Barrier Island Plan

Phase 1 - Step G Report

Forecasted Trends in Physical and Hydrologic Conditions

October 20, 1998

PROJECT OVERVIEW

The barrier island plan is authorized by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The purpose of this study is to determine whether the Louisiana barrier shoreline provides significant protection to Louisiana's coastal resources. If the study proves that the barrier shoreline provides these significant benefits, then this study will develop the most cost effective method to maximize those benefits.

The three year barrier island feasibility study is divided into three phases based on geographical location. Phase 1 is located between the Atchafalaya and Mississippi Rivers. Phase 2 encompasses the cheniere plain barrier formations in Vermilion and Cameron Parishes. Phase 3 focuses on the Chandeleur Islands. Phase 1 is the area currently being studied.

The project is structured to reach an implementation plan by starting from a broad descriptive analysis and gradually becoming more site-specific and detailed as the steps proceed. Each resource study or island option plan begins with some type of qualitative assessment and progresses to a more detailed quantitative analysis. For example : Step C will qualitatively focus on the status and trends of resources for the broad study area; whereas, Steps E and F will quantitatively assess and inventory the existing environmental and economic resources respectively. Also, Step I is a general evaluation of the needs and problems in the study area and development of management alternatives. Later, Step L will define the preferred plan criteria and choose a recommended implementation plan from the management alternatives developed in Step I, based on the quantitative assessments made in Steps J and K.

The first report completed for the barrier island feasibility study is Step A, which reviews prior studies, reports, and existing projects that pertain to the study's purpose, scope, and area. Step A also identifies and describes existing and potential barrier island and wetland restoration projects that affect the Phase 1 area. Step A is an overall orientation for the team on the project area. The literature review ensures that the team is knowledgeable and familiar with the most current literature available on the barrier islands and is using the most up-to-date information throughout the overall study.

Step B is also completed and contains a conceptual and quantitative framework for the barrier island study. The conceptual framework describes the functions and processes affected by barrier islands and the potential impacts on the significant resources in the study area. The significant resources include economic, cultural, recreational, and land-use resources. Step B also contains a review of the available methods for quantitatively predicting the effects of the barrier islands on environmental and economic resources. This information outlines the general study area for the team and describes the methodology that will be used in Step G to forecast physical and hydrological changes.

Step C provides qualitative assessments of the status and trends of the resources in the project area. A general study area map from Step B defines the area influenced by the barrier islands for the purposes of the Step C general resource assessment. These assessments include economic, social, cultural, water, biological, recreational, and land resources. In addition, the climatology, hydrology, and geological processes are analyzed with regard to their status and trends within the study area. Historical land losses are documented, as well as natural and human contributors to barrier island and wetland change. This information is gathered to demonstrate the characteristics of the study area and to show the resources at risk due to the loss of the barrier shoreline. It also orientates the team to the area and ensures the team will consider these resources in later steps.

Step D is a quantitative inventory of the physical parameters that are used to forecast changes in the economic and environmental resources. Step D involves delineating zones of environmental and economic analysis in the general study area described in Step B. The zones are designated using the Hurricane Andrew storm surge as criteria. The physical process parameters (waves, wind, sea level, sediment transport, etc.) and the geomorphic parameters (surficial sediments, topography, bathymetry) are identified, including data sources, type and quality of data, and any inconsistencies or "gaps" in the data. This information will be used as input for the modeling and forecasting effort in Step G. The results of Step D allow the team to evaluate the proposed modeling effort as outlined in Step B.

Step E provides a quantitative inventory and assessment of existing environmental resource conditions, with an emphasis on those resources considered significant. The team developed the criteria for determining "significant" environmental resources. Wildlife habitats, breeding grounds, and endangered species refuges are among those resources that have been assessed. Step E includes historical habitat/wetland change maps and describes the land loss rates and their associated changes. These data will be used to forecast the impact of the no-action scenario for environmental resources.

Step F is a quantitative inventory and assessment of existing economic resource conditions. This includes all structures, facilities, farmland acreage, and public resources (roads, channels, bridges, etc.) that are susceptible to the consequences of wetland/land loss, shoreline erosion, or hurricane induced flooding. The value of these economic resources and their residual worth will be included in the assessment. Historical damage and losses caused or induced by oil spills, waves, wetland/land loss, and shoreline erosion will also be evaluated. These data will be used to forecast the impact of the no-action alternative on economic resources.

The forecasted trends of physical and hydrological conditions are discussed in Step G. A 30 and 100 year forecast of the present and future physical conditions was modeled, showing the effects of a no-action scenario. The study was conducted using the methods described in the Step B report and the data specified in the Step D report. Bathymetry and topography, waves, tides, storm surge, and other factors that affect the economic and environmental resources were forecasted.

The effects on environmental and economic resource conditions will be forecasted in Step H. Projected wetland/land loss will be presented for the 30 and 100 year no-action scenario. This will estimate, through the modeling results from Step G and projected trends, the total land loss and the effects on the wildlife and economic resources in the Phase 1 study area that may be experienced in the future as present conditions proceed. At the completion of Step H, the team will have amassed information detailing the projected changes in the barrier shoreline and the anticipated effects of those changes on the environmental and economic resources in the area. The team can then use this information as a baseline for comparing other alternatives.

In Step I, the team begins to identify the options to be evaluated. This process will proceed through Steps J, K, L, and M. The later steps involve the identification and explanation of the preferred alternative(s). Step I involves identifying the problems, needs, and opportunities of the study area and developing strategic options. Options will be considered on an island-chain spatial scale. These options will include: restoring a historical island configuration, establishing a fall back line, no-action alternative, preserving present-island configurations, strategic retreat, and other possible options. A general assessment of engineering, environmental, economic, and social factors regarding strategic option implementation will be considered. An array will be built comparing the different options with these factors. Those options that cannot be implemented because of cost, long-term effects, or other conditions will no longer be considered. The remaining options will become management alternatives and will be analyzed in greater detail in Step J. Step I will provide the necessary island size and inlet locations for the modeling study in Step J.

Step J is the assessment of management alternatives. The most important input for Step J is the identification of the specific management alternatives found in the Step I report. Step J includes qualitative and quantitative assessment of the management alternatives. This step includes a more detailed analysis of the effects of the proposed management alternatives on the environmental and economical resources of the area. For example, if a management alternative being investigated in Step J is a 1930 island configuration, then in Step J the increased flood protection potential from hurricanes by virtue of the size increase of the barrier islands will be described. That protection estimate will be an approximate dollar estimate and not a general assessment as was done in Step I. The output for Step J will be a detailed assessment of the effects of the management alternatives on the resources in the area. Resources include environmental, economical, and social. Where possible, the effects on resources will be quantified. The report should be based on a thirty year projection into the future and compared to the no action scenario.

Step K involves identifying and assessing possible management and engineering techniques for the management alternatives developed in Step I. Step K assesses the engineering techniques that may be used to implement the management alternatives identified in Step I. The long-term impacts will be used to assess the effectiveness of the various engineering and management techniques. This step will determine possible use of beach fill, coastal structures, and possible regulatory controls that will provide optimal design life and cost effectiveness. Shoreline prediction and dune-erosion models will be used (when applicable) on a site-specific scale to determine long-term shoreline change and erosion rates. Output from these methods will predict maintenance quantity and frequency. Dune crest height and berm and beach slopes will be determined for limiting wave runup and overtopping. Volumes of beach fill will be calculated after the beach and dune configurations are established. In addition, borrow site identification and assessment will be completed. This will determine the cost, quantity available, and methodology for using various borrow sites for material if needed. The output for Step K will be the general applicability, cost, and impacts of various engineering alternatives.

Step L will be a description of the rationale for selecting a preferred plan. The criteria will be based upon the detailed assessments made in Steps J and K to develop a cost/benefit relationship. Step J will supply the benefits for each management alternative, while Step K details the cost. The selected management alternative and associated engineering and management techniques will be developed to form preliminary plans and cost estimates. Included will be all beach fill and coastal works concepts, sources of material, and cost of maintenance and monitoring.

In Step M, the team will select the preferred plan based on the criteria described in Step L. The team will then describe the methodology for instituting permitting, right-of-way/construction agreements, final engineering design, bidding, construction, mitigation, monitoring and maintenance. The preferred island configuration will be presented with potential structures, beach fill, dune restoration, and protection plans. Preferred sand sources and the effect of removing the sand will also be detailed. The Step M report will outline time, cost, and regulatory parameters.

Step N is a consolidation of all deliverables into one final report document. This final report will summarize the information provided in all previous documents.

FOREWORD

The purpose of this study is to determine whether the Louisiana barrier shoreline provides significant protection to Louisiana's coastal resources. The study will identify potential solutions to these problems, provide an economic evaluation, and determine the barrier configuration, which will best protect Louisiana's coastal resources from wind/wave activity, saltwater intrusion, and oil spills.

In order to accomplish the desired goals and objectives, the study team, thus far, completed the following steps of the study:

Phase 1 - Step A - A Review of Pertinent Literature

Phase 1 - Step B - Conceptual and Quantitative System Framework

Phase 1 - Step C - Assessment of Resource Status and Trends

Phase 1 - Step D - Quantitative Inventory and Assessment of Physical Conditions and Parameters

Phase 1 - Step E - Inventory and Assessment of Existing Environmental Resource Conditions

Phase 1 - Step F - Inventory and Assessment of Existing Economic Resource Conditions

This is the Step G report, which is a Forecasted Trends of Physical and Hydrological Conditions in the Phase 1 study area. The objective of this report is to forecast the changes in physical and hydrological conditions for 30 and 100 years for a future without project condition. Land loss and changes to the landscape were predicted for the barrier islands and the entire study area. The continued loss of the barrier islands and bay widening will change the hydrological conditions by enlarging tidal inlets and allowing offshore generated wave energy to propagate into the bays. Also, the diminishing function of the barrier islands and fringing wetlands as a hurricane buffer is quantified in this report.

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1.0. INTRODUCTION

The purpose of this report is to quantify the changes in the physical and hydrologic parameters and processes which are affected by barrier islands and which influence the environmental and economic resources of the study area. This quantification represents the "future with no action" scenario and predicts what the future conditions in the study area will be like if there is no restoration of the barrier islands. This scenario also establishes the baseline for evaluating the benefits of various strategic options for barrier island restoration.

The physical parameters and hydrologic processes considered in this report are barrier shoreline position, wetland distribution, tides, storm surge, circulation, salinity and wave height. These parameters were selected from a longer list of parameters inventoried in the Step D report "Quantitative Inventory and Assessment of Physical Conditions and Parameters." They were selected in Step D because they are the most significant parameters which influence the study area and which may be altered by the configuration of the barrier islands.

Forecasts are presented for 30 and 100 years into the future. The 30-year forecast is specified in the contract scope of work and represents a likely, near term future condition in the study area. Since the 30-year forecast is a relatively short interval, a second scenario was chosen. The second scenario was developed for 100 years into the future. This represents an interval more inline with time scales of infrastructure and also with the time scale of the barrier processes. Thus, taken together, these two forecasts are felt to provide a more complete description of the "no action" future conditions. The approach taken in developing future conditions was to first determine current geomorphic conditions of the shorelines and interior wetlands in the study area. Current conditions were determined using a variety of recent remote sensing images, archival maps and data, and ground survey data. These data were incorporated into a landscape map showing the topography, bathymetry, and shoreline and wetland configuration for the study area. The next step was to modify the landscape map by projecting past trends of landscape change into the future and new maps were developed for 30 years and 100 years into the future. The maps for each date were incorporated into the predictive hydrodynamic models. Then, computations of the spatial patterns of the hydrodynamic processes for average and extreme weather conditions were made. The results of the computations are presented in a series of maps and graphs.

2.0. PREDICTING FUTURE SHORELINE POSITION

Determination of future shoreline positions requires regional historical shoreline change data sets that are accurate, long-term (>80 yrs), and quantified. Although several shoreline change studies have been conducted for Louisiana's barrier island shoreline over the past 40 years (e.g., Morgan and Larimore 1957; Peyronnin 1962; Penland and Boyd 1981; Morgan and Morgan 1983; Shabica et al. 1984), Chapter 4 of the USGS Barrier Shoreline Change Atlas represents the most comprehensive, peer-reviewed investigation to date (McBride et al. 1992). Historical shorelines were compiled for the past 100 years with some shorelines dating back to the mid-1850s. Consequently, this long-term shoreline change data set incorporates all physical and human processes that have changed the barrier island shoreline for the past century (e.g., relative sea level rise [1 cm/yr] hurricane impacts, dredging, reduced sediment supply from the Mississippi River, coastal engineering structures). When scientists have access to this type of historical data, shoreline positions can be projected up to 100 years into the future.

2.1. Methods

Two methods were developed to quantitatively predict future shoreline position. These methods are: linear transect extrapolation and area change extrapolation. The two methods are discussed below.

2.1.1. Linear Transect Extrapolation

More than 800 shore-perpendicular transects were constructed for the USGS Barrier Shoreline Change Atlas (McBride et al. 1992). These transects occur at an average of 400 m (1,312 ft) intervals along the gulfside and bayside of the barrier shoreline. Measurements were made of the shoreline positions along transects to determine the magnitude of change for the period of record. The magnitude of change was divided by the total number of years between shoreline surveys (e.g., 1887 vs. 1988) to calculate a long-term rate of change at a particular transect location. The 1988 shoreline in the USGS Barrier Shoreline Change Atlas was used as the base shoreline upon which all future projections were made.

To determine the 30- and 100-year future shoreline scenarios, the long-term rate of change along each transect was multiplied by 30 and 100, respectively (e.g., 10 m/yr X 30 yr = 300 m and 10 m/yr X 100 yr = 1000 m) to calculate a magnitude of change. Long-term rates of change are important because they represent time-averaged physical and human processes, thus removing any bias toward short-term phenomena such as storm impacts. Moreover, long-term rates of change are assumed linear based on the historical record. Consequently, the 1988 shoreline position along the transect was moved either landward or seaward depending on whether the shoreline historically had been eroding or accreting. This procedure was completed for each transect and the new 30- and 100-year positions were connected by line segments thus producing future shorelines.

The procedure above was implemented along most of the Phase 1 Study Area except where existing or approved restoration projects (i.e., CWPPRA, state, and private) were located. In these localities, a slightly modified procedure was used. It was assumed that all approved restoration projects would be completed by 1998. Therefore, a 1998 shoreline was constructed for restoration project areas by first multiplying the long-term rate for each transect by 10 years. Once the 1998 shoreline was determined, the restored areas were added to the 1998 shoreline. Subsequently, the 30 and 100 year future shoreline projections were made by multiplying the long-term rate of change at each transect by 20 and 90 years, respectively.

2.1.2. Area Change Extrapolation

Some barrier shorelines in Louisiana are moving rapidly in a lateral direction whereas others move in an onshore/offshore direction (e.g., Timbalier Island). In these cases, the linear transect extrapolation method does not appropriately predict changes of the geomorphic feature. Therefore, area change extrapolation was used in combination with linear transect extrapolation to determine both life expectancy and geographic position for certain islands. In the USGS Barrier Shoreline Change Atlas, island area was measured between the 1880s and the late 1980s (McBride et al. 1992). Based on this long-term area change information, McBride et al. !1992) calculated the rate of change of island area to determine the projected date of disappearance of a particular island.

2.2. Shoreline Prediction

In the sections below, the Phase 1 Study Area was divided into three geomorphic systems based on the genetic relationship between abandoned delta lobes of the Mississippi River and barrier island geomorphology: 1) Isles Dernieres, 2) Bayou Lafourche, and 3) Plaquemines. For each barrier system, maps were constructed showing shore-perpendicular transects, 30-year future shoreline, 100-year future shoreline, and comparison of future shorelines with the 1988 shoreline. Since the predicted shorelines only show the barrier shoreline in 30- and 100-years, no date of disappearance is available.

2.2.1. Isles Dernieres Barrier Island System

The Isles Dernieres is one of the most rapidly deteriorating barrier island shorelines in the United States and has been characterized by the process of breakup for the past 100 years (McBride and Byrnes 1995). Based on long-term change rates at 184 shore-perpendicular transects, the 30- and 100-year future shorelines were projected (Figures 2-1, 2-2, and 2-3). Approved and authorized restoration projects for the Isles Dernieres were incorporated into the projections of the 30- and 100-year future shorelines (i.e., Raccoon Island FEMA repair and restoration project; Raccoon Island breakwaters [PTE-15bii]; Isles Dernieres Restoration - Phase II; Trinity Island - Phase 1 [XTE-41]; Eastern Isles Dernieres - Phase 0 [TE-20]; and Wine Island FEMA repair project). When compared with the 1988 shoreline, the 30- year future scenario shows that the islands will most likely continue to experience gulfside and bayside erosion resulting in island narrowing as well as island breaching (Figure 2-4). Only the short spit located on the western side of Whiskey Island and portions of East Island are predicted to experience landward rollover. Within 100 years, the entire subaerial portion of the Isles Dernieres barrier island system will most likely disappear except small land fragments associated with the western end of Whiskey Island and the eastern end of East Island (Figure 2-5). By this time, the outer gulf shoreline will translate landward due to waves propagating from the gulf and scouring interior bay bottoms and impacting mainland marshes to the north.

2.2.2. Bayou Lafourche Barrier System

The Bayou Lafourche barrier system was divided into two sections because of shoreline length: 1) Timbalier Islands and 2) Bayou Lafourche headland/Grand Isle. The Timbalier Islands extend from Cat Island Pass to Raccoon Pass and include Timbalier Island and East Timbalier Island. The Bayou Lafourche headland extends from Raccoon Pass to Barataria Pass.

2.2.2.1. Timbalier Islands.

Between 1887 and 1988, Timbalier Island experienced some of the highest rates of lateral movement in the United States, whereas East Timbalier Island underwent rapid landward migration (McBride et al. 1995). Based on change rates at 164 shore-perpendicular transects, the 30 and 100 year future shorelines were projected (Figures 2-6, 2-7, and 2-8). Approved and authorized restoration projects for the Timbalier Islands were incorporated in the projections of the 30 and 100 year future shorelines (i.e., East Timbalier Island restoration [XTE-67]; Timbalier Island Planting [TE-18]; Greenhill Petroleum Corporation marsh restoration project; and East Isle and Timbalier Island FEMA island restoration project).

Over the next 30 years, Timbalier Island is forecast to continue to migrate rapidly in a lateral direction at about 80 m/yr and undergo island narrowing and shortening (Figure 2-9). Although FEMA restored a section of the island, Timbalier Island is projected to disappear around the year 2050 and, therefore, is absent on the 100-year future shoreline forecast (Figure 2-10). Within 30 years, East Timbalier Island will likely develop two island breaches as it undergoes island narrowing. East Timbalier Island will likely disappear within 100 years except for a small land fragment on the eastern end. Consequently, increased wave climate conditions will directly impact Terrebonne and Timbalier Bays.

2.2.2.2. Bayou Lafourche Headland/Grand Isle.

Historically, the Bayou Lafourche headland area has experienced rapid retreat with rates up to 29 m/yr, whereas Grand Isle has been characterized by erosion on its southwestern end while remaining relatively stationary along its central portion and prograding seaward on the northeastern end (McBride and Byrnes 1995). However, the bayside shoreline of Grand Isle has undergone continuous erosion between 1887 and 1988 averaging 1.0 m/yr.

The 30- and 100-year future shorelines for the Bayou Lafourche headland/Grand Isle area were projected based on long-term change rates at 92 shore-perpendicular transects (Figures 2-11, 2-12, and 2-13). Although the impacts of recent implementation of coastal structures is included in the long-term rates, the overall trends show massive coastal erosion as a result of rapid retreat (Figures 2-14 and 2-15). Over the next 30 years, Grand Isle's southwestern end will most likely continue to narrow as a result of gulfside and bayside erosion, whereas the northeastern end widens due to beach progradation. Within 100 years, this narrowing trend will likely cause the southwestern end to disappear enabling Caminada Pass to widen greatly.

2.3. Plaquemines Barrier System

The average shoreline change rate for the Plaquemines barrier shoreline has been an erosion of 5.5 m/yr for the period 1884 to 1988 (McBride et al. 1992). Prediction of future shorelines was based on long-term change rates at 149 shore-perpendicular transects (Figures 2-16, 2-17, and 2-18). The 30-year future shoreline shows that high rates of erosion will likely continue to dominate the Cheniere Ronquille and Shell Island areas (Figure 2-19). Within 100 years, the Plaquemines shoreline is projected to be characterized by the absence of large segments of barrier shoreline (Figure 2-20). As a result, high energy gulf conditions will propagate into southern Barataria Bay, Bay Joe Wise, Bastian Bay, Shell Island Bay, Bay Coquette, and Bay Jaque.

3.0. PREDICTING FUTURE WETLAND AREAS

Maps of the distribution of wetlands and water within the study area were developed for current and future conditions. These maps, along with the maps of predicted future barrier shoreline position, were combined and used as input to the hydrodynamic models. A flowchart of the methodology is shown below:

Delineate polygons of similar land loss rates

↓

Calculate future land loss based on historical rates

↓

Incorporate the land loss impacts of
CWPPRA projects and the Davis Pond Diversion

↓

Modify LANDSAT image

Several data sets were used in developing the wetlands forecast. The analysis was based upon a 1993 LANDSAT image obtained from Mr. Dewitt Braud of the Geography and Anthropology Department at Louisiana State University. The boundaries of the CWPPRA project areas and the boundary of the Davis Pond project area were obtained from the CWPPRA Feasibility Studies Steering Committee via Mr. John Barras of the National Biological Service, National Wetland Research Center in Lafayette. Data on wetland loss rates were obtained from Ms. Sue Hawes and Mr. Del Britch of the New Orleans District of the U. S. Army Corps of Engineers. Ms. Hawes also provided computations of the future acreage of wetlands within each of several sub-areas in the study area and the effect of the CWPPRA projects.

3.1. Methodology

The method used to develop the wetland maps was based upon selectively modifying parts of the LANDSAT image to reflect the rate of loss of wetlands and the effects of CWPPRA projects. Figure 3.1 is the LANDSAT image taken in 1993. It covers an area from 91.4 degrees W longitude, 28.9 degrees north latitude to 56.1 degrees to 89.1 degrees west longitude, 30.1 degrees north latitude. The image pixel values contained a "brightness" based upon combining bands 3, 5, and 7 in the original LANDSAT data. The image had a spatial resolution of 25 m (82 ft) and was georeferenced. The whole image is composed of 8403 columns and 5464 rows of cells, each of which is numerically represented by a brightness value, ranging from 0 to 222 counts. In the LANDSAT image shown in Figure 3.1, each cell is assigned a pseudo-color varying from dark blue corresponding to the lowest end of the brightness range to bright white at the highest end of the range. Generally solid wetland areas have high brightness, while open water areas have low brightness.

Wetland areas having intermediate brightness values were assumed to be broken marsh, with a brightness proportional to the percentage of land. Brightness value can be used as a land/water boundary criterion such that areas having brightness values higher than the criterion are classified land and those areas giving brightness values lower than the criterion are considered water areas. The area of land corresponding to the given land/water criterion can then be calculated as the sum of the land cells. If the criterion for land is raised to a higher value, then the number of cells having brightness values greater than the raised criterion decreases, resulting in less land area in the image. On the other hand, if the land/water brightness criterion is lowered to a smaller value, then the number of land cells increases. Therefore, by lowering or raising the land/water criterion, wetland can be added or removed from the image.

3.1.1. Mapping Future Wetland Loss

The study area was divided into 25 sub-areas by the CWPPRA Feasibility Studies Steering Committee, lettered from A to X. The boundaries of these sub-areas were determined in such a way that the land loss rates and processes within each sub-area were judged to be similar. Prediction of land loss was performed for each of the 25 sub-areas. The names of these sub-areas are listed in Table 1 and the areas are shown in Figure 3.2.

Table 1. List of the 25 sub-areas used in the loss projection.

Sub-Area	Name
A	Lake Gasha area
B	Atchafalaya Bay Shoreline
C	Point au Fer Island
D	Turtle Bayou/Lake Decade/Lost Lake
E	Oyster Bayou area
F	Southern Shore Terrebonne Parish
G	Bayous Prevost and Pelton
H	Falgout Canal area
I	Lower Houma Nav. Canal
J1	West of Upper Lafourche
J2	East of Upper Lafourche
K	Boudreaux to Catfish Lake
L	Lake Salvador area
M	Perot/Rigolettes/Little Lake
N	L'Ours to Fourchon
O	Cheniere Caminada and north
P	The Pen and north
Q	Myrtle Grove Outfall
R	South of Mrytle Grove
S	Barataria Bay Shore
T	West of Pt. a la Hache
U	Adams Bay area
V	Grand Ecaille/Bastion Bay
W	Bastion Bay/Sandy Pt.
X	Ft. Jackson to West Bay

The boundaries of each of the authorized CWPPRA projects are also indicated in Figure 3.2. Each project area is delineated by dotted lines. There are 26 numbered polygons and Table 2 gives the project number and the project names for each. During the Wetland Value Assessment (WVA) conducted for each of the CWPPRA Projects, the WVA Interagency Team made an estimate of the area of wetlands impacted by the project, land loss rate for the project area, and the percentage reduction in the loss rate due to the CWPPRA project. These values are documented in the CWPPRA project files. In 1995, the WVA Team determined the longevity of each candidate CWPPRA project. The Corps of Engineers used this data to determine the generic longevity of each project type. For instance, the effectiveness of hydrologic restoration projects was found to be 30-years. The effects of freshwater diversions continue for 100-years, but at a reduced rate for the last 50-years. These generic longevities were used by the Corps of Engineers to determine the land loss reduction/land gain for each project from years 21-100.

The CWPPRA projects authorized on the barrier islands are included in the shoreline prediction discussed in Section 2.0. The future of these projects is separate from the above mentioned projects, because the methods used to predict the shoreline positions are not dependent on the WVA procedure. As stated in Section 2.0, linear transect extrapolation and area change extrapolation shoreline extrapolation are used.

Table 2. List of CWPPRA projects included in projection.

Project	Name
2	Lake Salvador Shoreline Protection Demo
3	Naomi Siphon and Outfall Management
4	Jonathon Davis Wetland Protection
5 and 6	Bayou Perot And Bayou Rigolette Restoration
7	Bayou Lafourche Siphon/Phase 1
9	GIWW To Clovelly Wetlands
8 and 10	Siphon At Myrtle Grove Phase 1
11	Barataria Waterway Shore Protection
12	Bayou Lafourche Siphon
13	West Point A La Hache Siphon and Outfall Management
16	Grand Bayou/GIWW Freshwater Diversion
17 (Part1)	Hydrologic Restoration Of Bayou L'ours Ridge
19	Brady Canal Hydrologic Restoration
24	Point Au Fer
25	Point Au Fer
26	West Belle Pass

*Projects 18, 20, 21, 22, and 23 are discussed in Section 2.0

The boundary of the Davis Pond project area covers sub-areas J2, L, M, N, O, P, Q, R, S, and V as shown in Figure 3-2 in dash lines.

The acres of land within each of the 25-sub-areas in 1993 were computed from the Corps of Engineers land loss maps. At the suggestion of the CWPPRA Feasibility Study Steering Committee, the 1974-90 land loss rate in each sub-area was applied by the Corps of Engineers to the remaining acres each year from one through 100 to determine the land remaining within each sub-area at years 30 and 100. Table 3 gives the acreage of wetlands in each of the sub-areas for current and future conditions. These results include the possible effects of past barrier island loss on mainland marsh loss rates.

Table 3. Area (hectares) of wetlands in the 25 sub-areas.

Sub-Area	Current	30 Years	100 Years
A	18,603	17,653	15,409
B	7,965	7,319	5,877
C	12,198	11,419	9,624
D	81,694	74,114	57,579
E	9,153	8,825	8,029
F	46,441	37,950	22,485
G	13,484	13,415	13,238
H	9,213	7,586	4,585
I	11,878	10,631	7,974
J1	57,970	56,731	53,640
J2	194,362	187,958	172,322
K	55,697	43,196	22,348
L	5,709	4,644	2,715
M	16,575	13,552	8,040
N	18,149	13,082	5,599
O	6,392	5,344	3,359
P	48,234	47,050	44,114
Q	6,514	4,892	2,328
R	20,375	19,293	16,746
S	20,679	16,665	9,525
T	4,508	3,259	1,406
U	8,971	7,663	5,093
V	6,342	3,333	629
W	2,910	949	52
X	9,886	8,444	5,612

The total amount of wetland acres in the study area will change from 693,905 ha at present to 624,970 ha in 30 years and 498,255 ha in 100 years without considering the impact of CWPPRA projects. This represents a land loss of 68,935 ha by year 30 and 195,650 ha by year 100.

3.1.2. Modification of the LANDSAT Image

Using the approach described above, each of the sub-areas in the LANDSAT image was modified to match the acreage of wetlands predicted to remain in that sub-area at a given year in future. As an example of the approach, consider sub-area A. Figure 3-3 shows the original LANDSAT image for sub-area A. From Table 3, the area of wetlands remaining in 30 years is 43,599 acres. The land criteria was raised to a brightness value of 40. The area of cells having a brightness equal to or greater than 40 is the wetlands acreage and was found to be 45,268.50 acres. This acreage of land is 1,669.5 acres greater than the target acreage for this sub-area, and indicates that the selected land criterion is too low. Using the same method, the land criterion was increased from 40 to 50. The corresponding areas of remaining land and the difference from the target acreage are shown in Table 4. The best land criterion for sub-area A for the year 30 is 45, at which the difference between the target acreage and image acreage is minimal, being only 57.20 acres. Using 45 as the land criterion, all cells having a brightness value less than 45 were classified as water cells and all those with brightness values equal to or greater than 45 as land. The land-water image for sub-area A that best fits the target land acreage for the year 30 is shown in Figure 3-4. Using the same method described, the land/water images of the rest of the 25 sub-areas for the present and for years 30 and 100, respectively, were computed.

Table 4. Example of land brightness criterion vs. area of remaining land and difference between the target and fitted area of land.

Land Criterion	Land Area (Hectares)	Difference (Hectares)
40	18,328.90	675.97
41	18,328.83	675.90
42	18,323.21	607.28
43	18,293.46	640.53
44	18,089.15	436.22
45	17,629.77	-23.16
46	17,140.64	-512.29
47	16,765.26	-887.66
48	16,434.07	-1,218.85
49	16,426.08	-1,226.85
50	16,376.39	-1,276.54

The effects of authorized CWPPRA projects were included in the land/water maps by adding land back into the image. The CWPPRA projects are expected to reduce the loss of wetlands. This effect can be accounted for in the land/water images by "restoring" areas of land to the CWPPRA projects that otherwise would have been lost. Table 5 gives the number of acres expected to be prevented from being lost and, hence, must be restored to the land/water images.

The CWPPRA projects are projected to reduce land loss by 4,483 hectares in year 30 and 3,338 hectares in year 100. The effects of the CWPPRA projects were included in the land/water maps by lowering the land criterion from the original value in the project area in such a way that the area of land gained by doing so fits the target. An example of this procedure is given for Project 19 (Brady Canal Hydrologic Restoration). Figure 3-5 is the 30 year land/water image of the project area for Project 19, using the value of 34 as the land criterion as determined for the sub-area containing Project 19. The project area for Project 19 is 3,038.08 ha, of which the area of land is 1,389.63 ha. According to Table 5, the acreage of land that will be prevented from being lost and hence must be restored in the image is 165 ha by the year 30. Table 6 shows the effect of lowering land criterion from 34 to 20 and the corresponding area of land gained.

Table 5. Hectares of wetland loss prevented by CWPPRA projects based upon the WVA estimates for each project.

	Future Year	
Project	30	100
2	91	97
3 (part1)	324	134
3 (part2)	279	158
4	279	158
5 and 6	198	5
7	45	106
9	50	44
8 and 10	519	694
11	60	3
12	21	2
13	964	666
16	918	894
17	121	68
17 (part 2)	243	134
19	165	111
24	71	--
25	66	24
26	70	38

Table 6. Land-water criterion & gained area of land.

Criterion	Land Gained (Hectares)
34	0.00
31	4.12
30	83.06
29	158.62
28	174.81
27	174.94
26	176.25
23	179.31
22	273.75
20	278.81

Obviously a brightness value of 29 is the best new land criterion, at which point 158.62 ha. of land would be added to the project area. This number is the best approximation to the target value of 165 ha. Setting 29 as the new land criterion for the area of Project 19, the new land/water image for the project area is shown in Figure 3-6.

The effects of the Davis Pond Diversion were included in the land/water maps by adding land preserved by the diversion to the sub-areas affected by the diversion (J2, L, M, N, O, P, Q, R, S and V). In the immediate area of Davis Pond (J2), 28 hectares per year were assumed to be created for the first 50-years. The areas of land to be preserved/created in each of the sub-areas are given in Table 7. Using the same procedure described in the previous section these land areas were added back into the modified LANDSAT image. The Davis Pond Project is estimated to restore 8,353 ha. by year 30 and 20,887 ha. by year 100. More detailed discussions on the impacts of Davis Pond are discussed in Step H - Forecasted Trends in Environmental Conditions.

Table 7. Area (hectares) of land to be restored by the Davis Pond project based upon the project estimates.

	YEAR	
Sub-area	30	100
o	176	474
q	458	1,099
m	1,359	3,564
l	481	1,252
r	302	938
s	1,079	2,805
v	348	618
n	574	1,322
j2	3,225	7,588
p	527	1,701

3.2. Results

The predicted future land/water maps for the study area are shown in Figures 3-7, 3-8, and 3-9. The 30-year conditions without David Pond (Figure 3-7) show essentially all wetland areas are spotted with numerous small water bodies producing a broken marsh-like pattern on a regional scale. Upland and leveed areas are clearly delineated as areas dense with land, as are the distributary channel ridges. The western Terrebonne marshes near the Atchafalaya River have the highest land density of any wetlands. The marshes surrounding Terrebonne and Barataria Bays are fragmented with the amount of land generally exceeding the amount of water. In 50-years, as shown in Figure 3-8, the land loss enhances the fragmentation of the marsh. Marsh areas near bays retain a greater density of land, but further inland open water and land are about equal. In 100 years, the marsh areas are mostly open water, as indicated in Figure 3-9. The wetland areas surrounding Terrebonne and Barataria bays show only scattered fragments of land located within large areas of open water. Some areas of the western Terrebonne marshes retain a greater density of land than water, however these areas have been considerably reduced in size and are surrounded by large bodies of open water. The boundary of Terrebonne Bay has expanded northward nearly to the Intracoastal Waterway and Barataria Bay extends northward almost to Bayou Perot and Rigolets. The corridor of land surrounding Bayou Lafourche is nearly gone.

4.0. PREDICTING FUTURE HYDROLOGIC CONDITIONS

The future hydrological conditions with the loss of barrier islands and wetlands within the study area were assessed using a computer model and the previously described landscape data. The landscape data was incorporated into the topographic/bathymetric grids for input to the model. Computer simulations were run for extreme and average conditions for the present landscape and for the two future conditions. The extreme conditions were represented by a hurricane storm, while the average conditions were represented by tides. Results of the simulation are presented as 2-D maps over the study area and as time series plots for particular points.

4.1. Hydrologic Model

The hydrologic model used in the study has been developed by the Federal Emergency Management Agency to predict hurricane flood elevations for the National Flood Insurance Program (FEMA 1988) and has been described in the Step D report.

4.1.1. Computer Model

The FEMA hydrologic model uses an explicit, two dimensional, spaced-staggered, finite difference scheme to simulate the flow of water caused by tides and wind systems. The inputs to the model include the bathymetry, coastline configuration, boundary conditions, and bottom friction and other flow resistance coefficients. Also included are the surface wind velocity and atmospheric pressure distributions of the hurricane. The model uses a square grid having sizes of 1 and 3 km. The model grid expands during a simulation to predict the flooding of low lying areas. Barriers and rivers, which occur in the coastal zone, have a controlling influence on flood levels. Barriers and rivers can be included in the computations as sub-grid scale elements.

4.1.2. Model Set-up

The land/water images for each future condition were converted to input data for the model. The model grid size is 1,000 m, therefore, each model grid cell contains 1600 LANDSAT pixels. Each of the 1 km grid cells had a percent land and water obtained from the number of LANDSAT pixels in each category. The LANDSAT image was superimposed upon the topographic data set for the study area and an average elevation was computed for each model grid cell. The average grid cell depth or elevation was adjusted to reflect the percentage of land in a given model grid cell. If the grid cell were 100 % land, then the land elevation was assigned to the cell. If the cell was 100 % water then the water depth was assigned to the cell. When the cell had a percentage of land between 0 and 100, a land or water elevation was assigned that was the weighted average of the land elevation and water depth. The procedure was repeated for the images of 30 and 100 years. The model topographic/bathymetric grids are shown in Figures 4-1, 4-2, and 4-3. The "land" areas in the Figures have a land percentage that is 41 % or greater. Cells shown as "water" have a land percentage that is between zero and 40%. Changes in the amount and distribution of emergent wetlands can be seen, such as in the areas surrounding Bayou Lafourche and Madison Canal. Levee elevations were held constant for all future conditions based upon the assumption that levees will be maintained at the same height relative to mean sea level.

The model was calibrated for average and extreme conditions using observed water level values for astronomical tides and for hurricane Andrew (Lovelace 1994). The results of the comparison of the predicted and observed data for Hurricane Andrew are shown in Figure 4-4. The forecast maximum surge elevation, for example, for Cocodrie was 2.68 m (8.8 ft) while the observed value was 2.74 m (9 ft). Tidal data for the Barataria Basin showed a decrease in tidal amplitude from the coast to Lake Salvador of about 90 % and a phase lag of about 10 hours. The model predictions were compared to observed values and were found to be in agreement.

4.2. Results

The results of the forecasts are presented in a series of 2-D maps and time series plots for selected locations. Figures 4-1, 4-2, and 4-3 show the locations of 21 sites where time series were generated.

4.2.1. Extreme Conditions

Extreme conditions refer to those that will occur infrequently over the next 30 years, such as those resulting from a hurricane storm, which represents the greatest threat to the natural and economic resources in the study area.

A hurricane storm was selected to represent the hurricane of record for the study area. The storm had a central pressure of 29.6 inches of mercury, a forward speed of 7.5 knots (3.86

m/s), a radius to maximum winds of 22 nmi (40.8 km) and a direction of movement that was due north. The radius and track direction are average values for all hurricanes affecting the study area (Ho et. al. 1987). The forward velocity is the speed for which 25 % of the historical storms had a lower velocity. The central pressure puts the storm in the Category 5 on the Saffir/Simpson Hurricane Scale and is similar in intensity to Hurricane Camille. Storms propagating along two different paths were simulated in the modeling. One path was along longitude 90 degrees 30 minutes which puts the worst of the flooding into the Barataria basin. The second path was along 91 degrees 30 minutes and puts the worst of the flooding into the Terrebonne basin.

The results for the hurricane model simulations are presented in Figures 4-5 through 4-20. The maximum flood elevations for each year and each storm are shown in Figures 4-5 to 4-10. The general pattern of flooding for each hurricane path remains the same for the various years. Slight increases in the areas of maximum flooding can be noted around Bully Camp and Thibodaux for the Barataria path. For the Terrebonne path, increases in the area of maximum flooding around the Thibodaux/Houma corridor can be noted.

Time series of flood elevations for four selected sites within the study area are given in Figures 4-11 to 4-18. The data for Leeville show the site is influenced by hurricanes on either path. Maximum surge elevations increase by about 0.15 m (0.5 ft) in both predicted cases with little variation between 30- and 100-years. Cocodrie shows much greater surge elevations for the Terrebonne path, with elevations reaching up to 3.0 m (10 ft). The increase in surge elevation in year 100 is about 0.15 m (0.5 ft). Lake Salvador also shows a greater response to the Terrebonne path, with a maximum surge elevation that increases from about 1.83 m (6 ft) to about 2.13 m (7 ft) by the year 2090. At the Venice site the maximum surge elevation is about 1.22 m (4 ft) and shows essentially no change for future conditions. Other hurricane paths would produce slightly different patterns and magnitudes of flooding for individual sites, however, the general result of the simulations is that the future loss of barriers and wetlands will increase maximum flood elevations in the study area by no more than about 10 to 20 %. This results from the fact that the islands and wetlands are currently in an advanced state of degradation and since little of these features are present in the 1993 date, their loss has little effect.

An example of the water current vectors for the model time at 48 hours for present conditions are shown in Figures 4-19 and 4-20. This period represents the time of maximum flooding for the northern portions of the basins. Water velocities of up to 0.61 m/s (2 ft/s) occur offshore, while bay velocities range up to 0.30 m/s (1ft/s). Water currents for the 30- and 100-year models showed essentially the same patterns and magnitudes.

4.2.2. Average Conditions

Average conditions are those associated with tides. The purpose of these simulations was to determine the change in water levels, salinity and circulation patterns for average resulting from the landscape changes. The tide simulations were for a 0.20 m (0.66 ft) tidal amplitude in the Gulf of Mexico. The tidal amplitude within the study area for present conditions is shown in Figure 4-21. The tidal amplitude decreases within the Barataria Basin to an amplitude of about 0.05 m (0.16 ft) in Lake Salvador. The change in tidal elevations for future conditions were very slight. The predicted tidal variations at St. Mary's Point for the present and for 100 years in the future are shown in Figures 4.22a and 4.22b. This is representative of coastal areas with having a constant a steady tidal range with little variations. The no-action simulations show that a slight change in tidal amplitude and flooding in the future will occur as a result of wetland and barrier island loss. Areas flooded by average tidal movement generally increase for future conditions. Tidal amplitude within the Barataria Basin fluctuates from about 0.2 m at St. Mary's Point increases to about 0.05 m in Lake Salvador. For future conditions, the tidal amplitude at St. Mary's Points increases to 0.21 m in 30-years and 0.22 m in 100-years. The amplitude in Lake Salvador increases to 0.08 m in 30-years and 0.10 m in 100-years.

Forecasts of salinity were made for present conditions and for 30- and 100-years into the future. The salinity computations were made on a coarser 3 km grid because the computer time required to run a 90-day simulation on the 1 km grid was prohibitive. Results of the salinity forecast for present conditions are shown in Figure 4-23a and b. The figures show isohaline lines after 2160 hours of simulation. The isohaline lines shown in the figures are 5, 10, 15 and 20 ppt. The locations of these lines shift with the tides so that the salinity at a point will show a 24-hour variation. Comparisons of the salinity results for the various conditions indicate that mean salinities will increase in the areas of the basins where land loss occurred by about 1 ppt. The tidal variation of salinity increases in the future. Figure 4-24 shows a comparison of salinity forecasts for St. Mary's Point at present and for 100-year conditions. Differences in the mean values and in the range of salinities can be clearly seen.

5.0. PREDICTING FUTURE WAVE HEIGHT CONDITIONS

5.1. Introduction

The role that barrier islands play in mitigating the wave climate in lower energy, bay or lagoonal environments has not yet been addressed in detail. With the exception of one study (List and Hansen 1992) in which a shallow water wave prediction model (HISWA) was applied to idealized barrier-bay configurations, the critical linkages between barriers, wave energy transmission into the bays and subsequent wave climate have not been made. In Louisiana, barrier disintegration is rapid over the short-term (<102 years) and the mere potential for impacts of barrier loss on the bay wave climate is highly significant. The objective here to provide information on the role of barriers in the Phase 1 Study Area on wave climate. Two scenarios, 30- and 100-years into the future, were forecast. The approach centered on numerically modeling wave propagation and decay during fair weather, storm and a catastrophic hurricane events. Appropriate storm surge levels were incorporated into the model simulations for hurricanes.

5.2. Methods

Two different types of bathymetric grid were generated from a base map shown in Figure 5-1. Type I has one coarse grid that covers most of the map in Figure 5-1. With a grid size of 500 m (1640 ft) in both longitudinal and latitudinal directions, this grid has 96,000 grid cells (400 x 240). Type II includes three finer resolution bathymetric grids that are shown by the three outlined boxes (Area 1, Area 2, and Area 3) in Figure 5-1. Their latitudinal grid size is 50 m (164 ft)and longitudinal size 135 m. Bathymetric grids of present (1988), 30-year, and 100-year no action scenario shoreline configurations were generated for each of the three areas. All shoreline configurations were provided using the methodology described in Section 2.0. A lower resolution grid (1 km) was used for hurricane simulations and encompassed the landward extent of the study area north of Lake Pontchartrain.

All bathymetric, shoreline and surge manipulations and numerical modeling computations were conducted on an Intergraph TD-40 workstation and an IBM RS/6000 Model 590 mainframe. MGE (Modular GIS Environment) software was used extensively. Several modules were used in this project for data acquisition, data process, and display: MGE Nucleus, MGE Coordinate System Operations, MGE Projection Management, MGE Grid Generation, and MGE Terrain Analyst. All work was carried out on Microstation software, a CAD product from Bentley System Incorporated. The MGE Terrain Analyst played a critical role in this project because of its utility in the analysis, manipulation, modification, and graphical display of three dimensional computerized data.

The Original bathymetric data used as input to STWAVE were generated in MGE base. With the projected shoreline configurations, the inner shelf bathymetry was conformed assuming an equilibrium profile. Thus, where the projected shoreline was shown to have transgressed or regressed, the inner shelf profile was adjusted accordingly, maintaining a similar configuration.

Historic bathymetric comparisons along the study area (List et al. 1994) confirm this trend and over the last century or so, validate the approach. Additionally, the rapid landward translation of Ship Shoal, which approximates 20 m/yr (66 ft/yr), was incorporated in the 30- and 100-year bathymetric scenarios.

Projected changes to the marsh coastline have not been incorporated for the sub-areas in the 30- and 100-year scenarios. Although the necessary high resolution data set is not yet available which would allow such an undertaking, omission of these data will not significantly bias the numerically modeled wave climate forecasted for the bays because of its shallow water depth, as projected in this report.

The lower resolution grid generated for the hurricane simulations are discussed in more detail elsewhere in this report. These data were converted to a TIN (Triangular Irregular Network) model and then to a GRID model using the MGE Terrain Analyst module before final merging to generate the area grid file in a UTM (Universal Transverse Mercator) projection.

STWAVE (described in the BSFS - Step B Conceptual and Quantitative System Framework) was first run over the coarse grid to model the wave height distributions for two input boundary conditions: storm (Hs=6 m, Tp=11 sec., Vwind=20 m/s) and fair weather (Hs=1 m, Tp=5 sec., Vwind=5 m/s). A southern wave direction was modeled under each condition where wind was always in the direction of wave propagation. As discussed in detail in the Step

D report, waves approaching from the southeast and south show the highest frequency of occurrence. For comparative purposes, the southern wave direction was used.

For the no-action analysis, two hurricane simulations were modeled for wave conditions, one representing conditions during Hurricane Andrew and the other representing conditions during a Category 5 storm making landfall over Timbalier Island. Respective deep water wave statistics used were Hs=16m (52.5 ft), Tp=18 s, V=40 m/s (131 ft/s) (Stone et al. 1995) and Hs=22m (72 ft/s), Tp=18 s and V=75 m/s (246 ft/s). (Ward et al. 1978). In Figures 51 and 52, the modeled wave height for storm and fair weather conditions are presented, respectively. In addition to the wave height output that are shown in Figures 5.2 and 5.3, directional wave spectra were collected at the middle of the offshore boundary of all three higher re solution grid areas.

These directional wave spectra were then used as input boundary conditions in model runs that computed wave height distributions over three higher resolution bathymetric grids. Thus, each area has three different grids that were generated for present, 30-year, and 100-year scenarios.

5.3. Results

The study area was divided into three grids to obtain higher resolution wave height data in both nearshore areas and bays. Area 1 covers Isle Dernieres, Caillou Bay, and Lake Pelto. Area 2 covers Timbalier Islands, Terrebonne Bay and Timbalier Bay. Area 3 includes the Plaquemines shoreline, Grand Isle, and Barataria Bay.

5.3.1. Area 1

The fair-weather wave height distributions for Area 1 are plotted in Figures 5-2 through 5-4 for the present, 30-, and 100-year shoreline configurations. The title on each plot describes the offshore input (to Type I grid) boundary conditions from which the directional wave spectra at the seaward boundary of Area 1 were computed. The changes in wave height for these years are shown in Figures 5-5 and 5-6. From present to the 100-year scenario, modeled wave heights in the bays increase due to the gradual disappearance of the barrier islands. The maximum wave height increase is 0.8 m and occurs in the 30-year scenario along the east end of East Island

(Figure 5-5). Nevertheless, a substantial increase in wave height is widespread across Caillou Bay and particularly Lake Pelto for all wave approaches, particularly for the 100-year scenario (Figure 5-6).

Under storm conditions, increases in wave height, caused by both landward rollover and area reduction of the barrier islands, over the 30-year bathymetry, are generally restricted to the vicinity of the barrier islands (Figure 5-19). The magnitude of wave height increase in the vicinity of Raccoon Island, Whiskey Island, and Trinity Island varies between 0.2 and 0.6 m. The maximum wave height increase occurs at the east end of East Island where wave height increases by 1 m. The eastern part of Lake Pelto also experiences wave height increase ranging from 0.1 to 0.6 m. The wave height increase for the 100-year scenario is markedly larger (Figures 5-20). Due to total denudation (erosion) of Trinity and Whiskey islands in the 100-year scenario, wave height in Lake Pelto increases by as much as 1 m. The wave height decrease at the east tip of East Island is caused by a seaward displacement of the island. The changes in storm wave heights for Area 1 are shown in Figures 5-21 and 5-22.

5.3.2. Area 2

The fair-weather wave height distributions in Area 2 are plotted in Figures 5-7 through 5-9 for the present, 30-, and 100-year shoreline configurations. Similar to the modeled results in Area 1, significant increases in wave height are observed in the bays as the islands and marsh deteriorate. The changes in wave height are shown in Figures 5-10 and 5-11. The maximum wave height increase of 0.9 m (3 ft) occurs at the headland for the 100-year scenario (Figure 5-11).

Under storm conditions changes in wave height for the 30-year scenario are generally restricted to the vicinity of the barrier islands (Figures 5-24 and 5-26). More than a 1 m (3.3 ft) wave height increase occurs at the east end of East Island (overlap with Area 1). Along the Timbaliers and the Caminada Moreau Headland, wave heights increase between 0.2 - 0.8 m (0.7 - 2.6 ft). In Terrebonne and Timbalier bays wave height increase generally ranges between 0.1 - 0.3 m (0.3 - 0.98 ft). Along west Timbalier Island, a dramatic decrease in wave height of 0.8 m (2.6 ft) occurs at the west end of Timbalier Island due to the westward progradation of the island in the 30-year scenario. Wave height increases over the 100-year scenario (Figures 5-25 and 5-27) are considerably different from those for the 30-year scenario. Total denudation of the Timbalier Islands results in wave height increases in Timbalier Bay by between 0.2 - 1.2 m. The magnitude of this increase decreases landward. The wave height decrease at the east tip of East Island is caused by accretion (overlap with Area 1). Due to substantial retreat of the Caminada-Moreau Headland, and increasing water depths as the shoreface erodes, wave height increases by as much as 3 m (9.8 ft) along the coast.

5.3.3. Area 3

The fair-weather wave height distributions in Area 3 are plotted in Figures 5-12 through 5-14 for the present, 30-, and 100-year shoreline configurations. In contrast to the significant variations in wave height shown in Areas 1 and 2, the differences in wave height for all three scenarios in Area 3 are minor, especially in Barataria Bay. The wave height changes are presented in Figures 5.15 and 5-16. Overall, fair-weather wave height increase in Barataria Bay is minimal in the range of 0.1 - 0.3 m (0.3 - 0.98 ft). Because of the predicted retreat of Cheniere Ronquille and widening of Pass Ronquille in the 100-year scenario, wave heights increase by up to 1 m (3.3 ft) (Figure 5-16).

Both storm and fair-weather waves show generally the same patterns. For the 30- and 100-year scenarios (Figures 5-29 through 5-32), increases (or decreases) in wave height are restricted to the vicinity of the barrier shoreline.

5.3.4. Hurricane Simulations

A combined storm surge-wave prediction simulation was conducted using data gathered on Hurricane Andrew to generally evaluate the performance of STWAVE by comparing output with field observation. Details on the impacts of Andrew on the Louisiana coast may be found in Stone and Finkl (1995). As shown in Figure 5-33, waves ranging from 2 to 4 m (6.6 - 13.1 ft) were breaking along the coast and exhibited a wave height gradient which increased to the east from the Isles Dernieres. This trend has been attributed to an increase in shelf slope to the east (Stone et al. 1993; 1995). Landward of the coast predominantly wind-generated waves attained heights of 1 m. The output appears reasonable when compared to observation and in situ measurement of water levels during Hurricane Andrew (Stone and Finkl 1995). The output from the Category 5 hurricane simulations are shown in Figures 5-34 through 5-36 for modern day, 30-year and 100-year scenarios. For the modern day scenario, the coastline is predominantly overtopped with waves approximating 2 m (6.6 ft) in height. Landward in the bays, waves typically attain heights of around 1 m (3.3 ft) increasing to 2 m (6.6 ft) southeast of New Orleans. A gradual landward shift of larger wave heights is noticeable with the disappearance of barrier islands and coastal retreat, particularly for the 100-year scenario. This does not significantly influence wave heights landward of the coast where waves are generally limited to 1 m.

6.0 CONCLUSIONS

The forecast trends in the physical and hydrologic conditions of the barrier island study area indicate significant changes will occur. The landscape changes of the barrier islands and wetlands will cause some increases in water levels and wave action well into the Barataria and Terrebonne Basins. Predictions of the Isles Dernieres barrier island conditions indicate that in 30 years, gulfside and bayside erosion will result in island narrowing as well as island breaching; within 100 years, the entire subaerial portion of the barrier island system will be gone except for small land fragments associated with the western end of Whiskey Island and the eastern end of East Island. Timbalier Island will continue to migrate rapidly in a lateral direction, will undergo island narrowing and shortening, and is projected to disappear in the year 2051. East Timbalier Island will develop two island breaches as it undergoes island narrowing and will disappear within 100 years except for a small land fragment on the eastern end. The Bayou Lafourche headlands are predicted to continue the historical trend of rapid retreat. Grand Isle's southwestern end will continue to narrow and, within 100 years, this narrowing will cause the southwestern end to disappear enabling Caminada Pass to widen significantly. The Plaquemines barriers will continue to erode with high rates of erosion for the Cheniere Ronquille and Shell Island areas and, within 100 years, large segments of the system will have completely disappeared. This will result in increased wave height conditions in southern Barataria Bay, Bay Joe Wise, Bastian Bay, Shell Island Bay, Bay Coquette, and Bay Jaque.

Forecasts of future wetland areas indicate substantial amounts of land loss will occur even with CWPPRA projects as authorized in 1996. The total wetland acreage in the study area will change from 1,713,798 at present to 1,543,544 in 30 years and 1,230,584 in 100 years without considering CWPPRA projects. This represents a land loss of 170,254 acres by year 30 and 483,214 acres by year 100. The effect of all the authorized CWPPRA projects is estimated to reduce this loss by 11,073 acres in year 30 and 8,243 acres in year 100. The Davis pond project is estimated to restore 16,393 acres by year 30 and 46,401 acres by year 100. The greatest land loss is predicted along the Bayou Lafourche corridor and in the northern parts of both the Barataria and Terrebonne basins. The density of land in these areas is shown to shift from predominantly land at present to predominantly water by year 100. Only the western Terrebonne marshes retain large areas which are predominantly land.

The results of the hydrologic computer simulations indicate that further loss of the barrier islands and wetlands will increase the elevation of hurricane flooding however it will not have a major effect on the pattern of hurricane flooding. Essentially the same areas that are flooded today will be flooded in the future. However, the maximum flood elevations will increase as a result of the landscape changes. Water levels will increase by 0.3 to 0.5 meters (1 to 1.5 ft) throughout the basins and as far into the basin as Lake Salvador. Average tide levels in the bays will increase only slightly, less than 0.01 m (0.4 in), in the future. Salinity patterns will show increases in mean salinities of about 1 ppt and increases in the range in salinities over a tidal cycle of about twice this amount.

Wave heights show considerable increase due to landscape changes. Under storm conditions, increases in wave height in the western portion of the study area in 30 years are generally restricted to the vicinity of the Isles Dernieres barrier islands, with the magnitude of wave height increase between 0.2 and 0.6 m (0.7 - 2.0 ft). The maximum wave height increase occurs at the east end of East Island where wave height increases by 1 m (3.3 ft). The wave height increase for the 100-year scenario is markedly larger. Wave height in Lake Pelto, for example, increases by as much as 1 m. In the central portion of the study area, changes in storm wave height for the 30-year scenario are generally restricted to the vicinity of the barrier islands, where more than a 1 m (3.3 ft) wave height increase occurs at the east end of East Island. In Terrebonne and Timbalier bays, wave height increase generally ranges between 0.1 - 0.3 m (0.33 - 0.98 ft). Wave height increases over the 100-year scenario are considerably different from those for the 30-year scenario. Wave height increases in Timbalier Bay by between 0.2 - 1.2 m. Due to substantial retreat of the Caminada-Moreau Headland and increasing water depths at the shoreface erodes, wave height increases by as much as 3 m (9.8 ft) along this section of the coast. In the eastern portion of the study area both storm and fair-weather waves show generally the same patterns. For the 30-year scenario, increases (or decreases) in wave height are restricted to the vicinity of the barrier shoreline. The largest increase (0.2 - 0.4 m (0.7 -1.3 ft)) occurs along the headland and the largest decrease (0.2 - 0.8 m (0.7 - 2.6 ft)) occurs along eastern Grand Isle. Variations in wave height are more pronounced for the 100-year scenario, where wave height increases by as much as 3 m (9.8 ft) along the headland and decreases over 1 m (3.3 ft) at eastern Grand Isle under storm conditions.

The data presented in this report will be used in the future without project assessments to quantify the impacts of the environmental and economic resources. Later, these baseline conditions will be compared to management alternatives analyzed in detail.

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