

FORMULATION METHODOLOGY

117. Formulation of plans was through an iterative three-stage process. An abbreviated work sequence diagram graphically illustrating the process is shown in figure 30. The stages were (1) Identification of Possible Solutions, (2) Development of Intermediate Plans, and (3) Development of Detailed Plans. Each stage contains essentially the same sequence of 4 tasks to be performed, but task emphasis shifts as the process proceeds.

PROFILE OF EXISTING CONDITIONS

118. A profile outlining existing physical, economic, social and environmental conditions in the study area was presented earlier. The profile provides the basis for comparison in the formulation of possible solutions to the problems and needs and a comparison of impacts from considered alternatives. Problems and needs identified included: hurricane protection for Mobile, Mobile County, and Dauphin Island; erosion control for Mobile County and Dauphin Island; control and stabilization of Petit Bois Pass; and expanded recreation facilities.

INITIAL ALTERNATIVES CONSIDERED

119. Table 23 lists possible solutions considered in the first stage of formulation. Table 24 shows the planning objectives that each of the alternatives would meet. Various deficiencies in many of the alternatives initially considered are discussed in the following paragraphs.

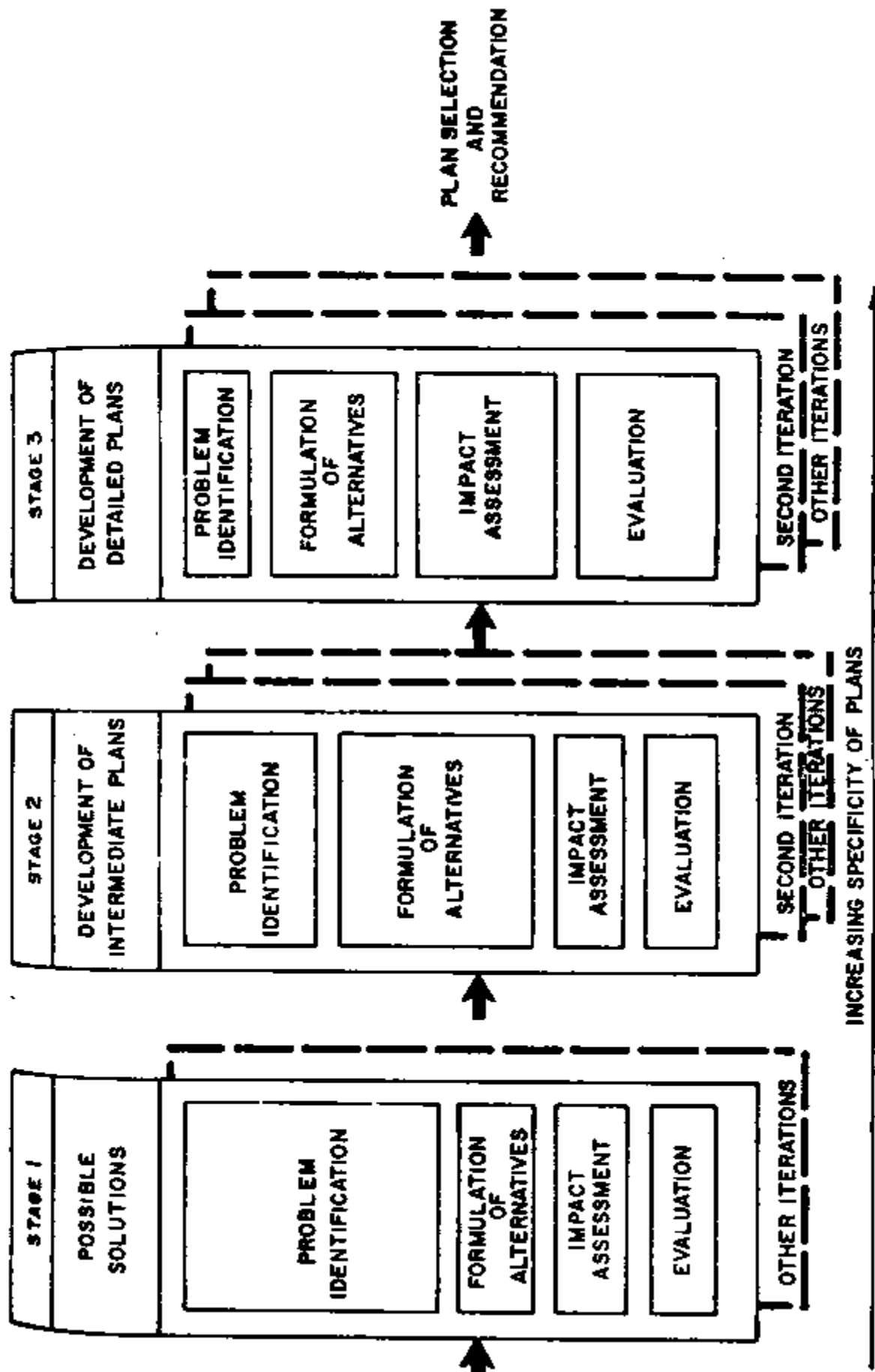


Figure 30. GENERAL RELATIONSHIP OF PLANS FORMULATION STAGES AND FUNCTIONAL PLANNING TASKS.

TABLE 23

Possible Solutions

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1. Beach restoration and nourishment
 2. Groin system
 3. Seawalls
 4. Offshore breakwater
 5. Relocate structures
 6. Flood proof structures
 7. Rezone area
 8. Modify building codes
 9. Moratorium on construction
 10. Flood insurance
 11. Evacuation planning
 12. Nourishment of shore with material
from channel maintenance
 13. Establish a "no growth" program
 14. Grass existing shore
 15. Develop artificial dune
 16. No further action
 17. Various combinations of above
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TABLE 24

Stage I Alternatives and Planning Objectives They Meet

Alternatives ¹	Local Planning Objectives ²			Principles and Standards ³			
	RB	FP	EC	NED	EQ	SWB	RD
1	F ⁴	P	P		P	F	F
2	P	P	P		P		
3		P	P			P	P
4	P	P	P		P	P	P
5	P	F			P	F	P
6		P			P	F	
7	P	F			P	P	P
8		P			P	P	
9		P			P	P	
10						P	P
11		P			P	P	
12	P	P	P	F	P	P	P
13					P	P	
14		P	P		P	P	
15					P		

1 Number of alternative refers to those alternative numbers in Table 23.

2 RB = Provisions of recreation beach
 FP = Protection from flooding and wave damage
 EC = Beach erosion control

3 NED = National economic development
 EQ = Environmental quality
 SWB = Social well being
 RD = Regional development

4 P = Meet fully
 P = Meet partially

Blank spaces indicate not meeting objective.

120. Grassing the existing shore would limit the use of the beaches for recreational purposes and would not be very effective in controlling erosion. Also, tests conducted by the Coastal Engineering Research Center indicate that artificial seaweed is not effective in attenuating wave energy at periods commonly found in the gulf. The other structural techniques identified are capable of effectively addressing various aspects of existing problems. However, their effectiveness and contributions to the planning objectives vary significantly.

121. From the array of possible nonstructural alternatives, several, such as a "no growth" program and a moratorium on construction, can be discounted as overall solutions that address existing problems or contribute to the planning objectives. Also, since Mobile County has implemented the Federal Flood Insurance Program, flood plain regulations and building regulations are presently in effect. In addition, evacuation planning has been effected by the Mobile Civil Defense Office. The value of certain construction restraints and nonstructural measures have also been recognized and implemented in the area.

122. In addition to the action courses, there is the "No Action" alternative. This option does not provide a solution to existing problems. However, this alternative is maintained throughout the formulation process since it avoids any undesirable effects that may be associated with other courses of action and thereby provides a basis for comparison.

INTERMEDIATE ALTERNATIVES CONSIDERED

123. The initial 16 possible techniques for addressing the problems and needs of the area were evaluated in terms of their practicality and contributions to the needs of the study area and the planning objectives. From the initial solutions, 10 were selected to address specific objectives and for further consideration. As listed in table 25, the first six of these alternatives are structural in nature, the next three are non-structural or local measures that could be implemented, followed by the "No Action" alternative and the combination of the other options. A further evaluation of these alternatives succeeded in additional eliminations and combinations.

EROSION CONTROL ALTERNATIVES

124. As related to shore erosion, preliminary cost and local requirements were developed for each of the alternatives. This information was coordinated with local interests. As discussed previously, structural plans that could be implemented for protection of the western shore of Mobile Bay, under existing Federal authorities for beach erosion, were strongly opposed by existing waterfront property owners. Accordingly, alternatives three through six were excluded from further consideration.

125. Structural alternative 1, which could be implemented under Federal navigation authorities, was further coordinated under the ongoing study for modifying the existing Federal project for Mobile Harbor. As part of this study, it was established through a direct survey that about 80 percent of the property owners along the west shore of Mobile Bay opposed this alternative. In view of the lack of support, this plan was also dropped.

TABLE 25

Intermediate Alternatives Considered

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1. Nourishment of the west shore of Mobile Bay with material from channel maintenance or construction
 2. As part of the ongoing maintenance program, place material dredged from the outer bar of the Mobile Ship Channel onto Dauphin Island.
 3. Beach restoration and nourishment - offshore borrow area
 4. Groin system
 5. Seawall
 6. Offshore breakwater
 7. Sand dune development and stabilization
 8. Relocation of structures
 9. Rezoning of area
 10. No further action
 11. Various combinations of above
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126. Investigations indicate that erosion occurring along the western 11 miles of Dauphin Island is probably attributed mainly to rising sea level and maintenance dredging of the ship channel through the bar fronting the Mobile Bay entrance channel. These investigations also indicate that material removed from the bar channel is suitable for nourishment of the shore of Dauphin Island. Accordingly, type 2 alternatives will be considered in more detail.

ALTERNATIVE FOR THE CONTROL AND STABILIZATION OF PETIT BOIS PASS

127. Preliminary analysis of the closing of Petit Bois Pass indicates this could best be accomplished by alternative 3, beach restoration and nourishment. Material for the initial fill and subsequent nourishment would be taken from offshore borrow areas at the west end of Dauphin Island, as shown on plate III. The removal of material from the end of Dauphin Island should stabilize the existing gorge of Petit Bois Pass. The initial fill would require about 6.2 million cubic yards. Excluding losses that occur when the area is under the influence of a severe storm, about 400,000 cubic yards of material every three years would be required to nourish the considered works. The initial fill should be to about 5 feet above mean sea level and nourishment could be accomplished by providing a feeder beach at the east end of the fill. Initial cost and annual cost of this alternative are estimated to be approximately \$15.6 million and \$1.2 million, respectively.

128. As discussed in previous paragraphs, it is indicated that Petit Bois Pass is being closed by the ongoing accretion of material at the west end of Dauphin Island, and that closing of the pass will not necessarily assure conditions in the north-eastern part of Mississippi Sound favorable for the production

of oysters. Also, in the event the Mobile entrance channel is deepened and the material removed from the channel is placed in the littoral zone, the westward extension of Dauphin Island may be accelerated. In view of the limitations, potential disadvantages and lack of authority for Federal involvement, this alternative was not evaluated further in this report. Such works could be considered as an integral part of other Federally approved activities being studied in Mississippi Sound.

EXPANDED RECREATION FACILITIES

129. The need for providing expanded recreation facilities on Dauphin Island was presented earlier. The Alabama Statewide Comprehensive Outdoor Recreation Plan, prepared by the Agricultural Experiment Station of Auburn University, inventoried the demand for brackish and salt water swimming in Mobile and Baldwin Counties. The study, published in 1975, indicated that the total resources in the area which are available for this type of swimming consist of almost 500,000 acres of water and 210 miles of sand beaches. This amount is considered adequate for demand to the year 2000.

130. Although ample beach areas exist along the undeveloped west end of Dauphin Island and at the county owned public beach, inaction by the county has prevented full usage by the public. A satisfactory swimming beach must provide sufficient access, facilities and maintenance, and few public beach facilities have been constructed. Therefore, since increased recreational benefits would be dependent on additional facilities and access rather than a need for increased beach area, Federal restoration of beach for recreation was not considered.

FLOOD CONTROL ALTERNATIVES

131. As related to providing hurricane flood protection with structures, preliminary analysis indicated that except at

Dauphin Island, protection can best be provided by the construction of seawalls and related structures. At Dauphin Island sand dune development and stabilization were considered more appropriate. Other alternatives considered would not provide the minimum 100 year degree of protection specified herein by planning criteria.

132. Preliminary design and cost estimates were made for protective systems for each of the study areas shown on figure 6. A summary of these analyses follows. Costs shown are based on the cost of similar structures elsewhere and are to be considered conservative and only a first order of approximation. The surge that would accompany a hurricane with an occurrence interval of once every 100 years was used as the design surge in these analyses. The development survey was completed in January 1977 and values determined based on average 1976 price levels. These values have subsequently been adjusted to reflect 1978 price levels.

133. Area 1 - Bayou La Batre. This area extends along the north of Mississippi Sound about 9 miles east from the Mississippi, Alabama, state line. Development within the 500 year flood plain of the area is comprised of 1468 residential units, valued at \$41.4 million; 84 commercial establishments, valued at \$6.3 million; and 24 institutional units, valued at \$4.3 million; 200 fishing vessels and docking facilities, valued at \$5.0 million; and 25 industrial concerns, valued at \$3.2 million.

134. The alternative considered for this area provided for about 4.1 miles of levee tied into high ground east of the City of Coden and west of the City of Bayou La Batre, closure structures across Bayou La Batre and Bayou Coden and for two

pumping plants. Annual cost and annual benefits for this alternative were computed to be \$3.4 million and \$1.2 million, respectively. Annual benefits that would stem from providing protection from flood damage that would result if the area came under the influence of a hurricane with a recurrence interval of 500 years were estimated at \$1.5 million.

135. Area 2 - Heron Bay. This area extends south from Alabama Point to Mississippi Sound, thence 4 miles west along the north shore of Mississippi Sound to Area 1. Development within the 500 year flood plain of this area is comprised of 221 residential unites, valued at \$2.8 million; 10 commercial establishments, valued at \$0.1 million; 5 institutional units valued at \$0.2 million; and marine facilities, valued at \$0.4 million.

136. The alternative considered for the area provided for encircling the area with about 3 miles of levee and necessary openings to facilitate drainage. The average annual cost and average annual benefits for this alternative were computed to be \$0.4 million and \$0.02 million, respectively. Annual benefits that would stem from providing protection from the flood damage that would occur if the area came under the influence of a hurricane with a recurrence of 500 years are estimated at \$0.03 million.

137. Area 3 - Dauphin Island. Development on Dauphin Island is concentrated primarily on the easternmost seven miles of the island. Development within the 500 year flood plain is comprised of 918 residential units valued at \$32.1 million; 31 commercial establishments, valued at \$3.6 million; 19 institutional units valued at \$2.2 million; and 4 marine installations valued at \$2.5 million. Annual benefits that

would stem from protecting the area from flood damage that would accompany hurricanes with recurrence intervals of 100 years and 500 years are estimated to be \$0.8 million and \$0.9 million, respectively.

138. A protective system for this area would be comprised of a minimum of a protective dune system extending along the gulf shore of the island and a seawall along the Mississippi Sound shore. Since the estimated annual cost of only providing the dune system was estimated to be \$1.1 million, protection was not considered economically feasible and no further analyses of protective structures were made.

139. Area 4 - Belle Fontaine. This area extends from Alabama Point to the middle fork of Deer River, a distance of about 11 miles. Development within the area is mostly residential. The surge with a recurrence interval of once every 100 years would affect about 492 residences valued at \$14.4 million and about 6 commercial establishments valued at \$0.6 million. Annual benefits that would stem from protecting this area from flood damages that would accompany hurricanes with recurrence of 100 years and 500 years are estimated at \$0.1 million and \$0.1 million, respectively.

140. A plan providing minimum protection for the area would be comprised of a levee extending along the shore of the reach, navigation and drainage openings through the levee system at Fowl River, and levees extending shoreward to high ground at each end of the system. Since the annual cost of only providing a levee fronting the reach is estimated to be \$1.4 million, no further analysis of this alternative was made.

141. Area 5 - Hollingers Island. This area extends from the middle fork of Deer River to near Dog River Point, a distance of about 6.5 miles. Development within the 500 year flood plain of the area is comprised of 3492 residential units, valued at \$141.9 million; 20 commercial establishments, valued at \$0.7 million; 10 institutional units, valued at \$1.7 million; 1 industrial facility, valued at \$0.01 million; and numerous marine facilities valued at \$4.4 million. Annual benefits that would stem from protecting this area from flood damages that would accompany hurricanes with occurrence intervals of 100 years and 500 years are estimated to be \$0.1 million and \$0.3 million, respectively.

142. The alternative considered for the area would be comprised, at a minimum, of a levee extending along the shore of the reach, navigation and drainage openings, a pumping plant, and back levees at each end of the system. Since the estimated annual cost of navigation structures, \$0.5 million, exceeds annual benefits that would stem from the protective works, no further analyses of this alternative were warranted.

143. Area 6 - Mobile. This area extends from Dog River Point to near Chickasaw, a distance of about 15 miles. Development within the 500 year flood plain of the area is located mostly along the shore and is comprised of 1034 residential units, valued at \$59.5 million; 81 commercial establishments, valued at \$33.5 million; 71 industrial sites, valued at \$182.7 million; 8 institutional facilities, valued at \$7.2 million; and 21 marine-related activities, valued at \$8.3 million. Included in this area are the industrial complex at Brookley Field and the dock facilities at Mobile. Accordingly, any protection plan for the area would have to provide for closure structures across the Mobile Ship Channel. It is estimated that these structures

would cost in excess of \$240 million. Annual benefits that would stem from protecting the area from hurricane surges with occurrence intervals of 100 years and 500 years would be \$0.09 million and \$9.7 million, respectively. Since interest and amortization charges on only the closure structures, \$16.6 million, exceed the annual benefits no further analyses of protecting this area with seawalls and associated structures were made.

144. Local interests suggested a plan to protect this area by the construction of a series of ungated barriers extending across the bay. These barriers would be positioned in the bay in such a manner as to intercept storm waves and surges traveling up the bay from the gulf toward the City of Mobile.

145. Detailed analyses of protective systems such as this have been made at other locations. These analyses indicate that along the Atlantic Coast at higher latitudes, such systems can be designed to give a bay area a high degree of protection from hurricane surges. However, this type of protective system was found generally not to be effective in the lower latitudes, particularly along the Gulf Coast of the United States.

146. A barrier system across any part of Mobile Bay would have to contain openings sufficient in size and number to accommodate tidal flows and navigation. Considering the number and size of openings that would be required and the potential duration of the hurricane surge that could be reasonably expected to affect the area, it was concluded that bay barriers with ungated openings would not be effective in significantly reducing flood damage caused by hurricane generated surges. This conclusion

is based on the large volume of water that would pass through the openings during the period the area could be under the influence of the hurricane generated surge.

147. Area 7 - Satsuma. This area extends north from the City of Mobile to Steel Creek just north of the City of Satsuma. Development within the 500 year flood plain of the area is comprised of 357 residential units, valued at \$9.6 million; 2 commercial establishments, valued at \$1.6 million; 8 industrial concerns, valued at \$9.1 million; and 1 marine facility, valued at \$0.2 million. Annual benefits that would stem from protecting this area from flood damages that would accompany hurricanes with recurrence intervals of 100 years or 500 years are estimated to be \$7,000.

148. The plan of protection considered for the area would require at a minimum, 1 mile of levee, pumping plants, and drainage structures. Since the estimated annual cost of only the levee system, \$0.1 million, exceeds annual benefits that would stem from the protective works, no further analysis of this alternative was made.

149. Since the annual cost of these alternatives greatly exceeds the benefits stemming from them, no further refinement of the costs is warranted and these alternatives were eliminated from further consideration.

150. Nonstructural Measures. Relocating structures and rezoning the area would not be economically feasible, practical or acceptable to local interests. Further investigation of local institutional organization indicated that essentially those non-structural measures offering potential benefits have been

implemented in the study area. Accordingly, nonstructural measures were not considered further in the plan formulation process.

ALTERNATIVES CONSIDERED FOR FURTHER ANALYSES

151. Except for placement of material dredged during maintenance of the Mobile Ship Channel on the shore of Dauphin Island, preliminary analyses of intermediate alternatives indicate structural alternatives to be either unacceptable to local interests or not economically feasible. These analyses also indicate that essentially nonstructural measures offering potential benefits have been implemented in the study area.

152. As discussed in earlier paragraphs, erosion along the westernmost 11 miles of Dauphin Island averages 10.3 feet per year. This recession of the island's shoreline represents a volumetric loss of about 600,000 cubic yards of material per year. In order to provide a total solution to the erosion problem in this reach it would be necessary to replace the lost material. This could be accomplished by pumping an equivalent amount of suitable beach nourishment material directly onto the shore. Preliminary estimates indicate that the annual cost of initially restoring the material lost to erosion as well as providing necessary periodic nourishment would be considerably in excess of the expected annual benefits of \$584,000. Therefore, a total solution for the island's erosion problem is not economically feasible.

153. Since it is not economically feasible to totally eliminate erosion on Dauphin Island, investigations were made to determine the possibility of partially alleviating the problem. Maintenance

✓ dredging of the Mobile Bay entrance channel has already been discussed as a probable cause for part of the island's erosion problem. About 264,000 cubic yards of material per year are dredged from the entrance channel into Mobile Bay and placed in deep water off the gulf shore of Dauphin Island. This material is essentially lost to the littoral drift system and represents a significant percentage of the total yardage lost to erosion. If this amount of material could be placed directly onshore, or placed so it could reenter the littoral drift system where waves and currents would distribute it and thereby contribute to stabilization of the littoral drift system, erosion could be reduced. Accordingly, the alternative providing for placing material dredged from the outer bar as part of the maintenance program for the Mobile Ship Channel onto Dauphin Island remains as a partial solution to the island's erosion problem. However, before undertaking the development of detailed plans, a further refinement of this alternative was made. The following sub-alternatives were therefore investigated:

- a. Place material dredged from the Mobile Bay entrance channel onto the bar west of the channel.
- b. Place material dredged from the Mobile Bay entrance channel directly onto the shore of Dauphin Island.
- c. Place material dredged from the Mobile Bay entrance channel in the nearshore littoral zone.

154. Based on data previously summarized, it is reasonable to assume that if alternative a. were implemented the ephemeral islands located on the seaward edge of the west bar would enlarge and move shoreward. Consequently, the existing swash channel across the bar would move shoreward. Thus, shore erosion in the area would be accelerated. Accordingly, this alternative was excluded from further consideration.

155. Alternative b. provides for placing material dredged from the Mobile Bay entrance channel directly onto the shore of Dauphin Island. Although the entire gulf shore of the island experiences a degree of erosion, the problem is most severe along its westernmost 11 miles. There the erosion rate is about 10.3 feet per year. Since the erosion rate is greatest in this reach, placing the dredged material directly onto the shore in this area is expected to result in direct benefits by significantly reducing erosion. Therefore, this alternative appears to be a partial solution to the island's erosion problem.

156. Alternative c. proposes an indirect method for alleviating the island's erosion problem. As demonstrated earlier, over 50 percent of the erosion along the gulf shore of Dauphin Island is attributable to rise in sea level. As the sea level rises, material is removed from the shore and deposited along the slope of the nearshore zone. This modification takes place as littoral forces reestablish the same water depths which existed before the rise in sea level. It is reasonable to assume that if material were placed directly onto the slope of the nearshore zone, the slope would tend to stabilize and the amount of material normally removed from the shore as a result of sea level rise would be reduced. Therefore, this alternative would also be effective in decreasing naturally caused erosion on Dauphin Island.

DEVELOPMENT AND EVALUATION OF DETAILED PLANS

157. Therefore, in addition to consideration of the "No Action" plan, two structural plans for partially solving the erosion problem on Dauphin Island were carried forward for more detailed investigation. The alternatives to be evaluated include:

- a. No Action

b. Place material dredged from the Mobile Bay entrance channel directly onto the shore of the westernmost 11 miles of Dauphin Island - Beach Nourishment.

c. Place material dredged from the Mobile Bay entrance channel in the nearshore littoral zone - Nearshore Nourishment.

✓ 158. No Action. - As stated previously, the "No Action" alternative is not considered to be a viable course of action since it would not solve the existing erosion problem. Material dredged from the Mobile Bay entrance channel would continue to be placed in deep water, thereby contributing to the erosion problem on the gulf shore of Dauphin Island.

159. Beach Nourishment. - The entrance channel into Mobile Bay is dredged approximately once every 1-1/2 years as part of the ongoing maintenance program for the Mobile Harbor Navigation Project. About 396,000 cubic yards of material (264,000 cy/yr x 1-1/2) are removed from the entrance channel each time maintenance dredging is performed. This alternative would provide beach nourishment by placing the material directly onto the shore of the westernmost 11 miles of Dauphin Island. The rate of erosion along this western section of the island averages about 10.3 feet per year. Prior calculations indicate that the loss of about 264,000 cubic yards per year in this reach would result in an average loss of shoreline of about 4.6 feet per year. Therefore, nourishment which would replace an equivalent amount of material would be assumed to reduce the annual erosion rate from 10.3 feet to 5.7 feet. To implement this alternative, the material dredged from the channel would be placed on the beach, west of Bienville Beach (88°07'). The littoral drift system could then transport the material westward.

The loaded hopper dredge would anchor off the gulf shore of the island near longitude $88^{\circ}10.5'$ in 28-30 foot depths. Pipes would extend from the dredge to the beach and the dredged material would be pumped onshore. By moving the pipe or adding on more pipes to the east or west, the material could be spread over a significant reach. Littoral forces would further distribute the material over the island's western gulf nearshore zone. In this manner, about 396,000 cubic yards of material would be pumped onto the beach every 1-1/2 years.

160. Since the charges for maintenance dredging recur regardless of implementation of an erosion abatement plan, only those costs over and above normal costs for present maintenance operations would be charged against this plan. Dredging costs would increase from the present average of \$573,000 to \$1,577,000, resulting in annual costs of \$1,004,000 for this alternative.

161. Benefits accrue to this alternative as a result of reduction in the amount of real estate lost to erosion on the westernmost 11 miles of the island's gulf shore. The estimates used herein were made on certain assumptions; (1) that lands normally considered "back lands" will actually be waterfront as the beach continues to erode; (2) that extra costs encountered in a few areas for relocation of roads or power lines will be more than offset by increased land values as the beachfront moves inland; (3) the 11 miles under consideration can be divided into two distinct parcels, the west parcel and the east parcel, as shown in the following illustration.