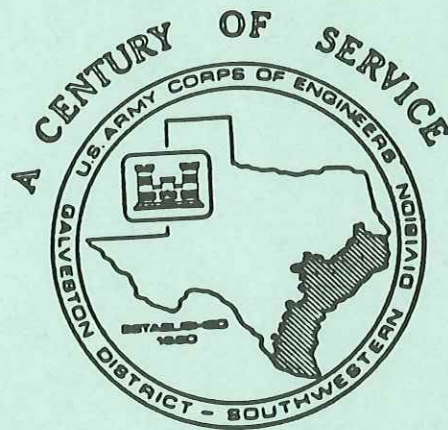


GALVESTON COUNTY SHORE EROSION STUDY

FEASIBILITY REPORT ON BEACH EROSION CONTROL

VOLUME 1 MAIN REPORT

John M. Arrington
7025 Kopman
Houston, Texas 77061
1-713-649-4795 1-409-737-2684
TEXAS BEACH RESTORATION



**U.S. Army Engineer District, Galveston
Corps of Engineers
Galveston, Texas**

SYLLABUS

The Galveston County Shore Erosion Study has been the vehicle to investigate erosion problems along the Gulf and bay shorelines of Galveston County and the Gulf beach at the Village of Surfside Beach in Brazoria County. The primary purposes of the study have been to determine the magnitude and extent of the shore erosion problems in these areas and to develop suitable plans for eliminating or minimizing the problems.

The results of the study show that the shorelines of Galveston Bay and the Gulf of Mexico are rapidly receding in some locations and, as a consequence of the erosion, there is a high potential for large economic losses. The study results also demonstrate that there is an opportunity to accommodate a portion of the increasing demand for recreational facilities in the coastal area. Beach erosion control measures were determined to be justified at three separate locations in the study area and the report recommends Federal participation in their construction. The plans for all the study sites were evaluated using a period of analysis of 50 years (1990 to 2040) and an interest rate of 7 7/8% established by a formula by the Department of the Treasury. Unit costs are at October 1982 price levels. The project sites are identified as Bayshore County Park, the Galveston groin field, and west beach. In addition, beach erosion control measures were determined to be justified at Surfside. However, a Federal project at Surfside is not recommended because of an apparent lack of local sponsorship. The recommended plan of protection for Bayshore County Park consists of a 2,000 foot long rock revetment constructed to a crest elevation of +4 feet National Geodetic Vertical Datum (NGVD), formerly mean sea level. The first cost of this project is approximately \$300,000 and it produces

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GALVESTON COUNTY SHORE EROSION STUDY

VOLUME I

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THE STUDY AND REPORT

STUDY AUTHORITY

The feasibility study to consider providing erosion control measures for the eroding Gulf and bay shorelines of Galveston County was authorized by the following House Committee on Public Works and Transportation resolution adopted on 10 October 1974.

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the titled reports "Gulf Shore of Galveston Island, Texas; Beach Erosion Control Study" submitted in House Document Numbered 218, Eighty-third Congress, First Session; "Shore of Galveston Bay, Galveston County, Texas" submitted in House Document Numbered 346, Eighty-Third Congress, Second Session; "The Gulf Shore of Bolivar Peninsula, Texas (Erosion at Rollover Fish Pass)" submitted in House Document Numbered 286, Eighty-sixth Congress, Second Session; and prior or related reports, with a view to determining the advisability of providing erosion control to the shores of the Gulf of Mexico and Galveston Bay in Galveston County, Texas".

A similar study of the erosion problem at the Village of Surfside Beach in adjacent Brazoria County was authorized by the following House Committee resolution adopted 22 September 1976.

"Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that in accordance with section 110 of the Rivers and Harbors Act of 1962 the Secretary of the Army is hereby requested to direct the Chief of Engineers to make a survey of the shore of the Gulf of Mexico at Surfside, Brazoria County, Texas, and such adjacent shores as may be necessary in the interest of beach erosion control and related purposes."

determined by: (1) identifying eroding shoreline areas, (2) identifying shoreline ownership and use, and (3) identifying shoreline areas where there is local interest in beach erosion control measures. The "Texas Shore Protection" brochure, available by request from the Galveston District, was prepared as part of this study to provide information on the causes of shore erosion and possible solutions to shore erosion problems. It is intended for use by owners or potential purchasers of land affected by shore erosion along Texas bay and Gulf shorelines where local management to minimize the adverse effects of erosion is more appropriate than Federal involvement. In addition, a brochure entitled "Low Cost Shore Protection" is available by request from the Galveston District. This brochure also presents low cost ways for the shoreline property owner to control or slow down shoreline erosion.

The first step in the study was to inventory the study area shorelines and delineate those areas which are experiencing erosion. The remaining shoreline areas that have been historically accreting or are stable were only considered as they relate to the existing erosion problem, or became a necessary part of any recommended erosion control measures. Two types of erosion problems are encountered in the study area: (1) Bank or bluff erosion on the bay shorelines, illustrated in Figure 2, and (2) Gulf beach erosion, illustrated in Figure 3. Both types result from the interactions of winds, waves, currents, water level changes, geologic activity (including subsidence), sediment availability, and the passage of storms. The Gulf beach erosion is the more complex of the two and required a much greater study effort because of the difficulty in assessing the contributing degree of each of the above possible causes to the total erosion problem. Additionally, the effects of inlets and their control structures had to be considered.



BLUFF EROSION ON BAY SHORELINE

FIGURE 2



GULF BEACH EROSION

FIGURE 3

The erosion on the bay shorelines is somewhat less complex in that the erosion results primarily from varying levels of wind-generated wave attack on the bank or bluffs. Also, the waves generated in Galveston Bay are smaller in height than Gulf waves because wave growth is limited by the available fetch and the shallow bay water depths. The smaller wave heights allow consideration of less massive erosion control measures than those necessary to control Gulf beach erosion.

The next step in selecting areas for detailed study was to identify shoreline ownership and use. Federal participation in shore erosion control projects depends on economic and environmental feasibility, i.e., the project must be justified on the basis of economic and environmental benefits. The amount of Federal participation is based on shore ownership, use, and type of benefits. Information developed using this criteria served to screen and eliminate those shorelines that are privately owned with no public recreational use, therefore not eligible for Federal assistance.

Lastly, those areas which were identified as problem areas through the public involvement and coordination process were investigated as to the feasibility of Federal participation in shore erosion control measures.

Five sites have been selected for detailed study. Although these sites are not the only places within the study area experiencing problems from erosion, because of their proximity to developed areas they appear either to have the highest potential for economic or recreation losses; a quantifiable need for providing additional recreational opportunities; or have received public support for beach erosion control measures. Two sites are on Galveston Bay, Bayshore County Park and the San Leon Cemetery (Figure 4), and three are Gulf sites,

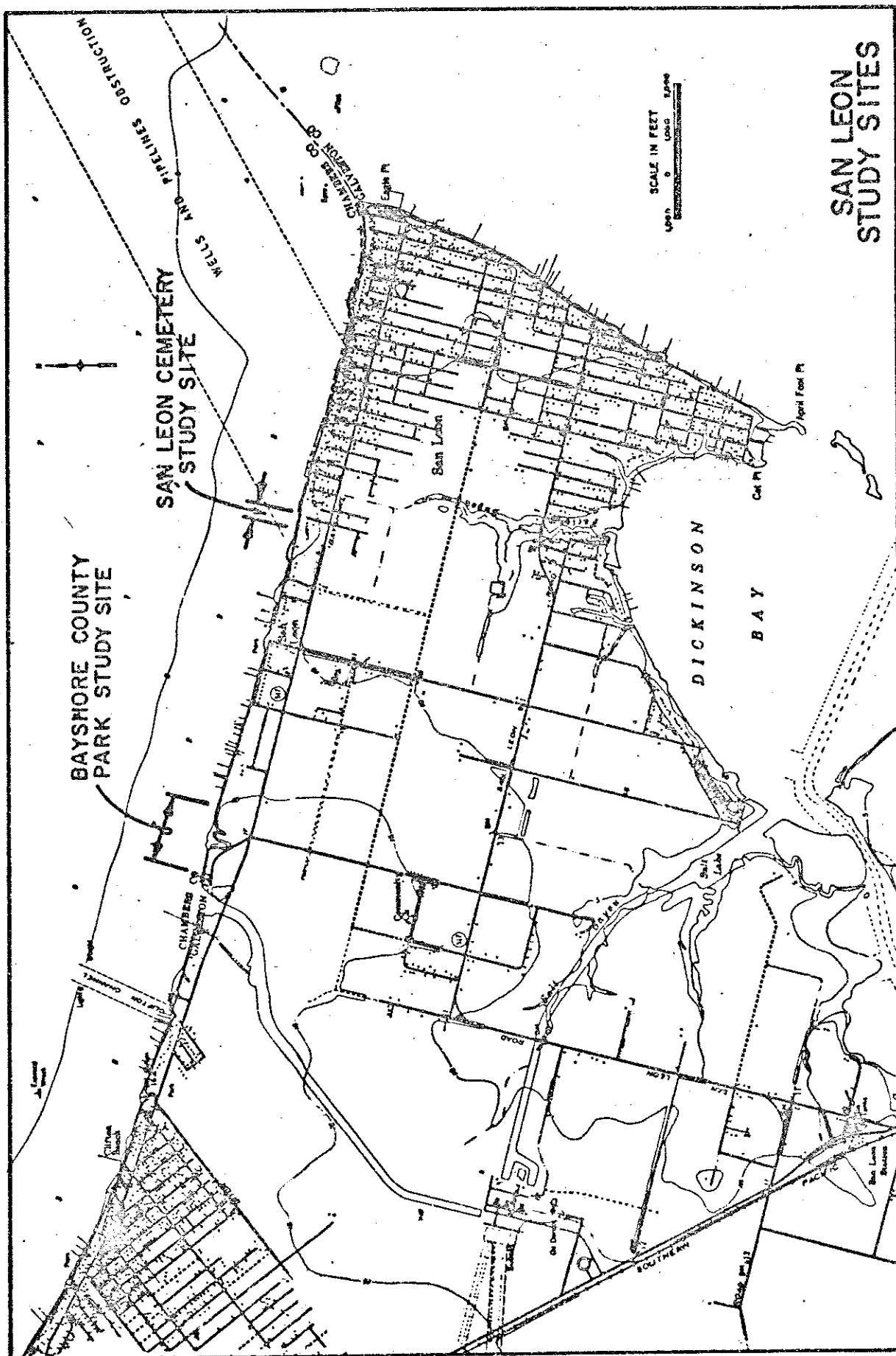


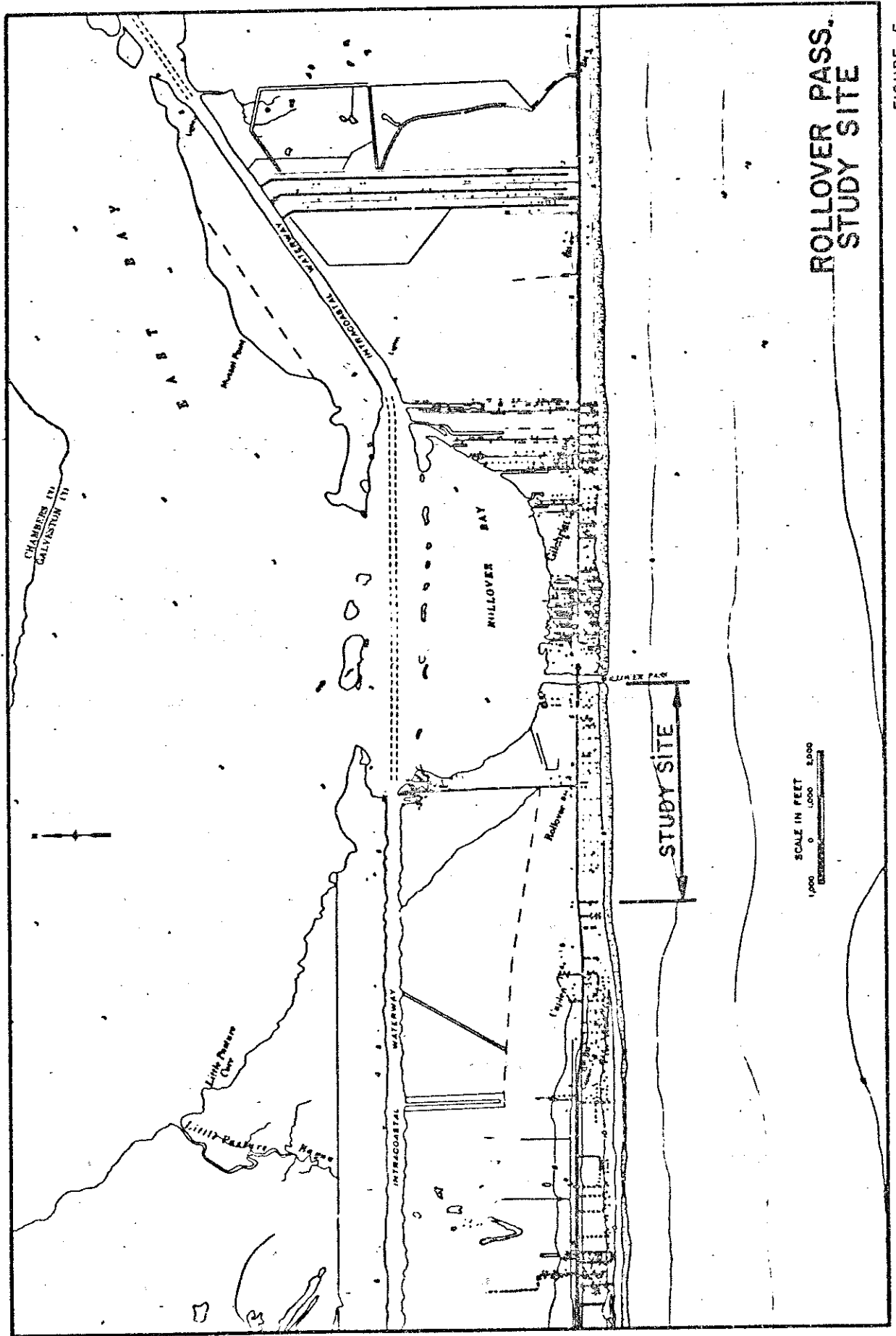
FIGURE 4

Rollover Pass (Figure 5), the Galveston seawall area which was studied as six separate beach segments (Figure 6), and Surfside (Figure 7). The bay shore sites have steep, almost vertical bluffs fronted in some places by very narrow beaches. Bayshore County Park is used mainly for picnicking and fishing. The San Leon Cemetery is a burial site for deceased property owners of San Leon. The beaches at Rollover Pass, west of the end of the Galveston seawall, and Surfside range in width from 100 feet to 200 feet. The beach within the Galveston groin field is approximately 100 feet wide next to the groins, but becomes almost nonexistent midway between the groins. There is essentially no beach area available in front of the seawall from the west end of the groin field to the west end of the seawall. The Rollover Pass area is used extensively for fishing, while the recreation activities at the other Gulf beach sites consist mainly of swimming, sunbathing, and surfing. Some fishing also occurs.

Alternative erosion control measures available for the bay and Gulf shorelines include vegetative erosion control measures, revetments, breakwaters, bulkheads, groins, beach nourishment, and other similar measures. Combinations of erosion control measures, buy-out, and no-action alternatives were also considered. Hydraulic, sedimentary, legal, social, economic, and environmental considerations were investigated during the study of both Gulf and bay erosion problems.

PUBLIC INVOLVEMENT AND COORDINATION

State and Federal legislators, Federal and state agencies, county and city officials, local and private clubs and associations, and the general public have been involved in the study since 1976. Four public meetings were held between 30 November and 9 December 1976 at Port Bolivar, Galveston, San



ROLLOVER PASS. STUDY SITE

FIGURE 5

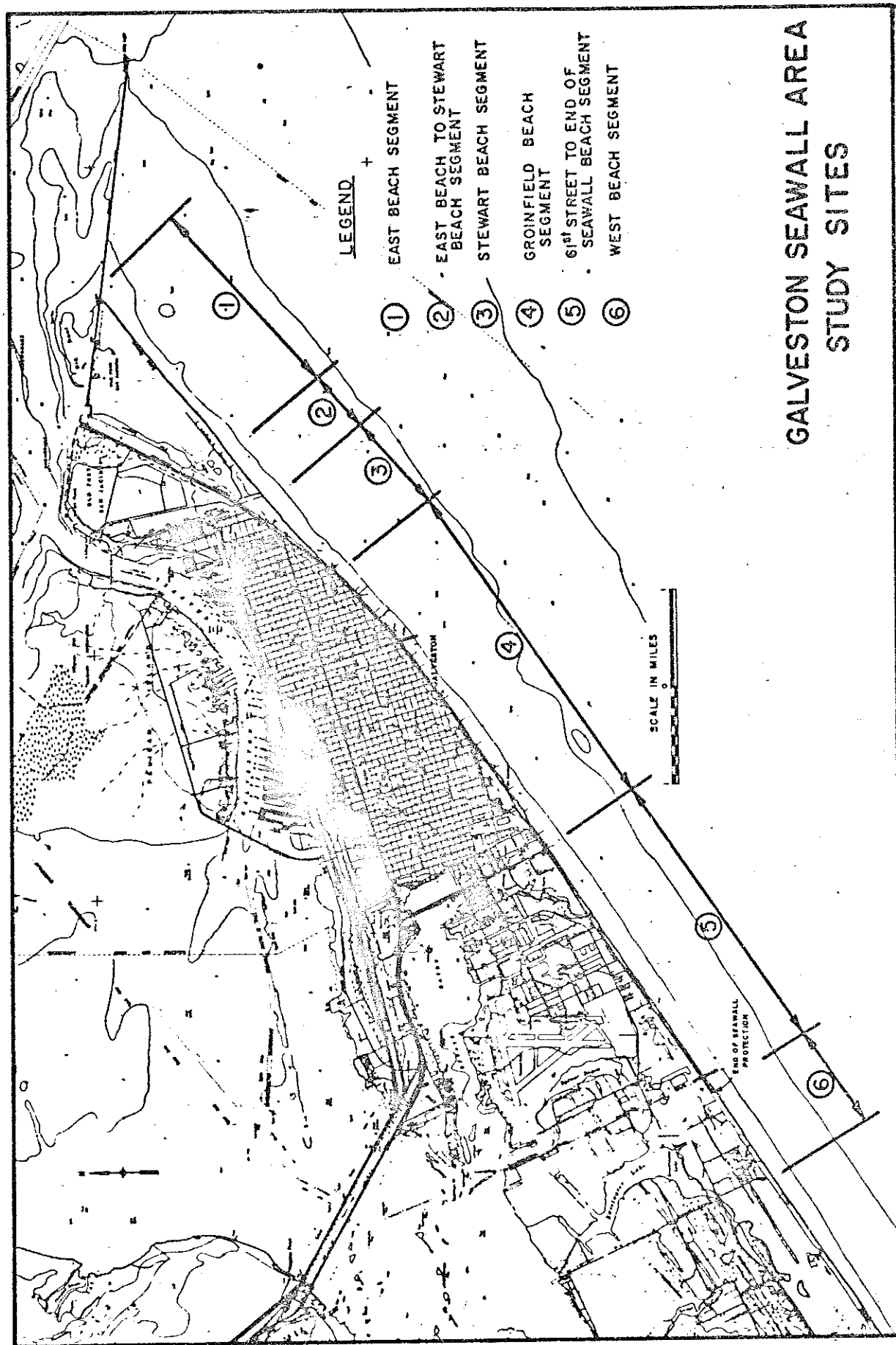


FIGURE 6

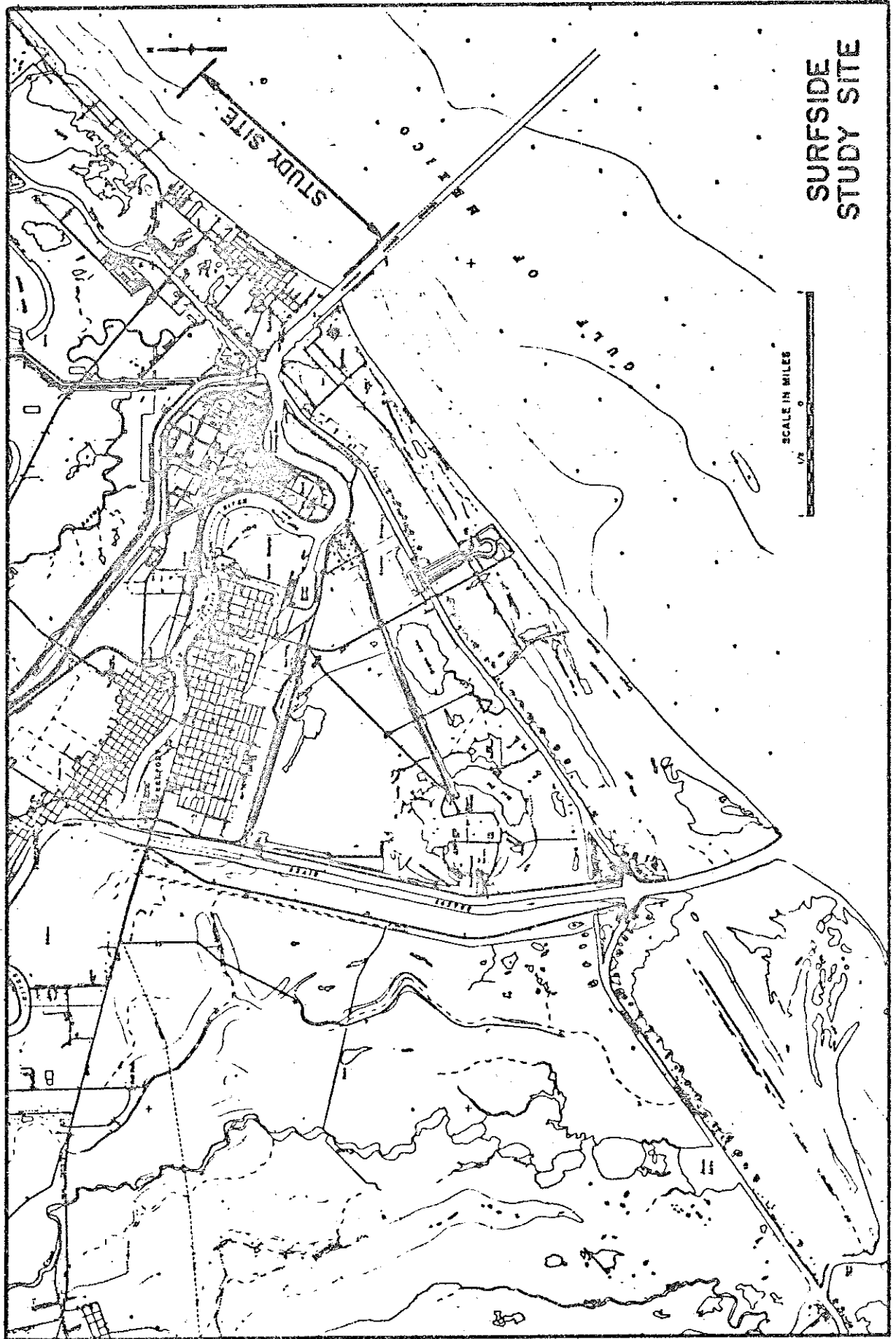


FIGURE 7

Leon and Surfside to involve concerned citizens, assess their views, and gather input for the planning process. There were numerous newspaper articles describing the results of the public meetings and subsequent articles dealing with erosion problems in the study area. Two television programs were aired in the Houston-Galveston viewing area which dealt with erosion causes and possible solutions. Several speeches have been given to technical organizations, school groups, civic organizations, and the U.S. Army, Coastal Engineering Research Board with specific references to this study. Also, numerous telephone calls and letters have been received regarding special concerns of the general public.

A workshop meeting was called by the District Commander on 26 February 1977 concerning the erosion problem at Surfside. The meeting was attended by Corps of Engineers personnel, a U.S. Congressman, a Texas Senator and Congressman, the Mayor of Surfside, the chairman of the Surfside Erosion Committee, the University of Texas Bureau of Economic Geology, a newspaper reporter, and 3 private citizens. The Corps was requested to provide interim technical assistance on beach control measures that could be implemented while the Galveston County Shore Erosion Study was in progress. This technical assistance was provided in June 1977.

A conference between Division and District personnel was held at the Southwestern Division Office on 23 June 1978. The conclusion of this conference was that future beach erosion control reports should not recommend creation of new lands, but restoration of lands for recreational purposes. Also there should be no Federal participation in the construction of access, parking, or sanitary facilities to support recreational use of project beaches; these items should be included as an item of local cooperation.

Several other meetings and workshops were held concerning the study. On 28 October 1980, a meeting with the Texas State Committee to Save Rollover Fish Pass was held at the committee's request so that they could learn of the status of the Galveston County Shore Erosion Study. A meeting on 30 September 1980 was held with the U.S. Fish and Wildlife Service to discuss the preparation of the Coordination Act Report. On 20 February 1981 a meeting was held with the Galveston County Judge to present updated project benefits and costs developed during the study. Similar meetings were held with the residents of Surfside on 27 February 1981 and with a representative from the Planning Department of the City of Galveston on 25 March 1981. A scoping meeting was held on 11 May 1981 at the District Office to identify the significant environmental issues which should be addressed during the study of shore erosion control measures for the study area shorelines.

STUDY PARTICIPANTS

The Galveston District had primary responsibility for conducting and managing the Galveston County Shore Erosion Study. The following paragraphs describe some of the more pertinent investigations accomplished by others for the Galveston District as part of this overall study.

Tetra Tech Inc., Pasadena, California. A contract was awarded to Tetra Tech, Inc., to perform wave and sediment budget analyses for the Gulf study area shoreline. The main purpose of the wave analyses was to define an optimum deepwater wave climate for use in calculations of surf-zone statistics and littoral drift estimates. Establishing the sediment budget over the study area allowed interpretations concerning the nature of the processes involved and causes of the erosion of the study area shorelines.

U.S. Army, Corps of Engineers, Coastal Engineering Research Center (CERC). Participation by CERC involved review of and augmenting wave and sediment budget analyses accomplished by Tetra Tech, Inc.; defining the sediment distribution, sand resources, and geologic character of the inner continental shelf offshore of the study area; and performing hydraulic and stability analyses of the inlets in the study area. The geologic work performed consisted of surveying the inner shelf of the study area using high-resolution, continuous seismic reflection profiles and cores to determine the general geologic character and surface and sub-bottom sediment distribution. The objective was to find and assess the suitability of sand deposits as fill for beach nourishment projects. Inlet hydraulic studies included defining tide-generated flow regimes, flushing capabilities, and bay areas influenced. Inlet stability was evaluated using existing numerical techniques to determine factors producing channel deposition or erosion. Two technical papers have been published as a result of these studies. These are Mason (1981) and Williams, et.al., (1979).

Ecology and Environment, Inc., Houston, Texas. A contract was awarded to Ecology and Environment, Inc., to perform a socioeconomic study. The work performed consisted of compiling socioeconomic data, establishing socioeconomic profiles, and developing input data for an impact assessment of erosion control alternatives evaluated at the areas selected for detailed study.

Rice University, Houston, Texas. A contract was awarded to Dr. John B. Anderson and H.C. Clark to perform geologic investigations. The work performed included; identifying the geologic processes involved and formation of the modern Galveston bay-estuary, fluvial-deltaic, and barrier island

systems; identifying the present-day geologic processes producing changes in the same systems; and assessing man's impact on the coastal geology of these systems.

U.S. Fish and Wildlife Service (USFWS). The USFWS has provided comments on proposed alternative plans and other project matters in a planning aid letter and related correspondence. They also provided a Fish and Wildlife Coordination Act report for the project.

PREVIOUS STUDIES - CORPS OF ENGINEERS

The Corps of Engineers' reports most pertinent to this study are summarized in the following paragraphs.

A report on beach erosion control at Galveston, Texas, printed in 1934 as House Document No. 400, 73rd Congress, 2nd Session, concluded that a system of groins would effectively protect the Galveston Seawall. The groins were completed in 1938. Rehabilitation of the Galveston groin system was authorized by the Chief of Engineers' letter, ENGCW-0, dated 27 October 1960. The work was completed in 1970.

Review of reports on the Gulf Intracoastal Waterway, Texas (Erosion of the West End of Bolivar Peninsula) dated 7 April 1960, considered the effects of waterway improvements on the erosion at the end of Bolivar Peninsula. The erosion was found to result from natural processes. Federal improvements were not recommended and the report was not printed as a congressional document.

A beach erosion control study of the Gulf shoreline of Galveston Island, Texas, made in cooperation with Galveston County and printed in 1953 as House Document No. 218, 83rd Congress, 1st Session, considered methods of providing a

permanent beach along the Gulf shore from the south jetty westward a distance of 12 miles. Federal improvements were not recommended because beach nourishment, the most practical method of providing a beach, did not qualify for Federal assistance under Federal law at that time.

A beach erosion control study of the Galveston Bay shoreline from April Fool Point to Kemah in Galveston County, Texas, was printed in 1954 as House Document No. 346, 83rd Congress, 2nd Session. Federal improvements were not recommended because existing laws included no provisions for assistance in protecting privately-owned shorelines.

A beach erosion control study of the Gulf shoreline of Bolivar Peninsula in the vicinity of Rollover Fish Pass, Texas, made in cooperation with the Texas Parks and Wildlife Department (formerly Texas Game and Fish Commission), was printed in 1959 as House Document No. 286, 86th Congress, 2nd Session. Recommendations proposed in the report to stabilize Rollover Fish Pass were undertaken between July 1958 and May 1959 by the Texas Parks and Wildlife Department.

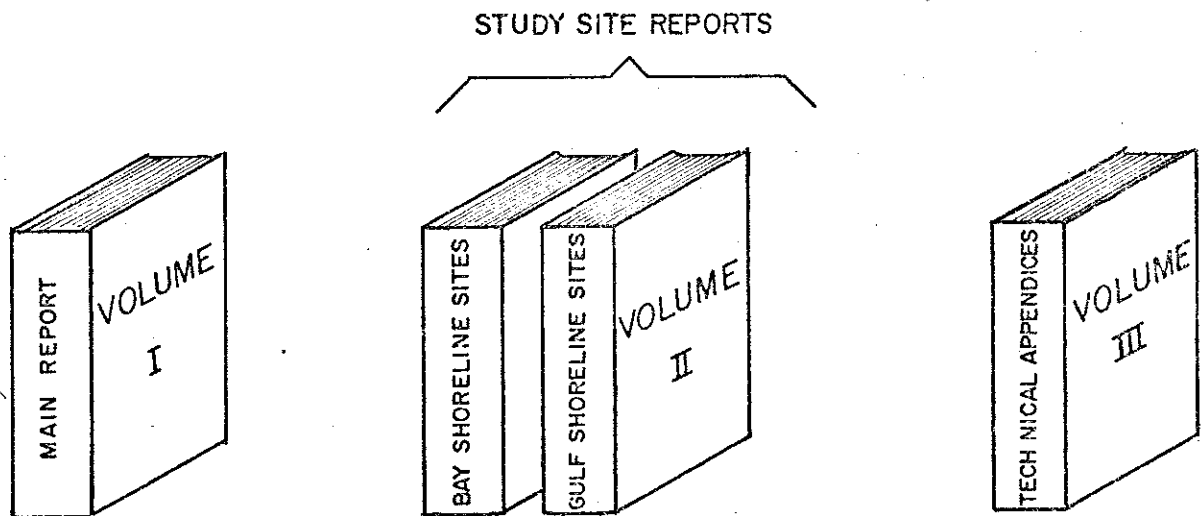
REPORT PRESENTATION

This report on the Galveston County Shore Erosion Study is presented in three volumes. Volume I, the Main Report, functions as an executive summary of the study and presents information on the background of the study, the resources of the study area, the general evaluation procedures and their application, the Federal policies relating to shore erosion control, the results of the engineering, economic and environmental studies, and the findings, conclusions, and recommendations of the District Commander. The Main Report contains the Environmental Impact Statement (EIS) and serves as the principal vehicle for presenting review information and

processing recommendations through the Corps of Engineers' review channels to the Congress. A summary of the methods, procedures, basic assumptions, and supporting data related to the specialized and technical aspects of the study is presented in the Main Report. Detailed information on economic, environmental, and engineering studies is presented in Volumes II and III.

Volume II, Study Site Reports, consists of two sections which cover the Galveston County bay shoreline sites (Bayshore County Park and San Leon Cemetery), and the Gulf shoreline sites (Rollover Pass, the Galveston seawall area, and Surfside). Each section of Volume II includes specific information on the problems of the area, as well as the results of studies performed to determine the engineering, economic, and environmental feasibility of beach erosion control measures for each area.

Volume III, Technical Appendices, augments information in Volumes I and II. It is not intended to "stand alone" but serves as "back-up" to the other volumes. The Appendices contain details on project economics and public involvement and coordination. Additional "supporting documentation" concerning coastal engineering analyses, area economic studies, socioeconomic factors, and natural resources is contained in the Galveston District study files. The sketch shown in Figure 8 is a graphical index to the organization of the Galveston County Shore Erosion Study report.



REPORT ORGANIZATION

FIGURE 8

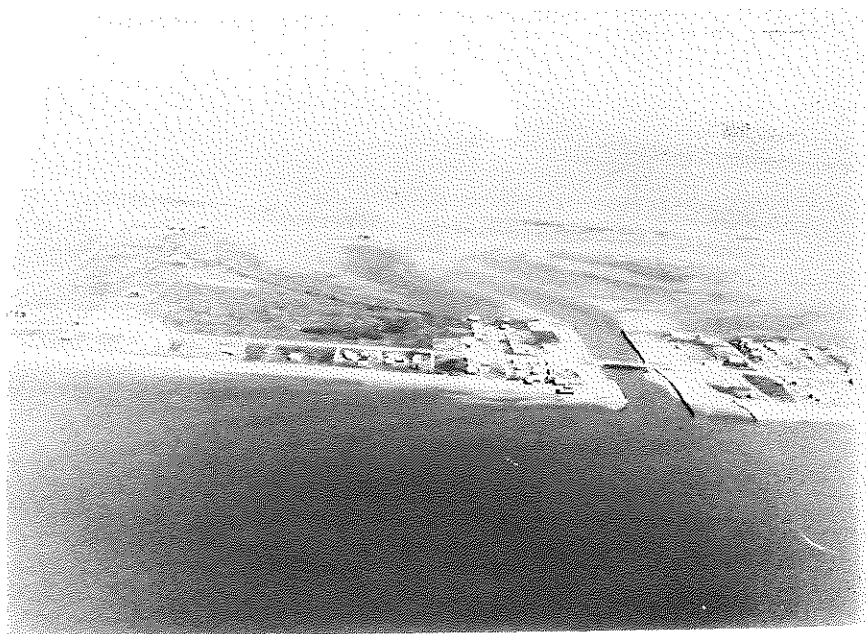
RESOURCES OF THE AREA (EXISTING CONDITION)

DESCRIPTION OF THE AREA

The Galveston County portion of the study area includes Bolivar Peninsula, Galveston Island, and the mainland shores of the county. Bolivar Peninsula extends about 25 miles southwestward from the mainland of the upper Texas coast and varies in width from 1/2 to 3 miles. With the exception of several small communities containing permanent and summer home residential developments, Bolivar Peninsula is essentially rural with only scattered development. Rollover Fish Pass, a man-made tidal pass between the Gulf of Mexico and East Bay, is located about 20 miles from the southwestern end of Bolivar Peninsula (Figure 9). The southwestern end of the peninsula is separated from Galveston Island by the Galveston Harbor Entrance which is a twin-jettied inlet between the Gulf and the Galveston Bay system (Figure 10). The Galveston Bay estuarine system covers an area of about 560 square miles and includes Galveston Bay, Trinity Bay, East Bay, West Bay, and numerous minor open water areas. In addition to water areas, estuarine marsh areas adjacent to the system total over 120 square miles.

Galveston Island is a 28-mile long barrier island, oriented in a northeast-southwest direction and varies in width from 1/2 mile to 3 miles. The developed portion of the City of Galveston occupies the northeastern 1/3 of the Island and is protected from storm waves on the Gulf side by a concrete seawall approximately 10 miles long (Figure 11).

The city has recently annexed most of the remaining 2/3 of the Island which contains several resort-type residential developments. The annexed area excludes a 1,920-acre state



ROLLOVER FISH PASS

FIGURE 9



GALVESTON HARBOR ENTRANCE

FIGURE 10



GALVESTON SEAWALL

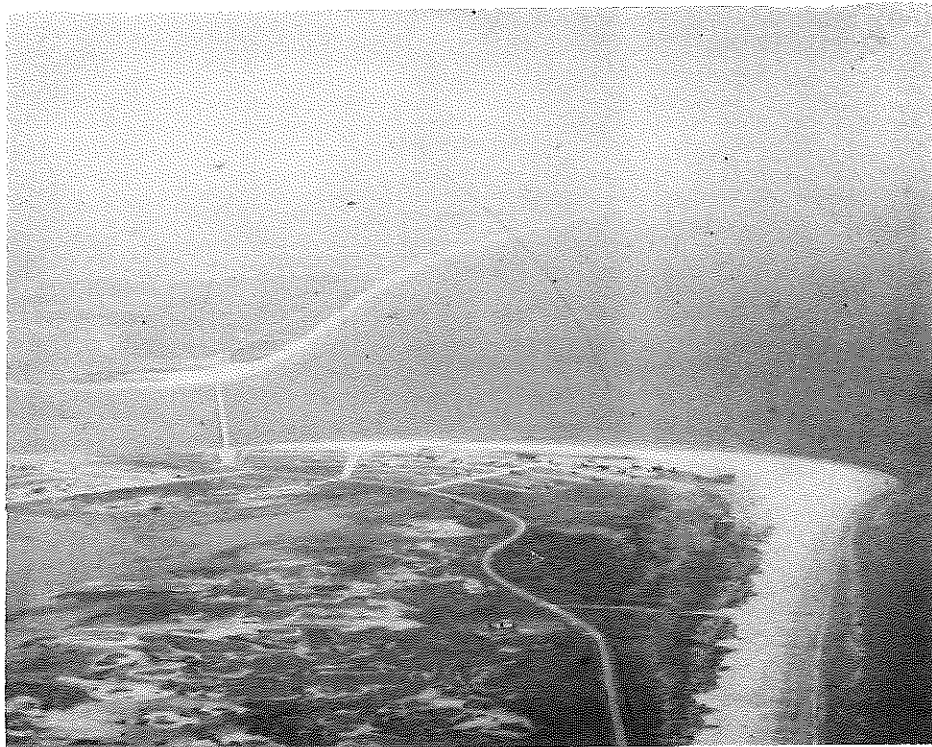
FIGURE 11

park located at about the midpoint of Galveston Island. Galveston Island State Park extends 1.7 miles along the Gulf shoreline and across the width of the Island. San Luis Pass, an unjettied tidal inlet, separates Galveston Island from Brazoria County (Figure 12).

The mainland portion of Galveston County is bounded by Galveston Bay on the east, West Bay on the south, Brazoria County on the west, and Harris County on the north. The 16-mile west shoreline of Galveston Bay, between the towns of Kemah and Texas City, is extensively developed with permanent and summer residences, and commercial establishments. It is characterized by narrow sandy beaches in front of steep eroding bluffs. The bluffs vary in elevation up to about 10 to 15 feet (Unless otherwise stated all elevations in this report are referenced to National Geodetic Vertical Datum, NGVD). The San Leon Cemetery and Bayshore County Park sites are typical of this reach of shoreline and are shown in the photographs of Figures 13 and 14, respectively. Much of the shoreline around the heavily industrialized portion of Texas City is protected from erosion by bulkheads and revetments with the remaining shoreline to Kemah being intermittently protected by similar structures.

Beyond the industrial area and extending west about 19 miles to the Brazoria County line, the mainland shoreline along West Bay consists of low banks and marshlands. This area is sparsely developed with fishing and hunting camps.

The Gulf beach at Surfside is a 2-mile segment of narrow, sandy beach located near Freeport in Brazoria County and is approximately 11 miles from the western limits of Galveston County. Surfside borders on the Gulf of Mexico and is immediately northeast of the jettied entrance to Freeport Harbor. (Figure 15). The shoreline is developed with residences and businesses. The beach at Surfside, as well as



SAN LUIS PASS

FIGURE 12



SAN LEON CEMETERY

FIGURE 13



BAYSHORE COUNTY PARK

FIGURE 14



GULF BEACH AT SURFSIDE

FIGURE 15

the Galveston County beaches, provides a recreational area for the Houston-Galveston metropolitan area, and also other parts of the country.

SHORELINE FEATURES AND LITTORAL PROCESSES

This section provides a limited discussion of the study areas' topographic features and littoral processes affecting the area shorelines. A more complete discussion of these topics may be found in the Volume II, Study Site Reports.

Topographic Features.

In terms of morphology, the Gulf shoreline topography in the study area consists of (1) strand plains, (2) peninsulas, and (3) a barrier island (McGowan and Scott, 1975). Strand plains are found at two segments in the study area; a segment between the western margin of the Sabine delta and High Island, and a segment between Follets Island and Brown Cedar Cut (located about 30 miles southwest of Surfside). These strand plains are characterized by narrow beaches consisting of a veneer of sand, shell, and rock fragments overlying older delta-plain deposits. A peninsula topography is found on Follets Island and Bolivar Peninsula. Follets Island is a low (elevations less than 10 feet), moderately vegetated sand body that rests upon marsh, bay, and deltaic muds. Bolivar Peninsula is densely vegetated and also consists mainly of fine sand. Maximum elevations along the seaward edge of the peninsula are about 10 feet. Galveston Island, the only barrier island in the study area, is a relatively wide sand body with numerous ridges and swales. Maximum elevations are about 15 feet.

Beach profiles in the study area typically feature gentle slopes, both above and below the water level (Figure 16). Between Sabine Pass and High Island, beach width is only about 50 to 75 feet, but widens to about 150 feet on Bolivar

Peninsula and to about 200 feet on the western portion of Galveston Island. Beach width ranges between 50 and 100 feet between San Luis Pass and Surfside.

The bays within the Galveston Bay System are relatively shallow with depths less than about 9 feet, except for the deep-draft navigation channels which cross the bays (Figure 17). The ports of Texas City, Freeport, Galveston, and Houston are served by deep-draft ship channels. The Gulf Intracoastal Waterway (GIWW) traverses lower Galveston Bay from northeast to southwest and crosses portions of Rollover, Galveston, and West Bays in open water. The GIWW serves the communities of Port Bolivar, Galveston, and Freeport.

The major rivers within the area are the Trinity, San Jacinto, and the Brazos which have a combined watershed of approximately 67,000 square miles. The relatively small Trinity River delta is the only delta which has formed within Galveston Bay. This delta is presently inactive and relatively stable because of heavy stands of marsh grasses.

Freshwater marshes are found along most of the streams in the area. Saltwater or brackish marshes occur along the bay sides of Bolivar Peninsula, Galveston Island, and Follets Island; and are also found around the mouths of the streams and rivers which empty into the various bays. These marsh and wetland areas are regularly inundated by the tide and are important to the biological productivity of the Galveston Bay system.

The bay shoreline sites are located near San Leon on the west, mainland shore of Galveston Bay. This portion of the bay shore is bordered by a steep bluff overlooking Galveston Bay. The bluff stands almost vertical in some reaches, with a flat slope at the base comprising a narrow sand or sand and shell beach varying from 5 to 50 feet in width.

The bluff shoreline on west Galveston Bay is composed largely of clay and sandy clays with some sand and shell pockets and is overlain with a layer of topsoil of fine sandy clay loam ranging in thickness from a few inches up to about 2 feet. The narrow beaches at the foot of the bluff are composed of a thin layer of sand or sand and shell overlying clay.

The land extending back from the shore is generally flat with a very slight decrease in elevation. Natural drainage is away from the bay shore. Native vegetation consists mainly of coarse grasses, weeds, some shrubbery, and scattered small trees.

Wave Climate and Littoral Drift.

The wave climate along the upper Texas coast is generally mild with an annual average significant height of about 1.5 feet and a mean period of about 6 seconds at Galveston (Thompson, 1977). As shown on Figure 18, deepwater waves approaching the Gulf shoreline generally arrive from the east side of the shoreline normal. The presence of a general westward littoral current along the Gulf shoreline has been inferred by a number of investigators. However, the wave incidence angles for predominant east, southeast, and south waves are relatively small, especially nearer the west end of the study area where the shoreline trends in the northeast-southwest direction. This coupled with the alongshore variations of offshore slope, variation of local shoreline orientations, and coastal structures, introduces reversals in the generally westward direction of littoral transport.

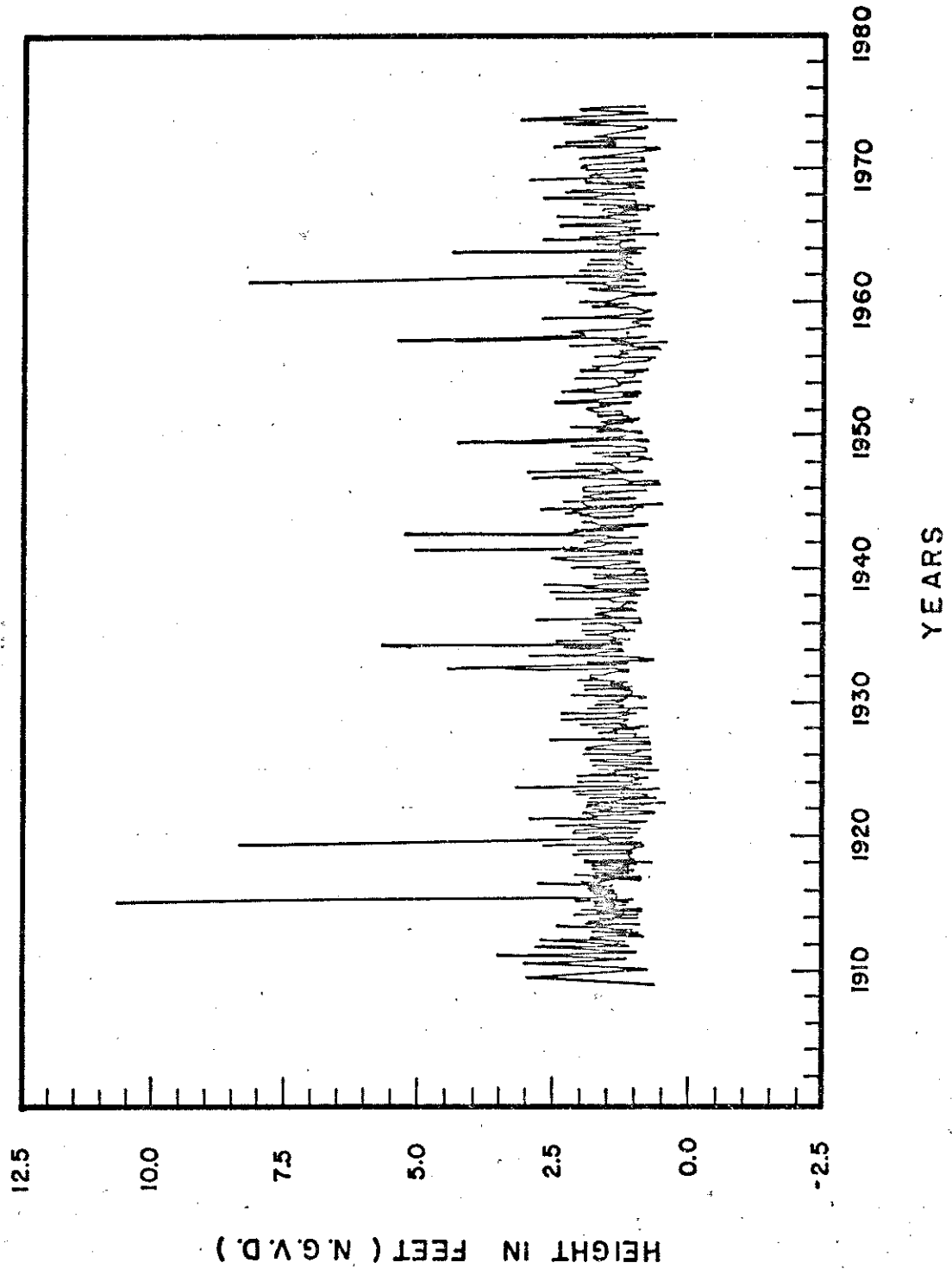
The portion of the bay shore under investigation is exposed only to waves originating in Galveston Bay. Red Fish Bar (located in open water between Eagle and Smith Points; see

Figure 1) and the dredged material disposal banks along the Houston Ship Channel generally define the unobstructed length of water area fronting the west shore of Galveston Bay. The shore is exposed to waves from the north with a fetch of 10 nautical miles and from the northeast with a fetch of 5 nautical miles.

Wave height seldom exceeds 2 feet because the shallow, nearshore bay bottom at the bay sites usually causes larger waves to break before reaching shore. The small accumulation of sand and shell deposits along the face of some of the existing shore protection structures on the bay shore suggest that there is very little longshore movement of material by wave action. The shallowness of the nearshore bay bottom suggests that most material eroded from the bluffs is transported bayward of the bluffs.

Tides and Water Levels.

Gulf tidal ranges are generally less than 2.0 feet while bay ranges vary from less than 2 feet just inside a Gulf inlet to less than one foot in the upper bays. Mason (1981) studied available tide records at the Sabine, Galveston, and Freeport Entrances and found that there is a uniform, long-term behavior of the tide throughout the study area. Maximum monthly tidal ranges occur during June and December while minimum ranges occur during September and March. Maximum water levels occur in September with a secondary maximum in May. Minimum water levels occur in February, with a secondary minimum in July. Most of the tidal behavior is due to astronomical forces, but meteorological effects also cause some variation. Predominant southeasterly winds from March through November add a rise in the mean water level during these months while predominant northerly winds from December through February cause a fall in the mean water level during the winter. Isolated events have similar effects. Onshore winds of tropical storms and



HIGHEST MONTHLY TIDES AT GALVESTON

Surfside during 1900 to 1981. Important effects of hurricanes on shoreline changes on the Texas coast have been recognized in numerous studies. Among the most prominent effects are: (1) increased shore erosion, (2) overwash, (3) increased sediment discharge from rivers, and (4) increased littoral transport.

BIOLOGICAL RESOURCES

The major coastal wetland areas within the study area are located along the bay shores of Bolivar Peninsula, Galveston Island, and Follets Island; along the mainland shores of East and West Bays; and along the terminal, downstream margins of the Trinity River, San Jacinto River, and Brazos River Valleys. These wetlands contain salt-, brackish-, and fresh-water marshes which support an abundance of marine animals, serve as nursery and feeding areas for commercial and sport species of marine animals, and provide nesting, resting, and feeding sites for migratory water fowl.

Vegetation within the area varies from salt-tolerant grasses along the dunes and bay shores to various upland species of grasses, brush, and hardwood trees. Wooded bottom-lands and cypress swamps are found in the lower reaches of the rivers. Some submerged vegetation exists near Galveston Island, Follets Island, and Bolivar Peninsula, and in the upper bay areas.

Usually only a few species of animals are found on the Gulf beaches and these fauna are highly specialized to deal with their environment. The ghost crab is characteristic of the drier beach sand. Large numbers of coquina clams inhabit the intertidal area of the foreshore zone and they are an important food source for some fish, crabs, and shore birds. Common bottom inhabitants include such fauna as hermit crabs and blue crabs which can rapidly adapt to a changing bottom

anchovy, spot, sea catfish, striped mullet and the silversides. The young of many sport fish also are present, particularly the Atlantic croaker and sea trout. Rare and endangered species which may occur in the study area are the sperm whale, finback whale, blue whale, black whale, northern bald eagle, southern bald eagle, brown pelican, Peregrine falcon, Attwater's greater prairie chicken, American alligator, and several species of sea turtles.

CULTURAL RESOURCES

The City of Galveston has a long and colorful history which in large part is not pertinent to an investigation of impacts to cultural resources located in the beach study sites. As a result, only a short sketch will be presented here. The earliest accounts of Galveston Island comes from ethnohistoric observations which variously report both Karankawan and Akokisa inhabitants on the Island at the time of initial European contact. European settlement of Galveston began in 1816 when the Island became the headquarters for pirates and revolutionaries such as Aury and Mina, the LaFitte brothers, Henry Perry, and Dr. James Long. The smuggling activities of LaFitte and others induced the Mexican government to establish a garrison of Mexican soldiers and a customhouse on the Island in 1830. By 1840, a town of over 3,000 had developed around a new wharf and expanded port facilities. The only significant historic sites located along the Gulf shoreline on the eastern end of the Island were temporary Civil War fortifications and gun emplacements at the ends of several streets along the beach. These temporary fortifications scarcely outlasted the Civil War and no evidence of them is expected to remain due to erosion and seawall construction.

highway (Highway 87). Since that time, the Gulf shoreline in the Rollover area has become lined with summer beach houses and the community of Rollover has become known as Gilchrist.

The Rollover Study Site was also surveyed to determine whether prehistoric archeological remains were present. Particular attention was paid to the eroded wave nick point in the shoreline beach ridge where two shell midden sites (41GV73 and GV74) have been recorded approximately 2.5 miles to the west of the Rollover Study area. No archeological sites were located on the one mile of beach just west of the Pass which was covered by the in-house survey. It is probable that any sites which were located along the present shoreline have been destroyed by the erosion taking place just west of the Pass and by recent construction and land use.

Archeological survey, testing, and historical research was performed in the Surfside area in 1981 by the Center for Archeological Research (CAR) at the University of Texas at San Antonio. The following short historical summary was taken from the detailed history of Old Velasco and Quintana presented in the CAR report. Old Velasco (now Surfside) was first settled in the early 1820's by members of Austin's first colony. The community was to figure significantly in the early history of the Republic of Texas and, later, in Texas's involvement in the Civil War. Built by the Mexican government in 1832, Fort Velasco was the site later that same year of the Battle of Velasco, a successful insurgency fought by Texas immigrants against the Mexican garrison. During the Texas revolution, Velasco became a strong point in the Republic's naval defense and it was later chosen as an interim capital of the Republic of Texas in 1836. Between annexation and the Civil War, Velasco reached its peak as a summer resort for wealthy plantation owners. From 1863 through the end of the war, Confederate troops stationed at Velasco are reported to have removed the last traces of old Fort Velasco for firewood. In

water and rail transportation connections, pear lands, oyster beds, fishing grounds, superior brick clay, and its status as a winter resort. The pamphlet also lists a woodenware factory, a saw mill, a new railroad, about 20 new residences, a brick factory, a box factory, new wharves, a new hotel, and a new school as being planned or under construction in the community at that time. The railroad mentioned in the pamphlet was the North Galveston, Houston, and Kansas City railroad which had completed a track between North Galveston and Virginia Point by 1893 and anticipated extending the line between North Galveston and Houston.

Unfortunately, 1893 was a year of economic panic in the United States as a whole and North Galveston was not unaffected. As a result of the panic, shipping needs were not sufficient to keep the new railroad in business, the company was placed in receivership that same year, and the community suffered a significant loss of population. Tax records suggest that North Galveston began to bounce back as a community in 1896 when subdivision of the original Edward's grant and sale of individual lots began. By the turn of the century, 23 individuals were paying taxes on properties in North Galveston and a population of 125 was reported for the town. Although the 1900 hurricane is reported to have destroyed most of the town, a few structures did survive and tax records indicate only a small drop in the number of individuals paying taxes in the community.

Between roughly 1910 and 1921, a large Victorian style luxury hotel named "The Industrial" was built and operated in North Galveston as a bayshore resort. It is reported that the hotel had a long esplanade between it and the bayshore down which guests could stroll. Only the palms which lined the esplanade survive today as the hotel burned in 1921.

The portion of Bayshore County Park which lies east of Houston Lighting and Power's outfall canal is located on land originally granted as Fourth Class Headright Certificates in late 1847. General Land Office files indicate that the grantees immediately sold their respective 640 acres for \$50 each to Jacob de Cordova who patented the properties in 1849.

Jacob de Cordova was one of the most prominent land speculators in Texas during the decade before the Civil War. Born in Jamaica in 1808, he moved to the United States in 1827 and became a merchant in New Orleans during and following the Texas Revolution. In 1837 he moved to Galveston where he became a prominent citizen. In 1847 he moved inland to Harris County and later to Austin. De Cordova is best remembered for his vast purchases of Texas script. By 1855, the De Cordova Land Agency controlled over 1 million acres of Texas land. However, by the late 1850's De Cordova owed approximately \$22,000 on his land purchases which he was unable to repay and court decisions forced the sale of his land at very low prices.

No information could be found in published references concerning any of the subsequent property owners identified in Galveston County Tax Records. Neither was any information found concerning structures or their possible locations on the study site property. As a result, it has been concluded that the area encompassing Bayshore County Park was not associated in the past with any historically significant person, structure, or event.

The Bayshore County Park study site was also investigated to determine whether prehistoric archeological remains were present on the property. An inspection of the eroding cliff face was performed and no cultural features or stained soil lenses were noted in the profile, nor were artifacts observed eroding from the bluff face. A cursory inspection of the

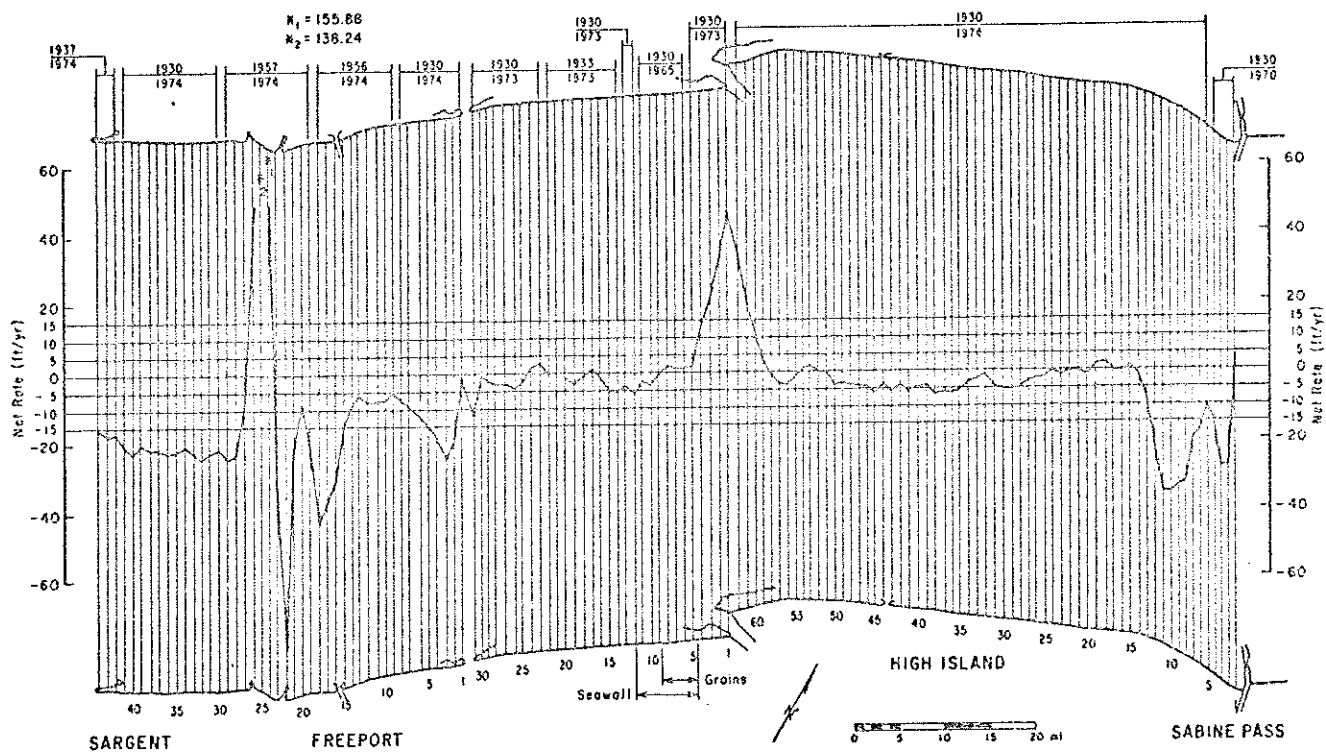
This trend is expected to continue in the future. A unique feature contributing income on a seasonal basis to the study area economy is the tourist and recreational trade attracted by the Gulf coast and its many opportunities for recreation. This feature not only attracts tourists and recreationists from the surrounding Galveston and Houston SMSA's, but from other parts of the country as well. These factors are all expected to continue influencing the growth of the study area throughout the analysis period.

PROBLEMS AND OPPORTUNITIES

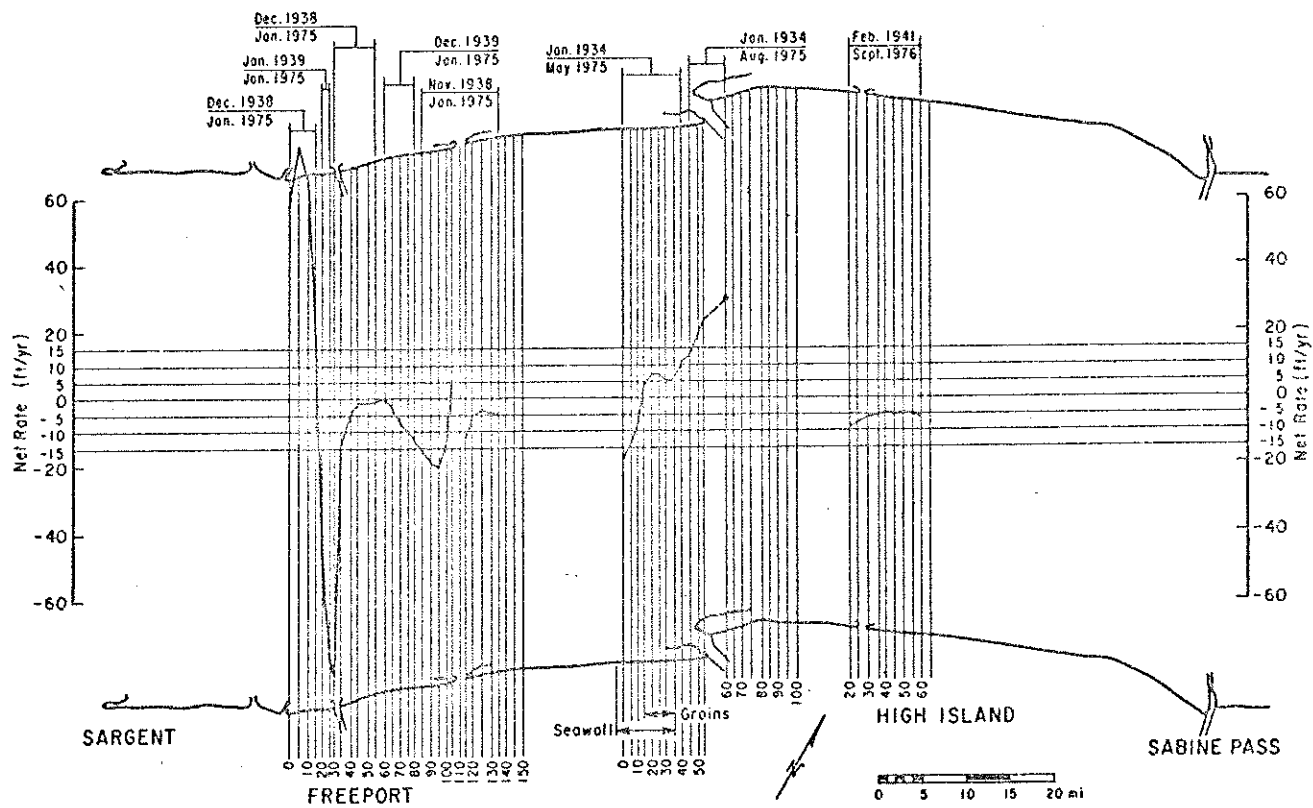
As will be shown in the following section, many of the study area shorelines have exhibited a gradual recession during the time periods analyzed. This general trend of erosion is likely to continue in the future. This study provides the opportunity to address the problem of shoreline recession in the study area.

Stabilization of the shoreline is needed to protect existing and future development against erosion and to insure the availability of adequate recreational beaches. Local interests have indicated that control of the erosion problems is of primary importance to the local economy and to their increasing tourist industry.

Local interests have attempted, mostly in vain, to protect their property as the beaches erode. They have built bulkheads, revetments, hauled in fill material, planted grasses, altered sand dunes and tried other products. However, there has been no major project undertaken to stabilize or restore the beaches.



LONG-TERM SHORELINE CHANGES FROM EARLY
1930'S TO PRESENT (MORTON'S DATA)



LONG-TERM SHORELINE CHANGES FROM LATE
1930'S TO PRESENT (GOSES DATA)

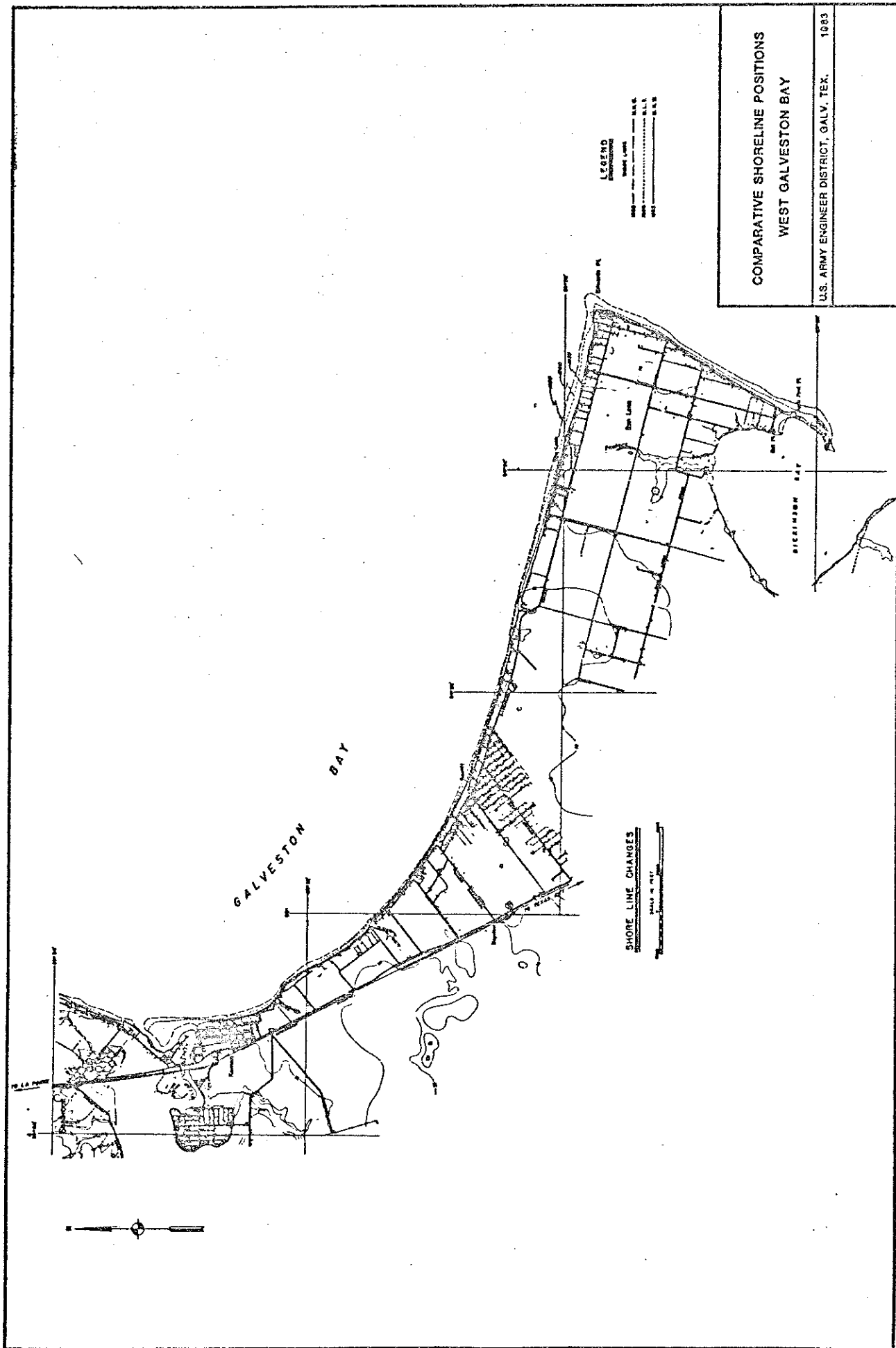


FIGURE 23

PLANNING CONSIDERATIONS

PLANNING FRAMEWORK

Each plan, or alternative whether structural or nonstructural has been evaluated within a National framework which provides a guide for the conservation, development, and management of water resources of the Texas coastal area. The framework provides a systematic basis for developing and evaluating alternative measures for addressing problems, needs, and opportunities to achieve the planning objectives. The process involves the application of the following principles:

0 The planning is to be conducted on a broad interdisciplinary basis.

0 Plans are to be developed in a systematic manner, beginning with a full range of alternatives and, through interactive processes, narrow the options to a final selected plan.

0 Detailed plans produced by the process are to be suitable for implementation.

0 Planning activities are to include a continuous program of public involvement and coordination.

0 The resource base and institutional arrangements of the study area are to be reflected in the various plans considered for implementation.

determining which plan, if any, should be analyzed in greater detail. This process is repeated until all viable alternatives have been reduced to one plan which may be recommended for construction, or all plans have been eliminated and the "no-action" alternative is adopted. Plans which fail to meet planning criteria are discarded regardless of the stage of analysis.

PLANNING CRITERIA

Before a plan can be recommended for implementation to the Congress, it must satisfy all of the following conditions:

- 0 It must be technically feasible,
- 0 It must be socially acceptable,
- 0 It must be economically and environmentally beneficial,
and
- 0 It must be sponsored by a local public body.

Technical Feasibility. All of the plans proposed for implementation should mitigate the effect of or prevent the erosion now being experienced. In addition, the plan should enhance the recreational potential of the areas studied and reduce potential future damages to development features. All components of the plans proposed for implementation should fall within the scope of present or near-future technology.

Economic Feasibility. Economic feasibility is determined by comparing the costs of providing protection measures with the benefits which would be derived from the protection. The initial construction costs are amortized over a 50-year

operate and maintain the project after its completion. To qualify as a local sponsor, the local body generally must be empowered with taxing authority and powers of eminent domain.

PLANNING OBJECTIVES

The basic objective of this study has been to develop alternatives to protect or preserve threatened shorelines with the least amount of damage to the environment. This includes their recreation potentials and development features as well. The planning objectives given below were developed to guide the formulation of alternatives to meet this objective. The objectives are the National, state, and local water resource management needs, opportunities, and problems specific to the study area that relate to enhancement of National Economic Development (NED) and environmental quality. The planning objectives are as follows:

(1) Protect or preserve threatened areas, and development of the recreational potential.

(2) Preserve and enhance, if possible, the human environment and aesthetic qualities of the shorelines.

(3) Preserve the integrity of the natural environment.

(4) Prevent degradation of water quality.

(5) Restore, protect, and enhance the beach areas for use by future generations.

(6) Prevent or minimize adverse effects on littoral processes.

(7) Provide for the public's safety.

Groins are usually constructed perpendicular to the shoreline and extend into the water far enough to effectively trap and retain littoral drift to build a beach or minimize erosion of an existing beach. Groins may cause rapid recession of the shoreline downdrift because the supply of sand to the downdrift shoreline is reduced by the accumulation on the updrift side. The placement of groins on the Gulf bottom may also eliminate local bottom-dwelling organisms and their habitats.

Beach nourishment or any sand pumping operation will cause some water turbidity at the beach placement site and at sand borrow sites. Turbidity created at either location is not expected to be more than is characteristic during and following severe storms. Some organisms may be displaced and destroyed at dredge sites and others buried at the beach site; however, no permanent, adverse effects from either operation is anticipated. A nourishment project maintained to suitable dimensions would provide a beach for recreation that would afford some storm protection for the land area behind the beach by dissipating wave energy. Beach nourishment directly replaces the littoral materials that are removed from the beach and not replaced by natural processes without inducing damage to shore areas beyond the beach segment being restored.

Vegetation is not considered to be effective in controlling erosion at areas subject to, at times, moderate to high wave energy. The use of vegetation is considered practical in stabilizing the slopes behind structures such as revetments and bulkheads.

Relocation of structures involves the relocation of buildings, structures, and other development features which would be susceptible to damage by beach erosion.

The annual costs of components which require periodic replacement are computed by converting the initial costs of the replacement items to present worth values at the beginning of the project life. Compound interest relationships are then applied in the same way as for the total construction costs. Since all operation and maintenance items would not be performed on an annual basis, the frequency each item is required is estimated and converted to an annual value. The sum of the annual construction costs and the annual operation and maintenance cost produces the average annual costs of the project.

BENEFITS ANALYSES

Benefits for the beach erosion control projects evaluated in this study area have been derived from analyses of the without-project and the with-project conditions. Benefit computations are given in Appendix A, Volume III. The principal benefit categories included in the analyses are prevention of damages and recreation.

BENEFITS FROM PREVENTION OF DAMAGES

Damages or losses due to shore erosion include physical losses of land, and losses or damages to development features such as roads and buildings. The area of land which would be lost in the absence of a project over the period of evaluation is estimated on the basis of the historical rate of shore recession taking into account any factors which may tend to modify the rate of loss, such as construction of coastal works which may reduce the supply of sand to the project area. Anticipated damages due to losses of land may be computed as the market value of the average annual area expected to be lost. The market value may be determined directly, or from an

directed by Congress (Public Law 520, 71st Congress) to investigate and study, in cooperation with the appropriate agencies of various states on the Atlantic, Pacific, and Gulf coasts, and on the Great Lakes, effective means of preventing erosion of coastal and lake shores. The Federal Government shared up to half the cost of each study but did not pay any construction costs unless federally-owned property was to be protected.

An act of Congress approved in 1946 (P.L. 727, 79th Congress) established a policy of Federal cost-sharing in construction costs where projects protected publicly-owned shores. That legislation was amended in 1956 (P.L. 826, 84th Congress) to authorize Federal participation in the protection of private property if such protection was incidental to the protection of publicly-owned shores, or if such protection would result in public benefits. The River and Harbor Act of 1962 (P.L. 87-874) made the total cost of performing studies to determine the feasibility of providing shore protection a Federal responsibility.

Congress has authorized Federal participation in the cost of restoring and protecting the shores of property on the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and lakes, estuaries, and bays directly connected to them. The erosion must be caused by wind and/or tidal generated waves and Federal participation in erosion control is limited to restoration of the historic shoreline. Any extension of the shoreline or creation of new beach areas must be done at the expense of non-Federal interests.

CALC. LOSS
SEA LEVEL
RISE +
EROSION

The extent of Federal participation toward beach erosion projects varies from 100 percent to none, depending upon shore ownership, use, and type and incidence of benefits. If there is no public use or benefit, Federal funds can not be used.

FEDERAL RESPONSIBILITY

Federal responsibilities include the preparation of a feasibility report, an environmental impact statement, a reanalysis of economic and environmental factors for compliance with existing regulations at the time of construction, and detailed plans and specifications; advertisement of the project for bids on construction features; awarding of the contract for construction; supervision and inspection of contract work; and provide a percentage of the total construction costs.

STUDY RESULTS

Gulf Shoreline Sites

Erosion control plans have been formulated for the Rollover Pass; the groin field, 61st Street to the end of the seawall, and West beach Galveston seawall area beach segments; and Surfside study sites. The remaining Galveston Island sites (East Beach, East to Stewart Beach, and Stewart Beach) were investigated only as part of the recreational analysis of the Galveston Island east-end beaches. A comprehensive discussion of the alternatives considered for each project site as well as the evaluation process to determine the recommended alternatives is presented in the Volume II, Gulf Shoreline Study Site Report.

Beach nourishment is considered the most economic investment at each study site. The project cost, average annual benefits, average annual costs, net benefits, and benefit-to-cost ratio (B/C ratio) for the beach nourishment alternatives at each study site are given in Table 1. Benefit computations are given in Volume III, Appendix A. The principal benefit categories are recreation and prevention of damages. As can be

seen in Table 1, the benefit-cost ratios for the beach nourishment alternative at each study site, except Rollover Pass, has a value greater than one. The average annual costs for the beach nourishment alternative at Rollover Pass greatly exceeds the average annual benefits which would be derived from the project. Therefore, a project at the site would not be economically feasible and Federal participation in the construction of any erosion measures is not warranted.

The projected excess recreation demand from the east-end Galveston Island beaches was used in considering project feasibility at either the groin field or 61st Street to the end of the seawall beach segments where recreation area is limited. Benefits are not sufficient to justify a combined project of both sites ($B/C=0.7$). Of these two sites, a project at the groin field segment would yield the largest net annual benefits.

Tables 2 and 3 present information on the economics and cost apportionment of the selected plans. Construction costs are based on quantities of beach nourishment material needed to provide a 200-foot berm width and a +5 - foot crest elevation at each site. Renourishment or operation costs are based on replacing half of the design construction volume each time half of the design berm width is eroded away. Initial nourishment and renourishment quantities for the selected sites, and the recommended borrow areas are given in Table 4.

Apportionment of project costs is the division or sharing of project costs among agencies that will pay for the project. Galveston County has indicated that they will act as the local sponsor for the Galveston Island study sites. The Village of Surfside Beach is interested in a project at their location, but the project is beyond their financial capability. The Village is pursuing other possible ways to provide local sponsorship, including assistance from the State of Texas.

TABLE 3

SUMMARY OF COST APPORTIONMENT

Site	Cost	Cost Apportionment		Average Annual Operation Costs	Annual Operation Cost Apportionment	
		Federal	Non-Federal		Federal	Non-Federal
Groin Field	\$22,918,000	\$11,459,000	\$11,459,000	\$78,500	\$39,250	\$ 39,250
West Beach	5,802,000	2,901,000	2,901,000	96,300	48,150	48,150
Surfside	24,731,000	12,118,000	12,613,000	413,600	202,700	210,900

Bay Shoreline Sites

Erosion control plans have been formulated for the San Leon Cemetery and Bayshore County Park study sites. A comprehensive discussion of the alternatives considered for each of these sites as well as the evaluation process used to determine the recommended alternatives is presented in the Volume II, Bay Shoreline Study Site Report.

Bulkhead and revetment construction are the recommended alternatives for the San Leon Cemetery and Bayshore County Park study sites, respectively. The project cost, average annual benefits, average annual costs, net benefits, and benefit-to-cost ratios for the bulkhead and revetment alternatives are given in Table 5. Benefit computations are given in Volume III, Appendix A. The benefit categories are recreation and prevention of damages.

As can be seen in Table 5, the B/C ratio for the revetment alternative at Bayshore County Park has a value greater than one and is, therefore, a feasible alternative for implementation. The bulkhead alternative at San Leon Cemetery has a B/C ratio less than one and is not feasible based on prevention of damages (loss of land and public roads).

Tables 6 and 7 present information on the economics and cost apportionment of the revetment plan for Bayshore County Park. Construction costs are based on rock quantity computations for the 2000-foot revetment constructed to a crest elevation of +4 feet. Maintenance costs are based on repair costs equal to 50 percent of the initial construction costs expended 25 years into project life. Apportionment of project costs is the division or sharing of project costs among agencies that will pay for the project. Galveston County has indicated that they will act as the local sponsor for the Bayshore County Park plan.

TABLE 6

SELECTED PLAN ECONOMICS

Site	Alternative Cost	Average Annual Maintenance Costs	Average Annual ^{1/} Costs	Average Annual Benefits	Net Benefits	B/C Ratio
Bayshore County Park	Revetment \$303,000	\$1,800	\$26,200	\$63,000	\$36,800	2.4

^{1/} Includes average annual maintenance costs

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DRAFT

ENVIRONMENTAL IMPACT STATEMENT
GALVESTON COUNTY SHORE EROSION STUDY

The responsible lead agency is the U.S. Army Engineer District, Galveston.

Abstract: The primary purpose of this study has been to develop plans to minimize or eliminate shore erosion problems along Gulf and bay shorelines of Galveston County and the Gulf beach at Surfside in Brazoria County. Study results show a high potential for large economic losses as a result of receding shorelines and an opportunity to accommodate increasing demand for beach recreation. Recommendations contained in the study are that beach restoration be provided along the Galveston Seawall from 10th to 61st streets for recreational purposes, beach restoration be provided on west beach from the west end of the seawall west for 6,000 feet for erosion control and recreational purposes, and that a rock revetment be provided at Bayshore County Park in San Leon for erosion protection. Potential environmental impacts of greatest concern are associated with restoration of the beaches on Galveston Island with an estimated 3,150,000 cubic yards of sand which would be excavated from Big Reef adjacent to the south jetty in Bolivar Roads and truck-hauled along Seawall Boulevard to the beaches. The recommended plan has a 1.6 to 1

SUMMARY

Major Conclusions and Findings.

Based on fulfillment of planning objectives and the economic efficiency of alternatives considered; it was concluded that approximately 20,000 feet of beach restoration should be accomplished in the Galveston groin field along the seawall from 10th to 61st streets to provide for additional beach recreation. Also, that 6,000 feet of beach restoration should be accomplished immediately west of the end of the Galveston Seawall to provide for additional beach recreation and erosion control. The restored beaches would have a designed berm 200 feet wide and have an elevation of +5 feet National Geodetic Vertical Datum (NGVD), formerly mean sea level. This beach nourishment would require the excavation of an estimated 3,150,000 cubic yards of sand from Big Reef, a 224 acre beach, dune, and wetland area adjacent to the south jetty in Bolivar Roads. Sand would be truck-hauled from Big Reef along Boddeker Drive and Seawall Boulevard to the nourishment sites. In order to maintain the restored beaches, renourishment would be required every 32 years in the groin field and every 16 years at west beach. Also recommended in the study was erosion protection for Bayshore County Park in San Leon consisting of a 2,000 foot long rock revetment constructed to a crest elevation of +4 feet NGVD. In order to maintain the revetment, some of the stone would have to be rehabilitated or replaced every 25 years. The above recommendations produce the maximum quantifiable net benefits and meet the criteria of a National Economic Development Plan. The recommended plan, described above, has a 1.6 to 1 benefit to cost ratio with a \$29,023,000 first cost to be equally shared between the Federal Government and Galveston County, the local sponsor for the recommended project.

(Peterson and Oja, 1981). This recommendation is based on the high fish and wildlife habitat value of the area and on the concern that excavation activities could interfere with migration of marine organisms between Galveston Bay and the Gulf of Mexico. The recommended plan includes the use of Big Reef as a borrow area because it is the most economical source of suitable sand. This information was not available to the USFWS at the time the Coordination Act Report was written nor was the recommended plan formulated. During future coordination this issue will be discussed in light of more recent information and taking mitigation possibilities into account.

Relationship of the Plans to Environmental Requirements

National Historic Preservation Act (NHPA) of 1966, as amended. The report is currently in partial compliance with the NHPA requirement for coordination with State and Federal agencies concerning impacts to cultural resources. Each of the study sites has been investigated for prehistoric and historic remains that would be impacted by the recommended plan. Full compliance would be accomplished through coordination of this document with the proper agencies. A determination of no effect will be requested through coordination of this document with the State of Texas as no impacts to cultural resources have been identified.

Clean Water Act, as amended. It has been determined that Section 404 of the Clean Water Act would apply to the proposed actions. An evaluation of the effects of discharge of dredged or fill material into waters of the U.S. using the Section 404(b)(1) guidelines has been prepared and is included in Appendix C. The recommended plan, as described in this Environmental Impact Statement (EIS), meets the requirements of

ecological systems, or economic potential. The project will be in full compliance with this statute following coordination activities.

National Environmental Policy Act. It has been determined that study recommendations are in full compliance with the requirements of this statute at this stage of planning. This EIS is being filed with the Environmental Protection Agency and sent for review and comment to Federal, State, and local agencies; environmental, business and political groups; and individuals known to have an interest in study recommendations.

Texas Water Quality Certificate. An application for a water quality certificate will be submitted to the State of Texas prior to project construction.

Table 1 describes the relationship of each plan considered to requirements of environmental laws and policies, land use plans, and state, local, and Federal requirements. This EIS has been prepared in accordance with Corps of Engineers regulations, ER 200-2-2 "Environmental Quality: Policy and Procedures for Implementing NEPA" and is in compliance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act regulations (40 CFR Part 1500).

Table - 1. Continued

Environmental requirements	Plans ^{1/}	
	Beach nourishment	Rock revetment
Land Use Plans		
Texas Coastal Zone Man agement Act (unapproved).	Full	Full
Local zoning.	Full	Full
Land use.	Full	Full
State and Local Policies		
Texas Water Quality Full Certificate.	Full ^{2/}	

^{1/} The compliance categories used in this table were assigned based on the following definitions:

- a. Full Compliance - Having met all requirements of the statute, E.O., or other environmental requirement for the current stage of planning.
- b. Partial Compliance - Not having met some of the requirements that normally are met in the current stage of planning.
- c. Non-Compliance - Violation of a requirement of a statute, E.O., or other environmental requirement.
- d. Non-applicable - No requirements for the statute, E.O., or other environmental requirement for the current stage of planning.

^{2/} A State Water Quality Certificate would be acquired prior to project construction.

1. NEEDS FOR AND OBJECTIVES OF ACTION

1.1 This study has been conducted to determine the magnitude and extent of shore erosion problems identified along Gulf and bay shorelines of Galveston County and the Gulf beach at Surfside in adjacent Brazoria County, and to subsequently develop suitable erosion control measures to alleviate or control these problems. Erosion problems were of particular interest in highly used recreational areas where sand supplies had been partially or completely depleted. Although the beach in the groin field has undergone erosion in the past, it is now stable or in some locations even accreting. Therefore, the action recommended for this area is to satisfy a need for additional beach recreation. This section describes the study in relation to needs and opportunities of the area and identifies public concerns upon which planning objectives and plan formulation were based.

1.2 Study Authority

1.2.1 The feasibility study for erosion control measures for Gulf and bay shorelines of Galveston County was authorized by a House Committee on Public Works and Transportation resolution adopted on 10 October 1974. A similar study of erosion problems at Surfside in Brazoria County was authorized by a House Committee resolution adopted 22 September 1976. The studies are similar in nature, data gathering requirements, and in adjacent locations; therefore, to avoid duplication of effort, the studies were combined. Authority to combine the two study resolutions was provided by the Office of the Chief of Engineers by DAEN-CWP letter dated 19 October 1976.

from an area which is presently emergent land. Borrow operations at Big Reef will prohibit land-related recreation on 224 acres of beach, dunes, and wetlands and may somewhat reduce recreation-related trade in nearby commercial establishments such as restaurants, bait camps, and the beach recreation center associated with R. A. Apffel Park, a city park adjacent to Big Reef. Unique recreational opportunities such as driving on the beach, wade fishing, beach camping, and use of off-road vehicles will be lost. Beach recreation at other island sites, however, is expected to increase as a result of removing sand from Big Reef and placing it along the seawall and west beach.

1.3.5 Impacts of contaminated material from Fort San Jacinto, if used as a borrow area. This site was not selected as a borrow area because the sand is unsuitable for beach nourishment; therefore, testing for contaminants was not conducted. However, any borrow material used for beach nourishment would be primarily sand. According to Environmental Protection Agency (EPA) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 CFR, Part 230, Subpart G, fill material is assumed to be free from chemical, biological, or other pollutants when it is composed primarily of sand.

1.3.6 Enhancement of dune habitat as well as beach front. The dunes on west beach adjacent to the Galveston Seawall would be enhanced by the recommended plan because of increased sand supplies, coupled with littoral forces and wind action. Enhancement of remaining dune habitat along the western end of Galveston Island was not considered in detailed planning. The existing dunes on Big Reef, which are some of the highest on Galveston Island, would be removed.

traps to varying degrees depending on individual depths and widths. Impacts of the inlets in the study area on longshore and onshore-offshore transport of sand are summarized in the Sediment Budget Section of Volume II, Gulf Shoreline Study Site Report.

1.3.12 Continuing erosion because of the removal of the ebb tidal delta at San Luis Pass. This ebb tidal delta was the recommended borrow area for the beach nourishment at Surfside Beach. Beach restoration at Surfside is not being recommended for authorization and construction because of an apparent lack of sponsorship by local interests. Therefore, the ebb tidal delta at San Luis Pass is unlikely to be used as a borrow area. Studies have shown, however, that inlet shoals such as the one at San Luis Pass are often excellent sources of sand for beach nourishment projects. Often such shoals refract incident waves and concentrate wave energy on adjacent shores, thereby contributing to erosive forces. Removal of shoals is not necessarily detrimental to adjacent coastal areas and may, indirectly, reduce adjacent shoreline erosion by spreading out wave energy over a greater coastal area.

1.3.13 Impacts on bay bottom with bulkhead construction and consequent wave deflection. Bulkhead construction at Bayshore County Park would result in some scouring at the toe of the structure; however, impacts of the scouring on the bay bottom are similar to those under present conditions. At the toe of the bulkhead, benthic organisms would not be abundant where scouring affects the bottom. Immediately beyond this scour area, benthic communities would exist. Bulkhead construction would also slightly decrease turbidity of the water column by armoring the shoreline. The recommended plan for this area is a revetment which would have similar effects on the bay bottom.

sand (see Storms Section of the Gulf Shoreline Study Site Report). Construction of this project is not expected to adversely affect the beach during major storms.

1.3.17 Impacts of subsidence at Surfside. The recommended plan does not include the Surfside area due to an apparent lack of local sponsorship. A relatively minor vertical rise in sea level as a result of either sea level changes or subsidence, may cause considerable horizontal displacement of land due to the gentle beach slopes in the study area (see Gulf Shoreline Study Site Report).

1.3.18 Impacts on businesses and recreation along the south jetty if Big Reef is used as a borrow area. The use of Big Reef as a borrow area for the Galveston Island nourishment plan will cause a loss of a 224 acre beach, dune, and wetland area. Although it is assumed that Big Reef beach users will relocate to east beach, recreation in the area of the south jetty will be substantially reduced. The redistribution of users is presented in the Project Economics Appendix. Businesses such as bait and fishing camps located along Boddeker Drive, the access road to the south jetty area, which also sell beach and picnic supplies would be adversely affected by reduced visitor traffic in the area. The recommended plan would benefit those establishments which also operate boat launching areas, however, as less dredging will be required to maintain the launching ramps which are now being filled in by sand from Big Reef. This is discussed further in the Socioeconomics section of the Environmental Impact Statement.

2. ALTERNATIVES

2.1 Plans Eliminated from Further Study

2.1.1 The authorized study area includes Gulf and bay shorelines of Galveston County and a two-mile reach of beach at Surfside in Brazoria County (Figure 1, Main Report). Technical investigations of littoral processes which effect the study area were conducted between Sabine Pass and the Brazos River. Shoreline areas were identified within the study area where considerable erosion has occurred or is presently occurring (see Main Report). Although several sites in the study area are experiencing erosion problems, five sites were selected for further study as they appear to have the highest potential for economic or recreational losses because of their proximity to developed areas. Also, a quantifiable need for providing additional recreational opportunities can be demonstrated and there is public support for beach nourishment and/or erosion control. Privately owned shoreline areas having no public recreational potential are not eligible for Federal assistance.

2.1.2 Of the shoreline areas initially investigated, three Gulf and two Galveston Bay sites were chosen for further study (Figures 4 through 7, Main Report). Gulf beach sites were a 6,000-foot segment of beach immediately west of Rollover Pass, the Galveston Seawall area which was separated into six individual segments for economic analysis, and Surfside beach located east of the Freeport jetties for a distance of 12,000 feet. The Galveston Bay sites were a 2,000-foot length of shoreline at Bayshore County Park and a 300-foot length of shoreline at the San Leon Cemetery, both in San Leon on the west shore of Galveston Bay.

enhancement plus erosion control for west beach. Structural alternatives included additional groins, breakwaters, bulkheads, revetments, and seawalls. Nonstructural alternatives included beach nourishment, dune development, shoreline stabilization using vegetation, land acquisition and permanent relocation, and no action. One combination alternative for west beach included beach nourishment with groins. Since one of the main planning objectives of this project is to provide additional recreation, all structural alternatives were dropped from further consideration as they can provide protection to existing beach areas but do not generally create additional beach area (see Main Report and Gulf Study Site Reports).

2.1.5 The most effective nonstructural method of restoring eroded beaches is beach nourishment with subsequent periodic renourishment. Other nonstructural alternatives such as dune building using sand fences or trapping sand using vegetation are generally effective in creating beaches only when there is a good supply of sand moving along the beach in the littoral zone. This is not the case along Galveston Island (see Gulf Study Site Reports); therefore, these alternatives were eliminated from the study. Government acquisition and/or relocation of existing facilities along the beach would not satisfy either of the main planning objectives of providing additional recreation or controlling erosion. Additionally, this alternative would be inordinately expensive compared to other alternatives. The combination plan of beach nourishment with construction of groins for west beach was dropped from further study because it was found to be economically unjustified (see Gulf Study Site Report). Therefore, two nonstructural plans (beach nourishment and no action) were considered for further study. The no action alternative is also the base condition upon which the economic, social, and environmental impacts are compared.

environmentally and socially acceptable are beach nourishment for the groin field and west beach on Galveston Island and rock revetment (riprap) for Bayshore County Park. All other alternatives have been eliminated from further study.

2.2 Without Condition (No Action)

2.2.1 On Galveston Island, this alternative would prevent Federal assistance in meeting the planning objectives for the groin field and west beach. There are no current plans by others which deal with beach nourishment or erosion control at the study sites. Therefore, within the groin field, the small existing beach area would probably continue in its present state. Recreational benefits would be forgone as the existing beach cannot accommodate expected future recreational demand. Additionally, hotels, beach attractions, restaurants, etc. along the seawall probably will not expand as rapidly as they would with beach nourishment, which could possibly affect future local employment opportunities.

2.2.2 At west beach, continued erosion can be expected. Not only will future recreational demand not be satisfied; but, because of erosion, existing use will diminish. Additionally, continued erosion at the west end of the seawall may eventually threaten the structural integrity of the seawall itself. This process will also reduce the rate of future commercial development in the area.

2.2.3 At Bayshore County Park this alternative would prevent Federal assistance in meeting planning objectives. The Galveston County Beach and Parks Department recently applied for a Department of the Army permit to provide protection from

2.3.3 Immediately after initial nourishment is finished, wave action and longshore currents will begin to erode the restored beaches. This process will be allowed to continue until the beaches are approximately one-half their original width, ie., 100 feet wide. This is expected to take about 32 years in the groin field and 16 years at west beach. At this time the beaches will be renourished with about 1,235,000 and 325,000 cubic yards of sand on the groin field and at west beach, respectively. Therefore, the groin field will be renourished once and west beach three times during the 50-year project life.

2.3.4 In order to implement this portion of the recommended plan, the Federal Government and Galveston County, the local project sponsor, would cost-share the first cost of construction of \$28,720,000 and future maintenance costs of \$174,800 annually over the recommended project life on a 50 percent Federal and 50 percent local basis. The Federal Government would design and carry out initial construction activities. Galveston County would carry out subsequent renourishment operations. The Federal Government would reimburse Galveston County for the Federal share of the cost of renourishment operations conducted over project life.

2.3.5 During this study considerable effort has gone into identifying potential sources of sand for beach nourishment. Areas investigated were bays, the Gulf, maintenance dredged material from various channels, and land deposits. Many of these sand sources were identified early in study investigations when the entire study area was still being considered. Since then, only two nourishment sites on Galveston Island are now recommended; therefore, many of the identified sources are too far from where the sand will be needed to be economical, even though they contain usable sand.

impacts to marine organisms as a result of removal and disposal of the overburden (Peterson and Oja, 1981). The jetty borrow location, although near Galveston beaches, does not contain sand of a suitable grain size for beach nourishment. Use of these fine-grained sands would require greater volumes for beach nourishment initially which would erode more quickly thus requiring more frequent renourishment during project life (see Gulf Study Site Report).

2.3.8 Maintenance dredging operations are conducted periodically in the navigation channels around Galveston Island. The dredged material removed from these channels usually contains a high proportion of fine silt, i.e., are very muddy. It has been determined that the only nearby source of suitable maintenance material for beach nourishment is found at the Galveston Entrance Channel. It is not practical to use this material in the initial nourishment because of uncertainty in predicting the quantity of suitable material available at any given time (see Gulf Study Report). However, the potential exists to reduce future renourishment quantities needed from other borrow sites through use of maintenance dredged material from the entrance channel. This will be coordinated during post-authorization studies.

2.3.9 Terrestrial sources of sand investigated in the vicinity of the Galveston beaches were Fort San Jacinto and Big Reef. Fort San Jacinto is a 640-acre disposal area located at the east end of Galveston Island, roughly between the seawall and Ferry Road. This area has been used for many years for disposal of dredged material from the Houston and Galveston Ship Channels. Based on core samples, the material within the disposal area is interbedded fine sands and muds resulting from successive dredging operations. As discussed previously, due to the fine grained nature of these essentially bay sands, it

12-month period to 61st Street. During the last six months of the 1.5-year construction period the pipeline would be lengthened along the base of the seawall to west beach which would then be nourished. Diesel-engine driven booster pumps would be installed in the pipeline as the dredge could not pump sand the entire length of the beaches. One pump would be in the pipeline between the dredge and the discharge while working in the groin field and two additional pumps would be added while nourishing west beach. This method of excavating and transporting sand was dropped from further consideration because, at this time, it is assumed the truck haul method would have more public support than a pipeline system fronting the seawall.

2.3.12 The truck haul and dragline method is recommended to move sand from Big Reef to the groin field and west beach. This method will utilize 15 diesel dump trucks of 12 cubic yard capacity and two draglines of 1.25 cubic yard capacity. The average round trip to the groin field will be 10 miles and 36 minutes long whereas trips to west beach will average 18 miles and take 59 minutes. It will take approximately 263,000 round trips to haul the approximately 3,150,000 cubic yards of sand along Seawall Boulevard from Big Reef to the nourishment sites. The trucks will be working 16 hours per day, seven days per week, eight months per year for a total of three years (two years at the groin field and one year for west beach).

2.3.13 Installation of a rock revetment is the most practical solution for accomplishing the planning objective at Bayshore County Park. Therefore, this is the only alternative considered in detail. The bay shoreline of the park will be shaped and covered with stone rip-rap for a distance of 2,000 feet from -1 to +4 feet NGVD. Approximately 6,000 tons of stone will be transported by rail from a central Texas quarry

mitigation is expected to be necessary is the removal of Big Reef. It may be possible to avoid the wetland portion of Big Reef by confining borrow operations to the seaward end of the sand spit during initial construction if a sufficient volume of sand can be obtained. This will be determined during the detailed engineering and design phase of project planning. As stated in paragraph 2.3.8 some future maintenance material may come from ship channel maintenance along with sand which accumulates at Big Reef between beach renourishment operations every 16 to 32 years. If the above should prove infeasible, mitigation might take the form of off site creation of shallow nursery habitat similar to the protected water area between Big Reef and the south jetty.

2.5 Comparative Impacts of Alternatives

2.5.1 As discussed above, the only alternative recommended for construction was beach nourishment for Galveston Island beaches and a stone revetment at Bayshore County Park on Galveston Bay. These are the most engineeringly and economically viable methods for satisfying project planning objectives. Also, the most economical source of suitable sand for the project is found at Big Reef.

2.5.2 Two different construction methods were considered for obtaining and placing sand at the Galveston sites: a dragline and truck-haul option, and a hydraulic dredge and pipeline option. Preliminary estimates showed no significant difference in cost between the two methods. Although the dragline and truck-haul option was chosen to demonstrate project feasibility in this report, both methods of obtaining and placing sand at the Galveston sites will be evaluated in detail during post-authorization studies (see Gulf Study Site Report). Comparative impacts between the recommended project plan and the no action alternative are presented in Table 2.

Table - 2. Continued

Condition	Water and sediment quality	Endangered species	Socioeconomic profile
Galveston Island			
Existing	Generally good at Big Reef and on Galveston Island beaches.	Kemp's ridley and loggerhead sea turtles occasional, peregrine falcon rare at Big Reef and on beaches.	Island tourism is an important industry. Little beach in groin field, west beach eroding. Heavy traffic and difficulty parking on summer weekends.
Future without project	No impact.	No impact.	Increases in unsatisfied demand for beach recreation. Continued erosion at west beach and Bayshore County Park.
Future with project	No meaningful impact.	Possible temporary disturbance to sea turtles, brown pelican, and peregrine falcon.	Substantial increase in beach use requiring remote parking and increased city services. Loss of unique recreational opportunities at Big Reef. Truck-hauling on Seawall causes traffic problems, blowing sand, road deterioration, etc.
Bayshore County Park			
Existing	Generally good sediment quality, turbid water due to shoreline erosion.	No significant habitat in area.	Park valued for picnicking and fishing. Utilized by visitors from Harris and Galveston Counties, and by local residents for social functions.
Future without project	No impact unless other shoreline protection is provided.	No impact.	With continued erosion park land will be lost and recreational use will cease.
Future with project	Possible reduction in shoreline turbidity.	No impact.	Action would prevent loss of recreational opportunities.

3. Effected Environment

3.1 Environmental Conditions

3.1.1 The project is located along Galveston Bay and the Gulf of Mexico in Galveston County, Texas, a rapidly growing industrial and urban area dominated economically by the City of Houston, approximately 50 miles north of Galveston Island. Comprehensive descriptions of the Galveston Bay area, which includes the project area, can be found in Shew, et al., 1981 (physical and biological resources); Aten, 1982 (Archeological resources); Liebow, Butler and Mout, 1980 (socioeconomic conditions). Galveston Island is a coastal barrier island about 30 miles long. Approximately the eastern one third of the island is occupied by the city of Galveston. The city fronts the Gulf of Mexico and is protected by a 10-mile long 17-foot high seawall topped by a wide four lane road, Seawall Boulevard. Bay Shore County Park is a Galveston County park located about midway along the west shoreline of Galveston Bay in the town of San Leon.

3.1.2 The Galveston Bay system which includes Galveston, Trinity, East and West Bays is the largest bay system along the Texas coast. Major deep draft navigation channels are the Houston, Texas City, and Galveston Ship Channels. Numerous shallow draft channels including the Gulf Intracoastal Waterway are also present. The most important economic activities on the bay system are waterborne commerce, mineral (oil and gas) extraction, commercial fishing, and recreational activities (primarily boating and sport fishing). From a fishery standpoint, Galveston Bay is the most productive bay system in Texas in spite of substantial man induced changes, mostly associated with shipping and mineral extraction. The most

the only drive-on beach on the east end of the island and the only dune area where off-road vehicles can operate. Greatest recreational use occurs during the warmer portion of the year when camping, swimming, and fishing are the primary activities. These activities can be expected to continue without the project.

3.1.5 The Galveston groin field is located along the Galveston Seawall and is used extensively for recreation. Swimming is the main activity where a narrow beach exists. Surfing and sailing are very popular just offshore. Fifteen rock groins each 500 feet in length have been installed along the seawall between 10th and 61st Streets. All of the groins are used for sport fishing and crabbing; however, four have been modified by Galveston County to also function as lighted fishing piers by installing tee-heads. The last groin at 61st serves as the first part of a long high-raised fishing pier. One additional structure extending into the Gulf from the base of the seawall is the Flagship Hotel and fishing pier at 25th Street. Running along the edge of the seawall adjacent to the Gulf is a continuous 10-mile long sidewalk which is very popular for walking, bicycle riding, roller skating, etc. All of the above activities can be expected to continue without the project.

3.1.6 West beach is an eroding natural beach. The main recreational activities are swimming with some surfing, sailing, and a little fishing. The beach is very popular with weekend tourists from the greater Houston area. Without the project, the beach will continue to erode and further limit recreational opportunity.

3.1.7 Bayshore County Park, the only public park in the San Leon area, is valued primarily for its sportfishing along an electric power plant outfall canal which bisects the park and

occupied by those animals that have the capacity to adapt to the regular displacement of sediments. The coastal beach system is generally in a state of dynamic equilibrium, i.e., continually shifting in response to waves, winds, currents, and tides. Each part of the beach is capable of receiving, storing, and losing sand which depends on constantly changing natural forces. A sandy beach, despite its uniform appearance, harbors a fauna of great ecological diversity.

3.2.3 Marine resources

3.2.3.1 Sandy beaches provide a unique habitat for burrowing animals which live on or in the sand, collectively referred to as the benthos. Animals which occupy the beach, surf, and nearshore zones represent the majority of the invertebrate fauna. These animals range from large strong swimmers such as blue crabs (Callinectes sapidus) which live on the sand to smaller animals such as mole crabs (Emerita portoricensis), clams, and worms which are strong active burrowers to tiny organisms such as protozoans, flatworms, and copepods which occupy interstitial spaces between sand grains. Most of these animals feed either by filtering sea water to catch plankton, by grazing on bacteria or algae and other organic material, or as predators and scavengers. They are, in turn, very important in the food chain for larger animals such as fish and shore birds.

3.2.3.2 Benthic animals that occupy the shifting sands of Big Reef and Galveston Island beaches are well adapted to the unusual conditions of their existence and tolerate various environmental factors in order to feed, burrow, and reproduce. The animals are adapted to withstand the beating and pulling action of waves and currents. Some quickly burrow when exposed

3.2.3.5 Shallow nearshore waters of the beaches on Big Reef or Galveston Island and the shoreline of Galveston Bay provide excellent habitat for a variety of shellfish and finfish species. This zone is a physically more stable environment than the beach or surf zone and has the greatest abundance of commercial and sport fish species such as Florida pompano Trachinotus carolinus, (Bellinger and Avault, 1971), red drum, Sciaenops ocellata, (Bass and Avault, 1975), southern flounder, Paralichthys lethostigma, (Stokes, 1977), and others. Most commercial and sport fishing occurs in this zone. Very few, if any, changes can be expected to occur in this zone along the beaches without the recommended project. In Galveston Bay, continued erosion will contribute somewhat to bay water turbidity which could adversely affect phytoplankton productivity and sight feeding fishes.

3.2.3.6 Gulf beaches such as the groin field and west beach and tidal passes such as Bolivar Roads are used extensively by migrating marine organisms (Cronin and Mansuete, 1971). Most commercial and sport fishes of the Gulf of Mexico spawn in the Gulf and their larval and juvenile stages enter estuaries through tidal passes on an almost continuous year round basis (King, 1971; Sabins and Truesdale, 1974). Many commercially important crustaceans such as shrimp (Baxter and Renfro, 1966) and crabs (More, 1969 and King, 1971) follow similar patterns where peak movement into the estuary occurs during spring and summer. Larva and post larva of most marine organisms are weak swimmers and are thought to be transported into the estuary by flood tidal currents (Hughes, 1969). It can be reasonably assumed that if shrimp larve are able to enter the estuary the larva of other organisms probably will also, although some differences undoubtedly exist. Migration out of the estuary, back into the Gulf by subadult and adult organisms is also important (Trent, 1966; Pullen and Trent 1969); however, it is

Baxter, 1969; Duronslet, Lyon, and Marullo, 1972). Without the recommended project, migration of marine organisms passed Big Reef and along Galveston beaches can be expected to continue.

3.2.3.8 The shallow nearshore area at Bay Shore County Park undoubtedly functions as a migration route and as nursery habitat for marine organisms. Many of species such as white shrimp (Penaus setiferus), Atlantic croaker (Micropogon undulatus), Gulf menhaden (Brevoortia patronus), blue crab, etc., travel long distances from the Gulf to low salinity waters at the head of the estuary near major rivers. Also, juvenile stages of some species prefer shallow nearshore areas to the deeper waters of the central bay (Loesch 1965). Without the project, the shoreline of the park will continue to erode along with most of the rest of the unprotected west shoreline of Galveston Bay, thus contributing to general bay turbidity. This would simply continue into the foreseeable future unless others undertake some form of shoreline protection.

3.2.4 Wildlife resources

3.2.4.1 The most numerous and important group of terrestrial animals in the project area is birds. The Big Reef site, in particular, is located favorably to be used as a wintering area and migration pathway for numerous migrant species of the Central Flyway. Big Reef is alongside a tidal pass which provides an abundant food source for fish-eating birds. It contains brackish marshes, tidal sand flats, and lagoons which are rich producers of avian food in the form of crustaceans, polychaete worms, small shellfish, and small finfish.

3.2.4.2 The bird fauna of Big Reef is diverse, and several species occur in fairly large numbers throughout most of the year. A recent study done by a private consulting group from

greater-yellowlegs	<u>Tringa melanoleucos</u>
lesser yellowlegs	<u>T. flavipes</u>
willet	<u>Cataptrophorus semipalmatus</u>
spotted sandpiper	<u>Actitis macularia</u>
ruddy turnstone	<u>Arenaria interpres</u>
short-billed dowitcher	<u>Limnodromus griseus</u>
long-billed dowitcher	<u>L. scolopaceus</u>
red knot	<u>Calidris canulus</u>
sanderling	<u>C. alba</u>
semipalmated sandpiper	<u>C. pusillus</u>
western sandpiper	<u>C. movri</u>
least sandpiper	<u>C. minutilla</u>
dunlin	<u>C. alpina</u>

3.2.4.5 Several species of fish-eating birds in the loon, grebe, heron, and duck families are commonly seen in the lagoon area between the sand flats and south jetty and in small, brackish to freshwater potholes in the vegetated back-dune area. These include the following:

common loon	<u>Gavia immer</u>
eared grebe	<u>Podiceps nigricollis</u>
pied-billed grebe	<u>Podilymbus podiceps</u>
great blue heron	<u>Ardea herodias</u>
green heron	<u>Butoroides virescens</u>
reddish egret	<u>Dichromanassa refescens</u>
great egret	<u>Casmerodius albus</u>
snowy egret	<u>Egretta thula</u>
Louisiana heron	<u>Hydranassa tricolor</u>
black-crowned night heron	<u>Nycticorax nycticorax</u>
least bittern	<u>Ixobrychus exilis</u>
American bittern	<u>Betaurus lentiginosus</u>
red-breasted merganser	<u>Mergus serrator</u>

3.2.4.9 Without the project the plant and animal community of Big Reef will continue to function as it does presently. However, Big Reef could be altered at any time by a hurricane which could isolate Big Reef from the mainland as happened during Hurricane Carla in 1961. Also, portions of the sand flats could be washed away. Should these events happen, the vegetated back-dune area would be lost as mammal and bird habitat; but the beach and sand flat habitat would become more valuable as feeding, loafing, and even nesting habitat for terns, gulls, and skimmers because of its increased isolation. No definable impacts would occur to wildlife in the groin field, on west beach or at Bayshore County Park as a result of not constructing this project.

3.2.5 Wetlands

3.2.5.1 The significant marine resources of the intertidal areas of the Galveston beaches, the shallow sandy shoreline of Big Reef, and Bayshore County Park have been discussed in Section 4.2.3. This section will be limited to the wetlands and associated open water area at Big Reef which functions as nursery area and feeding habitat for fishery resources. The extensive use of the area by shore and wading birds as a staging and resting area and as feeding habitat has been discussed in Section 3.2.4. This area consists of 20 acres of shallow protected open water bounded by the south jetty, 12 acres of intertidal salt marsh, and 18 acres of intertidal sand flats. Marsh vegetation is primarily smooth cordgrass (Spartina alterniflora) with some marsh-hay cordgrass (Spartina patens), salt grass, black mangrove (Avicennia germinans), and others. The tidal connection with Bolivar Roads is through a narrow constriction between the west end of Big Reef and the south jetty near the outlet of East Lagoon.

3.2.6 Water and sediment quality

3.2.6.1 Sediments in both the Big Reef borrow area and in the beach nourishment areas are predominantly sands which do not readily absorb pollutants. Additionally, these areas are not in close proximity to sources of pollutants and the sediments are subjected to a continuous washing process by wave and current action. Under these conditions, sediments are excluded from EPA testing requirements (40 CFR Part 230, Sub Part G) and are assumed to be of good chemical quality.

3.2.6.2 Water quality in the beach nourishment areas near Galveston Island is generally good. Results of tests on water samples collected biweekly by the Corps of Engineers over a six-month period in 1981 and 1982 near the Big Reef borrow site demonstrated that concentrations of heavy metals, pesticides, and PCB's tested consistently met the 1980 EPA (Acute) criteria.

3.2.6.3 Water and sediment quality in Galveston Bay near Bayshore County Park are also generally good. Results of 1980 Corps of Engineers chemical tests of water and sediments demonstrate that water quality meets the 1980 EPA (Acute) criteria. These results were obtained from samples collected in Galveston Bay near Redfish Reef, offshore of Bayshore County Park. No changes to water or sediment quality should occur in the study area as a result of not constructing the recommended plan.

Seawall, but probably does not regularly use the shoreline at San Leon. The least tern is given "Protected Nongame" status and is common on the Gulf beaches. The black skimmer is listed as threatened in the "TOES Watch-list of Endangered, Threatened and Peripheral Vertebrates of Texas." It feeds by skimming the surface of the water, usually in the surf zone, and is common along the Gulf beaches. The bottle-nosed dolphin is listed as threatened by the TOES and is protected by the Marine Protection Act of 1972. It occurs in bays, lagoons, and shallow nearshore waters and is frequently seen offshore along the Galveston Seawall and at Big Reef.

3.2.7.4 Two plants, Bothriochloa exaristata and Spigelia texana, are "candidate species" given no legal protection at present but are under a Notice of Review (Federal Register, 15 Dec 1980) for further study and possible future listing. Although they both potentially occur in the project area, neither is normally found in a beach or bluff shoreline environment.

3.2.8 Socioeconomic and Recreation Profile

3.2.8.1 On Galveston Island the two beachfront sites proposed for beach nourishment and the borrow site at Big Reef are located within the incorporated City of Galveston. The city, while being one of the top tourist attractions in the State, is characterized demographically by stagnant population growth (0.2 percent between 1970-1980); a large and diverse ethnic mix; a high unemployment rate (13.6 percent as of February 1983); and low per capita incomes (U.S. Dept. of Commerce, Bureau of the Census, 1982; Texas Employment Commission, personal communication, 1983). During recent years, the city has undergone significant economic development

recreational demand area, tourism is expected to increase in importance as a major sector of the island's economy and employment base. Capital investment in tourist-related development is expected to continue. Increasing numbers of island visitors will increase traffic volumes on all major island thoroughfares. Recreational demand presently exceeds the carrying capacity of the Island's urban beach area. If current trends continue, increasing deficits in unsatisfied demand will occur throughout project life. (Appendix A).

3.2.8.5 Presently, the daily beach capacity of Galveston Island from the south jetty to the west end of the seawall is about 35,000 persons, assuming a planning standard which allots 100 square feet of beach area per beach user (Appendix A). This total capacity estimate takes into account a discrepancy between total beach area available for recreational use and parking availability for full capacity utilization. Some beach areas have more potential parking available than the actual recreational beach area requires for full capacity use while other beach areas are limited in use by a lack of adequate available parking (Appendix A). The actual number of beach visitors may exceed the estimated carrying capacity of the beaches on certain peak recreational days.

3.2.8.6 As noted in paragraph 3.1.4, the Big Reef area provides some unique forms of recreational opportunities that are not found at other urban beach sites on Galveston Island. These opportunities include vehicle access to the beach, use of off-road vehicles on the beach and dune areas, overnight camping, and bird watching. Big Reef lies within the National Audubon Society Christmas count circle at Galveston and is very popular with local birders. Sport fishing at Big Reef occurs year round; however, it is most popular during the warmer

3.2.8.9 Occasionally traffic congestion occurs at the bait camp sites when vehicles pulling boat trailers are maneuvered onto Boddeker Drive in their approach to the boat ramps. Also, the only parking available for vehicles pulling trailers lies across Boddeker Drive from the bait camps producing potential traffic hazards from cross-traffic at these points.

3.2.8.10 Future conditions without implementation of the recommended plan are not expected to vary significantly from present conditions. Sport fishing and other recreational activities can be expected to continue much as under existing conditions.

3.2.8.11 The groin field and Seawall Boulevard, which borders the length of the Galveston Seawall and overlooks the Gulf of Mexico, is lined with numerous hotels, motels, restaurants, condominium developments, souvenir shops, amusement areas, and surfboard/skate rental shops. All of these establishments cater to the tourist trade. The seawall itself is a hub of activity throughout the year. Motorists can drive along the boulevard and observe visitors and residents alike using the seawall for walking, jogging, skate boarding, bicycling, roller skating, socializing, accessing the business establishments, simply viewing the gulf or watching the activity in the groin field. The traffic volume along the four-lane Seawall Boulevard consistently exceeds its design capacity of 30,000 - 35,000 vehicles per day during summer weekends (Nadon, personal communication, 1983). Also the parallel parking spaces along both sides of the boulevard from 6th to 61st Streets are fully utilized during summer weekends.

3.2.8.12 Because little beach area remains within the groin field, existing beach capacity can accommodate only about 5400 beach users per day (Appendix A). Surfing and sailing are

3.2.8.15 Future conditions on Seawall Boulevard and in the groin field area are not likely to vary considerably without the proposed project. Because the small beach area within the groin field is essentially stable, present beach use should continue. Sport fishing and other recreational activities can be expected to continue much the same as under existing conditions. Traffic congestion and parking along Seawall Boulevard during the tourist season will continue to be a problem.

3.2.8.16 Erosion within the west beach segment of the study area as discussed in paragraphs 3.1.6 and 2.2.2, detracts from the attractiveness of the area and diminishes the area's recreational utility (Appendix A). While existing peak day use is estimated to be approximately 2300 persons, peak day use without the project is expected to only slightly increase to approximately 2900 persons by 1990 and then decrease to approximately 2300 persons by 2040, due to continuing erosion (Appendix A). Continued erosion also threatens the property between the encroaching beach and Farm-to-Market Road (FM) 3005. This property includes Henderson Hole Lagoon, at which a boat-ride amusement operates, Galveston County Beach Pocket Park No. 1, and an 11-acre vacant tract which has been recently advertised for sale for \$3.75 per square foot (Funderburk Enterprises, personal communication, 1983). Since the beach area will retreat inland as erosion continues, future use of the property adjoining the beach area is also diminished.

3.2.8.17 Bayshore County Park is located on the Galveston County mainland on FM 517 about midway between the unincorporated communities of San Leon and Baycliff. Encompassing about 35 acres and fronting on Galveston Bay, the park is subject to erosion problems, as described in paragraphs 3.1.6 and 2.2.3. The park is divided by the outfall canal of

received compensation for property losses through the Federal Flood Insurance Program. (Ecology and Environment, Inc., 1979). The county provides maintenance to the site through the GCBPD and police protection through the Galveston County Sheriff's Department. (Ecology and Environment, Inc., 1979).

3.2.8.21 The primary effect of continued erosion will be loss of land area available for recreational purposes. Although no existing structures would be affected, erosion could undermine a gravel parking area and portions of the existing intrapark access road during the period of project life. Undercutting action along the steep bank is expected to present a safety hazard to persons utilizing the park. The extent of the adverse effects of erosion is such that, by the year 2000, park visitation will drop to zero. (Appendix A). Local commercial business establishments should be unaffected by continued erosion at the site, however, as will be the sport fishing activity along the outfall canal.

3.2.8.22 Bayshore County Park should become an increasingly important recreational area as the recreational demand in the Houston-Galveston metropolitan area grows. Without the recommended project, continued loss of recreational land area will diminish existing available recreational opportunities and do nothing to satisfy the increasing demand for recreation unless others undertake to provide the necessary protection without Federal assistance.

3.2.9 Cultural Resources:

3.2.9.1 Only limited historical research was conducted (Graham, 1945; Webb, 1952; and Hayes, 1974) and no field survey was performed for Big Reef or the beach nourishment sites. No prehistoric or historic sites were previously recorded and none

4. Environmental Effects

4.1 Marine Resources

4.1.1 Recent studies have shown that beach nourishment can be detrimental, beneficial or have no effect on benthic organisms depending primarily upon construction methods and nourishment material used (Nagvi and Pullen, 1982). Although most of the sand removed from the borrow site, Big Reef, will be excavated by dragline from above water and interior deposits, benthic organisms inhabiting the shoreline and submerged portions will be removed and deposited on the beach in the groin field or at west beach. No studies have been conducted to measure benthic mortality under these conditions; however, it is reasonable to assume that few will survive.

4.1.2 Recovery of the benthic community at a borrow site depends on the physical and biological conditions present at the site. Rapid colonization of the Big Reef borrow area will be encouraged by excavating to only shallow depths over a large area, ie., by not creating a deep hole or pit (Thompson, 1973; Pisapia 1974); and by borrowing in an unstable area influenced by strong currents (Thompson, 1973; Saloman, Naughton, and Taylor, 1982; Culter and Mahadevan, 1982). Colonization of other borrow sites similar in character to Big Reef has been found to be essentially complete within four months (Applied Biology, Inc., 1979) to one year (Culter and Mahadeven, 1982). After borrow operations are completed, the Big Reef area will closely resemble all the existing bottom area along the length of the north and south jettys in substrate characteristics, depth, and current patterns. Although deeper water benthic species will gain about 224 acres of habitat, the shallow shoreline dwellers will loose approximately 10,300 feet of shoreline on Big Reef. As stated in paragraph 2.3.10 a

4.1.4 Benthic organisms at Bayshore County Park would be essentially unaffected by the placement of rock along the shoreline. This is because the zone of rapid erosion where revetment would be placed probably has a very sparse population of these organisms. Secondly, the revetment would only be placed about one foot underwater. After the rock has been placed it would provide attachment substrate for a community of fowling and incrusting organisms such as algae, oysters (Crassostrea virginica), barnacles (Balanus sp), hydroids, brizoans such as Conopeum comensale, etc. The rocks will contribute to the ecological diversity of the shoreline by providing habitat for snails and perhaps false limpets (Siponaria pectinata) which eat algae, scavengers such as rock lica (Ligia exotica) and crabs, and predators such as oyster drills (Thais sp) which eat oysters and barnacles.

4.1.5 Large motile animals such as crabs, shrimp, and fish would be the least effected marine animals in the Big Reef borrow area because they are strong swimmers and easily avoid disturbance. Some studies of borrow areas for beach nourishment projects have shown an increase in the fish population after borrow operations are completed (Saloman, 1974; Courtenay, Hartig, and Loisel, 1980; Holland, Chambers, and Blackman, 1980; and Tubeville and Marsh, 1982). In effect, about 224 acres of additional habitat for these animals would be created and should be of about the same quality as along the rest of the north and south jetties.

4.1.6 The large animals would also be the least affected at the nourishment sites in the groin field and at west beach. Bottom feeding organisms such as southern flounder, Florida pompano, white shrimp, etc., would be affected most by having their food organisms either temporarily moved or buried. Because of the relatively silt free nature of the borrow

post-larval shrimp entering Galveston Bay through Bolivar Roads would result in a measurable reduction in the commercial fishery as tentatively shown by Baxter (1962). During three successive years (1960-62) the study showed the adult brown shrimp catch in the Gulf and the juvenile brown shrimp catch in Galveston Bay varied with the number of immigrating post-larva collected in samples in Bolivar Roads. To our knowledge there are no data which show larval mortality in the estuary. However, based on the large number of shrimp larva and post larva collected in samples during some of the studies previously cited, the actual numbers entering the bay must be enormous. Construction activities in one small portion of Bolivar Roads and on the beaches would probably only affect and infinitesimally small fraction of these larva during the three year construction period.

4.1.9 After project construction is complete and much of Big Reef and its associated shoreline has been removed there should be little if any impact on migrating organisms. This conclusion is based on the fact that large numbers of shrimp post larva were taken along the shoreline of Bolivar Peninsula in Bolivar Roads during the previously cited studies. These organisms evidently negotiated the 24,200-foot length of the north jetty or entered via the small boat cut through the jetty and did not have a shallow sandy beach available to them along the way until they reached Bolivar Peninsula. Even along the south jetty, the Big Reef shoreline is only 10,300 feet of the total 27,300-foot jetty length with its rock-water interface and 10 to 40-foot water depths. Although it has been shown that some immigrating juvenile fish (southern flounder, Stokes, 1977) do utilize shallow sandy areas in tidal passes when available, it has not been shown that these areas are necessary to successful movement from the Gulf into the estuary. If some organisms do depend on shallow shoreline habitat during

nursery area and feeding habitat for numerous fish and wildlife species. The only similar habitat to be found on Galveston Island is at San Luis Pass about 30 miles away. However, Bolivar Flats located on Bolivar Peninsula about 5 miles from Big Reef is similar. Loss of wetlands associated with Big Reef would reduce the habitat diversity and biological productivity of Bolivar Roads and to some extent lower Galveston Bay. Although no mitigation plan has yet been formulated for this project, during future coordination this possibility would be fully explored as discussed in paragraph 2.3.15.

4.5 Water and Sediment Quality

4.5.1 Water quality impacts at Big Reef would be limited to a slight increase in turbidity. The sands at Big Reef have been deposited by tidal currents and are relatively silt free. Also, much of the sand from Big Reef would come from above water and interior portions of the sand bar; therefore, the draglines would not be continuously working at the waters edge. The temporary increases in turbidity should have no effect on fish and wildlife resources of the area. Because Big Reef sands are considered chemically clean, no pollution problems are expected.

4.5.2 Water quality impacts at beach nourishment sites would be limited to temporary increases in turbidity as wave action redistributes the newly deposited sand. Since the sand is relatively silt free, increased turbidity levels would probably not be any higher than natural levels occurring during periods of heavy wave action. It is possible that sport fishing could be adversely affected on the beach front during late spring and early summer calm periods when the beach water normally becomes very clear.

Jetty and west beach on a peak day. By the year 2040, beach nourishment at the groin field and at west beach would generate sufficient beach area to accommodate about 49,000 additional visitors on a peak recreational day. This constitutes a 140 percent increase over 1980 beach capacity use. These 49,000 beach visitors are expected to increase local traffic volume by about 16,000 vehicles and parking demand by about 10,000 spaces (Appendix A).

4.7.2 While there exists parking area capable of accommodating the increase in projected recreational use at west beach, the parking area in the groin field section of Seawall Boulevard is saturated under existing conditions. Given that an additional 4,300 parking spaces could be developed at East Beach and beach users were shuttled to the groin field area, a parking deficit of about 5,800 spaces would exist by the year 2040. In order to fully utilize the newly created groin field beach area, some form of offsite parking and shuttle service would be necessary. An area about three times the size of the Galvez Shopping Mall parking lot would accommodate the projected deficit parking demand.

4.7.3 An increase in traffic volume of the magnitude projected to occur with the recommended plan would stress the design capacities of the city's major thoroughfares, eg., Broadway Boulevard, Seawall Boulevard, and 61st Street. Additionally, at the present time several new condominiums, townhouses, apartments, hotels and motels are being constructed along Seawall Boulevard. The cumulative effect of the above development would be to greatly increase traffic volume throughout the city during summer months.

some opportunity for continued bank fishing. The availability, desirability, or quality of this fishery relative to that which presently exists on Big Reef is difficult to predict. This is due to unsettled conditions on the shoreline following the excavation of sand. Initially, at least, the sand shoreline would have a more unstable, steeper slope than what exists now. Over time, sand would accumulate again in the area and sport fishing there may improve.

4.7.9 The Park Board of Trustees can expect some loss of revenue generated by entrance fees at R.A. Apffel Park because of the loss of beach capacity and recreational opportunities at Big Reef. Also, the bait camps and informal restaurants on Boddeker Drive may lose some revenue with fewer visitors at East Beach. The launching and mooring areas behind the bait camps would require less frequent dredging after Big Reef is removed.

4.7.10 The truck hauling method of transporting material along Seawall Boulevard to nourishment sites would produce adverse effects during the three-year construction period. Truck hauling at the rate described in paragraph 2.3.12 would produce public safety hazards in the form of traffic congestion along Boddeker Drive and Seawall Boulevard. On the average, a dump truck would be passing any one point along Seawall Boulevard about every 1.5 minutes either going to or coming from the nourishment sites. Traffic disruptions can also be expected at the nourishment sites as trucks are maneuvered into position for unloading. These disruptions can be minimized through use of control measures such as one-way traffic, flagmen, etc. Road deterioration can also be anticipated along the entire truck route. Adverse impacts to air quality are expected along the route as a result of sand blowing from truck beds and

Table 3. Projected peak day use of the groin field and parking requirements with the recommended plan by year.

Calendar Year	Projected ^{1/} visitation with project	Number of ^{2/} additional cars	Total parking spaces ^{3/} required by year	Excess parking ^{4/} available in project area	Additional ^{5/} parking to be developed
1990	10,123	3,374	2,250	4,300	0
2000	20,447	6,816	4,544	4,300	244
2010	25,855	8,618	5,746	4,300	1,446
2020	35,825	11,942	7,961	4,300	3,661
2030	45,563 ^{6/}	15,188	10,125	4,300	5,825
2040	45,563	15,188	10,125	4,300	5,825

1/ Projected numbers of people from the Texas Outdoor Recreation Plan, see Appendix A.

2/ An average of three visitors per car was assumed.

3/ An average turnover rate of 1.5 cars per parking space was assumed to account for some spaces being occupied by more than one car per day.

4/ These parking spaces are now available at east beach.

5/ These parking spaces will be provided by Galveston County.

6/ Visitation is not projected to increase during the last ten years of project economic life because the beach would be filled to capacity on a peak day.

4.7.15 Beach nourishment at the west beach site would enhance the aesthetic quality of the beach. Although use of the beach would be limited during the one-year construction period, nourishment of the beach area would increase the attractiveness of the beach for recreational use (Table 4). By the year 2040, beach visitation is expected to be 150 percent greater with project implementation than without it. Full capacity utilization can be anticipated within the project life since parking space is available to meet projected demand. Beach nourishment would also protect private property adjacent to the beach and would complement existing facilities at Galveston County Beach Pocket Park No. 1.

4.7.16 Expansion of the beach area would provide additional recreational opportunities for swimming, sunbathing, picnicking, and walking on the beach. Sport fishing is not expected to be affected by project implementation. Construction activity associated with beach nourishment would produce the same negative effects to traffic movement, public safety, and road deterioration as described with beach nourishment in the groin field.

4.7.17 Construction of the rock revetment at Bayshore County Park would protect existing park land and would preserve recreational opportunities available at the site (Table 5). The rock revetment would protect park users from the undercutting action of erosion along the park's steep bank. Although the little swimming activity that occurs at the park would be eliminated by the recommended plan, opportunities for other recreational activities that take place there would be preserved. The recommended plan would not affect fishing at the outfall canal or commercial business activity nearby. Little disruption of activity at the park is expected during construction of the revetment.

Table 5. Loss of area and peak daily attendance by year at Bayshore County Park.

Calendar Year	Park area ^{1/} acres	Capacity ^{2/}	Daily attendance without project	Peak daily attendance with project	Difference
1990	12.1	2,625	265	265	0
2000	10.2	2,225	0	319	319
2010	8.6	1,869	0	335	335
2020	7.1	1,537	0	387	387
2030	5.3	1,162	0	447	447
2040	3.6	787	0	501	501

^{1/} These losses will occur assuming a shoreline erosion rate of 5 feet per year.

^{2/} These people and the required parking can be accommodated in the park based on an area of 200 square feet per person.

4.10 Any Irreversible and Irretrievable Commitments of Resources Involved in Implementation of the Selected Plan.

4.10.1 The fish and wildlife resources associated with Big Reef would be lost during project life as the borrow area would be almost completely removed.

4.11 The Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

4.11.1 The proposed beach nourishment project would provide increased beach area at Galveston Island. Long-term benefits to the area would accrue from the increased width of the beach and, in turn, the revenue generated from increasing the recreational supply to the Houston-Galveston metropolitan area and surrounding regions. At Bayshore County Park the recommended project would provide protection to the eroding bayshore, and long-term benefits to the area would be reduced erosion-related loss of property and maintaining recreational opportunities.

4.11.2 There would be a reduction in long-term biological productivity because of the loss of shallow water habitat as well as the beach, dune, and marsh habitats associated with Big Reef as a result of using Big Reef as a potential borrow site for beach nourishment at Galveston Island. Recreational opportunities at Big Reef would be redistributed to more commercialized areas along the Galveston Seawall. Contact water recreation at Bayshore County Park, would be affected as a result of revetment construction. However, since picnicking, fishing, and crabbing are the predominate activities at the park, contact water sports are not a major consideration at this site.

6. PUBLIC INVOLVEMENT

6.1 Public meetings were held in the following locations during November and December 1976: Port Boliver, Galveston, San Leon, and Freeport to initiate public involvement in this study. More than 275 persons attended the four meetings in response to the congressionally-authorized study of erosion problems along Gulf and Bay shores of Galveston County and at Surfside/Beach in Brazoria County. The meetings were held to obtain information on the nature and extent of shoreline erosion problems in the study area, gather data on local ecological and environmental conditions, assess the extent of public interest, determine local preferences for erosion control measures, and identify potential local sponsors for the project.

6.2 A transcript for the four meetings is available for public inspection at the Galveston District. The transcript contains the announcement of the public meetings, the mailing list, lists of those in attendance, meeting proceedings, oral statements, and written statements submitted both at the meeting and subsequently by mail. Public sentiments at these meetings centered around the causes and control methods of erosion along the Gulf and bay shorelines and concern over the time involved in project study requirements. A Summary of a Series of Public Meetings to Discuss Shore Erosion Problems in Galveston County and at Surfside Beach in Brazoria County is contained in the Public Involvement Appendix.

6.3 A scoping meeting was held on 11 May 1981 to discuss the proposed project and identify any significant resources and issues to be addressed in the environmental statement. A brief summary of the scoping meeting is contained in the Public Concerns section of this statement. A memorandum of the

in Appendix D. No significant adverse effects are expected from placement of dredged or fill material associated with construction of this project.

6.4.4 Coordination with Federal, State, and local agencies and the interested public would continue after circulation of this Environmental Impact Statement and Feasibility Report if the project is authorized. During post-authorization studies and advanced engineering and design studies, coordination would continue with all interested parties through public announcements and other public involvement activities.

6.5 Statement Recipients

6.5.1 This statement as part of the Main Report, Study Site Reports, and related Appendices, will be circulated to all known interested local, state and Federal agencies; environmental and civic organizations; and individuals for review and comment. The project mailing list includes the following addressees:

Region VI, Environmental Protection Agency
Region VI, Department of Human Resources
Region VI, Department of Housing and Urban Development
Soil Conservation Service, U.S. Department of Agriculture
Forest Service, U.S. Department of Agriculture
U.S. Department of Energy
Advisory Council on Historic Preservation
Office of Environmental Project Review, Department of the
Interior
U.S. Fish and Wildlife Service
Bureau of Reclamation

Espey, Huston and Associates
Southern Plains Regional Conservation Committee
Mayor, City of Galveston
Galveston County Judge
Galveston Beach Park Board
Galveston Sierra Club
San Leon Chamber of Commerce
U.S. Coast Guard Eighth District
Galveston Chamber of Commerce
Gulf Coast Conservation Association
Gulf Intracoastal Canal Association
Houston Sportsmen's Club
Galveston Bay Conservation and Preservation Association

6.5.3 Publication of this document will be noted in the Federal Register with a notice of the date comments are due. A news release will also be issued at the time this document is circulated stating that single copies of the EIS are available to the public upon request to the Commander, Galveston District. Copies of the statement will be furnished to individuals and concerned groups who have requested the document. A notice of availability will be mailed to all groups and individuals known to have an interest in the project.

6.6 Public Views and Responses

6.6.1 Close coordination with Federal, State, and local agencies and interested groups and individuals revealed public views and concerns which have been utilized in the evaluation of alternative shore protection plans and in development of the scope of this EIS. Public views expressed as a result of public meetings, a scoping meeting, and other project coordination have been considered or addressed. Information and suggestions of various governmental agencies, groups, and

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DISCUSSION

The Administration is reviewing project cost-sharing and financing across the entire spectrum of water resource development functions and has submitted proposed legislation to Congress for navigation projects. The basic principle governing the development of specific cost-sharing policies is that whenever possible the cost of services produced by water projects should be paid for by their direct beneficiaries. It also is recognized that the Federal Government can no longer bear the major portion of the financing of water projects. New sources of project financing, both public and private, will have to be found. While specific policies applicable to the recommended projects in this report have not yet been established, non-federal interests can expect that, under the Administration's financing and cost-sharing principles, the level of their financial participation will need to be significantly greater than in the past.

d. Hold and save the United States free from damages due to construction and subsequent maintenance of the project, not including damage due to the fault or negligence of the United States or its contractors;

e. Assure continued conditions of public ownership and use of the share upon which the amount of Federal participation is based during the economic life of the project (50 years);

f. Assure maintenance and repair, and local share of periodic beach nourishment, where applicable, during the economic life of the project as required to serve the intended purposes; and

g. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

ALAN L. LAUBSCHER
Colonel, CE
District Commander

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