DRAFT

U.S. ARMY ENGINEER DISTRICT, HONOLULU
MARCH 1978

DRAFT
DETAILED PROJECT REPORT
KAILUA BEACH PARK EROSION CONTROL
KAILUA, OAHU, HAWAII

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SECTION A

THE STUDY AND REPORT

PURPOSE AND AUTHORITY

1. The purposes of this study were to identify the cause and extent of shoreline erosion at Kailua Beach Park, Oahu, Hawaii, and to develop a practical, efficient, and environmentally acceptable plan to reduce or eliminate beach erosion in the project area.

2. This study and report were accomplished under the authority provided by Section 103a of the River and Harbor Act of 1962, as amended, which states as follows:

> "The Secretary of the Army is hereby authorized to undertake construction of small shore and beach restoration and protection projects not specifically authorized by Congress, which otherwise comply with section 1 of this Act, when he finds that such work is advisable, and he is further authorized to allot from any appropriations hereafter made for civil works, not to exceed $25,000,000 for any one fiscal year for the Federal share of the costs of construction of such projects: Provided, That not more than $1,000,000 shall be allotted for this purpose for any single project and the total amount allotted shall be sufficient to complete the Federal participation in the project under this section including periodic nourishment as provided for under section 1 (c) of this Act: Provided further, That the provisions of local cooperation specified in section 1 of this Act shall apply: And provided further, That the work shall be complete in itself and shall not commit the United States to any additional improvement to insure its successful operation, except for participation in periodic beach nourishment in accordance with section 1(c) of this Act, and as may result from the normal procedure applying to projects authorized after submission of survey reports."

3. The beach erosion study was initiated following requests from the Director of the Department of Parks and Recreation, City and County of Honolulu, and the Director of the Department of Transportation, State of Hawaii, in letters dated 11 May 1976 and 16 August 1976, respectively. A reconnaissance report, indicating that Federal participation in a beach erosion control project may be feasible and recommending detailed studies, was completed in December 1976. Authority to prepare a detailed project report was granted by the Chief of Engineers in his first indorsement, dated 1 February 1977, to the letter from the Division Engineer, subject: Kailua Beach, Island of Oahu, State of Hawaii, Shore Erosion - Reconnaissance Report. Funds to initiate the detailed studies were received in March 1977.

SCOPE OF THE STUDY

4. The study focused on the evaluation of beach processes in Kailua Bay, with primary emphasis placed on erosion at Kailua Beach Park. The problems and needs were identified and summarized in planning objectives to guide the study, and alternative plans were developed to meet the needs for beach erosion control. The costs, benefits, and environmental impacts associated with implementing the plans were determined, and the plans evaluated with respect to the planning objectives as well as their compatibility with the overall needs and resources of the study area.

5. The project area was primarily limited to the area of Kailua Beach Park; however, the study area included the entire Kailua Bay shoreline from Wailea Point to the southeast to Kapoho Point to the northwest in order to analyze the problem and impacts of the possible solutions. The Corps of Engineers authority for beach erosion control projects extends only to protecting and/or restoring shorelines fronting public facilities, highways, or recreational parks. Hence, any erosion control improvements are restricted to the portion of the Kailua Bay shoreline comprising Kailua Beach Park.

6. Studies conducted during the preparation of this report include detailed site investigations, topographic and bathymetric surveys, oceanographic field studies and detailed beach processes analyses to define the problem and design criteria, and engineering design, economic evaluations, and environmental assessment. Marine environmental and archaeological reconnaissance studies were accomplished to aid in the impact assessment and evaluation.

7. The study has been conducted in sufficient depth and detail to define the problem, develop planning objectives, and to develop and assess alternative plans.

STUDY PARTICIPANTS AND COORDINATION

8. The U.S. Army Corps of Engineers, Honolulu Engineer District, is responsible for conducting and coordinating the study and preparing the report. The studies and investigations were performed with the assistance of the State Department of Transportation, Water Transportation Facilities Division, and the City and County Department of Parks and Recreation.

9. Information and comments received from the following agencies during study coordination in 1978 were also considered in identification of study concerns and development of alternative plans:

U.S. Environmental Protection Agency, Honolulu Office
U.S. Soil Conservation Service
U.S. Forest Service
U.S. National Park Service
U.S. National Marine Fisheries Service
U.S. Fish and Wildlife Service
State Historic Preservation Office

State of Hawaii, Department of Land and Natural Resources, Division of Fish and Game

State of Hawaii, Department of Land and Natural Resources, Division of Forestry

10. A public workshop meeting was held on 29 November 1977, to aid in determining the problems and needs for beach erosion control and the desires of the local community. A public meeting to discuss the study results and alternative plans is scheduled for April 1978.

PRIOR STUDIES AND REPORTS

11. A reconnaissance report on beach erosion for the project area was completed by the Honolulu Engineer District in December 1976. In conjunction with the detailed studies, a beach processes study, marine environmental survey, and offshore sand survey were accomplished to aid in the problem analysis and development and assessment of alternative plans.

S E C T I O N B

RESOURCES AND ECONOMY OF STUDY AREA

SECTION B

RESOURCES AND ECONOMY OF THE STUDY AREA

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SECTION B

RESOURCES AND ECONOMY OF THE STUDY AREA

GENERAL DESCRIPTION

STATE OF HAWAII

1. The Hawaiian Islands are centrally located in the Pacific Ocean, extending northwest to southeast from about 155° to 179° W. longitude and 19° to 28°N latitude. Eight major islands constitute more than 99 percent of the total land area of the state, or about 6,446 square miles. Honolulu, the State capital, is located on the island of Oahu which is situated approximately 2,100 miles southwest of San Francisco. The State of Hawaii is noted for its unique blend of multi-ethnic cultures, its natural beauty, and its equable subtropical climate, as well as its strategic location in the Pacific.

STUDY AREA

2. Of the eight major islands, Oahu is the third largest in size, consisting of 608 square miles of land and inland waters and is the third largest in length of coastline, totaling 112 miles. The island of Oahu, governed by the City and County of Honolulu, is the center of business, government, and social activities for the State of Hawaii. Although the smallest county in area, Oahu accounts for 81 percent of the State's population. Oahu's climate is characterized by very little seasonal variation with an average annual temperature of 75°F. Rainfall varies from 22 inches annually in the coastal areas to 185 inches at the higher inland elevations.

3. Kailua is located on the northeast, windward shoreline of the island of Oahu (Figure B-1). The two mile, crescent-shaped Kailua Beach is bordered by Kapoho Point on the northwest end and Alala Point to the southeast. Lanikai Beach is situated to the south, between Alala Point and Wailea Point. These two beaches together make up much of the shoreline fronting Kailua Bay. The bay is approximately 5.6 miles long and about 2.3 miles wide, opening eastward towards the prevailing onshore trade winds.

4. Kailua Beach Park is located on the southern end of the bay between Kailua Road and Alala Point. A low limestone island is located approximately 1/4 mile offshore. Kaelepulu Stream enters Kailua Bay about midway in the park's length. The park is a very popular public recreation area and includes a pavilion, food concession, comfort stations, parking areas, picnic areas, and a boat launching ramp. The ramp is situated near the southern end of the park near Alala Point. The Kailua Beach erosion study site is located between the boat ramp and the mouth of Kaelepulu Stream.

5. The Kailua area is essentially a suburban community of metropolitan Honolulu as many residents commute daily to places of employment across the Koolau Mountains. The town of Kailua supports a small, centrally located business district and no large industries. Kailua has a population of approximately 47,000.

NATURAL FORCES

WINDS

6. Wind data from the Kaneohe Marine Corps Air Station are applicable to the project area. The wind speed and direction for the observation periods of 1945 to 1949 and 1952 to 1972 are shown in Table B-1. The winds are predominantly trades from the east-northeast. Trades are prevalent during the summer months with Kona (southerly) winds occurring more frequently during the winter months. Kona winds usually result in calm or slightly offshore conditions. Mean wind speeds and frequency of occurrence by direction are tabulated for the summer period of mid-June through August for the 17-year period (1946-1949, 1953-1965) and for 1977, Tables B-2 and B-3, respectively. During the summer of 1977, the mean wind speed tended to be lower and the wind direction more easterly than usual.

WAVES

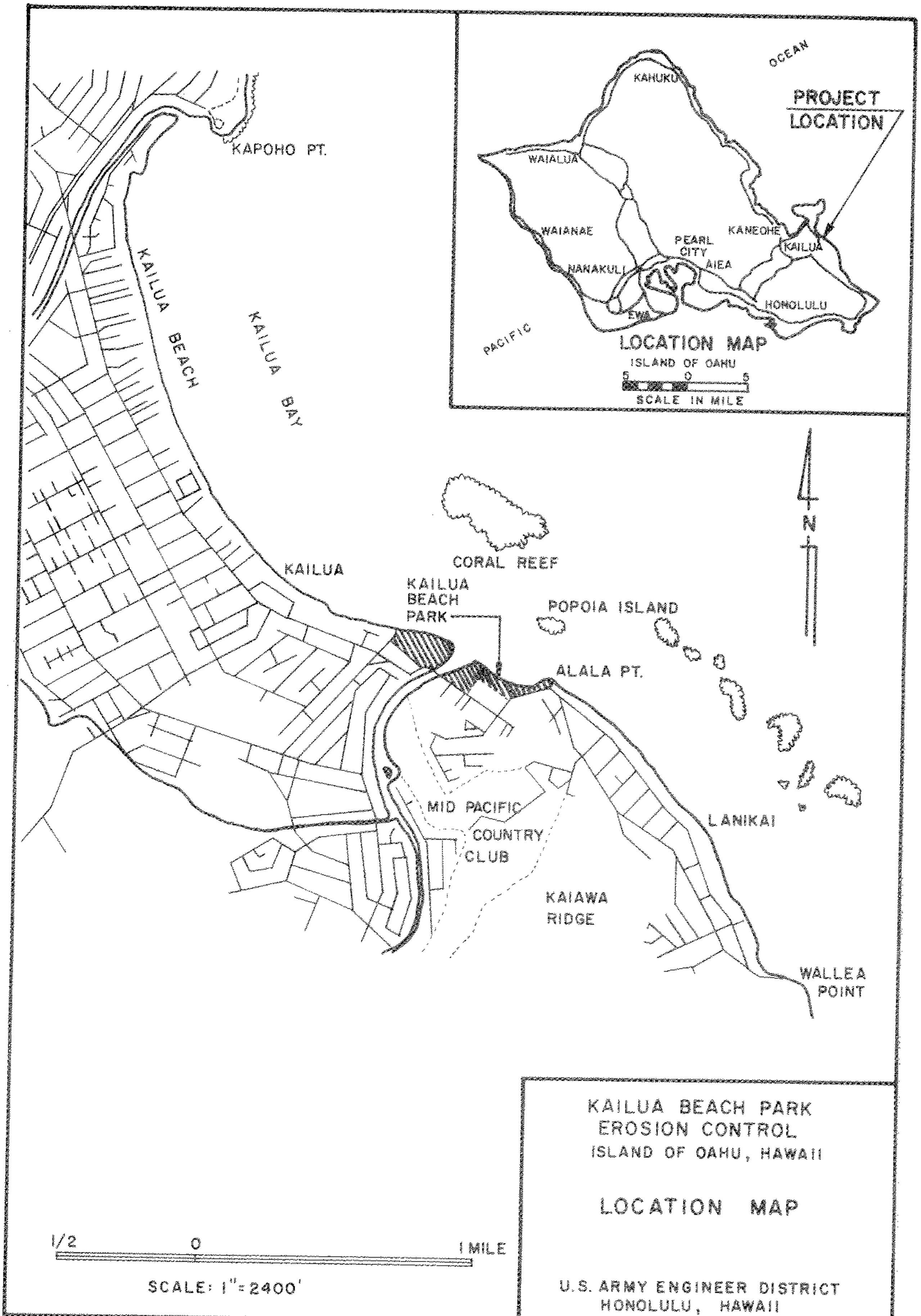
7. Waves arriving at Kailua Beach are generated in the northeastern sector of the Pacific Ocean, ranging from the Aleutian Islands in the north to South America. Two primary wave types affect the project site. These two types are (1) the east-northeast trade waves, and (2) the northern swell.

8. East-northeast trade waves may be present throughout most of the year, but are most frequent between May and September, the summer season, when they usually dominate the local wave spectrum. They result from the strong trade winds blowing out of the northeast quadrant over long fetches of open ocean. Typically these deepwater waves have periods ranging from 6 to 10 seconds and heights of 4 to 12 feet. Generally east-northeast trade waves are present from 80 to 90 percent of the time during the summer season, and from 60 to 70 percent of the time during the remainder of the year.

9. Northern swell is generated in the north Pacific Ocean by winter storms. Waves may typically have periods of 10 to 15 seconds, and heights of 5 to 15 feet. Some of the largest waves reaching the Hawaiian Islands are of this type. Northern swell usually occurs during the winter season of October through April.

10. Other wave types which may affect Kailua Beach less frequently than the primary types are (1) local storm and hurricane waves, and (2) southeasterly swell. Although storm and hurricane waves have a potential for rapid short-term beach erosion, they are very infrequent and have little long-term effect on Kailua Beach. Southeasterly swell likewise does not occur often enough to significantly affect the beach system.

11. The waves which reach Kailua Beach are very different from the offshore wave types previously discussed. The project site is somewhat protected from large waves by an offshore reef and Popoia Island. Incoming waves are transformed by processes of refraction, diffraction, shoaling, and breaking. Hence, only small waves passing over the reef and reformed broken waves affect the site. Wave heights measured on the reef adjacent to Popoia Island during June through August 1977 averaged 2.5 feet. Average wave heights at Kailua Beach Park shoreline were less than 1 foot with an average period of about 7 seconds during the same period.



KAPOHO PT.
KAILUA BEACH
KAILUA BAY
KAILUA
CORAL REEF
KAILUA
BEACH
PARK
POPOIA ISLAND
ALALA PT.
MID PACIFIC
COUNTRY
CLUB
LANIKAI
KAIAWA
RIDGE
WALLEA
POINT
N
OCEAN
KAHUKU
PROJECT
LOCATION
WAIALUA
WAIANAE
PEARL
CITY
KANEOHE
KAILUA
AIEA
NANAKULI
EWA
HONOLULU
PACIFIC
LOCATION MAP
ISLAND OF OAHU
5 0 5
SCALE IN MILE
1/2 0 1 MILE
SCALE: 1"=2400'
KAILUA BEACH PARK
EROSION CONTROL
ISLAND OF OAHU, HAWAII
LOCATION MAP
U.S. ARMY ENGINEER DISTRICT
HONOLULU, HAWAII

FIGURE B-1

TABLE B-1. PERCENTAGE FREQUENCY WIND VELOCITY AND DIRECTION FROM KMCAS OBSERVATIONS 1945-49 AND 1952-72

Speed (knots) / Direction	1-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	%	Mean Wind Speed
N	0.3	1.3	2.4	2.9	1.0	0.3	0.1		8.2	11.4
NNE	0.3	1.5	3.4	2.7	1.3	0.3			9.4	11.1
NE	0.3	1.5	3.2	3.5	1.3	0.3			10.0	11.3
ENE	0.5	1.6	4.9	8.3	2.3	0.4	0.1		18.1	12.3
E	0.8	1.4	3.4	4.8	1.6	0.2			12.3	11.5
ESE	0.3	1.3	1.8	2.0	0.7	0.3	0.0		6.4	11.0
SE	0.2	0.6	0.8	0.6	0.2				2.5	9.5
SSE	0.3	0.4	0.7	0.7	0.4	0.1			2.6	11.2
S	0.3	1.1	0.7	0.5	0.3	0.3	0.2	0.0	3.6	11.3
SSW	0.6	0.7	0.3	0.6	0.7	0.3	0.3	0.0	3.4	13.5
SW	0.3	0.8	0.6	0.2	0.2	0.3	0.3	0.0	2.7	12.6
WSW	0.2	1.0	0.3	0.3	0.2	0.0	0.0	0.0	1.9	8.1
W	0.6	1.7	1.0	0.2	0.1				3.5	6.6
WNW	0.2	0.6	0.8	0.2	0.2	0.1			2.2	9.0
NW	0.3	0.9	0.8	1.0	0.3				3.3	9.3
NNW	0.1	0.6	1.9	2.4	0.7	0.2	0.2		6.1	12.5
Calm									3.7	
	5.6	17.0	26.9	30.8	11.3	3.0	1.4	0.1	100.0	10.75

Table B-2. HISTORICAL WINDS AT KANEOHE MARINE CORPS AIR STATION: MID-JUNE THROUGH AUGUST FROM 17 YEARS OF RECORDS

Direction Sector	Mean Wind Speed (mph)	Percent Frequency of Occurrence
North	8.37	2.92
Northeast	11.31	42.20
East	11.74	50.00
Other	-	4.88
		100.00

Table B-3. WINDS AT KANEOHE MARINE CORPS AIR STATION: 13 JUNE 1977 TO 31 AUGUST 1977

Direction Sector	Mean Wind Speed (mph)	Percent Frequency of Occurrence
North	8.50	1.56
Northeast	9.40	31.23
East	10.38	65.63
Other	-	1.58
		100.00

12. Tsunami are seismic sea waves which are generated by catastrophic geological occurrences within an ocean basin. The Hawaiian Islands have experienced four major damaging tsunamis in the last 32 years. Three of these major tsunamis produced runup in Kailua Bay of about 5 feet.

CURRENTS

13. Currents in Kailua Bay may be of several types including (1) tidal currents, (2) wind-driven surface currents, and wave-induced, (3) mass-transport currents, (4) rip currents, and (5) longshore currents. Of the five types, only the wave-induced rip and longshore currents were found to be significant in the beach erosion-accretion processes, with the longshore current being the dominant factor. At Kailua Beach Park only the longshore current was found to move significant amounts of sand.

14. The longshore current results from waves breaking at an angle to the beach are confined to the zone between the beach and the breakers. Under trade

wind conditions, the longshore current sets in the northwesterly direction. Measured current speeds during a 3-month period at Kailua Beach Park near the boat ramp averaged about 7 feet per minute toward the northwest end of the beach, with a high of 33 feet per minute. When the winds shift to a more northerly direction and under north swell conditions, the longshore current tends to reverse and sets towards the southeast.

15. Longshore currents are capable of moving large quantities of sand, and the potential exists for dramatic accretion and erosion. Under trade wind conditions, the longshore current tends to move sand from the southeast end of the beach to the northwest end, resulting in erosion at the beach park area. However, when the current reverses, sand is transported towards the southeast end of the beach, resulting in accretion at the park.

TIDES

16. There is no tide gage at Kailua Bay. However, tidal data from the benchmark at Waimanalo, approximately 7 miles southeast of Kailua Bay are considered applicable. Tide measurements at Waimanalo by the US Coast and Geodetic Survey in 1938-39 are as follows:

	Feet
Highest tide (estimated)	3.00
Mean higher high water, MHHW	1.80
Mean high water, MHW	1.40
Half tide level	0.85
Mean low water, MLW	0.30
Mean lower low water, MLLW	0.00
Lowest tide (estimated)	-1.00

All elevations in this report refer to mean lower low water (MLLW) as zero elevation.

NATURAL RESOURCES

CLIMATE

17. The lowlands in the Kailua area can be characterized as windy, warm, and dry. The area is located on the coast exposed to the predominant northeasterly trade winds. The trade winds prevail 80-90 percent of the time during the summer, decreasing to about 60-70 percent of the time during the winter months with periods of Kona, adverse winds, and calms occurring more frequently. The mean air temperature is 75.2°F. The warmer months of the year are August through November, while cooler temperatures prevail between January and April.

Average annual precipitation for the period 1953 to 1958 was 45.4 inches in the lower elevations of Kailua. The wet months are November to March, with a drier period occurring between May and July.

GEOLOGY

18. The Kailua area is situated in the center of what was once the Koolau caldera and consequently the geologic structure of this region is highly complex. Furthermore, volcanic gases have modified the rocks making them more susceptible to erosive forces. In fact, the entire northeastern half of the Koolau shield volcano has been lost to either wave erosion at times of higher sea level or stream erosion. Stream erosion has apparently played a major role in shaping the fluted columns of the Pali cliffs. In general, the Kailua area lies on contiguous layers of Koolau basalt which are exposed and partially weathered on mountain ridges. In valley bottoms, the basalt basement is overlain by unconsolidated non-calcareous deposits which in the uplands consist of coarse and permeable detritus but in the lowlands comprise black, sticky, and highly impermeable mud.

19. Near the Kailua Bay shoreline, large calcareous deposits of marine origin obstruct the mouths of two large valleys, thus forming the Kawainui and Kaelepulu lagoonal marshes. The barrier beach is two miles wide, but only slightly over a mile wide where it meets the marsh. The beach is not lithified even though organic acids in swamp water undoubtedly percolate through the sand obstruction towards the ocean. The town of Kailua is built upon this deposit near the shore. The beach has an average elevation of about 13 feet. The sand continues another 200 to 300 feet into the marsh area as a firm bottom 2 to 5 feet below the water's surface.

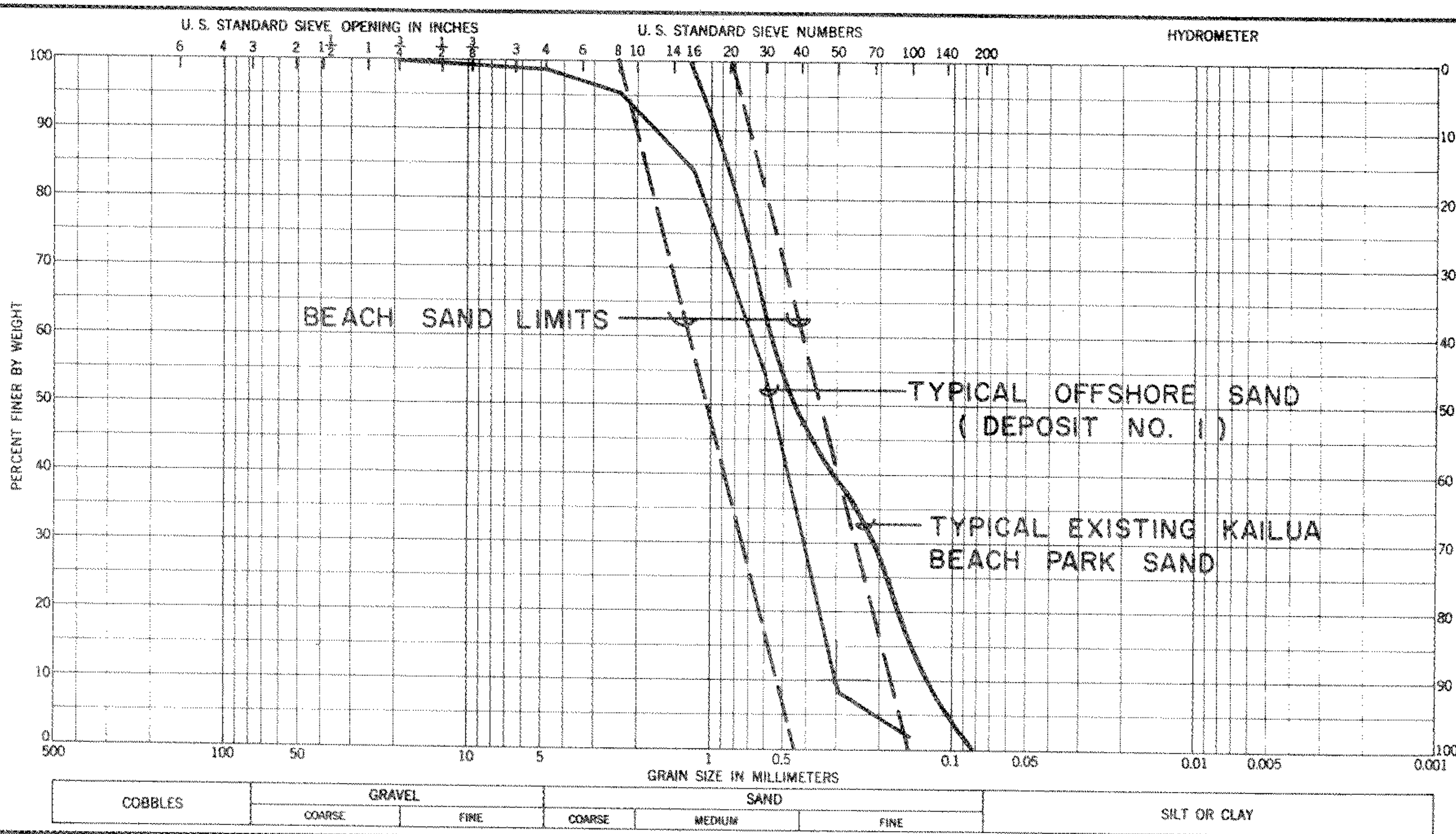
20. In the north and central portions of Kailua Bay the sand covered reef flat is deeper and slopes gently seaward to water depths of 40 to 60 feet before dropping more sharply to greater depths. At the southern end of the bay near the proposed project site, the reef flat is shallow extending nearly 1,000 feet seaward. At about 1,000 feet offshore, there is a protective barrier reef which rises to about mean lower low water and is breached in several places by deeper channels and covered at one point by Popoia Island.

LITTORAL MATERIALS

21. The beach sand at Kailua is primarily calcareous, with relatively low basalt content. The sand is medium to fine grained with a median diameter of 0.38 mm. Figure B-2 shows the gradation curves for sand samples subjected to mechanical sieve analysis.

22. Kailua Beach is nourished naturally by two sources of material: (1) calcareous sand generated on the broad offshore fringing reef and carried ashore by wave action, and (2) terrigenous material deposited by storm-water runoff.

23. A sand tracing study was conducted over a 15-day period in September 1977 to provide quantitative information on the movement of sand at Kailua Beach. A sand transport velocity of 96 ft/day was calculated for the site area, and a transport volume of 29 cubic yards/day. The sand particles were traced



KAILUA BEACH PARK
OAHU, HAWAII

SAND GRADATION

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE B-2

FIGURE B-2

moving in a northwesterly direction along the beach. The longshore currents and wind and wave conditions were typical of the summer season.

TERRESTRIAL WILDLIFE

24. Terrestrial flora and fauna at Kailua Beach Park consists of either intentionally cultivated (e.g. ironwood trees, coconut trees, banyan trees, and grasses) or unintentionally cultivated (e.g. kiawe trees) and introduced exotic species. No threatened or endangered species of wildlife are known to inhabit the beach park area although Popoia Island ("Flat" Island) has been designated a State Bird Refuge. Nesting seabirds on the island are protected by State and Federal laws, however, the island receives extensive human visitation due to its close proximity to the beach park and boat launching ramp. The Hawaiian duck (Anas Wyvilliana), an endangered species, is now found rarely in the Kalepulu Canal. It formerly nested on Popoia Island.

MARINE ENVIRONMENTAL SETTING

25. Marine Life. Present information indicates that Kailua Bay is sparsely populated by marine organisms. Lack of suitable habitats and possible over-exploitation of marine resources are major contributing factors in the paucity of marine organisms. The dominant fish observed during surveys were surgeon fish and butterfly fish, with fish having subsistence and commercial value being less frequently sighted. Waters of the inner bay (less than 20 feet deep) seem particularly lacking of flora and fauna. Most of this area, from Kawainui Canal to the north to Wailea Point to the south, is sand bottom. The constant movement of sand particles by wave action effectively prevents the settling and growth of benthic organisms and the area is devoid of any algal or coral cover. The project area is not located in or adjacent to any designated marine sanctuary and there are no significant or unique marine resources that inhabit the project area.

26. Water Quality. The State of Hawaii has classified the waters of Kailua Bay to be protected for recreation, aesthetic enjoyment, and the support and propagation of aquatic (marine) life. While high levels of bacteria are found in Kaelepulu Stream, concentrations in adjacent ocean waters are low since the stream is generally separated from the ocean by a sand bar, except for a short period of time following periodic cleaning or natural breaching. Also, rapid bacterial "die-off" as a result of contact with seawater and sunlight is partially responsible for maintaining the safe levels observed. Nutrients in the bay waters are higher than existing Department of Health standards. However, this is not unusual for waters in Kailua Bay, or for that matter, the marine waters of the State as a whole. Treated sewage effluent previously discharged in Kailua Bay has now been diverted to the new outfall offshore from Mokapu Point beginning December 1977. It is expected that the diversion of treated sewage discharge to Mokapu Peninsula will improve inshore water quality in Kailua Bay.

27. Offshore Sand Resource. An offshore reconnaissance survey was conducted of two potential sand source areas in Kailua Bay. Figure B-3 shows the approximate location of the sand source areas. The sand channel (Deposit #1) was found to contain sand in excess of 30 feet thick in most places, and is estimated to contain in excess of 4 million cubic yards of sand in water depths

less than 100 feet. Deposit #2 lies in water depths of about 15 feet and contains approximately 270,000 cubic yards of sand. The sand is within typical beach sand size limits (see figure B-2), yellow in color, and composed of about 90-95 percent calcareous material (fragmented coral, shells, limestone, algae, and sandstone) and 5-10 percent basalt.

HUMAN RESOURCES

POPULATION CHARACTERISTICS

28. Between 1960 and 1970, the population growth in the Kaneohe-Kailua district [illegible] substantial, representing about 24 percent of the total increase in population on Oahu. The town of Kailua has experienced much of this growth, increasing from 34,809 to 47,003, between 1960 and 1970 Census periods.

29. The population of Kailua, including the Kaneohe Marine Corps Air Station (KMCAS), is predominantly Caucasian (67.9%), with persons of Japanese ancestry comprising only 12.3 percent of the total. Each of the remaining ethnic groups makes up less than 10 percent of the population. The median age is 22.7 years and the median family income, $13,916 per annum. This compares to a population composition for the entire State of 38.8 percent Caucasian, 28.3 percent Japanese, and 12.2 percent Filipino, with the remaining ethnic groups again comprising less than 10 percent of the total. Also, the median age for the State of Hawaii is 25.0 years and the median family income is $11,554 per annum. In general, the population of Kailua is younger and families earn slightly higher incomes than the rest of the State. While the population growth rate of Kailua has stabilized (i.e. growing at a constant rate), the surrouning areas showing higher growth (Kaneohe and especially Kahaluu) are noticeably lacking in similar beach recreation opportunities as provided by Kailua Beach Park. The Kailua Beach Park facility provides an excellent family recreation area at one of the finest white sand beaches on the windward side of Oahu. Thus, increased use of the park is expected not only from present and future residents of Kailua, but from neighboring communites as well. The tributary area is shown on figure B-4.

CULTURAL/HISTORICAL RESOURCES

30. An archeological reconnaissance of the project area was conducted on 1 June 1977. The stretch of beach between the mouth of Kaelepulu Stream and Alala Point was examined. No archeological layers were found, and the only cultural remains found were of quite recent date. The project site is not located within or adjacent to any historical/archeological sites listed in, or eligible for inclusion in, the National Register of Historic Places.

RECREATION RESOURCES

31. Kailua Beach Park is fully developed providing park users with the following facilities: sheltered pavilion, picnic tables, potable water, restrooms, showers, cooking facilities, parking, a food concession, a playfield, telephone, and lifeguard towers. The park users engage in the following recreational activities: picnicking, windsurfing, diving, swimming, surfing, boating, jogging,

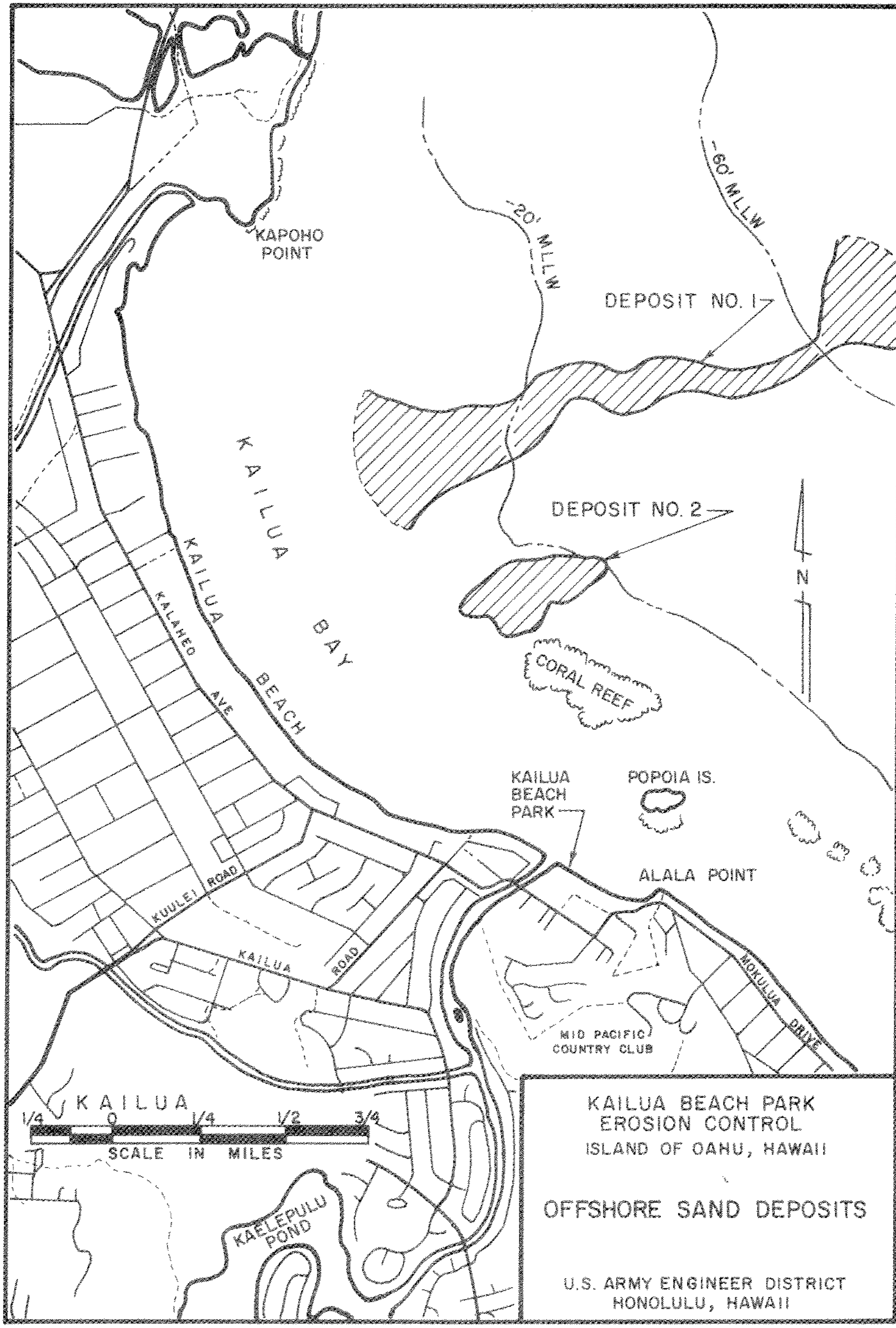

KAPOHO POINT
-20' MLLW
-60' MLLW
DEPOSIT NO. 1
DEPOSIT NO. 2
KAILUA BAY
N
CORAL REEF
KAILUA BEACH
KALAHEO AVE
KAILUA BEACH PARK
POPOIA IS.
ALALA POINT
KUULEI ROAD
KAILUA ROAD
MOKULUA DRIVE
MID PACIFIC COUNTRY CLUB
KAILUA
1/4 0 1/4 1/2 3/4
SCALE IN MILES
KAELEPULU POND
KAILUA BEACH PARK EROSION CONTROL
ISLAND OF OAHU, HAWAII
OFFSHORE SAND DEPOSITS
U.S. ARMY ENGINEER DISTRICT
HONOLULU, HAWAII

FIGURE B-3

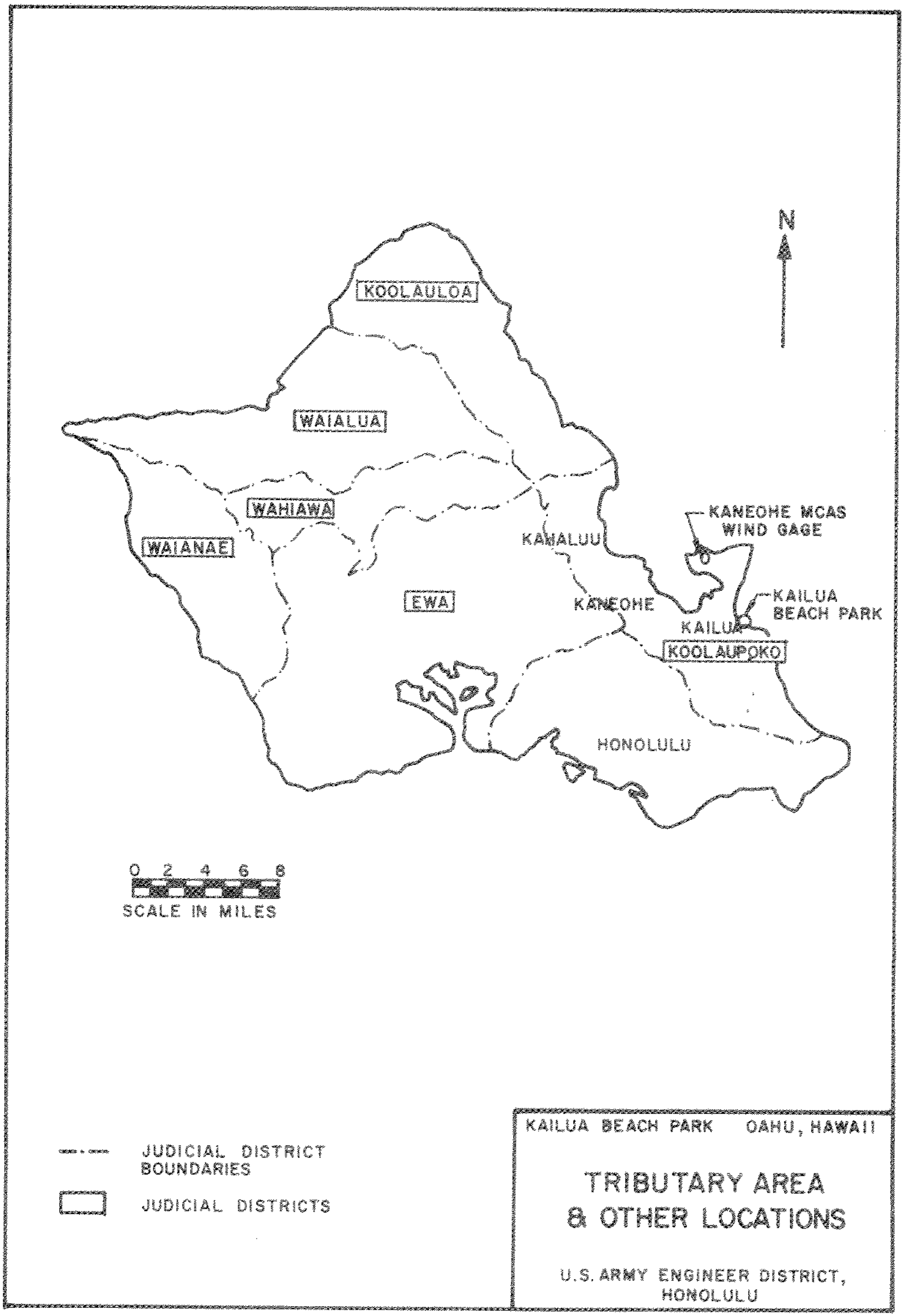

N
KOOLAULOA
WAIALUA
WAHIAWA
WAIANAE
EWA
KAHALUU
KANEOHE
KANEOHE MCAS WIND GAGE
KAILUA BEACH PARK
KAILUA
KOOLAUPOKO
HONOLULU
0 2 4 6 8
SCALE IN MILES
JUDICIAL DISTRICT BOUNDARIES
JUDICIAL DISTRICTS
KAILUA BEACH PARK OAHU, HAWAII
TRIBUTARY AREA & OTHER LOCATIONS
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE B-4

fishing, and sunbathing. Four buoys are located approximately 150 feet offshore from the park shoreline to delineate the safe swimming area. The sand beach at Kailua Beach Park is also used for launching and beaching Hawaiian outrigger canoes, Hobie cats, surfboards, and windsurfers.

32. Kailua Beach Park is the only public beach park along the shoreline of Kailua Bay and is also the most heavily used park facility in the Kailua area. The park has developed in stages from 1920 to the present in response to the growth of the Kailua area. The park consists of 29.9 acres of park lands and up to 4.3 acres of sandy beach areas. One and one-half acres of the park's recreational use is periodically lost to the public due to extensive erosion of sand from the beach with associated loss of trees and grass.

DEVELOPMENT AND ECONOMY

ECONOMIC DEVELOPMENT

33. Hawaii is a prosperous state with a growing population and economy. Between 1950 and 1975, the total resident population increased over 73 percent from 499,000 to 865,000. During the same period, the gross State product more than quadrupled, from $900 million to $6.49 billion. The three largest contributors to the state economy are tourism, defense expenditures, and agriculture, the bulk of the last activity being in the production of sugar and pineapple. The most rapid growth during the last several years has been in the tourist industry. It is expected that the trend in growth of the tourist industry will continue, together with the growth of the state economy in general.

URBANIZATION AND GROWTH

34. Rapid growth is most apparent on the island of Oahu which houses more than 80 percent of the state's population. While most residents of Oahu reside in and around Honolulu, the decreasing land areas available for residential development in Honolulu have led to growth in outlying areas. Rapid urbanization of Koolaupoko Judicial District, which includes Kaneohe, Kailua, and Waimanalo, during the past two decades has transformed most of the area from a rural agricultural and residential community to a suburb of the city of Honolulu.

35. The pace of suburbanization has accelerated in the past 5 years. Resident population increases have resulted in changes in income levels, occupational types, educational levels, living requirements, and lifestyles. The population trend in Kailua is towards younger, higher income families with more leisure time. This puts a great demand on Kailua Beach Park, being the only public park facility on the Kailua Bay shoreline. The overall quality of the beach is excellent, and surveys indicate that the park maintains a good level of satisfaction among users.

S E C T I O N   C

PROBLEMS, NEEDS, AND OBJECTIVES

SECTION C

PROBLEMS, NEEDS, AND OBJECTIVES

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SECTION C

PROBLEMS, NEEDS, AND OBJECTIVES

SHORELINE HISTORY

1. The shoreline at Kailua Beach Park has been traced quantitatively for a 29-year period from 1949 to the present by the use of aerial photographs and topographic and bathymetric surveys. Qualitative information on the beach movement prior to 1949 was obtained by discussions with long-time Kailua Beach residents.

2. The location of the Kailua Beach Park shoreline for the period 1949 to 1977 is shown in Figure C-1. During this period, the beach was in its most eroded state in the years 1949 and 1977, and its most accreted state in about 1970. The extent of shoreline movement during these extreme conditions was about 160 to 180 feet. Severe erosion occurred in 1963-64 which undermined and damaged the launch ramp at the southeast end of the park. However, by 1966, the beach park was in an accreted condition and the launch ramp was practically covered by sand. The beach continued to accrete until about 1970, after which time the trend reversed. Since 1975, erosion has not only caused extensive loss of dry sandy beach area, but has also caused portions of vegetated park area to be lost, including grassy picnic areas, ironwood trees used for wind breaks, and a lifeguard stand. By late 1977, the erosion had undermined and collapsed the boat ramp and came within about 20 feet of the paved parking lot.

3. Seasonal shoreline movement at Kailua Beach Park is typically ± 10 to 20 feet per season, although occasional extreme seasons can produce much greater shoreline movement. This extreme nature of sand movement at Kailua is well illustrated by the period from October 1976 to February 1978. Between October 1976 and December 1977, approximately 10,000 cubic yards of sand was lost from the beach park and the shoreline receded about 20 feet. Between December 1977 and March 1978, during a period of northerly and westerly winds coupled with a large north swell, approximately 21,000 cubic yards of sand moved into the park area and increased the beach width near the boat ramp by about 90 feet. The majority of the sand was observed to have actually returned during one 2-week period. The cumulative shoreline movement, however, can vary much more than the typical seasonal movement as figure C-1 illustrates. Discussions with long-time local residents substantiate the long-term cyclic trend of shoreline movement at Kailua Beach Park.

4. To protect the parking lot at the southeast end of the park in the event that erosion should progress inland, the City and County of Honolulu Department of Parks and Recreation installed a "sand grabber" (a patented shore protection device consisting of hollow concrete building blocks tied together with galvanized steel rods) in February 1978. The "sand grabber" is presently buried, and its purpose is to provide temporary protection for the parking lot until a permanent solution to the recurring erosion problem can be implemented.

BEACH PROCESSES

5. <u>General</u>. Kailua Beach is a very dynamic beach system subject to rapid changes in shoreline position resulting from seasonal and long term meteorological conditions. Analysis of the beach processes involved determining the

source of the driving force for sand movement, transforming this force to Kailua Beach Park, and determining the boundaries of the beach system and the longshore transport of sand.

6. Waves are the principal cause of shoreline changes at Kailua Beach. Statistical distributions of wave characteristics along the windward shore of Oahu provide a basis for describing the wave climate at the shore in Kailua Bay. Important wave characteristics affecting sand transport near the beach are height, period, and direction of breaking waves. Breaker height is significant in determining the quantity of sand in motion, and the angle of the breaking wave on the beach is a major factor in determining longshore transport direction and rate.

7. Deep-Water Waves. An examination of open ocean wave statistics compiled by the US Naval Weather Service Command for windward Hawaii and published in the Summary of Synoptic Meteorological Observations (SSMO) shows the occurrence of two distinct seasons, the summer season of May through September and the winter season of October through April. For each of these seasons, the frequency of occurrence of monthly waves from a given height and direction class were averaged to yield the statistics shown in Table C-1. These statistics represent average conditions based on 8 years of synoptic ship observations. It is apparent from Table C-1 that the predominant deepwater waves are from the northeast and east generated by the prevailing trade winds. During the summer and winter seasons, the trade wind waves occur about 85 percent and 65 percent of the time, respectively. While the statistics in Table C-1 represent average seasons, in any particular season variations can occur due to the natural randomness of meteorological conditions which results in changes in wave activity which ultimately influences the littoral transport at Kailua Beach.

8. Nearshore Wave Transformation. The deepwater waves approaching Kailua Bay are transformed by wave refraction and shoaling, wave diffraction, and bottom friction energy dissipation until they finally break on the beach. For the Kailua Beach Park area, the analysis of wave transformation is complicated by numerous shallow reef areas and the sheltering affect of Popoia (Flat) Island. In order to determine breaking wave heights and angles on the beach, a computer program is used to simultaneously integrate the wave transformation parameters.

9. An analysis of deepwater wave transformation shows that deepwater wave heights of about 5 feet or greater all yield about the same wave height immediately offshore of Kailua Beach Park of about 3 feet if no offshore coral reef is encountered by the incoming wave and less than 1 foot if the incoming wave crosses one of the shallow reef flats. Figure C-2 shows the shallow water versus deepwater wave angles for Kailua Beach Park.

10. Littoral Transport. Littoral transport is defined to be sand movement parallel to the shoreline or onshore-offshore. The wave-induced longshore currents which move sand at Kailua Beach are most sensitive to changes in breaker angle. Because Kailua Beach is aligned approximately perpendicular to the prevailing northeasterly trade winds, small shifts in the wind north or east can cause 180° shifts in the direction of longshore sand transport.

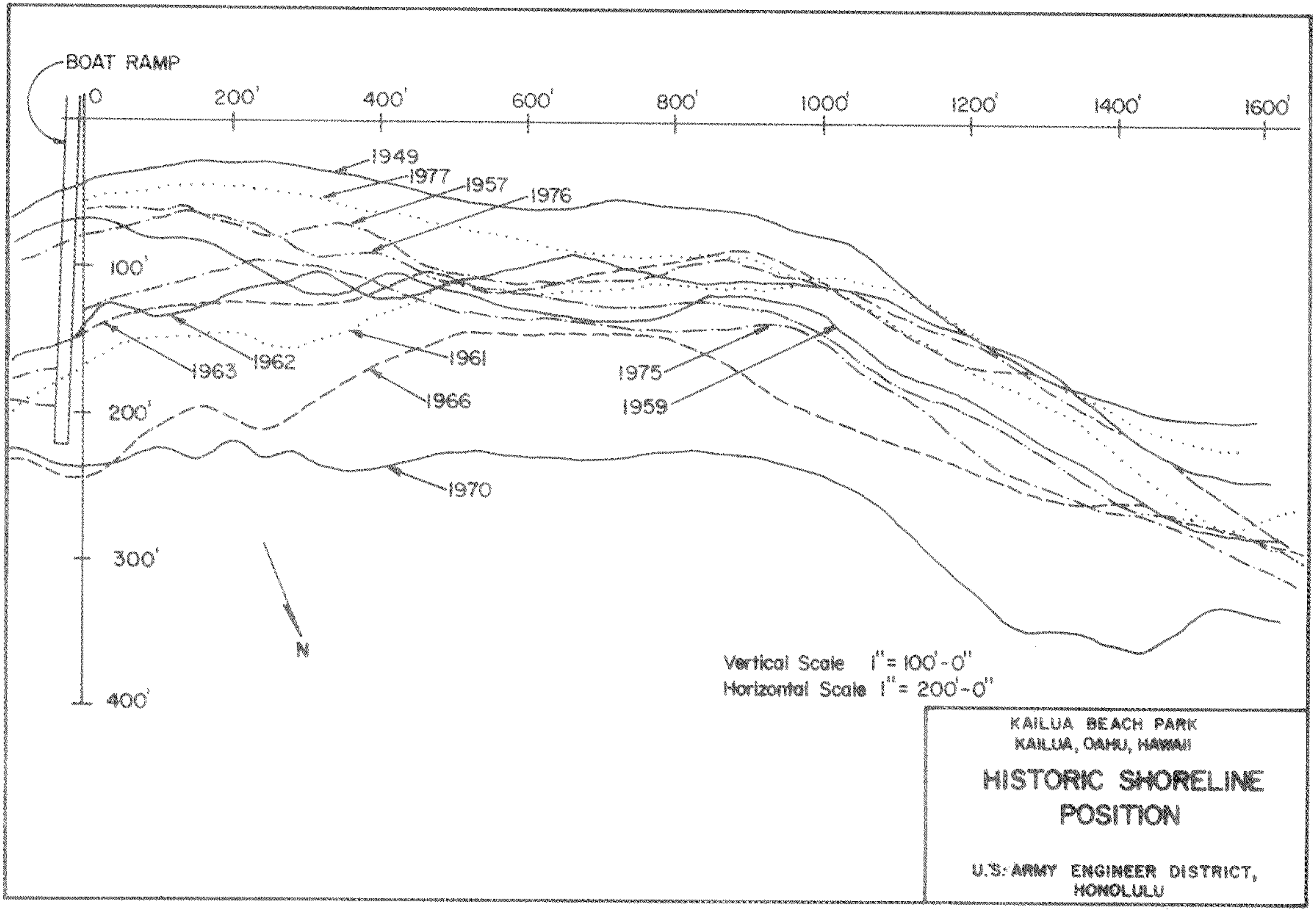

FIGURE C-1

FIGURE C-1

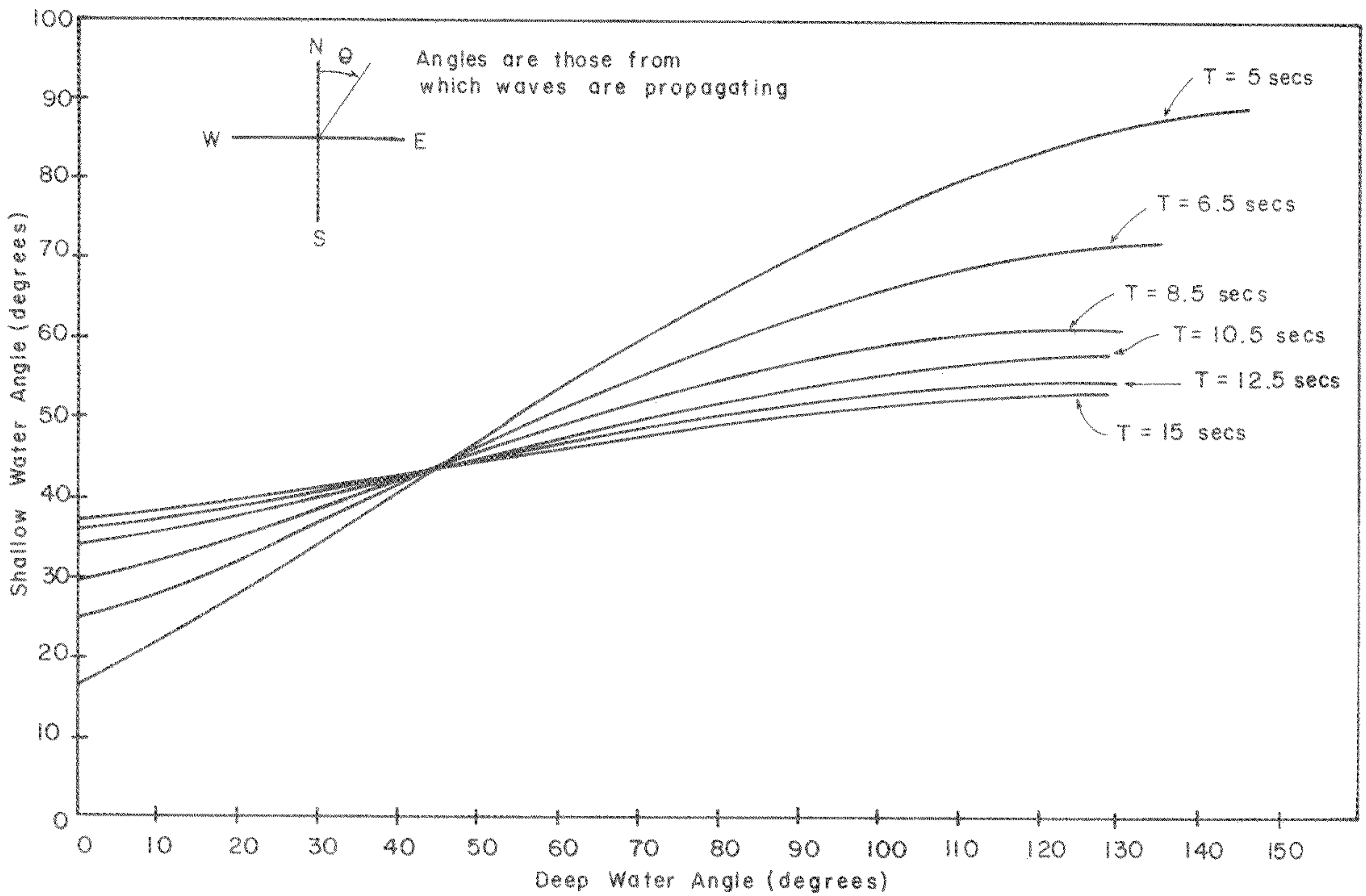

Figure C-2. SHALLOW WATER VERSUS DEEP WATER WAVE ANGLES FOR KAILUA BEACH PARK

Table C-1. SUMMARY TABLE OF PERCENT FREQUENCY OF OCCURRENCE OF WAVE HEIGHT VERSUS DIRECTION BASED ON SSMO DATA

Summer Season - May Through September

Height (ft)	N	NE	E	SE	S	SW	W	NW	TOTAL
=1	0.38	0.60	1.60	0.30	0.0	0.0	0.0	0.0	2.88
1-2	1.37	3.60	11.40	1.55	0.63	0.36	0.20	0.30	19.41
3-4	2.70	7.10	27.40	2.60	0.77	0.22	0.14	0.20	41.13
5-6	1.25	4.80	15.26	1.29	0.08	0.04	0.02	0.0	22.74
7	0.40	1.44	6.43	0.49	0.04	0.0	0.02	0.0	8.82
8-9	0.10	0.50	2.49	0.08	0.0	0.0	0.0	0.08	3.25
10-11	0.04	0.12	0.62	0.08	0.0	0.0	0.0	0.0	0.86
12	0.04	0.10	0.22	0.0	0.0	0.0	0.0	0.0	0.36
13-16	0.02	0.04	0.04	0.04	0.0	0.0	0.0	0.0	0.14
= 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	6.30	18.30	65.46	6.43	1.52	0.62	0.36	0.58	100.00

Winter Season - October Through April

Height (ft)	N	NE	E	SE	S	SW	W	NW	TOTAL
=1	0.84	1.13	1.20	0.36	0.60	0.29	0.43	0.15	5.00
1-2	2.26	5.00	8.70	2.23	1.65	0.70	1.16	0.68	22.68
3-4	2.60	8.22	12.93	3.00	1.78	0.56	1.00	0.70	30.79
5-6	1.67	4.71	11.18	1.64	1.11	0.38	0.24	0.36	21.29
7	0.99	2.74	5.73	0.47	0.15	0.16	0.20	0.16	10.60
8-9	0.17	1.53	3.28	0.12	0.21	0.12	0.04	0.19	5.66
10-11	0.15	0.39	1.18	0.24	0.07	0.07	0.06	0.04	2.20
12	0.09	0.03	0.50	0.07	0.04	0.0	0.01	0.0	0.74
13-16	0.05	0.05	0.23	0.0	0.0	0.0	0.05	0.0	0.38
= 16	0.08	0.14	0.12	0.0	0.0	0.0	0.01	0.0	0.35
TOTAL	8.90	23.94	45.05	8.13	5.61	2.28	3.50	2.28	100.00

During periods of northerly trade winds, the sand moves toward Kailua Beach Park, and during periods of easterly trade winds, the sand moves away from the park toward Kapoho Point.

11. For the Kailua Beach Park area, the shoreline movement is aggravated by the small volume storage capacity of the beach profile. The sand is only about 12 feet thick in the zone of active littoral movement, and a relatively small change in littoral transport causes relatively large changes in the shoreline movement. Thus, seasonal variations of the shoreline movement at Kailua Beach Park tend to be visually pronounced.

12. The influence of the boat launching ramp at Kailua Beach has only a local affect on the shoreline adjacent to the ramp itself. The long term cumulative erosion/accretion pattern would occur regardless of the ramp structure as seen in the 1966 and 1970 beachlines in Figure C-1, when sand completely covered the ramp structure, and the 1949 and 1957 beachlines which exhibit the erosive extent of the beach prior to the construction of the ramp in 1962.

13. The fillet beach on the southeast (Lanikai) side of the boat launching ramp is essentially stabilized by the launching ramp structure which acts as a groin for this small beach. This beach area is isolated from erosive wave action and will remain as long as the launching ramp remains.

14. The erosion-accretion processes at Kailua Beach Park are one part of the total dynamic phenomena making up the littoral cell known as Kailua Beach, which extends from Alala Point on the south to Kapoho Point on the north. This complete littoral cell responds to seasonal variations in wave direction and energy levels in a very complicated manner. If this complete littoral cell or beach can be visualized as being subdivided into a series of adjoining erosion/accretion cells (EAC), then the most visually evident shoreline changes would occur at the end cells. The shoreline in a cell adjacent to and downstream of an end EAC undergoing erosion, would remain relatively stable until the upstream EAC erodes to a shoreline position which causes significant alignment changes to the general shoreline shape or erodes to the point where no more erodible sediment material exists. At this stage, the adjacent downstream cell would exhibit significant shoreline erosion. For the Kailua Beach littoral cell, the southernmost EAC, defined by the boat launching ramp to a point 1,000 feet northward of the ramp is the end EAC. From the historic shoreline data this end erosion/accretion cell contains sufficient sand storage to weather the appetite of the seasonal erosive littoral stream. This cell then protects all other downstream cells and in a sense acts as a sacrificial sand supply for the Kaneohe-bound littoral stream. This concept plays an important role in the development and analysis of erosion control measures. A littoral stream will always attempt to transport its saturated load of littoral material; hence, if artificial shore protection structures, whether inhibiting the actual sediment movement or reducing the breaking wave energy on the beach, are built at one cell, then the adjacent downstream cell which is not likewise protected would now become the end cell and will similarly erode. Thus, the erosion problem has now shifted from one cell to another and once artificial shore protection has been started may require subsequent protection to all EAC's in the littoral cell. Thus, special care must be exercised in the implementation of artificial shore protection measures.

15. A computer simulation was used to combine the deep- to shallow-water wave transformation with the probabilistic variation of the seasonal deepwater wave statistics in order to calculate the seasonal volumetric littoral transport. The simulation model analyzed the shoreline movement (erosion/accretion) to evaluate the results of each seasonal littoral transport.

16. Thirty years of summer and winter activity and their attendant influence on the shoreline at Kailua Beach Park were simulated by the computer program. Figure C-3 describes the simulated shoreline movement during this period of time. During any arbitrary year, the bar graph in figure C-3 describes the absolute movement of the shoreline while the dotted line shows the cumulative or "actual" position of the shoreline relative to the start position. The historic data shows that for the 28-year period of available data, the shoreline has naturally moved about 160 to 180 feet. The simulation model also predicts excursions of the shoreline from minimum to maximum extent of about 160 feet. In view of this correlation, the analysis supports the conclusion that the shoreline movement is a random process dictated by the seasonal weather conditions.

17. Notice from figure C-3 that while each individual seasonal shoreline movement (erosion/accretion) is typically ±10 to 20 feet/season and although isolated extreme seasons can produce much more shoreline movement, the cumulative shoreline movement, which is what the populace notices, can vary much more than the typical seasonal movement. For the simulation period described in figure C-3, the long-term cumulative shoreline fluctuation was about ±80 feet of actual movement. Notice also that this cumulative shoreline movement takes place over a much longer time-span than the seasonal variations. For the 30-year simulation period, this fluctuation of the shoreline from minimum to maximum onshore-offshore movement was approximately 15 years. From the historical data shown in figure C-1, the last cycle was about 25 years from minimum to maximum onshore-offshore extent.

18. Typical rates of littoral transport were calculated by the computer model. For the summer season, the average rate of littoral transport is toward the northwest which produces erosion at Kailua Beach Park. The computer model simulation indicates that the average summer season erosion is about 4,300 cubic yards with a maximum summer season erosion of 10,000 cubic yards. Simulated data for the winter season shows that both accretion and erosion occur during the winter months. The average accretion is about 8,600 cubic yards and the average erosion is about 4,300 cubic yards during the winter. The maximum simulated accretion during the winter season was about 20,000 cubic yards. While there is a definite difference in both the average and maximum rates of accretion and erosion during the summer and winter seasons, nevertheless the mean long-term drift rate is about zero. Thus it can be inferred and visually verified by figure C-3 that the erosive tendency dominates over time, but the magnitude of the northwest-bound littoral drift is generally smaller than the southeast-bound accreting littoral transport.

19. It is important not to interpret more relevance into the time-dependent motion of the simulated shoreline than actually exists. The results shown in figure C-3 were obtained by utilizing a random model for the seasonal wave activity based on the available data. The fluctuation of this random model

is essentially arbitrary, within defined statistical bounds of a normal or Gaussian probability distribution. Thus the shoreline movement in any particular season or year cannot and should not be directly associated to a specific historic year. Nevertheless, this simulation model is quantitatively indicative of the dynamic processes involved in shaping the beach at Kailua Beach Park, rather than a purely deterministic assessment of where the beachline was or will be located in any past or future year.

MOST PROBABLE FUTURE

20. The Kailua Beach Park shoreline will continue to respond to random fluctuations in seasonal wave conditions. Analysis of historical shoreline positions and computer simulation of the beach processes indicates that the most probable extreme excursions of the shoreline will be in the order of 160 to 200 feet, that is, from an extreme eroded condition near the paved parking lot to an extreme accreted condition when the sand completely covers the launch ramp structure. Because the long-term cumulative shoreline position is dependent on random weather patterns however, it is entirely possible that the erosion could exceed the historical and theoretical limit.

21. The weighted average dry beach area between eroded and accreted conditions of the 1,000-foot reach requiring erosion control will be about 75,000 square feet. However, the fluctuating shoreline will result in periods of greatly reduced recreational beach area. In addition, trees and other vegetation planted during accretion cycles will be lost when the cyclic trend reverses and the shoreline erodes.

DESIRED IMPROVEMENTS

22. Because of the recent severe erosion at Kailua Beach Park and the loss of trees and damage to the boat ramp, the City and County Department of Parks and Recreation and the State Department of Transportation have stated concern for the preservation of the beach and recreational resources. Desired improvements include restoration of the sand beach for recreation use and a permanent solution to the recurring erosion problem.

23. At a public workshop held on 29 November 1977, local residents expressed concern about the loss of beach, trees, and the threat to the parking lot. In addition, they stated the need to carefully evaluate the impact of improvements on existing water recreation activities in Kailua Bay. Kailua Beach Park and the bay are heavily used by small beach-launched sailboats and windsurfers, as well as trailered boats using the boat ramp. Surfing sites are located offshore of the park adjacent to Popoia Island, and the waters offshore of the park are used by persons swimming, snorkeling, and canoeing. The local residents were generally opposed to any improvements that would conflict, reduce, or restrict existing water recreation activities.

NEEDS AND PLANNING OBJECTIVES

24. With 80 percent of Hawaii's population but less than ten percent of the land area, Oahu faces a critical potential shortage of recreational sand beach. Outdoor recreation plays an important role in the lives of Hawaii's people.

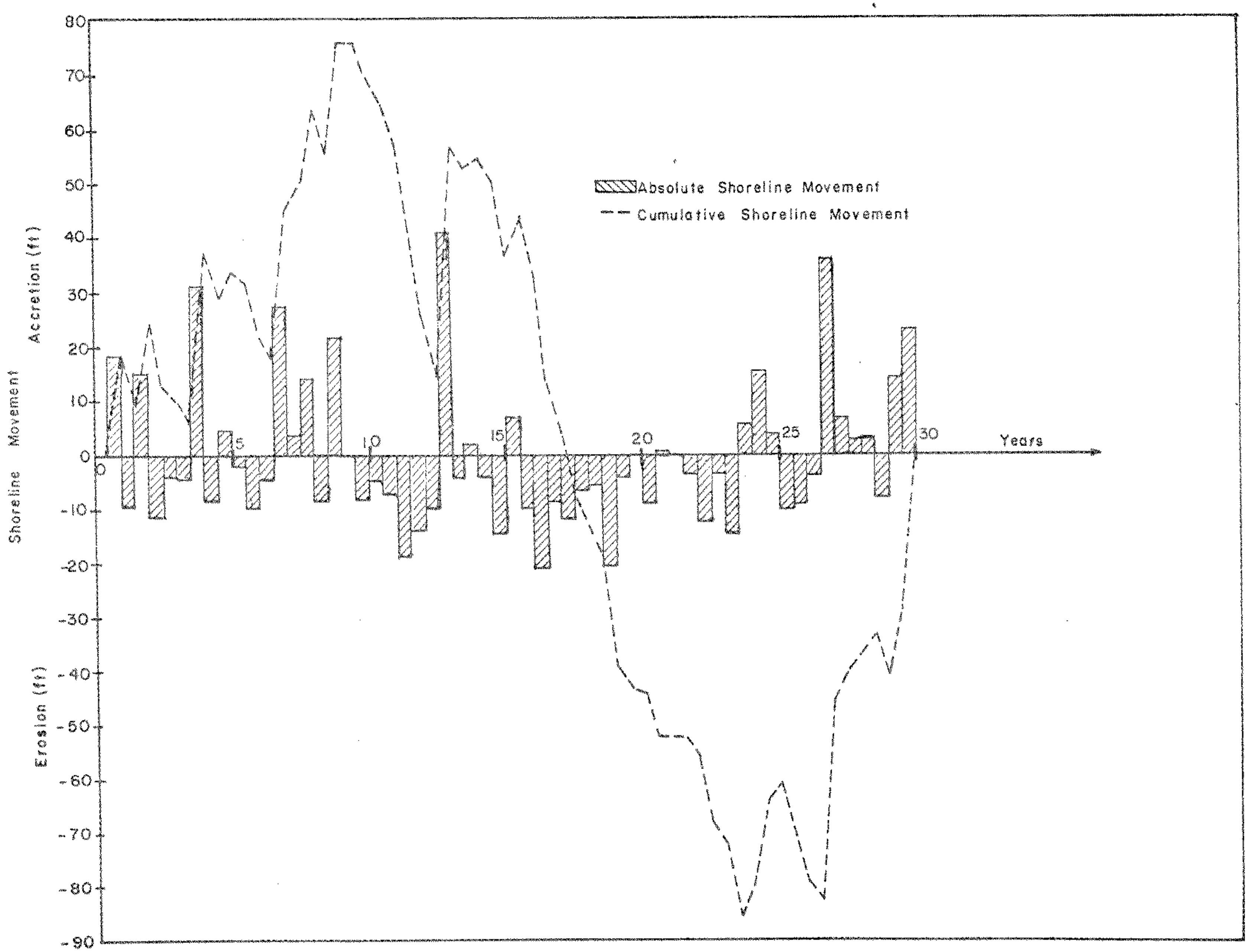

Figure C-3. SIMULATION OF KAILUA BEACH PARK SHORELINE MOVEMENT

People who go to the beach parks generally participate in various activities, such as swimming, surfing, sunbathing, picnicking, sailing, and volleyball. The southeastern (windward) coast of Oahu centered around Kailua has approximately 250 acres of existing and planned beach parks, including the 34-acre Kailua Beach Park.

25. The quality of the beach at Kailua Beach Park is excellent, and the sand and small waves make it ideal for sunbathing and swimming. The beach, gentle waves, and prevailing trade winds also make it a popular area for sailing small beach-launched boats and windsurfers.

26. Beach park use surveys accomplished during this study indicate average weekday and weekend use of the sandy beach area to be about 870 and 1,350 persons, respectively. Of these beach users, over 90 percent are swimmers and sunbathers.

27. Based on the foregoing, the needs for Kailua Beach Park are to maintain the maximum amount of dry sandy beach area as possible without serious adverse effect to the existing park and water-related recreation activities.

28. Planning objectives for the Kailua Beach Park erosion control project have been developed based on a determination of the social, economic, and environmental aspects of the project area, and the analysis of beach processes as well as environmental and human resources, the following planning objectives were adopted to guide the formulation and evaluation of alternative project plans:

a. Provide improvements to restore and maintain the dry sandy beach area for recreation and protection of park facilities.

b. Beach improvements should not result in serious adverse impact to existing water recreation activities at Kailua Beach Park or in Kailua Bay.

c. Preserve and enhance the visual/aesthetic qualities of the park.

d. Beach improvements should be in accord with the local residents desires.

S E C T I O N D

FORMULATING A PLAN

SECTION D

FORMULATING A PLAN

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SECTION D

FORMULATING A PLAN

FORMULATION AND EVALUATION CONCEPTS

1. Guidance. The formulation and evaluation of alternative plans have been guided by the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources (P&S). In addition, the concepts and assessment procedures of Section 122 of the River and Harbor Act of 1970 (PL 91-611) and the National Environmental Policy Act of 1969 (NEPA) have been incorporated into the formulation/evaluation process. In accordance with the Water Resources Council's and Corps of Engineers' guidance policies, the principal national objectives of water resources development, (1) environmental quality (EQ) and (2) national economic development (NED), have been addressed.

2. Direction of Formulation. This section of the report is directed toward the development and analysis of alternative resource management systems or plans which address the planning objectives defined in the previous section. The initial step in the formulation process is the identification of a broad range of technical and institutional measures available to address the planning objectives. An effort has been made to include both nonstructural and structural measures, as well as measures implementable by agencies or organizations other than the Corps of Engineers.

3. Following a preliminary screening of these measures for their applicability to the problems and the extent to which they meet the planning objectives, the range of applicable management measures is reduced. The remaining measures which are to be pursued further are then developed singly or in combination with other measures to create management plans, each of which satisfy some or all of the planning objectives and to varying degrees. The formulation of alternative plans of improvement was guided by the following technical, economic, and environmental criteria.

4. Technical Criteria. The alternative plans of improvement should provide engineeringly sound beach erosion control to meet the design criteria and project objectives.

5. Economic Criteria.

a. The plans should be economically sound, the benefit-to-cost ratio should be at least unity, and the net benefits, as far as practicable, should be maximized.

b. The cost for alternative plans of improvement are based on preliminary layouts and estimates of quantities, and January 1978 unit prices. The benefits and costs are expressed in comparable quantitative economic terms to the fullest extent possible. Annual costs are based on a 50-year amortization period and a 6-5/8 percent interest rate. The annual charges include maintenance cost.

6. Environmental Criteria.

a. Minimize the physical destruction of marine resources in the project area.

b. Minimize long-term disturbances to the physical environment (e.g., water circulation, water quality, and sediment transport) which may have secondary impacts on the living resources that inhabit the project area.

7. The following general concepts were also used to guide the formulation, assessment, and evaluation of alternative plans:

a. Both adverse and beneficial impacts of alternative plans should be identified and measured, and the beneficial or adverse contributions of each plan evaluated;

b. The plans should be developed in order to minimize conflicts, maximize compatibility, and insure completeness;

c. The desires of local interests should be given full consideration; and

d. The plans should be evaluated with respect to their acceptability, certainty, completeness, effectiveness, efficiency, equity, benefit-cost ratio, and reversibility.

IDENTIFICATION OF MANAGEMENT MEASURES

NONSTRUCTURAL MEASURES

8. No Action - The "Without Condition". Although "no action" is not truly a management measure, it is being discussed under the nonstructural category as a management option for Kailua Beach Park. "No action" is interpreted for the purposes of this report as "no action by anyone," or leaving the situation unchanged.

9. Under this option, the southeastern shoreline of the park will continue to undergo fluctuations in width. During the erosion phase of the erosion-accretion cycle, park lands would be lost including possibly park facilities such as the boat ramp and parking lot. It is not possible to accurately predict the future configurations of the shoreline, or maximum erosion limits. The estimated excursion of the shoreline between erosion and accretion is shown on Figure D-1. Based on historical trends and theoretical analysis, the shoreline could be expected to fluctuate by as much as 200 feet between erosion and accretion phases of the cyclic beach movement. However, because the estimated beach excursion is completely dependent on random changes in meteorological conditions, it would not be at all unreasonable for these estimated limits to be exceeded.

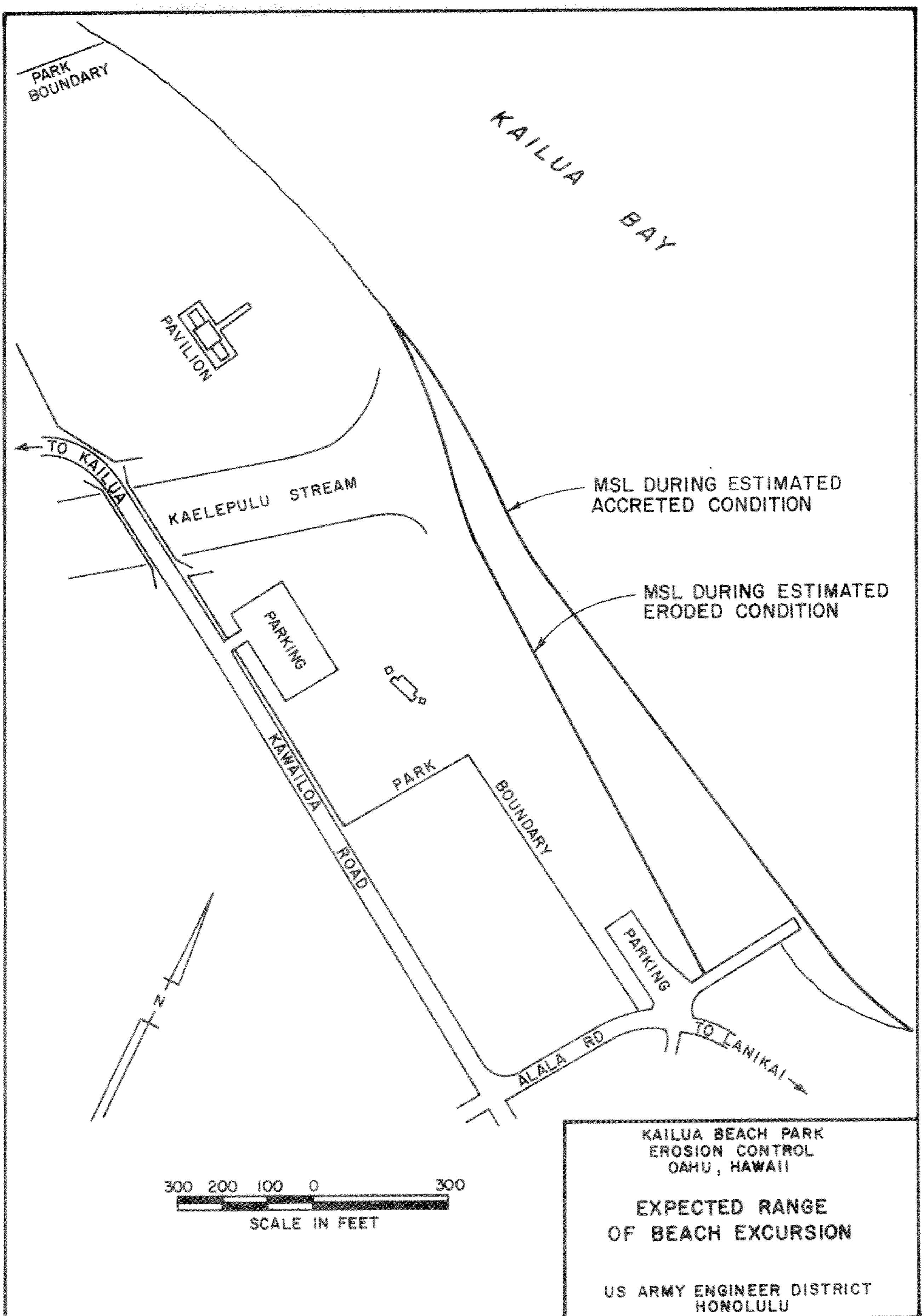

PARK BOUNDARY
KAILUA BAY
PAVILION
TO KAILUA
KAELEPULU STREAM
MSL DURING ESTIMATED ACCRETED CONDITION
MSL DURING ESTIMATED ERODED CONDITION
PARKING
KAWAILOA ROAD
PARK BOUNDARY
PARKING
ALALA RD
TO LANIKAI
N
300 200 100 0 300
SCALE IN FEET
KAILUA BEACH PARK
EROSION CONTROL
OAHU, HAWAII
EXPECTED RANGE
OF BEACH EXCURSION
US ARMY ENGINEER DISTRICT
HONOLULU

FIGURE D-1

10. Shoreline Management or Setback. Shoreline management at Kailua Beach Park would involve planning for shoreline uses which are compatible with the risks of shoreline erosion. Open space park use is considered compatible with such recognized risks. Shoreline management would establish a setback zone in which no damageable structure or park facility would be constructed near the eroding shoreline. Management and setback would not abate the erosion, but would prevent loss of park facilities and structures, much as flood plain management reduces flood damages by controlling the types of development within flood plains.

11. Shoreline management could be implemented by local agencies, primarily the City and County of Honolulu, and could be implemented in conjunction with any structural measures. At Kailua Beach Park, existing facilities located close to the fluctuating shoreline, such as the parking area near the boat ramp, may be damaged or lost unless relocated inland. Park lands would continue to be lost during the erosion cycle, reducing the size of a major recreational white sand beach. Conversely, sand would be deposited during the accretion phase of the cycle, providing additional beach area to the park.

STRUCTURAL MEASURES

12. Shoreline Revetment. The construction of a revetment is the most direct method of protecting a shoreline from continued erosion. It would be constructed adjacent and parallel to the eroding shore to separate land from water. Although there are many types of revetments and many kinds of materials available for their construction, a rock riprap revetment would be the most practical and feasible type based on cost, ease of construction, availability of materials, durability, and maintenance.

13. Groins/Groin Systems. A groin is a shore protection structure designed to build a protective beach or to retard erosion of an existing or restored beach by trapping beach material in the nearshore zone. Groins are usually perpendicular to the shore and extend from a point landward of predicted shoreline recession into the water far enough to accomplish their purpose.

14. Groins are narrow and vary in length from less than 100 feet to several hundred feet. Depending on their specific purpose, groins can be classified as permeable or impermeable, high or low, long or short, and fixed or adjustable. In Hawaii, groins have normally been constructed of rock materials, but other material such as concrete, steel, or timber may be used. A series of groins acting together to protect a long section of shoreline is called a groin system or groin field.

15. Offshore Breakwater. An offshore breakwater is a structure designed to protect an area from wave action. They are usually constructed to intercept the movement of littoral material by dissipating the wave forces that would normally move it. In the same manner, an offshore breakwater can provide shoreline protection by dissipating wave energy that would normally strike the shore and cause erosion. Offshore breakwaters may be built as low profile structures, or to a height sufficient to prevent overtopping under design wave conditions, depending on the degree of protection desired. They can be continuous for long distances or segmented with passages between them to allow exchange of water and are generally of rubblemound construction.

16. Protective Beach. A protective beach, created by placing clean beach sand along the shore, would dissipate wave energy impinging on the shoreline and protect the backshore area from erosion. The beach fill would function as a shore protection structure as well as serve as a recreation area. Since it extends beyond the existing shoreline, it continues to be subject to erosion. Subsequently, periodic nourishment would be required to replace sand losses and to maintain an acceptable beach width.

PRELIMINARY SCREENING OF APPLICABLE MANAGEMENT MEASURES

OBJECTIVES OF SCREENING PROCESS

17. The conceptual plans presented above require preliminary analysis to screen out all but the most feasible alternatives for detailed analysis. The criteria for evaluation of plans involves the consideration of the following items:

a. Technical soundness and effectiveness of the plans.

b. Potential negative environmental impacts of the plans.

c. Support for the plans by the local public and local government.

d. The economics of the plans - benefits versus costs and net benefits.

Clearly each of the above items are related to the planning objectives presented in section C.

SCREENING ANALYSIS

18. "No Action" Plan. The "no action" or "do nothing" alternative has not been considered an acceptable course of action. In addition to loss of public beach park land, potential loss of park facilities may occur during the erosion phases of the erosion-accretion cycle. For these reasons, the request for some type of action on the erosion problem has been made by the State of Hawaii and the City and County of Honolulu.

19. Shoreline Management Plan. Shoreline management in varying degrees may be implemented by the City and County of Honolulu at any time. The establishment of a setback area would be based on the historical limits of shoreline recession, and all future structures would be built inland of the setback line. The setback zone would act as a buffer area where recreation activities could continue to take place, although it is understood that those lands would be subject to cyclical erosion. In addition, all existing park facilities located within this zone would be relocated inland.

20. Revetment Plan. Of the structural measures considered, revetments were eliminated from further consideration primarily because of the varied recreational use of the beach and visual/aesthetic aspects. The revetment is essentially a rock wall parallel to the shore and may interfere with shoreline access to the sandy beach. The revetment may also discourage the

accumulation of sand fronting the structure. For this reason a revetment is generally used for shore protection of structures rather than beach erosion control.

21. Groins with Protective Beach Plan. Groins may simplistically be compared to rock walls perpendicular to the shore. A properly designed groin system would effectively control shore erosion and promote the accumulation of sand along the shore. However, because of the nature of the beach processes at Kailua, it is likely that the beach adjacent to the end groin would become the end cell as discussed in paragraph C-13. If groins were used to stabilize the beach between the boat ramp and Kaelepulu Stream, the beach park fronting the pavilion would in all likelihood be subject to the same dramatic erosion and accretion as the beach near the boat ramp is now. Since this would in essence be trading one problem for another, no benefits would result unless groins were used to stabilize the entire beach park. If this were done, the problem would shift to the beach fronting private residences adjacent to the beach park with possible serious impact to homes built near the shore. For these reasons, the use of groins is not considered a feasible alternative for erosion control at Kailua Beach Park.

22. Offshore Breakwater Plan. The offshore breakwater shares some of the visual/aesthetic disadvantages of both revetments and groins. It would also interfere with recreational water activities such as power boating, windsurfing, and sailing. Engineering design elements of an offshore breakwater at Kailua Beach Park are complex and there is some doubt as to the effectiveness of this alternative in stabilizing the shoreline. In addition, the offshore breakwater would shift the problem to the adjacent unprotected beach similarly to the effect of groins as discussed in the previous paragraph. For these reasons, the offshore breakwater plan was eliminated from additional consideration.

23. Protective Beach Plan. A protective beach continues to be the most natural and one of the most effective ways of protecting the shoreline. Beach restoration with periodic nourishment to maintain an established beach width represents a measure which is compatible with the existing natural, visual, and cultural setting of the park. An important consideration, however, is the probable commitment of large quantities of clean, natural beach sand over the life of the project.

24. Alternative Sand Sources. Important considerations in the protective beach alternative are the availability and cost of suitable sand. The plan requires a large initial quantity of clean, natural beach sand and periodic nourishment over the life of the project. Two basic sources exist for beach replenishment: (1) commercial sand at Mokuleia, and (2) offshore sand from deposits in Kailua Bay (see Figure B-3 for locations).

25. The commercial sand source at Mokuleia is readily available but is priced at approximately $23 per cubic yard. An offshore reconnaissance survey has revealed two potential sand source areas in Kailua Bay. At the present time, commercial offshore sand mining within 1,000 feet of the shoreline or in water depths of less than 30 feet is prohibited by State law (Hawaii Revised Statutes Section 205.33). The survey indicates that there is

sufficient sand in deposit #1 located outside the water depth and distance restrictions to warrant consideration. The cost of mining this deposit and pumping it to Kailua Beach Park is approximately $12 per cubic yard. A draft amendment (Bill R16) to the State Offshore Mining Law has been introduced into the legislature which will allow Government agencies to mine offshore sand deposits in depths shallower than 30 feet and less than 1,000 feet offshore for the purpose of beach replenishment. This would further reduce the cost of the offshore sand since mining could be done closer to shore, thus reducing the pumping costs.

DEVELOPMENT OF ALTERNATIVE PLANS

26. Based on the screening and analysis and initial coordination efforts, the following alternative plans have been developed to provide a long-term method of protecting the shoreline and recreational resources of Kailua Beach Park.

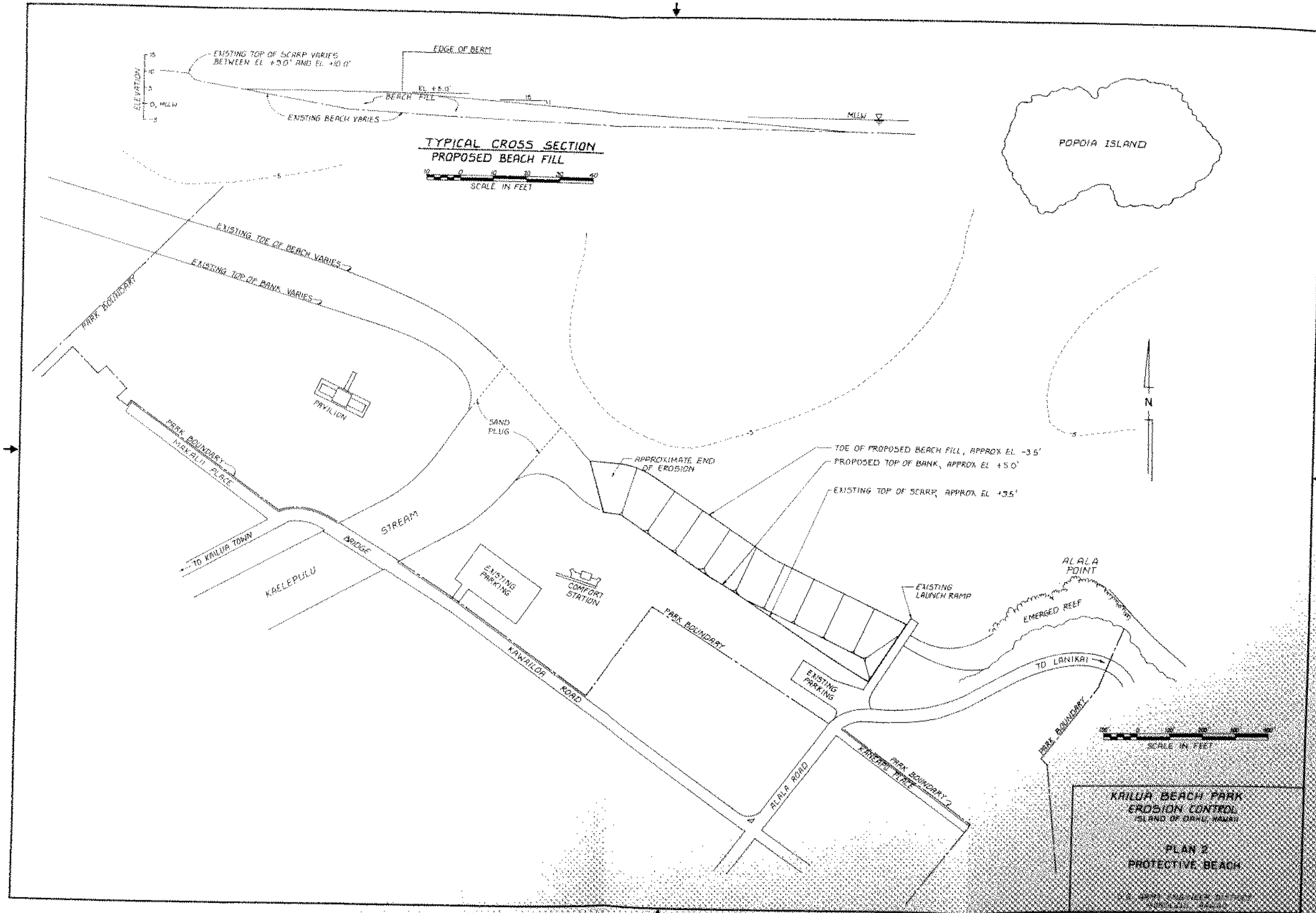
PLAN 1 - SHORELINE MANAGEMENT

27. As described earlier, this alternative could be implemented by local agencies, primarily the City and County of Honolulu, and could be used in conjunction with other construction measures. At Kailua Beach Park, implementation of this measure would require re-evaluation and restructuring of the park master plan. Since the shore erosion would not be reduced, existing facilities located close to the shoreline may be damaged or lost unless relocated inland. The establishment of a setback area is difficult due to the uncertainties associated with estimating the future configuration or width of the dynamic Kailua Beach shoreline. A reasonable setback line would be slightly landward of the estimated shoreline during a typical eroded condition as shown by Figure D-1.

28. During the erosion phase of the erosion-accretion cycle, park land would be reduced with losses of the recreational white sand beach. In addition, the limits of erosion may progress past the setback line. For these reasons, implementation of a shoreline setback area as the sole plan alternative may not be feasible or acceptable to agencies or persons most concerned about protecting existing recreational facilities. It remains, however, a potentially viable nonstructural plan, implementable by agencies other than the Corps of Engineers, and is presented in the summary evaluation tables and assessments for comparative purposes and consideration by the public. Since the plan does not fulfill the primary project planning objective of maintaining the sand beach, quantitative costs and benefits were not developed, although a statement of the types of costs to be incurred by the implementing agency are outlined.

PLAN 2 - PROTECTIVE BEACH

29. This plan provides for the construction of a protective beach along a 1,000-foot-long reach of park shoreline (Figure D-2). The beach berm would be restored to a 150-foot width adjacent to the existing launch ramp and



TYPICAL CROSS SECTION
PROPOSED BEACH FILL
SCALE IN FEET
ELEVATION
EXISTING TOP OF SCARP VARIES BETWEEN EL +5.0' AND EL +10.0'
EDGE OF BERM
EL +5.0'
BEACH FILL
EXISTING BEACH VARIES
MLLW
POPOIA ISLAND
N
EXISTING TOE OF BEACH VARIES
EXISTING TOP OF BANK VARIES
PARK BOUNDARY
PAVILION
SAND PLUG
MAKALII PLACE
TO KAILUA TOWN
BRIDGE
STREAM
KAELEPULU
EXISTING PARKING
COMFORT STATION
APPROXIMATE END OF EROSION
TOE OF PROPOSED BEACH FILL, APPROX EL -3.5'
PROPOSED TOP OF BANK, APPROX EL +5.0'
EXISTING TOP OF SCARP, APPROX EL +3.5'
KAWAILOA ROAD
ALALA ROAD
EXISTING LAUNCH RAMP
ALALA POINT
EMERGED REEF
TO LANIKAI
KAPAPA PLACE
KAILUA BEACH PARK
EROSION CONTROL
ISLAND OF OAHU, HAWAII
PLAN 2
PROTECTIVE BEACH

would taper to the existing shoreline 1,000 feet to the northwest. The average dry beach area in the restored reach would increase to 95,000 square feet from the existing long-term average area of 75,000 square feet. In addition, periodic nourishment would eliminate the severe short-term erosion which has occurred in the past. The restored beach would have a berm elevation of about +5 feet above MLLW, and would have a foreshore slope of about 1 vertical to 15 horizontal.

30. Assuming that the shoreline erosion continues as it has in the past, sand volumes in the amount of 25,000 cubic yards would be required every 5 years to nourish the beach and maintain it at its increased width.

31. In accordance with the provisions of the Section 103 authority, to be eligible for a Federal share of up to 70 percent of the total project cost, exclusive of land costs, up to the $1 million Federal share limitation, certain conditions must be met to the satisfaction of the Chief of Engineers. These conditions, specified below, must be maintained by local interests for continued Federal cost sharing for periodic sand nourishment, subject to the $1 million Federal share limitation in accordance with the findings of this report.

a. The land must be publicly owned.

b. The park must include a zone extending landward from the mean low water line which excludes all permanent human habitation, including summer residences, but not including the residences of park administrative and maintenance personnel.

c. The park must include a beach suitable for recreational use.

d. The park must provide for preservation, conservation, and development of the natural resources of the environment. In accordance with the overall mission or purpose of the park, the areas must be developed, operated, and maintained in a manner which preserves the desirable features and the natural resources of the locale.

e. The park or conservation area must extend landward a sufficient distance to include protective dunes, bluffs, or other natural features such as swamps or low-lying areas, all of which must absorb and dissipate wave energy and flooding effects of storm tides.

f. Areas must provide essentially full park facilities for appropriate public use. In the case of recreational beach parks intended for mass usage, full park facilities must include adequate access and bathhouse, comfort, parking, and recreational facilities to insure realization of anticipated recreational benefits.

32. As discussed in the following paragraphs, conditions "a" through "f" either have been or will be met following construction of beach restoration improvements.

a. The land within the project limits is public beach park, owned and operated by the City and County of Honolulu.

b. The park area landward of the beach is 200 to 500 feet wide. There is no permanent human habitation within this area.

c. Restoration and maintenance of a recreational beach is a project planning objective. The proposed beach would provide increased opportunity for swimming, sunbathing, and other beach related activities.

d. The park contributes to preservation and conservation of the natural coastal environment. The proposed protective beach would preserve the desirable natural features of the shoreline.

e. A protective beach, together with the existing park land, will provide sufficient area for the absorption and dissipation of wave energy and flooding effects of storm tides.

f. Existing park facilities include a sheltered pavilion, restrooms, showers, picnic tables, cooking facilities, a food concession, and parking.

33. Based upon the above existing and assured future conditions, the 70 percent Federal, 30 percent non-Federal apportionment of project costs is considered appropriate for implementation of the project.

34. Table D-1 presents a summary of the costs and benefits associated with the protective beach plan. All prices are in 1978 dollars.

Table D-1. COST AND BENEFIT SUMMARY

	Commercial Sand	Offshore Sand
Nourishment Costs 1/		
Federal	$1,000,000 2/	$945,000
Non-Federal	1,480,000	405,000
TOTAL	$2,480,000	$1,350,000
Average Annual Costs 3/	$171,000	$93,000
Average Annual Benefits 4/	$111,000	$111,000
Benefit-Cost Ratio	0.6	1.2

1/ The nourishment costs are the sum of the cost of periodic nourishment at 5-year intervals for a 50-year project life ($710,000 each nourishment using commercial sand, and $385,000 each nourishment using offshore sand) discounted to a base year of 1980 at 6-5/8%.

2/ Federal cost subject to the statutory Federal limitation of $1 million.

3/ At 6-5/8% for a 50-year project life.

4/ Based on a 20,000 square foot average increase in sandy beach area.

ASSESSMENT AND EVALUATION

35. The economic, social, and environmental effects of the two alternative plans have been assessed and evaluated, and a summarization of these evaluations is presented in Table D-2, System of Accounts and Summary Comparison of Alternative Plans. This table displays the significant contributions, beneficial and adverse effects, and the extent to which various planning objectives and evaluation criteria are met by each plan. The table will be revised and refined when comments on the plans are received during the review of the project documents and during the public meeting. A final plan selection will follow consideration of all public input and will be documented in the final report and final environmental statement.

36. Implementation of the protective beach plan will be subject to compliance with the requirements of Section 404 of the Federal Water Pollution Control Act of 1972. Sand placement along the shore is included within the definition of "discharge of fill material" within the navigable waters of the United States. The public meeting will provide the public with the opportunity to comment on Section 404 evaluation matters as well as project formulation aspects.

37. Additional sections of this report to be completed after the public meeting are:

The Selected Plan
Economics of the Selected Plan
Plan Implementation, Conclusions, and Recommendations

TABLE D-2

SUMMARY OF COMPARISON OF ALTERNATIVE PLANS AND SYSTEM OF ACCOUNTS

	PLAN 1 SHORELINE MANAGEMENT/SETBACK	PLAN 2 PROTECTIVE BEACH
A. PLAN DESCRIPTION	ESTABLISHMENT OF A SETBACK LINE BASED ON THE ESTIMATED LIMIT OF SHORELINE RECESSION DURING EROSION PERIODS. FUTURE PARK FACILITIES/DEVELOPMENT WOULD BE LANDWARD OF THE SETBACK LINE.	CONSTRUCTION OF A 1,000-FOOT-LONG PROTECTIVE BEACH, REQUIRING APPROXIMATELY PERIODIC NOURISHMENT OF ABOUT 25,000 CY OF SAND EVERY 5 YEARS.
B. SIGNIFICANT IMPACTS		
1. ECONOMIC		
a. BENEFIT	NO SIGNIFICANT ECONOMIC COST OR BENEFIT, BEACH AREA WOULD CONTINUE TO FLUCTUATE.	STABILIZES SHORELINE AND PROVIDES RECREATIONAL BENEFITS ASSOCIATED WITH APPROXIMATELY 20,000 SQUARE FEET OF DRY BEACH AREA (SEE ITEM 3a).
2. ENVIRONMENTAL		
a. MARINE ENVIRONMENT	NO CHANGE FROM EXISTING CONDITION	APPROXIMATELY 1 ACRE OF NEARSHORE AREA COVERED BY RESTORED BEACH.
b. TERRESTRIAL ENVIRONMENT	CONTINUED FLUCTUATION OF LAND AREA IN PARK.	PROTECTS AND MAINTAINS BACKSHORE AREA, AND CREATES APPROXIMATELY 0.5 ACRES OF TERRESTRIAL HABITAT.
c. WATER QUALITY	NO CHANGE	TEMPORARY TURBIDITY DURING CONSTRUCTION. NO LONG-TERM CHANGES.
d. FISH AND WILDLIFE	CONTINUED FLUCTUATIONS OF MARINE/TERRESTRIAL HABITAT.	NO IMPACT TO THREATENED OR ENDANGERED SPECIES OR THEIR HABITAT.
e. NATURAL RESOURCES		COMMITS APPROXIMATELY 250,000 CY OF SAND OVER THE LIFE OF THE PROJECT.
f. HISTORIC/CULTURAL RESOURCES	NO IMPACT	NO IMPACT
3. SOCIAL		
a. HEALTH, SAFETY, COMMUNITY WELL-BEING	NO CHANGE FROM EXISTING CONDITIONS	PROMOTES WELL-BEING THROUGH RECREATION
b. RECREATIONAL OPPORTUNTIES	CONTINUED FLUCTUATIONS IN RECREATIONAL BEACH AREA. DURING EROSION PERIODS DRY SANDY BEACH AREA OF PARK REDUCED BY ABOUT 30%	RESTORES AND MAINTAINS RECREATIONAL BEACH AREA.
c. AESTHETIC VALUES	ERODED APPEARANCE WOULD CONTINUE INTERMITTENTLY.	RESTORES AND MAINTAINS NATURAL SHORELINE APPEARANCE.

	PLAN 1 SHORELINE MANAGEMENT/SETBACK	PLAN 2 PROTECTIVE BEACH	
C. PLAN EVALUATION			
1. EFFECTIVENESS	CYCLIC EROSION/ACCRETION WOULD CONTINUE, PARK IMPROVEMENTS CONSTRUCTED INLAND OF SETBACK LINE WOULD BE SUBJECT TO DAMAGE SHOULD FUTURE EROSION EXCEED ESTIMATED LIMITS.	WOULD MAINTAIN WIDE RECREATIONAL BEACH AND PROTECT BACKSHORE AREA AND PARK IMPROVEMENTS, REQUIRED DURING PERIODS OF PROLONGED EROSION.	
2. CONTRIBUTIONS TO PLANNING OBJECTIVES			
a. RESTORE AND MAINTAIN BEACH	NO CHANGE TO EXISTING CYCLICAL EROSION/ACCRETION.	RESTORES AND MAINTAINS RECREATIONAL BEACH. SOME VARIABILITY OF BEACH WIDTH WOULD STILL OCCUR BUT PARK FACILITIES WOULD BE PROTECTED.	
b. NO ADVERSE IMPACTS	CONTINUED FLUCTUATION OF RECREATIONAL BEACH AREA AND PERIODIC INCONVENIENCE FOR WATER RECREATION ACTIVITIES SUCH AS BEACH LAUNCHED SAIL BOATS.	NO IMPACT.	
c. PRESERVE/ENHANCE PARK AESTHETICS	NO CHANGE, PERIODIC ERODED APPEARANCE WOULD CONTINUE.	ENHANCES SHORELINE BY WIDENING BEACH AND ELIMINATING ERODED APPEARANCE.	
d. MEET COMMUNITY DESIRES	TO BE COMPLETED FOLLOWING COORDINATION OF DRAFT REPORT AND PUBLIC MEETING		
3. RELATIONSHIP TO NATIONAL ACCOUNTS			
a. NATIONAL ECONOMIC DEVELOPMENT		COMMERCIAL SAND	OFFSHORE SAND
AVERAGE ANNUAL BENEFITS	0	$111,000	$111,000
AVERAGE ANNUAL COSTS	0	$171,000	$ 93,000
NET ANNUAL BENEFITS	0	(-)	$ 18,000
B/C RATIO	-	0.6	1.2
b. ENVIRONMENTAL QUALITY	SEE ITEM 3.2 ON THIS TABLE		
c. SOCIAL WELL-BEING	SEE ITEM 3.3 ON THIS TABLE		
d. REGIONAL DEVELOPMENT	NO SIGNIFICANT EFFECT	SAME AS PLAN 1.	
4. RESPONSE TO EVALUATION CRITERIA			
a. ACCEPTABILITY	TO BE COMPLETED FOLLOWING COORDINATION AND REVIEW OF DRAFT REPORT AND PUBLIC MEETING		
b. CERTAINTY	LOW	HIGH	
c. COMPLETENESS	COMPLETE	COMPLETE	
d. EFFICIENCY		COMMERCIAL SAND - LOW OFFSHORE SAND - HIGH	
e. REVERSIBILITY	REVERSIBLE	REVERSIBLE	
5. IMPLEMENTATION RESPONSIBILITY	CITY AND COUNTY OF HONOLULU	CORPS OF ENGINEERS, STATE OF HAWAII, AND CITY AND COUNTY OF HONOLULU.	

APPENDIX A

BENEFIT ANALYSIS

METHODOLOGY

1. The economic feasibility of the proposed improvements was determined by comparing the equivalent average annual charges (interest, amortization, and operation and maintenance costs) to an estimate of the equivalent average annual benefits resulting from the project. The average annual benefits should equal or exceed the annual costs for Federal Government participation.

2. The benefits and costs accruing at different points in time over the project life are converted to equivalent annual amounts using the Federal interest rate established by the U.S. Water Resources Council. This discount rate is 6-6/8 percent for fiscal year 1978. The average annual benefits and costs are then compared as a basis for economic feasibility.

3. A number of economic and physical factors, such as physical depreciation, obsolescence, changing requirements for project services, and inaccuracies in making long-term projections, limit the economic life of the project. Federal policy establishes a life of 50 years for the purpose of analyzing this type of project.

4. The development of project costs and benefits follows standard Corps of Engineers practice. The value of all goods and services used in the project is estimated on the cost side. Project benefits result

from increases in recreational beach use. Specifically, benefits are the difference in recreation beach use activity between conditions with and without the project.

BENEFITS

GENERAL

5. The island of Oahu has 65.7 linear miles of sandy beach totaling 442 acres of dry sand beach area. At present, there are only 164 acres of dry sand beach in public parks. Using the Corps of Engineers criteria of a minimum of 75 square feet of beach per user, the maximum capacity of the beaches within the present park system would be about 95,000 at peak use. The latest State Comprehensive Outdoor Recreation Plan, (SCORP 1976) showed 161,000 beach users based on recreation activity at peak-use time, a clear indication of overcrowding. With the population expected to double over the next 50 years (OBERS-E projections and Hawaii Water Resources Regional Study (HWRRS) population projection, 1975, Series E-2 base), this overcrowding during peak-use periods is expected to continue into the forseeable future.

SUMMARY

6. Benefits result from greater beach use activity with a project than without one. Beach use activity is measured in beach visits per year. A value of $1.20 per visit is used in the analysis. Estimates of benefits creditable to the alternative plans of maintaining a beach by

nourishment are based on the following general assumptions. The ratio of annual beach visits to average beach area at the project site will be the same with a project as for the adjacent unaffected beach area. Without a project, this ratio is about 50 percent less. Under natural conditions of erosion and accretion, the relatively unstable project site beach tends to be less desirable for beach recreation, especially under severely eroded conditions. With a stabilized project beach of larger average size, both the aesthetic quality and the physical capacity are enhanced. These assumptions are based largely on beach use survey counts conducted as a part of this study. The average beach size for the proposed protective beach is 95,000 square feet of dry sand area. Average beach size without a project is 75,000 square feet, with fluctuation from zero to about 100,000 square feet. Beach visitation will increase over time with or without a project, as a reflection of population growth for the different areas from which the users come.

EXISTING BEACH-USE DATA

7. The beach area within the project limits extends about 1,000 feet along the park's shore, has an average dry beach width of about 75 feet (75,000 square feet), and can accommodate approximately 1,000 people at peak use based on the Corps' guideline of 75 square feet per person. The proposed beach nourishment alternative would provide a stabilized dry beach area of 95,000 square feet, with a park use capacity of 1,270 people.

8. Recent survey counts revealed little beach use within the project area because of the deteriorated condition of the beach. Between about 1972 and 1977 the beach eroded and shifted shoreward. It recently (November 1977) extended from a steep embankment created by erosion leaving a 33,000-square-foot dry beach area. The estimated number of users of the existing beach is based on data from surveys of Kailua Beach use made during a summer month and a winter month. One survey was completed in October 1975 and the other in July 1977. Both weekday and weekend day counts were used to estimate annual beach users as presented in Table A-1. Included in this table also are annual beach users of the 67,000-square-foot beach adjacent to the project site, not affected by erosion. Beach users are swimmers, sunbathers, fishermen, picnickers, and spectators or sightseers.

PROJECTED BEACH VISITATION

9. Estimates of projected beach visitation were based on the number of visits that the residential population of Oahu will make to Kailua Beach under normal weather conditions during weekdays and weekend days. Population projections from the Hawaii Water Resources Study 1975 (Series E-2) by hydrographic areas are presented in Table A-2. Hydrographic areas are identified by the County corresponding Judicial District. Projections for year 2030 were computed using the same rate of growth from 2010 to 2020. It should be noted that the population projection for Koolaupoku Judicial District, in which Kailua Beach is located, shows 183 percent increase for the 50-year period beginning 1980.

TABLE A-1. CURRENT ANNUAL BEACH VISITS

Location	Season	Average Day	Average Day Attendance	Number of Days	Estimated Annual Beach Visits
Project	Summer	Weekday	62	70	4,340
Site Beach		Weekend day	277	28	7,756
(33,000 sf)	Winter	Weekday	45	191	8,595
		Weekend day	130	76	9,880
		Estimated Total Annual Visits			30,571
			Rounded		31,000
		Ratio of Annual Visits to Square Feet of Beach Area		= .9	
Adjacent	Summer	Weekday	211	70	14,770
Beach		Weekend day	524	28	14,672
(67,000 sf)	Winter	Weekday	152	191	29,032
		Weekend day	436	76	33,136
		Estimated Total Annual Visits			91,610
			Rounded		92,000
		Ratio of Annual Visits to Square Feet of Beach Area		= 1.4	

TABLE A-2. OAHU POPULATION PROJECTION BY HYDROGRAPHIC AREAS

Hydrographic Areas by Corresponding Judicial District Identification	Projected Population					Percent Increase 1980-2030 (%)
	1976 1/	1980 2/	2000	2020	2030	
Koolauloa	12,900	11,400	13,400	18,400	22,000	93%
Koolaupoku	103,100	107,200	146,600	234,400	303,000	183%
Honolulu	356,000	364,300	449,600	495,600	509,000	40%
Ewa	167,300	190,800	340,700	556,500	707,000	270%
Waianae	27,300	27,300	35,300	63,900	90,000	230%
Wailua-Wahiawa	51,900	48,700	53,800	67,200	76,000	56%
TOTAL OAHU	718,500	749,500	1,039,400	1,436,000	1,707,000	128%

1/ Provisional estimate of Judicial Districts by the Hawaii State Department of Economic Development (Oct 1977) rounded to the nearest 100.

2/ Figures may be lower than 1976 estimates because the 1980 projection was made in 1975.

10. Origin of beach users was estimated for Kailua Beach in the 1977 survey. The survey indicated that about 77 percent of visitors are Oahu residents and the remaining 23 percent are visitors to the island. The results of the survey, 3,542 visitors to Kailua Beach for weekday plus weekend day, are shown in Table A-3 with a percent distribution. Of the 77 percent Oahu visitors to Kailua Beach about 96 percent originate from the Koolaupoku and Honolulu Judicial Districts. Kailua is located in the Koolaupoku Judicial District. The results of the survey, 2,731 Oahu visitors to Kailua Beach, for weekdays plus weekend days, are shown in Table A-4.

TABLE A-4. ORIGIN OF ALL USERS OF KAILUA BEACH

Origin	Weekday Count	Weekend Day Count	Total	Percent Distribution
Oahu	1,363	1,363	2,731	77%
Other	403	408	811	23%
TOTAL	1,766	1,766	3,542	100%

TABLE A-4. ORIGIN OF OAHU USERS OF KAILUA BEACH

Origin	Weekday Count	Weekend Day Count	Total Count	Percent Distribution
Koolauloa	7	1	8	0.3%
Koolaupoku	1,108	1,019	2,127	77.9%
Kailua 1/	(652)	(637)	(1,289)	--
Honolulu	213	302	515	18.8%
Ewa	35	42	77	2.8%
Waianae	0	2	2	0.1%
Wailua-Wahiawa	0	2	2	0.1%
TOTAL	1,363	1,368	2,731	100.0%

1/ Kailua statistics are included in Koolaupoku total, but are also shown separately as additional information.

11. Annual visits under normal weather conditions with a project are expected to conform to the use density of the adjacent beach in Kailua Bay Beach Park, which has not been affected by erosion. The adjacent beach has a dry beach area of about 67,000 square feet with an estimated 92,000 annual visits. With an improved beach at the project site, base year beach use is based on annual use density of 1.4 annual visits per square foot Table A-1). The number of annual visitors will increase by about 2.45 times by the end of the 50-year project life, as computed in Table A-5. Computations include data from Table A-3, Table A-4, and Table A-2. It is not surprising that of the Oahu visitors (Table A-3) coming to Kailua Beach, a majority (77.9% - Table A-4) originate from Koolaupoku Judicial District. That District's population will more than double (an increase of 183 percent) by the end of the 50-year project life. Also, it is reasonable to assume that as total population of Oahu increases, especially in the Honolulu Judicial District, demand for use of any other beach on Oahu that is already overcrowded will make Kailua Beach a more attractive place to visit. The demand for beach recreation by tourists will contribute to this effect. Current studies by the Office of Tourism, Department of Planning and Economic Development, State of Hawaii, indicate that the number of tourists in Hawaii will double within the next ten years. The study does not go beyond ten years.

12. The proposed protective beach plan would reduce the loss of beach and provide a stable buffer to protect the park land area. The increased dry sand beach area would allow additional space for beach users and

TABLE A-5. COMPUTED FACTOR FOR ANNUAL BEACH VISITS IN 2030

Origin	Percent of Oahu Beach Visitors 1/	Percent of Total Beach Visitors 2/	Factor Change in Population 1980-2030 3/	Factor Change in Population 1980-2030
Koolauloa	.3	.0023	1.93 (2.10)	.0044 (.0048)
Koolaupoku	77.9	.5998	2.83 (2.57)	1.6974 (1.5149)
Honolulu	18.8	.1448	1.40 (1.44)	.2027 (.2085)
Ewa	2.8	.0215	3.70 (3.60)	.0796 (.0774)
Waianae	0.1	.0008	3.30 (3.41)	.0026 (.0027)
Wailua-Wahiawa	0.1	.0008	1.56 (1.29)	.0012 (.0010)
Other	--	.2300	2.00 (2.00)	.4600 (.4600)
			FACTOR TOTAL =	2.4479 (2.2960)
			ROUNDED =	2.45 (2.30)

1/ Data from Table A-4.

2/ Computation Example 0.3% (Table A-4) x 77% (Table A-3) = .0023.

3/ Data from Table A-2 (Data in parenthesis and based on the County of Honolulu General Plan - for comparison purposes only).

picnickers. The plan will provide an average dry beach area of 95,000 square feet, with periodic nourishment as erosion takes place. The average annual visits to the improved beach were based on having the same annual use density as the adjacent beach, or 1.4 annual visits per square foot (Table A-1) in the base year, with annual visitation growing to 2.45 times the 1980 usage by 2030. Estimated annual visitation for 1980 and 2030 for the protective beach and for the without-project condition are shown in Table A-6.

TABLE A-6. PROJECTED ANNUAL VISITATION, KAILUA BEACH

	Plan 2 Nourishment	Without Project (Natural Conditions)
Average Beach Size	95,000 sf	75,000 sf
Annual Visitation		
1980	133,000 1/	67,000 2/
2030 3/	326,000	165,000
Average Annual Equivalent Visitation 4/	187,000	94,000

1/ Based on ratio of annual visitation to square feet of beach area = 1.4 (Table A-1).

2/ Based on ratio of annual visitation to square feet of beach area = .9 (Table A-1).

3/ 2030 Visitation = (2.45) x (1980 visitation) based on population growth (Table A-4).

4/ 80 = 1980 visitation.

30 = 2030 visitation.

(.27972) = average annual equivalent factor, straight line growth gradient for 50 years, 6-5/8 percent.

Average annual equivalent visitation = 80 + (.27972) (30 - 80).

13. Results from recent survey information developed for Kailua Beach indicate that annual visitation can be estimated from peak use data using the following relationships:

Peak day attendance (104 weekend days per year)	=	2 times peak hour attendance
Weekday attendance (260 per year)	=	2/5 times peak day attendance
Good weather days (days during which most beach use takes place)	=	83% of the year

Using these relationships, Table A-7 shows, for the beach size being considered, peak hour attendance associated with estimated annual visitation, and maximum capacity peak hour attendance. Maximum capacity is based on the Corps of Engineers recommended limit of 75 square feet per visitor. As the table shows, peak hour use would not likely exceed capacity.

TABLE A-7. PROJECTED PEAK USE VS CAPACITY

Project Average Beach Size (Square Feet)	Annual Visits 1/		Peak Hour Attendance		
	1980	2030	1980 2/	2030 2/	Maximum Capacity 3/
95,000	133,000	326,000	385	944	1,270

1/ See Table A-6.

2/ Peak hour attendance = P
Annual Visitation = A
Since $A = (.83) \times (104 \times 2P + 260 \times .4 \times 2P)$

$$p = \frac{A}{345.28}$$

3/ $\text{Maximum Capacity} = \frac{\text{square feet of beach area}}{\text{75 square feet per visitor}}$

RECREATION BENEFITS FROM INCREASED BEACH USE

14. Average annual benefits are computed based on the difference between with and without a project. A value of $1.20 per visit was used because the visitor could expect practically every recreational service and convenience during his visit. Average annual benefits are summarized in Table A-8. Estimated annual benefits are $111,000 for the protective beach plan.

TABLE A-8. AVERAGE ANNUAL BENEFITS

Average Beach Size	With Improvement		Without Improvement		Average Annual Benefits 1/
	Average Annual Visits	Annual Value ($1.20/Visit)	Average Annual Visits	Annual Value ($1.20/Visit)	
95,000 sf	187,000	$224,000	94,000	$113,000	$111,000

1/ Benefits = (Annual Value With Improvement) - (Annual Value Without Improvement)

ATTACHMENT 1

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
BEACH EROSION CONTROL
KAILUA BEACH PARK
OAHU, HAWAII

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
BEACH EROSION CONTROL
KAILUA BEACH PARK
OAHU, HAWAII

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1 This Draft Environmental Impact Statement (DEIS) was prepared, as a companion report to the Detailed Project Report (DPR), Kailua Beach Park Erosion Control, Oahu, Hawaii. Treatment of general State and county-wide descriptive data, engineering-related oceanography, and description of the alternatives is provided primarily in the DPR. Because there is only one set of plates and figures for the combined report, references to figures in this report will not be consecutively numbered.

1.2 Detailed project benefit and cost analysis is presented in the DPR.

SECTION 2

DESCRIPTION OF ALTERNATIVE PLANS

2. DESCRIPTION OF ALTERNATIVE PLANS

2.1 Based on the preliminary screening, analysis, and initial coordination efforts, the following alternative plans have been developed to provide a long-term method of protecting recreation and natural resources at Kailua Beach Park from beach erosion.

2.2 Shoreline Management (Alternative No. 1)

2.2.1 Shoreline management at Kailua Beach Park would involve planning for shoreline uses which are compatible with the risks of shoreline erosion. Open space and park use are considered compatible with such recognized risks. Shoreline management would establish a setback zone in which no damageable structures or park facilities would be constructed near the eroding shoreline. The setback line would be set landward of the estimated maximum eroded condition (see Figure D-1). All future park facilities would be confined to the park area landward of the setback line where shore erosion would not threaten them. Management and setback would not reduce the rate of erosion, but would prevent loss of park facilities and structures, much the same as flood plain management reduces flood damages by controlling the types of development within flood plains.

2.2.2 Shoreline management could be implemented by local agencies, primarily the City and County of Honolulu, and could be implemented in conjunction with any structural measures. At Kailua Beach Park, implementation of this measure would require re-evaluation and restructuring the park master plan. Parkland would continue to be lost during periods of erosion, reducing the size of a major recreational, white sand beach in the Kailua Bay region and on the island of Oahu. During periods of accretion, sand would be added to the beach area of the park thus providing additional beach area to the park, the region, and the island. Realistic establishment of such a setback area may be difficult due to the uncertainties associated with estimating the future configuration or width of the dynamic Kailua Beach shoreline. Shoreline erosion in the past has not progressed passed the estimated erosion condition shown on Figure D-1; however, it could in the future. A more cautious approach may be to expand the setback area further inland to allow for this uncertainty of estimating the limits of erosion-prone area. However, erosion has in the past progressed to a point where park trees, beach and grass areas have been destroyed. For the above reasons, implementation of a shoreline setback area may not be feasible or acceptable to agencies or persons most concerned about protecting existing recreational facilities.

2.3 Protective Beach (Alternative No. 2)

2.3.1 The alternative plan provides for the maintenance of a protective beach along a 1,000-foot long reach of park shoreline (see Figure D-2). The average dry beach width would be increased by about 20 feet, increasing the average dry beach area by about 20,000 square feet. An estimated 25,000 cubic yards would be required about every 5 years to nourish the beach and maintain the increased average size. Based on the existing beach slopes, the new beach would have a foreshore slope of about 1 vertical to 15 horizontal.

2.3.2 A protective beach, created by placing clean beach sand along the shore, would dissipate wave energy impinging on the shoreline and protect the backshore area from erosion. The protective beach would function as a shore protection structure as well as serve as a recreation area, and would be a relatively natural and effective way of protecting the shoreline. Beach restoration with periodic nourishment to maintain an established beach width represents a measure which is considered compatible with the existing natural and visual setting of the park. A serious consideration, however, is the commitment of large quantities of clean, natural beach sand over the life of the project.

2.4 Commercial Sand Sources

2.4.1 Important considerations in the beach restoration alternative were the availability and cost of commercial sand. The plan would require large initial quantities of clean, natural beach sand over the life of the project.

2.5 Offshore Sand Mining

2.5.1 An offshore reconnaissance survey of two potential sand source areas in Kailua Bay for Kailua Beach Park beach nourishment has been conducted (Ref. 13). The survey delineated the area, depth, and type of sand resources in these areas. Figure B-3 shows the approximate location of the potential sand sources in relation to the project area. At the present time, commercial offshore sand mining within 1,000 feet of the shoreline or in water depths of less than 30 feet is prohibited by State Law (Hawaii Revised Statutes § 205.33, as amended). Figure B-3 shows that all of Deposit #2 and some of Deposit #1 probably lie within depths shallower than 30 feet but more than 1,000 feet offshore. A draft amendment (Bill R16) to the State offshore mining law is now in the State Attorney General's Office and will be introduced into the legislature in 1978. This amendment, if passed, will allow government agencies to mine offshore sand deposits in depths shallower than 30 feet and less than 1,000 feet offshore, if the purpose is for the replenishment of beaches, and if the responsible government agency obtains permission of all government agencies having jurisdiction thereof.

SECTION 3

ENVIRONMENTAL SETTING WITHOUT THE PROJECT

3. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

3.1 Physical Setting. The geologic setting of Oahu has been described in the DPR (Reference 10 & 16). The Kailua area is essentially a suburban community of metropolitan Honolulu as many residents commute daily to places of employment across the Koolau mountains. There are no major industries located in the Kailua area. Kaneohe Marine Corps Air Station is located on Mokapu Peninsula at the extreme northwestern end of Kailua Bay. The 2-1/2 mile crescent-shaped Kailua Beach is bordered by Kapoho Point on the northwest and Alala Point on the southeast. The Kailua Beach Park Erosion Control study area is located on the southeastern end of Kailua Bay. Kailua Beach Park is bounded on the southeast by Alala Point and on the northwest by Kailua Road. Popoia, popularly known as "Flat Island", a low limestone island is located approximately 1/4 mile offshore from the park. The park area has an average elevation of about 8 to 10 feet above Mean Lower Low Water (MLLW). A fringing reef extends about 1,000 feet seaward of the park's northeasterly-southwesterly trending shoreline. Kaelepulu Stream enters Kailua Bay about midway in the park's length. A sandbar usually closes the mouth of Kaelepulu Stream. The two large sand deposits proposed as possible sources for the project are located approximately 3,000 to 6,000 feet offshore in Kailua Bay. Kailua Beach Park is a very popular public recreation area and includes a pavilion, comfort stations, a food concession, parking areas, picnic tables, potable water and showers. A boat launching ramp is located at the south end of the park. The park users engage in the following recreational activities: picnicking, swimming, surfing, boating, fishing, games and jogging (Ref. 18).

3.2 Land Use

3.2.1 Kailua Beach Park has developed in stages from 1920 to the present in response to the growth of the Kailua area (oral comm., Y. Takeda, City and County Department of Parks and Recreation). The park consists of 29.8 acres of land (January 1978). Existing land uses in the Kailua area generally conform to the present land use zoning. Kailua Beach Park is zoned for park use and the surrounding area is zoned residential. The park is surrounded by single-family residences on all sides except on the southeast, where there are cliffs, a road, and natural vegetation (see Figure B-1). Popoia Island, located 1/4 mile offshore is designated as a State Bird Refuge. Improvements in the park include picnic areas, landscaping (trees and grass), restroom facilities, a pavilion, parking areas, water, sewer, electric, and telephone utilities. Shoreline erosion in the southeastern portion of the park has destroyed trees, reduced the sand beach area and the grassed area, and damaged a boat launching ramp, and has deprived the public of the use and enjoyment of these land facilities.

3.3 Historical/Cultural

3.3.1 The proposed project is not located within or adjacent to any historical/archeological sites listed in, or eligible for inclusion in, the National Register of Historic Places (SHPO letter dated 8 February 1978). An archeological reconnaissance of the project area at Kailua Beach Park was conducted on 1 June 1977 (Reference 4). The stretch of beach between the mouth of

Kaelepulu Stream and Alala Point was examined. Hawaiian archeological sites in sand areas are usually apparent as thin (10 to 20 cm thick) black, horizontal layers with charcoal, shell, and artifacts (e.g., Bellows Sand Dune, Oahu; Halawa Sand Dune, Molokai). They can often be observed as black bands in erosion faces. The area between the boat ramp and Alala Point contained no evidence of archeological remains. The area between Kaelepulu Stream mouth to a spot on the beach fronting the comfort station in the south section of the park also had no evidence of archeological remains. The area between the present boat ramp to the spot on the beach fronting the comfort station revealed thin, black lines (less than 1 cm thick) in the sea erosion face. However, all layers observed appeared to be recent, being either compaction of old grass or humus lines, or the result of recent human disturbance. The few cultural artifacts recovered were also quite recent in age.

3.4 Physical Processes

3.4.1 Kailua Beach Park and Vicinity. The physical processes in operation off Kailua Beach Park have been described in detail in the DPR. As a result of these processes, Kailua Beach Park shoreline has eroded and accreted on a recurring basis over a period of years as shown in Figure C-1. Erosion between 1970 and 1977 resulted in the loss of approximately 35,000 cubic yards of sand and 100 feet of beach width (2-1/2 acres) within seven years at the project site. The beach erodes or accretes on minor basis during the seasons and on a major basis over a longer time period apparently related to the long-term direction and duration of trade winds and their effect on longshore currents and sand transport. Sand transport is usually to the northwest, parallel to the beach, during easterly trade wind conditions and to the southeast, parallel to the beach, during northerly and westerly winds and large north swell.

3.5 Biological Resources

3.5.1 Terrestrial. Flora at Kailua Beach Park consists of either intentionally cultivated (e.g., ironwood trees, coconut trees, banyan trees, and grasses) or unintentionally cultivated (e.g., kiawe trees) introduced exotic species. Some ironwood and coconut trees have been lost from erosion of the beach and some ironwoods are currently in danger of loss due to root exposure. The predominant faunal species in the vicinity of the proposed project are birds (see Appendix B). Nesting seabirds on Popoia Island a State Bird Refuge are already subject to considerable disturbance from boaters that land on the island to explore or camp. The birds are protected by State and Federal laws. None of these birds feed to a significant extent in the inshore waters of the proposed project. The project park shoreline (beach) is not a designated wildlife refuge nor a unique ecological area and is of little present value to waterbird species. The Hawaiian duck (*Anas wyvilliana*), an endangered species, is now found rarely in the Kaelepulu Canal. It formerly nested on Popoia Island (Ref. 1). Mammals found in the area consist of rats, the house mouse, the mongoose, feral and domestic cats and loose domestic dogs. Except for the Hawaiian duck, there are no other endangered terrestrial species of flora or fauna at or in the vicinity of the proposed project.

3.5.2 Marine. Data from past studies of Kailua Bay (Refs. 2, 9 & 14) indicate that Kailua Bay is poorly populated by marine organisms. Lack of suitable habitats and possibly over-exploitation of marine resources may have been the primary causes. The project area is practically devoid of algal or coral cover. The dominant fish observed during surveys were surgeon fish and butterfly fish with fish of subsistence and recreational value being less frequently sighted. The area from Kawainui Canal to the north, to Wailea Point to the south consists of a sand bottom extending from the shoreline to about the 20-foot depth. Apparently the constant movement of sand particles by wave and current action effectively prevents the settling and growth of benthic organisms in this area. A marine biological survey offshore from the project area was performed (Ref. 5) and the average depth of the study area was about two meters. This survey confirmed the relative paucity of macro-organisms off Kailua Beach Park. Surgeon fish and wrasses, although low in number, were the predominant fish species during the study and increased slightly in abundance in response to a slight increase in substratum relief as Alala Point was approached (see Appendix C). Local fishermen indicated that fishing for papio and bonefish is good off the boat ramp and off Alala Point. The project area is not located in or adjacent to any designated marine sanctuary and there are no significant or unique marine resources that inhabit the project area.

3.5.3 Aquatic. Kaelepulu Stream exits through Kailua Beach Park, although the stream is usually blocked from entering the sea by a sand bar. The sand bar is periodically breached during large storm runoffs, and by sand bar removal during stream maintenance by the City and County of Honolulu. During these periods, salt-tolerant aquatic fish species pass between Kaelepulu Stream and the sea. Conspicuous fishes at the mouth of the stream are aholehole (Kuhlia sandvicensis), papio (Carangidae), awa (Chanos chanos), and tilapia (Sarotherodon (Tilapia) spp.), unpublished data, (Ref. 19). There are no significant or unique aquatic biota resources that inhabit the Kaelepulu Stream mouth area.

3.6 Water Quality

3.6.1 The waters of Kailua Bay are classified "A" (Reference 15) to be protected for recreation, aesthetic enjoyment, and the support and propagation of aquatic (marine) life. Kailua Bay is located in a Effluent Limitation II Segment (EL II) of the Hawaii Water Resources Regional Study (1975) (Ref. 7). The EL II segment includes those water areas where water quality is meeting or will be higher than the applicable State water quality standards. The water quality of Kailua Bay has been, and is presently, monitored by the State Department of Health at two shoreline locations; the Kalama Beach station (#207) situated about midway down the length of Kailua Beach and the Kailua Beach Park station (#193) near the mouth of Kaelepulu Stream. These stations are sampled twice monthly for bacterial analyses, and in addition, the Kailua Beach Park station is sampled once a month for chemical data. Results from these stations are generally typical of nearshore waters on Oahu (Eugene Akazawa, DOH, pers. comm., January 1978). While high levels of bacteria are found in Kaelepulu Stream, concentrations in adjacent ocean waters are low since the stream is generally separated from the ocean by a sandbar, except for a short period of time following periodic cleaning or natural breaching. Also, rapid bacterial "die-off" as a result of contact with seawater and sunlight may be responsible for maintaining the safe levels observed. Nutrients in bay waters do not meet existing State Class "A" water quality standards for receiving waters. However, this is not unusual for waters in Kailua Bay, or for that matter, the marine waters of the State as a whole (Hawaii Water Resources Regional Study, 1975). Injection of treated sewage effluent previously discharged into Kailua Bay has now been diverted to the new outfall offshore from Mokapu Point beginning in December 1977. Holmes and Narver, Inc. (1959) predicted that with the diversion of treated sewage discharge to Mokapu Peninsula outside Kailua Bay, inshore water quality in Kailua Bay would improve (Ref. 8). Since the new outfall has been in operation and the sewage treatment plant operations have been improved, the number of odor complaints has dropped significantly downwind of these facilities. The amount of water quality data that has been obtained since initiation of the new outfall is insufficient to accurately assess or detect any significant change or trend in the water quality of Kailua Bay. Bacterial contamination of the Kailua Beach Park project area by effluent from the new outfall will not occur during trade wind conditions due to current direction, distance and bacterial "die-off" factors. During "Kaneohe wind" conditions and heavy rains there may be a very slight possibility of bacterial contamination at Kailua Beach Park due to southeasterly longshore currents and the extended die-off times of bacteria in the top freshwater layer of the bay. Confirmation of this scenario has not been made because these conditions have not occurred since initiation of the new sewer outfall.

3.7 Noise Quality

3.7.1 The natural noise level in the project area is generated by wave, wind, and wildlife. Superimposed upon the natural level are man-induced noises generated primarily by nearby automobile traffic and the other usual noise sources of a residential district.

3.8 Air Quality

3.8.1 The nearest State air quality monitoring station is located at the town of Waimanalo, located approximately 3-1/2 miles distant to the southeast. The values at this station for the period January 1976 to March 1977 did not exceed the State Air Quality Standards of 100 micrograms/m^3 for particulate matter. The air quality at the project site may be described as excellent.

3.9 Recreation

3.9.1 Kailua Beach Park provides park users with the following facilities: a sheltered pavilion, picnic tables, potable water, restrooms, showers, cooking facilities, parking, a food concession, a playfield, a pay telephone, and lifeguard towers. The park users engage in the following recreational activities: picnicking, windsurfing, diving, swimming, surfing, boating, jogging, and fishing (Ref. 10). Four floats (buoys) are located approximately 150 feet offshore from the park shoreline. They are used to delineate the safe swimming area off the park shoreline. The sand beach at Kailua Beach Park is used for launching and beaching Hawaiian outrigger canoes, Hobie cats, surfboards, and windsurfers. Kailua Beach Park is the only public beach park along the shoreline of Kailua Bay and is also the most heavily used park facility in the Kailua area (City and County Department of Parks and Recreation) (Oral comm., Y. Takeda, 25 January 1978).

SECTION 4

RELATIONSHIP OF THE ALTERNATIVES TO LAND USE PLANS

4. RELATIONSHIP OF THE ALTERNATIVES TO LAND USE PLANS

4.1 The project does/does not conflict with existing or future Federal, State, or local land use plans, policies or controls for the Kailua Bay area or Kailua Beach Park. The Kailua Beach Park Study area is expected to remain in park use and open space indefinitely. Beach nourishment is not expected to conflict with future park use and plans but may affect the Park Master Development Plan. The shoreline management (setback) alternative may also conflict with the Park Master Development Plan now being devleoped (Ref. 6).

SECTION 5

PROBABLE EFFECT OF THE ALTERNATIVES ON THE ENVIRONMENT

5. PROBABLE EFFECT OF THE ALTERNATIVES ON THE ENVIRONMENT

5.1 Shoreline Management or Setback (Alternative #1).

5.1.1 This alternative does not involve any physical alteration of the shoreline or marine environment by man. A long-term erosion/accretion pattern exists at Kailua Beach Park. During the erosion phase of the long-term cycle, erosion would probably continue at a current average annual rate of 20 feet per year resulting in the loss of park land, sand, vegetation, and creating new marine habitat. During the accretion phase of the cycle, land area, sand, and vegetation would be gained and a marine habitat lost. The cyclical erosion/accretion at Kailua Beach Park is primarily governed by random fluctuations in meteorlogical conditions; hence it is impossible to predict with any certainty the future shoreline position.

5.1.2 A setback could require modification of the Kailua Beach Park Master Development Plan. The gradual cyclic reduction in park land area and the setback zone may limit or restrict development of activities or facilities envisioned in the Master Plan, and may reduce the recreational value of Kailua Beach Park. Fixed facilities presently threatened by erosion may eventually be lost. It is possible under this alternative that future erosion may progress to the park boundary and threaten the safety of adjacent private properties.

5.1.3 This alternative poses no significant adverse impacts to the sparse terrestrial, marine, and estuarine biota of the project area. This alternative will not change the present air, noise or water quality, nor alter the natural physical regime of the ocean in the project area.

5.2 Protective Beach (Alternative #2).

5.2.1 This alternative would result in the placement of an estimated 25,000 cubic yards of sand at about 5-year intervals to nourish the beach and increase the average width by 20 feet and average area by 20,000 square feet. Sand, if obtained from a terrestrial source, would be hauled to the construction site by truck and dumped at the shoreline. A bulldozer or grader should be used to spread the sand along the beach. Vehicular traffic would create temporary traffic, noise, and air pollution nuisances in the park and in the adjacent residential area. Because the park has a low visitor usage during the week days, traffic inconveniences are not expected to be significant in the park, but would add extra traffic to the highways between the sand source and the project site. Placement and working of sand may temporarily increase water turbidity adjacent to the shoreline. Sand, if obtained from an offshore source, would be pumped onto the beach through a pipeline and some temporary increase in turbidity may occur, but certain sand mining methods have been developed which can minimize turbidity problems (Ref. 3.11). No nuisances from sand hauling vehicles would occur from offshore sand mining; however, some noise, and air pollution may be generated by equipment utilized to spread the sand on the beach (if such equipment is needed). The use of a portion of the beach area would be prohibited during beach nourishment operations. No known archeological resources in the park would be affected by beach nourishment. No threatened or endangered species or their habitats would be significantly affected by the beach restoration activities. Disturbance of the shoreline (beach) in the project area will eliminate or alter some shorebird feeding habitat, but the area is not unique and is of little present value to these species by comparison to other areas. Also, the restored beach will provide similar if not better feeding habitat after completion of the project. If the project opens the Kaelepulu Canal, it may help to restore some circulation in the upper Canal and in Kaelepulu Pond, with potential positive effects on resident waterbirds. Presumably, the project will have little, if any effect on vegetated portions of the beach park. In any event, birds in the park are all common, widely distributed urban species and would adjust to disturbances quickly.

5.3 Commercial Sand Sources

5.3.1 Use of natural commercial beach sand for beach nourishment will commit quantities of nonreplenishable sand from land sources to shoreline recreational use. Land sources for sand are in great demand and in limited supply in Hawaii. After initial beach nourishment, the nourishment sand may be lost to deeper waters or transferred along the shoreline to other areas outside of the project area. Periodic maintenance of the project area with commercial sand will be required.

5.4 Offshore Sand Mining

5.4.1 Use of offshore sand for beach nourishment amounts to the loss of certain quantity of offshore sand and a gain of the same quantity of sand along the shoreline at the project site. After initial beach nourishment, this sand may be lost back to deeper waters or transferred along the shoreline to other areas outside of the project area. It is possible that sand removed by mining may be naturally replenished over a period of time although the extent and mechanisms for sand replacement at the proposed offshore recovery sites are unknown at this time. Any benthic biota utilizing the sand mining source area as a habitat would be destroyed or displaced. However, available information indicates that benthic organisms are sparse at two proposed offshore sand sites in Kailua Bay. Similar species near the sand source area would act as the "seed" populations or sources of recruitment during recolonization of the dredged sand source area. Equipment utilized for mining the source area will be sufficiently far removed from the shoreline that it will cause no noise impacts upon shoreline residents or beach users. Some offshore boating and windsurfing activity may be temporarily affected.

SECTION 6

ANY PROBABLE ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

6. ANY PROBABLE ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

6.1 Shoreline Management or Setback

6.1.1 The establishment of a shoreline management or setback zone is an administrative procedure and does not involve a physical modification to the existing environment. The establishment of the shoreline management or setback zone could influence future development plans for the Kailua Beach Park, possibly limiting or restricting the types of recreational activities and facilities planned for the park under present planning concepts. Erosion of the park shoreline would result in the loss of park land, sand, and vegetation. Restroom facilities and other fixed structures may be threatened or damaged. There would be a net gain of marine habitat at the loss of terrestrial habitat in the park.

6.2 Protective Beach

6.2.1 Nourishing the beach involves temporary traffic, noise, and air pollution nuisances within the park. Placement and movement of sand would temporarily increase water turbidity close to shore. Individual algal and sessile marine organisms would be destroyed by burial. Their loss would not alter the presence of similar species in the Kailua coastal area. Use of portions of the park beach would be prohibited to the public during the beach restoration operations.

6.3 Commercial Sand Sources

6.3.1 A loss of sand from the commercial sand source(s) will occur during periodic nourishment of the beach at the project area.

6.4 Offshore Sand Mining

6.4.1 A loss of sand from the offshore sand mining source(s) will occur during periodic nourishment of the beach at the project area. Any benthic biota utilizing the sand mining source area(s) as a habitat would be destroyed or displaced.

SECTION 7

ALTERNATIVES TO THE PROPOSED ACTION

7. ALTERNATIVES TO THE PROPOSED ACTION

7.1 This section discusses those alternative plans which were not selected after the initial screening and analysis of all reasonable alternatives.

7.2 Non-Structural Measures

7.2.1 No Action - The "Without Condition". The no action condition means that the Federal Government or local agencies would not take any action to prevent or minimize recurring erosion of the park shoreline or erosion-related damages to the park. The "no action" or "do nothing" alternative has not been considered an acceptable course of action. In addition to loss of public beach park land, potential loss of park facilities may occur during the erosion phases of the erosion-accretion cycle. For these reasons, the request for some type of action on the erosion problem has been made by the State of Hawaii and the City and County of Honolulu.

7.3 Structural Measures

7.3.1 Shoreline Revetment. The construction of a revetment is the most direct method of protecting a shoreline from continued erosion. It would be constructed adjacent and parallel to the eroding shore to separate land from water. Revetments were eliminated from further consideration primarily because of the varied recreational use of the beach and visual/aesthetic aspects. The revetment is essentially a rock wall parallel to the shore and may interfere with shoreline access to the sandy beach. The revetment may also discourage the accumulation of sand fronting the structure.

7.3.2 Groins. Groins, or short walls perpendicular to the shore, can be used to effectively control beach erosion and promote the accumulation of sand along the shore and are particularly effective in retarding erosion due to the longshore transport of sand. However, because of the beach processes at Kailua Beach as discussed in the DPR, it is likely that the use of groins to stabilize one portion of the beach park shoreline would shift the area of recurring erosion/accretion to the beach immediately adjacent to the last groin. For this reason, the use of groins is not considered a feasible alternative for erosion control at Kailua Beach Park.

7.3.3 Offshore Breakwater. An offshore breakwater is a structure designed to protect an area from wave action and intercept the movement of littoral material by dissipating the wave forces that would normally move it. The offshore breakwater shares some of the visual/aesthetic disadvantages of both revetments and groins. It would also interfere with recreational water activities such as power boating, windsurfing, and sailing. In addition, an offshore breakwater would shift the problem to the adjacent unprotected shoreline similarly to the effect of groins.

7.4 Supplementary Measures/Programs: Plans of Others

7.4.1 In recognition of the severity and urgency of the erosion problem, the City and County of Honolulu is presently undertaking temporary interim measures to minimize the erosion and to stabilize the existing park shoreline until a long-term plan can be implemented. The temporary measure consists of placing hollow concrete building blocks tied together with galvanized steel rods parallel to the shoreline to entrap sand and build back sections of the beach. The system is known as the "Sandgrabber". A 250-foot length of sandgrabber has been buried in the sand seaward of the parking lot at the southeast corner of the park to protect it during periods of erosion.

SECTION 8

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

8. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

8.1 Shoreline Management and Setback. Kailua Beach Park is situated on a sand barrier which has been changing its configuration as a result of the natural forces acting on the beach. The development of the Kailua Beach Park with fixed facilities and landscaped areas created a conflict between man's intended use of the area and the natural shoreline processes affecting the dynamic, sand barrier environment. Shoreline management and setback is intended to reduce the conflict between man and nature by limiting or restricting certain development in the areas threatened by erosion. The alternative allows natural processes to occur with minimal impact or physical modification to the park environment. Shoreline management and setback does not protect existing facilities in the area threatened by erosion and does not prevent further loss of subsurface cultural resources. The alternative may limit and restrict development of the long-term recreational potential of the park area. Erosion may continue to result in a net decrease of park land and terrestrial habitat, but also resulting in a possible net increase in marine habitat.

8.2 Protective Beach

8.2.1 Beach nourishment would provide a protective sand beach area along the southeastern park shoreline and increase the average size of the sand beach area. The alternative would permit continued long term park development in accordance with the master plan. However, this alternative requires periodic sand replenishment possibly contributing to a drain on existing non-replenishable sand sources in Hawaii. The alternative would destroy many benthic marine organisms which may have colonized the sandy bottom, but does not affect any fishing activities located at Kailua Beach Park.

8.3 Foreclosure of Future Options

8.3.1 None of the above alternatives completely forecloses possible future options such as a breakwater or shoreline revetment.

SECTION 9

ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED SHOULD THE ALTERNATIVES BE IMPLEMENTED

9. ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED SHOULD THE ALTERNATIVES BE IMPLEMENTED

9.1 Shoreline Management or Setback

9.1.1 This alternative modifies human concepts in the development of the area as a park. Natural shoreline processes would remain unchanged. Money and human labor would be committed irretrievably to the management program.

9.2 Protective Beach

9.2.1 This alternative requires the irretrievable commitment of money, human labor, and an estimated 25,000 cubic yards of sand nourishment every 5 years for beach maintenance. Sand supplies on land are valuable depletable resources in Hawaii. Marine sources of sand may be periodically replenished naturally.

SECTION 10

COORDINATION AND COMMENT AND RESPONSE

10. COORDINATION AND COMMENT AND RESPONSE

10.1 The US Army Corps of Engineers, Honolulu Engineer District, is responsible for conducting and coordinating the study and preparing the study report. Close contact has been maintained with the State of Hawaii, Harbors Division, which initially requested the study and serves as local sponsor of the project; and with the City and County of Honolulu, Department of Parks and Recreation on whose behalf the request for assistance was made.

10.2 Information and comments received from the following agencies during study coordination in 1978 were also considered in identification of study concerns and development of alternative plans:

- US Environmental Protection Agency, Honolulu Office
- US Soil Conservation Service
- US Forest Service
- US National Park Service
- US National Marine Fisheries Service
- US Fish and Wildlife Service
- State Historic Preservation Office
- State of Hawaii, Department of Land and Natural Resources, Division of Fish and Game
- State of Hawaii, Department of Land and Natural Resources, Division of Forestry

10.3 A public workshop for community organizations was held on 29 November 1977. The workshop focused on the beach processes affecting erosion and the development of planning objectives and the evaluation of alternative beach erosion control measures. Additional informal presentations and coordination of the plans discussed in this report will be made to representatives of community organizations and public agencies during March and April 1978. A formal public meeting is scheduled for April 1978. The Corps circulated a public notice on the interim "sandgrabber" alternative on 16 September 1977. Public response to the public notice resulted in the Corps sponsoring a public hearing for the "sandgrabber" project on 6 December 1977. At the public hearing the County presented a modified version of the project and subsequently submitted a modification to their permit application. A Department of the Army permit was issued to the County on 16 January 1978.

10.4 The draft environmental statement is being circulated to the agencies listed in paragraph 10.2 and all interested parties and individuals.

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REFERENCES

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APPENDIX A

PREDOMINANT FAUNAL SPECIES IN THE PROJECT AREA

APPENDIX A

	Offshore Islands	Shoreline	Kailua Park Area
Marine Birds			
Wedge-tailed Shearwater	common nests	uncommon	
Bulwer's Petrel	common nests		
Other seabirds - fly by only (Brown Booby, Red-footed Booby, Great Frigatebird, Sooty Tern, Black Noddy, Brown Noddy)	fly by	fly by	
Waterbirds *(Migratory mostly Sep - May)			
Mallard			uncommon in canal only
Hawaiian Duck	formerly nested		rare in lower canal
American Golden Plover*	uncommon	uncommon	common on grass
Bristle-thighed Curlew*		rare	
Wandering Tattler*	common	common	
Ruddy Turnstone*	common	uncommon	
Sanderling*		uncommon	
Introduced Non Game Birds			
Red-vented Bulbul			common
Japanese White-eye			common to abundant
Common Mynah			abundant
House Sparrow		uncommon	common to abundant
Spotted Munia		uncommon	uncommon
Red-crested Cardinal			common

APPENDIX A (cont)

	Offshore Islands	Shoreline	Kailua Park Area
Introduced Non Game Birds (cont)			
Northern Cardinal			uncommon
House Finch			common
Introduced Game Birds			
Rock Dove (pigeon)			uncommon
Spotted Dove		common	abundant
Barred Dove		common	abundant
Mammals			
Black Rat (Roof)		probably uncommon	probably common
Brown Rat (Norway)		probably uncommon	probably uncommon
Polynesian Rat	uncommon		probably uncommon
House Mouse	common	uncommon	common
Dogs (probably very few wild but many loose domestic)		common	common
Mongoose		uncommon	common
Cat (Feral and domestic)		uncommon	uncommon

APPENDIX B

MARINE BIOLOGICAL SURVEY IN THE PROJECT AREA
RECOMMENDATIONS AND CONCLUSIONS

APPENDIX B

(Extracted from: Marine Biological Survey for the Kailua Beach Erosion Control Project Site, Kailua, Oahu, 1977; Environmental Consultants, Inc.)

RECOMMENDATIONS AND CONCLUSIONS

Sometime in the distant past sand inundated the area surrounding the hard bottom communities at Kailua Beach Park (Stations 1 through 5). The assemblages here now are subjected to scouring and periodic burial with subsequent uncovering and recolonization of hard bottom. Much of the extant biota consists of species able to rapidly colonize hard bottom or survive in areas of shifting sand. Generally, these organisms have a high turnover rate (i.e., growth, reproduction, and death), and seasonal variations in their abundance can be expected. At present, it appears that these are the types of organisms most successful on the back reef environment off Kailua Beach. Many biological components of flourishing coral reef systems are presumably long-lived, have low turnover rates and, hence, would tend not to be found in this environment.

Movement of sand across the bottom in the survey area is a natural factor in this environment. The presence of extensive shoreline sand deposits at Kailua Beach Park demonstrates this long-standing trend of onshore sand transport. The beach is supplied from submarine deposits (e.g., the sand flats immediately offshore and sand channels extending across the reef flat) of sediments generated on the reef by the death and fragmentation of lime-secreting organisms (foraminifera, Halimeda, corals, molluscs). It is necessary for this onshore sand movement to continue if a beach is to be maintained at the Park because sand is always being lost by wind-transport inland, or carried into deeper water by longshore currents.

Increased bedloads of sand may occur locally as a consequence of the erosion at the shore. Much of the sand cut back from the beach is deposited on the reef flat. Some of this sand may be lost from the system if carried into deeper water, but the remainder may eventually return to the beach. A seasonal or periodic onshore/offshore cycle of sand transport is probably a normal characteristic of the area, accounting for the low faunal diversity observed here. Although mitigation of shoreline erosion could have the effect of temporarily increasing sand transport through the nearshore reef areas surveyed (depending on the course of action taken), the effect would not prove detrimental to the biotic communities present.

The biota observed on hard bottom is comprised primarily of species able to colonize under the conditions of sediment abrasion and local deposition. A change in abundance might accompany increased nearshore bedloads, but such changes would be local, temporary, and probably within the variation now expressed seasonally or periodically. Deposition over wide areas resulting in loss of the hard bottom biota would be unlikely, and certainly temporary, as exposure of this substratum is in equilibrium with present sea level and beach development. The extant biota on hard bottom contains no unique or endangered marine species.

Biota associated with the sand deposit immediately seaward of the beach (only Ptyehodera flava was observed here) would not be adversely affected by beach restoration or activities carried out in conjunction with restoration. No unique or important marine features were observed in this area. The biota present should readily adjust to changes in deposition and/or sand movement resulting from additions of sand to the beach.