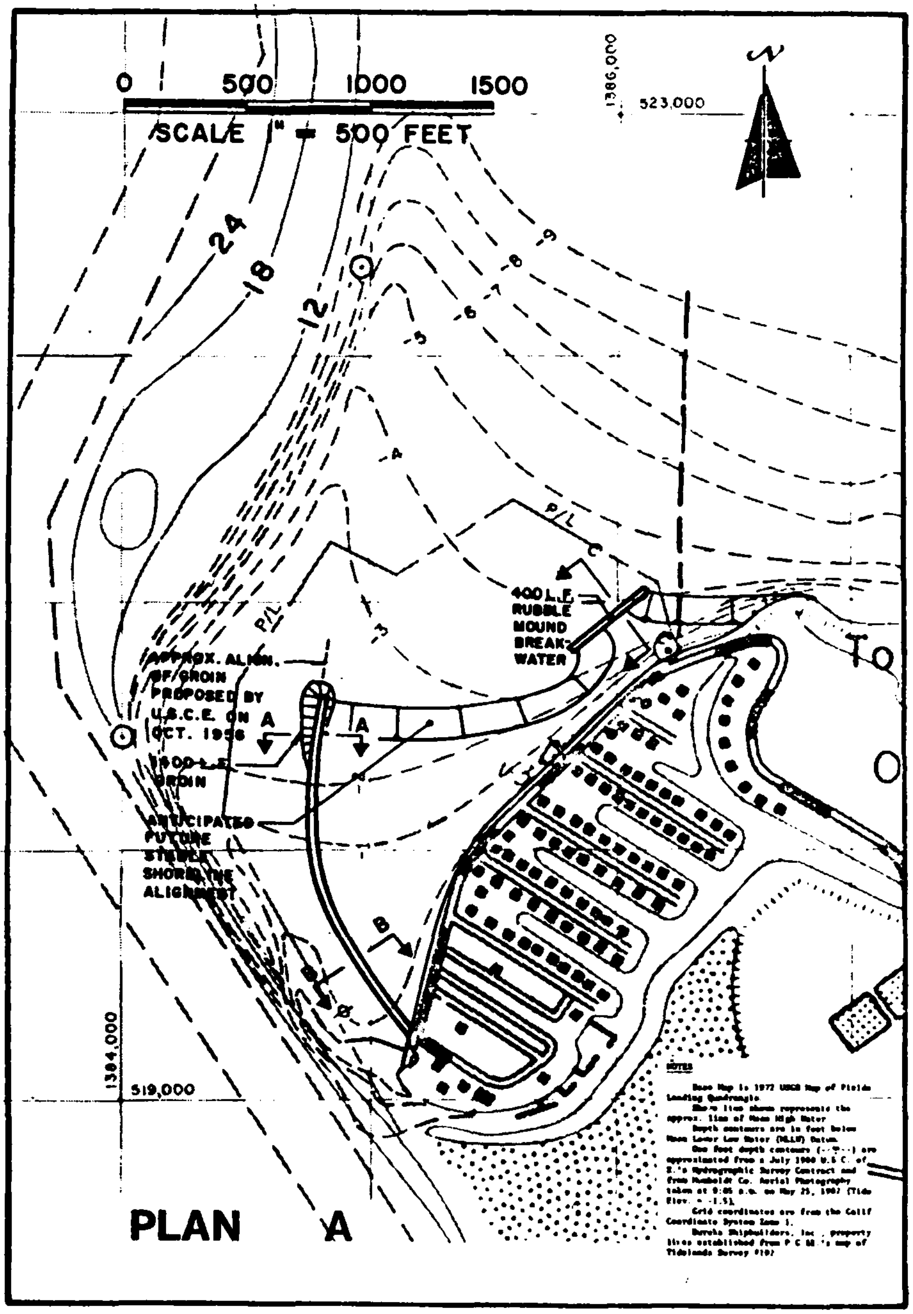


Figure 3. Project Layout Plan A

During the period from 1977 to date, the shoal has eroded away southwesterly along Buhne Point Drive in the King Salmon area. The shoal has lowered 5-10 feet along the road and is scoured to the bay mud foundation material along its entire length. There is a very small shoal between Halibut Avenue and the ship channel that is above mean lower low water. To protect Buhne Point Drive and the underlying utilities (consisting of water lines, natural gas lines and the main sanitary sewer line) from destruction. Humboldt County has reveted the bayside of the road with large rock. The emergency rock revetment has protected the roadway during recent storms but was not designed as a permanent structure to withstand large breaking waves. Consequently, during all subsequent severe storms, the revetment has been overtopped by waves. Smaller rocks from the revetment have been carried onto the roadway and cascaded into nearby homes, breaking windows and causing minor structural damage. The revetment has settled and also unravelled at numerous locations. Buhne Point Road has been undermined by wave wash-through and has collapsed at numerous locations. The above conditions have created an extreme safety hazard during moderate large storm wave conditions. It is a matter of time until one of the large rocks on the revetment is dislodged and rolls/tumbles onto the roadway, blocking access to King Salmon for emergency vehicles and the public. The present condition can only grow worse as the remaining sand spit recedes horizontally and vertically allowing larger and larger waves to break further up onto the rock revetment.

PROPOSED PROJECT

The proposed project consists of a 1000 to 1400-foot groin constructed of H-Beam Piles with timber lagging between the piles with a rock reveted bayward end and a 400-foot rock rubble mound offshore breakwater as shown on Figure 3. The groin follows an alignment parallel to the Fields Landing Channel from the southwest end of Buhne Point Drive near the intersection of Halibut Avenue. The offshore rock rubble mound breakwater will be constructed parallel to the shore about 250 feet bayward of the intersection of Buhne Point Road and Herring Avenue, extending northeasterly to the Eureka Shipbuilders Incorporated/Pacific Gas and Electric Company common boundary line. The long groin will provide a downcoast impervious barrier to reduce sand transport into Fisherman's Channel/PG&E's cooling water intake channel and at the same time accumulate sand to rebuild the shoal. The offshore breakwater will provide a sheltered region shoreward of the structure that will reduce sand transport and build out a protective beach from Buhne Point Drive. Both structures will function as barriers to retain sand to build out a wide protective beach along the existing rock revetment which parallels Buhne Point Drive. The groin pockets formed by the two structures will be filled with sand and dredge spoils from the U. S. Army Corps of Engineers harbor maintenance dredging. With the use of these dredge spoils and other imported sand Buhne Spit can be reconstructed to its area that existed in 1955.

This project is designed to restore Buhne Spit shoal to its 1955 area and provide an interim project for shore protection until the Corps of Engineers constructs the project proposed in House Document No. 282, 85th Congress, 2nd Session.

BENEFITS

The proposed groin and offshore breakwater project and anticipated dredge spoil sand from the U. S. Army Corps of Engineers maintenance dredging from the Fields Landing Channel will restore a protective/recreation beach on Buhne Spit. The project will protect the adjacent recreation area and residences along Buhne Point Drive from wave damage, and maintain accessibility to the public, emergency vehicles and county maintenance crews during severe high wave conditions. Additionally, the project will protect the road and underlying public utilities from wave damage due to the extreme erosion of the low spit upon which they are located.

CLIMATOLOGICAL FACTORS

STORMS

The Pacific Ocean area in the vicinity of Humboldt Bay is subject to storms accompanied by high waves during the winter months. Data are available regarding the duration, frequency, or intensity of storms from "Winds of California" and "Wind Storms in California". Wind data contained in these publications indicate that winds with velocities of 40 miles per hour or greater generally occur from the southwest and south. The greatest wind velocity of record is 56 miles per hour. Information furnished to USCE by local residents and by officials of the Northwestern Pacific Railroad Company indicates that, during storms occurring at the time of high tides, waves break on and overtop the revetment bordering the railroad right-of-way north of Buhne Point. Also, at such times, waves inundate and wash out sections of Buhne Point Drive, the only access road to the King Salmon area on Buhne Spit. Such storms are reported to occur about 10 times each year. Although these storms cause no serious structural damage, railroad officials state that railroad operations are suspended, on the average of about 4 hours during each storm, in order to clear the tracks of sand and rocks deposited by waves overtopping the existing structures. Thus, railroad operations are interrupted about 40 hours annually.

TIDAL DATA

Tidal data obtained at the north jetty of Humboldt Bay, which are considered to be representative of tidal conditions in the study area, are summarized below. The data, abstracted from National Ocean Surveys publications, Tidal Bench Mark, Part 1, Northern California, are based on 11 1/2 months of automatic tide-gaging records (October 1940 to March 1941 and June to December 1962) reduced to mean values. Unless otherwise noted, elevations in this report refer to the plane of mean lower low water (MLLW).

TIDAL DATA, NORTH JETTY, HUMBOLDT BAY

	Feet (MLLW)	Feet (NGVD)
Estimated Highest Water Level	9.50	6.16
Mean Higher High Water	6.70	3.36
Mean High Water	6.00	2.66
Mean Tide Level	3.60	0.26
Mean Sea Level (NGVD)	3.34	0.00
Mean Low Water	1.20	-2.14
Mean Lower Low Water	0.00	-3.34
Estimated Lowest Water Level	-3.00	-6.34

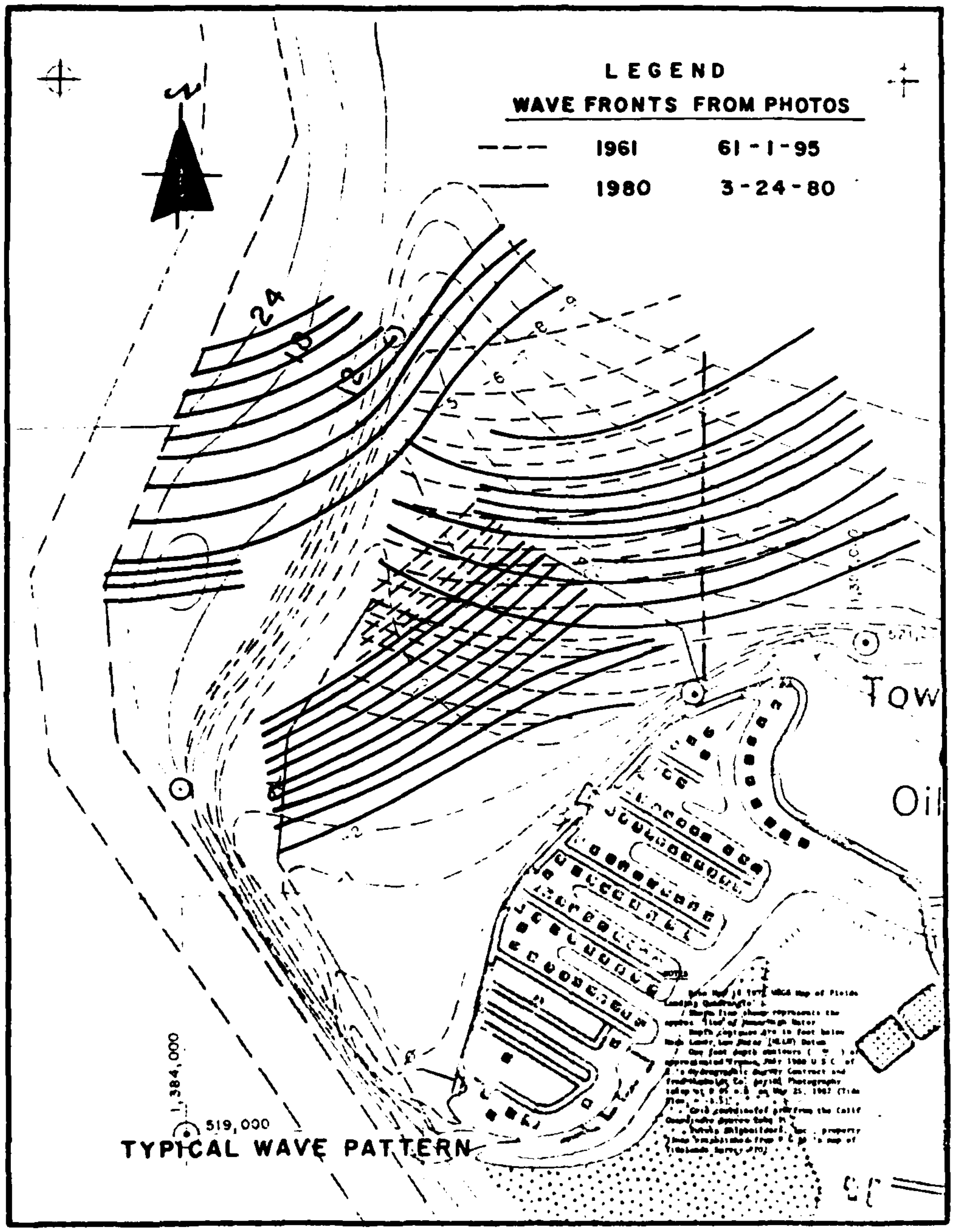


Figure 4. Typical Wave Pattern

WINDS

Wind characteristics in the Buhne Point area were assumed to be similar to those for the city of Eureka for which wind records are available. Data obtained by the United States Weather Bureau station at Eureka covering the period July 1939 to December 1942 and at the Humboldt Bay Power Plant from January 1966 to December 1966 were used to prepare the wind diagram shown on Plate I . The available data indicate that during the greater part of the year the prevailing winds are from the north and northwest and have velocities ranging from 4 to 15 miles per hour. However, the climatological summary given on Table 1 indicates that the prevailing direction of the wind shifts seasonally.

TABLE 1

MONTHLY AVERAGE AND MAXIMUM WINDS

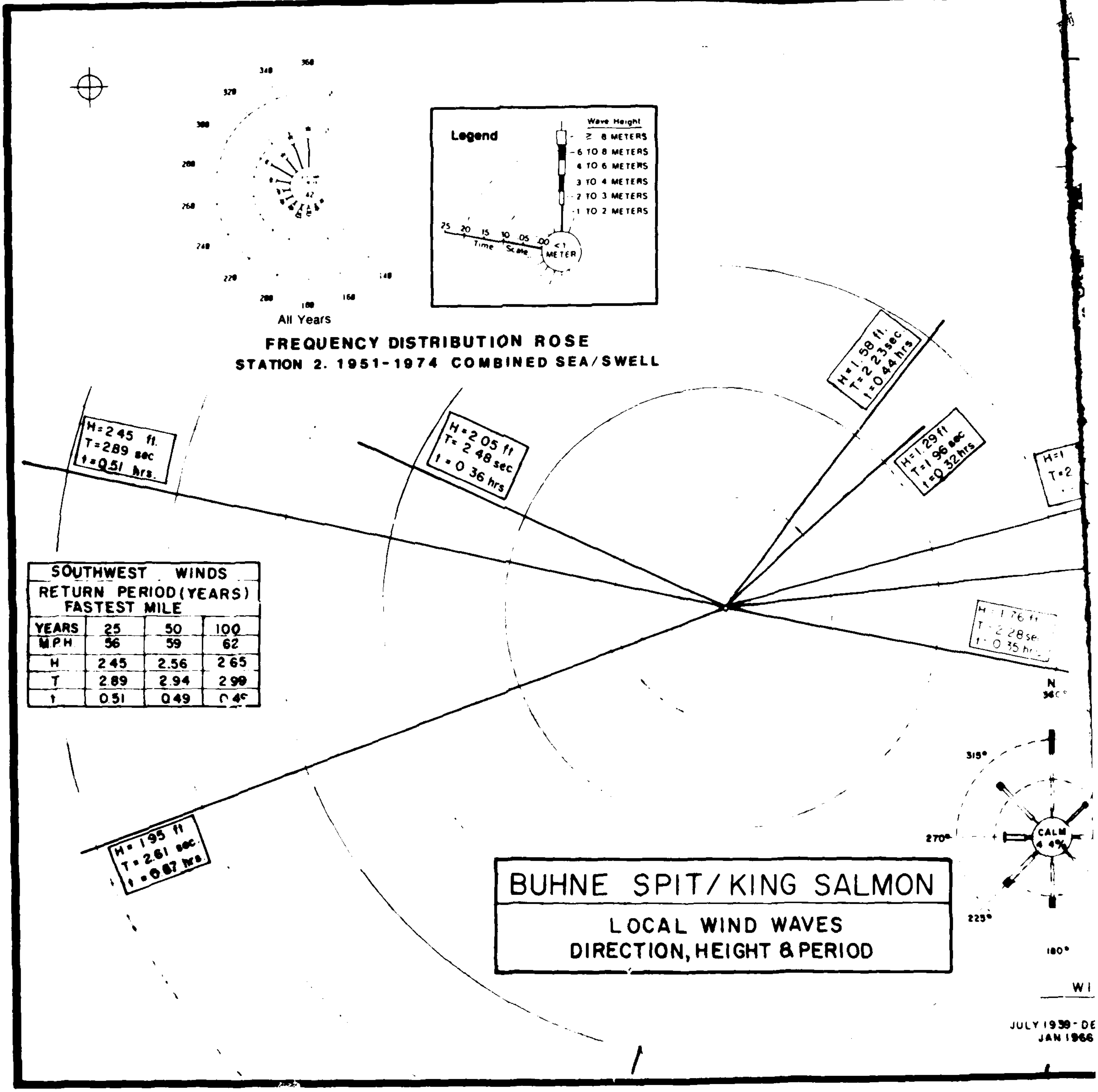
MONTH	MEAN WIND SPEED (MPH)	PREVAILING DIRECTION	MAXIMUM WIND SPEED (MPH)	MAXIMUM WIND SPEED DIRECTION
JAN	6.9	SE	54	S
FEB	7.2	SE	48	SW
MAR	7.6	N	48	SW
APR	8.0	N	49	N
MAY	7.9	N	40	NW
JUN	7.4	N	39	NW
JUL	6.8	N	35	N
AUG	5.8	NW	34	N
SEP	5.5	N	44	N
OCT	5.6	N	56	SW
NOV	6.0	SE	43	S
DEC	6.4	SE	56	S
ANNUAL	6.8	N	56	SW
LENGTH OF RECORD (YRS)	54	54	67	67

WAVES

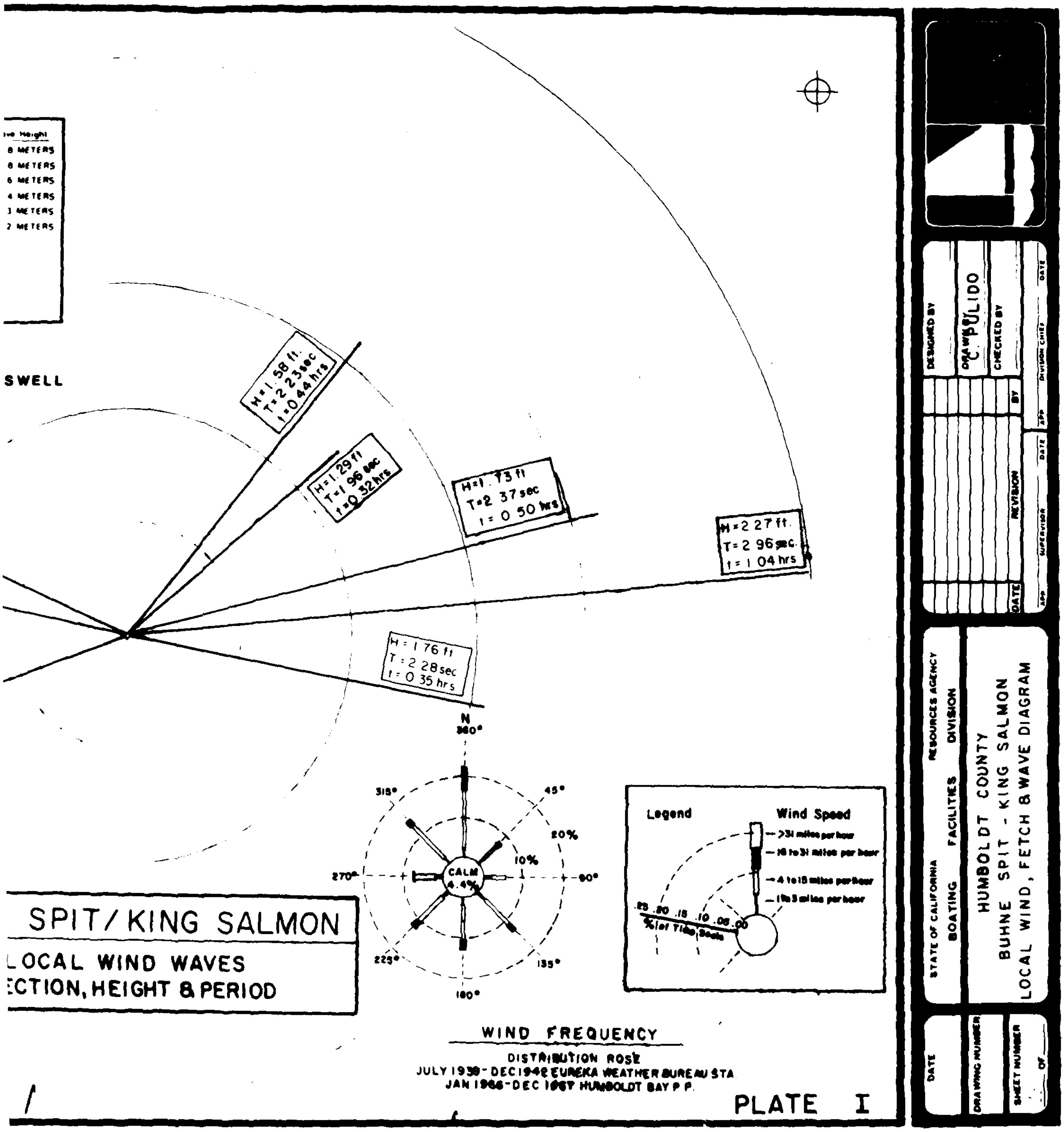
No statistical data are available for wave conditions within Humboldt Bay. Insofar as wind waves within the bay are concerned, the critical direction of wave approach in the problem area is from the southwest, for which direction the fetch is maximum. Based on the maximum wind record from this direction (56 miles per hour) and the assumption that the duration of the wind was sufficient for maximum wind wave generation, it is estimated that the maximum wind waves generated would have had a significant height of about 3 feet and a period of 3 seconds. Based on the historical record, wind waves of this height are rare occurrences. However, the area under investigation is exposed to waves generated in the Pacific Ocean that enter the bay through the jettied entrance. The relative alignment of the entrance and the eastern shore of the bay is such that all waves entering the bay impinge on the shore in the study area. Although the seaward end of the jettied entrance is exposed to high waves, the height of waves reaching the eastern shore is controlled by the available depth of water over the two shoal areas near the bayward end of the jetties and by the shallow water in the study area. At extreme high tide (9.5 feet above mean lower low water), the controlling depth over the shoals near the jetties is about 25 feet. Thus, only waves of about 18 feet or less in height can enter the bay without breaking on the shoal. Entering waves less than 18 feet would cross the bay and break at varying distances from the shoreline, depending upon their initial height. (For example, neglecting the effect of refraction and diffraction, a 15 foot wave would break at about the 10 foot depth contour during a 9.5 foot high tide.) After breaking, the wave would reform and continue on to shore. Local residents report that waves about 6 feet high break directly on shore in the problem area when high waves enter the bay at high tide. Wave analysis made by USCE in connection with their previous report also indicate that breakers 6 feet high can reach shore.

WAVES WITHIN BAY. USCE used available aerial photographs of waves entering the bay to show that the waves diffract and fan out so that the wave crests increase in length with increasing distance from the bayward end of the entrance channel. Measurements made from aerial photographs taken by USCE during the occurrences of high waves in the Pacific Ocean and at times when waves were breaking upon the shoal area near the jetties indicate that the wave length averaged about 80 feet at a point about 2,400 feet from the Buhne Point shore at a water depth of 10 feet. The effective period of these waves would be about 5-seconds. Aerial photographs also show that waves impinge on Buhne Point in a manner likely to cause littoral movement both to the north and to the south of the point. Typical wave patterns within the bay approaching Buhne Spit transferred from historical aerial photographs are shown on Figure 4.

OFFSHORE WAVES. A study of wave action in the vicinity of the Humboldt Bay jetties was made by the USCE for a survey report "Humboldt Bay-1950" using refraction diagrams. The characteristics of the waves used for the diagrams were for waves occurring most frequently as shown in the Scripps Institution of Oceanography "Wave Report No. 68". The diagrams were constructed for existing conditions of the bar seaward of the jetties and assumed a condition in which the depths over the bar and areas adjacent to it were increased to 40 feet. Their refraction diagrams indicated that, for 1950 conditions, waves were affected by the seaward submarine slope of the bar which caused some convergence to occur before the waves reached and/or passed over the bar crest. The crest of the bar produced additional convergence so that waves either broke on the bar or advanced toward the jettied entrance considerably higher than waves in comparable



SOUTHWEST WINDS			
RETURN PERIOD (YEARS) FASTEST MILE			
YEARS	25	50	100
MPH	56	59	62
H	2.45	2.56	2.65
T	2.89	2.94	2.99
t	0.51	0.49	0.4[illegible]



8 METERS
8 METERS
6 METERS
4 METERS
3 METERS
2 METERS
SWELL
H=1.58 ft.
T=2.23 sec
t=0.44 hrs
H=1.29 ft
T=1.96 sec
t=0.32 hrs
H=1.73 ft
T=2.37 sec
t=0.50 hrs
H=2.27 ft.
T=2.96 sec.
t=1.04 hrs
H=1.76 ft
T=2.28 sec
t=0.35 hrs
N
360°
315°
45°
20%
10%
270°
90°
CALM
4.4%
225°
135°
180°
Legend
Wind Speed
>31 miles per hour
16 to 31 miles per hour
4 to 15 miles per hour
1 to 3 miles per hour
.25 .20 .15 .10 .05 .00
% of Time Scale
SPIT/KING SALMON
LOCAL WIND WAVES
ECTION, HEIGHT & PERIOD
WIND FREQUENCY
DISTRIBUTION ROSE
JULY 1939 - DEC 1942 EUREKA WEATHER BUREAU STA
JAN 1966 - DEC 1967 HUMBOLDT BAY P.P.
PLATE I
DESIGNED BY
DRAWN BY C. PULIDO
CHECKED BY
REVISION
DATE
BY
SUPERVISOR
DIVISION CHIEF
APP
STATE OF CALIFORNIA
RESOURCES AGENCY
BOATING FACILITIES DIVISION
HUMBOLDT COUNTY
BUHNE SPIT - KING SALMON
LOCAL WIND, FETCH & WAVE DIAGRAM
DATE
DRAWING NUMBER
SHEET NUMBER
OF

depths elsewhere. The USCE refraction diagrams also indicate that waves advancing from any direction south of west-northwest will tend to produce upcoast littoral drift along the south and north spits.

Waves with a height of 10 feet or greater, occurring most frequently in the Pacific Ocean in the vicinity of Humboldt Bay, have an average period of 9 seconds. this period over the bar, assumed as 20 feet, has little effect on the wave height so that the effect of refraction determines the height of waves seaward of the jetties. Waves having a period of from 12 seconds to 16 seconds are increased in height from 15 percent to 30 percent, respectively, by the bar. This increase is in addition to the effect of USCE's comparisons of the refraction diagrams constructed for conditions existing during their survey report study period with those drawn for an assumed depth of 40 feet over the bar and indicated that no appreciable reduction in the height of 9 second waves would occur with an increase in depth over the bar. The reason for this assumption by USCE is that the seaward slope of the bar, in depths greater than 40 feet,caused wave convergence before the 40 foot depth is reached. However, the increase in depth would permit practically all 9 second waves from the northwest and the west to pass over the bar without breaking. Present depths over the bar cause northwest waves and west waves to break when the deep-water wave height is about 12 to 15 feet. For waves with periods of 12 seconds or greater, the USCE comparison indicated that a bar depth of 40 feet would result in a decrease in wave height in the vicinity of the entrance channel. For example, a 12 second wave from the northwest breaks on the bar when the deep-water wave height is about 9 feet or greater. When the depth over the bar is increased to 40 feet, 12 second nortwest waves do not break on the bar. USCE indicated that these waves are reduced in height about 12 percent at the bar and about 7 percent near the jetties.

WAVE STATISTICS. The Department of Boating and Waterways has compiled wave statistics from the California Coastal Data Program (CCDP). Humboldt Bay wave rider (Inner) buoy and the California Deep-Water Wave Statistics (Station 2) (CDWS) to compare the occurrence and frequency of ocean waves near the entrance to Humboldt Bay as shown in Table 2. The California Coastal Data Program buoy was in operation for 15 months and can only be used for a general comparison against the 25 year record of the deep-water statistics. CCDP indicated that, 22.5% of the time waves with a significant height of 4-6 feet occurred, compared with CDWS where waves with a significant height of 4.9-6.6 feet occurred 27.3% of the time. The major wave activity occurred between periods of 4-6 to 6-8 seconds with significant heights between 1.6 to 6.5 feet, comprising 57.2 percent of the time. These waves can pass through the Humboldt Bay entrance jetties and be the dominant sediment transport vehicle. A review of the wave statistics compiled

TABLE 2

CALIFORNIA COASTAL DATA PROGRAM

Humboldt Bay Wave Rider (Inner)

Number Of Days in Month That Significant Wave Height < 18-Feet

Wave Height- (Feet)	YEAR 1981 -JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	OCT	NOV	YEAR 1982 JAN	FEB	MAR	APR	MAY	- Total Occ's (Days)
18+	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4
16-18	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4
14-16	3	1	2	-	-	-	-	-	1	3	4	-	2	-	-	16
12-14	1	2	4	2	-	1	-	-	2	3	3	-	3	1	1	23
10-12	5	2	9	3	1	1	-	-	1	4	4	1	6	4	5	46
8-10	1	4	6	7	5	2	4	-	5	4	4	2	4	4	5	57
6-8	2	6	4	11	6	5	10	8	5	7	2	1	4	7	9	87
4-6	0	5	3	5	11	12	9	13	12	2	2	2	3	9	5	93
2-4	0	3	0	2	7	7	6	10	4	1	1	1	1	3	6	52
0-2	14	5	3	0	1	2	2	-	1	0*	0*	-	1	0	0	29
Total	31	28	31	30	31	30	31	31	31	25	20	7	24	30	31	411

* Gage not recording part of month

DEEP-WATER WAVE STATISTICS
of the
CALIFORNIA COAST--STATION 2
January 1951-1974
PERIOD FREQUENCY OF OCCURRENCE DISTRIBUTION
COMBINED SEA/SWELL

WAVE PEROID (Seconds) / WAVE HEIGHT (Feet)	4-6	6-8	8-10	10-12	12-14	14-16	16-+	TOTAL OCC'S
23.0- +	-	-	-	2	10	2	-	14
19.7-23.0	-	-	-	17	2	-	-	19
16.4-19.7	-	-	19	38	5	2	-	64
13.1-16.4	-	1	112	7	17	3	-	140
9.8-13.1	-	114	220	38	22	5	3	402
8.2-09.8	-	289	34	38	18	9	6	394
6.6-08.2	13	493	107	37	41	14	21	726
4.9-06.6	372	499	135	87	64	62	38	1257
3.3-04.9	934	329	169	121	188	147	21	1909
1.6-03.3	683	231	115	111	270	55	4	1469
0.0-01.6	10	75	31	16	63	15	3	213
TOTAL	2012	2031	942	512	700	314	96	6607

by Marine Consultants (MC) for the same station as CDWS indicated waves with a significant height between 1 to 4.9 feet occurred 60% of the time. Table 3 below compares the three statistical bases for offshore deep-water combined sea/swell waves in the vicinity of Humboldt Bay.

TABLE 3

DEEP-WATER WAVE STATISTICS COMPARISON
COMBINED SEA/SWELL

HEIGHT (Feet)	Occurrence percent of time CDWS	CCDP	MC
0-2	7.0	7.1	27.2
2-4	15.2	12.7	24.5
4-6	25.8	22.6	18.5
6-8	23.2	21.2	10.1
8-10	8.5	13.9	6.0

The above comparison indicates that the CDWS and CCDP have very close correlation with wave heights between 0 to 6 feet and that the MC statistical data for combined sea/swell does not compare to CDWS or CCDP until the 8 to 10 foot wave height. This would indicate that CDWS and CCDP should be used for sediment transport within the bay, assuming that these waves would pass through the jetties and reach Buhne Spit without breaking offshore and reforming.

ENVIRONMENTAL FACTORS WITHIN THE BUHNE POINT AREA

GEOMORPHOLOGY

The area adjacent to Buhne Point is composed of alluvium-filled valley floors between ridges of Pliocene-Pleistocene marine sediments. Inland and east of Buhne Point are rocks of the Franciscan formation. The bluff area at Buhne point is part of the Pliocene-Pleistocene marine deposits and is composed of interbedded layers of medium and fine-grained, reddish to buff-colored sandstone, blue clay (Mud-rock) and gravel. The material comprising the bluff is relatively soft and, prior to the construction of the PG&E's rock revetment along the base of the bluff, was easily eroded by wave action. The adjacent low land to the north and east of the bluff at Buhne Point is peaty silt underlain by sandy silts and clay to a depth averaging about 10 feet below mean lower low water. The bluff at Buhne Point is probably the last remnant of a more extensive series of beds, which once extended over the area.

Two sandy spits are located in the vicinity of Buhne Point. The Elk River Spit at the northern end of the area is composed of fine, cohesionless, gray sand with a trace of shell. Additionally, small rounded gravel is also found on Elk River Spit. The spit has an average height of about 17 feet above mean lower low water. Buhne Spit, located at the southern end of the area, projects from shore at the southwestern end of Buhne Point. The surface material of the spit consists of coarse to fine sand, gray to black in color, with a trace of shell. Buhne Spit has an average height of about 16 feet above mean lower low water. Over the period of record, both Buhne Spit and Elk River Spit have undergone considerable change with respect to location. Details regarding changes in the location of the spit are given in the section of this report headed "EROSION BUHNE SPIT" and shown on Plates II and III.

Samples of materials obtained in connection with the USCE investigations indicate that the bottom material in the study area consists generally of cohesionless, gray to black-colored sand, ranging in size from very fine to medium. In the vicinity of the juncture of Buhne Point and Buhne Spit, the bottom is also composed of bluish clay, clayey silt, pieces of shale and organic material.

WINDBORNE TRANSPORT OF BEACH MATERIAL

There is no evidence of extensive windborne transport of beach material in the study area. However, during strong northerly and northwesterly winds, it has been observed that movement of sand occurs from the north spit into the jettied entrance channel near the root of the north jetty. The amount of sand moved in this manner is unknown.

CHARACTERISTICS OF LITTORAL MATERIAL

Samples of shore and bottom materials were obtained by USCE from the Buhne Spit-Elk River Spit area at locations shown on Figure 2 in Appendix 2 of their Buhne Point Study 1956 (BPS). Shore samples were taken at midtide level, approximately 3.5 feet above mean lower low water, and bottom samples were taken in depths of 6 feet below mean lower low water. The samples were analyzed for grain size. Details of the analyses are contained in BPS appendix 2.

USCE found that the shore materials consisted of grayish-black colored, fine and medium sands, with median diameters ranging from 0.20 millimeter to 1.40 millimeters and sorting coefficients ranging from 1.24 to 3.34. The bottom samples were also grayish-black in color and consisted principally of fine sand having median diameters ranging from 0.22 to 0.25 millimeter and sorting coefficients ranging from 0.21 to 1.31. Of four bottom samples taken, 1 consisted of a sandy silt or clay with a median diameter and sorting coefficient of 0.017 and 3.74, respectively.

SUBSURFACE MATERIALS

For the USCE's Buhne Point Study, 1 boring was made in the Buhne Point area to a depth of 34 feet below mean lower low water at the location shown on Figure 2 in Appendix 2. The boring indicates that the problem area was underlain by a 4.5 foot layer of sand, silt, and loose sand and gravel extending to a depth of about 3 feet above mean lower low water. Below this elevation, the subsurface material consists of a gumbolike clay extending to 9 feet below mean lower low water. Additional borings were taken by USCE along the Fields Landing Channel in July 1974 for their "Navigation Channel Implementations Study" and indicates a gray silty clay at a depth of 29.5 feet MLLW. A comparison of the two borings confirms the presence of a sandy silty clay below any remaining sand on Buhne Spit.

SOURCES OF LITTORAL MATERIAL

USCE has identified five possible sources of littoral material available to the present shore in the study area.

These sources are: (a) sediment brought into the bay by tributary streams; (b) material from within Humboldt Bay made available by scouring action of currents and waves on the banks and channels and on shoals and shallow-bottom areas; (c) littoral material from the Pacific Ocean deposited in the bay channels by waves, tidal currents, or winds; (d) material dredged from project channels and dumped in the bay; and (e) material eroded from the Buhne Point area. Due to the nature of the tributary drainage areas and the size of the streams entering Humboldt Bay, the amount of sediment carried by streams is considered insignificant and will not be considered as a source for beach nourishment

In the Buhne Point area, marked changes have occurred in the shallow-water area between Buhne Spit and Elk River Spit. For the period 1911 to 1955, the net change in the shallow-water area has been erosion. Within the limits covered by the USCE 1955 survey, it was estimated that 2,107,000 cubic yards of bottom material below mean lower low water were eroded during this period. Some of this material may have been carried to shore by wave action and tidal currents.

LITTORAL TRANSPORT. Material derived from littoral transport along the Pacific Ocean shoreline may be deposited within the bay by waves, tidal currents, or winds. Based on studies made by USCE in connection with navigation improvements of Humboldt Bay, it appears that the predominant direction of littoral transport along the Pacific Ocean shoreline is from north to south. The net rate of transport is not known. However, the relative stability of the Humboldt Bay bar and of the shoreline of the South Spit seems to indicate a fairly constant supply of sand from littoral sources. Therefore, it is possible that littoral material deposited in the vicinity of the entrance channel is redeposited ultimately on the bar or moves past the jettied entrance.

BUHNE SPIT NOURISHMENT. Prior to 1950, material derived from maintenance dredging of the Humboldt Bay project channels was dumped within the limits of the Bay. As determined from available dredging maps, the principal dump areas were: (a) deep water at the bayward end of the entrance channel; (b) a deep water area west of the northern end of Fields Landing Channel; and (c) deep water near Fairhaven, in what is now part of North Bay Channel. Before 1915, no dredged material was dumped in the bay. Between 1915 and 1949, inclusively, it is estimated that 2,711,000 cubic yards of dredge spoil were dumped in the bay. Since 1950, all dredge spoil material has been deposited in the Pacific Ocean in deep water south of the bar and entrance channel.

Between 1854 and 1952, it has been estimated by USCE that 4,700,000 cubic yards of material were eroded from the Buhne Spit area. Table 4 gives the loss above elevation +6.0 (MLLW), that occurred for certain intervals during the period of record.

TABLE 4
EROSION AT BUHNE POINT AREA HUMBOLDT BAY
Above Elevation +6.0 Feet (MLLW)

Period	Years	Amount	Average Annual Rate
1854-1911	57	1,850,000	32,500
1911-1930	20	650,000	32,500
1930-1946	16	1,470,000	92,000
1946-1952 1/	6	780,000	130,000
1854-1952	99	4,750,000	48,000

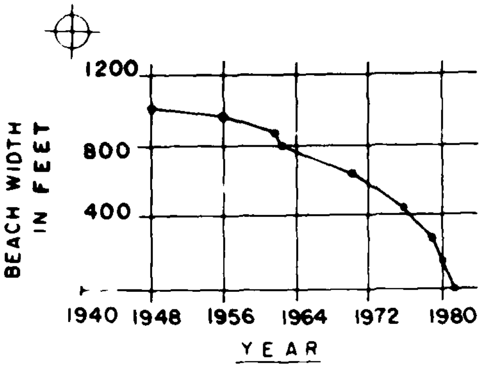
1/ Erosion during period 1946-52 based in part on a survey made in June 1955. However, the 1955 survey is considered to represent 1952 conditions at the point because the revetment, now protecting the shore, was constructed in 1952.

EROSION BUHNE SPIT

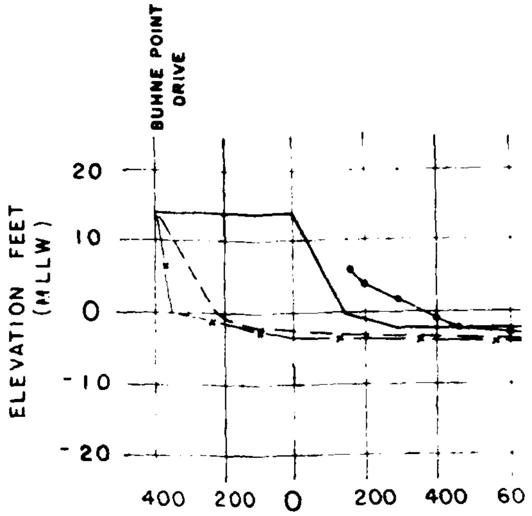
The Department of Boating and Waterways has compiled aerial photographs for the period 1948 through 1980 and transferred the interpreted high water line to a base map shown on Plate II to determine the area of the spit bounded by the present development at King Salmon. The area of the spit in 1948 was about 25 acres, increasing to about 29 acres in 1956, and was assumed to reach zero in the spring of 1982. There was a uniform rate of erosion on the spit from 1961 until 1979. The annual erosion rate was about 14,000 cubic yards per year. During this period the beach face eroded at a rate of about 27 feet per year. The average rate of erosion of the beach face from 1948 through 1980 was about 25 feet per year. The offshore profiles along USCE profile line NO. 15 indicate that only the sand fill area has suffered appreciable erosion. The offshore beyond the sand fill has maintained a fairly uniform elevation during the entire period, indicating very little erosion of the clayey material. Some scouring has occurred along the rock revetment paralleling Buhne Point Drive.

TRIBUTARY DRAINAGE

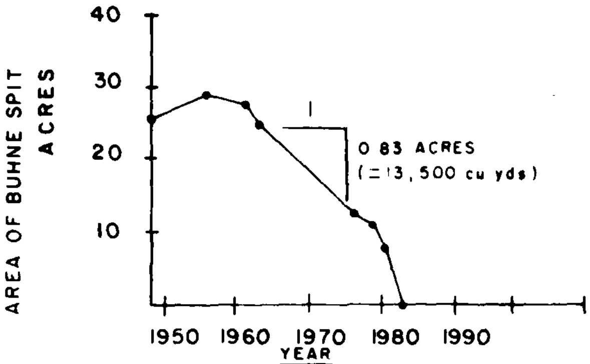
The drainage area tributary to Humboldt Bay is about 225 square miles in extent. The principal streams entering the bay between Eureka and the southerly limits of the bay are Elk River and Salmon Creek, which have drainage areas of 57



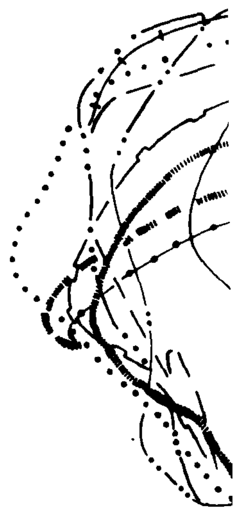
REDUCTION IN BEACH WIDTH
ALONG BASELINE A-A



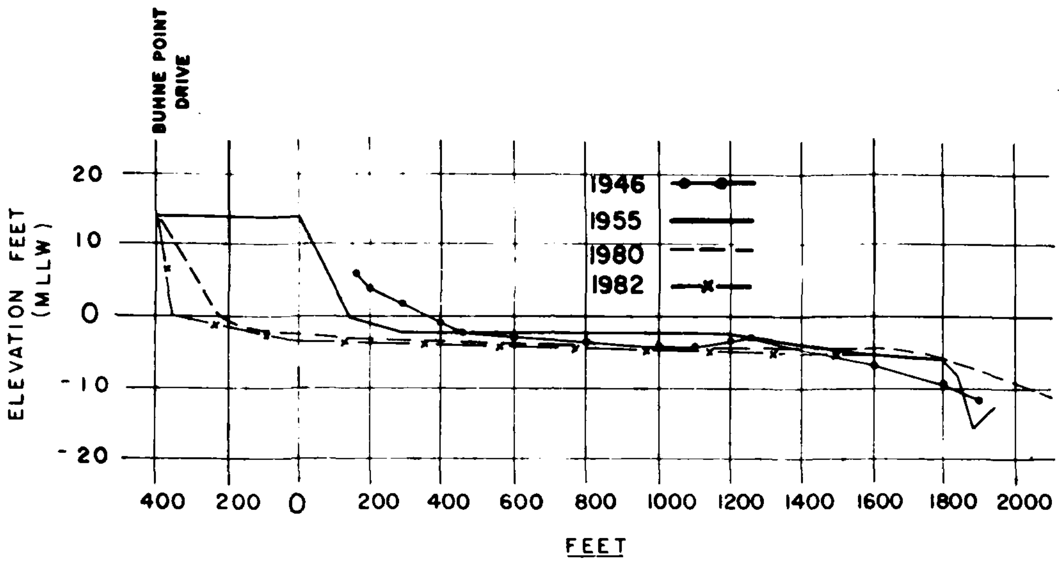
PR
ELEVA



LAND LOST BY EROSION



AERIAL PHOTOGRAPHY		
AGENCY	**DATE**	**PHOTO NO.**
U.S.C.E.	DEC. 1939	—
TELEDYNE	NOV. 6, 1941	7490-720
U.S.C.E.	DEC. 23, 1941	CVL-5B
U.S.C.E.	FEB. 8, 1942	R14 - 52
HUMBOLDT CO.	JUNE 22, 1948	CDF2-14-80
U.S.G.S.	DEC. 23, 1956	QUAD MAP
HUMBOLDT CO.	AUG. 1962	HCN-2-7-118
U.S.C.E.	DEC. 19, 1962	HH7-4
D.W.R.	MAY 14, 1970	76-8-58
D.N.O.D.	DEC. 19, 1976	AFU-C-124
AIR DATA SYSTEMS	JUNE 6, 1979	—
AIR DATA SYSTEMS	MARCH 24, 1980	23-124



PROFILE NO. 15

ELEVATION CHANGE (1946-1980)

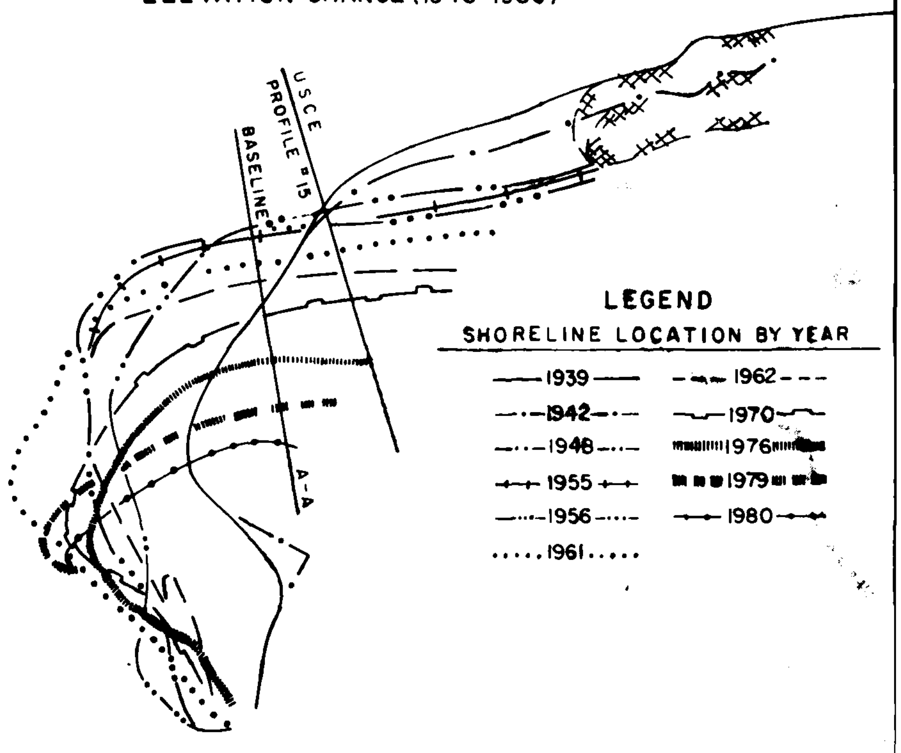
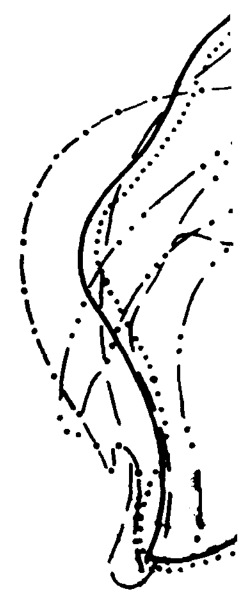


PHOTO NO.
7490 - 720
CVL - 58
R14 - 52
CDF2-14-80
QUAD MAP
HCN-2-7-118
HH7 - 4
76-8-58
AFU - C - 124
[illegible]3 - 124

PLATE II



LEGEND

SHORELINE LOCATIONS BY YEARS

—·—1955—·—

········1946········

———1939———

— — —1931— — —

—··—1929—··—

—···—1926—···—

NOTES:

Base Map is 1972 USGS Map of Fields Landing Quadrangle.

Shore line shown represents the approx. line of Mean High Water.

Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.

One foot depth contours (··?··) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. = -1.5).

Grid coordinates are from the Calif. Coordinate System Zone 1.

Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102.

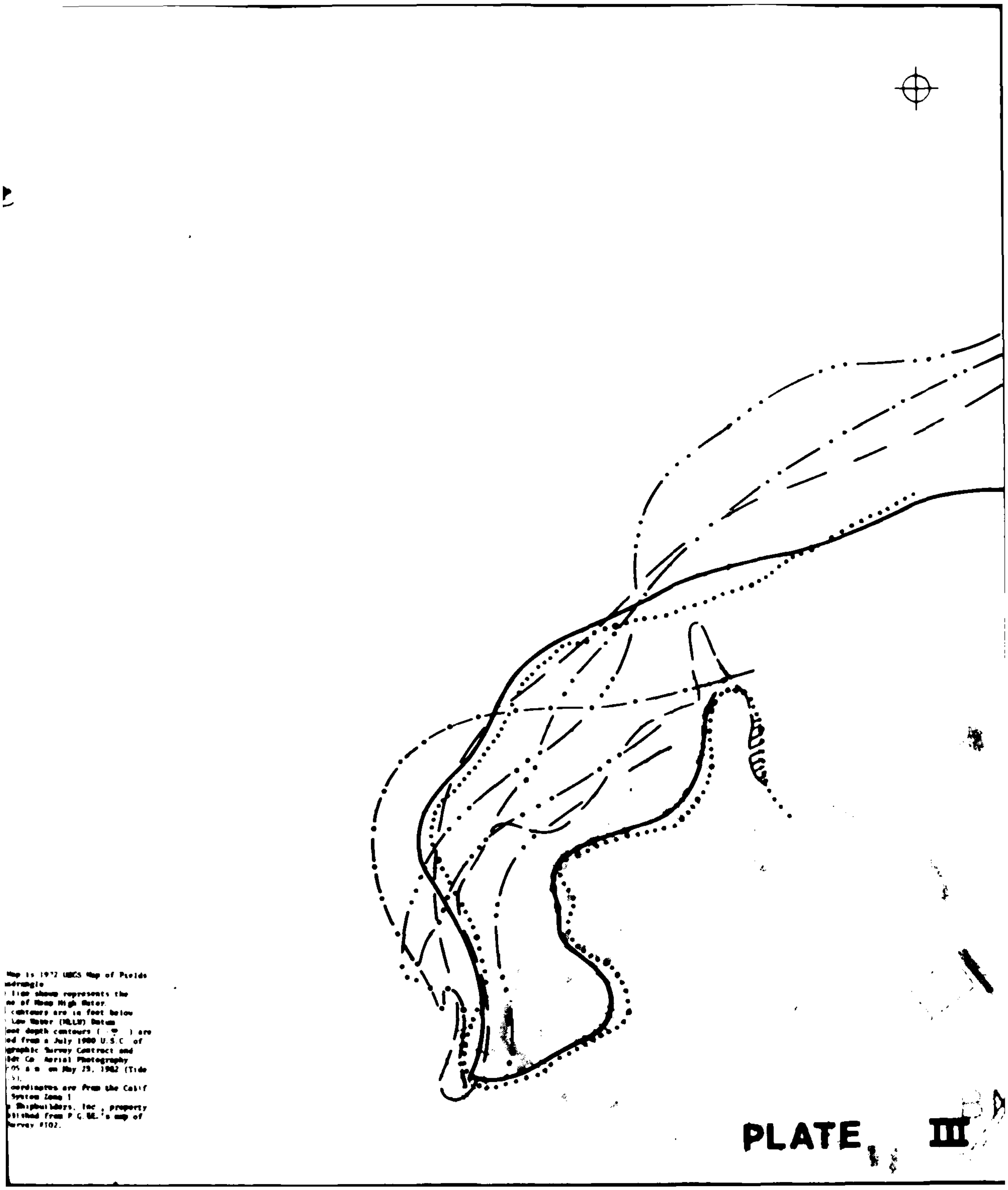

Map is 1972 USGS Map of Fields
ndrangle
line shown represents the
ne of Mean High Water.
contours are in feet below
Low Water (MLLW) Datum
foot depth contours ( ) are
ed from a July 1980 U.S.C of
graphic Survey Contract and
ldt Co. Aerial Photography
05 a.m. on May 25, 1982 (Tide
5).
oordinates are from the Calif
System Zone 1
Shipbuilders, Inc., property
blished from P.G.&E.'s map of
urvey #102.

PLATE III

and 17 square miles respectively. No data are available regarding runoff from or detritus carried by these streams. At the present time, Elk River drains an area consisting of, for the most part, second-growth timber lands on which selected logging is practiced. Even during periods of high runoff, Elk River is seldom able to break through Elk River Spit. Several attempts have been made to provide a channel across Elk River Spit but the river has not been able to maintain such a channel. This lack of sediment transport by the two major tributary streams confluencing with Humboldt Bay does not provide sufficient beach nourishment to sustain the sand bar and protective beaches in the Buhne Point to Elk River stretch of bayfront. The major beach nourishment material is transported into the bay through the jettied entrance across the navigation channels and onto the bar. The Corps of Engineers present maintenance dredging program which dredges the main navigation channels within the bay and deposits the dredge spoil at a deep ocean site has further depleted any beach nourishment material available to the the Buhne Spit area.

MAPS

The maps used in the preparation of this report include the latest and the historical editions of the National Ocean Survey Chart No. 18622 ; the U. S. Geological Survey quadrangle sheets for Eureka, Ferndale and Fortuna:and Corps of Engineers condition survey maps of Humboldt Bay. In addition, use was made of aerial photographs taken by various federal and state agencies for the years 1932 through 1982. These aerial photographs are on file in the Humboldt County Environmental Center. Maps were also prepared by the Department of Boating and Waterways to accompany this report.

SHORE OWNERSHIP

The entire Buhne Point area is privately owned. Buhne Spit has been developed as a fishing resort known as King Salmon Resort. No bathing beaches are involved within the proposed project area but the spit is utilized for sport fishing and clamming. The project area is presently owned in fee by the Eureka Shipbuilders Inc. and title to the property is in the process of being transferred to the Humboldt Bay Harbor, Recreation and Conservation District. The property line of the Eureka Shipbuilders holdings is delineated on the plan view of the project area on Plate II and is designated P/L.

BUHNE POINT/KING SALMON SHORE PROTECTION PROJECT

ENGINEERING DESIGN CRITERIA

The design of the rubble-mound structures in this project - breakwaters, seawalls, and groins - was done in accordance with procedures, tables, charts and criteria contained in the U.S. Army Corps of Engineers, SHORE PROTECTION MANUAL, Volumes I,II and III, dated 1977, (SPM), which was developed by their Coastal Engineering Research Center. The design wave selected was the largest wave possible that could break on the structure as determined by the still water depth (ds) at the toe of the structure. The design tidal stage is the estimated maximum high water level, which is +9.5 feet MLLW. The depth of the toe of the structure varies in the various structures. The average depth of the toe of the 400' offshore breakwater is -3.7' (MLLW) which will produce a still water depth of 13.2'. The average depth of the toe of the 2000' seawall varies from +0.0 feet at the south end to -1.5 feet MLLW at the northerly end, resulting in still water depths of 9.5' and 11.0' respectively. The depth of the toe of the outboard end of the groins is about -2.5' to -3.5' MLLW. The larger waves in this area have a period (T) of 8 to 14 seconds and a design wave period of 9 seconds was selected as explained in the section on Waves.

OFFSHORE BREAKWATER STRUCTURE: With d_s = 13' and T = 9 sec $d_s/gT^2 = 13/32.2\ (9)^2 = 0.00498$, from Fig 7-4 with $d_s/gT^2 = 0.005$ and m = 0.01; $H_b/d_s = 0.78$, so $H_b = 0.85 \times 13' = 11.0'$.

But with T = 14 sec , Hb/ds = 0.87 and Hb = 11.3'

So a design wave height of 11.5' was selected for the offshore structures. Using equation 7-110 from SPM to determine the nominal weight of the armour stone gives:

$$W = w_r H^3 / K_D (S_r - 1)^3 \text{ Cot } \theta = 12{,}724\# \text{ or } 6 \text{ Tons}$$

for a KD of 2.5 which anticipates that no damage would result from the design wave. These wave heights and rock sizes correspond very closely with the determinations of the Corps of Engineers in their Beach Erosion Control Report for Humboldt Bay (Buhne Point) dated 5 October 1956.

A top elevation of 7.0' was selected for the breakwater to enable it to practically eliminate any waves occurring at Mean High Tide and to substantially reduce any waves which might occur very rarely at the estimated highest water level of 9.5'. With a still water level of +6.0 feet MLLW the still water depth, d_s, is :

$$d_s = 6.0 + 3.7 = 9.7' \quad \text{and } h = 7.0 + 3.7 = 10.7'$$

Using a 1:2 slope on the breakwater and a top thickness, b, of 12.0' will give b/h=12/10.7=1.12 and h/ds=10.7/9.7=1.104; with ds/gT2 = 9.7/32.2 (9)2 = 0.0037, so interpolating from figure 7-40 & 7-41 gives Ht/Hi = 0.307, or Ht = 0.307 Hi which results in approx. 90% reduction of wave energy. With a still water level of 9.5', ds = 13.2, so ds / gT2 = 0.00506, and h/ds = 10.7 / 13.2 = 0.8106, so Ht = 0.575 Hi which results in approx. 66% reduction of the wave energy. The breakwater was placed about 250' offshore so it would be far enough from the shore to allow sand to accumulate behind it but not far enough to allow the waves to reform after they have broken over it.

RUBBLE-MOUND SEAWALL: For the seawall the ds varies from 11.0' to 9.5'. With m = 0.02, a ds = 12.0' would produce ds/gT2 = 0.004, and from Fig. 7-4 Hb = 0.94 ds = 10.34'. For ds = 9.5, Hb = 9.0'. Using equation 7-110 from the SPM again would indicate rock sizes of 5.0 Ton to 3.0 Ton with a K_D of 2.5.

Wave run-up was checked to determine the design height of the wall using ds= 11.0', m= 0.02, T= 9.0 sec, and Hb= 10.3'; so Hb/gT2 = 0.00395 and from Fig 7-5 Hb/Ho! = 1.2 which gives Ho! = 8.6', Ho!/gT2 = 0.0033, and ds/Ho! = 1.28. Using Cot θ = 2 (2:1 slope on the face of the seawall) and interpolating between Fig. 7-10 and 7-11 will result in R/Ho!=2.9 for a smooth surface. Therefore Rs=2.9 x 8.6=25.3' or Rr = 0.55 x 25.3 = 13.9'. This indicates run-up to elevation. 9.5 + 13.9 = 23.4' MLLW. Which is way above street level so run-up is rechecked using the composite slope method with a seawall to elev. 18.0' with a 10' wide top and a 2:1 slope.

Then H'_o =8.6, H'_o/gT^2 = 0.0033,

and H_o/L_o = 2 (H_o/gT^2) = 6.28 (0.0033) = 0.0207,

then from Fig 7-3 H_b =1.19 H'_o =10.2', and H'_b/gT^2 =0.00392.

From Fig 7-2 d_b/H_b = 1.15 so d_b = 1.15 x 10.2 = 11.73'

and X_b = (11.73 - 11.0)/0.02 = 36.5'

Then X=36.5+39+10=85.5, and Y=11.73+8.5=20.23, and Cot θ=4.23

with db/Ho =11.73/8.6=1.36. from Fig 7-10 & 7-11 R/Ho =1.73 Then R = 1.73 x 8.6 x 0.55 = 8.2' which would indicate run-up to elev. 8.2 + 9.5 = 17.7' in the very worst conditions. So elev 18.0' is considered high enough for this design.

RUBBLE-MOUND GROINS: With a maximum ds = 13' for the groins and a T= 9 sec. ds/gT2= 0.0046 and from Fig 7-4 Hb/ds= 0.85 for m = 0.01. So Hb will vary from 11.0' to 9.4'. Using equation 7-110 from the SPM again but using Kd = 4.0 will produce a rock size of 3.5 Tons to 2.2 Tons for the armour stone. The 2:1 slope would be used for 50' at the offshore end of the groin with a 1.5:1 slope on the rest of the length. It was anticipated that the protective sand beach would be built up to elev +10.0' MLLW so the top of the groin was set for +12.0' MLLW.

H-PILE WITH WOOD LAGGING GROIN: It is anticipated that the top of the sand fill upcoast of the groin would be elev. +10.0' max. The elev of the existing ground downcoast of the groin varies from 0.0 to -2.5' MLLW so the height of retained material would be 10 to 12 feet. General guidelines for cantilver sheet piles in fairly loose granular material call for a depth of penetration for the pile of 1.3 to 1.5 times the height of retained material. Using a factor of 1.5 would give a penetration length of 15 to 18 feet or a pile tip elev of -15' to -20' MLLW. For H-Beam piles with timber lagging, the penetration factor is increased to 2.0 which produces a penetration length of 20 to 24 feet and a pile tip elev. of -20' to -26' MLLW. Previous borings indicate that there may be some stiffer material at these depths and the tip elevation may be reduced somewhat in the final design. Experience at previous projects indicates that the 4" x 12" lagging on an 8' simple span are adequate and that HP 12 x 74 pilings will also be sufficient.

ALTERNATIVES COMPARISION

The recommended shore protection alternative was determined from two analvtical phases: (1) preliminary screening and, (2) final selection. Each of these comparative phases is described in the following sections.

PRELIMINARY SCREENING. A preliminary comparison of alternatives was used to eliminate those protection methods that clearly were less favorable than the others. This allowed the final selection to be more closely analyzed without unnecessary confusion. Since a relatively large number of alternatives were developed and analyzed, a numerical comparison was used for preliminary screening (see the following Table 5).

The numerical comparison relates to the previously described project goals and constraints. Under the general category of "function", two factors are listed. The first is "protection capability", which encompasses the probable effectiveness in controlling erosion and the justifiable feeling of well being by adjacent residents. The other factor is "engineering confidence" which includes an evaluation of each alternative's ability to provide long-term project life and to withstand structural or operational stresses due to extreme storm events.

The "economics" category relates simply to factors of expected "construction cost" and "maintenance cost" for each alternative. The higher ratings reflect lower costs. To further enhance the economic comparison, the table presents the estimated construction costs of each alternative in dollar amounts and relative maintenance costs in terms of high, moderate or low.

The "environmental" category also is divided into two factors, "social" and "biological". The social factor relates to protection of aesthetics, visual, recreational, and navigational aspects. The biological factor accounts for impacts upon burial and destruction of habitats.

TABLE 5

BUHNE POINT/KING SALMON HARBOR
SUMMARY OF COST ESTIMATES

PLAN	DESCRIPTION	TOTAL COST
A-3	1400' Curved Combination Groin w/400' Rubble Mound Breakwater.	$640,000
B-3	1600' Bent Combination Groin w/200' Rubble Mound Groin Upcoast.	$602,000
C	1750' Combination Groin W/200' Rubble-Mound Groin Upcoast.	$660,000
D	1400' Bent Combination Groin w/400' Rubble Mound Groin.	$615,000
E	1200' Bent Combination Groin w/2 Rubble-Mound Groins Upcoast (400' & 300').	$640,000
F	2000' Rubble-Mound Seawall along Buhne Point Drive.	$1,080,000
G-1	Import 490,000 cyds. of Sand Fill to Rebuild Spit to 1961 Alignment.	$1,970,000
G-3	Import 170,000 cyds. of Sand Fill to Rebuild Spit to 1980 Alignment.	$680,000
H	700' Curved Combination Groin w/3-350' Rubble Mound Breakwaters.	$736,000
I	1200' Curved Combination Groin w/550' "L" Shaped Rubble-Mound Groin.	$602,000
J-1	1300' H-Beam Pile & Timber Groin on South End w/450' Rubble-Mound Groin on North End Connected by a 950' Low Rubble-Mound Sill.	$795,000
J-2	J-1 + 350,000 cyds. Additional Sand Fill for Construction of a Perched Beach.	$2,200,000

From Tables 5 and 6, certain conclusions can be readily drawn. The alternatives ranked in the top four places all are a long groin/retaining structure with sand filled pockets. Each of these top four alternatives attained more than 20 points. This creates a preponderance of evidence that the recommended alternative should be selected from within the group:

(a) Alternative A-3, 1400' Groin w/400' Offshore Breawater
(b) Alternative D, 1400' Groin w/400' Upcoast Groin
(c) Alternative I, 1200' Groin w/550' "L" shaped groin
(d) Alternative J, 1300' Groin w/950' low sill & perched beach.

Three of the other alternatives also relied principally upon beach filled groin pockets but appear to provide less functionability, higher costs, and/or notably adverse social impacts. These include Alternatives B,C, and E. The various other configurations of the top four alternatives seem to be too costly for the degree of protection provided.

TABLE 6
DESIGN SELECTION TABLE

Rating Factor	Points Max	A-3	B-3	C	D	E	F	G-1	H	I	J-1
FUNCTION:											
Protection Capability	6	4	3	3	3	3	5	2	4	3	5
Engineering Confidence	6	5	2	2	4	3	5	1	4	4	5
COST :											
Construction Cost	6	4	5	4	5	4	2	1	3	6	3
Maintenance Cost	6	4	2	2	3	3	3	1	4	4	5
ENVIRONMENTAL:											
Social	6	4	2	2	4	4	1	2	3	4	4
Biological	6	5	3	3	4	4	2	2	5	4	3
TOTAL POINTS	36	26	19	17	23	21	18	9	23	25	25
RANKING		1	7	9	4	6	7	10	4	2	2

FINAL SELECTION. As a result of their inclusion in the final selection process, the long groin with the other alternate features were analyzed in more detail to more confidently assess comparative qualities.

Little comparative difference was found between these alternatives in the preliminary screening; therefore, the combination of long groin and offshore structure, the perched beach configuration and the long groin and upcoast groin were combined and analyzed. Because of the offshore depths and the three dimensional nature of the problem, a range of project effectiveness and costs can be achieved by the various combinations of groin length, length of offshore structure and segmentation configurations.

CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF FINDINGS: Approximately 2000 lineal feet of shoreline at Buhne Spit, located just west of King Salmon opposite the Humboldt Bay entrance jetties, persistently in the past few years has receded at rates of 15 to 27 feet per year, threatening Buhne Point Drive and adjacent residences. The shoreline recession is principally caused by waves and swell that enter Humboldt Bay through the navigation channel between the jetties. These waves (with annual recurrence heights of about 10 feet impact on the beach in the Buhne Spit area and transport sand along the spit and into Fields Landing Channel and PG&E's powerplant cooling water intake channel.

An analysis of the twelve shoreline protection measures demonstrates that placement of various groins, seawalls, or other structures upon Buhne Spit to retard erosion is preferable for this project. Some of the alternatives exhibit excessive maintenance costs and would require renourishment of the beach at frequent intervals.

Offshore structures that dissipate wave energy, thereby reducing erosional conditions at the shoreline, are favored over other protection methods. These offshore structures can function effectively over the long-term and form an open pocket beach for nourishment to move downcoast into the groin pocket. They avoid unacceptable impact upon the social and biological values of the spit. Their slight danger to shallow water navigation can be mitigated by navigational aids (buoys and/or lights).

RECOMMENDATIONS: Future project phases should concentrate upon the design and construction of a long groin and offshore rock rubble breakwater to protect the eroding shoreline from excessive wave energy and concomitant erosion problem. The final design phase should begin with establishment of precise design criteria relating to function, cost, and environmental protection. The long groin and offshore rock rubble breakwater with a crest elevation of about 7 feet MLLW can be constructed for about $640,000 and the configuration can be relied upon to substantially reduce long-term shore recession rates at Buhne Spit. This conceptual design can be altered to accomplish a wide variety of functional or cost requirements. The recommended design is Phase I of a total shore protection project to re-establish Buhne Spit to its approximate area in 1955. Subsequent phases include the placement of about 300,000 cubic yards of sand fill in the groin pocket established by Phase I. Beach nourishment would be furnished by USCE's periodic channel maintenance dredging within Humboldt Bay. Additionally, lengthening of the long groin would prevent sediment from being carried offshore and around the head of the groin during extreme winter wave conditions.

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APPENDIX A

COST ESTIMATES for ALTERNATE PLANS

at

BUHNE SPIT AREA

COST ESTIMATES

The cost estimates were prepared using 1983 mill price quotes for Mariner Steel at $670 per ton plus $120 for transportation from Pennsylvania to Eureka, Calif. Labor and equipment charges for installation were added at $3.03 per linear foot of pile for a vibratory driving system. This results in a unit price for the steel H-Beam piles of $32.20 per linear foot of pile installed. Wood prices used in these estimates were $300 per Thousand Board Foot for treated Doug Fir timber plus $1.00 per square foot for labor, equipment and misc. materials neccessary for installation which results in an installed price of $2.20 per square foot for the timber lagging. Prices for the rock and granular material were extracted from recent similair contracts in the project area.

In estimating the construction costs it was anticipated that the contractor would be allowed to import and compact granular material for a work platform/access road above high tide as part of his construction method. Although the amount of material could vary between alternatives and contractors, an amount of 25,000 cubic yards was considered with each alternate to maintain a consistent figure for comparison purposes. This material was estimated at a relatively low $3.00 per cubic yard.

Concrete and steel sheet piling were also considered for groin construction at the beginning of the estimating. But, as their costs appeared to be more than double the cost per linear foot of the other types of construction, they were dropped from consideration at an early stage.

Buhne Point/King Salmon Harbor

Summary of Cost Estimates

PLAN	DESCRIPTION	TOTAL COST
A-3	1400' Curved Combination Groin w/400' Rubble-Mound Breakwater	$ 640,000
B-3	1600' Bent Combination Groin w/200' Rubble-Mound Groin Upcoast	$ 609,000
C	1750' Combination Groin w/200' Rubble-Mound Groin Upcoast	$ 660,000
D	1400' Bent Combination Groin w/a 400' Rubble-Mound Groin	$ 615,000
E	1200' Bent Combination Groin w/2 Rubble-Mound Groins Upcoast (400' & 300')	$ 640,000
F	2000' Rubble-Mound Seawall along Buhne Dr.	$1,080,000
G-1	Import 490,000 cu.yd. Sand to Rebuild Spit to 1961 Alignment	$1,970,000
G-3	Import 170,000 cu.yd. Sand to Rebuild Spit to 1980 Alignment	$ 680,000
H	700' Curved Combination Groin w/3-350' Rubble-Mound Breakwaters	$ 736,000
I	1200' Curved Combination Groin w/550' "L" Shaped Rubble Mound Groin	$ 602,000
J-1	1300' H Beam Pile & Timber Groin on South End w/450' Rubble-Mound Groin on North End Connected by a 950' Low Rubble Mound Sill	$ 795,000
J-2	J-1 + 350,000 c.yds. Additional Sand Fill for Perched Beach	$2,200,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan A-1

I. Rock Rubble-Mound Groin Alternate

Item	Quantity	Unit	Cost	Amount	Total
1. 1400 LF Rock Groin					
Core material	4,340	cu.yd.	$ 6.00	$ 26,100	
Rock armour stone, 4 ton average	11,620	ton	20.00	232,400	
Bedding layer ½" Ø avg.	7,420	ton	15.00	111,300	
Toe rock, ½ ton avg.	1,870	ton	15.00	28,000	
Filter cloth	84,000	sq.ft.	.25	21,000	
					$418,000
2. 400 LF Rock Breakwater					
6 ton rock	4,280	ton	20.00	$ 85,600	
Bedding stone, 50# avg.	2,120	ton	15.00	31,800	
Sand dike access road	9,000	cu.yd.	4.00	36,000	
					$153,400
3. Imported Sand Fill					
Move sand dike	9,000	cu.yd.	1.50	13,500	
Additional sand	16,000	cu.yd.	3.00	48,000	
					$ 61,500
TOTAL ESTIMATED CONTRACT COST					$633,700
Engineering, Contract Admin. & Contingency					$126,300
TOTAL ESTIMATED PROJECT COST					$760,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan A-2

I. Steel H-Beam Piles w/Wood Lagging Alternate

Item	Quantity	Unit	Cost	Amount	Total
1. 1400 LF Pile Groin					
HP 12x74 piling	6,125	LF	$32.20	$197,300	
4x12 wood lagging	22,400	sq.ft.	2.20	49,300	
4 ton end rock	680	ton	20.00	13,600	
Sand dike access road	20,700	cu.yd.	4.00	82,800	
					$343,000
2. 400 LF Rock Breakwater					
6 ton rock	4,280	ton	20.00	$ 85,600	
Bedding stone, 50# avg.	2,120	ton	15.00	31,800	
Sand dike access road	9,000	cu.yd.	4.00	36,000	
					$153,400
3. Imported Sand Fill					
Move sand dike	25,000	cu.yd.	1.50	$ 37,500	
					$ 37,500
TOTAL ESTIMATED CONTRACT COST					$533,900
Engineering, Contract Admin. & Contingency					$107,100
TOTAL ESTIMATED PROJECT COST					$641,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan A-3

I. Combination Groin w/400' of Rubble-Mound Groin + 1000' of H-Beam Pile Groin

Item	Quantity	Unit	Cost	Amount	Total
1. 400 LF Rock Groin Section					
Core material	890	cu.yd.	$ 6.00	$ 5,300	
Rock armour stone, 4 ton average	2,995	ton	20.00	59,900	
Bedding layer ½" Ø avg.	1,987	ton	15.00	29,800	
Toe rock, ½ ton avg.	533	ton	15.00	8,000	
Filter cloth	24,000	sq.ft.	.25	6,000	
					$109,000
2. 1000 LF Pile Groin Section					
HP 12x74 piling	4,375	LF	32.20	$140,900	
4x12 wood lagging	15,000	sq.ft.	2.20	33,000	
Sand dike access road	14,000	cu.yd.	4.00	56,000	
					$229,900
3. 400 LF Rock Breakwater					
6 ton rock	4,280	ton	20.00	$ 85,600	
Bedding stone, 50# avg.	2,1[illegible]0	ton	15.00	31,800	
Sand dike access road	9,000	cu.yd.	4.00	36,000	
					$153,400
4. Imported Sand Fill					
Move sand dike	23,000	cu.yd.	1.50	$ 34,500	
Additional sand	2,000	cu.yd.	3.00	6,000	
					$ 40,500
TOTAL ESTIMATED CONTRACT COST					$532,800
Engineering, Contract Admin. & Contingency					$107,200
TOTAL ESTIMATED PROJECT COST					$640,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan B-1

I. Rock Rubble-Mound Groin Alternate

Item	Quantity	Unit	Cost	Amount	Total
1. 1600 LF Rock Groin					
Core material	4,960	cu.yd.	$ 6.00	$ 29,800	
Rock armour stone, 4 ton	13,280	ton	20.00	265,600	
Bedding layer, ½" Ø	8,480	ton	15.00	127,200	
Toe rock, ½ ton	2,130	ton	15.00	32,000	
Filter cloth	96,000	sq.ft.	.25	24,000	
					$478,500
2. 200 LF Rock Groin					
Core material	620	cu.yd.	6.00	$ 3,700	
Rock armour stone, 4 ton	1,660	ton	20.00	33,200	
Bedding layer, ½" Ø	1,060	ton	15.00	15,900	
Toe rock, ½ ton	267	ton	15.00	4,000	
Filter cloth	12,000	sq.ft.	.25	3,000	
					$ 59,900
3. Imported Sand Fill	25,000	cu.yd.	3.00		$ 75,000
TOTAL ESTIMATED CONTRACT COST					$613,400
Engineering, Contract Admin. & Contingency					$121,600
TOTAL ESTIMATED PROJECT COST					$735,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan B-2

I. Steel H-Beam Piles w/Wood Lagging Alternate

Item	Quantity	Unit	Cost	Amount	Total
1. 1400 LF Pile Groin					
HP 12x74 piling	7,000	LF	$32.20	$225,400	
4x12 wood lagging	25,600	sq.ft.	2.20	56,300	
4 ton end rock	680	ton	20.00	13,600	
Sand dike access road	23,680	cu.yd.	4.00	94,700	
					$390,000
2. 200 LF Rock Groin					
Core material	620	cu.yd.	6.00	$ 3,700	
Rock armour stone, 4 ton	1,660	ton	20.00	33,200	
Bedding layer, ½" Ø	1,060	ton	15.00	15,900	
Toe rock, ½ ton	267	ton	15.00	4,000	
Filter cloth	12,000	sq.ft.	.25	3,000	
					$ 59,000
3. Imported Sand Fill					
Move sand dike	23,500	cu.yd.	1.50	$ 35,300	
Additional sand	1,500	cu.yd.	3.00	4,500	
					$ 39,800
TOTAL ESTIMATED CONTRACT COST					$489,[illegible]
Engineering, Contract Admin. & Contingency					$ 98,[illegible]
TOTAL ESTIMATED PROJECT COST					$588,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan B-3

I. Combination Groin w/600' of Rubble-Mound Groin + 1000' of H-Beam Pile Groin

Item	Quantity	Unit	Cost	Amount	Total
1. 600 LF Rock Groin Section					
Core material	1,334	cu.yd.	$ 6.00	$ 8,000	
Rock armour stone, 4 ton	4,490	ton	20.00	89,800	
Bedding layer, ½" Ø	2,980	ton	15.00	44,700	
Toe rock, ½ ton	800	ton	15.00	12,000	
Filter cloth	36,000	sq.ft.	.25	9,000	
					$163,500
2. 1000 LF Pile Groin Section					
HP 12x74 piling	4,375	LF	32.20	$140,900	
4x12 wood lagging	15,000	sq.ft.	2.20	33,000	
Sand dike access road	14,000	cu.yd.	4.00	56,000	
					$229,900
3. 200 LF Rock Groin					
Core material	620	cu.yd.	6.00	$ 3,700	
Rock armour stone, 4 ton	1,660	ton	20.00	33,200	
Bedding layer, ½" Ø	1,060	ton	15.00	15,900	
Toe rock, ½ ton	267	ton	15.00	4,000	
Filter cloth	12,000	sq.ft.	.25	3,000	
					$ 59,900
4. Imported Sand Fill					
Move sand dike	14,000	cu.yd.	1.50	$ 21,000	
Additional sand	11,000	cu.yd.	3.00	33,000	
					$ 54,000
TOTAL ESTIMATED CONTRACT COST					$507,300
Engineering, Contract Admin. & Contingency					$101,700
TOTAL ESTIMATED PROJECT COST					$609,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan C

I. 1750' Combination Groin w/200' Rubble-Mound Groin

Item	Quantity	Unit	Cost	Amount	Total
1. 750' Section of Rubble-Mount in Combination Groin					
Core material	1,667	cu.yd.	$ 6.00	$ 10,000	
Rock armour stone, 4 ton	5,613	ton	20.00	112,300	
Bedding layer, ½" Ø	3,725	ton	15.00	55,900	
Toe rock, ½ ton	1,000	ton	15.00	15,000	
Filter cloth	45,000	sq.ft.	.25	11,200	
					$204,400
2. 1000' Section of H-Beam Piles in Combination Groin					
HP 12x74 piling	4,375	LF	32.20	$140,900	
4x12 wood lagging	15,000	sq.ft.	2.20	33,000	
Sand dike access road	14,000	cu.yd.	4.00	56,000	
					$229,900
3. 200' Rock Rubble-Mound Groin					
Core material	620	cu.yd.	6.00	$ 3,700	
Rock armour stone, 4 ton	1,660	ton	20.00	33,200	
Bedding layer, ½" Ø	1,060	ton	15.00	15,900	
Toe rock, ½ ton	267	ton	15.00	4,000	
Filter cloth	12,000	sq.ft.	.25	3,000	
					$ 59,900
4. Imported Sand Fill					
Move sand dike	14,000	cu.yd.	1.50	$ 21,000	
Additional sand fill	11,000	cu.yd.	3.00	33,000	
					$ 54,000
TOTAL ESTIMATED CONTRACT COST					$548,200
Engineering, Contract Admin. & Contingency					$111,800
TOTAL ESTIMATED PROJECT COST					$660,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan D

I. 1400' Combination Groin w/400' Rubble-Mound Groin

Item	Quantity	Unit	Cost	Amount	Total
1. 400' Section of Rubble-Mound in Combination Groin					
Core material	888	cu.yd.	$ 6.00	$ 5,300	
Rock armour stone, 4 ton	3,000	ton	20.00	60,000	
Bedding layer, ½" Ø	2,000	ton	15.00	30,000	
Toe rock, ½ ton	533	ton	15.00	8,000	
Filter cloth	24,000	sq.ft.	.25	6,000	
					$109,300
2. 1000' Section of H-Beam Piles in Combination Groin					
HP 12x74 piling	4,375	LF	32.20	$140,900	
4x12 wood lagging	15,000	sq.ft.	2.20	33,000	
Sand dike access road	14,000	cu.yd.	4.00	56,000	
					$229,900
3. 400' Rock Rubble-Mound Groin					
Core material	1,240	cu.yd.	6.00	$ 7,400	
Rock armour stone, 4 ton	3,320	ton	20.00	66,400	
Bedding layer, ½" Ø	2,120	ton	15.00	31,800	
Toe rock, ½ ton	533	ton	15.00	8,000	
Filter cloth	24,000	sq.ft.	.25	6,000	
					$119,800
4. Imported Sand Fill					
Move sand dike	14,000	cu.yd.	1.50	$ 21,000	
Additional sand fill	11,000	cu.yd.	3.00	33,000	
					$ 54,000
TOTAL ESTIMATED CONTRACT COST					$513,000
Engineering, Contract Admin. & Contingency					$102,000
TOTAL ESTIMATED PROJECT COST					$615,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan E

I. 1200' Combination Groin w/400' & 300' Rubble-Mound Groins

Item	Quantity	Unit	Cost	Amount	Total
1. 300' Section of Rubble-Mound in Combination Groin					
Core material	666	cu.yd.	$ 6.00	$ 4,000	
Rock armour stone, 4 ton	2,250	ton	20.00	45,000	
Bedding layer, ½" Ø	1,500	ton	15.00	22,500	
Toe rock, ½ ton	400	ton	15.00	6,000	
Filter cloth	18,000	sq.ft.	.25	4,500	
					$ 82,000
2. 900' Section of H-Beam Piles in Combination Groin					
HP 12x74 piling	3,940	LF	32.20	$126,900	
4x12 wood lagging	13,500	sq.ft.	2.20	29,700	
Sand dike access road	12,600	cu.yd.	4.00	50,400	
					$207,000
3. 400' Rock Rubble-Mound Groin					
Core material	888	cu.yd.	6.00	$ 5,300	
Rock armour stone, 4 ton	3,000	ton	20.00	60,000	
Bedding layer, ½" Ø	2,000	ton	15.00	30,000	
Toe rock, ½ ton	533	ton	15.00	8,000	
					$103,300
4. 300' Rock Rubble-Mound Groin					
Core material	930	cu.yd.	6.00	$ 5,600	
Rock armour stone, 4 ton	2,490	ton	20.00	49,800	
Bedding layer, ½" Ø	1,590	ton	15.00	23,900	
Toe Rock, ½ ton	400	ton	15.00	6,000	
					$ 85,300
5. Imported Sand Fill					
Move sand dike	12,500	cu.yd.	1.50	$ 18,700	
Additional sand fill	12,500	cu.yd.	3.00	37,500	
					$ 56,200
TOTAL ESTIMATED CONTRACT COST					$533,800
Engineering, Contract Admin. & Contingency					$106,200
TOTAL ESTIMATED PROJECT COST					$640,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan F

I. 2000' Permanent Rock Seawall Along Buhne Drive

Item	Quantity	Unit	Cost	Amount	Total
1. 1200' of Rock Seawall using 6 ton Armour Stone					
Sand excavation	13,200	cu.yd.	$ 3.00	$ 39,600	
Move/re-use exist. rock	6,000	ton	7.00	42,000	
Rock armour stone, 6 ton	15,000	ton	20.000	300,000	
Rock riprap, 1 ton	9,700	ton	15.00	145,000	
Bedding layer	4,200	ton	12.00	50,400	
					$577,500
2. 800' of Rock Seawall using 4 ton Armour Stone					
Sand excavation	3,600	cu.yd.	3.00	$ 10,800	
Move/re-use exist. rock	4,000	ton	7.00	28,000	
Rock armour stone, 4 ton	5,520	ton	20.00	110,400	
Rock riprap, 3/4 ton	4,600	ton	15.00	69,000	
Bedding layer	2,600	ton	12.00	31,200	
					$249,400
3. Imported Sand Fill	25,000	cu.yd.	3.00		75,000
TOTAL ESTIMATED CONTRACT COST					$901,900
Engineering, Contract Admin. & Contingency (20% ±)					$178,100
TOTAL ESTIMATED PROJECT COST					$1,080,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan G

I. Import Sand to Rebuild Spit to Approx. 1961 Alignment

1.	Imported Sand Fill - 490,000 cu.yds. @ $3.50 -	$1,715,000
2.	Engineering, Contract Admin. & Contingency (15% ±) -	255,000
	TOTAL ESTIMATED PROJECT COST	$1,970,000

III. Import Sand to Rebuild Spit to Approx. 1980 Alignment

1.	Imported Sand Fill - 170,000 cu.yds. @ $3.50 -	$ 595,000
2.	Engineering, Contract Admin. & Contingency (15% ±) -	85,000
	TOTAL ESTIMATED PROJECT COST	$ 680,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan H

I. 700' Combination Groin w/three - 350' Rock Rubble Breakwaters

Item	Quantity	Unit	Cost	Amount	Total
1. 200' Section of Rubble-Mound in Combination Groin					
Core material	236	cu.yd.	$ 6.00	$ 1,400	
Rock armour stone, 4 ton	1,264	ton	20.00	25,300	
Bedding layer, ½" Ø	1,028	ton	15.00	15,400	
Toe rock, ½ ton	266	ton	15.00	4,000	
Filter cloth	10,000	sq.ft.	.25	2,500	
					$ 48,600
2. 500' Section of H-Beam Piles in Combination Groin					
HP 12x74 piling	2,064	LF	32.20	$ 66,500	
4x12 wood lagging	7,500	sq.ft.	2.20	16,500	
Sand dike access	7,000	cu.yd.	4.00	28,000	
					$111,000
3. Three - 350' Rock Rubble Breakwaters					
Rock armour stone, 6 ton	11,340	ton	20.00	$226,800	
Bedding stone, 50#	6,300	ton	15.00	94,500	
Sand dike access	23,800	cu.yd.	4.00	95,200	
					$416,500
4. Move Sand Dikes	25,000	cu.yd.	1.50		37,500
TOTAL ESTIMATED CONTRACT COST					$613,600
Engineering, Contract Admin. & Contingency (20% +)					122,400
TOTAL ESTIMATED PROJECT COST					$736,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan I

I. 1200' Combination Groin w/550' "L" shaped Rubble-Mound Groin

Item	Quantity	Unit	Cost	Amount	Total
1. 300' Section of Rubble-Mound in Combination Groin					
Core material	666	cu.yd.	$ 6.00	$ 4,000	
Rock armour stone, 4 ton	2,250	ton	20.00	45,000	
Bedding layer, ½" Ø	1,500	ton	15.00	22,500	
Toe rock, ½ ton	400	ton	15.00	6,000	
Filter cloth	18,000	sq.ft.	.25	4,500	
					$ 82,000
2. 900' Section of H-Beam Piles w/Wood Lagging in Combination Groin					
HP 12x74 piling	3,940	LF	32.20	$126,900	
4x12 treated timber lagging	13,500	sq.ft.	2.20	29,700	
Sand dike access	12,600	cu.yd.	4.00	50,400	
					$207,000
3. 550' "L" Shaped Rubble-Mound Groin					
Core material	1,705	cu.yd.	6.00	$ 10,200	
Rock armour stone, 4 ton	4,565	ton	20.00	91,300	
Bedding layer, ½" Ø	2,915	ton	15.00	43,700	
Toe rock, ½ ton	732	ton	15.00	11,000	
					$156,200
4. Imported Sand Fill					
Move sand dike	12,500	cu.yd.	1.50	$ 18,800	
Additional sand fill	12,500	cu.yd.	3.00	37,500	
					$ 56,300
TOTAL ESTIMATED CONTRACT COST					$501,500
Engineering, Contract Admin. & Contingency (20% ±)					$100,500
TOTAL ESTIMATED PROJECT COST					$602,000

Buhne Point/King Salmon Harbor

Cost Estimate for Plan J

1. 800' Curved H-Beam Pile Groin w/400' Rubble-Mound Groin & 1400' Rubble-Mound Low Sill

Item	Quantity	Unit	Cost	Amount	Total
1. 1300' H Beam Pile w/Wood Lagging Groin					
HP 12x74 piling	5,850	LF	$32.20	$188,400	
4x12 treated timber lagging	20,800	sq.ft.	2.20	45,800	
Sand dike access	18,200	cu.yd.	4.00	72,800	
					$307,000
2. 450' Rubble Mound Groin					
Core material	1,395	cu.yd.	6.00	$ 8,400	
Rock armour stone, 4 ton	3,735	ton	20.00	74,700	
Bedding layer, ½" Ø	2,385	ton	15.00	35,800	
Toe rock, ½ ton	600	ton	15.00	9,000	
					$127,900
3. 950' Rubble-Mound Sill					
Rock armour stone, 1 ton	3,565	ton	20.00	$ 71,300	
Bedding stone, 50'	4,180	ton	15.00	62,700	
Filter cloth	11,300	sq.ft.	.25	2,900	
Sand dike access	13,300	cu.yd.	4.00	53,200	
					$190,100
4. Move Sand Dike	25,000	cu.yd.	1.50		$ 37,500
TOTAL ESTIMATED CONTRACT COST					$662,500
Engineering, Contract Admin. & Contingency (20% ±)					$132,500
TOTAL ESTIMATED PROJECT COST					$795,000

APPENDIX B

WAVE DATA STATISTICS and SUMMARY

for

HUMBOLDT BAY AREA

WAVE DATA STATISTICS

The following pages of data were reproduced from the California Coastal Data Collection Program's monthly reports and from the Deep-Water Wave Statistics for the California Coast, Report for Station 2. This data, along with the summary sheet, were used to select the design wave conditions that the Pacific Ocean area could reasonably be expected to experience on a recurring basis. Wave heights are recorded as the H_s or $H_{1/3}$ value. The significant wave height is the average height of the highest 33 percent of waves for the specified time period. The Shore Protection Manual recommends that the H_{10} wave height be used as the design wave height along the North Pacific Coast. The H_{10} wave height is the average height of the highest 10 percent of waves for the specified time. The $H_{1/3}$ wave can be converted to a H_{10} wave height using the equation $H_{10} = 1.27 \times H_s$.

CALIFORNIA COASTAL DATA PROGRAM

Humboldt Bay Wave Rider (Inner)

Number Of Days in Month That Significant Wave Height < 18-Feet

Wave Height (Feet)	YEAR 1981 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	OCT	NOV	YEAR 1982 JAN	FEB	MAR	APR	MAY	Total Occ's (Days)
18+	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4
16-18	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4
14-16	3	1	2	-	-	-	-	-	1	3	4	-	2	-	-	16
12-14	1	2	4	2	-	1	-	-	2	3	3	-	3	1	1	23
10-12	5	2	9	3	1	1	-	-	1	4	4	1	6	4	5	46
8-10	1	4	6	7	5	2	4	-	5	4	4	2	4	4	5	57
6-8	2	6	4	11	6	5	10	8	5	7	2	1	4	7	9	87
4-6	0	5	3	5	11	12	9	13	12	2	2	2	3	9	5	93
2-4	0	3	0	2	7	7	6	10	4	1	1	1	1	3	6	52
0-2	14	5	3	0	1	2	2	-	1	0*	0*	-	1	0	0	29
Total	31	28	31	30	31	30	31	31	31	25	20	7	24	30	31	411

* Gage not recording part of month

DEEP-WATER WAVE STATISTICS
of the
CALIFORNIA COAST--STATION 2
January 1951-1974
PERIOD FREQUENCY OF OCCURRENCE DISTRIBUTION
COMBINED SEA/SWELL

WAVE PERIOD (Seconds) / WAVE HEIGHT (Feet)	4-6	6-8	8-10	10-12	12-14	14-16	16-+	TOTAL OCC'S
23.0- +	-	-	-	2	10	2	-	14
19.7-23.0	-	-	-	17	2	-	-	19
16.4-19.7			19	38	5	2	-	64
13.1-16.4		1	112	7	17	3	-	140
9.8-13.1	-	114	220	38	22	5	3	402
8.2-09.8		289	34	38	18	9	6	394
6.6-08.2	13	493	107	37	41	14	21	726
4.9-06.6	372	499	135	87	64	62	38	1257
3.3-04.9	934	334	169	121	183	147	21	1909
1.6-03.3	633	271	115	111	270	55	4	1469
0.0-01.6	10	75	31	16	63	15	3	213
TOTAL	2012	2031	942	512	700	314	95	6607

COASTAL DATA INFORMATION PROGRAM

US Army Corps of Engineers

State of California
The Resources Agency
DEPARTMENT OF BOATING AND WATERWAYS

HUMBOLDT BAY BUOY (OUTER)
JAN 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- FEET OR LESS

FEET	DAYS			
1	0.			
2	0.			
3	0.			
4	0.			
5	0.			
6	0.			
7	0.			
8	1.	1.		
9	1.	2.		
10	1.	2.		
11	1.	2.	3.	
12	2.	1.	3.	3.

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR JAN 1981

DATE (JAN)	1	2	3	4	5	6	7
SIG. HT (FT.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (JAN)	8	9	10	11	12	13	14
SIG. HT (FT.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (JAN)	15	16	17	18	19	20	21
SIG. HT (FT.)	12.0	11.1	15.1	12.4	14.2	18.1	21.5

DATE (JAN)	22	23	24	25	26	27	28
SIG. HT (FT.)	19.0	16.5	11.0	8.0	12.3	17.7	14.5

DATE (JAN)	29	30	31
SIG. HT (FT.)	11.5	9.4	7.7

HUMBOLDT BAY BUOY (INNER)
FEB 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- FEET OR LESS

FEET	DAYS				
1	0,				
2	0,				
3	1,				
4	3,	2,			
5	8,				
6	9,				
7	9,	1,	1,	1,	
8	12,	1,	1,	2,	
9	13,	1,	1,	1,	2,
10	13,	2,	1,	1,	2,
11	16,	1,	1,	2,	
12	19,	1,	2,		

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR FEB 1981

DATE (FEB)	1	2	3	4	5	6	7
SIG. HT (FT.)	8.6	8.1	6.4	5.5	4.4	3.9	3.9

DATE (FEB)	8	9	10	11	12	13	14
SIG. HT (FT.)	5.0	3.4	4.1	5.3	7.6	7.9	10.9

DATE (FEB)	15	16	17	18	19	20	21
SIG. HT (FT.)	9.6	7.4	12.2	7.3	12.1	16.0	9.2

DATE (FEB)	22	23	24	25	26	27	28
SIG. HT (FT.)	0.0	0.0	0.0	0.0	0.0	7.1	8.1

DATE (FEB)	29	30	31
SIG. HT (FT.)	0.0	0.0	0.0

HUMBOLDT BAY BUOY (INNER)
MAR 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- FEET OR LESS

FEET	DAYS								
1	0.								
2	0.								
3	0.								
4	0.								
5	1.								
6	1.	2.							
7	1.	1.	1.	2.					
8	1.	1.	1.	1.	1.	1.	2.	1.	
9	3.	1.	1.	1.	2.	2.	1.	1.	
10	3.	2.	1.	1.	1.	5.	1.	2.	
11	3.	2.	1.	2.	1.	5.	1.	1.	2.
12	3.	2.	6.	6.	1.	4.			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAR 1981

DATE (MAR)	1	2	3	4	5	6	7
SIG. HT (FT.)	6.8	8.9	5.5	14.7	10.0	8.2	14.3

DATE (MAR)	8	9	10	11	12	13	14
SIG. HT (FT.)	13.7	9.6	11.9	11.5	7.3	11.7	7.5

DATE (MAR)	15	16	17	18	19	20	21
SIG. HT (FT.)	13.1	11.6	9.1	8.1	10.3	5.8	5.3

DATE (MAR)	22	23	24	25	26	27	28
SIG. HT (FT.)	0.0	0.0	0.0	11.0	12.7	13.9	7.5

DATE (MAR)	29	30	31
SIG. HT (FT.)	11.9	10.4	9.2

HUMBOLDT BAY BUOY (INNER)
APR 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- FEET OR LESS

FEET	DAYS				
1	0,				
2	0,				
3	1,	1,			
4	1,	1,			
5	2,	1,	2,	1,	
6	4,	1,	2,	1,	
7	1,	1,	7,	1,	7,
8	2,	2,	11,	8,	
9	2,	14,	8,		
10	2,	15,	8,		
11	4,	24,			
12	5,	24,			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR APR 1981

DATE (APR)	1	2	3	4	5	6	7
SIG. HT (FT.)	10.5	11.0	8.0	7.2	12.3	13.2	9.7

DATE (APR)	8	9	10	11	12	13	14
SIG. HT (FT.)	7.1	8.1	8.5	8.4	8.2	4.5	3.1

DATE (APR)	15	16	17	18	19	20	21
SIG. HT (FT.)	5.6	6.2	7.3	7.4	4.7	7.8	7.1

DATE (APR)	22	23	24	25	26	27	28
SIG. HT (FT.)	10.6	8.3	7.2	6.6	4.9	3.4	6.9

DATE (APR)	29	30	31
SIG. HT (FT.)	7.3	4.6	0.0

HUMBOLDT BAY BUOY (INNER)
MAY 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.50	0,				
1.00	1,	1,			
1.50	1,	1,	1,	4,	3,
2.00	6,	6,	10,	1,	
2.50	7,	20,			
3.00	9,	21,			
3.50	31,				
4.00	31,				
4.50	31,				
5.00	31,				
5.50	31,				
6.00	31,				

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAY 1981

DATE (MAY)	1	2	3	4	5	6	7
SIG. HT (M.)	2.5	2.5	1.8	1.7	2.0	1.7	1.9

DATE (MAY)	8	9	10	11	12	13	14
SIG. HT (M.)	0.9	2.8	3.4	2.6	2.1	0.9	1.6

DATE (MAY)	15	16	17	18	19	20	21
SIG. HT (M.)	1.8	1.7	1.0	1.9	2.1	1.9	1.4

DATE (MAY)	22	23	24	25	26	27	28
SIG. HT (M.)	1.2	1.2	1.2	1.6	1.8	1.4	1.1

DATE (MAY)	29	30	31
SIG. HT (M.)	1.4	2.2	1.9

HUMBOLDT BAY BUOY (INNER)
JUN 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS					
0.50	0.					
1.00	2.	1.				
1.50	3.	5.	2.	1.	1.	1.
2.00	13.	6.	1.	1.	2.	
2.50	13.	6.	1.	2.	2.	
3.00	13.	6.	4.	3.		
3.50	13.	6.	5.	3.		
4.00	13.	6.	9.			
4.50	13.	6.	9.			
5.00	13.	6.	9.			
5.50	13.	6.	9.			
6.00	13.	6.	9.			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR JUN 1981

DATE (JUN)	1	2	3	4	5	6	7
SIG. HT (M.)	1.5	0.9	1.0	1.6	1.6	2.0	1.7

DATE (JUN)	8	9	10	11	12	13	14
SIG. HT (M.)	1.7	1.3	1.3	1.1	1.2	1.2	0.0

DATE (JUN)	15	16	17	18	19	20	21
SIG. HT (M.)	0.9	1.3	1.9	1.6	1.4	1.6	0.0

DATE (JUN)	22	23	24	25	26	27	28
SIG. HT (M.)	1.5	2.8	2.1	1.9	3.4	3.7	2.7

DATE (JUN)	29	30	31
SIG. HT (M.)	2.0	1.0	0.0

HUMBOLDT BAY BUOY (INNER)
JUL 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.5	0,				
1.0	0,				
1.5	1,	1,			
2.0	4,	1,	2,		
2.5	4,	4,	4,	2,	1,
3.0	11,	8,	7,		
3.5	12,	10,	7,		
4.0	12,	10,	7,		
4.5	12,	10,	7,		
5.0	12,	10,	7,		
5.5	12,	10,	7,		
6.0	12,	10,	7,		

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR JUL 1981

DATE (JUL)	1	2	3	4	5	6	7
SIG. HT (M.)	3.0	2.5	1.2	0.8	1.2	1.4	2.1

DATE (JUL)	8	9	10	11	12	13	14
SIG. HT (M.)	2.2	0.8	1.6	1.8	1.6	0.0	2.1

DATE (JUL)	15	16	17	18	19	20	21
SIG. HT (M.)	2.2	1.8	1.4	1.1	1.6	2.1	2.2

DATE (JUL)	22	23	24	25	26	27	28
SIG. HT (M.)	2.5	2.9	0.0	2.3	2.2	1.7	1.7

DATE (JUL)	29	30	31
SIG. HT (M.)	2.1	2.1	1.9

HUMBOLDT BAY BUOY (INNER)
AUG 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.5	0,				
1.0	0,				
1.5	3,	6,			
2.0	5,	7,	2,	1,	
2.5	7,	3,	9,	3,	1,
3.0	31,				
3.5	31,				
4.0	31,				
4.5	31,				
5.0	31,				
5.5	31,				
6.0	31,				

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR AUG 1981

DATE (AUG)	1	2	3	4	5	6	7
SIG. HT (M.)	1.1	0.8	0.7	0.8	1.4	1.6	1.8

DATE (AUG)	8	9	10	11	12	13	14
SIG. HT (M.)	2.2	1.8	1.7	1.8	2.3	2.2	1.7

DATE (AUG)	15	16	17	18	19	20	21
SIG. HT (M.)	1.4	0.8	0.7	0.9	0.9	0.7	0.7

DATE (AUG)	22	23	24	25	26	27	28
SIG. HT (M.)	1.6	2.3	1.7	1.4	1.4	2.4	2.2

DATE (AUG)	29	30	31				
SIG. HT (M.)	1.3	2.1	2.3	,			

HUMBOLDT BAY BUOY (INNER)
OCT 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS			
0.5	0,			
1.0	1,	2,		
1.5	1,	6,	1,	
2.0	3,	10,	3,	2,
2.5	4,	16,	2,	1,
3.0	6,	16,	3,	1,
3.5	6,	16,	3,	2,
4.0	6,	16,	6,	
4.5	24,	6,		
5.0	24,	6,		
5.5	24,	6,		
6.0	24,	6,		

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR OCT 1981

DATE (OCT)	1	2	3	4	5	6	7
SIG. HT (M.)	2.5	2.2	1.8	1.7	1.3	2.9	4.3

DATE (OCT)	8	9	10	11	12	13	14
SIG. HT (M.)	4.2	2.2	2.4	1.8	1.7	1.7	1.4

DATE (OCT)	15	16	17	18	19	20	21
SIG. HT (M.)	0.9	1.1	1.0	0.8	1.0	1.8	2.1

DATE (OCT)	22	23	24	25	26	27	28
SIG. HT (M.)	1.6	1.3	1.5	0.0	1.8	1.6	2.8

DATE (OCT)	29	30	31
SIG. HT (M.)	3.8	3.1	2.3

HUMBOLDT BAY BUOY (INNER)
NOV 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.5	0,				
1.0	0,				
1.5	2,				
2.0	1,	3,			
2.5	3,	5,	1,	1,	1,
3.0	9,	1,	2,	1,	1,
3.5	9,	6,	2,		
4.0	11,	7,	2,		
4.5	13,	8,	2,		
5.0	13,	11,			
5.5	13,	11,			
6.0	13,	11,			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR NOV 1981

DATE (NOV)	1	2	3	4	5	6	7
SIG. HT (M.)	2.3	1.9	2.3	3.0	2.1	2.1	1.8

DATE (NOV)	8	9	10	11	12	13	14
SIG. HT (M.)	1.4	1.1	3.7	4.0	4.5	4.4	7.1

DATE (NOV)	15	16	17	18	19	20	21
SIG. HT (M.)	3.6	2.8	3.1	2.9	2.4	3.5	2.5

DATE (NOV)	22	23	24	25	26	27	28
SIG. HT (M.)	4.2	4.8	3.4	2.4	0.0	0.0	0.0

DATE (NOV)	29	30	31
SIG. HT (M.)	0.0	0.0	0.0

HUMBOLDT BAY BUOY (INNER)
JAN 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS			
0.5	0.			
1.0	0.			
1.5	1.	1.		
2.0	4.			
2.5	5.			
3.0	5.	1.	3.	
3.5	5.	1.	4.	3.
4.0	5.	6.	1.	3.
4.5	5.	7.	5.	
5.0	20.			
5.5	20.			
6.0	20.			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR JAN 1982

DATE (JAN)	1	2	3	4	5	6	7
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (JAN)	8	9	10	11	12	13	14
SIG. HT (M.)	0.0	0.0	0.0	0.0	2.2	1.9	1.5

DATE (JAN)	15	16	17	18	19	20	21
SIG. HT (M.)	1.6	1.1	4.8	4.5	4.1	2.5	4.0

DATE (JAN)	22	23	24	25	26	27	28
SIG. HT (M.)	3.0	2.5	2.9	3.4	4.8	3.7	4.3

DATE (JAN)	29	30	31
SIG. HT (M.)	3.3	3.3	3.3

HUMBOLDT BAY BUOY (INNER)
FEB 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS	
0.5	0.	
1.0	0.	
1.5	2.	
2.0	3.	
2.5	1.	3.
3.0	6.	
3.5	7.	
4.0	7.	
4.5	7.	
5.0	7.	
5.5	7.	
6.0	7.	

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR FEB 1982

DATE (FEB)	1	2	3	4	5	6	7
SIG. HT (M.)	3.2	2.6	2.0	2.9	1.8	1.4	1.2

DATE (FEB)	8	9	10	11	12	13	14
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (FEB)	15	16	17	18	19	20	21
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (FEB)	22	23	24	25	26	27	28
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (FEB)	29	30	31
SIG. HT (M.)	0.0	0.0	0.0

HUMBOLDT BAY BUOY (INNER)
MAR 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.5	0,				
1.0	0,				
1.5	1,	1,			
2.0	2,	1,	1,		
2.5	2,	5,			
3.0	2,	1,	1,	2,	5,
3.5	5,	4,	8,	1,	
4.0	5,	5,	9,	1,	
4.5	11,	9,	1,		
5.0	11,	11,			
5.5	11,	11,			
6.0	11,	11,			

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAR 1982

DATE (MAR)	1	2	3	4	5	6	7
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (MAR)	8	9	10	11	12	13	14
SIG. HT (M.)	0.0	1.5	1.6	3.1	2.7	3.3	4.1

DATE (MAR)	15	16	17	18	19	20	21
SIG. HT (M.)	3.7	2.5	3.3	3.0	2.6	0.0	1.4

DATE (MAR)	22	23	24	25	26	27	28
SIG. HT (M.)	2.2	2.2	2.3	2.0	3.4	3.1	3.1

DATE (MAR)	29	30	31
SIG. HT (M.)	3.7	4.6	3.1

HUMBOLDT BAY BUOY (INNER)
APR 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS				
0.5	0,				
1.0	1,	1,			
1.5	2,	2,	2,		
2.0	3,	1,	8,		
2.5	1,	1,	4,	2,	11,
3.0	1,	9,	2,	11,	
3.5	1,	10,	3,	12,	
4.0	1,	10,	16,		
4.5	1,	27,			
5.0	30,				
5.5	30,				
6.0	30,				

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR APR 1982

DATE (APR)	1	2	3	4	5	6	7
SIG. HT (M.)	2.3	4.9	4.9	2.4	2.7	2.9	2.1

DATE (APR)	8	9	10	11	12	13	14
SIG. HT (M.)	1.0	1.4	1.7	2.9	2.7	3.4	4.1

DATE (APR)	15	16	17	18	19	20	21
SIG. HT (M.)	3.1	2.3	1.6	3.5	3.1	1.3	1.1

DATE (APR)	22	23	24	25	26	27	28
SIG. HT (M.)	1.8	1.7	1.8	1.7	1.4	0.9	2.3

DATE (APR)	29	30	31
SIG. HT (M.)	2.4	2.2	0.0

HUMBOLDT BAY BUOY (INNER)
MAY 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS					
0.5	0.					
1.0	1.	1.				
1.5	1.	5.				
2.0	2.	1.	8.	1.	1.	
2.5	2.	2.	8.	3.	1.	4.
3.0	2.	13.	4.	1.	4.	
3.5	3.	20.	6.			
4.0	31.					
4.5	31.					
5.0	31.					
5.5	31.					
6.0	31.					

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAY 1982

DATE (MAY)	1	2	3	4	5	6	7
SIG. HT (M.)	1.5	1.5	3.3	3.5	2.9	1.8	2.5

DATE (MAY)	8	9	10	11	12	13	14
SIG. HT (M.)	2.9	1.9	1.9	1.9	1.1	1.1	0.8

DATE (MAY)	15	16	17	18	19	20	21
SIG. HT (M.)	1.2	0.9	2.8	3.1	2.6	1.6	2.1

DATE (MAY)	22	23	24	25	26	27	28
SIG. HT (M.)	2.1	3.0	2.4	4.0	3.3	3.2	2.4

DATE (MAY)	29	30	31
SIG. HT (M.)	2.4	2.0	1.6

HUMBOLDT COAST GUARD
NOV 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS		
0.5	3,	3,	4,
1.0	13,		
1.5	13,		
2.0	13,		
2.5	13,		
3.0	13,		
3.5	13,		
4.0	13,		
4.5	13,		
5.0	13,		
5.5	13,		
6.0	13,		

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR NOV 1981

DATE (NOV)	1	2	3	4	5	6	7
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (NOV)	8	9	10	11	12	13	14
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (NOV)	15	16	17	18	19	20	21
SIG. HT (M.)	0.0	0.0	0.0	0.3	0.4	0.3	0.6

DATE (NOV)	22	23	24	25	26	27	28
SIG. HT (M.)	0.6	0.3	0.3	0.5	0.5	0.3	0.4

DATE (NOV)	29	30	31
SIG. HT (M.)	0.4	0.4	0.0

HUMBOLDT COAST GUARD
DEC 1981

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS	
0.5	23,	7,
1.0	31,	
1.5	31,	
2.0	31,	
2.5	31,	
3.0	31,	
3.5	31,	
4.0	31,	
4.5	31,	
5.0	31,	
5.5	31,	
6.0	31,	

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR DEC 1981

DATE (DEC)	1	2	3	4	5	6	7
SIG. HT (M.)	0.4	0.4	0.4	0.5	0.4	0.4	0.4

DATE (DEC)	8	9	10	11	12	13	14
SIG. HT (M.)	0.3	0.3	0.2	0.3	0.4	0.5	0.5

DATE (DEC)	15	16	17	18	19	20	21
SIG. HT (M.)	0.4	0.1	0.4	0.3	0.3	0.4	0.2

DATE (DEC)	22	23	24	25	26	27	28
SIG. HT (M.)	0.1	0.3	0.7	0.4	0.4	0.3	0.3

DATE (DEC)	29	30	31
SIG. HT (M.)	0.2	0.2	0.3

HUMBOLDT COAST GUARD
JAN 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS
0.5	31,
1.0	31,
1.5	31,
2.0	31,
2.5	31,
3.0	31,
3.5	31,
4.0	31,
4.5	31,
5.0	31,
5.5	31,
6.0	31,

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR JAN 1982

DATE (JAN)	1	2	3	4	5	6	7
SIG. HT (M.)	0.5	0.3	0.2	0.2	0.2	0.2	0.2

DATE (JAN)	8	9	10	11	12	13	14
SIG. HT (M.)	0.2	0.3	0.2	0.2	0.2	0.2	0.2

DATE (JAN)	15	16	17	18	19	20	21
SIG. HT (M.)	0.1	0.4	0.5	0.5	0.4	0.4	0.4

DATE (JAN)	22	23	24	25	26	27	28
SIG. HT (M.)	0.2	0.3	0.3	0.5	0.4	0.5	0.4

DATE (JAN)	29	30	31
SIG. HT (M.)	0.4	0.4	0.3

HUMBOLDT COAST GUARD
FEB 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS
0.5	28.
1.0	28.
1.5	28.
2.0	28.
2.5	28.
3.0	28.
3.5	28.
4.0	28.
4.5	28.
5.0	28.
5.5	28.
6.0	28.

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR FEB 1982

DATE (FEB)	1	2	3	4	5	6	7
SIG. HT (M.)	0.2	0.2	0.3	0.3	0.2	0.3	0.2

DATE (FEB)	8	9	10	11	12	13	14
SIG. HT (M.)	0.2	0.1	0.1	0.2	0.2	0.2	0.2

DATE (FEB)	15	16	17	18	19	20	21
SIG. HT (M.)	0.2	0.2	0.2	0.2	0.4	0.3	0.4

DATE (FEB)	22	23	24	25	26	27	28
SIG. HT (M.)	0.3	0.3	0.2	0.1	0.2	0.2	0.2

DATE (FEB)	29	30	31
SIG. HT (M.)	0.0	0.0	0.0

HUMBOLDT COAST GUARD
MAY 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS
0.5	13.
1.0	13.
1.5	13.
2.0	13.
2.5	13.
3.0	13.
3.5	13.
4.0	13.
4.5	13.
5.0	13.
5.5	13.
6.0	13.

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAY 1982

DATE (MAY)	1	2	3	4	5	6	7
SIG. HT (M.)	0.3	0.1	0.3	0.3	0.4	0.4	0.2

DATE (MAY)	8	9	10	11	12	13	14
SIG. HT (M.)	0.3	0.4	0.5	0.1	0.2	0.0	0.0

DATE (MAY)	15	16	17	18	19	20	21
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (MAY)	22	23	24	25	26	27	28
SIG. HT (M.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DATE (MAY)	29	30	31
SIG HT (M.)	0.0	0.0	0.0

HUMBOLDT COAST GUARD
APR 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS
0.5	30.
1.0	30.
1.5	30.
2.0	30.
2.5	30.
3.0	30.
3.5	30.
4.0	30.
4.5	30.
5.0	30.
5.5	30.
6.0	30.

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR APR 1982

DATE (APR)	1	2	3	4	5	6	7
SIG. HT (M.)	0.4	0.2	0.2	0.2	0.2	0.2	0.2

DATE (APR)	8	9	10	11	12	13	14
SIG. HT (M.)	0.1	0.2	0.1	0.1	0.2	0.2	0.2

DATE (APR)	15	16	17	18	19	20	21
SIG. HT (M.)	0.2	0.1	0.2	0.2	0.1	0.2	0.3

DATE (APR)	22	23	24	25	26	27	28
SIG. HT (M.)	0.4	0.2	0.4	0.2	0.3	0.2	0.4

DATE (APR)	29	30	31
SIG. HT (M.)	0.3	0.3	0.0

HUMBOLDT COAST GUARD
MAR 1982

PERSISTENCE
CONSECUTIVE DAYS (1 OR MORE) SIGNIFICANT
WAVE HEIGHT IS -N- METERS OR LESS

METERS	DAYS		
0.5	12,	11,	6,
1.0	31,		
1.5	31,		
2.0	31,		
2.5	31,		
3.0	31,		
3.5	31,		
4.0	31,		
4.5	31,		
5.0	31,		
5.5	31,		
6.0	31,		

MAXIMUM DAILY SIGNIFICANT WAVE HEIGHT FOR MAR 1982

DATE (MAR)	1	2	3	4	5	6	7
SIG. HT (M.)	0.4	0.5	0.3	0.1	0.2	0.2	0.2

DATE (MAR)	8	9	10	11	12	13	14
SIG. HT (M.)	0.3	0.2	0.2	0.4	0.4	0.8	0.5

DATE (MAR)	15	16	17	18	19	20	21
SIG. HT (M.)	0.3	0.4	0.4	0.4	0.4	0.2	0.2

DATE (MAR)	22	23	24	25	26	27	28
SIG. HT (M.)	0.3	0.3	0.3	0.5	0.5	0.4	0.4

DATE (MAR)	29	30	31
SIG. HT (M.)	0.5	0.2	0.2

TABLE 19

HUMBOLDT BAY BUOY (INNER) MAR-DEC 1980

CUMULATIVE HEIGHT PROBABILITIES

HEIGHT (CM)	PROBABILITY	OCCURRENCE (HRS)
295	0.1236	1083
285	0.1453	1272
275	0.1693	1482
265	0.1921	1682
255	0.2377	2082
245	0.2713	2376
235	0.3217	2818
225	0.3649	3196
215	0.4106	3596
205	0.4562	3996
195	0.4982	4364
185	0.5534	4847
175	0.5954	5216
165	0.6387	5594
155	0.6819	5973
145	0.7395	6477
135	0.7791	6825
125	0.8223	7203
115	0.8523	7466
105	0.9004	7887
95	0.9220	8076
85	0.9424	8255
75	0.9712	8507
65	0.9880	8654
55	0.9964	8728
45	0.9988	8749
35	0.9988	8749
25	0.9988	8749
15	0.9988	8749
5	0.9988	8749

CUMULATIVE PEAK PERIOD PROBABILITIES

PERIOD (SEC)	PROBABILITY	OCCURRENCE (HRS)
22+	0.0048	42
20	0.0084	73
17	0.0276	241
15	0.0768	673
13	0.1849	1619
11	0.3782	3312
9	0.7071	6194
7	0.9520	8339
5	0.9988	8749

HUMBOLDT BAY BUOY(OUTER) MAR-APR 1980

CUMULATIVE HEIGHT PROBABILITIES

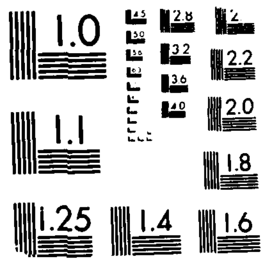
HEIGHT (CM)	PROBABILITY	OCCURRENCE (HRS)
295	0.3333	2919
285	0.4222	3698
275	0.5333	4671
265	0.6000	5255
255	0.6667	5839
245	0.6667	5839
235	0.7333	6423
225	0.7333	6423
215	0.7556	6618
205	0.7778	6813
195	0.8222	7202
185	0.8222	7202
175	0.8444	7397
165	0.8667	7591
155	0.8667	7591
145	0.9111	7981
135	0.9333	8175
125	0.9556	8370
115	0.9556	8370
105	0.9778	8565
95	0.9778	8565
85	0.9778	8565
75	0.9778	8565
65	0.9778	8565
55	0.9778	8565
45	0.9778	8565
35	0.9778	8565
25	0.9778	8565
15	0.9778	8565
5	0.9778	8565

CUMULATIVE PEAK PERIOD PROBABILITIES

PERIOD (SEC)	PROBABILITY	OCCURRENCE (HRS)
22+	0.0000	<12
20	0.0000	<12
17	0.0667	583
15	0.1778	1557
13	0.5111	4477
11	0.6000	5255
9	0.6889	6034
7	0.9333	8175
5	0.9778	8565

AD-A189 838 BUHNE POINT SHORELINE EROSION DEMONSTRATION PROJECT VOLUME 2 APPENDICES E(U) ARMY ENGINEER DISTRICT LOS ANGELES CA AUG 87 2/3

UNCLASSIFIED F/G 13/2 NL



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NATIONAL BUREAU OF STANDARDS 1963 A

TABLE 22.

HUMBOLDT BAY BUOY(INNER) JAN-NOV 1981

CUMULATIVE HEIGHT PROBABILITIES

HEIGHT (CM)	PROBABILITY	OCCURRENCE (HRS)
900	0.0000	<12
870	0.0000	<12
840	0.0000	<12
810	0.0000	<12
780	0.0000	<12
750	0.0000	<12
720	0.0018	15
690	0.0018	15
660	0.0018	15
630	0.0018	15
600	0.0018	15
570	0.0018	15
540	0.0027	23
510	0.0053	46
480	0.0062	54
450	0.0133	116
420	0.0283	247
390	0.0469	410
360	0.0760	666
330	0.1061	929
300	0.1574	1378
270	0.2219	1944
240	0.3271	2865
210	0.4500	3942
180	0.6118	5359
150	0.7675	6722
120	0.8798	7706
90	0.9841	8620
60	0.9991	8752
30	0.9991	8752

CUMULATIVE PEAK PERIOD PROBABILITIES

PERIOD (SEC)	PROBABILITY	OCCURRENCE (HRS)
22+	0.0000	<12
20	0.0062	54
17	0.0407	356
15	0.0937	821
13	0.2042	1789
11	0.3820	3345
9	0.7065	6189
7	0.9496	8318
5	0.9991	8752

TABLE 23.

HUMBOLDT BAY BUOY(OUTER) JAN-JUN 1981

CUMULATIVE HEIGHT PROBABILITIES

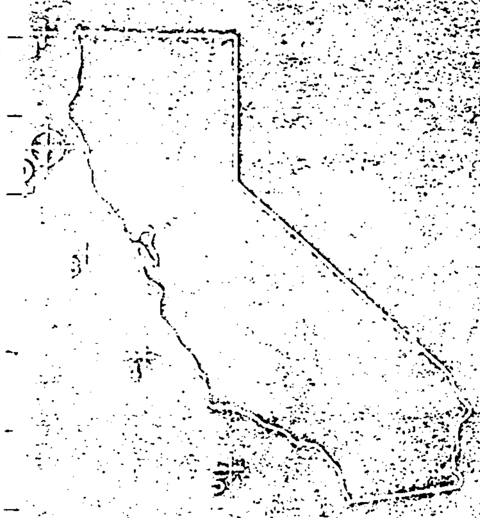
HEIGHT (CM)	PROBABILITY	OCCURRENCE (HRS)
900	0.0000	<12
870	0.0000	<12
840	0.0000	<12
810	0.0000	<12
780	0.0000	<12
750	0.0000	<12
720	0.0000	<12
690	0.0000	<12
660	0.0034	29
630	0.0034	29
600	0.0068	59
570	0.0102	89
540	0.0137	119
510	0.0239	209
480	0.0307	269
450	0.0751	657
420	0.1092	956
390	0.1741	1524
360	0.2662	2332
330	0.3345	2929
300	0.4164	3647
270	0.5119	4484
240	0.6075	5321
210	0.6962	6099
180	0.7850	6876
150	0.8464	7414
120	0.9352	8191
90	0.9966	8730
60	0.9966	8730
30	0.9966	8730

CUMULATIVE PEAK PERIOD PROBABILITIES

PERIOD (SEC)	PROBABILITY	OCCURRENCE (HRS)
22+	0.0034	29
20	0.0171	149
17	0.0853	747
15	0.1980	1734
13	0.3652	3199
11	0.6519	5710
9	0.8396	7354
7	0.9693	8490
5	0.9966	8730

Deep-Water WAVE STATISTICS for the California Coast

Station 2



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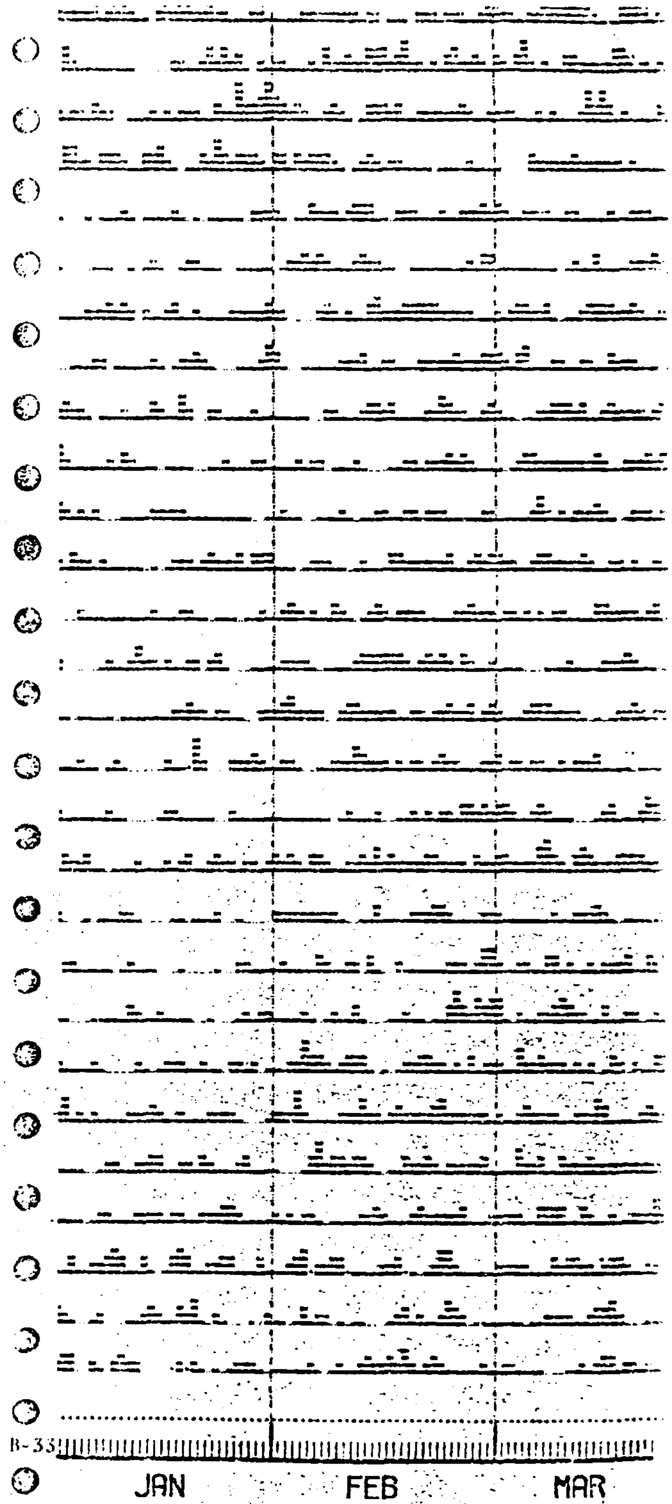
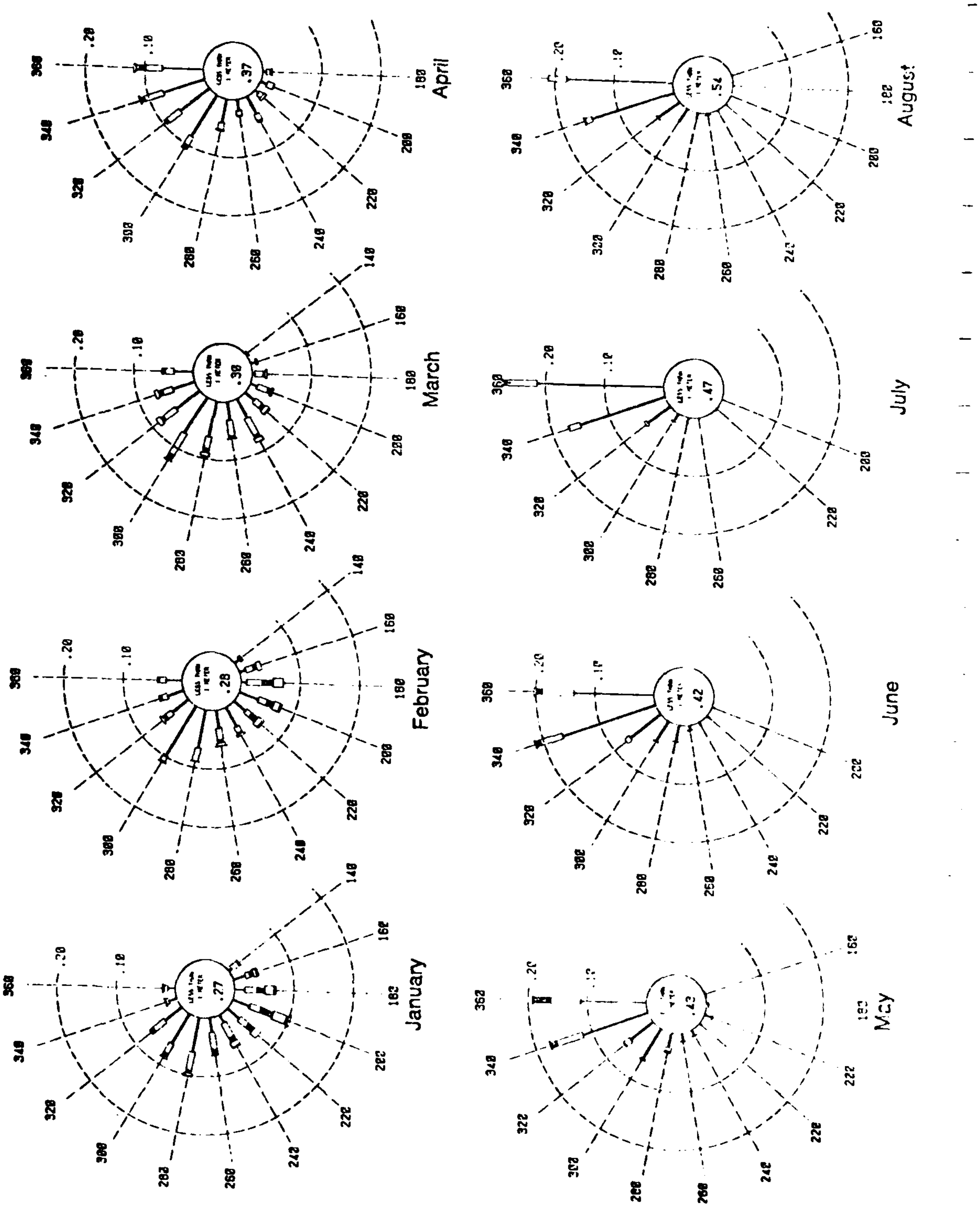
AND OCEAN DEVELOPMENT



2-III-2



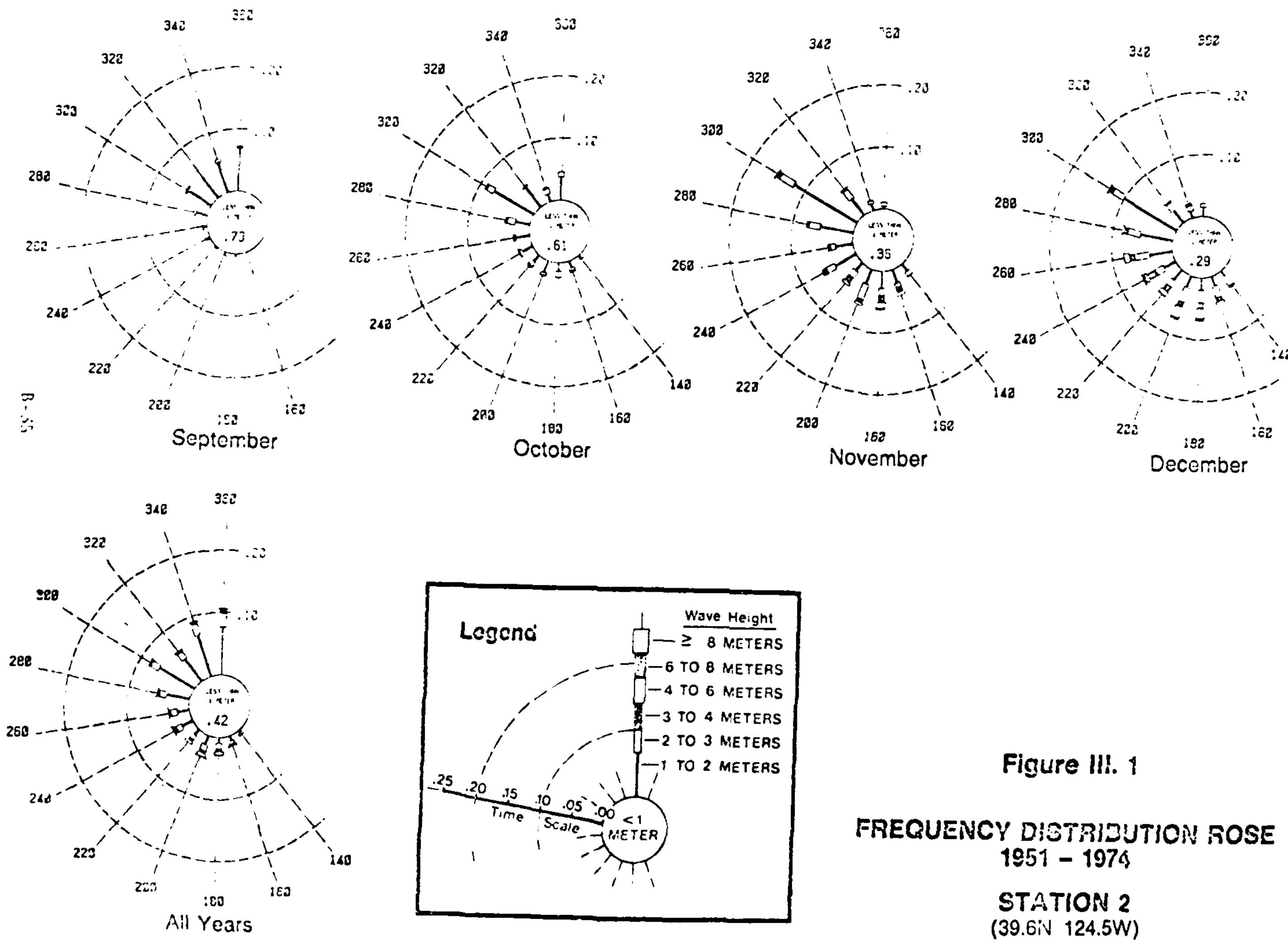


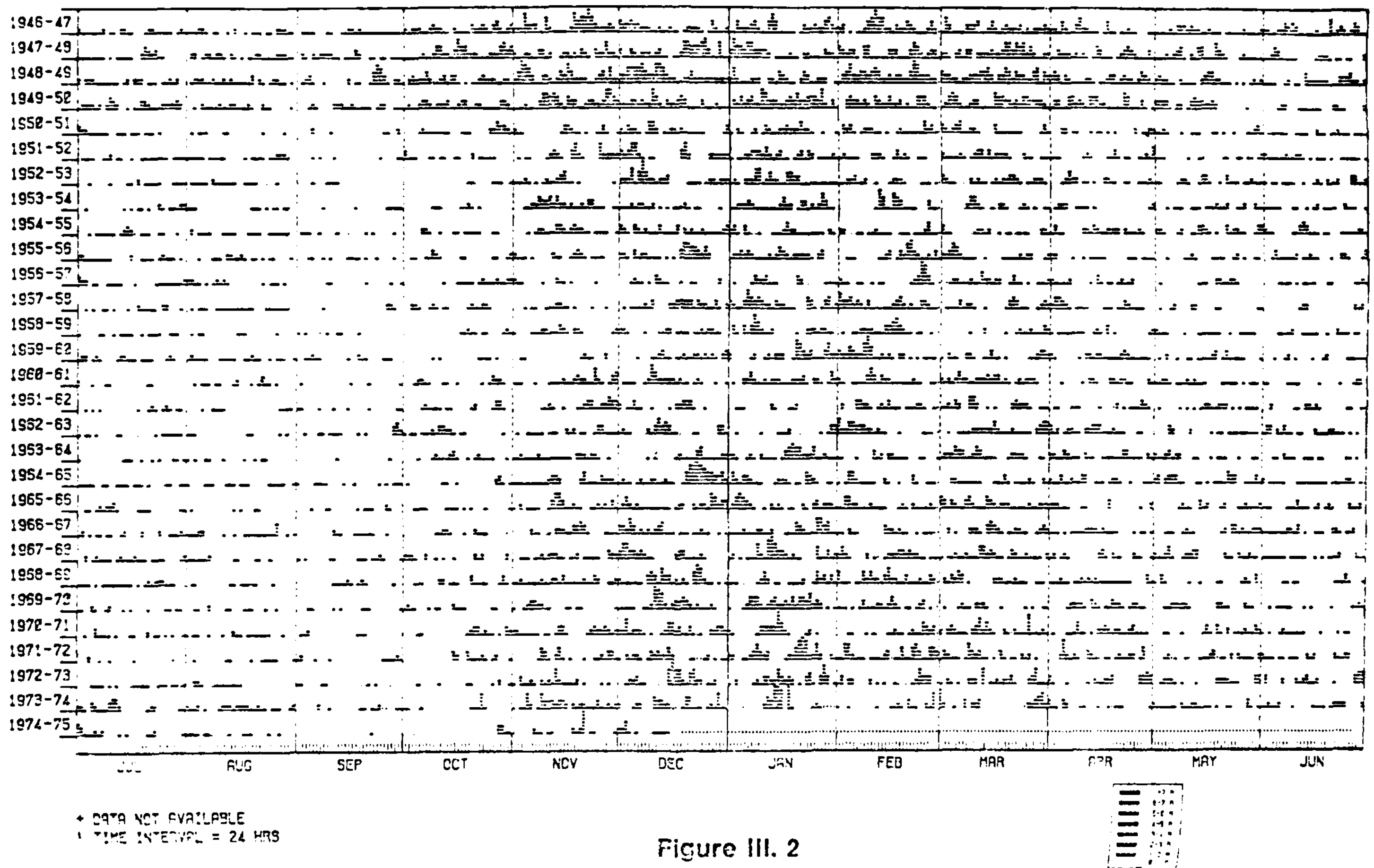
Figure III. 1

FREQUENCY DISTRIBUTION ROSE
1951 – 1974

STATION 2
(39.6N 124.5W)

COMBINED SEA/SWELL

STATION 2
WAVE HEIGHT DURATION GRAPH
1946-1974
COMBINED SEA/SWELL HEIGHT[1]



+ DATA NOT AVAILABLE
1 TIME INTERVAL = 24 HRS

Figure III. 2

STATION 2
(39.6N 124.5W)

EXTREME WAVE EVENT LISTING

COMBINED SEA/SWELL ¬ 5 METERS

COMPILED FROM ONCE-DAILY WAVE COMPUTATIONS
1951-1974

CHRONOLOGICAL ORDERING				WAVE HEIGHT ORDERING				PERIOD ORDERING			
DATA	HEIGHT	PERIOD	DIRECTION	DATA	HEIGHT	PERIOD	DIRECTION	DATA	HEIGHT	PERIOD	DIRECTION
18 NOV 51	5.0	10	173	22 DEC 64	10.0	15	231	15 FEB 69	5.1	15	260
25 NOV 51	5.1	10	185	14 JAN 74	8.9	14	207	22 DEC 64	10.0	15	231
04 DEC 51	5.7	9	211	15 JAN 74	8.2	13	208	09 JAN 72	5.1	14	280
05 DEC 51	5.9	9	301	18 JAN 74	8.2	13	205	14 JAN 74	8.9	14	207
19 DEC 51	5.1	9	323	09 FEB 60	8.0	11	267	15 JAN 74	8.2	13	208
04 DEC 52	5.5	10	191	16 DEC 72	7.9	13	180	15 JAN 71	7.8	13	201
07 DEC 52	7.9	12	245	07 DEC 52	7.9	12	245	12 MAR 71	5.5	13	248
08 JAN 53	5.5	10	177	15 JAN 71	7.8	13	201	16 DEC 72	7.9	13	180
09 JAN 53	5.1	9	207	22 JAN 72	7.8	12	238	18 JAN 74	8.2	13	205
27 JAN 54	5.2	10	204	13 JAN 68	7.7	12	166	23 FEB 72	5.0	13	280
12 FEB 54	6.9	12	199	24 FEB 57	7.7	12	213	21 NOV 74	7.2	12	180
16 FEB 54	5.4	10	159	23 DEC 64	7.5	11	249	07 DEC 52	7.9	12	245
19 DEC 55	5.1	8	203	21 NOV 74	7.2	12	180	22 JAN 72	7.8	12	238
20 DEC 55	5.0	9	201	11 DEC 69	7.2	12	199	12 FEB 54	6.9	12	199
20 FEB 56	5.1	10	229	12 FEB 54	6.9	12	199	21 DEC 64	6.8	12	218
21 FEB 56	6.7	11	218	21 JAN 72	6.9	10	249	13 JAN 68	7.7	12	166
04 MAR 56	5.0	9	259	23 JAN 72	6.8	11	259	11 DEC 69	7.2	12	199
24 FEB 57	7.7	12	213	24 DEC 64	6.8	11	263	24 FEB 57	7.7	12	213
25 FEB 57	6.0	10	197	21 DEC 64	6.8	12	218	01 FEB 63	5.1	12	187
06 JAN 58	6.5	11	142	23 DEC 68	6.8	11	179	03 DEC 67	5.0	12	255
01 FEB 58	5.2	10	150	08 JAN 59	6.7	11	186	26 JAN 72	5.1	12	353
08 JAN 59	6.7	11	186	21 FEB 56	6.7	11	218	09 FEB 60	8.0	11	267
17 FEB 59	5.5	10	199	01 MAR 74	6.6	11	216	28 JAN 73	6.3	11	170
20 JAN 60	6.0	11	151	10 DEC 60	6.6	11	172	21 FEB 56	6.7	11	218
21 JAN 60	5.0	9	168	06 JAN 58	6.5	11	142	12 JAN 68	6.4	11	162
29 JAN 60	5.5	10	187	12 JAN 68	6.4	11	162	08 JAN 59	6.7	11	186
08 FEB 60	5.7	10	234	28 JAN 73	6.3	11	170	06 JAN 58	6.5	11	142
09 FEB 60	8.0	11	267	05 APR 72	6.3	11	108	23 DEC 64	7.5	11	249
24 NOV 60	5.0	9	227	26 MAR 71	6.0	11	219	05 APR 72	6.3	11	108
10 DEC 60	6.6	11	172	20 JAN 60	6.0	11	151	15 DEC 72	5.9	11	168

-CONTINUED

TABLE III 5(CONT.)

STATION 2
(39.6N 124.5W)

EXTREME WAVE EVENT LISTING

COMBINED SEA/SWELL ¬ 5 METERS

COMPILED FROM ONCE-DAILY WAVE COMPUTATIONS
1951-1974

CHRONOLOGICAL ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
10 FEB 61	5.6	10	216
12 DEC 62	5.2	10	169
01 FEB 63	5.1	12	187
19 JAN 64	5.1	9	246
21 DEC 64	6.8	12	218
22 DEC 64	10.0	15	231
23 DEC 64	7.5	11	249
24 DEC 64	6.8	11	263
25 DEC 64	5.4	10	260
13 NOV 65	5.9	11	167
14 NOV 65	5.1	9	174
27 DEC 65	5.3	10	204
04 JAN 66	5.6	10	228
04 DEC 66	5.1	9	212
26 JAN 67	5.4	10	205
27 JAN 67	5.1	9	196
02 DEC 67	5.1	9	191
03 DEC 67	5.0	12	255
09 JAN 68	5.3	10	199
12 JAN 68	6.4	11	162
13 JAN 68	7.7	12	166
14 JAN 68	5.2	9	176
13 DEC 68	5.4	10	185
23 DEC 68	6.8	11	179
24 DEC 68	5.2	9	182
15 FEB 69	5.1	15	260
11 DEC 69	7.2	12	199
12 DEC 69	6.0	10	201
13 DEC 69	5.9	10	184
24 JAN 70	5.5	10	226

WAVE HEIGHT ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
25 FEB 57	6.0	10	197
16 JAN 74	6.0	11	204
12 DEC 69	6.0	10	201
13 DEC 69	5.9	10	184
05 DEC 51	5.9	9	301
15 DEC 72	5.9	11	168
13 NOV 65	5.9	11	167
17 DEC 72	5.8	11	192
03 DEC 70	5.8	10	208
08 FEB 60	5.7	10	234
04 DEC 51	5.7	9	211
23 OCT 73	5.6	10	244
10 FEB 61	5.6	10	216
04 JAN 66	5.6	10	228
17 FEB 59	5.5	10	199
12 MAR 71	5.5	13	248
08 JAN 53	5.5	10	177
24 JAN 70	5.5	10	226
22 DEC 72	5.5	10	242
04 DEC 52	5.5	10	191
29 JAN 60	5.5	10	187
28 FEB 74	5.5	10	212
26 JAN 67	5.4	10	205
29 DEC 73	5.4	10	262
25 DEC 64	5.4	10	260
13 DEC 68	5.4	10	185
16 FEB 54	5.4	10	159
13 MAR 73	5.4	10	345
09 JAN 68	5.3	10	199
18 DEC 72	5.3	10	184

PERIOD ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
01 MAR 74	6.6	11	216
13 NOV 65	5.9	11	167
16 JAN 74	6.0	11	204
26 MAR 71	6.0	11	219
24 DEC 64	6.8	11	263
23 DEC 68	6.8	11	179
23 JAN 72	6.8	11	259
10 DEC 60	6.6	11	172
20 JAN 60	6.0	11	151
17 DEC 72	5.8	11	192
18 NOV 51	5.0	10	173
03 DEC 70	5.8	10	208
13 DEC 68	5.4	10	185
10 FEB 61	5.6	10	216
29 DEC 73	5.4	10	262
27 JAN 54	5.2	10	204
17 FEB 59	5.5	10	199
08 FEB 60	5.7	10	234
09 JAN 68	5.3	10	199
25 NOV 51	5.1	10	185
25 DEC 64	5.4	10	260
28 FEB 74	5.5	10	212
13 DEC 69	5.9	10	184
20 FEB 56	5.1	10	229
18 DEC 72	5.3	10	184
12 DEC 62	5.2	10	169
15 JAN 73	5.2	10	189
12 DEC 69	6.0	10	201
04 FEB 72	5.1	10	154
16 FEB 54	5.4	10	159

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TABLE III.5

-CONTINUED

TABLE III 5(CONT)

STATION 2
(39.6N 124.5W)

EXTREME WAVE EVENT LISTING

COMBINED SEA/SWELL ¬ 5 METERS

COMPILED FROM ONCE-DAILY WAVE COMPUTATIONS
1951-1974

CHRONOLOGICAL ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
03 DEC 70	5.8	10	208
15 JAN 71	7.8	13	201
12 MAR 71	5.5	13	248
26 MAR 71	6.0	11	219
09 JAN 72	5.1	14	280
21 JAN 72	6.9	10	249
22 JAN 72	7.8	12	238
23 JAN 72	6.3	11	259
26 JAN 72	5.1	12	353
03 FEB 72	5.0	9	153
04 FEB 72	5.1	10	154
23 FEB 72	5.0	13	280
09 MAR 72	5.0	9	182
05 APR 72	6.3	11	188
13 NOV 72	5.1	9	188
15 DEC 72	5.9	11	168
16 DEC 72	7.9	13	180
17 DEC 72	5.8	11	192
18 DEC 72	5.3	10	184
22 DEC 72	5.5	10	242
15 JAN 73	5.2	10	189
2[illegible] JAN 73	6.3	11	170
24 FEB 73	5.0	10	185
13 MAR 73	5.4	10	345
28 MAR 73	5.0	10	346
23 OCT 73	5.6	10	244
05 NOV 73	5.1	10	217
09 NOV 73	5.1	10	197
29 DEC 73	5.4	10	262
14 JAN 74	8.9	14	207

WAVE HEIGHT ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
27 DEC 65	5.3	10	204
12 DEC 62	5.2	10	169
27 JAN 54	5.2	10	204
15 JAN 73	5.2	10	189
24 DEC 68	5.2	9	182
01 FEB 58	5.2	10	150
14 JAN 68	5.2	9	176
30 MAR 74	5.2	10	249
09 JAN 72	5.1	14	280
19 DEC 51	5.1	9	323
14 NOV 65	5.1	9	174
04 FEB 72	5.1	10	154
19 DEC 55	5.1	8	203
25 NOV 51	5.1	10	185
20 FEB 56	5.1	10	229
27 JAN 67	5.1	9	196
07 DEC 67	5.1	9	191
09 JAN 53	5.1	9	207
19 JAN 64	5.1	9	246
15 FEB 67	5.1	15	260
13 NOV 72	5.1	9	188
09 NOV 73	5.1	10	197
04 DEC 66	5.1	9	212
01 FEB 63	5.1	12	187
05 NOV 73	5.1	10	217
26 JAN 72	5.1	12	353
21 JAN 60	5.0	9	168
24 NOV 60	5.0	9	227
09 MAR 72	5.0	9	182
04 MAR 56	5.0	9	259

PERIOD ORDERING

DATA	HEIGHT	PERIOD	DIRECTION
28 MAR 73	5.0	10	346
23 OCT 73	5.6	10	244
05 NOV 73	5.1	10	217
09 NOV 73	5.1	10	197
24 FEB 73	5.0	10	185
21 JAN 72	6.9	10	249
25 FEB 57	6.0	10	197
08 JAN 53	5.5	10	177
01 FEB 58	5.2	10	150
04 JAN 66	5.6	10	228
29 JAN 60	5.5	10	187
24 JAN 70	5.5	10	226
22 DEC 72	5.5	10	242
26 JAN 67	5.4	10	205
04 DEC 52	5.5	10	191
13 MAR 73	5.4	10	345
27 DEC 65	5.3	10	204
30 MAR 74	5.2	10	249
03 FEB 72	5.0	9	153
05 DEC 51	5.9	9	301
19 DEC 51	5.1	9	323
21 JAN 60	5.0	9	168
04 MAR 56	5.0	9	259
19 JAN 64	5.1	9	246
24 NOV 60	5.0	9	227
09 MAR 72	5.0	9	182
20 DEC 55	5.0	9	201
14 JAN 68	5.2	9	176
14 NOV 65	5.1	9	174
04 DEC 51	5.7	9	211

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TABLE III 5

-CONTINUED

TABLE III.5(CONT.)

STATION 2
(39.6N 124.5W)

EXTREME WAVE EVENT LISTING

COMBINED SEA/SWELL ¬ 5 METERS

COMPILED FROM ONCE-DAILY WAVE COMPUTATIONS
1951-1974

CHRONOLOGICAL ORDERING				WAVE HEIGHT ORDERING				PERIOD ORDERING			
DATA	HEIGHT	PERIOD	DIRECTION	DATA	HEIGHT	PERIOD	DIRECTION	DATA	HEIGHT	PERIOD	DIRECTION
15 JAN 74	8.2	13	208	28 MAR 73	5.0	10	346	24 DEC 68	5.2	9	182
16 JAN 74	6.0	11	204	20 DEC 55	5.0	9	201	04 DEC 66	5.1	9	212
18 JAN 74	8.2	13	205	23 FEB 72	5.0	13	280	13 NOV 72	5.1	9	188
28 FEB 74	5.5	10	212	03 FEB 72	5.0	9	153	27 JAN 67	5.1	9	196
01 MAR 74	6.6	11	216	24 FEB 73	5.0	10	185	02 DEC 67	5.1	9	191
30 MAR 74	5.2	10	249	03 DEC 67	5.0	12	255	09 JAN 53	5.1	9	207
21 NOV 74	7.2	12	180	18 NOV 51	5.0	10	173	19 DEC 55	5.1	8	203

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TABLE III 5

TABLE III 1.13

[illegible] YEARS (1951-1974) DIRECTION-HEIGHT-PERIOD FREQUENCY OF OCCURRENCE DISTRIBUTION

[illegible] COMPILED FROM [illegible] ONCE-DAILY WAVE COMPUTATIONS — STATION 2 (39 6N [illegible] 5W)

DIRECTION 360 DEGREES (355-005)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	1	7						8
0.5-1.0	120	17	3	1				141
1.0-1.5	204	26	8					238
1.5-2.0	67	120	4	2				193
2.0-2.5	3	78	3					84
2.5-3.0		40	1					41
3.0-4.0		6	37	1				44
4.0-5.0			5	1				6
5.0-6.0								0
6.0-7.0								0
7.0+								0
SUM	395	294	61	5	0	0	0	755

DIRECTION 350 DEGREES (345-355)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		19	3					22
0.5-1.0	127	32	5					164
1.0-1.5	191	21	16	2				230
1.5-2.0	64	92	5	1	1			163
2.0-2.5		72	1					73
2.5-3.0		38						38
3.0-4.0		6	18					24
4.0-5.0			4					4
5.0-6.0				2	1			3
6.0-7.0								0
7.0+								0
SUM	382	280	52	5	2	0	0	721

DIRECTION 340 DEGREES (335-345)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		6	1					7
0.5-1.0	97	16	3					116
1.0-1.5	134	29	17					180
1.5-2.0	41	55	11	3				110
2.0-2.5	3	43		4				50
2.5-3.0		19		1				20
3.0-4.0		4	10					14
4.0-5.0			3					3
5.0-6.0								0
6.0-7.0								0
7.0+								0
SUM	275	172	45	8	0	0	0	500

DIRECTION 330 DEGREES (325-335)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		4	1	1				6
0.5-1.0	74	19	4	4	5			106
1.0-1.5	73	35	12	3				123
1.5-2.0	24	25	7	2	3			61
2.0-2.5	1	30	3	2				36
2.5-3.0		16		3		1		20
3.0-4.0		4	7	2	2			15
4.0-5.0			3					3
5.0-6.0								0
6.0-7.0								0
7.0+								0
SUM	172	133	37	17	10	1	0	370

DIRECTION 320 DEGREES (315-325)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	3	4		2	13	1		23
0.5-1.0	48	18	12	12	11	3		104
1.0-1.5	65	24	12	10	6	1	1	119
1.5-2.0	17	18	7	11	6	1	1	61
2.0-2.5		21	5	2	7			35
2.5-3.0		9	5	2	1	1		18
3.0-4.0		1	3	5	3			12
4.0-5.0			2	1	3			6
5.0-6.0			1					1
6.0-7.0								0
7.0+								0
SUM	133	95	47	45	50	7	2	379

DIRECTION 310 DEGREES (305-315)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	2	4	2	3	21	9		41
0.5-1.0	27	16	12	17	63	22	1	158
1.0-1.5	35	20	13	20	36	27	2	153
1.5-2.0	14	13	9	12	13	9	5	75
2.0-2.5	1	19	8	2	7	3	1	41
2.5-3.0		6	4	3	3			16
3.0-4.0		3	1	3	3	2		12
4.0-5.0			1		4			5
5.0-6.0								0
6.0-7.0								0
7.0+								0
SUM	79	81	50	60	150	72	9	501

DIRECTION 300 DEGREES (295-305)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	1	6	6	3	13	3	2	34
0.5-1.0	20	15	17	14	81	14	1	162
1.0-1.5	18	18	19	26	65	56	10	212
1.5-2.0	6	10	13	16	9	24	12	90
2.0-2.5		14	5	3	8	4	8	42
2.5-3.0		8		5	6	3	1	23
3.0-4.0		3	2	3	4	1	3	16
4.0-5.0					2			2
5.0-6.0			1					1
6.0-7.0								0
7.0+								0
SUM	45	74	63	70	188	105	37	582

DIRECTION 290 DEGREES (285-295)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		4	5	1	6	1		17
0.5-1.0	13	15	16	22	61	9	1	137
1.0-1.5	17	22	18	20	40	36	2	155
1.5-2.0	11	12	10	8	11	15	8	75
2.0-2.5	1	9	8	4	7	4	2	35
2.5-3.0		4	4		3	1	2	14
3.0-4.0		3	6	4	3	1		17
4.0-5.0					3	1		4
5.0-6.0								0
6.0-7.0								0
7.0+								0
SUM	42	69	67	59	134	68	15	454

DIRECTION 280 DEGREES (275-285)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		3	3		3	1		10
0.5-1.0	18	13	8	15	26	3	1	84
1.0-1.5	14	11	16	16	24	14	2	97
1.5-2.0	5	16	11	7	8	10	1	58
2.0-2.5		13	7	4	4	2	2	32
2.5-3.0		7	3	1	2	1	2	16
3.0-4.0		4	6	1	1	1		13
4.0-5.0			3		3	1		7
5.0-6.0					1	1		2
6.0-7.0								0
7.0+								0
SUM	37	67	57	44	72	34	8	319

DIRECTION 270 DEGREES (265-275)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5			1	2	5		1	9
0.5-1.0	15	6	6	9	18	4		58
1.0-1.5	10	12	6	8	11	11		58
1.5-2.0	6	12	15	4	7	1	3	48
2.0-2.5		15	14	4	2			35
2.5-3.0		5	2	3	1			11
3.0-4.0		5	7	2				14
4.0-5.0			2		1			3
5.0-6.0								0
6.0-7.0								0
7.0+				1				1
SUM	31	55	53	33	45	16	4	237

DIRECTION 260 DEGREES (255-265)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	2		5	1	1			9
0.5-1.0	10	2	4	5	5			26
1.0-1.5	13	7	3	6	3	2	3	37
1.5-2.0	5	17	8	7			2	39
2.0-2.5		12	7	6	2			27
2.5-3.0		8	4	6		2		20
3.0-4.0		4	4	5	1			14
4.0-5.0		1	1			1		3
5.0-6.0			1	2	1	1		5
6.0-7.0				2				2
7.0+								0
SUM	30	51	37	40	13	6	5	182

DIRECTION 250 DEGREES (245-255)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		3	2	1	1			7
0.5-1.0	11	7	8	3				29
1.0-1.5	14	13	5	5	1			38
1.5-2.0	5	8	4	3	1	1		22
2.0-2.5	1	13		1	2	1	1	19
2.5-3.0		13	1	2			1	17
3.0-4.0		8	7	2	1			18
4.0-5.0			3					3
5.0-6.0			1	1	1			3
6.0-7.0				1				1
7.0+				1	1			2
SUM	31	65	31	20	8	2	2	159

2.III.30 — TABLE III 1.13 — CONTINUED

TABLE III.1.13(CONT.)

ALL YEARS (1951-1974) DIRECTION-HEIGHT-PERIOD FREQUENCY OF OCCURRENCE DISTRIBUTION

COMBINED SEA/SWELL - COMPILED FROM 8727 ONCE-DAILY WAVE COMPUTATIONS STATION 2 (39.6N 124.5W)

DIRECTION 240 DEGREES (235-245)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		1		1				2
0.5-1.0	15	11	4	4				34
1.0-1.5	17	25	7	4			1	54
1.5-2.0	12	14	8	1			4	39
2.0-2.5		15	13	1			5	34
2.5-3.0		9	1	1	1			12
3.0-4.0		4	8	2	1			15
4.0-5.0			6	1				7
5.0-6.0				2				2
6.0-7.0								0
7.0-+					1			1
SUM	44	79	47	17	3	0	10	200

230 DEGREES (225-235)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		4	1	1				6
0.5-1.0	8	13	5	3				29
1.0-1.5	18	17	8		1			44
1.5-2.0	7	11	5	3	1		1	28
2.0-2.5	1	7	8	1	1		2	20
2.5-3.0		8	2	5				15
3.0-4.0		6	12	4				22
4.0-5.0			7					7
5.0-6.0			1	4				5
6.0-7.0								0
7.0-+						1		1
SUM	34	66	49	21	3	1	3	177

220 DEGREES (215-225)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	1	2						3
0.5-1.0	10	3	1	1				15
1.0-1.5	10	4	2					16
1.5-2.0	7	7	5	2		1	1	23
2.0-2.5		12	3	1				16
2.5-3.0		8	3		1			12
3.0-4.0		9	10		2			21
4.0-5.0			10					10
5.0-6.0				2				2
6.0-7.0				3	1			4
7.0-+								0
SUM	28	45	34	9	4	1	1	122

210 DEGREES (205-215)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		4	1					5
0.5-1.0	3	[illegible]	1	1				12
1.0-1.5	18	8	3					29
1.5-2.0	12	8	5	1	2			28
2.0-2.5	1	[illegible]	7		1			24
2.5-3.0		[illegible]	1					19
3.0-4.0		13	13	1				27
4.0-5.0			[illegible]					15
5.0-6.0			3	3				6
6.0-7.0								0
7.0-+					3	1		4
SUM	34	73	50	6	6	1	0	170

DIRECTION 200 DEGREES (195-205)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5								0
0.5-1.0	12	6	3					21
1.0-1.5	11	21	2					34
1.5-2.0	12	14	1	3	1			31
2.0-2.5		15	8	2				25
2.5-3.0		12	1	3				16
3.0-4.0		5	11	2	1			19
4.0-5.0			12	1	1			14
5.0-6.0			3	5				8
6.0-7.0				3	1			4
7.0-+					2			2
SUM	35	73	41	19	6	0	0	174

190 DEGREES (185-195)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5								0
0.5-1.0	8	8	1					17
1.0-1.5	15	10	2	1				28
1.5-2.0	8	15	1					24
2.0-2.5	1	22						23
2.5-3.0		17	1					18
3.0-4.0		9	16	1				26
4.0-5.0			6	2				8
5.0-6.0			2	7	1			10
6.0-7.0				2				2
7.0-+								0
SUM	32	81	29	13	1	0	0	156

180 DEGREES (175-185)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		1						1
0.5-1.0	11	4						15
1.0-1.5	10	3						13
1.5-2.0	12	9		1	1			23
2.0-2.5		19	5					24
2.5-3.0		16		1				17
3.0-4.0		5	14					19
4.0-5.0			17	1				18
5.0-6.0			3	3				6
6.0-7.0				1				1
7.0-+					2			2
SUM	33	57	39	7	3	0	0	139

170 DEGREES (165-175)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		2						2
0.5-1.0	6	1	1					8
1.0-1.5	10				1			11
1.5-2.0	11	7	2					20
2.0-2.5		18	1					19
2.5-3.0		5	1					6
3.0-4.0		[illegible]	11					15
4.0-5.0			7					7
5.0-6.0			2	4				6
6.0-7.0				2				2
7.0-+					1			1
SUM	27	38	25	6	2	0	0	98

DIRECTION 160 DEGREES (155-165)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5								0
0.5-1.0	11	2						13
1.0-1.5	12	2						14
1.5-2.0	12	7	1					20
2.0-2.5		9	1					10
2.5-3.0		8		2				10
3.0-4.0		3	7					10
4.0-5.0			3					3
5.0-6.0				1				1
6.0-7.0				1				1
7.0-+								0
SUM	35	31	12	4	0	0	0	82

150 DEGREES (145-155)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5		1						1
0.5-1.0	10							10
1.0-1.5	13	1						14
1.5-2.0	9	5	2					16
2.0-2.5		12						12
2.5-3.0		9						9
3.0-4.0		3	5					8
4.0-5.0			1					1
5.0-6.0			1	2				3
6.0-7.0				1				1
7.0-+								0
SUM	32	30	[illegible]	[illegible]	0	0	0	74

140 DEGREES (135-145)

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5								0
0.5-1.0	9		1					10
1.0-1.5	12							12
1.5-2.0	5	4	1					10
2.0-2.5		10						10
2.5-3.0		7						7
3.0-4.0		1	5					6
4.0-5.0								0
5.0-6.0								0
6.0-7.0				1				1
7.0-+								0
SUM	26	22	7	1	0	0	0	56

TOTAL OCCURRENCES

SECONDS / METERS	4-6	6-8	8-10	10-12	12-14	14-16	16+	SUM
0.0-0.5	10	75	31	16	63	15	3	213
0.5-1.0	683	[illegible]	115	111	[illegible]	55	4	1469
1.0-1.5	934	[illegible]	169	[illegible]	188	147	21	1909
1.5-2.0	372	[illegible]	135	97	64	[illegible]	38	[illegible]
2.0-2.5	13	[illegible]	[illegible]	37	41	14	21	[illegible]
2.5-3.0		[illegible]	34	[illegible]	18	9	6	[illegible]
3.0-4.0		[illegible]	220	35	22	5	3	[illegible]
4.0-5.0		[illegible]	112	7	17	3		[illegible]
5.0-6.0			[illegible]	38	5	1		[illegible]
6.0-7.0				[illegible]	[illegible]			[illegible]
7.0-+				[illegible]	[illegible]	2		[illegible]
SUM	5820 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

2 III 31 TABLE III.1.13

NUMBER [illegible] CASES = [illegible]
NUMBER [illegible] CASES = [illegible]

TABLE 2.13 AVERAGE Annual HEIGHT-PERIOD-DIRECTION FREQUENCY DISTRIBUTION (PERCENT)[1]

SWELL AVERAGE TOTAL HOURS

DIR.	NNW							NW						
H_s \ T_s	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+
1-2.9	26	126	40	.12	02			139	908	818	118	44	.16	
3-4.9	.16	88	60	.14				72	558	184	87	48	[illegible]	.02
5-6.9		43	20					05	150	120	46	.20	.07	.02
7-8.9		.09	.20	.05					23	94	24	14	07	
9-10.9									.07	41	32	12		
11-12.9									.02	14	.05	.05	.02	
13-14.9										21	12	07	.02	
15-16.9										07	05	05		
17-18.9										.14	.05			
19-20.9											.07			
21-22.9											.02			
23-24.9														
25-26.9														
27 +														
Σ	.42	266	140	31	02			216	1648	1313	343	155	51	04

DIR.	WNW							W						
H_s \ T_s	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+
1-2.9	123	714	351	105	66	27	14	104	477	186	72	51	17	02
3-4.9	91	657	282	114	107	47	10	116	326	171	79	31	17	02
5-6.9	.26	217	218	108	.54	07	02	37	159	132	44	27	07	
7-8.9	07	95	105	.73	14	05		02	47	65	50	13		
9-10.9		.29	51	35	23	05			22	27	18	07		
11-12.9		07	.25	15	12				10	16	05	02		
13-14.9			16	14	05	05			10	14	10	.12		
15-16.9			.09	09						07	09	02	02	
17-18.9				.12	02					05	02		02	
19-20.9				07						02	02			
21-22.9				.02							.07	02		
23-24.9												02		
25-26.9												02	02	
27 +														
Σ	247	1699	1057	490	283	96	26	259	1051	631	298	60	47	04

DIR.	WSW							SW				
H_s \ T_s	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	1
1-2.9	18	139	103	.27	05	02		.09	123	.63	.12	[illegible]
3-4.9	36	93	47	12	07	05		.17	.22	.02	.02	
5-6.9		.70	52	14	12			.10	18	.16	.04	
7-8.9		17	13	13	05				.05	07	15	
9-10.9		.13	12	02	04	.02			12		02	
11-12.9		02	07	07	02							
13-14.9		02	05	07								
15-16.9			04	[illegible]		02				.02		
17-18.9				12	02						02	
19-20.9										02	02	
21-22.9												
23-24.9												
25-26.9												
27 +												
Σ	14	[illegible]	[illegible]	86	[illegible]	1		56	180	92	79	.05

SEA

DIR.	N					NNW					NW				
H_s \ T_s	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+
1-2.9	228	17				313	34	02			587	28			
3-4.9	27	280	40			91	392	36			87	555	43	.02	
5-6.9		150	14				181	23	04			144	52	.04	
7-8.9		22	214				[illegible]	322	07			08	250	05	
9-10.9			14	05				130	09				36	14	
11-12.9			09	16				14	21				07	22	
13-14.9			.02	12				05	12					.09	
15-16.9				05					15					02	
17-18.9									07						
19 +															
Σ	255	579	555	38		404	624	532	75		674	715	388	58	

DIR.	WNW					W					WSW				
H_s \ T_s	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+
1-2.9	45	02				146	09				[illegible]	05			
3-4.9	12	42	02			28	69	05			2	57	07		
5-6.9		16	02				21	04			02	22	02		
7-8.9		04	22				02	32					[illegible]		
9-10.9													[illegible]		
11-12.9				.02									[illegible]	[illegible]	
13-14.9															
15-16.9															
17-18.9															
19 +															
Σ	60	64	26	02		174	101	41			65	81	48	02	

DIR.	SW					SSW				
H_s \ T_s	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+
1-2.9	96	[illegible]				36	02			
3-4.9	57	78	[illegible]			13	[illegible]	06		
5-6.9		77	05				02	02		
7-8.9			63	05			5	39		
9-10.9		74	[illegible]	02				22		
11-12.9			[illegible]	02				12	02	
13-14.9			07						13	
15-16.9									05	
17-18.9									12	
19 +									.24	02
Σ	253	216	110	14		58	94	80	36	02

1 Based on 365-1/3 Days

2 Includes waves of 0 to 0.9 feet

HEIGHT-PERIOD-DIRECTION FREQUENCY DISTRIBUTION (PERCENT)[1] STATION 2 (1956,1957,1958)

		W							WSW							SW							SSW							S							SSE							Σ
16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	6-8	8-10	10-12	12-14	14-16	16-18	18+	
	4	1.04	4.77	1.86	.72	51	.17	02	18	1.39	1.03	.27	05	02		.09	1.23	.63	.12	.05			.02	.18	27					.07	47	.13						.04						51.83
4	10	1.16	3.26	1.77	79	37	.17	02	36	93	47	12	.07	05		.17	.22	.02	.02				.05	.02						02	16	05						.02						34.63
07	02	37	1.59	1.32	44	.27	.07			.70	52	14	12			.10	.18	.16	.04					.05						.02	.07	02	.02					.04						16.69
05		02	47	65	50	13				.17	13	13	05				.05	.07	.05																									7.37
05			22	27	.18	07				.13	12	.02	04	.02			12		02												02	02												3.60
			10	16	05	02				02	07	07	.02																															1.36
05			10	14	.10	.12				02	05	07																																1.42
				07	09	02	02				04	02		02				.02																										.65
				05	02		02					12	02						02																									.48
				02	02													02	02																									.22
					.07	.02																																						.13
						02																																						.02
						02	.02																																					.04
96	26	2.59	10.51	6.31	2.98	1.60	47	.04	54	3[illegible]	[illegible]	86	37	[illegible]		36	1.80	92	29	05			.07	25	.27					[illegible]	72	.22	02					.10						118.44

W					WSW					SW					SSW					S					SSE					OFFSHORE	CALM[2]	Σ
4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12+	4-6	6-8	8-10	10-12	12	4-6	6-8	8-10	10-12	12+			
[illegible]	09				.51	.02				[illegible]	[illegible]				46	02				2.43	09				47	02						20.78
[illegible]	69	05			12	57	07			1.57	.78	[illegible]			13	65	05			35	.84	18			05	46	12					24.06
	21	04			02	22	02				77	06				22	02				.81	05				07	02					7.92
	02	32					27					63	05			15	39				[illegible]	1.26				02	37	05				12.28
							07				04	07	02				22					59	05				24	02				4.00
							05	02				07	07				12	02				60	13				15	21				2.35
												07						13				12	12				02					.86
																		05				07	07				02					.43
																		12					14									.33
																		04	02				09	02				.02				.19
																														.21	26.59	26.80
[illegible]	1.01	41			65	.81	48	02		2.53	2.16	1.10	14		58	94	80	36	02	2.78	2.88	2.87	.60	02	52	57	94	30		.21	26.59	100.00

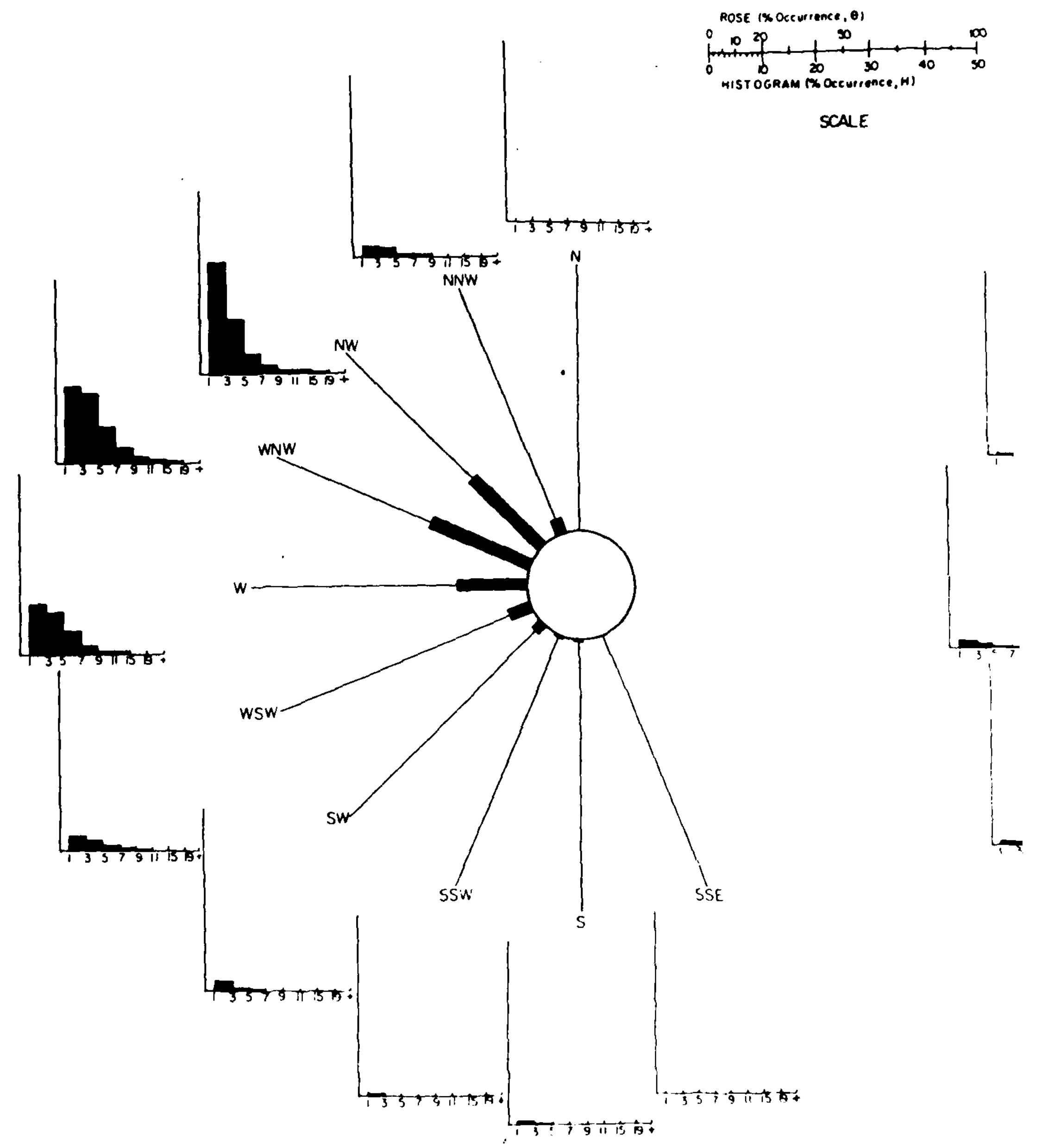
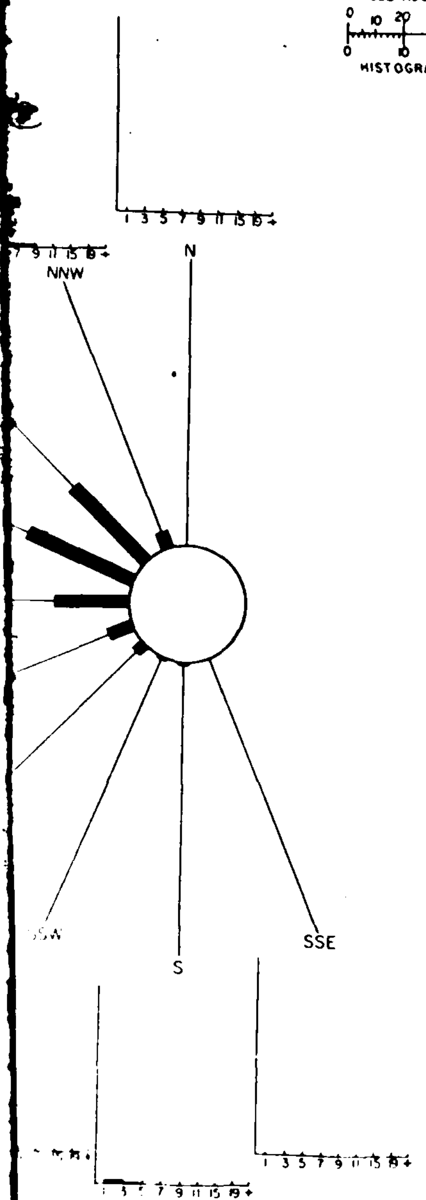
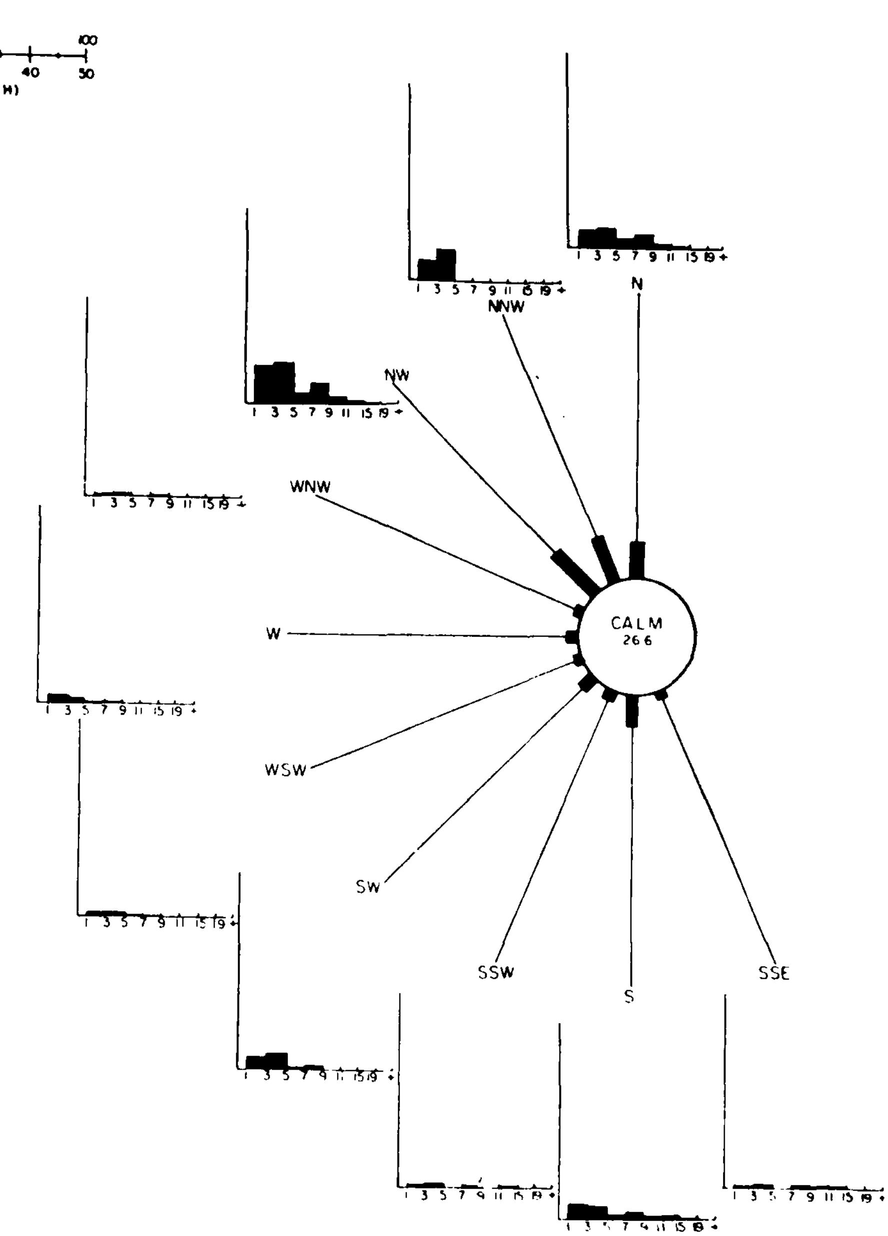


FIGURE: 5

AVERAGE ANNUAL SWELL ROSE FOR STATION 2



FOR STATION 2



AVERAGE ANNUAL SEA ROSE FOR STATION 2

APPENDIX C

WIND DATA STATISTICS and SUMMARY

for

HUMBOLDT BAY AREA

SUMMARY OF COMBINED WIND DATA
FROM
EUREKA WEATHER STATION
AND
HUMBOLDT BAY POWER PLANT

DIRECTION	WIND SPEED (Miles per Hour) 1-3	4-5	16-31	32-47	PERCENT OF TIME	MEAN WIND SPEED (MPH)
N	1.7	15.5	5.0	-	22.2	12.1
NE	1.6	4.9	0.7	-	7.2	9.2
E	2.0	3.7	0.0	-	5.7	6.9
SE	2.7	8.4	2.0	-	13.1	10.1
S	1.7	8.5	2.8	-	13.0	11.5
SW	1.9	8.9	1.5	-	12.3	10.0
W	1.8	5.7	0.3	-	7.8	8.3
NW	1.9	11.4	1.1	-	14.3	9.3
CALM	-	-	-	-	4.4	9.0
TOTAL	15.2	67.0	13.4	0.0	100.0	

Total Number of Observations 81,122

Data Compiled from records obtained from Eureka, California, U. S. Weather Bureau Station July 1939 to December 1967 and Humboldt Bay Power Plant Weather Station . January 1966 to December 1967.

SURFACE WINDS

PERCENTAGE FREQUENCY OF WIND
DIRECTION AND SPEED
(FROM HOURLY OBSERVATIONS)

STATION: Eureka, CA WBO (STATION NAME) — July 1939 thru December 1942 (YEARS) — ALL (MONTH)

ALL WEATHER (CLASS) — ALL (HOURS (L.S.T.))

40° 48', 124° 10', 13' (LOCATION)

88' (HEIGHT ABOVE GROUND)

SPEED MPH / DIR.	1-3	4-15	16-31	32-47	> 47	%	MEAN WIND SPEED
N	1.3	10.4	1.7			13.4	9.5
NNE	0.7	2.3	0.1			3.0	6.7
NE	1.3	2.4				3.7	4.8
ENE	0.6	1.2	0.0			1.8	4.6
E	1.6	1.6				3.2	3.9
ESE	1.3	2.8				4.1	4.9
SE	2.9	6.7	0.3			9.9	6.0
SSE	0.8	5.8	1.0			7.6	9.7
S	1.3	4.6	0.4			6.3	7.8
SSW	0.7	3.9	0.4	0.0		5.0	8.1
SW	1.4	6.2	0.4			8.0	7.6
WSW	0.3	2.2	0.0			3.0	5.7
W	1.0	2.9				3.9	5.8
WNW	0.7	3.5	0.0			4.2	6.2
NW	1.1	7.7	0.2			9.0	7.2
NNW	0.7	7.9	0.9			9.3	9.4
CALM						4.5	7.1
4.5	18.0	72.1	5.5	0.0		100.0	

DATA FROM NATIONAL CLIMATIC CENTER
FEDERAL BUILDING – ASHEVILLE, N.C., 28801

TOTAL NUMBER OF OBSERVATIONS 63,771

SURFACE WINDS

PERCENTAGE FREQUENCY OF WIND
DIRECTION AND SPEED
(FROM HOURLY OBSERVATIONS)

STATION: ______ STATION NAME: Eureka CA, Humboldt Bay P.P. YEARS: Jan 1966 thru Dec 1967 MONTH: ALL

CLASS: ALL WEATHER HOURS (L.S.T.): ALL

LOCATION: 40°48', 120°12'

HEIGHT ABOVE GROUND: ______

SPEED MPH / DIR.	1-3	4-7	8-12	15-18	19-24	> 25						%	MEAN WIND SPEED
N	0.7	3.7	6.1	4.7	2.2	1.1						18.4	12.7
NNE	0.6	2.1	2.7	1.2	0.3	0.1						6.9	9.6
NE	0.4	1.6	1.2	0.2	0.0							3.5	7.3
ENE	0.4	1.3	0.5	0.1	0.0							2.3	6.2
E	0.6	1.4	0.5	0.0								2.5	5.5
ESE	0.3	1.3	0.7	0.1	0.0	0.0						2.4	6.9
SE	0.2	1.0	0.8	0.9	0.5	0.5						3.9	13.3
SSE	0.3	1.0	1.0	2.1	1.4	0.9						6.7	15.7
S	0.5	1.5	2.1	1.9	0.6	0.2						6.7	11.3
SSW	0.6	1.9	2.3	1.0	0.4	0.2						6.5	10.1
SW	0.7	2.5	2.1	0.9	0.5	0.4						7.2	10.2
WSW	1.0	2.0	1.3	0.5	0.2	0.1						5.1	10.3
W	1.0	2.0	0.9	0.2	0.1	0.0						4.2	6.1
WNW	0.9	1.5	0.7	0.1	0.1	0.0						3.1	6.2
NW	0.9	2.2	1.5	0.3	0.1	0.1						5.0	7.3
NNW	0.7	2.9	3.5	1.8	0.5	0.1						9.6	9.9
CALM												5.9	9.6
5.9	9.9	30.0	27.8	15.9	6.9	3.8						100.0	

DATA from Pacific Gas and Electric Company

TOTAL NUMBER OF OBSERVATIONS 17,351

TABLE 1. PERCENT FREQUENCY OF WIND SPEEDS OF 17 KNOTS OR MORE

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Yrs Rec
Alameda	6.5	8.2	8.0	7.7	8.3	7.6	3.4	3.0	2.7	3.2	4.2	5.1	5.7	12
Arcata	4.2	6.9	6.3	6.6	7.8	5.6	2.6	1.7	1.9	2.0	3.0	3.2	4.2	12
Bakersfield Meadows	0.9	1.6	1.5	1.9	2.3	1.8	0.3	0.3	0.3	0.3	0.5	0.7	1.0	12
Beale AFB	4.1	4.5	3.0	2.2	0.9	1.8	0.4	0.7	1.2	2.8	2.9	3.9	2.4	7
Beaumont	8.2	2.0	3.8	[illegible]	0.6	0.5	0.8	0.6	0.9	3.6	9.9	6.7	3.2	4
Blythe	7.1	8.2	10.7	6.8	6.9	6.5	4.4	3.6	2.1	2.6	6.3	6.2	6.0	7
Burbank	1.3	2.5	1.7	2.0	0.7	0	0	0	0	0.5	1.4	1.7	1.0	12
Castle AFB	3.3	4.7	3.7	3.9	2.9	3.2	1.2	0.6	0.6	2.0	1.4	2.9	2.5	12
Chico	8.7	14.3	11.7	11.6	12.4	9.4	1.6	1.6	5.4	6.6	7.7	5.4	8.0	4
China Lake	9.6	12.6	18.7	19.3	17.5	15.5	10.2	10.3	8.6	9.2	7.8	7.9	12.3	12
Crescent City	20.7	11.7	15.9	13.0	17.4	12.2	9.7	4.1	4.8	5.8	8.1	0.5	11.2	6
Crows Landing	2.3	1.5	2.1	1.2	1.5	1.0	0.1	0.1	0.1	1.8	1.3	1.4	1.2	7
Daggett	9.9	13.3	25.5	25.9	32.5	29.2	15.3	10.5	10.1	8.2	7.8	7.5	16.3	12
Edwards AFB	8.6	8.9	15.6	17.5	20.0	19.8	12.0	10.3	8.2	6.0	6.8	7.5	11.8	12
El Centro	6.2	8.1	13.3	15.7	18.1	16.1	4.3	4.0	4.6	5.5	6.1	4.8	8.9	12
El Toro	1.4	1.9	1.2	0.9	0.5	0.1	0	0.1	0.1	0.3	2.4	2.4	0.9	12
Fall River Mills	2.3	2.3	3.2	2.0	1.8	1.3	0.2	0.3	0.6	1.4	1.4	2.5	1.6	10
Fallon	1.5	2.9	4.0	4.1	2.7	1.8	0.7	0.4	0.6	1.6	0.9	1.9	1.9	12
Fort Bragg	5.4	8.1	7.1	5.6	3.6	2.4	1.2	1.0	2.2	1.0	2.0	3.4	3.6	3
Fort Ord	0.2	0.3	1.3	1.8	1.4	0.7	0.4	0.3	0.3	0.4	0.3	0.2	0.6	6
Fresno AT	0.6	0.6	1.1	1.3	0.9	0.8	0.1	0	0.2	0.4	0.2	0.3	0.5	12
George AFB	7.1	9.7	13.1	13.9	13.2	10.4	5.9	6.6	4.4	4.7	6.1	6.3	8.5	13
Hamilton AFB	2.6	3.6	2.4	2.3	2.0	1.6	0.4	0.6	0.7	2.1	2.0	3.2	2.0	12
Hollister	2.3	1.5	2.1	1.2	1.5	1.0	0.1	0.1	0.1	1.8	1.3	1.4	1.2	7
Holtville	1.5	3.6	2.8	3.8	2.3	2.6	3.6	2.8	0.9	1.1	2.0	1.5	2.4	12
Imperial Beach	2.9	2.5	1.3	1.8	1.0	0.9	0.5	0.3	0.3	0.4	1.9	1.3	1.3	10
Las Vegas	6.3	11.0	14.2	15.4	15.8	13.7	9.2	8.4	7.7	7.6	5.6	6.3	10.1	12
Lemoore	1.6	2.0	3.3	3.6	3.4	3.8	1.2	1.2	1.0	1.2	1.5	1.0	2.1	9
Livermore	2.5	2.3	2.2	1.9	1.6	1.8	0.3	0.1	0.4	1.7	1.1	1.4	1.5	9
Long Beach	0.8	1.8	1.5	1.7	1.0	0.3	0.1	0.3	0.3	0.4	1.3	1.1	0.9	12
Los Alamitos	1.7	1.9	2.5	1.8	1.4	0.3	0	0	0.2	0.2	2.3	2.2	1.2	12
Los Angeles AP	1.5	3.0	2.8	2.8	1.7	0.3	0.1	0.1	0.2	0.6	1.2	1.7	1.3	12
March AFB	0.8	0.9	0.9	0.9	0.5	0.5	0.4	0.4	0.1	0.4	0.9	0.9	0.6	12
Mather AFB	8.9	8.5	5.9	3.7	2.2	2.3	1.1	0.6	0.6	2.5	3.5	6.7	3.9	12
McClellan AFB	6.3	7.4	6.2	3.9	4.2	3.5	1.0	1.3	0.6	3.3	4.0	6.7	4.1	11
Medford	3.3	2.9	2.7	2.6	2.1	1.7	1.1	1.0	0.7	0.9	1.6	1.6	1.9	12
Miramar	0.6	0.4	0.8	0.6	0	0	0	0	0	0.1	0.5	0.5	0.3	12
Moffett Field	4.1	5.2	3.3	4.1	4.4	6.0	3.6	2.6	2.0	1.9	2.1	3.9	3.6	12
Mojave	10.1	9.6	19.6	30.0	21.3	29.4	16.9	11.2	11.7	14.2	10.8	5,8	15.9	3
Montague	11.6	6.3	9.4	8.7	4.7	4.2	4.0	3.2	1.7	5.7	9.4	6.8	6.3	5
Monterey	1.1	1.8	1.5	2.3	2.0	0.9	0.2	0.3	0.2	0.5	0.9	2.5	1.2	12
Needles	8.0	10.1	10.2	9.1	8.4	7.1	3.5	3.8	3.2	5.9	8.9	8.3	7.2	7
Nellis AFB	4.6	7.3	11.3	10.8	9.8	7.2	4.3	4.5	4.0	5.1	5.2	3.6	6.5	12
Norton AFB	1.7	3.5	2.1	0.8	0.6	0.3	0.1	0.1	0.4	0.7	1.9	2.1	1.2	12
Oakland AP	2.6	4.6	4.5	4.9	5.4	3.9	1.5	1.4	1.2	2.2	2.3	2.7	3.1	12
Oceanside	4.6	1.4	3.2	2.0	1.9	0.3	0	0.2	0.4	0.8	1.2	3.8	1.7	5
Ontario	3.3	2.9	2.9	0.9	1.0	0.1	0.1	0.1	0.7	0	4.2	1.9	1.5	4
Oxnard	4.0	3.3	2.4	2.1	1.8	0.4	0	0.1	0.1	0.8	3.2	5.9	2.0	13
Palm Springs	2.6	3.7	6.8	14.9	16.9	17.8	9.6	5.3	5.2	3.1	1.7	0.8	7.4	4
Palmdale	8.7	8.5	15.7	14.7	15.8	15.1	8.4	6.9	4.5	5.3	7.2	8.4	9.9	7
Paso Robles	2.3	2.9	4.6	6.5	10.3	13.7	11.8	8.8	5.0	2.6	2.0	3.0	6.0	7
Point Arguello	3.8	5.5	8.3	9.4	8.2	1.6	0.7	0.4	0.7	2.9	3.0	3.0	4.0	7
Point Mugu	12.1	10.8	9.7	7.5	6.6	2.3	1.1	1.0	1.0	3.0	11.4	16.3	6.9	12
Porterville	1.6	2.0	3.3	3.6	3.4	3.8	0.8	0.8	0.7	1.2	1.5	1.0	2.0	9
Red Bluff	10.6	12.4	11.0	8.8	6.9	4.8	1.8	1.4	4.5	7.2	7.7	7.8	7.1	12
[illegible]	11.1	12.7	10.9	8.5	6.5	5.1	1.7	1.4	4.2	7.0	6.9	7.9	7.0	12
[illegible]	7.2	6.8	8.5	7.4	7.1	6.1	4.4	4.5	3.0	4.5	4.1	5.0	5.7	12
[illegible]	8.3	9.4	7.1	5.4	5.2	6.1	3.8	3.7	2.7	4.8	4.5	7.5	5.7	13
[illegible]	2.3	2.1	2.5	0.5	0.2	0.3	0	0	0	0.7	1.8	4.1	1.2	7
San Clemente Is.	11.0	5.7	11.0	5.9	5.7	1.8	0.7	0.6	0.9	1.7	6.9	5.8	4.8	5

TABLE 3
EXTREME ANNUAL WIND SPEED
FASTEST MILE, 1871-1978
(mph)

Year	Eureka	Fresno	Los Angeles	Mt. Tamalpais	Red Bluff	Sacramento	San Diego	San Francisco	Yuma, AZ
1871									
1872								30	
1873							30	38	
1874							19	27	
1875							27	40	
1876							30	36	
1877							57	32	
1878			22		37	32	47	33	36
1879			24		41	32	26	33	30
1880			22		47	32	29	36	27
1881			37		34	27	29	30	34
1882			38		32	29	30	30	31
1883			34		31	30	27	30	35
1884			32		38	30	27	37	27
1885			30		35	30	21	30	38
1886			30		40	35	30	35	35
1887	34		30		36	32	30	30	33
1888	31	26	27		36	38	30	33	37
1889	35	24	21		35	34	30	31	37
1890	34	22	21		38	34	25	30	37
1891	32	25	24		41	32	25	40	38
1892	40	25	21		38	38	22	49	35
1893	32	24	24		30	36	28	39	35
1894	37	28	25		37	47	29	33	43
1895	35	24	22		32	38	22	36	37
1896	38	31	21		34	38	29	35	32
1897	36	27	28		30	35	29	37	30
1898	35	27	21		30	34	27	36	35
1899	32	27	25	70	34	38	27	39	34
1900	35	22	20	62	30	41	25	40	29

Corrected to true wind speed.

TABLE 3 (cont)
EXTREME ANNUAL WIND SPEED
FASTEST MILE, 1871-1978
(mph)

Year	Eureka	Farallon	Fresno	Los Angeles	Mt. Tamalpais	Point Reyes	Red Bluff	Reno, NV	Sacramento	San Diego	San Francisco	San Jose	Yuma, AZ
1901	32		24	21	69		37		47		47		32
1902	37		30	25	66		32		49		49		35
1903	35		30	22	69		30		32		35		34
1904	28	54	31	30	54		35		51		40		31
1905	38	56	28	30	61		30		35		35		32
1906	36	59	30	30	57		32	47	41		52		33
1907	36	50	22	28	60		27	40	35		35		33
1908	38	46	21	32	60		32	37	31		29	30	32
1909	38	52	25	28	64		28	43	38		40	34	30
1910	36	53	30	32	56		31	36	30		31	29	32
1911	37		27	31	66	64	32	44	32		36	30	35
1912	35		30	34	57	68	27	47	38		40	30	32
1913	35		30	31	57	66	30	40	35		35	30	32
1914	46		32	30	68	72	27	38	36		36	35	29
1915	46		35	30	68	84	29	45	45		42	38	32
1916	35		41	34	70	80	27	43	40	43	40	37	32
1917	35		28	29	70	77	26	47	39	35	43	37	37
1918	40		31	31	68	65	27	39	32	34	35	30	32
1919	35		30	24	68	65	30	40	38	32	51	30	34
1920	32		34	29	70	69	31	40	32	30	37	30	30
1921	38		30	35		76	35	43	40	32	47	35	33
1922	39		29	28		64	32	46	38	41	37	35	33
1923	37		34	30		59	32	41	32	29	52	26	34
1924	34		30	25		64	30	38	32	34	35	30	29
1925	38		27	22		57	27	37	27	31	33	30	35
1926	36		28	30		73	31	41	32	30	41	30	30
1927	32		38	26			26	40	41	31	36	32	30
1928	36		29	24			27	39	32	26	42	30	31
1929	32		30	21			27	40	33	26	38	30	40
1930	59		30	21			25	38	37	31	32	34	30

Corrected to true wind speed.

TABLE 3 (cont)
EXTREME ANNUAL WIND SPEED
FASTEST MILE, 1871-1978
(mph)

Year	Eureka	Fresno	Los Angeles	Oakland AP	Red Bluff	Red Bluff AP	Redding	Sacramento	San Diego	San Francisco	Santa Maria	Yuma, AZ
1931	42	33	24		36			31	30	33		35
1932	37	32	28		30			58	28	40		34
1933	30	30	25		35			34	32	30		35
1934	31	25	23					29	24	30		30
1935	30	32	23				30	30	29	41		35
1936	34	30	25				38	35	31	34		32
1937	38	31	23				36	29	28	31		29
1938	35	35	26				41	46	34	38		34
1939	35	40	30	57			42	32	34	34		30
1940	34	26	33	44			40	34	33	34		29
1941	35	35	36	49			36	37	36	39		29
1942	37	31	36	45			36	35	34	34		31
1943	40	30	43	63			34	33	44	35		29
1944	37	34	35	44				35	37	30	35	30
1945	35	32	38	46		37		36	36	32	36	33
1946	38	35	48	48		38		34	33	31	40	37
1947	34	31	34	45		39		29	27	31	38	34

Records before 1931 corrected to "true" windspeed.

(Table 3 continued on next page)

TABLE 5
PEAK GUST IN KNOTS
(Direction/Windspeed)

	Yrs Rec	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Alameda	28	W 60	SSW 59	50	SSE 46	W 46	W 43	W 35	W 32	NNE 42	W 55	SSW 61	NW 62	NW 62
Beale AFB	16	17 51	16 54	16 44	32 38	34 37	15 38	SSW 28	SSE 30	NNE 42	S 46	15 56	19 58	19 58
Camp Pendleton	4	ESE 40	S 39	W 37	W 44	W 26	SW 23	W 16	W 24	SW 29	NW 30	SE 35	WSW 33	W 44
China Lake	20	SW 67	W 69	W 70	SW 64	WSW 71	WSW 67	SW 52	WSW 50	WSW 60	SW 59	W 58	SSW 62	WNW 71
Castle AFB	29	SE 51	NW 54	SE 49	NNW 48	NW 43	NW 43	NNW 30	NNW 29	NW 42	SSE 43	14 46	SE 47	NW 54
Edwards AFB	26	WNW 51	W 58	W 64	NW 50	29 54	27 51	27 44	ENE 52	W 65	WNW 65	W 48	WSW 59	W 65
El Centro	13	WSW 50	WSW 52	WSW 58	WSW 58	W 58	W 52	WSW 41	SE 51	SSE 48	W 48	WSW 53	W 55	WSW 58
El Toro	27	NE 59	NE 65	NE 55	SSW 46	NE 48	NNE 33	SE 47	SSE 36	NE 43	E 45	NE 63	E 60	NE 65
Fort Ord	11	13 44	18 50	SE 37	WNW 40	27 40	SW 38	WSW 26	W 28	WSW 29	SW 40	ESE 42	SSW 42	18 50
George AFB	23	S 54	15 52	SSE 62	S 52	WNW 46	W 76	N 50	SE 44	19 39	NW 44	SW 51	N 56	W 76
Hamilton AFB	24	SSW 56	SSW 75	S 49	SW 49	WNW 45	WNW 41	WNW 32	WNW 48	SSW 46	NNW 64	S 53	S 53	SSW 75
Imperial Beach	18	SSE 48	S 37	WNW 44	WSW 48	WSW 28	SW 27	SSW 28	SW 26	NE 30	28 41	W 51	S 40	W 51
Lemoore	12	NNW 38	NW 43	N 38	NNW 32	N 37	25 33	N 28	NNW 27	NNW 32	34 39	SSE 32	32 41	NW 43
Los Alamitos	20	W 54	NE 42	WSW 54	WNW 47	NE 33	ENE 32	W 25	SE 26	E 26	NW 39	ENE 53	ENE 54	ENE 54
Los Angeles WBAS	15	SW 42	N 50	W 54	N 51	N 39	W 28	W 25	SW 27	SW 23	N 40	N 48	S 43	N 54
March AFB	19	NNE 46	NW 43	NNE 41	NNE 38	W 34	N 39	NE 43	S 35	SE 39	N 39	W 40	NNE 49	NNE 49
Mather AFB	31	SSE 61	15 62	S 62	SE 53	NNE 43	NNW 45	SSW 33	24 32	SSE 50	S 63	SSE 58	SSE 64	SSE 64
McClellen AFB	31	ESE 66	15 60	SE 66	SSE 55	NW 55	NW 56	S 39	S 32	S 40	SSE 71	SSE 55	SSE 65	SSE 71
Miramar	26	WSW 39	SSW 39	W 37	WSW 41	ESE 31	S 25	32	S 28	NE 41	E 33	SW 50	W 41	SW 50
Moffett Field	27	ESE 56	SE 56	SE 44	N 43	NW 38	NW 40	NNW 30	NW 31	SE 33	SE 48	N 48	SSE 54	SE 56
Monterey	16	SSW 54	SSW 69	100	SW 46	WNW 39	WSW 40	SSW 33	N 32	ESE 31	W 56	SSE 49	SW 63	100
Norton AFB	27	NW 69	N 55	N 47	NE 47	NE 40	NNW 48	SE 39	WSW 56	SW 60	SW 57	01 52	N 64	NW 69
Oxnard AFB	10	ESE 47	ENE 44	WSW 43	W 36	WNW 36	W 23	SW 22	SW 21	ENE 32	ENE 44	ENE 50	ENE 45	ENE 50
Point Mugu	13	ENE 61	NE 49	W 47	W 50	WNW 44	W 29	SE 33	SE 29	NE 40	ENE 48	ENE 56	NE 58	ENE 61
San Clemente	10	NW 39	NE 44	NW 42	WNW 39	WNW 34	WNW 31	SW 24	14 28	NE 29	23 33	E 39	NW 38	NE 44
San Diego USN	33	SSE 52	W 46	S 52	WNW 63	ENE 33	W 28	NW 24	NW 28	NW 23	NNW 54	SW 46	S 40	WNW 63
San Francisco AP	17	WSW 68	WNW 56	SW 50	SSW 52	W 54	W 50	W 41	W 43	S 49	SW 56	SSW 58	S 57	WSW 68
San Nicolas Island	11	WNW 52	W 64	NW 54	NW 55	NW 56	NW 52	NW 45	WNW 41	N 47	NW 50	NW 52	NW 55	W 64
Santa Ana	10	NE 57	NE 53	04 42	SSE 39	ENE 40	WSW 28	SSW 26	N 31	NE 40	05 37	NE 52	NE 59	NE 59
Travis AFB	25	N 60	NNW 65	SE 56	SE 53	SSW 45	SSW 47	23 46	SW 45	34 47	NNW 51	N 51	SE 49	NNW 65
Vandenberg	13	33 41	19 41	SE 40	40	WNW 35	32 36	30	30	31 32	33 32	44	44	44
White Mountain 1	22	W 94	SW 68	S 58	W 52	49	56	38	65	38	58	W 55	S 64	W 94
White Mountain 2	18	N 82	70	NW 65	W 72	W 56	W 44	S 46	SW 46	NE 44	W 70	N 58	W 66	N 82
San Diego NWS	7	W 38	SE 44	S 46	W 37	S 34	NE 26	S 26	S 39	NE 26	W 30	W 41	SE 34	SE 44

TABLE 6
FASTEST MILE,
FROM LOCAL CLIMATOLOGICAL DATA
(Direction/Windspeed in mph)

	Yrs Rec	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Bakersfield	28	02 35	29 44	36 38	29 40	32 38	15 41	29 25	06 30	14 35	32 31	34 30	17 35	29 44
Bishop	2	47	52	58	58	53	60	46	75	48	48	56	66	75
Blue Canyon	19	20 67	17 76	07 67	20 50	23 37	07 49	09 32	07 30	09 49	05 70	19 54	07 51	17 76
Eureka	66	S 54	SW 48	SW 48	N 49	NW 40	NW 39	N 35	N 34	N 44	SW 56	S 43	S 56	SW 56
Fresno	26	SE 32	W 38	NW 41	NW 36	N 38	W 34	NE 25	S 31	SW 29	NE 40	NW 29	NW 43	NW 43
Long Beach	18	17 37	18 40	32 35	29 44	27 30	27 21	16 23	27 23	33 23	32 37	34 35	32 39	29 44
Los Angeles AP	26	SW 48	N 57	W 62	N 59	N 45	W 32	W 29	SE 33	SW 26	W 46	N 55	S 49	W 62
Los Angeles CC	35	N 49	NW 40	NW 47	NW 40	NW 39	N 32	W 21	E 24	NW 27	N 42	N 42	SE 44	N 49
Oakland	28	16 40	36 49	20 45	25 35	27 38	27 42	27 28	27 29	02 33	25 43	02 46	23 48	36 49
Red Bluff	32	SE 59	SE 61	SE 63	SE 50	S 46	NW 38	N 38	SW 30	SE 50	SE 68	SE 56	SE 60	SE 68
Sacramento FAP	28	SE 60	SE 51	S 66	SW 45	S 35	SW 47	SW 36	SW 38	SW 42	SE 68	SE 70	SE 70	SE 70
San Diego	33	SW 39	S 35	SW 46	S 37	SW 27	S 26	NW 23	SW 23	W 25	N 31	SE 51	S 34	SE 51
San Francisco FOB	36	SE 47	SW 47	S 44	W 38	W 38	W 40	W 38	W 34	W 32	SE 43	S 41	SE 45	SE 47
San Francisco AP	27	16 58	25 52	20 40	16 46	30 41	28 44	27 38	27 36	28 28	25 40	20 47	18 47	16 58
Sandberg	21	20 61	32 77	34 74	36 64	34 59	34 64	34 46	34 40	35 45	34 55	34 62	34 53	32 77
Stockton	13	14 46	35 33	33 35	24 35	34 33	26 31	25 26	32 28	34 33	34 30	13 40	15 44	14 46
Reno Nevada	16	SW 80	SW 66	SW 80	SE 48	SW 48	NW 46	SW 44	SW 43	W 42	S 50	SW 52	SW 63	SW 80
Yuma Az.	26	NW 41	W 50	N 43	NE 47	NW 38	SW 42	NE 52	SE 60	E 57	S 47	N 47	W 47	SE 60
Medford Ore.	27	23 50	25 47	16 55	14 35	12 38	33 18	07 44	16 48	14 32	20 40	16 38	14 44	16 55
Las Vegas	12	SW 52	NW 60	SW 52	SW 52	SW 52	SW 46	NE 64	NE 55	NW 54	NW 52	SW 46	SW 54	NE 64

TABLE 8

ANNUAL FASTEST MILE IN MILES PER HOUR

Station	Years of Record[a]	Latitude	Longitude	Elevation Feet	Inst. Height Feet	Mean MPH	Return Period-Years 10	25	50	100	Record Maximum
Bakersfield	30	35 25	119 03	497	20	34	41	44	46	60	4[illegible] WSW
Blue Canyon	22	39 17	120 42	5,280	20	49	69	78	84	90	76 [illegible]
Eureka	31	40 48	124 10	43	88	43	52	56	59	62	56 SW
Farallon[b]	7	37 42	123 00	30		53	59	61	63	65	59 S
Fresno	31	36 46	119 43	328	20	33	39	42	44	46	43 NW
Las Vegas											64 NE
Long Beach	20	33 49	118 09	34	20	33	40	43	45	47	44 W
Los Angeles	29	34 02	118 14	257	104	45	54	58	61	63	62 N
Medford	30	42 22	122 52	1,298	20	37	47	51	54	57	55 SSE
Mt. Tamalpais[b]	22	37 56	122 35	2,586		64	72	75	77	79	70 NW
Oakland	31	37 44	122 12	6	20	39	47	51	53	56	50 N
Point Reyes[b]	16	38 00	123 01	510		69	79	84	87	90	84 SE
Red Bluff	31	40 09	122 15	342	20	50	61	65	69	72	68 SE
Redding[b]	9	40 35	122 23	560		37	42	44	46	47	42 SE
Reno	28	39 30	119 47	4,404	20	56	69	75	79	82	80 SW
Sacramento EAP	31	38 31	121 30	17	20	43	59	66	70	75	70 SE
San Diego	31	32 44	117 10	13	37	33	40	43	45	47	47 SE
San Francisco AP	28	37 37	122 23	5	20	45	55	59	62	65	60 SE
San Francisco FOB	25	37 47	122 25	52	132	38	45	49	51	53	47
San Jose[b]	23	37 20	121 54	95		32	36	38	39	40	38 SE
Sandberg	29	34 45	118 44	4,517	30	66	82	90	96	101	97 NW
Santa Maria	17	34 54	120 27	236	24	36	44	47	50	52	46
Stockton	31	37 54	121 15	22	20	34	41	44	47	49	46 SE
Yuma	31	32 40	114 36	194	20	44	54	58	61	63	60 SE

a/ Based on 1948 to 1978 data except where noted.

b/ Based on older records which have been corrected.

APPENDIX D

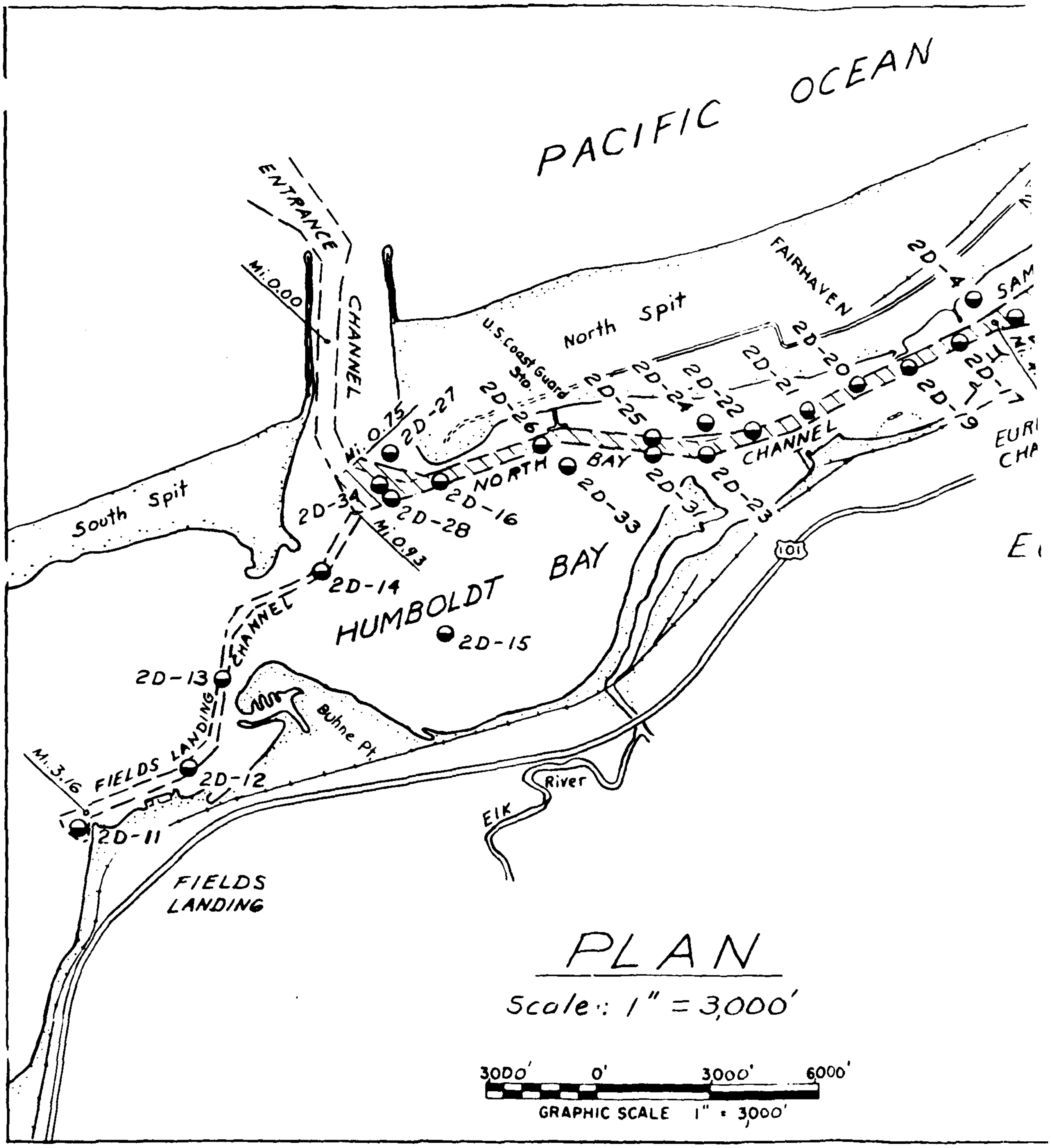
PLATES from PREVIOUS U.S. CORPS of ENGINEERS REPORTS

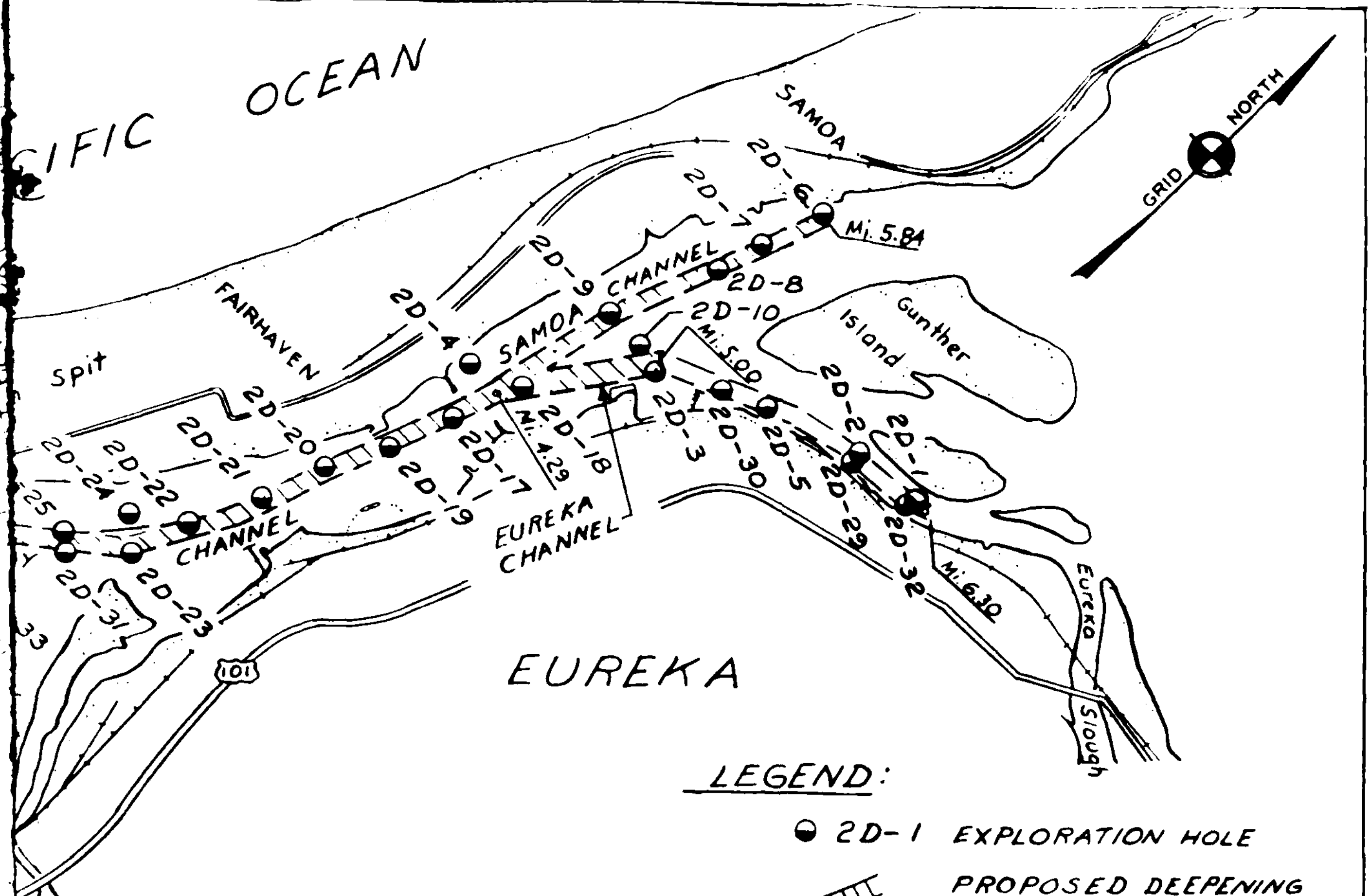
at

BUHNE POINT/KING SALMON AREA

REFERENCE MATERIAL
FROM
U. S. ARMY CORPS OF ENGINEERS
REPORTS

Previous investigations and studies made by the Corps of Engineers were used to obtain a background on the wave climate, surface and subsurface soils, and sediment transport system along the shore between Fields Landing Channel to Buhne Point. The Corps' previous report "Beach Erosion Control Report on Cooperative Study of Humboldt Bay (Buhne Point)" furnished most of the design data needed to formulate our design study. Surface and subsurface materials investigations carried out by the Corps for their "Design Memorandum No. 1 Humboldt Harbor and Bay" set parameters for the design of the sheet-pile groins and the H-Beam Pile structures. Needed background on the wave climate within the bay in the vicinity of Buhne Spit was obtained from the Corps' "Survey Report Humboldt Bay, California". The plates appended to this report were copied from the Corps' reports and are used to give the reader a better understanding of the bottom materials within the bay and the erosion that has taken place within the Buhne Point area during the past five decades.


PACIFIC OCEAN
ENTRANCE CHANNEL
MI. 0.00
North Spit
U.S. Coast Guard Sta.
FAIRHAVEN
2D-4
2D-20
2D-21
2D-22
2D-24
2D-25
2D-26
2D-27
2D-9
2D-17
MI. 0.75
South Spit
2D-34
2D-28
2D-16
NORTH BAY CHANNEL
2D-33
2D-31
2D-23
MI. 0.93
2D-14
HUMBOLDT BAY
2D-15
2D-13
CHANNEL
Buhne Pt.
MI. 3.16
FIELDS LANDING
2D-12
2D-11
FIELDS LANDING
Elk River
101
PLAN
Scale: 1" = 3,000'
3000' 0' 3000' 6000'
GRAPHIC SCALE 1" = 3,000'



LEGEND:

2D-1 EXPLORATION HOLE

PROPOSED DEEPENING OF THE CHANNEL TO ELEV -35'

NOTE:

LOGS OF EXPLORATION HOLES ARE SHOWN ON PLATES C-2 AND C-3

LAN

1" = 3,000'

3000' 6000'

CALE 1" = 3000'

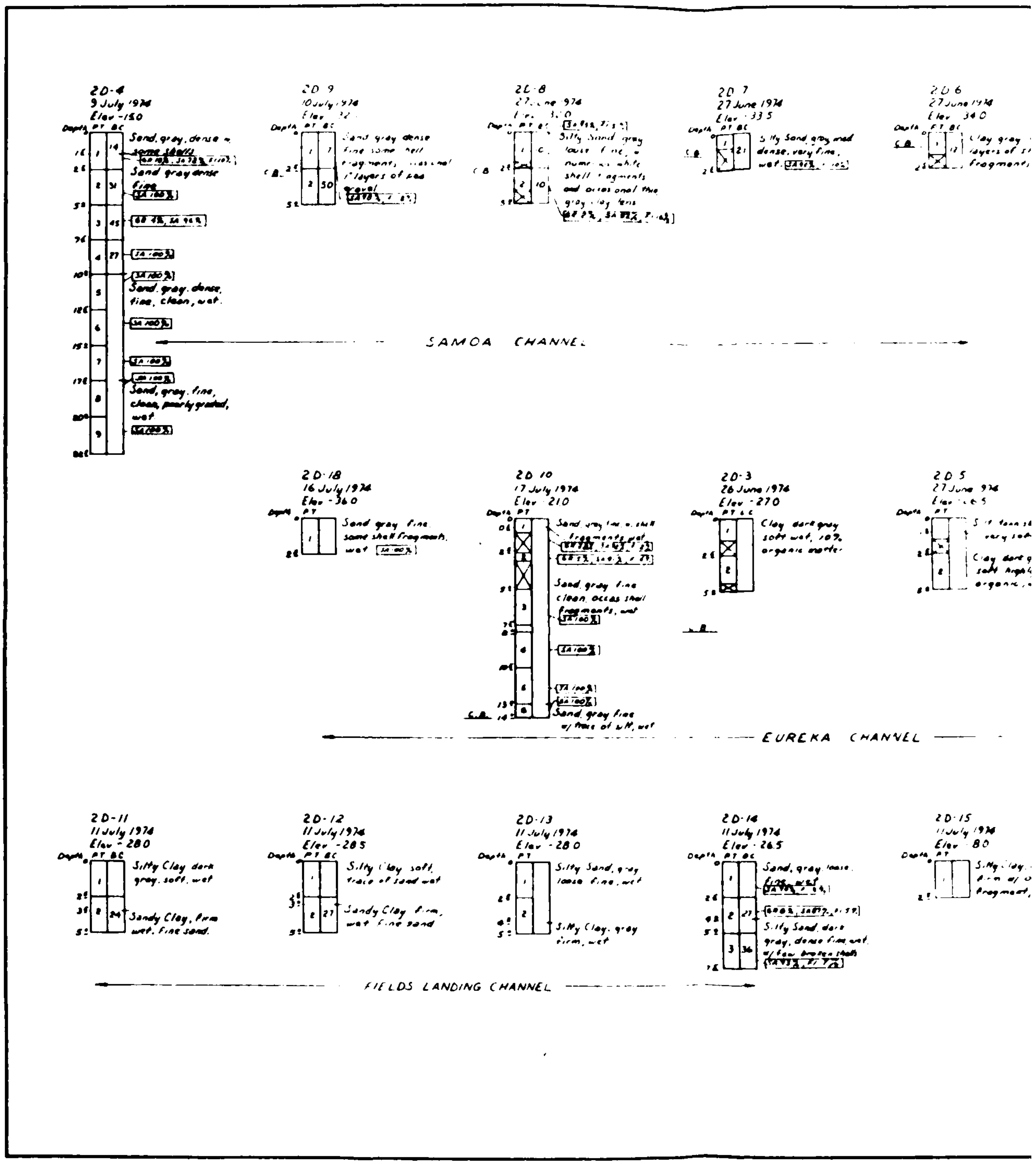
HUMBOLDT COUNTY CALIFORNIA

HUMBOLDT HARBOR AND BAY NAVIGATION CHANNEL IMPROVEMENTS

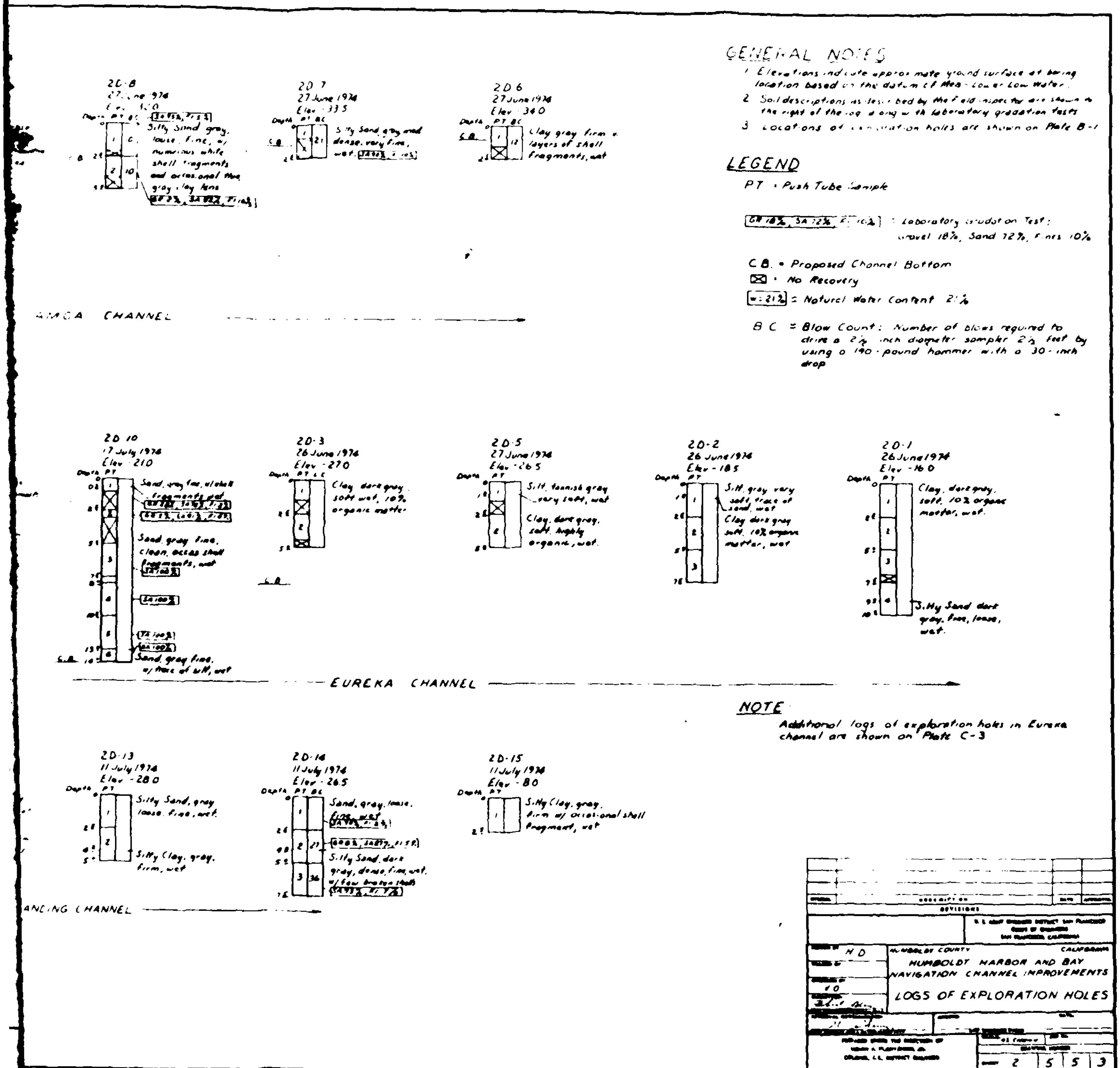
LOCATIONS OF EXPLORATION HOLES

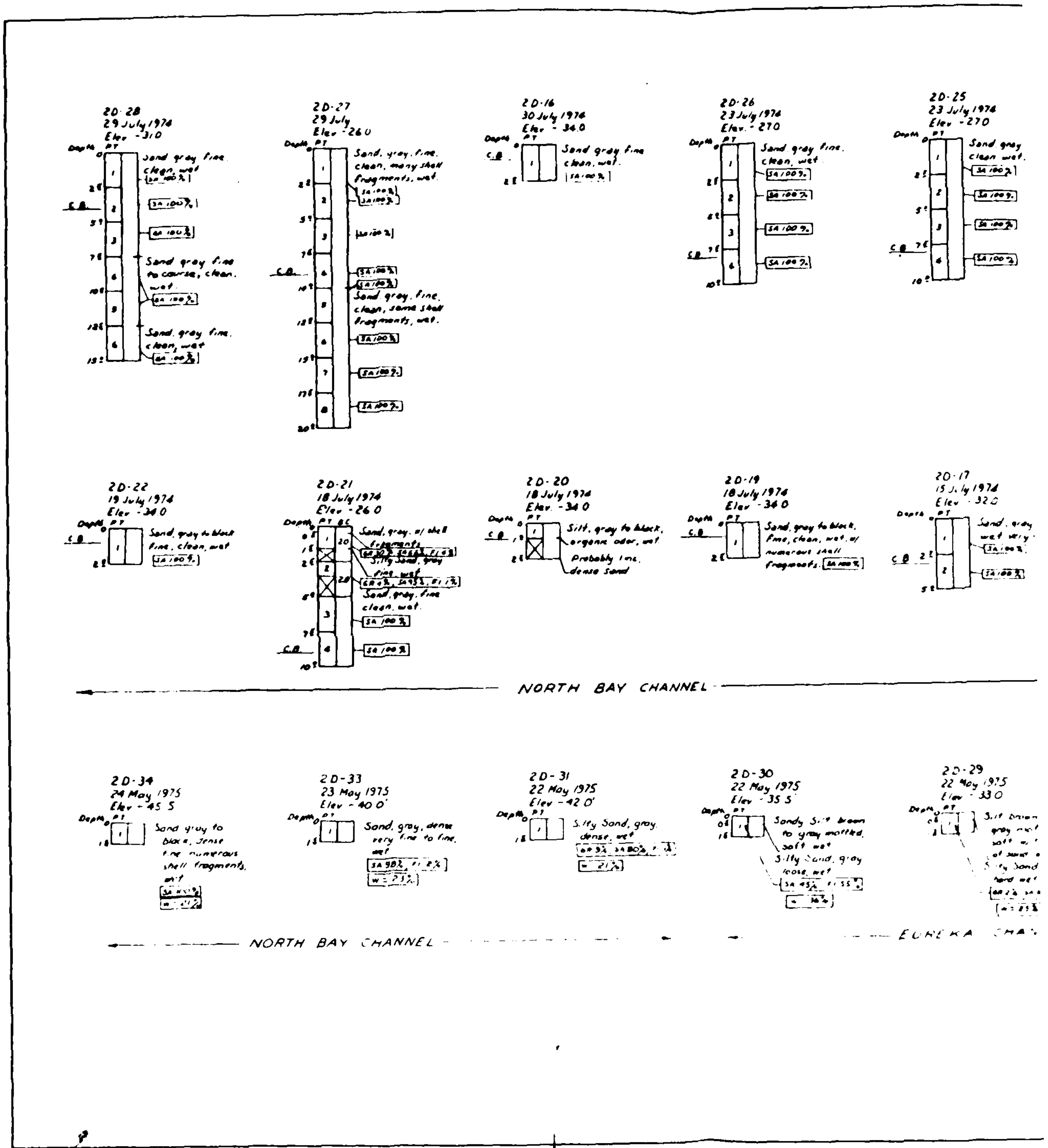
FILE NO. 5-5-3

PLATE C-1

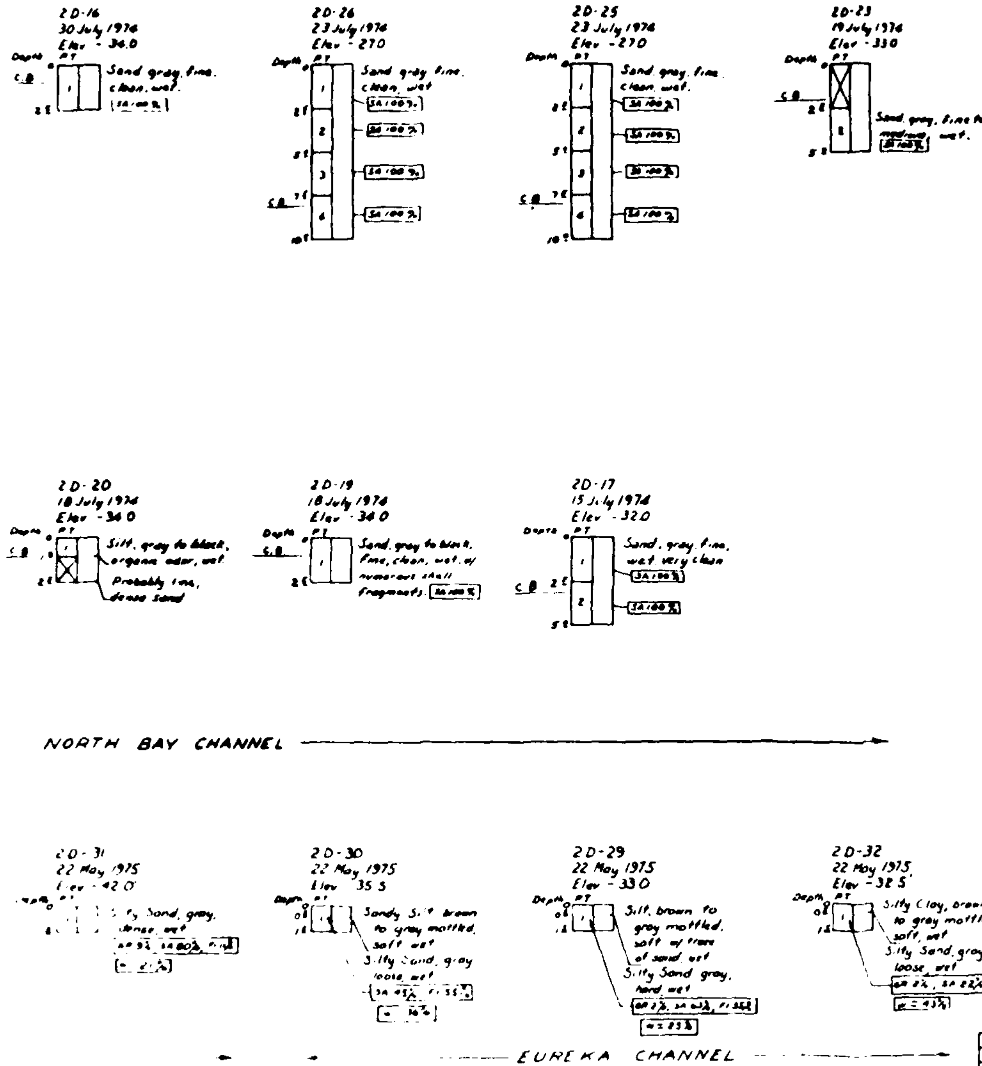


2D-4
9 July 1974
Elev -15.0
Sand, gray, dense w some shells
Sand gray dense fine
Sand, gray, dense, fine, clean, wet
Sand, gray, fine, clean, poorly graded, wet
SAMOA CHANNEL
2D-9
2D-8
2D-7
27 June 1974
Silty Sand gray and dense, very fine, wet
2D-6
27 June 1974
2D-18
16 July 1974
Elev -36.0
Sand gray fine, some shell fragments, wet
2D-10
17 July 1974
Elev -21.0
Sand, gray fine, clean, occas shell fragments, wet
Sand, gray fine w/ trace of silt, wet
2D-3
26 June 1974
Elev -27.0
Clay dark gray, soft, wet, 10% organic matter
2D-5
EUREKA CHANNEL
2D-11
11 July 1974
Elev -28.0
Silty Clay dark gray, soft, wet
Sandy Clay, firm, wet, fine sand
2D-12
11 July 1974
Elev -28.5
Silty Clay soft, trace of sand wet
Sandy Clay firm, wet fine sand
2D-13
11 July 1974
Elev -28.0
Silty Sand, gray loose fine, wet
Silty Clay, gray firm, wet
2D-14
11 July 1974
Elev -26.5
Sand, gray loose, fine, wet
Silty Sand, dark gray, dense fine, wet w/ few broken shells
2D-15
FIELDS LANDING CHANNEL


GENERAL NOTES
1 Elevations indicate approximate ground surface at boring location based on the datum of Mean Lower Low Water.
2 Soil descriptions as described by the field inspector are shown to the right of the log along with laboratory gradation tests
3 Locations of exploration holes are shown on Plate B-1
LEGEND
PT = Push Tube Sample
GR 18%, SA 72%, Fi 10% = Laboratory Gradation Test: Gravel 18%, Sand 72%, Fines 10%
C.B. = Proposed Channel Bottom
No Recovery
w=21% = Natural Water Content 21%
B C = Blow Count: Number of blows required to drive a 2½ inch diameter sampler 2½ feet by using a 140-pound hammer with a 30-inch drop
2D-8
27 June 1974
2D-7
27 June 1974
Elev -33.5
Silty Sand, gray and dense, very fine, wet.
2D-6
27 June 1974
Elev -34.0
Clay, gray, firm, w/ layers of shell fragments, wet
Silty Sand, gray, loose, fine, w/ numerous white shell fragments and occasional thin gray clay lens
SAMOA CHANNEL
2D-10
17 July 1974
Elev -21.0
Sand, gray, fine, clean, occas shell fragments, wet
Sand, gray fine, w/ trace of silt, wet
2D-3
26 June 1974
Elev -27.0
Clay, dark gray, soft, wet, 10% organic matter
2D-5
27 June 1974
Elev -26.5
Silt, tannish gray, very soft, wet
Clay, dark gray, soft, highly organic, wet.
2D-2
26 June 1974
Elev -18.5
Silt, gray, very soft, trace of sand, wet
Clay, dark gray, soft, 10% organic matter, wet
2D-1
26 June 1974
Elev -16.0
Clay, dark gray, soft, 10% organic matter, wet.
Silty Sand, dark gray, fine, loose, wet.
EUREKA CHANNEL
NOTE
Additional logs of exploration holes in Eureka channel are shown on Plate C-3
2D-13
11 July 1974
Elev -28.0
Silty Sand, gray, loose, fine, wet.
Silty Clay, gray, firm, wet
2D-14
11 July 1974
Elev -26.5
Sand, gray, loose, fine, wet
Silty Sand, dark gray, dense, fine, wet, w/ few broken shells
2D-15
11 July 1974
Elev -8.0
Silty Clay, gray, firm w/ occasional shell fragment, wet
ANCHORING CHANNEL
REVISIONS
HUMBOLDT COUNTY
CALIFORNIA
HUMBOLDT HARBOR AND BAY NAVIGATION CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
2 5 5 3
PLATE C-2



2D-28
29 July 1974
Elev -31.0
Sand gray fine clean, wet
Sand gray fine to course, clean, wet
Sand, gray fine, clean, wet
2D-27
29 July
Elev -26.0
Sand, gray, fine, clean, many shell fragments, wet.
Sand gray, fine, clean, some shell fragments, wet.
2D-16
30 July 1974
Elev -34.0
Sand gray fine clean, wet.
2D-26
23 July 1974
Elev. -27.0
Sand gray fine, clean, wet
2D-25
23 July 1974
Elev -27.0
Sand gray clean wet.
2D-22
19 July 1974
Elev -34.0
Sand, gray to black fine, clean, wet
2D-21
18 July 1974
Elev -26.0
Sand, gray, w/ shell fragments
Silty Sand, gray fine, wet
Sand, gray, fine clean, wet.
2D-20
18 July 1974
Elev. -34.0
Silt, gray to black, organic odor, wet.
Probably fine, dense Sand
2D-19
18 July 1974
Elev -34.0
Sand, gray to black, fine, clean, wet, w/ numerous shell fragments.
2D-17
15 July 1974
Elev -32.0
NORTH BAY CHANNEL
2D-34
24 May 1975
Elev -45.5
Sand gray to black, dense fine, numerous shell fragments, wet
2D-33
23 May 1975
Elev -40.0'
Sand, gray, dense very fine to fine, wet
2D-31
22 May 1975
Elev -42.0'
Silty Sand, gray, dense, wet
2D-30
22 May 1975
Elev -35.5
Sandy Silt brown to gray mottled, soft wet
Silty Sand, gray loose, wet
2D-29
22 May 1975
Elev -33.0
NORTH BAY CHANNEL
EUREKA CHA



NOTES:

1. Legend and General Notes are shown on Plate C-2.
2. Additional logs of exploration holes in Eureka channel are shown on Plate C-2.

REVISIONS

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

HUMBOLDT COUNTY — CALIFORNIA

HUMBOLDT HARBOR AND BAY NAVIGATION CHANNEL IMPROVEMENTS

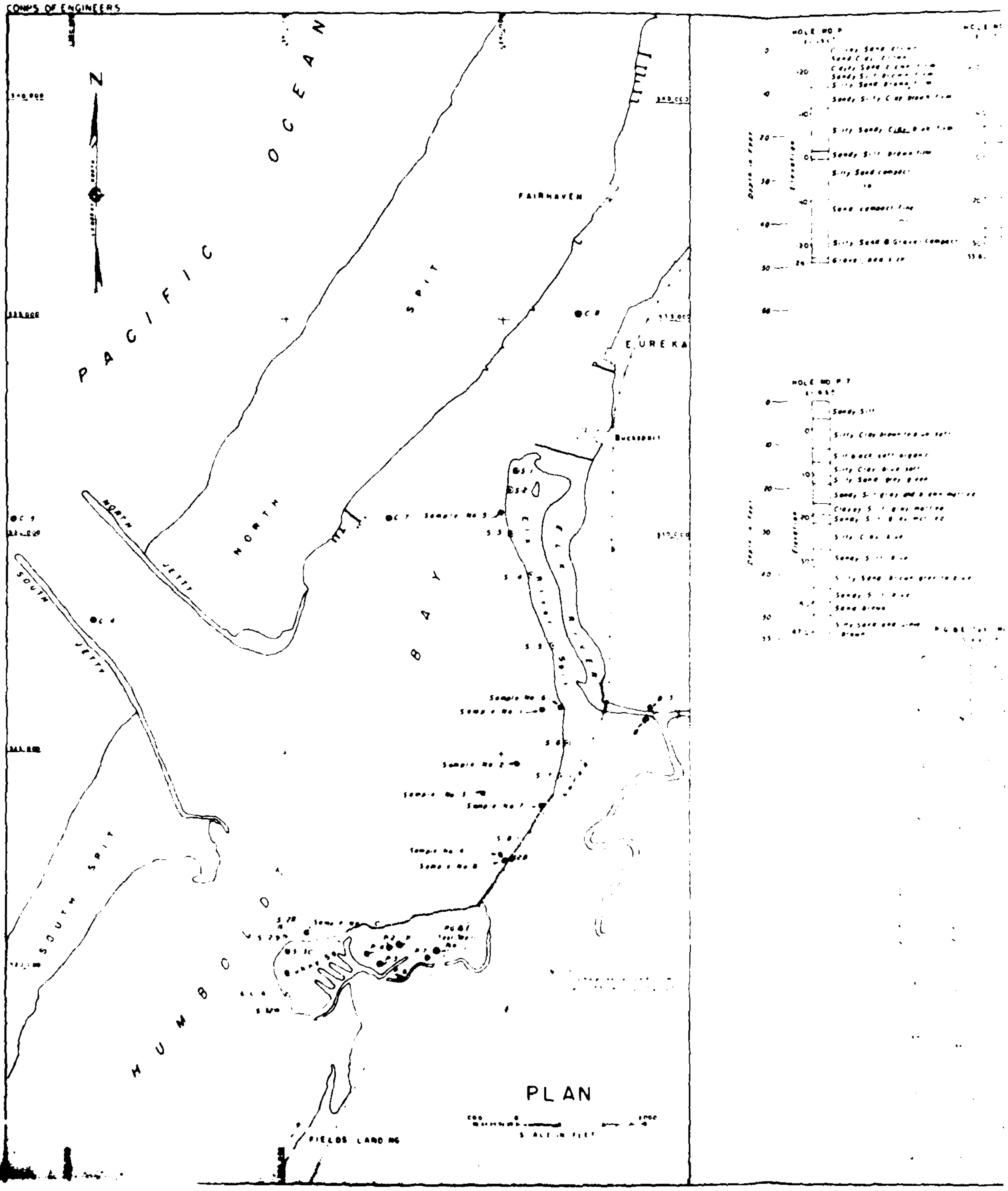
LOGS OF EXPLORATION HOLES

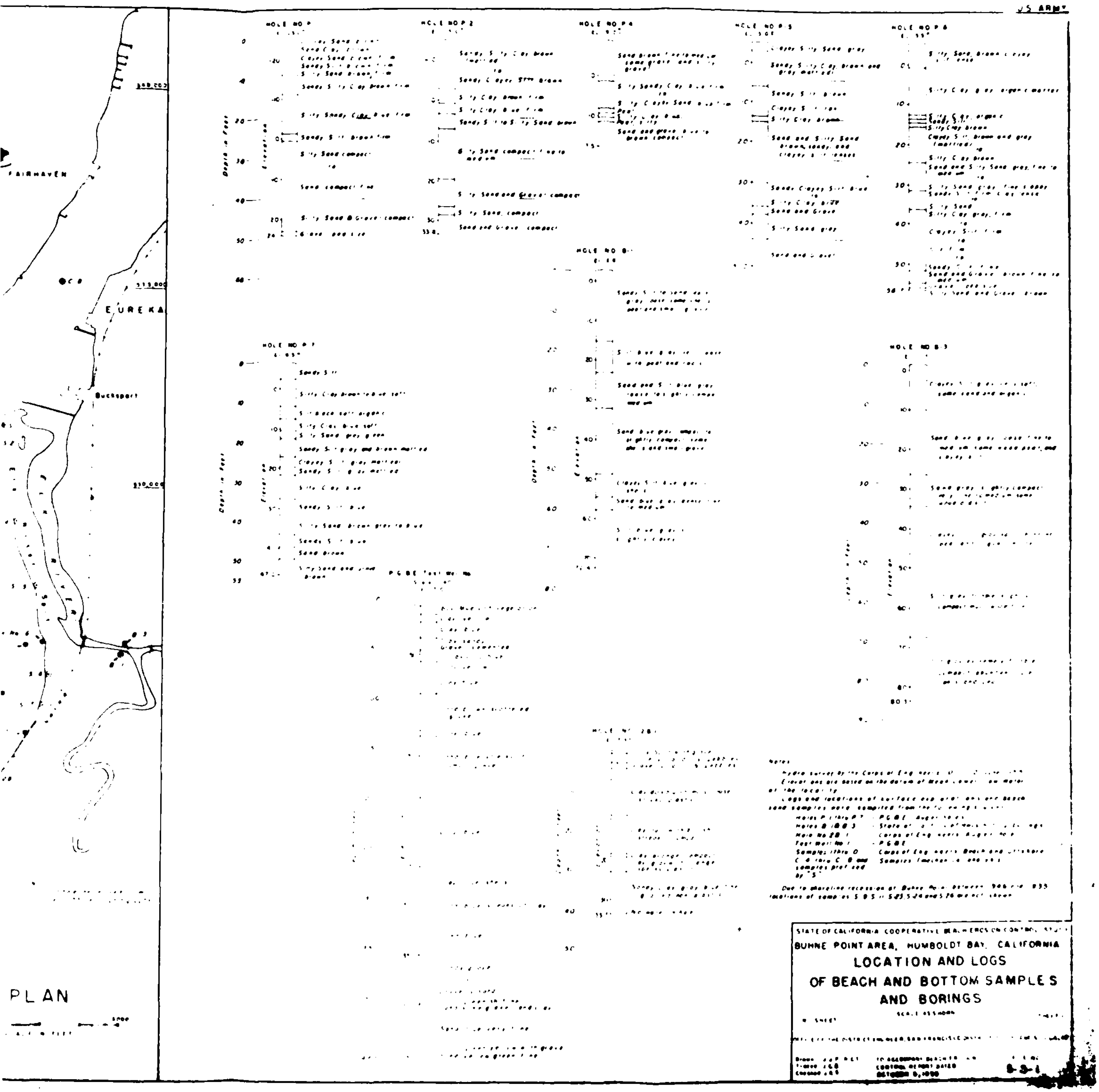
PREPARED UNDER THE DIRECTION OF
COLONEL, C.E. DISTRICT ENGINEER

AS SHOWN

3 5 5 3

PLATE C-3

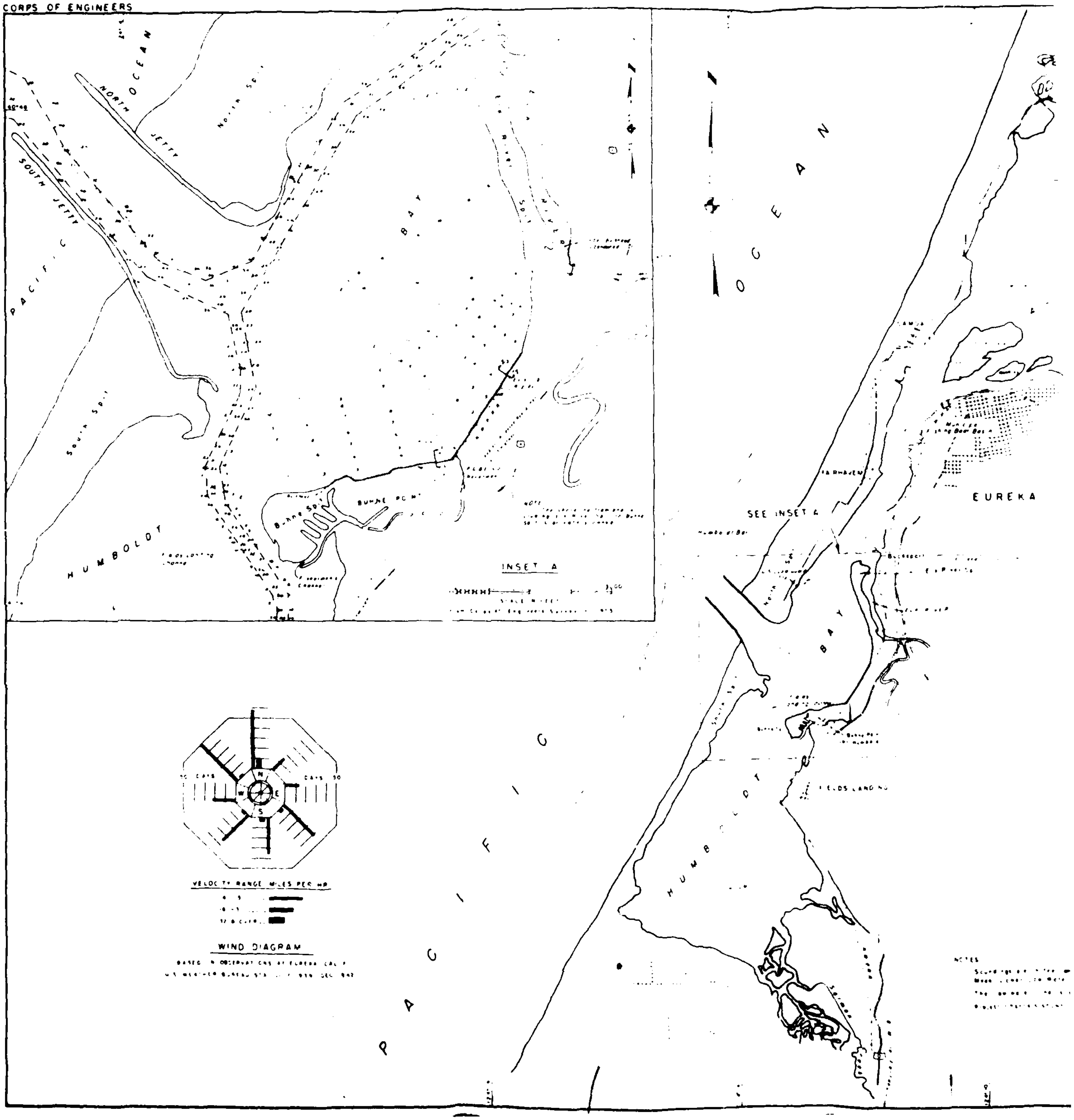

CORPS OF ENGINEERS
N
PACIFIC OCEAN
NORTH SPIT
NORTH JETTY
SOUTH JETTY
SOUTH SPIT
HUMBOLDT BAY
FAIRHAVEN
EUREKA
Bucksport
PLAN
SCALE IN FEET
FIELDS LANDING
HOLE NO. P-7
Sandy Silt


U.S. ARMY
HOLE NO. P-1
HOLE NO. P-2
HOLE NO. P-4
HOLE NO. P-5
HOLE NO. P-6
HOLE NO. P-7
HOLE NO. B-1
HOLE NO. B-3
HOLE NO. 2B-1
FAIRHAVEN
EUREKA
Bucksport
PLAN
Notes
STATE OF CALIFORNIA COOPERATIVE BEACH EROSION CONTROL STUDY
BUHNE POINT AREA, HUMBOLDT BAY, CALIFORNIA
LOCATION AND LOGS
OF BEACH AND BOTTOM SAMPLES
AND BORINGS
SCALE AS SHOWN
CONTROL REPORT DATED

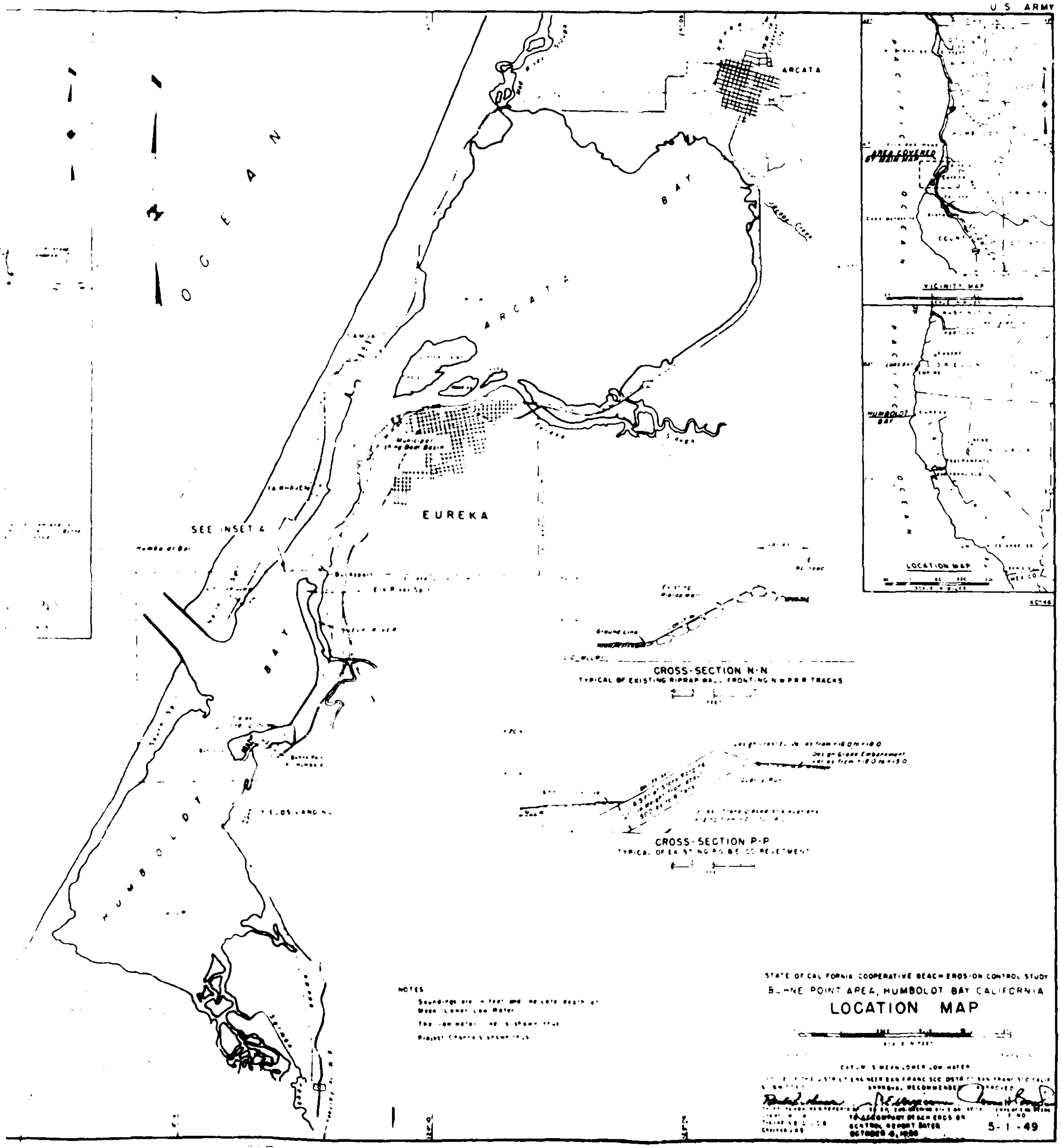
1

2

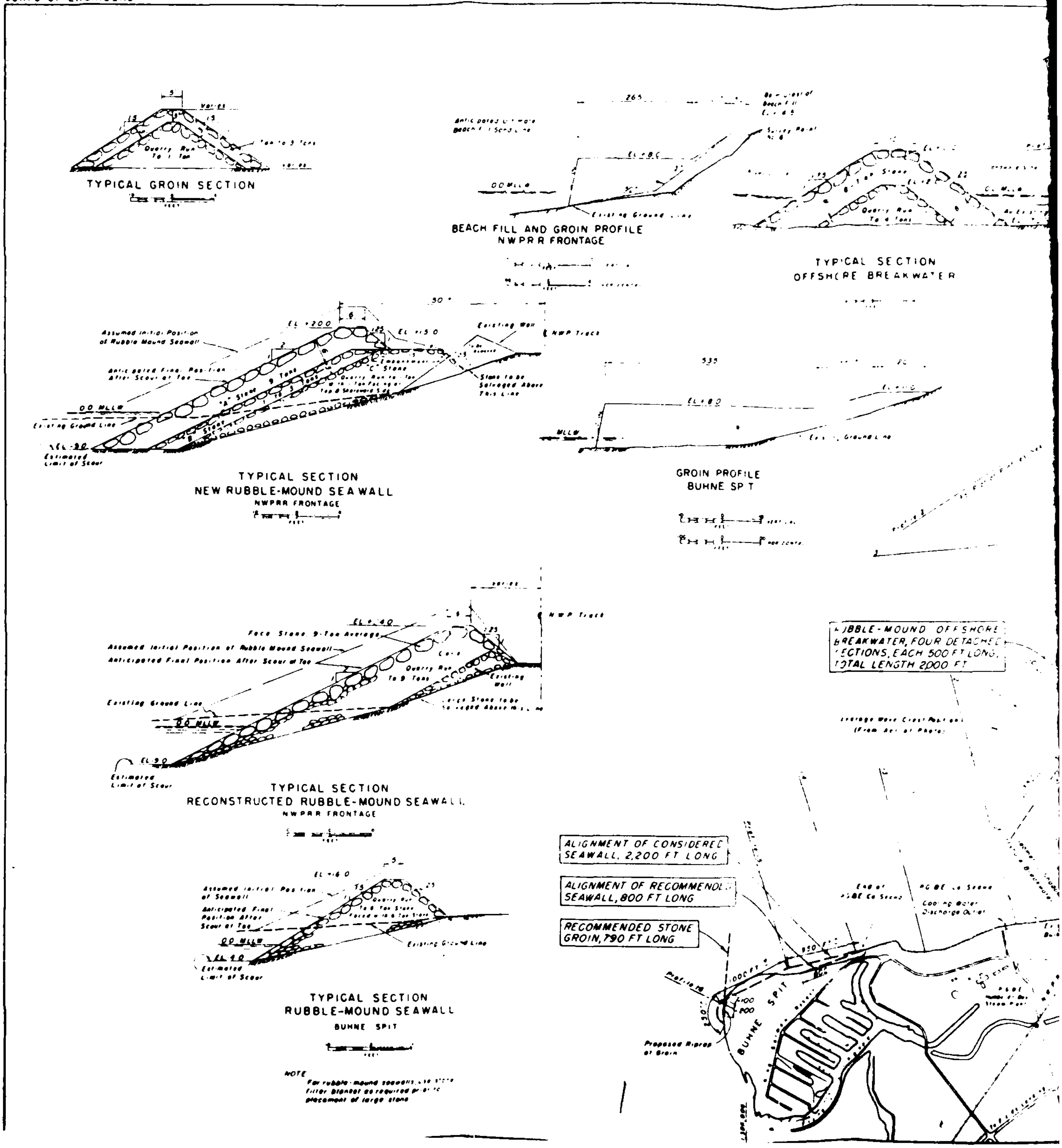
CORPS OF ENGINEERS

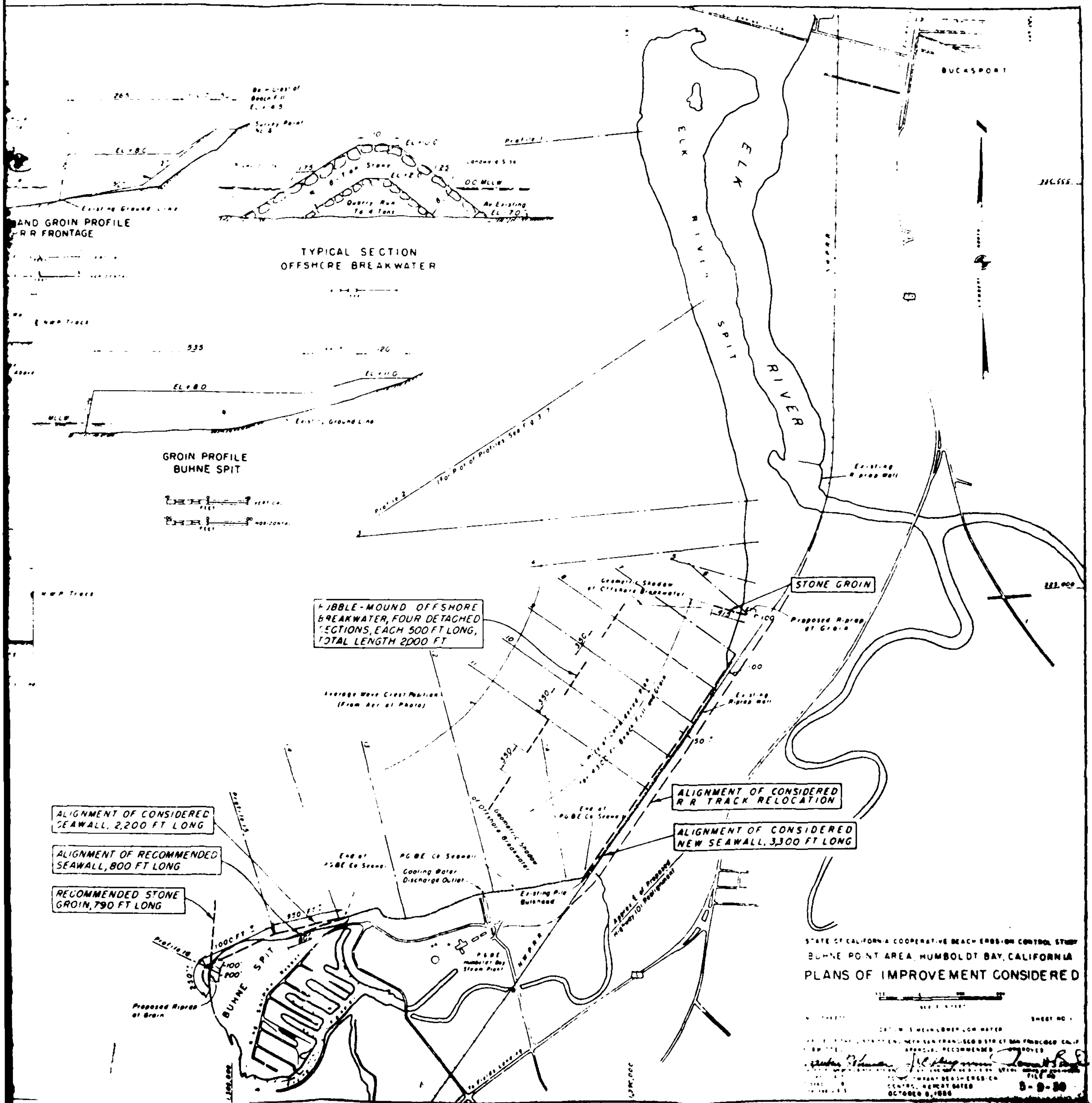


91076 O - 56 (Follows text) No. 1

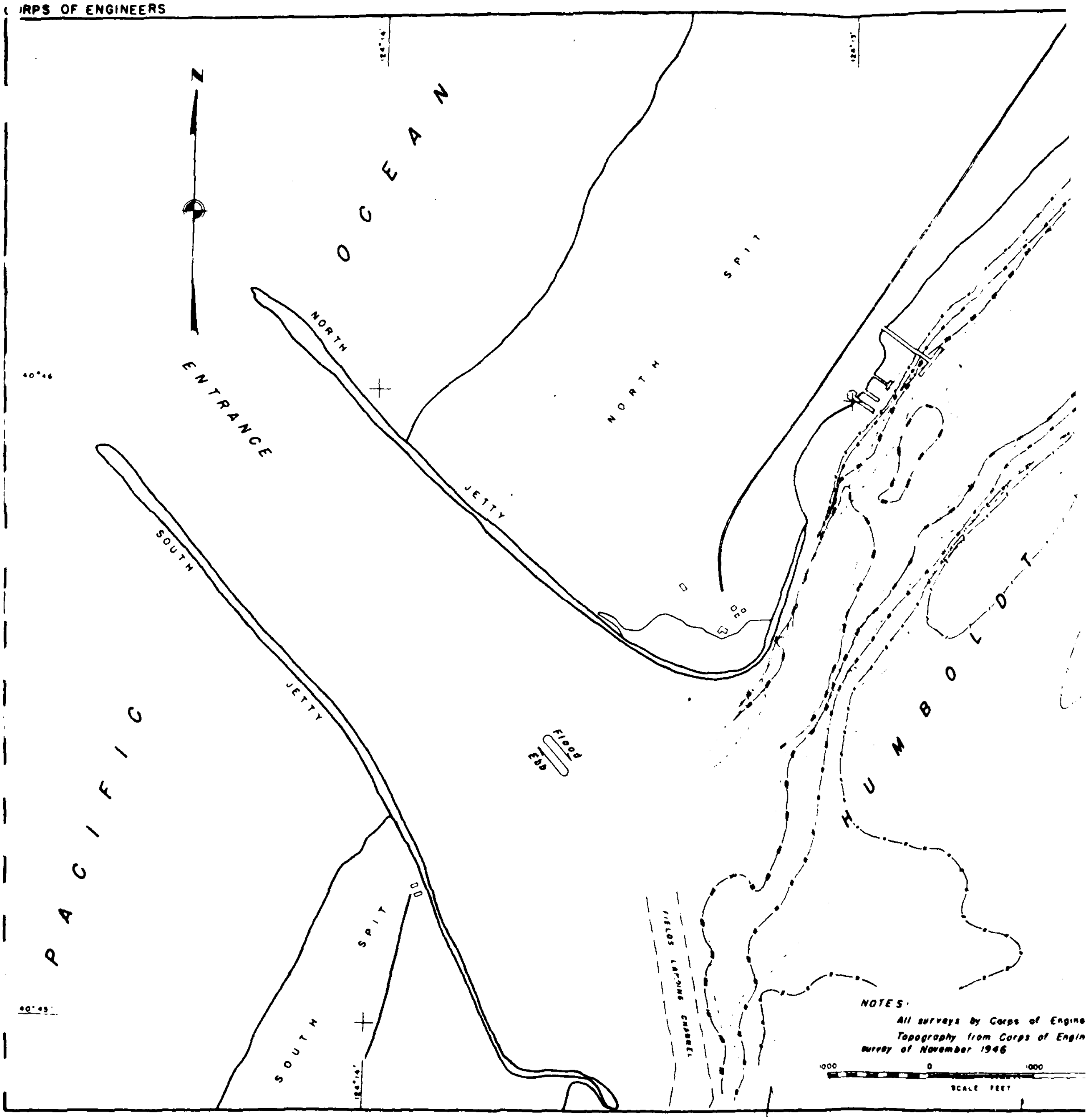

U.S. ARMY
ARCATA
BAY
ARCATA
OCEAN
EUREKA
SEE INSET A
BAY
HUMBOLDT
Municipal Fishing Boat Basin
AREA COVERED BY MAIN MAP
VICINITY MAP
HUMBOLDT BAY
OCEAN
LOCATION MAP
Ground Line
CROSS-SECTION N-N
TYPICAL OF EXISTING RIPRAP WALL FRONTING N.W.P.R.R. TRACKS
CROSS-SECTION P-P
NOTES
STATE OF CALIFORNIA COOPERATIVE BEACH EROSION CONTROL STUDY
BUHNE POINT AREA, HUMBOLDT BAY CALIFORNIA
LOCATION MAP
TO ACCOMPANY BEACH EROSION CONTROL REPORT DATED OCTOBER 4, 1950
5-1-49

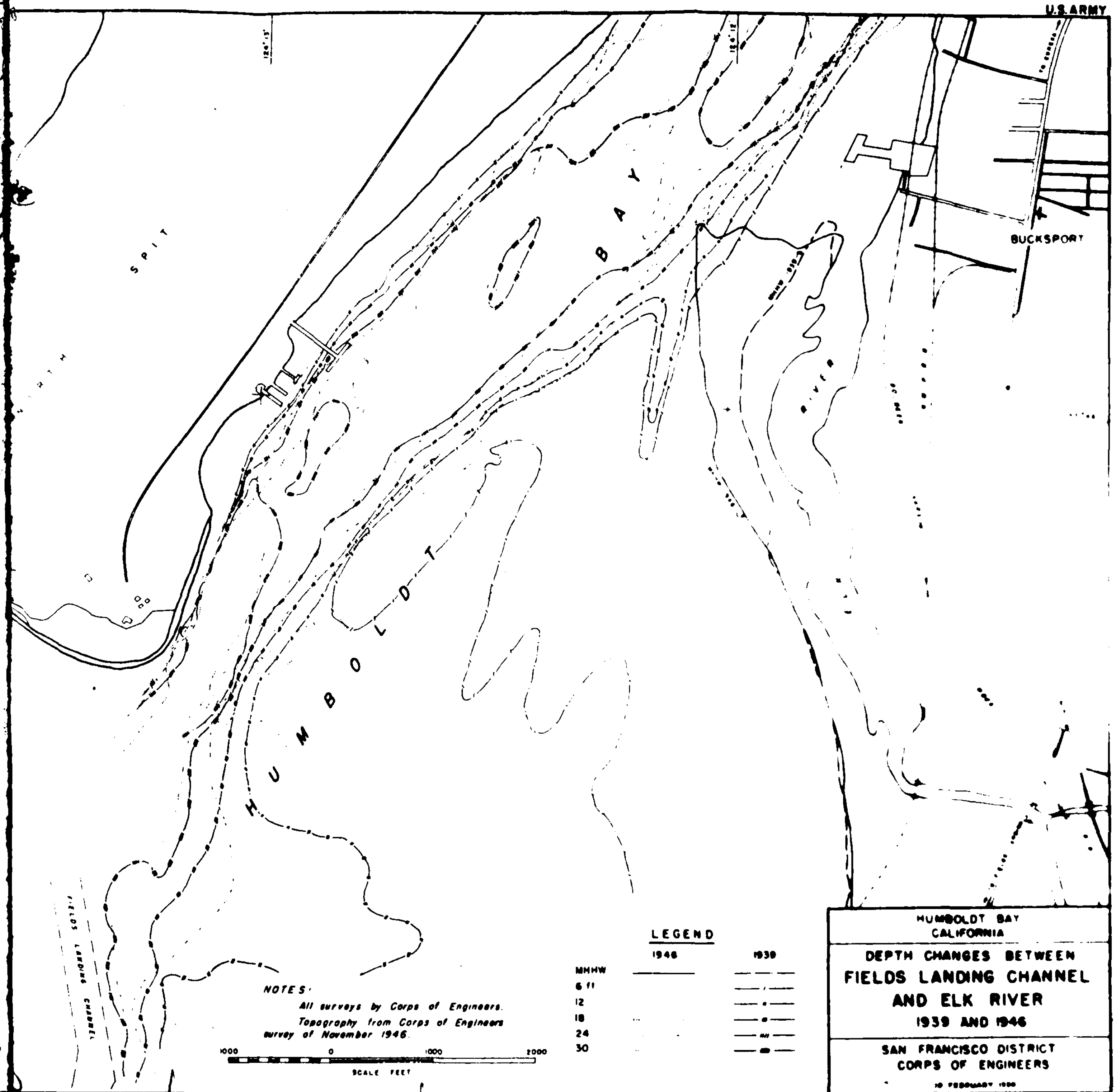
CORPS OF ENGINEERS




TYPICAL SECTION
OFFSHORE BREAKWATER
Quarry Run To 4 Tons
Av Existing EL -7.0
AND GROIN PROFILE
R R FRONTAGE
Existing Ground Line
GROIN PROFILE
BUHNE SPIT
Existing Ground Line
ELK RIVER SPIT
ELK RIVER
BUCKSPORT
Existing Riprap Wall
STONE GROIN
Proposed Riprap at Groin
RUBBLE-MOUND OFFSHORE BREAKWATER, FOUR DETACHED SECTIONS, EACH 500 FT LONG, TOTAL LENGTH 2000 FT
Average Wave Crest Position (From Aerial Photo)
Geometric Shadow of Offshore Breakwater
ALIGNMENT OF CONSIDERED R R TRACK RELOCATION
ALIGNMENT OF CONSIDERED NEW SEAWALL, 3,300 FT LONG
ALIGNMENT OF CONSIDERED SEAWALL, 2,200 FT LONG
ALIGNMENT OF RECOMMENDED SEAWALL, 800 FT LONG
RECOMMENDED STONE GROIN, 790 FT LONG
Proposed Riprap at Groin
Cooling Water Discharge Outlet
Existing Pile Bulkhead
BUHNE SPIT
STATE OF CALIFORNIA COOPERATIVE BEACH EROSION CONTROL STUDY
BUHNE POINT AREA, HUMBOLDT BAY, CALIFORNIA
PLANS OF IMPROVEMENT CONSIDERED
OCTOBER 6, 1955
B-9-30

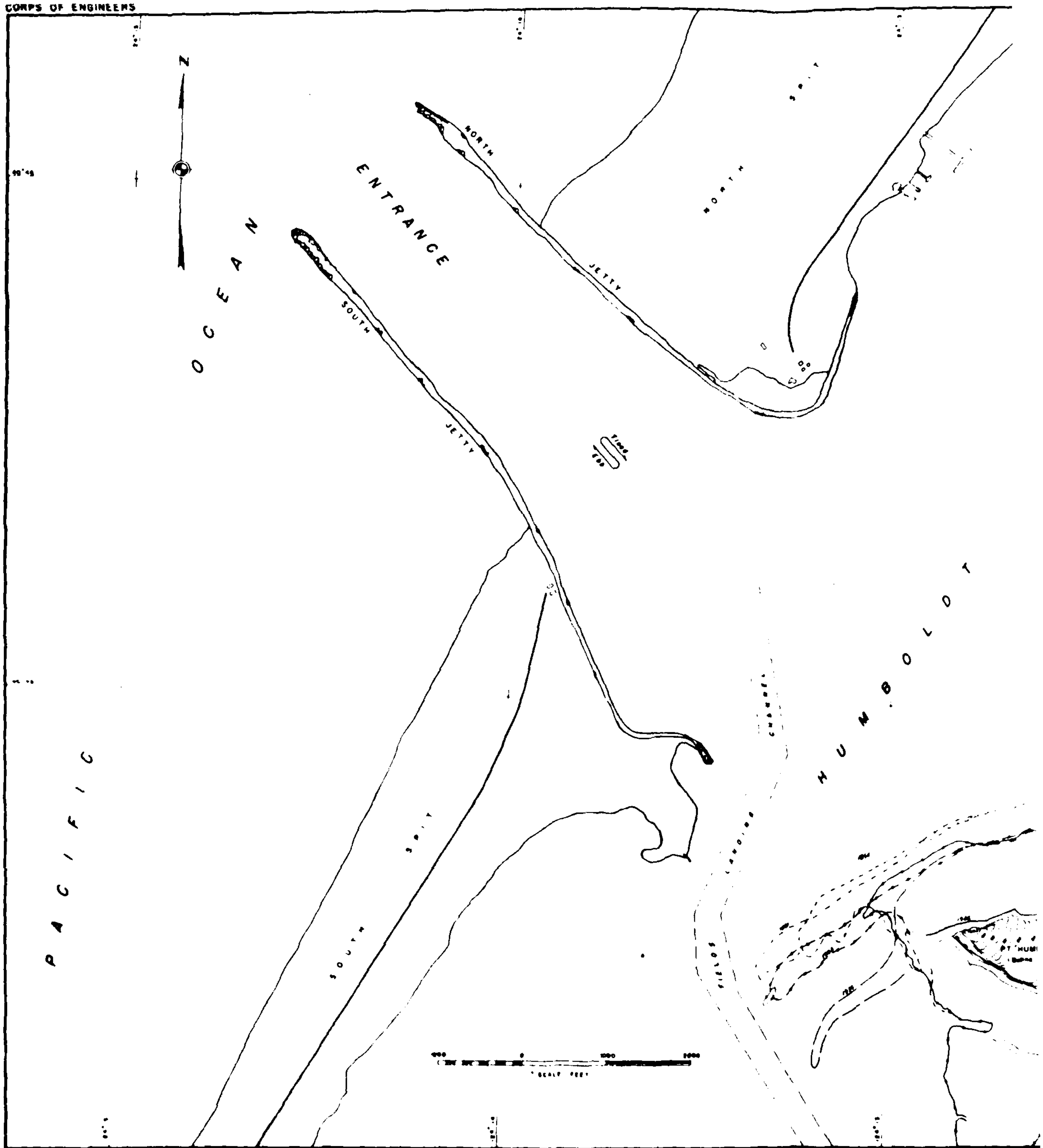
(IRPS OF ENGINEERS

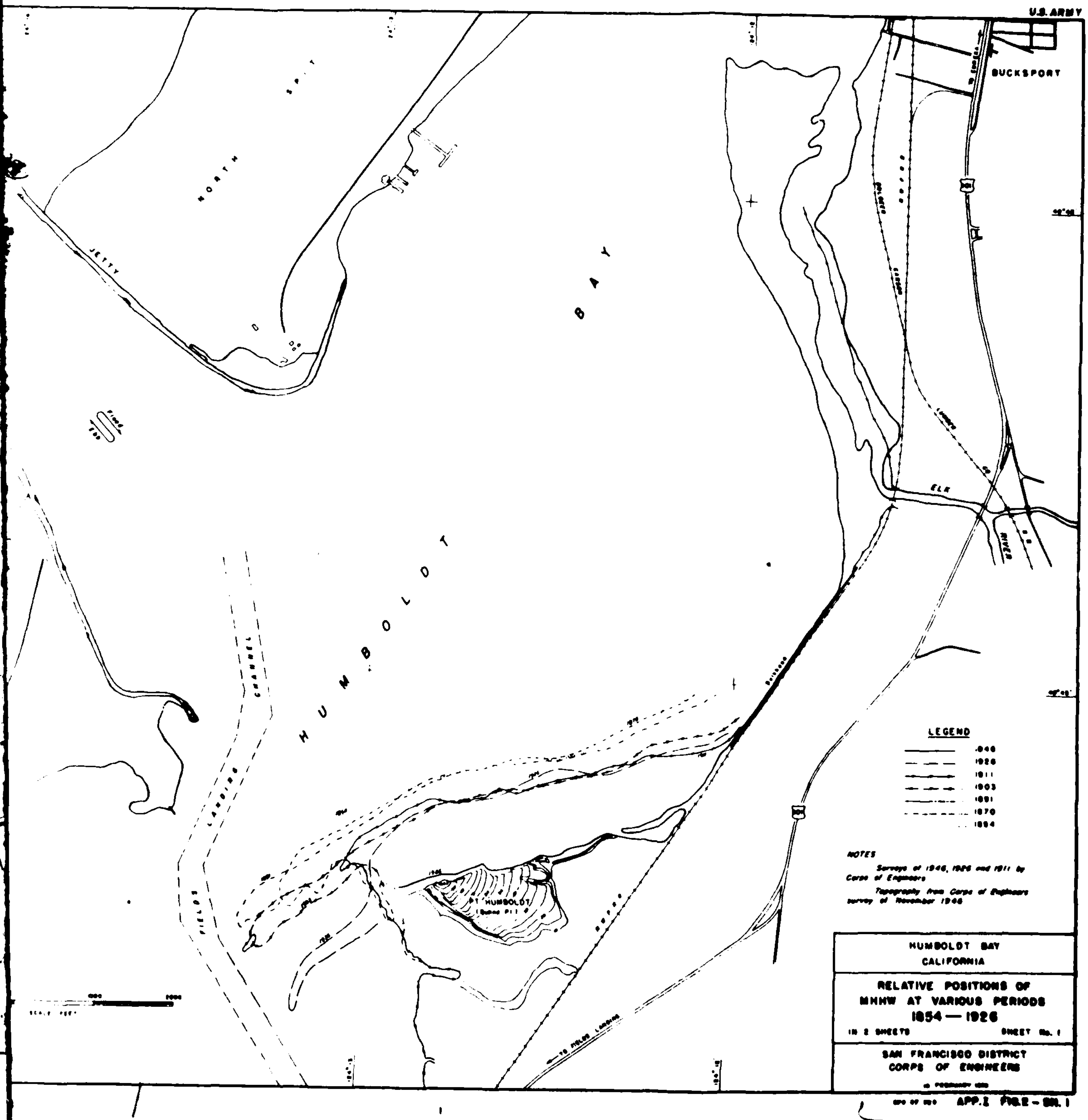


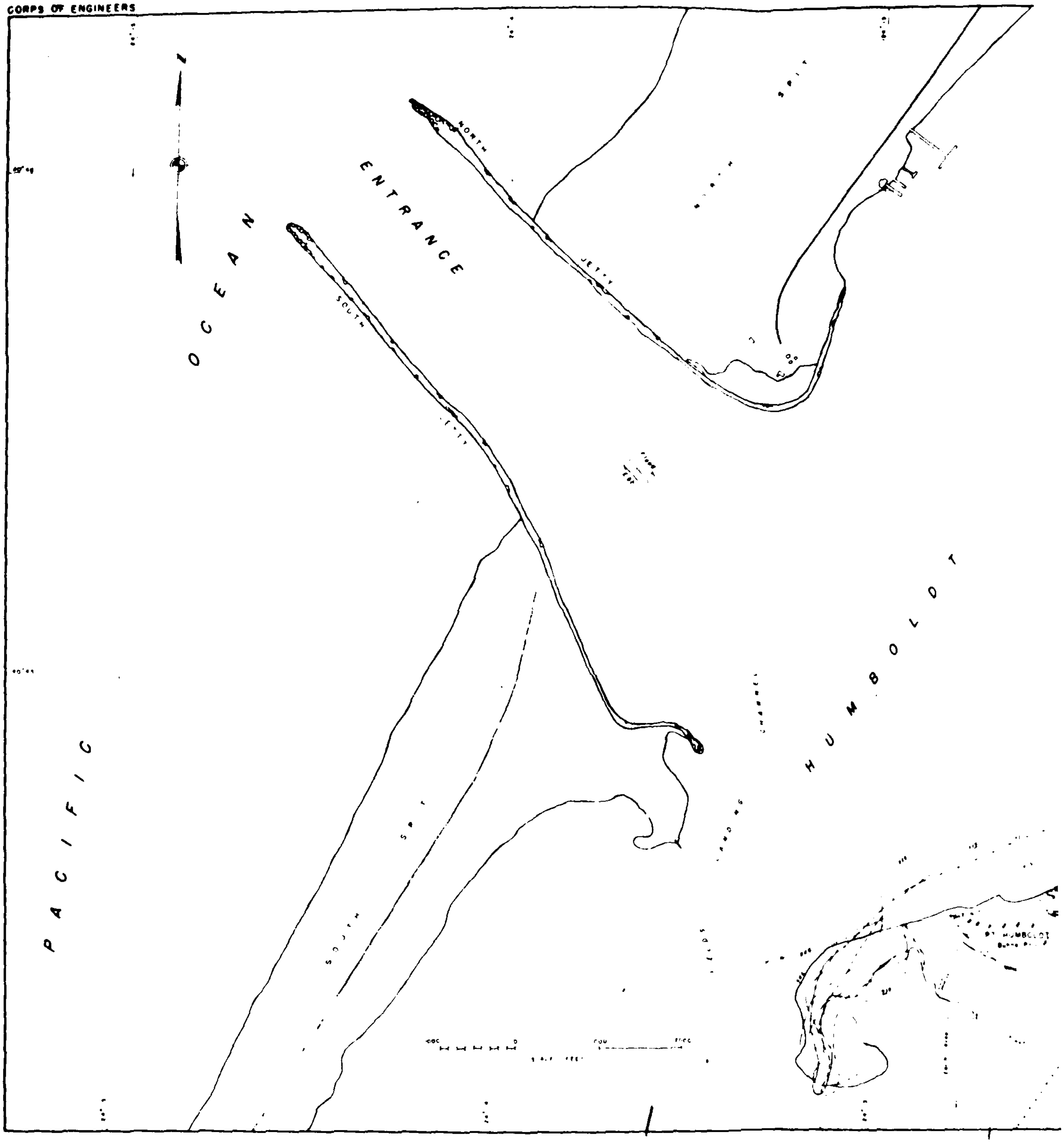

U.S. ARMY
HUMBOLDT BAY
SPIT
BUCKSPORT
FIELDS LANDING CHANNEL
LEGEND
1946
1939
MHHW
6 ft
12
18
24
30
NOTES:
All surveys by Corps of Engineers.
Topography from Corps of Engineers survey of November 1946.
1000
0
1000
2000
SCALE FEET
HUMBOLDT BAY
CALIFORNIA
DEPTH CHANGES BETWEEN
FIELDS LANDING CHANNEL
AND ELK RIVER
1939 AND 1946
SAN FRANCISCO DISTRICT
CORPS OF ENGINEERS

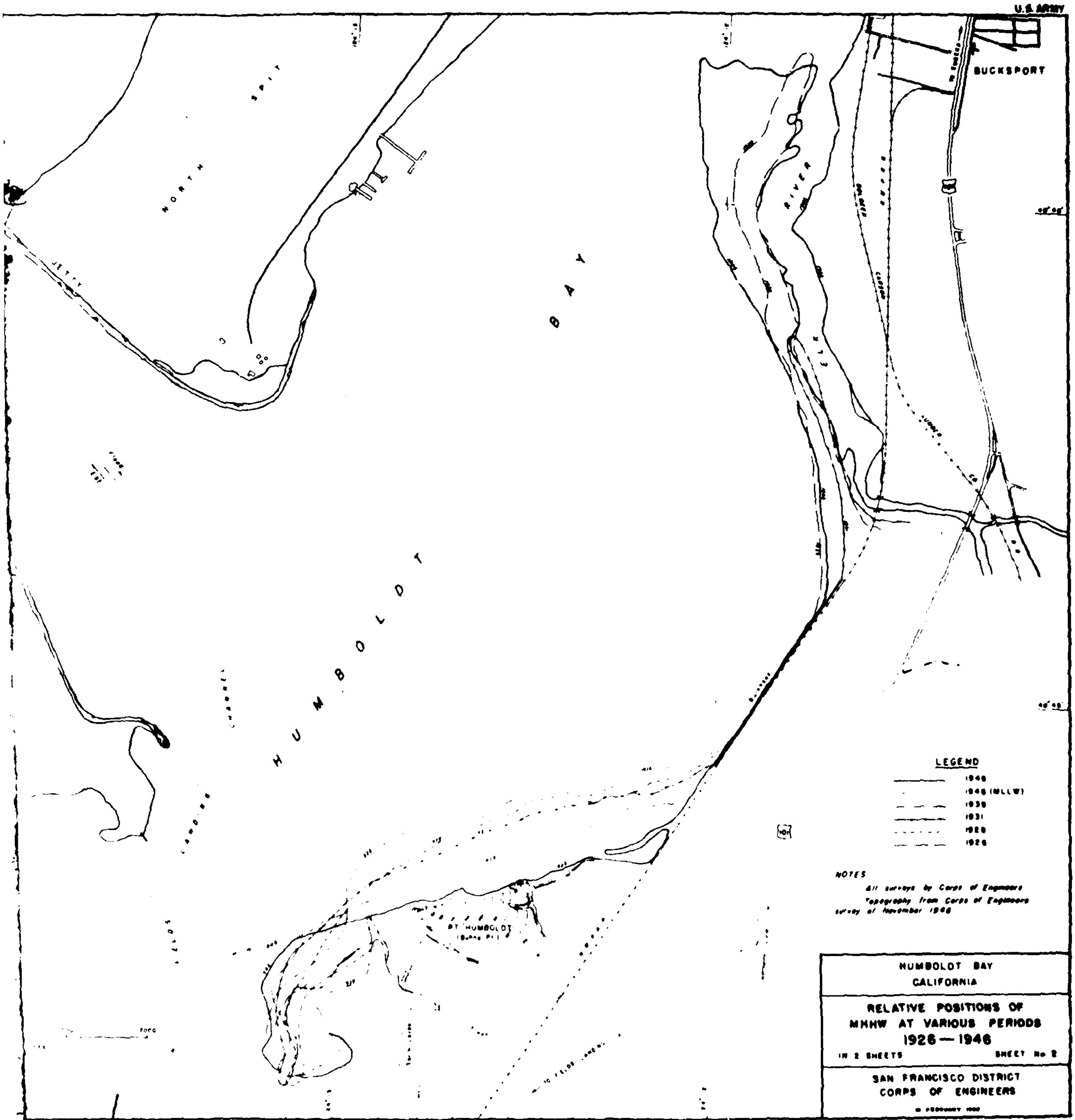
APP I FIG 3

CORPS OF ENGINEERS




U.S. ARMY
BUCKSPORT
NORTH SPIT
JETTY
HUMBOLDT BAY
LANDING CHANNEL
ELK RIVER
PT HUMBOLDT
LEGEND
1946
1926
1911
1903
1891
1870
1854
NOTES
Surveys of 1946, 1926 and 1911 by Corps of Engineers
Topography from Corps of Engineers survey of November 1946
HUMBOLDT BAY
CALIFORNIA
RELATIVE POSITIONS OF MHHW AT VARIOUS PERIODS
1854 — 1926
IN 2 SHEETS
SHEET No. 1
SAN FRANCISCO DISTRICT
CORPS OF ENGINEERS
APP. I FIG. 2 - SH. 1


CORPS OF ENGINEERS
OCEAN
ENTRANCE
PACIFIC
HUMBOLDT
NORTH
SOUTH
JETTY
SPIT



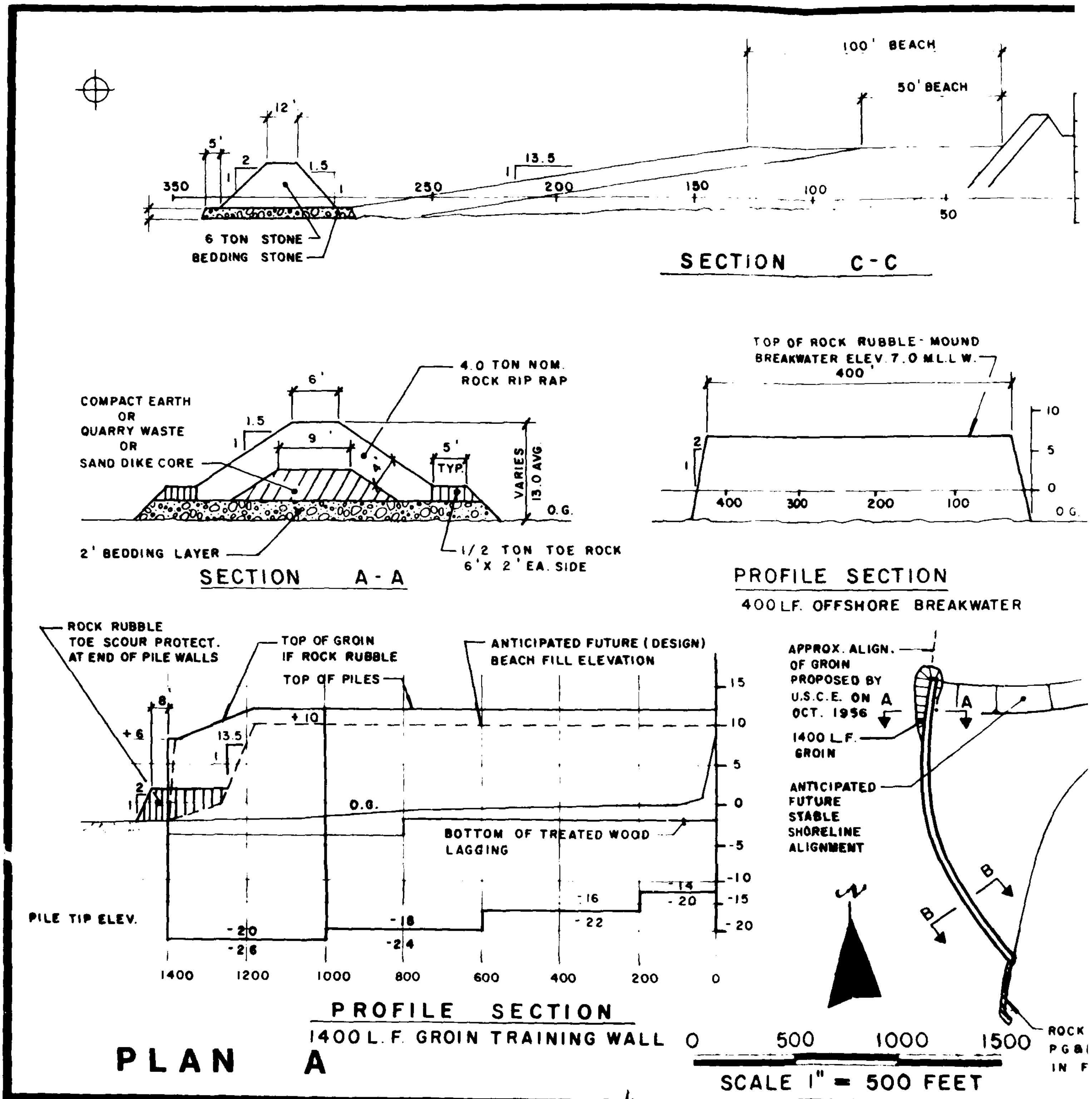
APP.I FIG.2 - SH.2

APPENDIX E

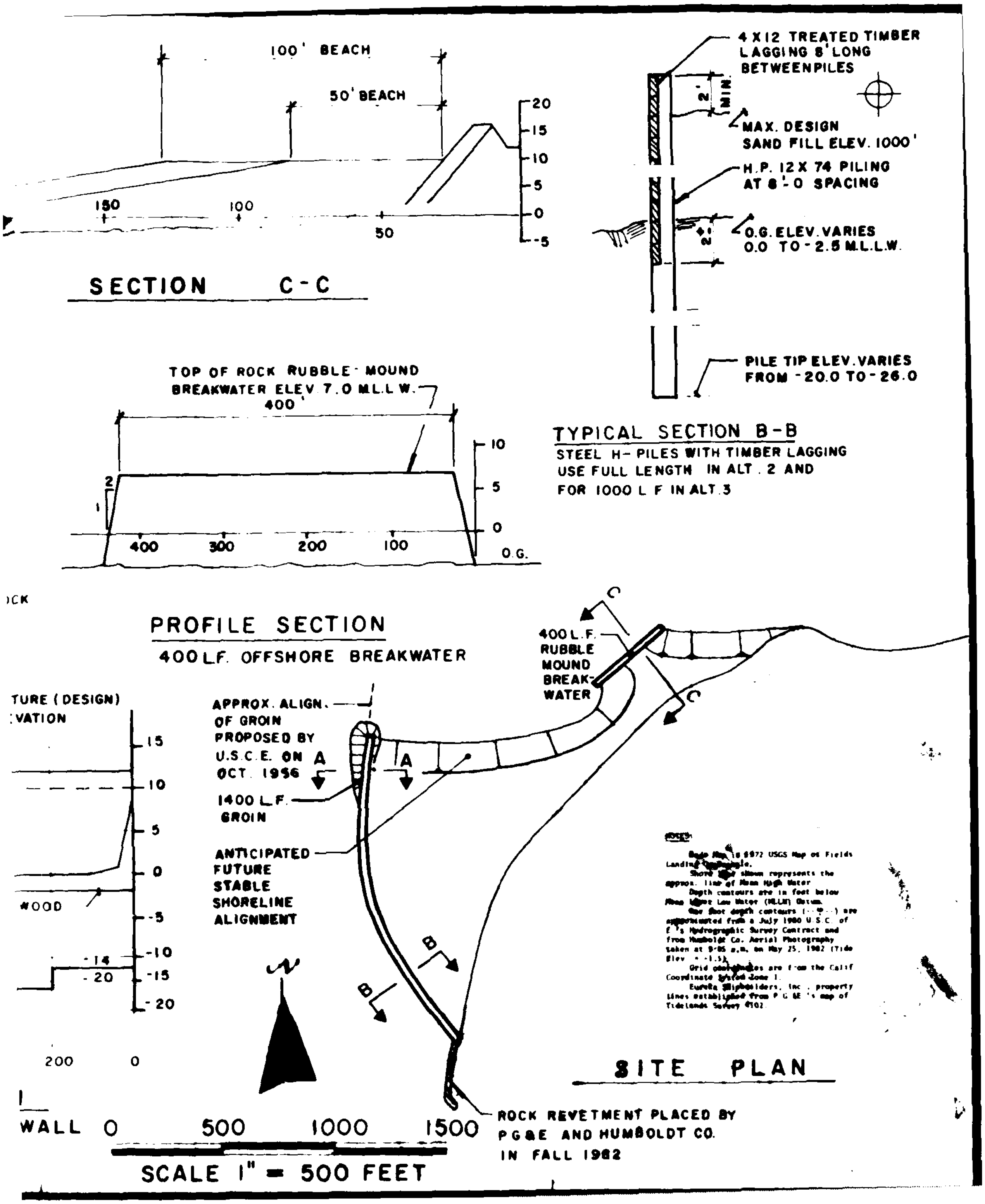
CONCEPTUAL PLANS of ALTERNATE DESIGNS

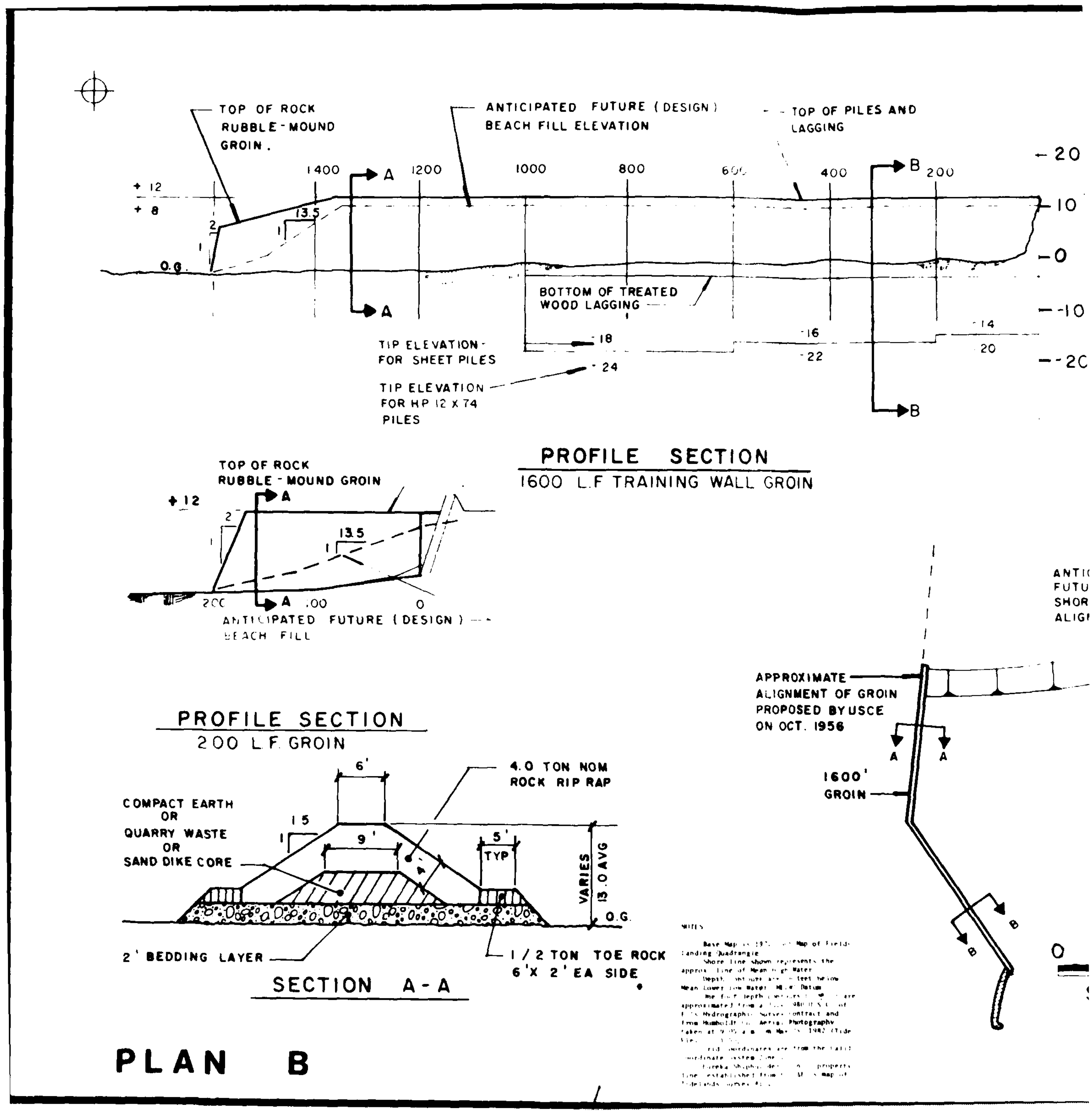
at

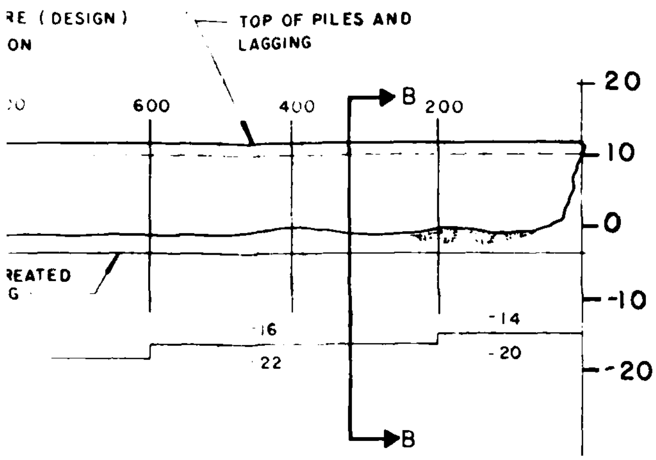
BUHNE SPIT AREA



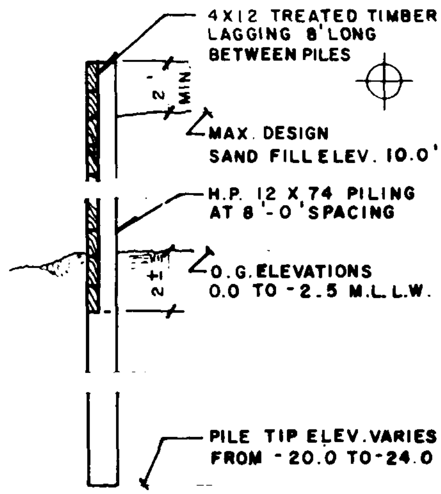
100' BEACH
50' BEACH
12'
5'
2
1.5
13.5
350
250
200
150
100
50
6 TON STONE
BEDDING STONE
SECTION C-C
TOP OF ROCK RUBBLE-MOUND BREAKWATER ELEV. 7.0 M.L.L.W.
400'
4.0 TON NOM. ROCK RIP RAP
COMPACT EARTH OR QUARRY WASTE OR SAND DIKE CORE
6'
9
5' TYP.
VARIES 13.0 AVG
O.G.
2' BEDDING LAYER
1/2 TON TOE ROCK 6' X 2' EA. SIDE
SECTION A-A
PROFILE SECTION
400 LF. OFFSHORE BREAKWATER
ROCK RUBBLE TOE SCOUR PROTECT. AT END OF PILE WALLS
TOP OF GROIN IF ROCK RUBBLE
TOP OF PILES
ANTICIPATED FUTURE (DESIGN) BEACH FILL ELEVATION
+6
8
+10
BOTTOM OF TREATED WOOD LAGGING
PILE TIP ELEV.
-20
-26
-18
-24
-16
-22
-14
-20
1400
1200
1000
800
600
400
200
0
PROFILE SECTION
1400 L.F. GROIN TRAINING WALL
APPROX. ALIGN. OF GROIN PROPOSED BY U.S.C.E. ON OCT. 1956
1400 L.F. GROIN
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
A
B
ROCK
PG&
IN F
0 500 1000 1500
SCALE 1" = 500 FEET
PLAN A


100' BEACH
50' BEACH
20
15
10
5
0
-5
150
100
50
SECTION C-C
4 X 12 TREATED TIMBER LAGGING 8' LONG BETWEEN PILES
2' MIN
MAX. DESIGN SAND FILL ELEV. 1000'
H.P. 12 X 74 PILING AT 8'-0 SPACING
O.G. ELEV. VARIES 0.0 TO -2.5 M.L.L.W.
PILE TIP ELEV. VARIES FROM -20.0 TO -26.0
TYPICAL SECTION B-B
STEEL H-PILES WITH TIMBER LAGGING
USE FULL LENGTH IN ALT. 2 AND
FOR 1000 L F IN ALT.3
TOP OF ROCK RUBBLE-MOUND BREAKWATER ELEV 7.0 M.L.L.W.
400'
10
5
0
2
1
400
300
200
100
O.G.
PROFILE SECTION
400 L.F. OFFSHORE BREAKWATER
TURE (DESIGN)
VATION
15
10
5
0
-5
-10
-15
-20
-14
-20
WOOD
200
0
WALL
400 L.F. RUBBLE MOUND BREAKWATER
C
C
APPROX. ALIGN. OF GROIN PROPOSED BY U.S.C.E. ON OCT. 1956
A
A
1400 L.F. GROIN
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
B
B
Depth contours are in feet below
Hydrographic Survey Contract and
Coordinate
SITE PLAN
ROCK REVETMENT PLACED BY PG&E AND HUMBOLDT CO. IN FALL 1962
0
500
1000
1500
SCALE 1" = 500 FEET


TOP OF ROCK RUBBLE-MOUND GROIN.
ANTICIPATED FUTURE (DESIGN) BEACH FILL ELEVATION
TOP OF PILES AND LAGGING
1400
A
1200
1000
800
600
400
B
200
+12
+8
13.5
2
1
O.G.
20
10
0
-10
-20
BOTTOM OF TREATED WOOD LAGGING
TIP ELEVATION FOR SHEET PILES
-18
-16
-14
-22
-20
-24
TIP ELEVATION FOR HP 12 X 74 PILES
PROFILE SECTION
1600 L.F TRAINING WALL GROIN
TOP OF ROCK RUBBLE-MOUND GROIN
+12
2
1
13.5
1
200
100
0
ANTICIPATED FUTURE (DESIGN) BEACH FILL
PROFILE SECTION
200 L.F. GROIN
6'
4.0 TON NOM ROCK RIP RAP
COMPACT EARTH OR QUARRY WASTE OR SAND DIKE CORE
1.5
1
9'
5'
TYP
VARIES 13.0 AVG
O.G.
2' BEDDING LAYER
1/2 TON TOE ROCK 6'X 2' EA SIDE
SECTION A-A
APPROXIMATE ALIGNMENT OF GROIN PROPOSED BY USCE ON OCT. 1956
1600' GROIN
ANTI
FUTU
SHOR
ALIG
PLAN B

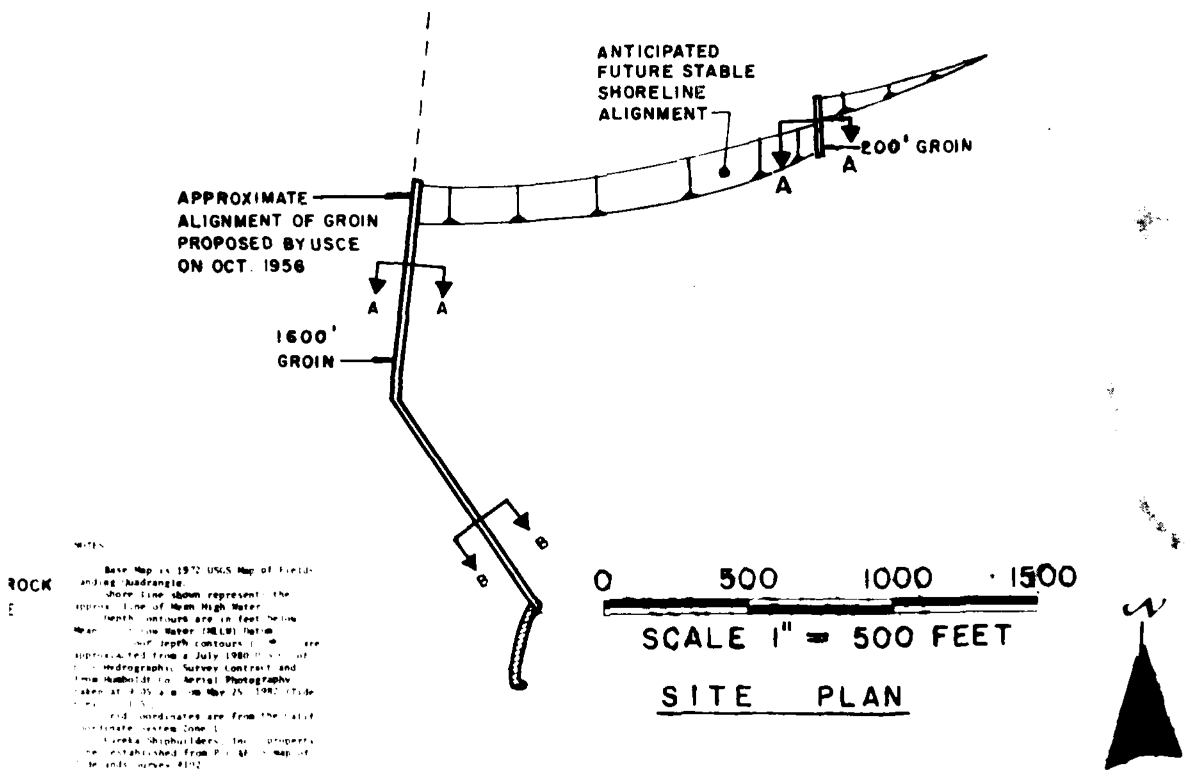


E SECTION
RAINING WALL GROIN

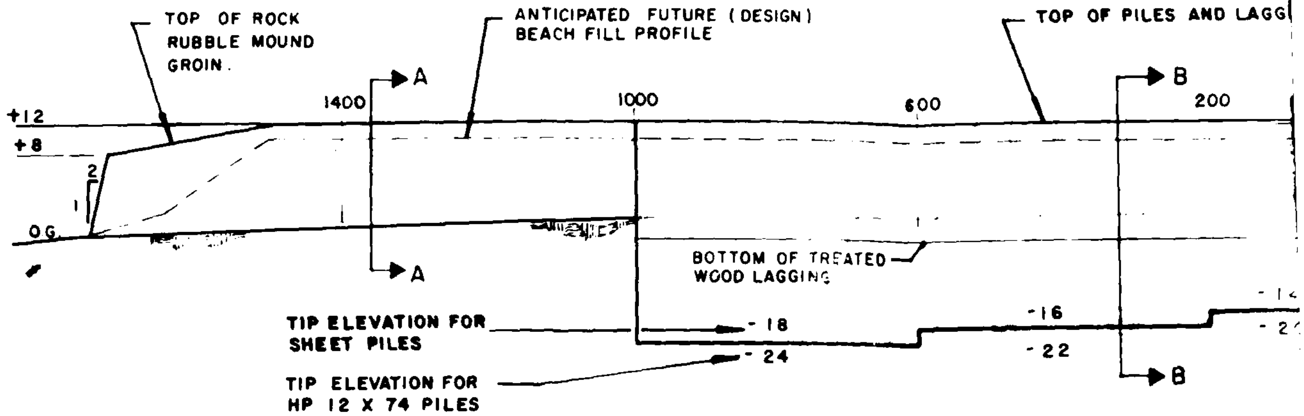


TYPICAL SECTION B-B

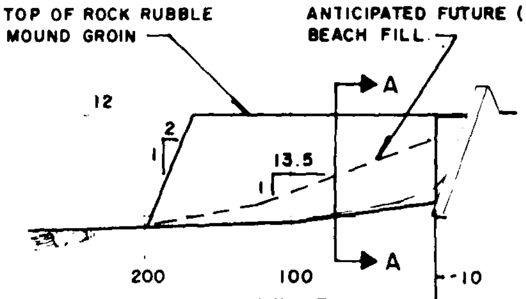
STEEL H-PILES WITH TIMBER LAGGING
USE FULL LENGTH IN ALT. 2 AND
FOR 1000 L.F. IN ALT. 3



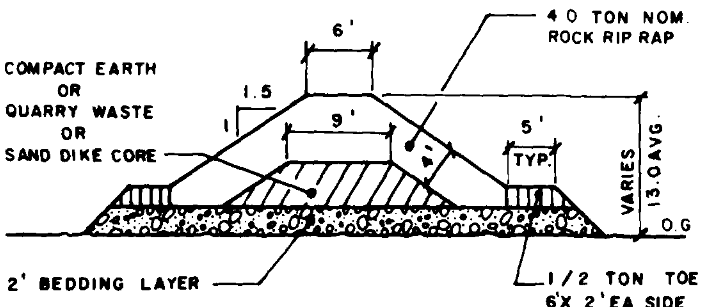
SITE PLAN



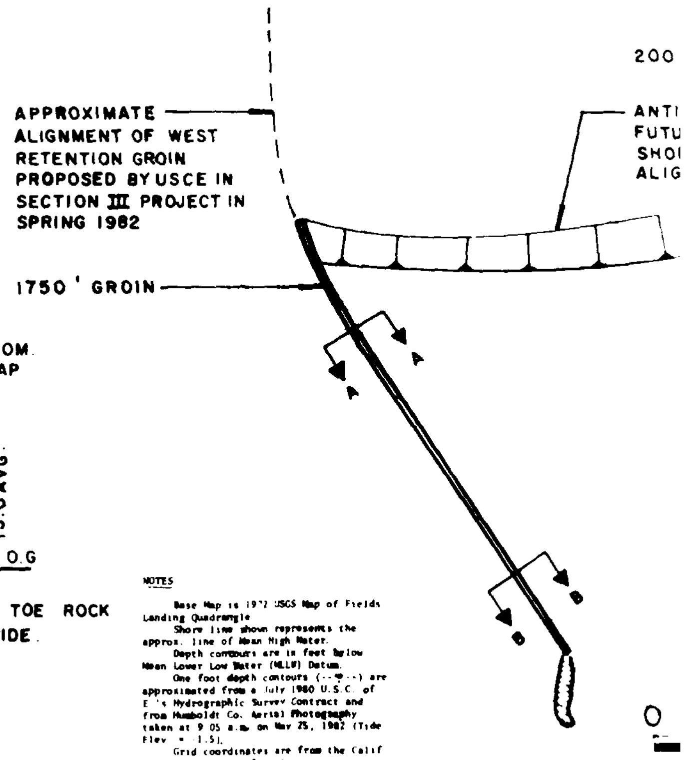
PROFILE SECTION
1750 L.F. TRAINING WALL GROIN



PROFILE
200 L.F. GROIN



SECTION A-A



NOTES

Base Map is 1972 USGS Map of Fields Landing Quadrangle

Shore line shown represents the approx. line of Mean High Water.

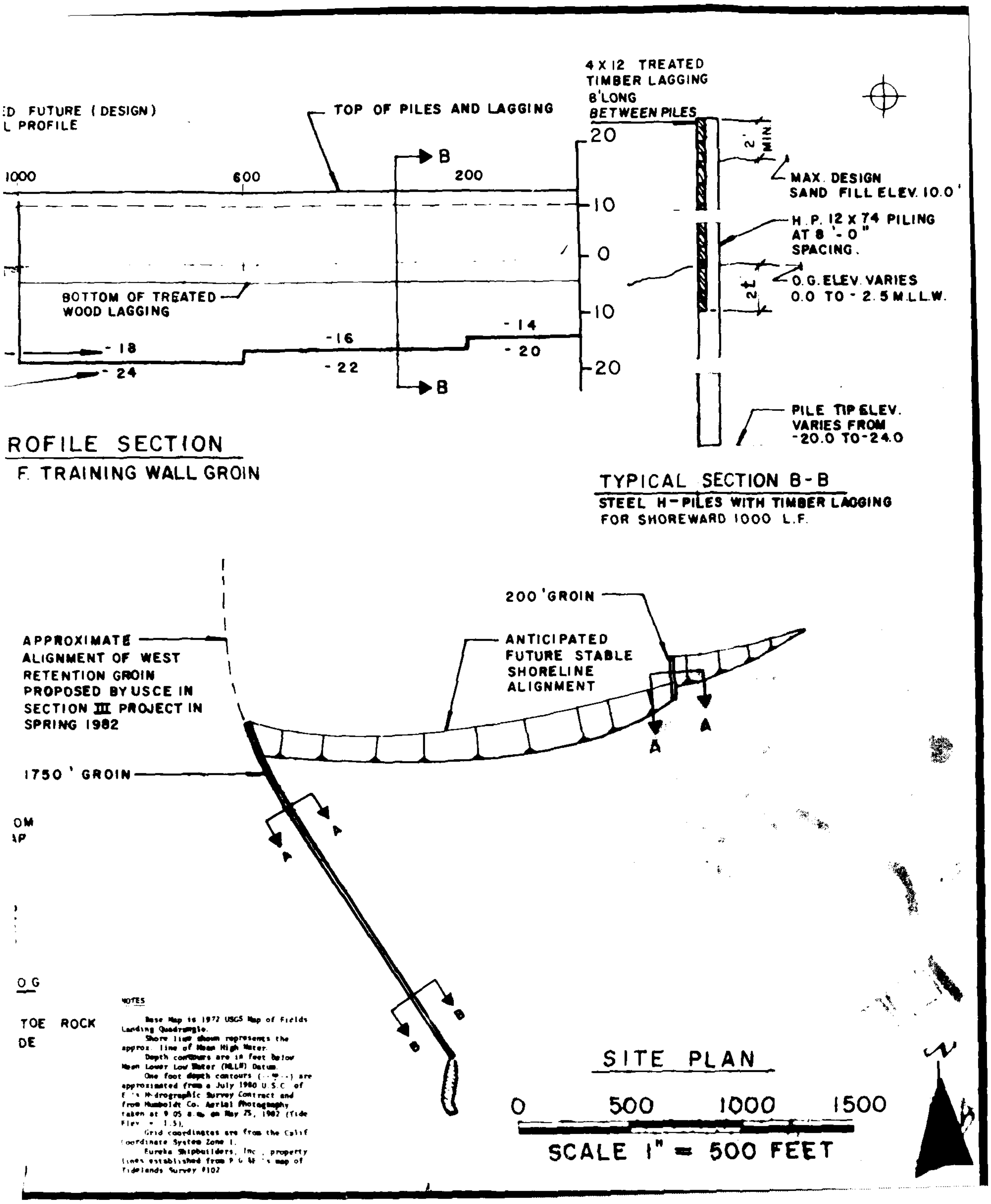
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.

One foot depth contours (--9--) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. = -1.5).

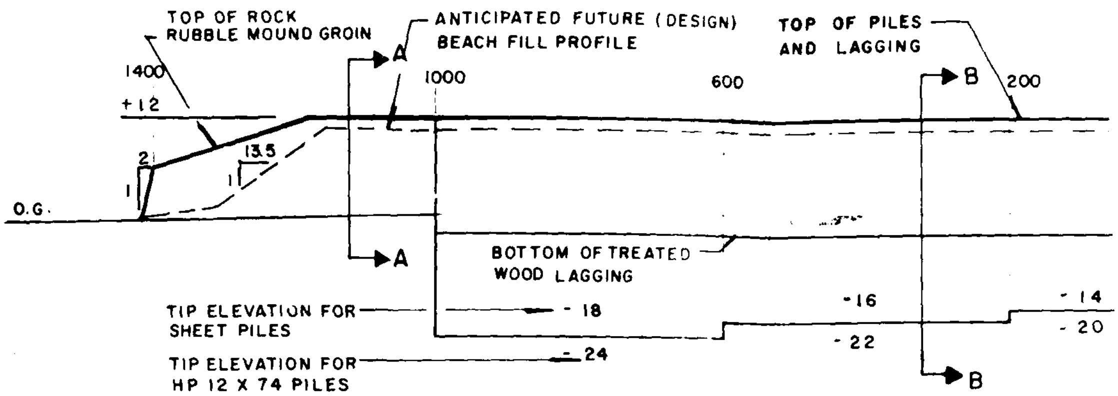
Grid coordinates are from the Calif Coordinate System Zone I

Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102

PLAN C

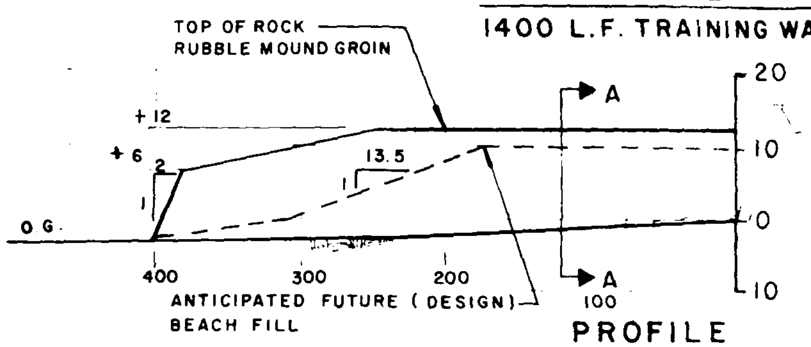


:D FUTURE (DESIGN)
L PROFILE
TOP OF PILES AND LAGGING
4 X 12 TREATED
TIMBER LAGGING
8'LONG
BETWEEN PILES
1000
600
200
B
20
10
0
-10
-20
BOTTOM OF TREATED
WOOD LAGGING
-18
-24
-16
-22
-14
-20
2' MIN
MAX. DESIGN
SAND FILL ELEV. 10.0'
H.P. 12 X 74 PILING
AT 8'-0"
SPACING.
O.G. ELEV. VARIES
0.0 TO -2.5 M.L.L.W.
2'±
PILE TIP ELEV.
VARIES FROM
-20.0 TO -24.0
ROFILE SECTION
F. TRAINING WALL GROIN
TYPICAL SECTION B-B
STEEL H-PILES WITH TIMBER LAGGING
FOR SHOREWARD 1000 L.F.
200' GROIN
APPROXIMATE
ALIGNMENT OF WEST
RETENTION GROIN
PROPOSED BY USCE IN
SECTION III PROJECT IN
SPRING 1982
ANTICIPATED
FUTURE STABLE
SHORELINE
ALIGNMENT
A
1750' GROIN
OM
AP
O.G
TOE ROCK
DE
NOTES
Base Map is 1972 USGS Map of Fields Landing Quadrangle.
Shore line shown represents the approx. line of Mean High Water.
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.
One foot depth contours (--9--) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. = 1.5).
Grid coordinates are from the Calif. Coordinate System Zone I.
Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102
SITE PLAN
0
500
1000
1500
SCALE 1" = 500 FEET
N



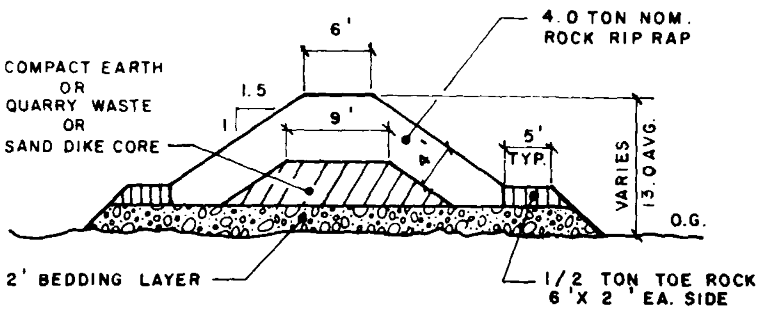
PROFILE

1400 L.F. TRAINING WALL

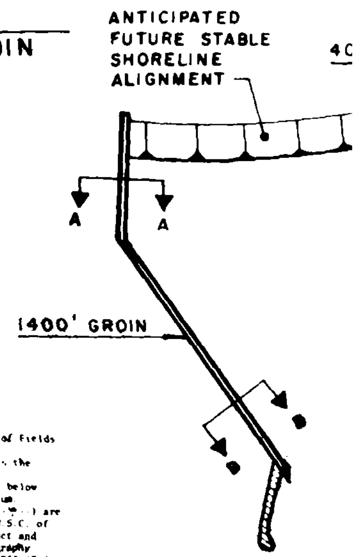


PROFILE

400 L.F. ROCK GROIN



SECTION A-A



NOTES:

Base Map is 1972 USGS Map of Fields Landing Quadrangle.

Shore line shown represents the approx. line of Mean high Water.

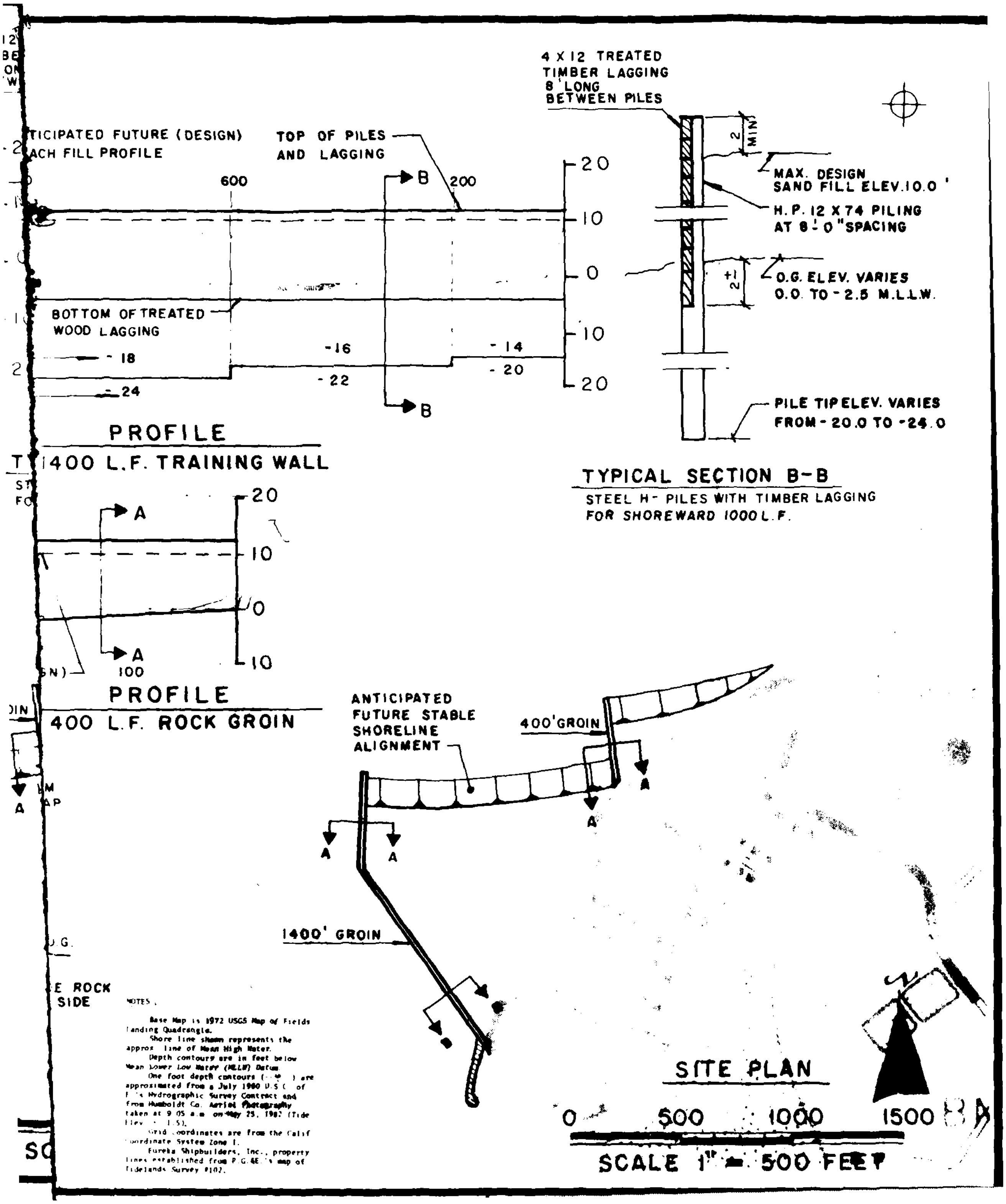
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.

One foot depth contours (--9--) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 15, 1982 (Tide Elev. + 1.5).

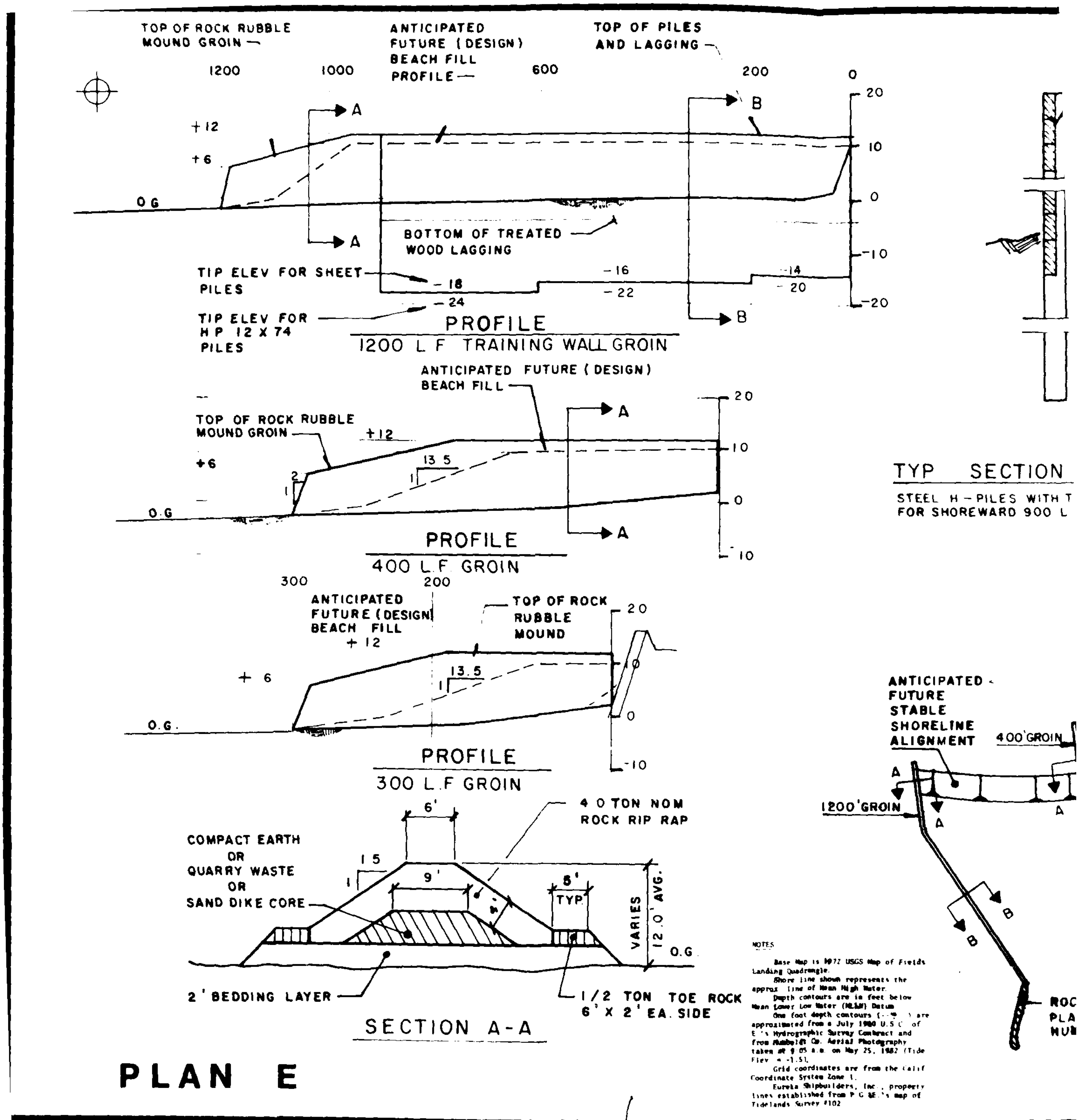
Grid coordinates are from the Calif. Coordinate System Zone 1.

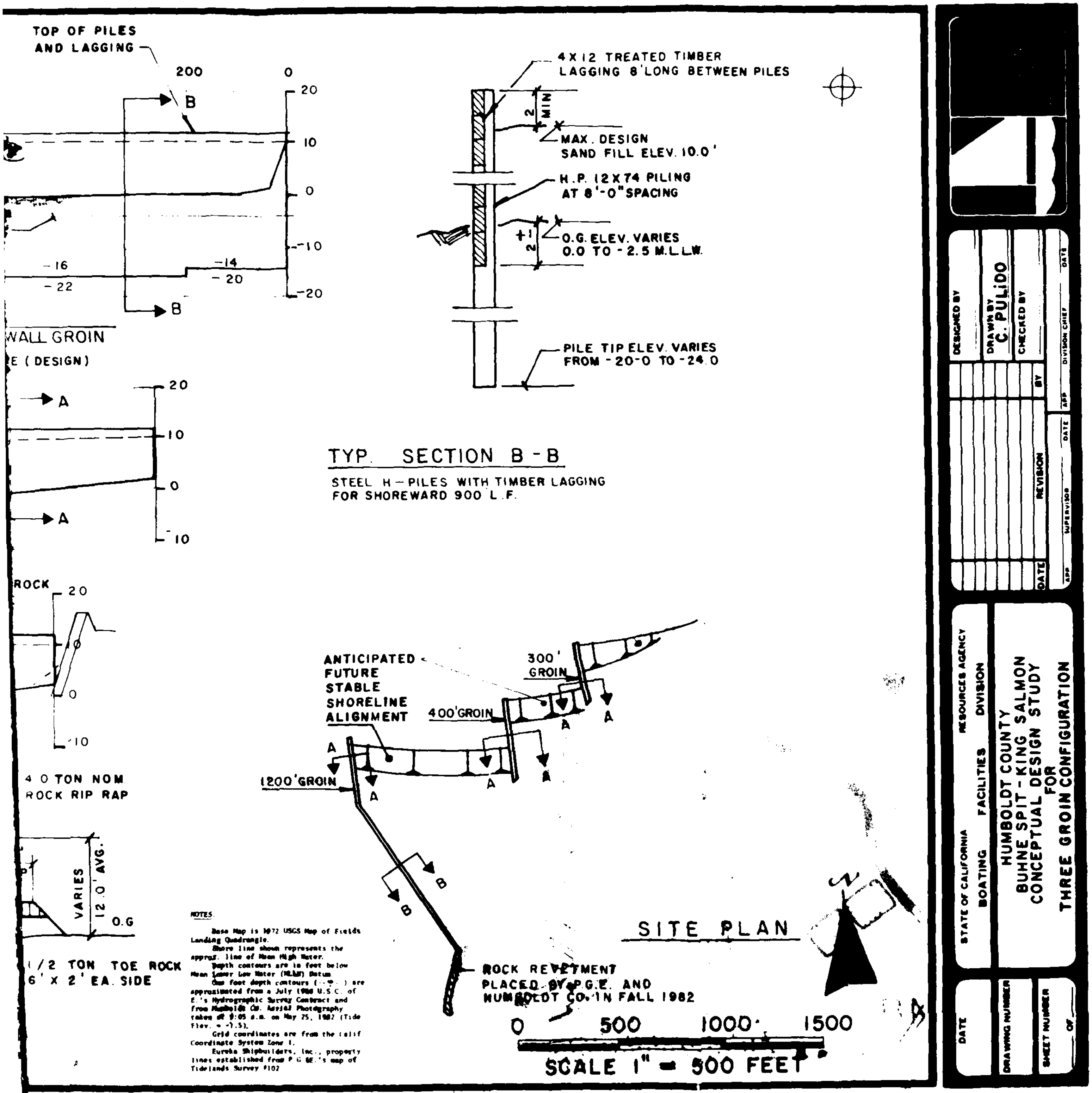
Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102.

PLAN D

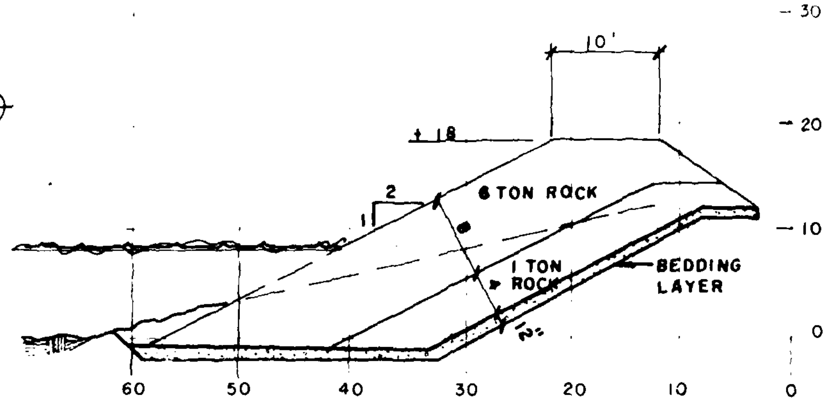


4 X 12 TREATED TIMBER LAGGING 8' LONG BETWEEN PILES
ICIPATED FUTURE (DESIGN)
ACH FILL PROFILE
TOP OF PILES AND LAGGING
600
200
B
20
10
0
10
20
BOTTOM OF TREATED WOOD LAGGING
- 18
- 24
-16
- 22
- 14
- 20
MAX. DESIGN SAND FILL ELEV. 10.0'
H. P. 12 X 74 PILING AT 8'- 0" SPACING
O.G. ELEV. VARIES 0.0 TO - 2.5 M.L.L.W.
PILE TIP ELEV. VARIES FROM - 20.0 TO - 24.0
PROFILE
1400 L.F. TRAINING WALL
TYPICAL SECTION B-B
STEEL H- PILES WITH TIMBER LAGGING FOR SHOREWARD 1000 L.F.
A
100
PROFILE
400 L.F. ROCK GROIN
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
400' GROIN
1400' GROIN
E ROCK
SIDE
NOTES:
Base Map is 1972 USGS Map of Fields Landing Quadrangle.
Shore line shown represents the approx. line of Mean High Water.
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.
One foot depth contours are approximated from a July 1980 U.S. of Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982
Grid coordinates are from the Calif. Coordinate System Zone I.
Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102.
SITE PLAN
0
500
1000
1500
SCALE 1" = 500 FEET

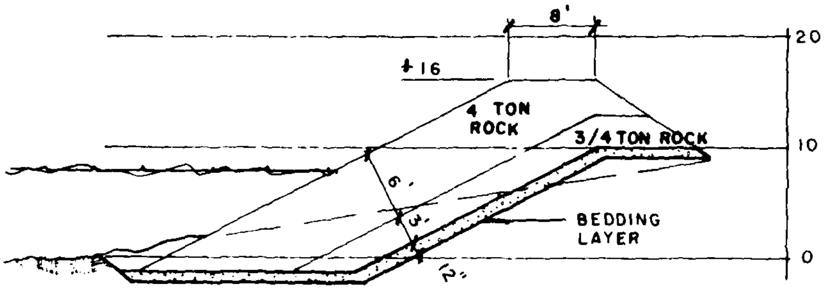

TOP OF ROCK RUBBLE MOUND GROIN
ANTICIPATED FUTURE (DESIGN) BEACH FILL PROFILE
TOP OF PILES AND LAGGING
1200
1000
600
200
0
+12
+6
O G
A
B
20
10
0
-10
-20
BOTTOM OF TREATED WOOD LAGGING
TIP ELEV FOR SHEET PILES
-18
-16
-14
-22
-20
-24
TIP ELEV FOR HP 12 X 74 PILES
PROFILE
1200 L F TRAINING WALL GROIN
ANTICIPATED FUTURE (DESIGN) BEACH FILL
TOP OF ROCK RUBBLE MOUND GROIN
+12
+6
2
1
13 5
O.G
PROFILE
400 L.F. GROIN
300
200
ANTICIPATED FUTURE (DESIGN) BEACH FILL
+12
TOP OF ROCK RUBBLE MOUND
+ 6
13.5
O.G.
PROFILE
300 L.F GROIN
6'
4 0 TON NOM ROCK RIP RAP
COMPACT EARTH OR QUARRY WASTE OR SAND DIKE CORE
1 5
9'
5'
TYP
VARIES
12.0' AVG.
O.G
2' BEDDING LAYER
1/2 TON TOE ROCK 6' X 2' EA. SIDE
SECTION A-A
PLAN E
TYP SECTION
STEEL H-PILES WITH T
FOR SHOREWARD 900 L
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
400'GROIN
1200'GROIN
ROC
PLA
HUM
NOTES
Base Map is 1972 USGS Map of Fields Landing Quadrangle.
Shore line shown represents the approx line of Mean High Water.
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum
One foot depth contours ( ) are approximated from a July 1980 U.S C of E's Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9 05 a.m. on May 25, 1982 (Tide Elev = -1.5).
Grid coordinates are from the Calif Coordinate System Zone 1.
Eureka Shipbuilders, Inc., property lines established from P G &E.'s map of Tidelands Survey #102



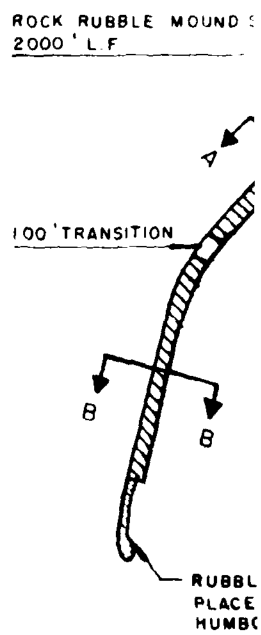
TOP OF PILES AND LAGGING
200
0
20
10
0
-10
-16
-22
-14
-20
-20
B
WALL GROIN
E (DESIGN)
20
10
0
10
A
ROCK
20
0
-10
4 0 TON NOM ROCK RIP RAP
VARIES
12.0' AVG.
0.G
1/2 TON TOE ROCK 6' X 2' EA. SIDE
4 X 12 TREATED TIMBER LAGGING 8' LONG BETWEEN PILES
2' MIN
MAX. DESIGN SAND FILL ELEV. 10.0'
H.P. 12 X 74 PILING AT 8'-0" SPACING
2' ±
O.G. ELEV. VARIES 0.0 TO -2.5 M.L.L.W.
PILE TIP ELEV. VARIES FROM -20.0 TO -24.0
TYP. SECTION B-B
STEEL H-PILES WITH TIMBER LAGGING FOR SHOREWARD 900 L.F.
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
300' GROIN
400' GROIN
1200' GROIN
A
B
ROCK REVETMENT PLACED BY P.G.E. AND HUMBOLDT CO. IN FALL 1982
SITE PLAN
N
0
500
1000
1500
SCALE 1" = 500 FEET
NOTES.
Base Map is 1972 USGS Map of Fields Landing Quadrangle.
Shore line shown represents the approx. line of Mean High Water.
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.
One foot depth contours (- - - -) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. = -1.5).
Grid coordinates are from the Calif Coordinate System Zone I.
Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102
DESIGNED BY
DRAWN BY C. PULIDO
CHECKED BY
DIVISION CHIEF
DATE
BY
APP.
DATE
REVISION
SUPERVISOR
DATE
APP.
STATE OF CALIFORNIA
RESOURCES AGENCY
BOATING FACILITIES DIVISION
HUMBOLDT COUNTY
BUHNE SPIT-KING SALMON
CONCEPTUAL DESIGN STUDY
FOR
THREE GROIN CONFIGURATION
DATE
DRAWING NUMBER
SHEET NUMBER
OF



PROFILE A – A



PROFILE B – B



NOTES

Base Map [illegible] USGS Map of Fields Landing Quadrangle.

Shore line shown represents the approx. line of Mean High Water.

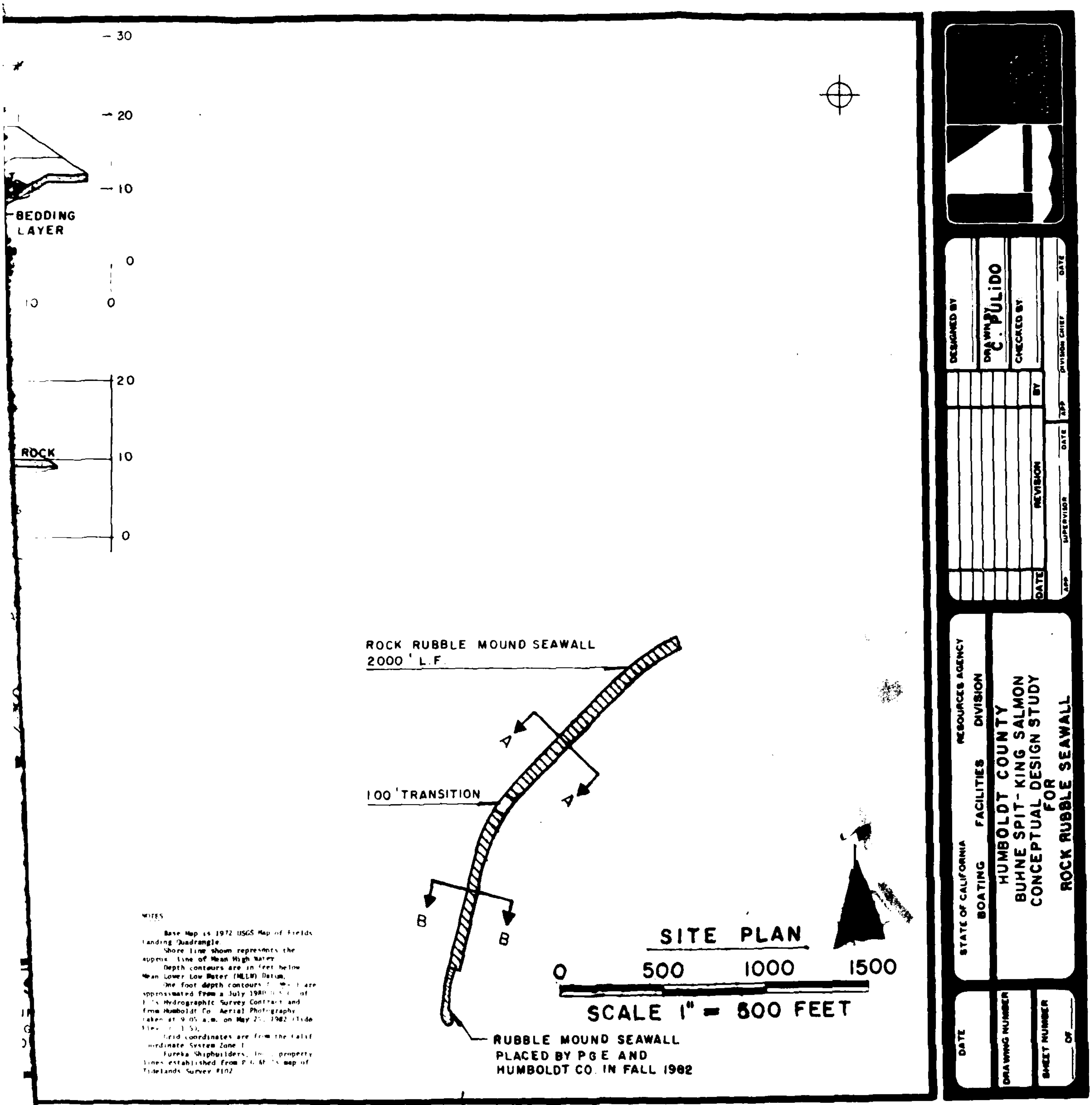
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.

One foot depth contours [illegible] are approximated from a July 1980 U.S. [illegible] of E.'s Hydrographic Survey contract and from Humboldt Co. Aerial Photographs taken at 9 [illegible] a.m. on May 25, 1982 (Tide Elev. [illegible]).

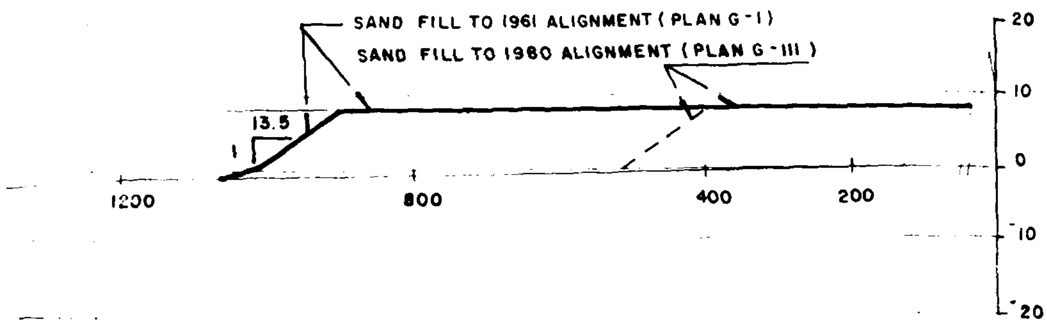
Grid coordinates are from the Calif. Coordinate System Zone I.

Eureka Shipbuilders, Inc. property lines established from [illegible] map of Tidelands Survey [illegible]

PLAN F

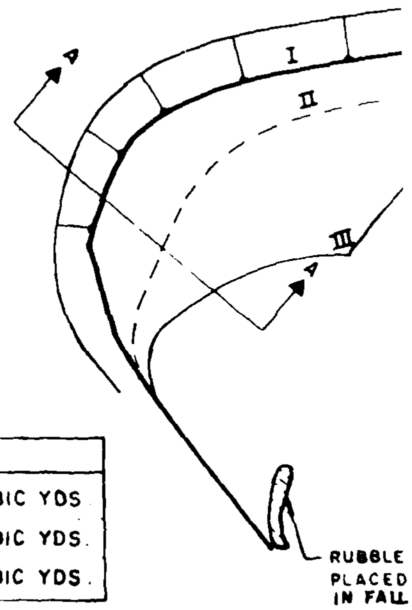


BEDDING LAYER
ROCK
ROCK RUBBLE MOUND SEAWALL 2000 ' L.F.
100 'TRANSITION
RUBBLE MOUND SEAWALL PLACED BY PGE AND HUMBOLDT CO. IN FALL 1982
SITE PLAN
0 500 1000 1500
SCALE 1" = 500 FEET
NOTES
Base Map is 1972 USGS Map of Fields Landing Quadrangle.
Shore line shown represents the approx. line of Mean High Water.
Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.
Grid coordinates are from the Calif. Coordinate System Zone I.
STATE OF CALIFORNIA RESOURCES AGENCY
BOATING FACILITIES DIVISION
HUMBOLDT COUNTY
BUHNE SPIT - KING SALMON
CONCEPTUAL DESIGN STUDY
FOR
ROCK RUBBLE SEAWALL
DESIGNED BY
DRAWN BY C. PULIDO
CHECKED BY
REVISION
DATE
BY
APP
SUPERVISOR
DIVISION CHIEF
DRAWING NUMBER
SHEET NUMBER
OF



SECTION A-A

SCALE 1" = 500 FEET



NOTES

Base Map is 1972 USGS Map of Fields Landing Quadrangle

Short line shown represents the approx. line of Mean High Water.

Depth contours are in feet below Mean Lower Low Water (MLLW) Datum.

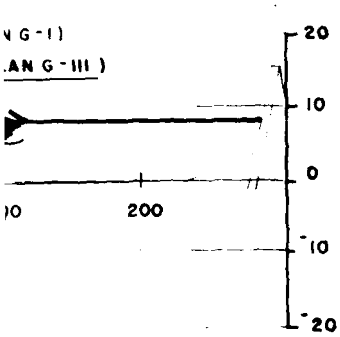
One foot depth contours ( ) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. + 1.5).

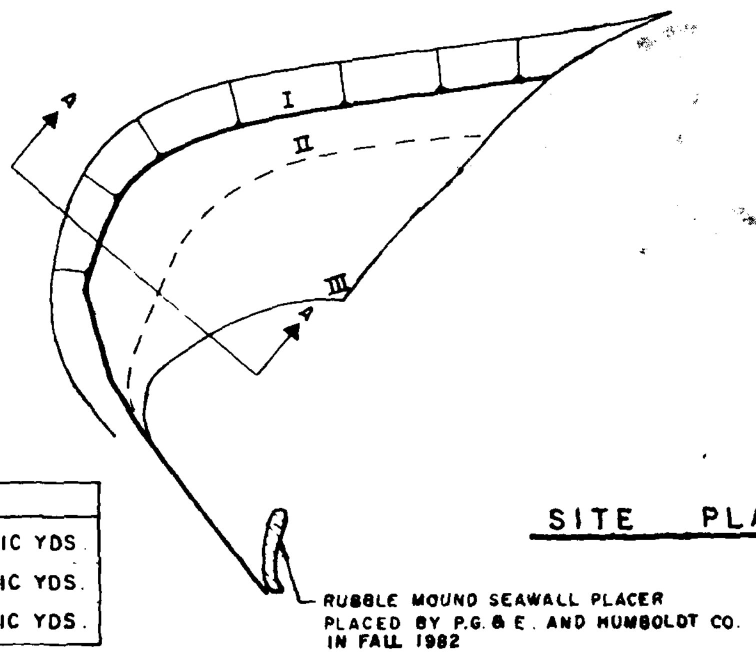
Grid coordinates are from the Calif. Coordinate System Zone 1.

Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102

OPTION	SAND FILL
I	488,000 CUBIC YDS.
II	347,000 CUBIC YDS.
III	170,000 CUBIC YDS.

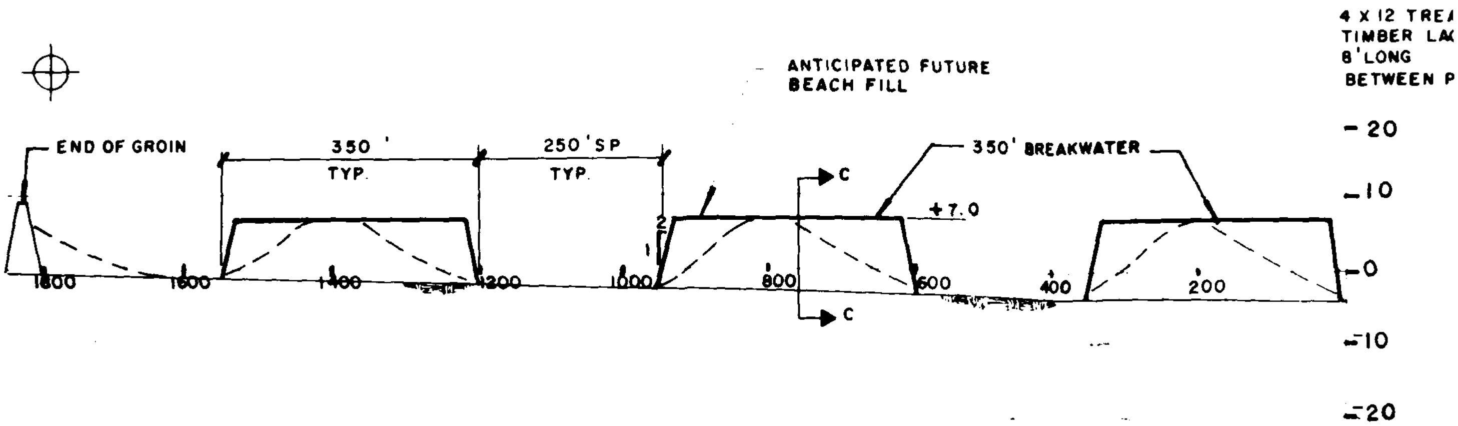
PLAN G





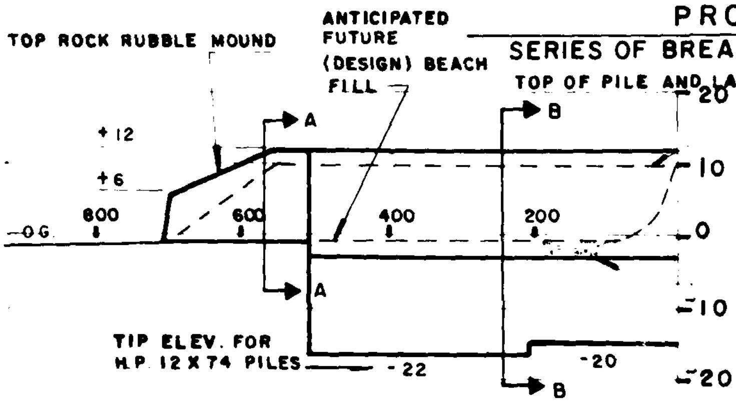
OPTION	SAND FILL
I	488,000 CUBIC YDS.
II	347,000 CUBIC YDS.
III	170,000 CUBIC YDS.

SITE PLAN



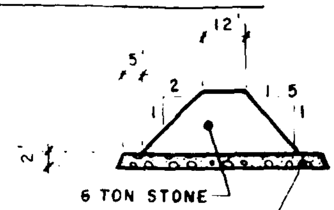
PROFILE

SERIES OF BREAKWATERS

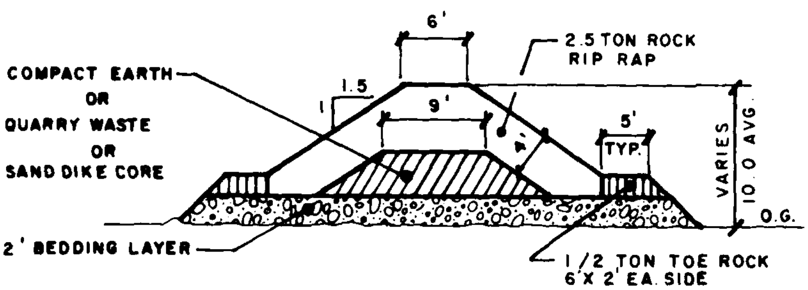


PROFILE

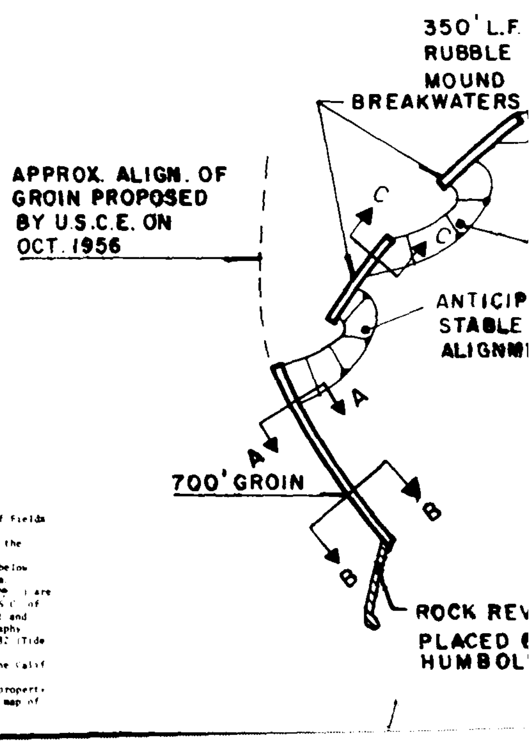
700' TRAINING WALL GROIN



SECTION C-C



SECTION A - A



NOTES

Base Map is 1972 USGS Map of Fields Landing Quadrangle.

Shore line shown represents the approx. line of Mean High Water

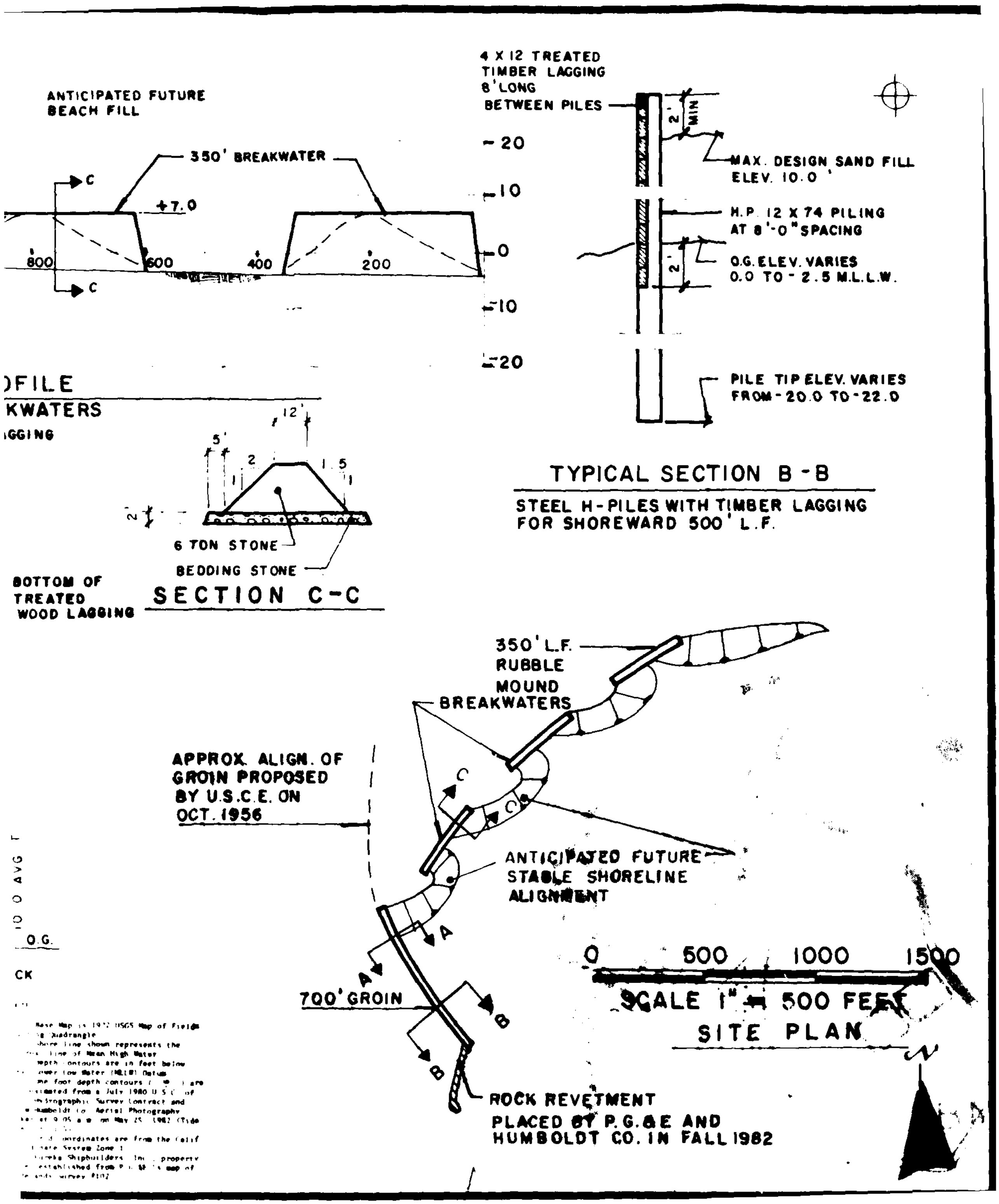
Depth contour' are in feet below Mean Lower Low Water (MLLW) Datum.

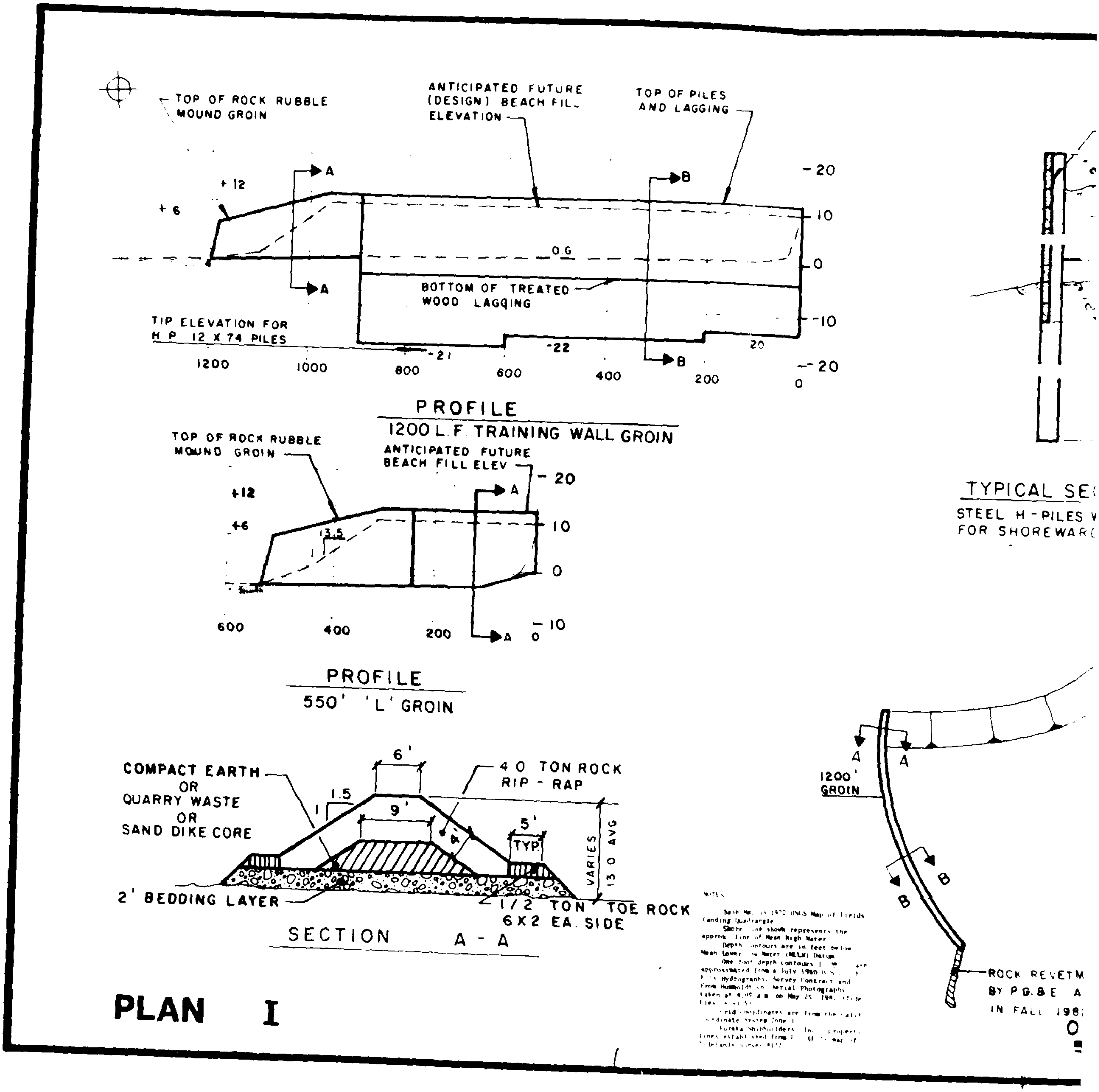
One foot depth contours (-) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. + 1.5).

Grid coordinates are from the Calif. Coordinate System Zone I

Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102

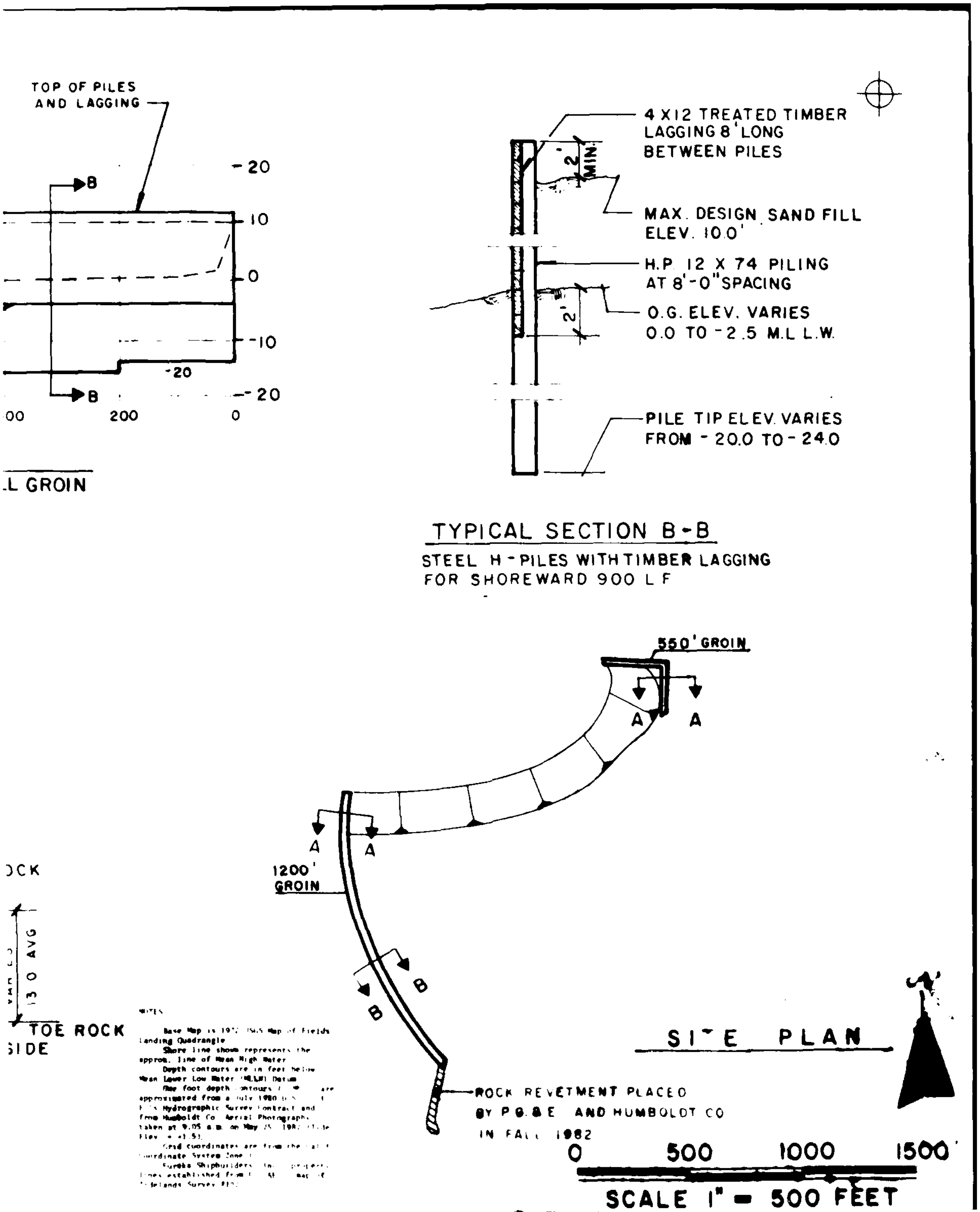
PLAN H

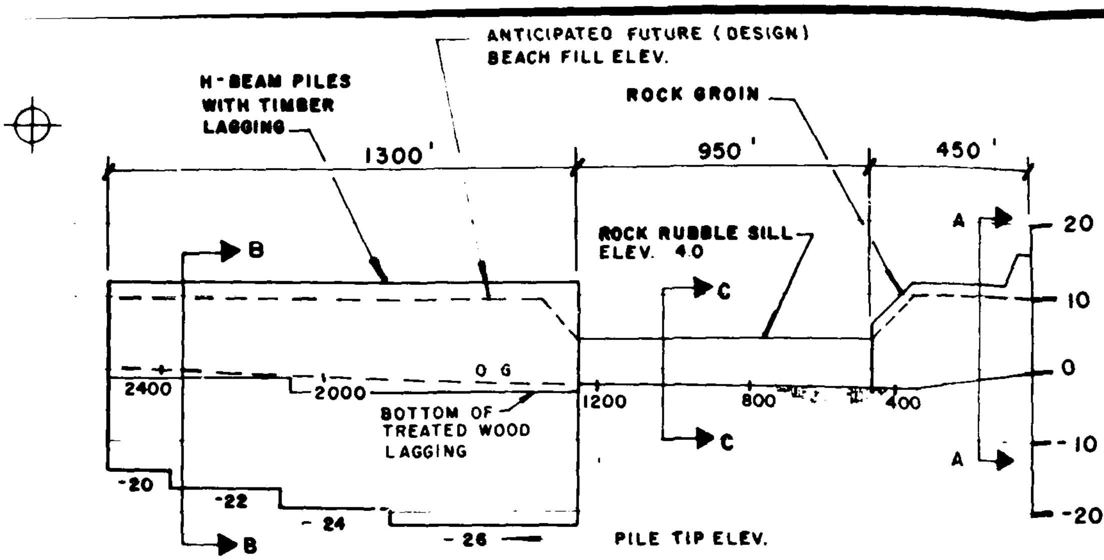

ANTICIPATED FUTURE BEACH FILL
350' BREAKWATER
+7.0
800
600
400
200
)FILE
KWATERS
GGING
5'
12'
2
1.5
6 TON STONE
BEDDING STONE
BOTTOM OF TREATED WOOD LAGGING
SECTION C-C
4 X 12 TREATED TIMBER LAGGING 8' LONG BETWEEN PILES
MAX. DESIGN SAND FILL ELEV. 10.0'
H.P. 12 X 74 PILING AT 8'-0" SPACING
O.G. ELEV. VARIES 0.0 TO -2.5 M.L.L.W.
PILE TIP ELEV. VARIES FROM -20.0 TO -22.0
TYPICAL SECTION B-B
STEEL H-PILES WITH TIMBER LAGGING FOR SHOREWARD 500' L.F.
350' L.F. RUBBLE MOUND BREAKWATERS
APPROX. ALIGN. OF GROIN PROPOSED BY U.S.C.E. ON OCT. 1956
ANTICIPATED FUTURE STABLE SHORELINE ALIGNMENT
700' GROIN
ROCK REVETMENT PLACED BY P.G.&E AND HUMBOLDT CO. IN FALL 1982
0 500 1000 1500
SCALE 1" = 500 FEET
SITE PLAN
O.G.
CK



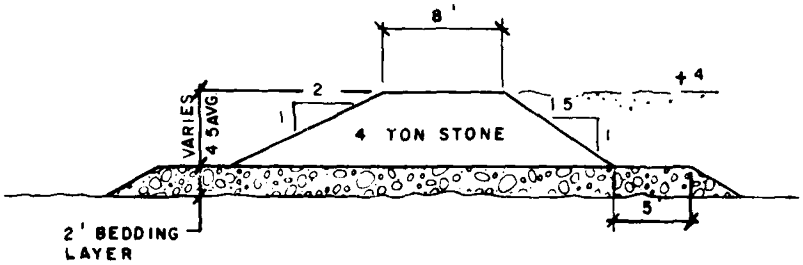
TOP OF ROCK RUBBLE MOUND GROIN
ANTICIPATED FUTURE (DESIGN) BEACH FILL ELEVATION
TOP OF PILES AND LAGGING
+12
+6
A
B
20
10
0
-10
-20
0 G
BOTTOM OF TREATED WOOD LAGGING
TIP ELEVATION FOR H P 12 X 74 PILES
-21
-22
20
1200
1000
800
600
400
200
0
PROFILE
1200 L. F. TRAINING WALL GROIN
TOP OF ROCK RUBBLE MOUND GROIN
ANTICIPATED FUTURE BEACH FILL ELEV
13.5
1
PROFILE
550' 'L' GROIN
COMPACT EARTH OR QUARRY WASTE OR SAND DIKE CORE
6'
1.5
9'
5'
TYP
4 0 TON ROCK RIP - RAP
VARIES
13 0 AVG
2' BEDDING LAYER
1/2 TON TOE ROCK 6 X 2 EA. SIDE
SECTION A - A
TYPICAL SE
STEEL H - PILES
FOR SHOREWAR
1200' GROIN
ROCK REVETM
BY P G & E
IN FALL 198
NOTES

PLAN I

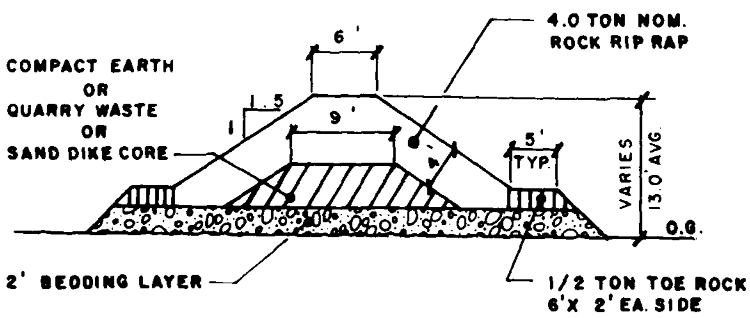

TOP OF PILES AND LAGGING
B
B
20
10
0
-10
-20
-20
00
200
0
.L GROIN
4 X 12 TREATED TIMBER LAGGING 8' LONG BETWEEN PILES
2' MIN.
MAX. DESIGN SAND FILL ELEV. 10.0'
H.P. 12 X 74 PILING AT 8'-0" SPACING
2'
O.G. ELEV. VARIES 0.0 TO -2.5 M.L.L.W.
PILE TIP ELEV. VARIES FROM -20.0 TO -24.0
TYPICAL SECTION B-B
STEEL H-PILES WITH TIMBER LAGGING FOR SHOREWARD 900 L.F.
550' GROIN
A
A
A
A
1200' GROIN
B
B
)CK
13.0 AVG
TOE ROCK
;IDE
SI E PLAN
ROCK REVETMENT PLACED BY P.G.&E. AND HUMBOLDT CO. IN FALL 1982
0
500
1000
1500'
SCALE 1" = 500 FEET



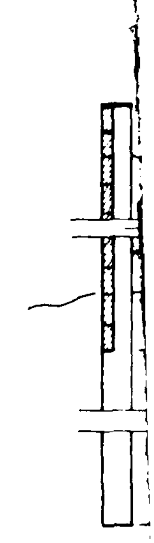
PROFILE SECTION



SECTION C-C

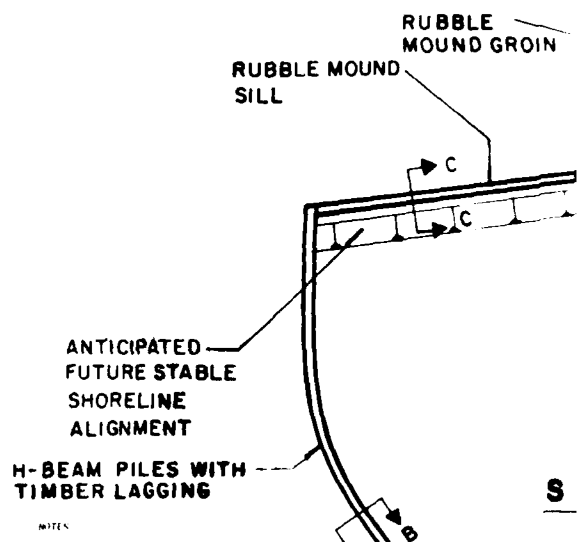


SECTION A-A



TYPICAL

STEEL H-PILE



NOTES

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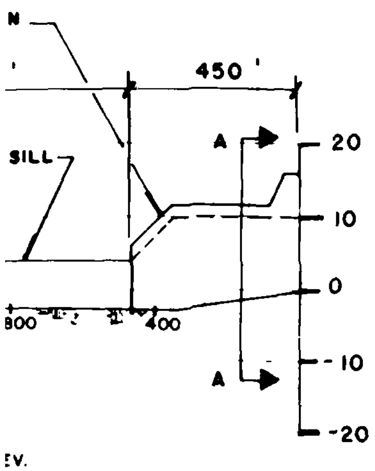
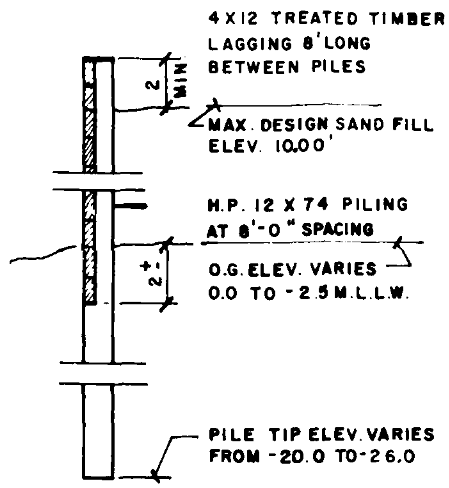
One foot depth contours ( ) are approximated from a July 1980 U.S.C. of E.'s Hydrographic Survey Contract and from Humboldt Co. Aerial Photography taken at 9:05 a.m. on May 25, 1982 (Tide Elev. + 1.5).

Grid coordinates are from the Calif. Coordinate System Zone 1.

Eureka Shipbuilders, Inc., property lines established from P.G.&E.'s map of Tidelands Survey #102

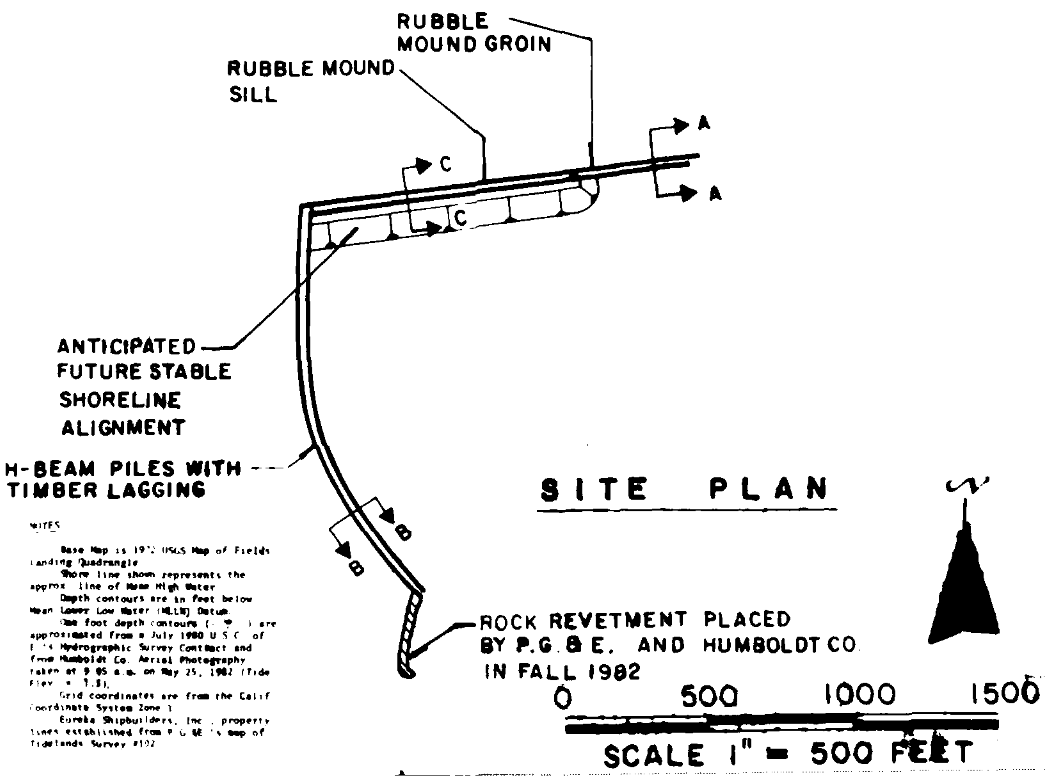
PLAN J





TYPICAL SECTION B-B

STEEL H-PILES WITH TIMBER LAGGING



SITE PLAN

APPENDIX F

CORRESPONDENCE and DOCUMENTS

for

BUHNE SPIT/KING SALMON

SHORE PROTECTION PROJECT

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
211 MAIN STREET
SAN FRANCISCO, CALIFORNIA 94105

April 25, 1983

Construction-Operations Div.

Mr. George Armstrong
Department of Boating & Waterways
1629 S. Street
Sacramento, California 95814

Dear Mr. Armstrong:

This is to confirm the Buhne Point Demonstration Project Steering Committee Meeting to be held at the Humboldt Bay Harbor Recreation and Conservation District Office on 3 May 1983 at 1:00 PM.

Preliminary plans, schedules and cost estimates for Phase I (H - pile with wood lagging groin parallel to Fields Landing Channel from the southwest end of Buhne Point Road near the intersection of Halibut Avenue and a smaller offshore structure north of the spit); Phase II (placement of dredged fill material in the area formed by the two structures;)and proposed model studies of the project area. Additional items to be discussed are the lands, easements and rights-of-way for project construction; maintenance agreement for the erosion phase of project; schedule and cost estimates for design/construction of Buhne Point Road; and coordination with Coastal Zone Commission and Regional Water Quality Control Board.

The following persons have been invited to attend this meeting:

Dave Eyres	Federal Highway Administration
Tom Smith	Federal Highway Administration
Jack Alderson	Humboldt Bay Harbor Recreation and Conservation District
Guy Kulstad	County of Humboldt
Don Tuttle	County of Humboldt
George Armstrong	California Department of Boating and Waterways
Ed Weeks	Pacific Gas and Electric Company
Mrs. Scott	King Salmon Area Residents
Don Spensor	Los Angeles District, Corps of Engineers
Jack Farless	San Francisco District, Corps of Engineers
Jack McKellar	Eureka Project Office, S.F. District, Corps of Engrs.

Sincerely,

Jay K. Soper
Chief, Planning/Engineering Division

Copy furnished:
Federal Highway Administration
HNG-31
400 7th St., S.W.
Washington, D. C. 20590

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:

WRSC-D

6 APR 1983

Mr. Frank Torkelson, Interim Director
Department of Boating and Waterways
State of California - Resources Agency
1629 S. Street
Sacramento, California 95814-7291

Dear Mr. Torkelson:

I am responding to your letter of February 23, 1983, in which you provided a status of your agency's planning efforts for the Buhne Spit shore protection project.

The San Francisco District has been given the lead role for development and construction of the shore protection at Buhne Point. Colonel Ed Lee, San Francisco District Engineer, is the overall manager for the project. He will insure close coordination at all levels - Federal, state, and local.

In connection with the beach replenishment, San Francisco District will do sediment sampling to determine the best area to position a hydraulic cutterhead dredge to enable the coarser sands to be pumped directly on the beach. Plans and specifications for the beach replenishment will be prepared, and we anticipate a contract award early this fall.

I appreciate your interest in our dredging program, and particularly your interest in dredged material as a beneficial resource. Colonel Lee and his staff will continue to coordinate directly with you on their efforts at Buhne Point.

Sincerely,

John F. Wall
Major General, U. S. Army
Director of Civil Works

Maj. Gen. John F. Wall
Director of Civil Works
Department of the Army
Office of the Chief of Engineers
Washington, D. C. 20314

Reply to Attention of: WSRC-D

SUBJECT: Buhne Point Dredge Spoil Area, Humboldt Bay, California

Dear General Wall:

We appreciate your consideration and study for placing dredge spoils within the Buhne Point Shoal area. At the present time, the Department of Boating and Waterways (Cal Boating) is in the preliminary design phase of a shore-protection project for the Buhne Spit area. We have developed several alternative plans for the project area which provide a groin system. The groins will prevent sands from the Buhne Point area being transported into the Fields Landing Channel and also into the Pacific Gas and Electric Company (PG&E) cooling water intake channel (Fisherman's Channel). Prints of the conceptual plans and cost estimates are enclosed.

The Buhne Point/King Salmon Shore Protection Project is included in Cal Boating's FY 1983-84 Budget. We have sufficient funds for construction of the structures but no funds allocated this year for sand fill to provide the protective beach within the groin pocket. We have assumed that the Corps of Engineers would deposit dredge spoils within the project area over a period of several years, providing sand fill for a protective beach. Plan A, enclosed would require approximately 200,000 cubic yards of sand fill. The other alternatives would require about the same quantity of sand.

Dredge material from the Middle ground would provide the grain size required for our project. We would suggest that the San Francisco District investigate the use of an auxiliary pumpout barge. The barge could be anchored alongside the hopper dredge within the Fields

Landing Channel, immediately downbay of the project area. This method would be an alternative to dumping the material in quiet waters and pumping the sand to the site by use of a hydraulic cutterhead dredge. Cal Boating used this method successfully on the Alameda Beach Renourishment Project, completed last fall.

Cal Boating will be very interested in the cost of sand and method of delivery to the Buhne Spit project site. If you have any questions about the shore-protection project, please contact George Armstrong, Supervisor, Beach Erosion Branch, at (916) 445-8349.

Sincerely,

FRANK TORKELSON
Interim Director

Enclosures

cc: Mr. J. Robert Edmisten w/encls.
USCE, South Pacific Div.

Col. Gary Lord, District Engineer w/encls.
USCE, San Francisco District

Mr. Jack Alderson
Humboldt Bay Harbor, Recreation
and Conservation District

CAA:am

February 18, 1983

Mr. Roy Trent
Department of Transportation
Federal Highway Administration
Research Department, Room 6320
400 - 7th St., South West
Washington, D.C. 20590

SUBJECT: Buhne Point Shore Protection Project, King Salmon, Humboldt Bay, California

Dear Mr. Trent:

Enclosed are copies of the conceptual plans and cost estimates for the Buhne Point project. The various plans are designed to intercept sand which would be transported down bay toward the Fields Landing Channel and subsequently find its way into the PG&E cooling water intake channel (Fisherman's Channel). The plans also provide a "groin pocket" to trap any littoral transport and with time build a wide protective beach.

The proposed projects will recreate Buhne Spit to its approximate area in 1955. Sand fill is not included in the cost estimates enclosed. We anticipate that the U. S. Army Corps of Engineers will deposit their maintenance dredge spoils within the groin pocket. The time necessary to fill the pocket will be dependent on the availability of sand and the frequency of maintenance dredging.

The Department will be coordinating the project design with all local, state and federal agencies. We will send you a copy of our feasibility report when completed. The conceptual design will give you an understanding of the scope of the project and how it will fit into your future project. Our project can be considered "Phase I" of any subsequent development on Buhne Spit.

If you have any further questions about our proposed project, please feel free to contact George Armstrong, Supervisor, Beach Erosion Branch, at (916) 445-8349.

Sincerely,

BILL S. SATOW, Chief
Boating Facilities Division

By

[illegible] A. [illegible], Supervisor
Beach Erosion Branch

[illegible]
cc: [illegible] Alderson

[illegible]

February 17, 1983

Mr. Don Tuttle
Natural Resources Division
Department of Public Works
County of Humboldt
1106 Second Street
Eureka, California 95501-0579

SUBJECT: Buhne Point Shore Protection Project, King Salmon, Humboldt County

Dear Mr. Tuttle:

Enclosed are prints and masters of the alternative plans and cost estimates for the Buhne Point project to be included in your environmental document.

We will forward to you a draft copy of the feasibility report when completed.

If you need any other plates from the feasibility report for your environmental document, please contact George Armstrong, Supervisor, Beach Erosion Branch, at (916) 445-8349.

Sincerely,

BILL S. SATOW, Chief
Boating Facilities Division

By

GEORGE A. ARMSTRONG, Supervisor
Beach Erosion Branch

Enclosures

cc: [illegible]
Engineering [illegible] boldt Co.

[illegible]

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:

WRSC-D

24 JAN 1983

Ms. Marty Mercado
Department of Boating and Waterways
State of California-Resources Agency
1629 S Street
Sacramento, California 95814

Dear Mr. Mercado:

This is in further response to your letter of October 22, 1982, to Lieutenant General J. K. Bratton, Chief of Engineers, regarding the Buhne Point dredged material disposal area.

The Corps agrees that efforts should be made to utilize dredged sands for beach replenishment at Buhne Point. The area in question was a disposal site for new construction dredging of Fields Landing Channel which was accomplished in the 1930's. The sediment, which was fine sand and silt, was placed hydraulically in a confined area and dewatered.

Most of the sediments presently hopper dredged from the Fields Landing and North Bay Channels tend to be finer, ranging from sandy silts to silts and clays and, therefore, may not be suitable for beach replenishment. However, sediments removed from the middle ground, at the east end of the entrance channel, are coarse sands, and should be ideal for beach replenishment. Two requirements for use of these sands at Buhne Point are a groin system to prevent sand transport into Fields Landing Channel and equipment to transfer the sand to the beach.

Dredging of the middle ground must be accomplished by hopper dredges. There are no suitable hopper dredges available for this project which have a direct pumpout capability. Because of severe currents, waves, weather and safety considerations, other types of dredging plant, such as hydraulic cutterhead or clamshell equipment, cannot be utilized at this location. In order to satisfactorily place the dredged sand on the beach, it would be necessary to mobilize a hydraulic cutterhead dredge to pump the sand from a deep, quiet water dump location of the hopper dredges. This rehandling and hydraulic dredge time would result in additional dredging costs which would have to be borne by the project local sponsor or entity promoting the beach replenishment.

24 JAN [illegible]

The Corps is well aware of the erosion problems at Buhne Point and the potential benefits of erosion control, recreation and sandy habitat development with a beach replenishment program. The San Francisco District is presently developing cost analysis estimates for beach replenishment from the potential sources mentioned above. The District Engineer will provide these estimates to you as soon as they are finalized.

Sincerely,

John P. Wall
Major General, U. S. Army
Director of Civil Works

DEPARTMENT OF PUBLIC WORKS

COUNTY OF HUMBOLDT

MAILING ADDRESS. 1106 SECOND STREET, EUREKA, CA 95501-0579
AREA CODE 707

OFFICE LOCATIONS

CLARK COMPLEX
HARRIS & H ST., EUREKA
REAL PROPERTY SERVICES 445-72[illegible]

JACOBS AVENUE GARAGE
JACOBS AVENUE, EUREKA
EQUIPMENT MAINTENANCE 445-7575
ROADS & ADMINISTRATION 445-7421

PUBLIC WORKS BUILDING
SECOND & L ST., EUREKA
ADMINISTRATION 445-7491
BUSINESS 445-7652
ENGINEERING 445-7[illegible]
NATURAL RESOURCES 445-7741

December 24, 1982

Mr. George Armstrong
California Department of Boating and Waterways
1629 "S" Street
Sacramento, CA 95814

REGARDING: Buhne Point Shore Protection Project, King Salmon, Humboldt Bay, Environmental Document

Dear Mr. Armstrong:

Enclosed is a copy of the preliminary environmental document for the Buhne Point project.

We intend to revise the document (after the draft feasibility study is sent to us) to include a discussion of the sub-alternatives to the groin/rubble-mound breakwater project. We will revise the document to include any additional impacts, if any, and correlate the alternative construction project titles.

The document is double-spaced for purposes of making any comments, additions, corrections you find are necessary.

Hope to hear from you after January 1.

Sincerely,

[illegible signature]
[illegible] A. GLATZEL
NATURAL RESOURCES DIVISION

[illegible]

[illegible]

PACIFIC GAS AND ELECTRIC COMPANY

77 BEALE STREET • SAN FRANCISCO, CALIFORNIA 94106 • (415) 781 4211 • TWX 910 372 6587

December 3, 1982

Mr. Don Tuttle
Department of Public Works
1106 Second Street
Eureka, CA 95501

Subject: Humboldt Bay Bathymetry Survey

Dear Don,

Please find enclosed the Bathymetry profiles we discussed on the phone. I hope they will be of use to you.

I have been informed that our contractor has completed our seawall and that your section should be completed by Saturday. I plan to fly up to Eureka next week to take a look at the wall and hope to see you at that time.

If I can be of any further help or wish to discuss the enclosed data, please call me at (415) 781-4211, extension 2521.

Sincerely,

Courtney Allen

COURTNEY ALLEN

CFA:db

Enclosures

15 NOV 1982

Mr. Marty Mercado, Director
Department of Boating and Waterways
State of California Resources Agency
1629 S Street
Sacramento, CA 95814-7291

Dear Mr. Mercado:

I [illegible] your letter of October [illegible], 19[illegible], to Lieutenant General J. [illegible], Chief of Engineers, in which you relayed the State of California's desire to [illegible] dredged sediments for beach restoration in the [illegible] Point Area, [illegible] Bay, California.

[illegible] for a report on this matter from the District [illegible]. Upon receipt of this report, I will [illegible].

Sincerely,

[illegible], III
Brigadier General, [illegible]
Acting Director of Civil [illegible]

HUMBOLDT BAY
HARBOR, RECREATION, AND CONSERVATION
DISTRICT
(707) 443-0801
P. O. Box 134
Eureka, California 95501

Mr. [illegible] Armstrong
Department of Boating & Waterways
Commission
1629 "S" Street
[illegible], CA 95814

Dear Mr. Armstrong:

[illegible] to our telephone conversation of [illegible] Nov. 1982; the property needed for [illegible] Beach [illegible] of [illegible] Drive is in private ownership. However, [illegible] Bay Harbor, Recreation, and Conservation District is in the process of [illegible].

[illegible] of Eureka Shipbuilders, Inc. and at a meeting earlier [illegible] the property as a gift to the District. This [illegible] principal and majority shareholder of Eureka Shipbuilders, Inc. [illegible]

[illegible], [illegible] willing to transfer, at no cost to the District, [illegible] Erosion Control Project.

[illegible] will [illegible] become a valuable recreational [illegible] children [illegible] park [illegible] productive [illegible] fishermen [illegible]

[illegible] 60 people [illegible] recreational [illegible] extremely important to the people of King Salmon [illegible] children living there.

[illegible]

OCT 22 1982

Major General Joseph K. Bratton
Chief of Engineers
Department of the Army
Forrestal Building
Washington, D.C. 20312

SUBJECT: Buhne Point Dredge Spoil Area, Humboldt Bay, California

Dear General Bratton:

The State of California's "Policy for Shoreline Erosion Protection" promulgated on September 14, 1978 by the Secretary of Resources under Section II, Planning and Regulations, Subsection C stipulates:

> "Beach and dune sand, and similar sediment lying in river beds, estuaries or in harbor channels is a valuable resource that should be used for shoreline protection. It is, therefore, the policy of the Resources Agency that all such dredge or excavation material removed within the coastal zone or near-shore waters, which is suitable in quantity, size, distribution, and chemical constituency, be discharged as follows:
>
> 1. Directly onto a natural beach in an appropriate manner for effective beach nourishment and in a manner to protect significant natural resources and the public use of such resources at those locations; or
>
> 2. When beach nourishment is not needed or appropriate at the time of dredging, the sand should be deposited at locations for eventual use for beach nourishment, provided that suitable locations are available and steps are taken to protect both significant natural resources and the public use of such resources at those locations; or
>
> 3. In those instances where quantity, distribution, or chemical constituency of dredge or excavation material limit its use as described in paragraphs one and two, the material should be used to optimize its mineral values or its utility as construction material;"

[illegible] Law 94-587 - October 22, 1976, 94th Congress, Section [illegible] states: [illegible] Secretary of the Army, acting through the Chief of Engineers, is [illegible] upon request of the State, to place on the [illegible] of such [illegible] beach-quality [illegible] which has been dredged in constructing and maintaining navigation inlets and channels adjacent to such beaches, if the Secretary deems such action to be in the public interest and upon payment of the increased cost thereof above the cost required for alternative methods of disposing of such sand."

The Buhne Point area, on Humboldt Bay, California, was built from previous Corps of Engineers' channel maintenance dredging spoils in the late 1930's. This dredge spoil sand fill lasted for over 40 years.

The State of California requests, under the provisions of PL 94-587, and in conformance with "The Policy for Shoreline Protection", that the Corps of Engineers place channel maintenance and/or new work dredged sand on the Buhne Point Spit area. It is believed that placement of sand on Buhne Spit will be less costly than the present method of placement at sea. The State also requests that a determination of cost be made if the placement of sand on Buhne Spit is more costly. The State would consider contributions to make up the difference in cost.

Informal discussions between Mr. George Armstrong, Supervisor, Beach Erosion Branch of this Department and the Department of Fish and Game, North Coast Region Water Quality Control Board and the State Coastal Commission indicates that the proposed dredge spoil project at Buhne Point does not have any major environmental problems.

Sincerely,

MARTY MERCADO
Director

cc: Mr. Jack Alderson
Mr. Guy Kulstad
Brig. Gen. Homer Johnstone
Col. Gary Lord

CAA:pm

SECTION 2

PHASE II BASIS FOR DESIGN

Buhne Point Shoreline Erosion Demonstration Project, Phase II, Humboldt Bay Basis For Design

1. Phase I Timber Groin. The Phase I timber groin was designed by Humboldt County with soil design values provided by the Los Angeles District Corps of Engineers. The design values are based upon soil investigation conducted in June 1983 and are given in Table 4 of the inclosed foundation report. The total length of the timber groin would be 1,250 feet. It would begin at the existing stone riprap along Buhne Drive at coordinates N 519,204.06 and E 1,385,293.08. From sta. 0+00 to sta. 10+00, the timber groin would have a direction north 32 degrees west, generally paralleling the existing Fields Landing channel. From sta 10+00 to sta 12+50, the timber groin enters a circular curve of 600 feet radius and central angle of 57 degrees, 17 minutes, and 45 seconds. A 200-foot long rubble mound head (sta 12+00 to sta 14+00) would be provided to protect the seaward end of the timber groin. A 6-foot-wide, 5-foot high stone toe protection structure consisting of one-ton stone and quarry waste would be placed along the downcoast (south) side of the timber groin to prevent scouring of the toe. A filter fabric on the upcoast (north) side would be provided to prevent the phase II sandfill from passing through voids in the timber groin.

2. The primary function of the timber groin is to stabilize the phase II sandfill and prevent it from being transported downcoast into the Fields Landing Channel by the predominant downcoast drift. The downcoast drift is caused by the diffracted deep water wave trains approaching through the entrance channel and tidal current in the bay. The length of the timber groin is based upon the amount of structure that can be constructed with the State Department of Boating and Waterways budgeted funds of $495,000. The objective is to build the longest groin possible with the available funds for stabilizing the phase II sandfill.

3. Soils Investigation. Soils investigations were conducted in July 1983 to determine the extent, distribution, and physical properties of the foundation and borrow area materials for the proposed alignments of the timber and stone groin and stone slope protection and fill off Buhne Point in Humboldt Bay, California. Detailed information of the borrow materials and foundation conditions were obtained in order to provide a sound basis for the design of the proposed structures. The inclosed report describes the soils and soil properties, soil explorations, field survey and laboratory testing, analysis of data, soil design values, and discusses some of the design and construction considerations(Incl 1).

4. Phase II Sandfill. The phase II sandfill was designed to temporarily restore the spit at Buhne Point and provide protection for Buhne Drive and underground utilities. A borrow area about 4,000 feet long and 400 feet wide adjacent to the North Bay Channel of Humboldt Bay will be dredged to a project depth of minus 35 feet mean lower low water (MLLW) and will provide about

600,000 cubic yards of materials for the sandfill. A 2 feet over-depth is allowed for the dredging.

5. The materials in the borrow area consist predominantly of loose to very dense, fine to medium grained sands with shells. For the sands, the percent of the material by weight passing the No. 4 sieve varies from 98 to 100 percent; the percent passing the No. 10 sieve varies from 92 to 100 percent, and the percent passing the No. 200 sieve varies from 1 to 6 percent. Approximately 90 percent of the material in the borrow area will be sand. The remainder consists of silt or clay material.

6. The materials at Buhne Point consist of layered heterogeneous soils extending to a depth greater than 60 feet. The upper layer, varying in thickness from 9 feet near shore to 20 feet, consists of gravelly sands and sands with shells. The percent of the material by weight passing the No.4 sieve varies from 64 to 100 percent, and the percent of the material by weight passing the No. 200 sieve varies from 1 to 9 percent.

The second layer, varying in thickness from 8 to 14 feet, consists of plastic sandy silts and sandy clays. The percent by weight passing the No. 4 sieve varies from 95 to 100 percent, and the percent by weight passing the No. 200 sieve varies from 56 to 81 percent. The third layer occurs below elevations ranging from -32 to -35.5 feet MLLW and consists of dense silty sands and medium to fine sands. One hundred percent of the material by weight passes the No. 4 sieve. The percent of the material by weight passing the No. 200 sieve varies from 5 to 21 percent.

7. The material in the borrow area would be excavated by hydraulic dredging and could be placed from the upcoast end to the downcoast end of the timber groin until the required amount of material has been dredged. The average pumping distance from the borrow area to the sandfill is approximately 1.2 miles. To minimize erosion the crest elevation of the sandfill would be plus 15 feet MLLW, and the material would be spread out during the phase III project to plus 12 feet MLLW. The seaward construction slope of the sandfill would be 1 vertical on 10 horizontal, and it is estimated that the equilibruim slope would be 1 vertical on 15 horizontal. The construction slope of the sandfill at the timber groin would be 1 vertical on 3 horizontal which is approximately the angle of repose for the dredged material. The elevation of the sandfill at the timber groin would be about plus 11 feet MLLW.

8. Model Study. Tidal currents and wave-induced currents are the major contributors to the erosion problem at Buhne Point. Since there is no guidance for the design of engineering structures for such areas where wave-induced and tidal current interaction is significant, a series of model studies are proposed to evaluate alternative plans required for the alleviation of shoreline erosion. A 1:100-scale physical model of central Humboldt Bay is proposed to determine the wave climate (angle of the wave front) and will include the entrance to Humboldt Bay, the central portion of the Bay, the Buhne Point area, and approximately 18,000 linear feet of shoreline inside the Bay. A range of significant wave periods and heights will be generated through the jetties (from the Pacific Ocean) for various

directions and still-water levels (SWL's) both with and without tidal flow conditions to determine the wave climate in the vicinity of the problem area.

A 1:50-scale physical model of Buhne Point is proposed to determine the causes of erosion at the point and the effectiveness of various improvement structures under various wave and tidal current conditions. A curved wave generator capable of reproducing a variable height wave front (as determined in the 1:100-scale model of central Humboldt Bay) will be used to generate test waves for various SWL's both with and without tidal flow conditions. A 1:50-scale model is required since wave breaking and sediment transport are important in the area, and scale effects become significant for scales greater than approximately 1:50.

A two-dimensional hydrodynamic tidal circulation numerical model is proposed to determine the tidal current field in central Humboldt Bay and adjacent Buhne Point. Maximum flood and ebb tidal current velocities will be determined and used in both the 1:100-scale physical model of central Humboldt Bay and the 1:50-scale physical model of Buhne Point.

A three-dimensional sediment transport numerical model of Humboldt Bay is proposed to determine the impacts of the proposed Buhne Point structures on adjacent areas in the Bay. It will determine if the proposed structures would produce or result in erosion problems at other locations not included in the physical model or shoaling problems in the navigation channels.

In summary, the two physical hydraulic models and two numerical models would determine the effectiveness of engineering structures to alleviate erosion problems at Buhne Point, Humbdolt Bay, California. The final solution required to protect the project, based on the hydraulic model tests results, will be incorporated into the Phase III project.

Prepared by

Los Angeles District

February 1984

SECTION 3

PHASE II FOUNDATION REPORT

HUMBOLDT BAY, CALIFORNIA

FOUNDATION REPORT

FOR

BUHNE POINT

SHORELINE EROSION DEMONSTRATION PROJECT

PHASE II, HUMBOLDT BAY

U.S. ARMY ENGINEER DISTRICT,

LOS ANGELES

CORPS OF ENGINEERS

AUGUST 1983

FOUNDATION REPORT

FOR

BUHNE POINT

SHORELINE EROSION DEMONSTRATION PROJECT

PHASE II, HUMBOLDT

1. PURPOSE AND SCOPE.

Soils investigations were conducted to determine the extent, distribution and physical properties of the foundation and borrow area materials for the proposed alignments of the timber and stone groin and stone slope protection and fill off Buhne Point in Humboldt Bay, California. Detailed information of the borrow materials and foundation conditions were obtained in order to provide a sound basis for the design of the proposed structures. The report describes the soils and soils properties, the soils exploration, field and laboratory testing, analysis of data, soil design values, and discusses some design and construction considerations.

2. SITE DESCRIPTION.

The proposed project is located off Buhne Point in Humboldt Bay, California. The site is a tidal mud flat varying in elevation from +1 to -4 feet MLLW. The site is normally covered by water and is exposed only during low tide. See plate 1 for location of project.

3. PROJECT FEATURES.

The proposed project consists of a timber groin 1250 feet in length, a stone groin 150 feet in length from the end of the timber groin, approximately 600,000 cubic yards of sand fill and stone slope protection. See plate 1 for location and typical section of project features.

4. FIELD INVESTIGATIONS.

Geotechnical investigations consisted of drilling holes with a barge mounted, 4 inch diameter rotary wash drill rig along the proposed alignment of the groin in the fill area and in the borrow area. See plate 1 and 2 for location of drill holes. Representative disturbed samples were obtained at 5-foot intervals for classification tests. Undisturbed samples along the proposed alignment of the groin were obtained with a drive Sampler at depths below 30 feet in TH 83-3 thru 5 and with a 3-inch diameter Shelby tube sampler in TH 83-1 thru 3 to obtain samples for detailed laboratory testing. The borings by general location and depths are summarized in the table 1.

TABLE 1

EXPLORATION SUMMARY

LOCATION	HOLE NO.	DEPTHS (Ft.)
Groin	TH 83-1 thru 5	22 to 65.5
Fill Slope Area	TH 83-7 thru 11	11.5 to 21.5
Borrow Area	TH83-6, 8 thru 10	15 to 28.5

5. FIELD TESTS AND RESULTS.

a. Standard Penetration Tests.

Standard Penetration Tests were performed in all the test holes. The test consists of driving a sampling spoon, having an inside diameter of 1-3/8 inches and an outside diameter of 2 inches, with a 140-pound hammer falling from a height of 30 inches. The sampling spoon is seated 6 inches and the penetration resistance is recorded as the number of blows required to drive the sampler one additional foot.

b. Drive Sampler.

Density samples were obtained using a Drive Sampler and submerged hammer along the proposed groin alignment. The sampler which has an inside diameter of 2.0 inches and an outside diameter of 2.5 inches consists of a solid spoon which contains four 3-inch long brass rings having an inside diameter of 1.93 inches and an outside diameter of 2.0 inches and a 6-inch waste barrel. The hammer was dropped from a height of 18 inches and has a weight of 376 pounds. The driving resistance was measured as the number of blows by the submerged hammer to drive the sampler one foot after seating the sampler 6-inches.

6. LABORATORY TESTS AND RESULTS.

a. Testing Methods.

Representative disturbed and undisturbed samples were sent to the South Pacific Division (SPD) Laboratory for testing. The testing program consisted of unconfined compression, consolidation, density, mechanical analysis and Atterber limits. These tests were performed in general accordance with EM 1110-2-1906 "Laboratory Soils Testing" dated 30 November 1970.

b. Test Results.

Results of classification tests are shown on the soils logs on plates 3 and 4. The results of the density tests are shown in table 2, the results of the unconfined compression tests are shown in table 3, and the results of the consolidation tests are shown in table 4.

TABLE 1

DENSITY TESTS

Hole Number	Depth (Ft)	Soil Classification	Dry Density (Pcp)	Water (%)
83-1	14	ML	85	35
83-2	30	SP/SM	103	24
83-3	10	SP	125	13
83-3	25	CL	93	30
83-3	45	SP/SM	102	21
83-3	55	SP/SM	97	25
83-4	30	CL/ML	90	31
83-4	40	SP/SM	102	23
83-5	36	ML	106	21
83-5	46	SP/SM	101	22

TABLE 2

UNCONFINED COMPRESSION TESTS

Hole Number	Depth (Ft)	Unconfined Compressive Strength (Psf)
83-1	14	720
83-2	30	1240
83-3	25	1300

TABLE 3

CONSOLIDATION TESTS

Hole Number	Depth (Ft)	Initial Void Ratio	Compression Index (Cc)
83-1	14	1.043	0.28
83-2	30	0.679	0.155
83-3	25	0.929	0.27

7. ANALYSIS OF DATA.

a. Groin Foundation.

The foundation materials for the groin consist of layered heterogeneous alluvial soils extending to a depth greater than 60 feet. Interpretation of the data contained on the soils logs indicate that there are three distinct soil layers in the groin foundation.

The upper layer, varying in thickness from 9 feet near shore (TH 83-1) to 20 feet (TH 83-2 thru 5), consists of gravelly sands and sands with shells. The percent of the material by weight passing the No. 4 sieve varies from 64 to 100 percent and the percent of the material by weight passing the No. 200 sieve varies from 1 to 9 percent. The SPT penetration resistance for this layer ranged from N=2 to N=9. The layer is approximately 20 feet thick.

The second layer consists of plastic sandy silts and sandy clays. The percent by weight passing the No. 4 sieve varies from 95 to 100 percent and the No. 200 sieve varies from 56 to 81 percent. The plastic index varies from 4 to 8 and the liquid limit varies from 27 to 31. The in-situ dry density of this material varies from 85 to 106 pcf with an average of 94 pcf. The in-situ moisture content of this material varies from 24 to 35 percent with an average of 30 percent. The SPT penetration resistance for this layer ranged from N=4 to N=9. The unconfined compression strength (qu) ranged from 720 pounds per square foot (psf) to 1300 psf with an average of 1087 psf. The compression index varies from o.27 to 0.28. The layer varies in thickness from approximately 8 feet (near shore TH 83-1 and 2) to 14 feet in TH 83-3 thru 5.

The third layer consists of silty sands and medium to fine sands. One hundred percent of the material, by weight passes the No. 4 sieve. The percent of the material by weight passing the No. 200 sieve varies from 5 to 21 percent. The in-situ dry density of this material varies from 90 to 103 pcf with an average of 101 pcf. The in-situ moisture content of this material varies from 21 percent to 30 percent with an average of 24 percent. The SPT penetration resistance for this layer in TH 83-2 was N=60+. The California Modified Sampler driving resistance averages 32 for the layer. The penetration and driving resistance data indicate that the materials are dense to very dense.

b. Fill Slope Foundation.

The foundation materials for the fill slope consist of sandy silts, sandy clays and sands with shells. The percent of the material by weight passing the No. 4 sieve varies from 98 to 100 percent and the percent of the material by weight passing the No. 200 sieve varies from 5 to 95 percent. For the plastic soils the plastic index varies from 3 to 13 and the liquid limit varies from 27 to 36. The SPT penetration resistance for these soils ranged from N=3 to N=7.

c. Borrow Area.

The materials in the borrow area consist predominately of loose to very dense fine to medium grained sands with shells. For the sands the percent of the material by weight passing the No. 4 sieve varies from 98 to 100 percent, the No. 10 sieve varies from 92 to 100 percent, and the No. 200 sieve varies from 1 to 6 percent. The range of field gradations for the sands in the borrow area are shown in figure 1. Approximately 90 percent of the material in the borrow area will be sand. The remainder will be minus No. 200 material. The material in the borrow area becomes denser with depth. The penetration resistance ranged from N=6 to N=16 in the upper 10 feet, from N=16 to N=35 at a depth 10 to 25 feet, and N=60+ below 25 feet.

A clay layer was encountered at 19 feet in TH 83-6. TH 83-6 was located on the eastern edge of the borrow area.

8. DESIGN VALUES.

a. General.

The adopted design values are based on the results of laboratory and field tests. The selected design values for the groin foundation and the fill are presented in table 4 and the basis for the selection follows.

TABLE 4

FILL AND FOUNDATION, SUMMARY OF DESIGN VALUES

	Elevation Depth (Ft.)	Unit Weight Sat (Pcf)	Ø Degree	C (Psf)	Kw (Pcf)	Kp Pcf
Fill	+15 to -1	125	30	0	40	[illegible]
Foundation						
Gravelly sand	-1 to -21	110	27	[illegible]	[illegible]	
Silt and clay	-21 to -36	120	0	[illegible]		
Silty sand	-36 to -67	125	35			

AD-A189 838 BUHNE POINT SHORELINE EROSION DEMONSTRATION PROJECT VOLUME 2 APPENDICES E(U) ARMY ENGINEER DISTRICT LOS ANGELES CA AUG 87 3/3

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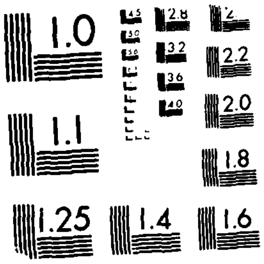


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU STANDARDS

b. Fill Materials.

A saturated unit weight of γ_{sat}=125 pcf and a shear strength of ϕ=30° were selected for the fill material. The design values were based on the material characteristics in the borrow area and the method of placement for the materials.

c. Foundation Materials.

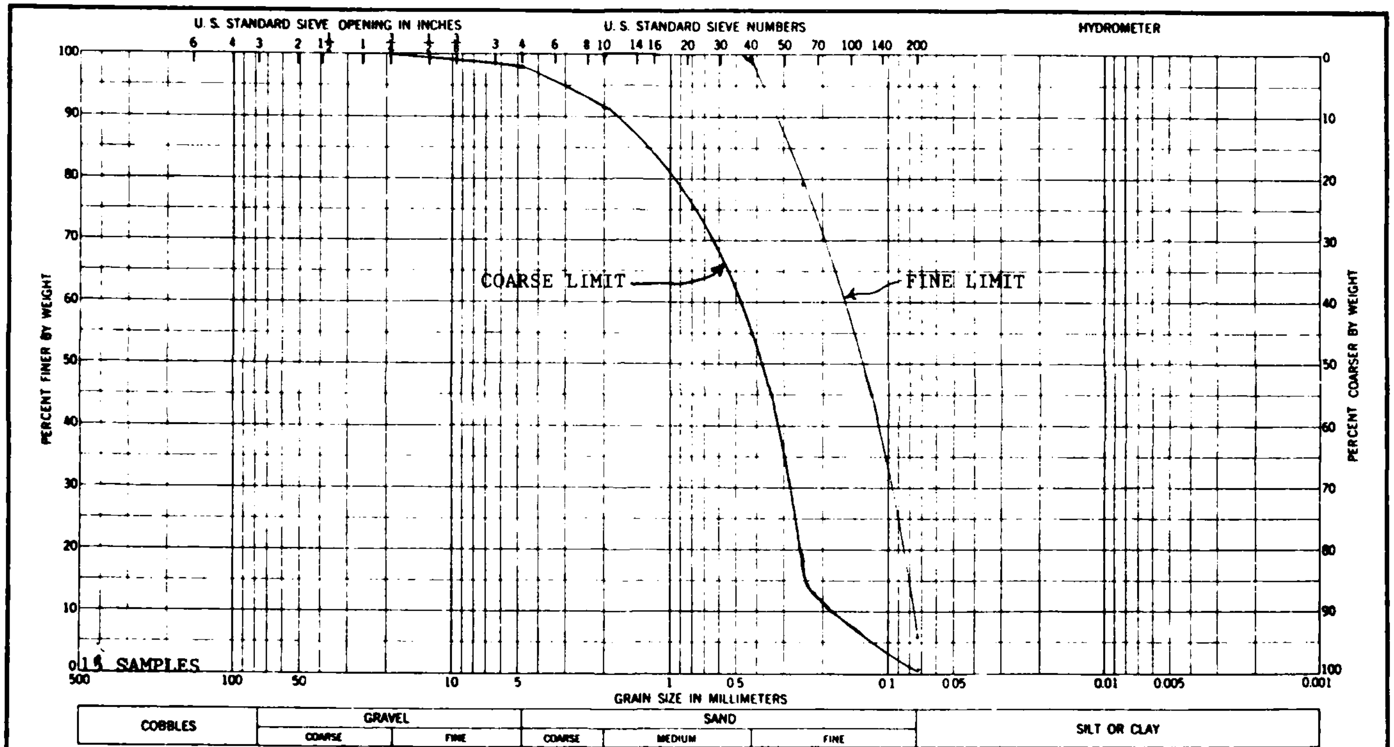
From an elevation of -1 to -21, a saturated unit weight of γ_{sat}=110 pcf and a shear strength of ϕ=27° were selected for the gravelly sand layer. The design values were based on the SPT results and gradation of the materials.

From an elevation of -21 to -36, a saturated unit weight of γ_{sat}=120 pcf and a shear strength of c=500 psf were selected for the clay layer. The unit weight was based on the average of the in-situ density tests and the shear strength was based on the average of the unconfined compression test results.

From an elevation of -36 and below, a saturated unit weight of γ_{sat}=125 pcf and a shear strength of ϕ=35° were selected for the silty sand. The unit weight was based on the average of the in-situ density tests and the shear strength was based on the SPT results.

9. DESIGN AND CONSTRUCTION CONSIDERATIONS.

The following items should be considered during the design and construction of the Buhne Point groin, stone breakwater and fill. (1) A filter system will have to be designed for the groin to prevent the migration of material through the groin, (2) a filter system will have to be designed to prevent the migration of material through the stone breakwater, (3) to prevent the erosion of fill by waves and to contain the dredged materials during placement the stone breakwater should be constructed before placement of the fill, and (4) for estimating purposes the total settlement for the groin foundation is estimated to be less than 6 inches.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

Project BUHNE POINT

Area BORROW

Boring No

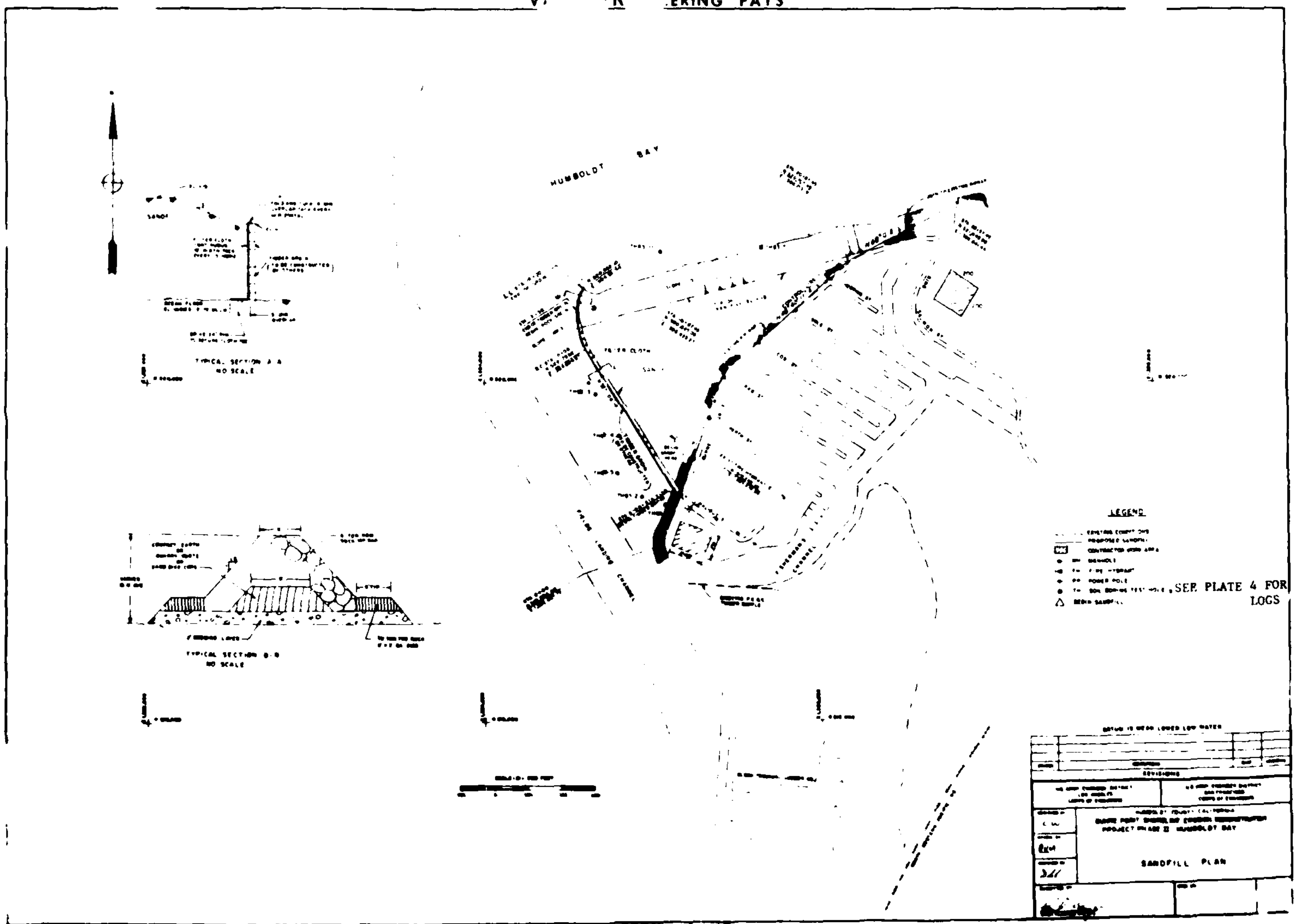
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Figure 1. FIELD GRADATIONS (SANDS IN THE BORROW AREA)

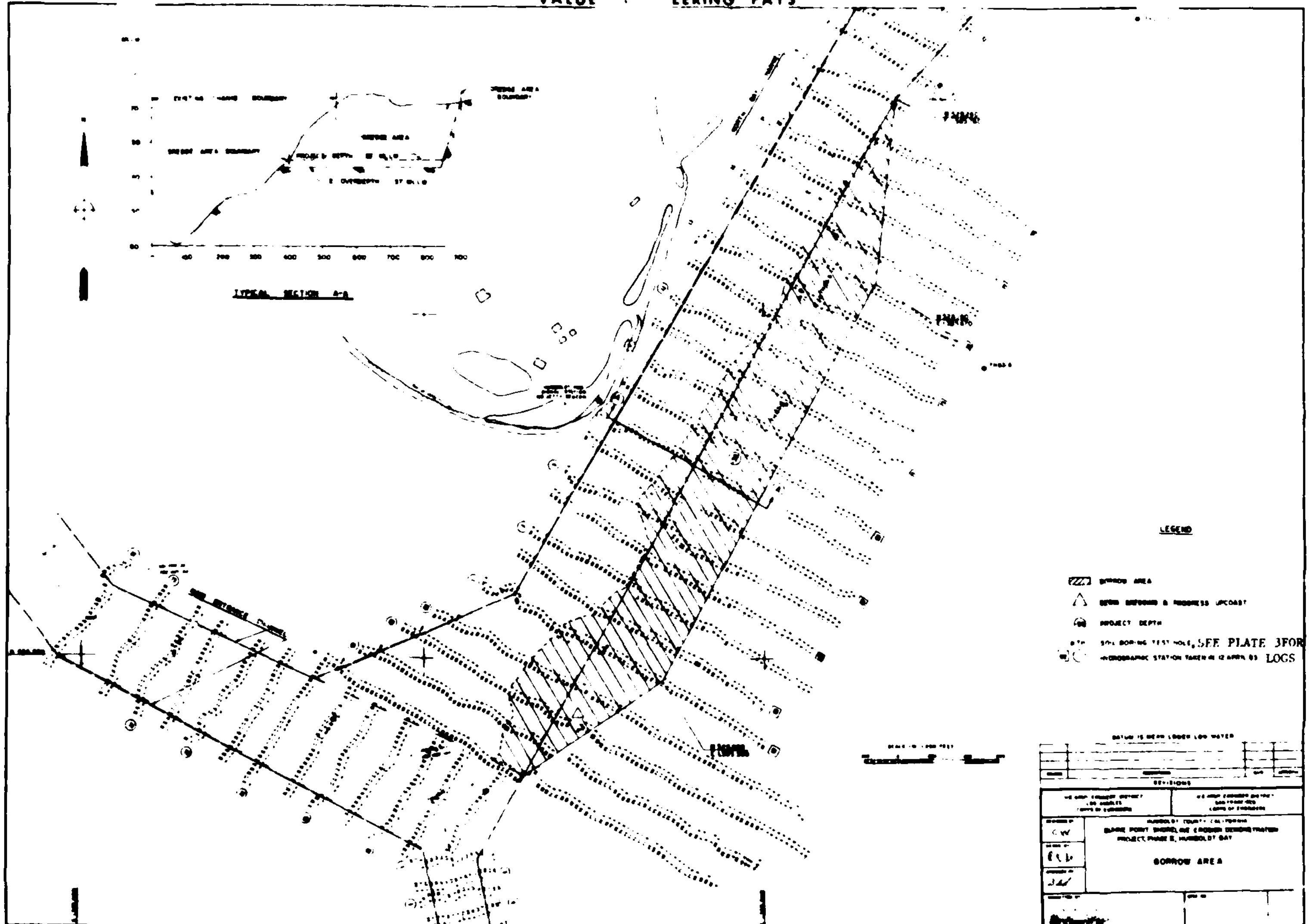
V N ERING PAYS



SAFETY PAYS

PLATE 1

VALUE ... EERING PAYS



SAFETY PAYS

PLATE 2

UNIFIED SOIL CLASSIFICATION SYSTEM

LEGEND

NOTES:

1. TEST HOLES WERE DRILLED BY A ROTARY WASH DRILL RIG (JUNE 1983).

2. SEE PLATE 2 FOR LOCATION OF TEST HOLES.

3. * PENETRATION RESISTANCE VALUES OBYAINED USED CALIFORNIA MODIFIED SAMPLER, A 376 POUND SUBMERGED HAMMER, AND A 18-INCH DROP.

REVISIONS

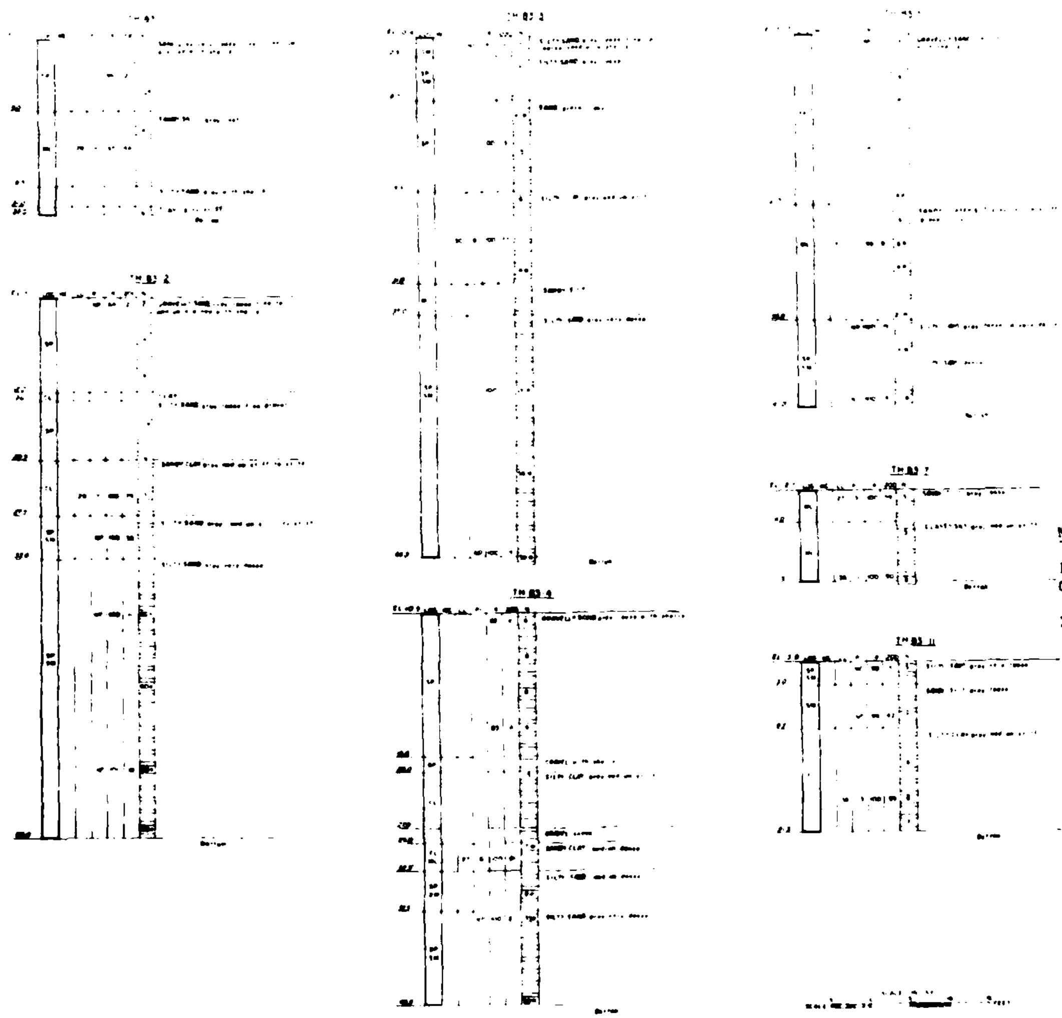
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

BUHNE POINT SHORELINE EROSION DEMONSTRATION
PROJECT PHASE II HUMBOLT BAY

BORROW AREA SOIL LOGS

PLATE 3

VALUE EI EERING PAYS



NOTES:

1. SEE PLATE 3 FOR LEGEND, NOTES, AND BASIS OF CLASSIFICATION.

2. SEE PLATE 1 FOR LOCATION OF TEST HOLES.

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HUMBOLDT COUNTY, CALIFORNIA

DUNE POINT SHORELINE EROSION DEMONSTRATION PROJECT PHASE II HUMBOLDT BAY

SANDFILL AREA SOIL LOGS

SAFETY PAYS

PLATE 4

DATE
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