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Mississippi River–Gulf Outlet
St. Bernard Parish, La.

Bank Erosion

Reconnaissance Report

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SYLLABUS

This report presents the results of continued reconnaissance phase investigation of bank erosion and erosion-related problems in the vicinity of the Mississippi River-Gulf Outlet (MR-GO) channel. The results of this preliminary analysis indicate that construction of bank stabilization measures along the MR-GO may be warranted. Based on an evalution of project costs and both monetary and non-monetary benefits, continuation into the feasibility phase is advisable.

The affected study area is located in southeast Louisiana, and encompasses Orleans (City of New Orleans), St. Bernard, Jefferson, and Plaquemines Parishes. This report specifically addresses a 37 mile segment of the MR-GO navigation channel and adjacent wetlands in Orleans and St. Bernard Parishes, Louisiana.

Severe bank erosion is occurring on the MR-GO navigation channel. Approximately 41 miles of the 66 mile long channel consists of a land cut through unstable marsh and shallow water areas. Since its completion in 1968, the top width of the channel has increased from 650 feet to an average of 1,500 feet, in 1993, principally due to erosion. The channel banks have eroded beyond the existing channel right-of-way in several locations. Much of the bank erosion is caused by wave-wash and drawdown from large displacement vessel traffic on the restrictive waterway. Passage of these vessels causes very large quantities of water to be displaced from the channel into the adjacent marsh, followed by rapid return flow into the channel. The tremendous forces exerted by these rapid and extreme water level fluctuations cause the relatively soft marsh adjacent to the channel to break up and be swept into the waterway. Since 1968, bank erosion has resulted in the loss of approximately 4,200 acres of highly productive marsh adjacent to the MR-GO channel.

Continued erosion threatens to produce large breaches in the rapidly dwindling marsh buffer between the navigation channel and the open waters of Lake Borgne and Breton Sound. Once the buffering marshes are lost, dredging frequency and quantity in the vicinity of the breached bank area will increase significantly. The navigation channel will be exposed to storms, currents, and less attenuated tidal action from the north and northeast. Attendant sedimentation and shoaling problems are expected to occur.

Based on an analysis of the erosion problem, three objectives of constructing measures along the MR-GO were identified: 1) to control bank erosion to minimize channel maintenance requirements, 2) to reduce the rate of loss of valuable coastal wetlands adjacent to the channel, and 3) to restore, to the extent practicable, wetlands previously converted to open water as a result of bank erosion and saltwater intrusion.

The most favorable plan identified in the reconnaissance study to meet these objectives involves the construction of 30 miles of rock dike along the north bank of the MR-GO. While smaller plans may be more efficient at meeting the objectives, they do not provide the desired magnitude of environmental outputs or are not supported by potential non-Federal sponsors. The total first costs to construct this plan would be $39,056,000, and the total average annual costs, including approximately $5,951,000 for operation and maintenance, would be $10,773,000. The plan would reduce average annual costs of maintenance dredging by $4,367,000 and provide $471,000 in average annual benefits through the preservation and restoration of marsh. In addition, the non-monetary value associated with this preservation and restoration would be 2,786 Average Annual Habitat Units.

Preliminary results of the reconnaissance study have been provided to the potential non-Federal sponsor, the Port of New Orleans.

The report contains recommendation to proceed to the feasibility phase. The report also recommends that cost sharing for the feasibility, construction, and operation and maintenance phases be adjusted to reflect project outputs. The recommended Federal shares for these three phases are 70, 85, and 40 percent, respectively.

MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH, LA--BANK EROSION RECONNAISSANCE REPORT

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INTRODUCTION

This report presents the findings of a reconnaissance study of bank erosion and erosion-related problems in the vicinity of the Mississippi River-Gulf Outlet (MR-GO) channel in Orleans and St. Bernard Parishes, Louisiana. The report includes six appendixes: Appendix A--Climatological and Hydrologic Data; Appendix B--Environmental Resources; Appendix C--Mississippi River-Gulf Outlet Maintenance Analysis; Appendix D--Cost and Benefit Estimates; Appendix E--Real Estate Cost Estimates; Appendix F--U.S. Fish and Wildlife Service Planning Aid Letter. Information on the follow-on feasibility phase study is contained in a separate document, the Draft Feasibility Study Cost Sharing Agreement and Initial Project Management Plan (IPMP). The draft agreement outlines the obligations, responsibilities, and relationships between the Federal government and the non-Federal sponsor for the feasibility phase. The IPMP is comprised of the study schedule, scope of work, a breakdown of study tasks and responsible organizations, and time and cost estimates.

STUDY AUTHORITY

The study was authorized by a resolution adopted September 23, 1982, by the Committee on Public Works and Transportation of the United States House of Representatives at the request of Representative Robert L. Livingston, Louisiana 1st Congressional District. The resolution is as follows:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River Gulf Outlet, Louisiana, published as House Document No. 245, 82nd Congress, 1st Session, and other pertinent reports, with a view to determining whether, in light of extensive erosion which has been occurring in St. Bernard Parish along the unleveed banks of the Gulf Outlet Channel, any modifications to the recommendations contained therein are advisable at this time with reference to the feasibility of bank protection measures."

STUDY PURPOSE AND SCOPE

This study is in response to the study resolution and will be conducted in two phases: a reconnaissance phase and a feasibility phase. This report contains the results of the reconnaissance phase studies.

The purpose of the reconnaissance phase is to accomplish the following objectives:

- define the extent of erosion and erosion-related problems projected to occur in the study area;
- identify opportunities to implement potential solutions to the defined problems;
- appraise the Federal interest in potential solutions to defined problems by evaluating the costs, benefits, and environmental effects of the potential solutions;
- determine, based on the appraisal of Federal interest, whether planning should proceed beyond the reconnaissance phase into more detailed feasibility phase investigations;
- estimate the time and cost required to complete feasibility phase studies, if Federal interest is indicated; and
- assess the level of interest and support of non-Federal interests in the identified potential solutions to defined problems.

Study efforts in the reconnaissance phase include the use of available information and data, ground reconnaissance of the study area, limited field surveys, and office studies. Existing conditions and projected conditions with and without Federal improvements are assessed. Problems and opportunities are identified. The feasibility and performance of potential improvements are determined. Social, cultural, economic, and environmental impacts are evaluated.

The study area is located in southeast Louisiana in Orleans and St. Bernard Parishes. The study specifically addresses a segment of the Mississippi River-Gulf Outlet navigation channel. The study area is shown on Plate 1.

MISSISSIPPI RIVER-GULF OUTLET PROJECT

The Mississippi River-Gulf Outlet, Louisiana, project was authorized by the Rivers and Harbors Act of 29 March 1956 (Public Law 84-455) substantially in accordance with recommendations of the Chief of Engineers in House Document No. 245, 82nd Congress, 1st Session, entitled, Mississippi River-Gulf Outlet, Louisiana. The project is located in southeast Louisiana, in Orleans, St. Bernard, and Plaquemines Parishes and provides for deep-draft navigation access to the Inner Harbor Navigation Canal from the Gulf of Mexico via a new tidewater channel. Features of the project are:

- a 76-mile channel with a project depth of 36 feet Mean Low Gulf (MLG) and a 500-foot bottom width extending from the Inner Harbor Navigation Canal in New Orleans to the Chandeleur Islands and increasing gradually to a width of 600 feet and a depth of 38 feet to the -38-foot contour in the the Gulf of Mexico;
- a turning basin with a project depth of 36 feet MLG, a width of 1,000 feet, and a length of 2,000 feet at the junction of the new channel and the Inner Harbor Navigation Canal in New Orleans;
- a suitable bridge over the new channel for Louisiana Highway 47;

- a new lock and connecting channels between the new channel and the Mississippi River in the vicinity of Meraux, Louisiana, or at the site of the existing Inner Harbor Navigation Canal Lock, when economically justified by obsolescence of the existing Inner Harbor Navigation Canal Lock or by increased traffic;
- a permanent retention dike through Chandeleur Sound and a wing dike along Breton Island, as necessary;
- a bank stabilization measure along 17.5 miles of the Chalmette Area Unit of the Lake Pontchartrain, Louisiana, and Vicinity hurricane protection levee;
- a bank stabilization measure along 6 miles of the north bank of the Mississippi River-Gulf Outlet in the reach which is part of the Gulf Intracoastal Waterway (GIWW) and along 3.5 miles of the MR-GO approximately from channel mile 54 to mile 51; and
- jetties extending from the seaward end of the land cut to the six-foot contour in Chandeleur Sound and a south jetty extension to mile 20.2.

OTHER STUDIES, REPORTS, AND EXISTING WATER PROJECTS

Relevant studies and reports by the U. S. Army Corps of Engineers, and other Federal, state, and local agencies on water resources development in the study area are described in the following paragraphs.

- Between 1987 and 1991, the U. S. Army Corps of Engineers, New Orleans District conducted a preliminary study to determine the advisability of constructing bank stabilization measures along the MR-GO. The purpose of this study was to: 1) identify the extent of shoaling due to increased bank erosion and 2) determine whether bank stabilization measures are justified based on savings in channel maintenance costs. In connection with this study, the U. S. Army Corps of Engineers, Waterways Experiment Station prepared a numerical modeling investigation of shoaling in the MR-GO. The model addressed the impacts that the widening channel gaps between the MR-GO and Lake Borgne would have on rates of channel shoaling and marsh loss. The model results show that there is a 50 percent probability that the ultimate increase in channel shoaling due to continued erosion is 300 percent higher than current rates. Based on these results, the New Orleans District concluded that bank stabilization measures are not likely to be economically justified if project benefits are based solely on maintenance savings.

- The Coastal Wetlands Planning, Protection and Restoration Act (Title III of Public Law 101-646) was enacted on 29 November 1990. The act establishes a Task Force consisting of the Secretary of the Army (chairman); the Governor of Louisiana; the Administrator of the Environmental Protection Agency; and the Secretaries of Agriculture, Commerce, and the Interior. Section 303(b) of the act provides for the preparation of a comprehensive plan to restore and prevent the loss of coastal wetlands of Louisiana. Section 303(a) of the act provides for the development of annual lists of priority projects, to be submitted to the Congress. These projects are to provide for the long-term conservation of the state's wetlands and dependent fish and wildlife populations. The first two priority project list reports were submitted to the Congress in November 1991 and November 1992; the report containing the third list is schedule for submission in November 1993. These reports recommend projects which can be implemented within a 5-year time period, as required by the authorization.

Those projects pertinent to this study which have been approved for implementation by the Task Force are as follow: West Bay Sediment Diversion, Caernarvon Outfall Management, Violet Freshwater Distribution, and MR-GO Back Dike Marsh Protection. The West Bay Sediment Diversion project will provide an initial 20,000 cubic feet per second (cfs) diversion of Mississippi River flows at mile 4.7 above Head of Passes, with anticipated enlargement to 50,000 cfs. The Caernarvon Outfall Management project will increase the use of fresh water, nutrients, and sediments provided by the existing Caernarvon Freshwater Diversion project on the Mississippi River. The Violet Freshwater Distribution project will increase the use of fresh water, nutrients, and sediments drawn from the Mississippi River by the existing Violet siphon. The MR-GO Back Dike Marsh Protection project will rebuild the dikes surrounding a dredged material disposal area adjacent to the channel, thus preventing the drainage and loss of the fresh marsh which has developed on the site.

Also proposed for consideration under this authority is a project to provide bank stabilization and marsh creation along 30 miles of the north bank and one-half mile of the south bank of the MR-GO. However, because this proposal is considered to be a high cost item, implementation under this authority is unlikely.

- The U.S. Army Corps of Engineers, New Orleans District, prepared a draft feasibility report in May 1993, entitled "Land Loss and Marsh Creation, St. Bernard, Plaquemines, and Jefferson Parishes, Louisiana." The report addresses measures to reduce and reverse the loss of vegetated wetlands in three of Louisiana's coastal parishes--St. Bernard, Plaquemines, and Jefferson--located adjacent to the Mississippi River, below the latitude of New Orleans. This three-parish area lost vegetated wetlands at a rate of about 9.5 square miles per year during the period 1974 through 1990. The tentatively selected plan identified in the report consists of the following measures: 1) creating vegetated wetlands with small-scale uncontrolled sediment diversions from six passes of the active Mississippi River delta: Pass a Loutre, South Pass, Main Pass, Grand Pass, Octave Pass, and Raphael Pass, 2) creating vegetated wetlands using a large-scale uncontrolled sediment diversion to the east bank of the Mississippi River at mile 7.5 Above Head of Passes, 3) creating vegetated wetlands using sediments dredged for maintenance of the Tiger Pass navigation channel.

• The U. S. Army Corps of Engineers, New Orleans District, prepared a preliminary analysis of the feasibility of providing future maintenance for the Mississippi River-Gulf Outlet under increasing shoaling conditions. This report was completed in April 1989 (see Appendix C). The analysis shows that it is clearly in the Federal interest to continue maintenance of the channel for commercial navigation, even under conservative (no-growth) deep-draft traffic projections and high channel shoaling rates. Three alternatives to using the MR-GO were considered: 1) diversion of containerized cargo to the Mississippi River, 2) diversion of containerized cargo to another port, and 3) use of the Mississippi River and a connecting deep-draft lock to access MR-GO facilities. Alternatives 1 and 3 above clearly involve more cost than the cost of continued maintenance. Alternative 2 is more costly than continued channel maintenance, but not by the same margin as the other alternatives. The analysis did not include an evaluation of the environmental benefits or impacts associated with closure of the MR-GO.

• Study of the Louisiana coastal area was authorized by resolutions of the Committees on Public Works of the U. S. Senate and House of Representatives. The Senate resolution was sponsored by Senator Russell B. Long and the late Senator Allen J. Ellender and adopted on 19 April 1967. The House of Representatives adopted an identical resolution of 19 October 1967. The U. S. Army Corps of Engineers, New Orleans District, prepared a final feasibility report, "Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins," in September 1984. The report recommended diverting Mississippi River water into the Breton Sound Basin near Caernarvon and into the Barataria Basin near Davis Pond to enhance habitat conditions and improve fish and wildlife resources. The report also recommended that the plan be implemented under the authorized Mississippi Delta Region project, which is identical in purpose. The diversions would reduce land loss and save about 99,200 acres of marsh. The construction of the Caernarvon structure was initiated in June 1988, and the project became operational in January 1991.

• The Mississippi-Louisiana Estuarine Areas, Bonnet Carré Freshwater Diversion project was authorized by Section 3 of the Water Resources Development Act of 1988 (Public Law 100-676). This project provides for the diversion of Mississippi River flows through the Bonnet Carré Spillway west of New Orleans, Louisiana, to Lake Pontchartrain to reduce saltwater intrusion affecting Lakes Maurepas, Pontchartrain, and Borgne and the Mississippi Sound and adjacent wetlands. Features of the project include modification of the existing Bonnet Carré Spillway structure to provide for the diversion of Mississippi River flows and the construction of a channel in the spillway to convey flows to Lake Pontchartrain. Construction of the project is scheduled to begin in 1994.

• Coastal Environments, Incorporated, published results of a study of bank stabilization for the Mississippi River-Gulf Outlet channel in December 1984.

The study was conducted for the St. Bernard Police Jury and funded by the U. S. Department of Commerce, National Oceanic and Atmospheric Administration; the State of Louisiana, Department of Natural Resources, Coastal Management Section; and the St. Bernard Parish Police Jury. This report addressed a 22.5-mile reach of the Mississippi River-Gulf Outlet channel on the north bank between Bayou Bienvenue and Bayou LaLoutre. The report addressed the factors that influence, or are influenced by, bank erosion. These factors include geology, soils, hydrology, vegetation, dredging, vessel traffic, and ship waves. Two bank protection structure designs, imposition of a speed limit for vessel traffic, and enlargement of the Mississippi River-Gulf Outlet channel were discussed as potential erosion abatement measures.

- The U. S. Army Corps of Engineers, New Orleans District, prepared an interim evaluation report on test sections of selected foreshore protection structure designs in 1983. This report included an assessment of the performance of six erosion control structure designs. The foreshore protection structures were designed specifically for the leveed portion of the Mississippi River-Gulf Outlet south bank. Two of the test sections showed satisfactory results.

- St. Bernard Parish completed a Draft Coastal Management Program Document in May 1982. The document will be the basis for parish planners to manage the coastal resources of the parish.

- St. Bernard Parish has conducted studies of its wetlands and established guidelines and goals for a parish wetlands management program. A report defining the wetlands management program was published in August 1978. Freshwater diversion to combat saltwater intrusion, and enhance fish and wildlife productivity is included as one plan feature.

- The Lake Pontchartrain, Louisiana, and Vicinity hurricane protection project, was authorized in Section 204 of Public Law 298, 89th Congress, 1st Session, approved 27 October 1965. This project provides improved hurricane protection for most of the developed areas on the east bank of the Mississippi River in Orleans, Jefferson, St. Bernard, and St. Charles Parishes. It also provides for the rehabilitation of a seawall located along Lake Pontchartrain in Mandeville, Louisiana, in St. Tammany Parish. Features of the project pertinent to this study include the Chalmette Area Unit and the New Orleans East Unit. These features are described below.

Chalmette Area Unit. This unit, which is located in St. Bernard Parish and in Orleans Parish south of the Gulf Intracoastal Waterway, provides for a new levee along the east side of the Inner Harbor Navigation Canal (IHNC) from the IHNC lock to the MR-GO, along the south/southwest bank of the Mississippi River-Gulf Outlet to approximately 2-1/2 miles northeast of Verret, Louisiana, and west to the Mississippi River levee near Caernarvon, Louisiana.

New Orleans East Unit. This unit consists of an enlarged levee on the Orleans lakefront levee landward of the seawall; levee and floodwalls on the east side of the 17th Street outfall canal and both sides of London Avenue and Orleans Avenue outfall canals; a new and enlarged levee and floodwall along both sides of the Inner Harbor Navigation Canal; a new levee and floodwall along the lakefront from the New Orleans Lakefront Airport to South Point; and enlarged levee from South Point to the Gulf Intracoastal Waterway at Chef Menteur; an enlarged levee and new floodwall along the north bank of the Mississippi River-Gulf Outlet and GIWW from Chef Menteur to the IHNC

- The U. S. Army Corps of Engineers, Waterways Experiment Station, published a miscellaneous paper (3-259) in 1958 which reported the results of a geological investigation of the Mississippi River-Gulf Outlet channel. This report documents soils and foundation conditions along the alignment of the Mississippi River-Gulf Outlet channel and adjacent wetlands.

- A report entitled "Louisiana-Texas Intracoastal Waterway, New Orleans, La. to Corpus Christi, Texas," was published in March 1939 as House Document No. 230, 76th Congress, 1st Session. The report and and prior River and Harbor Acts provide for the construction of a 12- by 125-foot channel 384 miles long from the mouth of the Rigolettes to the Sabine River. The project was authorized by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944. In the study area, the main stem of the Gulf Intracoastal Waterway (GIWW) utilizes the Inner Harbor Navigation Canal lock, the Inner Harbor Navigation Canal between the lock and the Mississippi River-Gulf Outlet, and the east-west reach of the Mississippi River-Gulf Outlet channel in Orleans Parish.

PROBLEM IDENTIFICATION

Defining existing conditions and analyzing historical trends provide the base for forecasting future conditions. These analyses provide the focus required to define the magnitude and extent of problems. Problems, once well defined, lead to the identification of water and related land resources needs, and allow opportunities to be exploited that address those needs and produce solutions to water resources problems.

The problems identified in this study relate to the loss of wetlands along the Mississippi River-Gulf Outlet and the increased costs of channel maintenance dredging due to the bank erosion. The primary causes of wetlands loss in the study area are the interrelated effects of subsidence, sea level rise, erosion, saltwater intrusion, and human activities. The Mississippi River-Gulf Outlet was a new cut constructed through wetlands and open water. The direct construction impacts, increase in salinity intrusion, and bank erosion associated with the project have significantly increased wetlands loss in the study area. Additionally, the erosion resulting from wave activity generated by vessel traffic increases the rate of channel shoaling and maintenance dredging costs. The problems addressed in this study are related primarily to erosion of wetlands along the banks of the Mississippi River-Gulf Outlet.

NATIONAL OBJECTIVE

The national objective of Federal water resources planning is to contribute to the national economic development in a manner consistent with protecting the nation's environment in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to the national economic development are increases in the net value of the national output of goods and services, expressed in monetary units, that occur in the planning area and the rest of the nation. Corps planning should also provide for the restoration of environmental quality such that the recommended plan benefits the quality and/or quantity of fish and wildlife resources affected by the plan. These fish and wildlife outputs are expressed in monetary and non-monetary units.

EXISTING CONDITIONS

TRANSPORTATION

Status of the MR-GO Navigation Project. The construction of the MR-GO deep-draft channel was initiated in March 1958. An interim channel 36 by 250 feet (bottom width) was opened to traffic in July 1963. A high-level bridge for

Louisiana Highway 47 was completed in 1967. Enlargement to project dimensions was completed in January 1968 (see page 2 for project dimensions). The turning basin at the intersection of the MR-GO with the IHNC has been completed. Jetties extending from the seaward end of the land cut to the six-foot contour in Chandeleur Sound and a south jetty extension to mile 20.2 in Chandeleur Sound have also been completed.

The project also provides for replacement of the existing IHNC lock or an additional lock with suitable connections when economically justified by obsolescence of the existing IHNC lock or by increased traffic. A study is in progress to determine the feasibility of replacing the existing IHNC lock.

The project was modified in August 1969 under the discretionary authority of the Chief of Engineers. The project modification provided for, as a mitigation measure, protecting a portion of the foreshore lying between the Lake Pontchartrain and Vicinity Hurricane Protection project levees and the MR-GO. This included six miles along the north bank of the MR-GO in the reach which is part of the GIWW and 18 miles along the south bank of the MR-GO. Foreshore protection along the leveed reaches of the MR-GO, as authorized by the August 1969 project modification, has been completed.

Of the 66 miles of waterway between the Chandeleur Islands and the IHNC, approximately 25 miles are through the shallow bay of Chandeleur Sound. About 41 miles are through land and water area. A dredged material disposal area approximately 0.5 miles wide extends along the remaining 23 miles of the MR-GO south bank. Dike protection along the north bank from channel mile 51 to mile 54 was completed in March of 1993. Bank stabilization measures along the south bank of the MR-GO between miles 66 and 60 have been authorized but have not been constructed.

Current MR-GO Channel Maintenance Requirements. The MR-GO channel was designed for a relatively small general cargo vessel (freighter). However, ship sizes have increased and larger container vessels move over the MR-GO to and from several container facilities located in New Orleans. The wave-wash and drawdown caused by these larger vessels moving over the restrictive channel have eroded its banks beyond the limits of the channel rights-of-way in some areas. Passage of these vessels causes very large quantities of water to be displaced from the channel into the adjacent marsh, followed by rapid return flow into the channel. The tremendous forces exerted by these rapid and extreme water level fluctuations cause the relatively soft marsh adjacent to the channel to break up and be swept into the waterway.

Although some project features were still under construction until 1968, maintenance of the MR-GO channel was initiated in 1965. On average, at least one reach of the inland portion of the waterway, selected on the basis of annual reconnaissance surveys, is dredged for maintenance purposes every two years.

The most frequently dredged reaches of the inland portion of the waterway since inception of channel maintenance are as follow (see Plate 1 for channel mile numbers):

- mile 24 to mile 27, dredged four times, 6.0 million cubic yards total,
- mile 38 to mile 42, dredged four times, 4.2 million cubic yards total, and
- mile 33 to mile 38, dredged three times, 3.6 million cubic yards total.

Most of the the other reaches of the inland portion of the MR-GO have been dredged once for maintenance since 1970.

Where the MR-GO traverses marsh areas in the land cut reaches (mile 23 to mile 60), the average shoaling rate is between 60,000 and 90,000 cubic yards per mile per year (cu yd/mi/yr). Required maintenance dredging in these reaches results almost exclusively from erosion of the channel banks. Little sediment enters the system from other sources.

Erosion along both the north and south banks of the land cut portion of the channel is significant. The average rate of bank retreat is about 15 feet per year for each bank.[1/] The south bank of the MR-GO along the Chalmette loop of the Lake Pontchartrain and Vicinity Hurricane Protection levee (mile 47 to mile 59.4) is protected with a rock foreshore dike. No erosion protection measures exist along the MR-GO south bank between mile 23 and mile 47. Protection measures for mile 59.4 to mile 60 are authorized but have not been constructed. In 1991 Congress funded construction of dike bank protection, "MR-GO North Bank Protection, Mile 50 to 54." This project provided protection from channel mile 50.9 to mile 54.0. The construction was begun in 1992 and was completed in March of 1993. For this study the project is assumed to provide three miles of bank protection. No other erosion protection measures exist along the MR-GO north bank.

Shoaling rates in the land cut reaches are significantly less than in the open water area of Breton Sound where maintenance dredging can vary from 350,000 cu yd/mi/yr to 1 million cu yd/mi/yr. Records from the first and second maintenance dredging periods after the channel was completed indicate that shoaling varied between 700,000 and one million cu yd/mi/yr in Breton Sound. However, a large percentage of the shoaling was attributed to recirculation of dredged material from disposal areas that were located too close to the channel.

1/ These data were based on comparing uncontrolled aerial photographs with an approximate scale of 1 inch = 1000 ft (1:12,000) for the following years; 1968, 1973, 1979, 1982, 1983, 1986, and 1992. The erosion varies considerably since the bank line is not uniform and often consists of broken or irregular marsh shorelines or embayments.

Substantially more dredging in the inland reaches of the MR-GO has been performed for purposes other than for channel maintenance. A significant amount of dredging has been performed to obtain construction material for the Lake Pontchartrain and Vicinity Hurricane Protection levees. Between 1968 and 1983 an estimated 100 million cubic yards of dredged material (33 million cubic yards of in-place levee fill) were removed from the MR-GO for use in levee construction. The extraction of this quantity of fill material has reduced maintenance dredging requirements between mile 47 and mile 60.

An analysis of the feasibility of providing continued maintenance for the MR-GO under increasing shoaling conditions is shown in Appendix C. The analysis clearly shows that it is in the Federal interest to continue maintenance of the channel for commercial navigation, even under conservative (no growth) deep-draft traffic projections and high channel shoaling rates.

Commerce. The MR-GO, along with the Mississippi River, provides deep-draft navigation access to the Port of New Orleans. In 1990 the traffic through the Port of New Orleans totaled 61.2 million tons. This included 54.1 million tons of traffic on the Mississippi River between channel miles 81 and 115, and 7.1 million tons of traffic on the MR-GO. In 1990, ocean-going cargo over the Mississippi River-Gulf Outlet totaled approximately 5.6 million tons, including crude materials, chemicals, and general cargo. Ocean-going cargo and internal cargo moving over the Mississippi River-Gulf Outlet during the period, 1977 through 1990, are presented in Table 1.

Vessel Traffic. The Mississippi River-Gulf Outlet is utilized by both ocean-going and shallow-draft vessels comprising a wide range of sizes and types. Shallow-draft vessels include barge tows, commercial fishing boats, oil field crew and supply boats, offshore drilling vessels, and pleasure craft. The deep-draft vessels include dry bulk carriers, tankers, and general cargo vessels, including container ships. Vessel trips and drafts for the period 1977 through 1989 are shown in Table 2.

General Cargo Facilities on the MR-GO. In 1986, 2.7 million tons (360,000 twenty-foot equivalent units) of container cargoes were handled by the four main berths that make up the MR-GO's 351-acre France Road Complex. This amounted to more than 80 percent of the port's total container traffic. While several container handling wharves exist on the Mississippi River, their container capacity is limited. This is particularly true with respect to marshaling yard space. The other major facilities along with the France Road Complex that handle the bulk of deep draft traffic on the MR-GO are the Jourdan Road Terminal and the Public Bulk Terminal. Jourdan Road is designed for roll on-roll off (ro-ro), container and general cargo operations. The Public Bulk Terminal handles bulk cargoes and Galvez Street handles primarily general cargo. All facilities have public access. Approximately 35 percent of the port's

Table 1. Historical Commerce over the Mississippi River-Gulf Outlet, 1977-1990

YEAR	SHORT TONS INTERNAL	OCEAN-GOING
1977	2,902,100	5,878,567
1978	2,884,883	6,526,194
1979	1,436,149	6,791,076
1980	737,001	4,804,463
1981	1,053,368	4,741,392
1982	1,251,212	4,320,628
1983	1,370,493	2,114,507
1984	2,092,483	5,942,048
1985	1,440,648	5,475,798
1986	2,131,553	6,013,002
1987	1,656,111	6,046,681
1988	1,808,927	5,877,768
1989	1,587,556	5,701,654
1990	1,446,000	5,612,000

Table 2. Trips and Drafts of Vessels over the Mississippi River-Gulf Outlet, 1977-1989 1/

	DRAFT IN FEET				
YEAR	Less than 20	21-25	26-30	31-35	36-40
1977	15,821	288	450	101	14
1978	16,786	408	589	149	24
1979	4,795	428	553	264	50
1980	7,983	376	429	249	25
1981	6,499	271	558	243	17
1982	17,234	301	626	240	18
1983	4,225	349	616	311	8
1984	5,309	550	571	257	20
1985	4,490	450	582	218	18
1986	4,793	553	527	240	9
1987	3,291	419	511	187	34
1988	3,343	414	589	129	31
1989	3,253	337	476	182	45

1/ Includes upbound and downbound.

tonnage over public general cargo wharves is handled by MR-GO facilities, and the Public Bulk Terminal represents one of only two public non-grain bulk facilities in the port. A summary of general cargo facilities on the MR-GO and the Inner Harbor Navigation Canal is shown on Table 3.

CLIMATE

The climate of the area is subtropical marine, with long humid summers and short moderate winters. Southerly winds prevail throughout the warmer months and produce intense thunderstorms during the summer. In the colder months the area is subjected to frontal movements which produce squalls and sudden temperature drops.

Temperature readings have been taken at New Orleans, Louisiana, since 1870. The extremes recorded were a high of 102 °F occurring on four different days and a low of 7 °F in February 1899. The annual normal temperature based on the period 1951-1980 is 69.5 °F, with monthly normal temperatures varying from 83 °F in July to 54 °F in January. Extremes for the normal period were a maximum temperature of 102 °F in August 1980 and a minimum of 14 °F in January 1963. The average winter and summer temperatures are 55.3 °F and 82.4 °F, respectively.

Precipitation data from four climatological stations are used to represent the study area. The average annual rainfall for New Orleans at Algiers, St. Bernard, LSU Citrus Research Center, and Boothville, Louisiana, based on the period 1967-1986 is 61.2 inches.

Wind data at Boothville, Louisiana, are representative of shoreline wind conditions for the study area. These winds averaged about 8.8 mph annually, based on the period July 1971 through December 1978. Predominant wind directions are northeast from September through February and southeast from March through June.

Seasonal weather patterns which simultaneously affect large portions of the Gulf of Mexico cause three kinds of wind-generated tidal conditions in the study area. These are described in the following paragraphs.

- The Frontal Gulf Return and Gulf Return weather types have moderate-to-strong southeast to south-southwest winds associated with storms which cause moderate to severe wave set up in Breton Sound and the Mississippi River-Gulf Outlet. These weather patterns occur when the returning air flow is affected by lifting and convergence along an approaching cold front. This front is either a Pacific High, Continental High, or a Frontal Overrunning weather type generating winds from the northwest or northeast.

Table 3. Summary of General Cargo Facilities on the Mississippi River-Gulf Outlet and the Inner Harbor Navigation Canal 1/

Terminal	Operator	Berthing Space (ft.)	Depth Alongside (ft.)	Container Freight Stations No.	Container Freight Stations Capacity (sq. ft.)	Container Storage Capacity2/	Cargo Capability3/
Jourdan Road Terminal, Berths Nos. 4 and 5	Ceres Gulf, Inc.	1,400	36	---	---	10 acres	Conv., Cont., Ro-Ro
Florida Avenue, Roll on-Roll off Wharf	Unassigned	482	20	---	---	4.9 acres	Ro-Ro
France Road Terminal Berth No. 1	Sea Land Service, Inc.	830	35	1	67,000	940 fc 160 rfc	Cont.
Berth No. 4	Puerto Rico Marine Management, Inc.	700	30-36	1	60,000	739 fc 60 rfc	Cont.
Berths Nos. 5 & 6	Marine Contractors, Division of Baton Rouge Marine Contractors, Inc.	1,585	30	1	31,200	On chassis: 430 fc 74 rfc Stacked: 3,564 fc	Cont., Ro-Ro
Berth No. 6, Roll on-Roll off Ramp	" "	300+1,585	30-36	1	100,000		
Galvez Street Wharf	Coastal Cargo Co.	2,470	35	---	---	---	Conv., Cont.

1/ From Waterborne Commerce Statistics Center's Publication NDC 90-P-4, The Port of New Orleans, Louisiana, Port Series No. 20, dated 1990.
2/ fc = 40-foot container; rfc = refrigerated 40-foot container
3/ Ro-Ro = roll on-roll off cargo; Conv. = conventional cargo; Cont. = containerized cargo

- The Gulf Tropical Disturbance weather type sometimes affects southern Louisiana during the summer and fall, and occasionally during late spring. These disturbed tropical systems normally drift from east to west across the northern gulf and range from relatively weak easterly waves to strong, severe hurricanes.

- The Gulf Extra-Tropical disturbance weather type has behavior similar to tropical storms except that it occurs in winter-spring. It consists of a strong northeast to east wind component which causes wave set-up and flooding.

WATER RESOURCES

The Inner Harbor Navigation Canal, the upper reach of the Mississippi River-Gulf Outlet, and the Gulf Intracoastal Waterway are a hydraulic connection between Lake Pontchartrain and Lake Borgne, the Breton and Chandeleur Sounds, adjacent estuaries, and the Gulf of Mexico. A portion of the freshwater inflow to Lake Pontchartrain is discharged through these waterways, and they convey tidal exchange. Bayous Bienvenue, Dupre, Yscloskey, and La Loutre are relatively small natural waterways that intersect the Mississippi River-Gulf Outlet in the study area. Numerous smaller bayous and pipeline canals crisscross the marshlands adjacent to the Mississippi River-Gulf Outlet channel.

Tides and Stages. Tides in the Breton and Chandeleur Sound areas are of the daily or diurnal type; that is, they exhibit only one high water and one low water per day. The most prominent feature of the daily tide is the variation in the daily range produced by changes in the moon's declination. In a shallow body of water such as Breton Sound, tidal effects other than the daily range are masked by meteorological conditions which cause prominent water level fluctuations.

The tides in Breton Sound have a range of 1.4 feet. In Lake Borgne the tides have a range of 1.2 feet. Tidal ranges at several stations in the general vicinity of the study area include 0.70 foot in the Inner Harbor Navigation Canal near Lake Pontchartrain (at Seabrook); 1.2 feet at Shell Beach, 1.1 feet at Paris Road Bridge, 1.45 feet at Gardner Island in the Mississippi River-Gulf Outlet; and 1.0 foot in the Mississippi Sound at Biloxi, Mississippi.

During the period, 1893 to 1992, a total of 50 storms have either struck or affected the coastal area between Grand Isle, Louisiana, and the Louisiana-Mississippi line. The highest maximum observed winds at landfall came from Hurricane Camille (14-22 August 1969) and measured 160 miles per hour near the center with gusts to 190 miles per hour. This storm produced the maximum stage of 11.1 feet at Shell Beach. Hurricane Andrew (1992) was the last storm to affect the study area.

A coastal storm with very strong winds hit the study area in January 1983. The storm produced tides of 3 to 6 feet above normal along the Mississippi River-Gulf Outlet, including a high stage of 6.8 feet at Shell Beach and 7.61 feet at the Louisiana Highway 47 (Paris Road) Bridge.

Hurricane Juan (1985) did not have record-breaking wind speeds; however, because of this storm's path and rate of forward motion, it caused high stages along the Mississippi River-Gulf Outlet. This storm produced recorded stages of 3.53 feet on the protected (west) side of the Bayou Dupre Floodgate and 7.61 feet on the flood (east) side, 7.98 feet on the flood (east) side of the Bayou Bienvenue Floodgate was recorded. A 6.86 feet stage was recorded on Bayou Terre Aux Boeufs at Delacroix, Louisiana. A high water mark of 7.5 feet was recorded at Shell Beach, Louisiana.

Discharges. Lake Pontchartrain has a total drainage area of approximately 13,600 square miles. Maximum and average inflows are 67,000 and 6,200 cubic feet per second, respectively. The maximum monthly freshwater inflow to Lake Pontchartrain, exceeding 18,000 cubic feet per second, occurs during the period March through May. The minimum monthly flow, less than 2,000 cubic feet per second, occurs during the period July through November. The Bonnet Carré, a flood control feature of the Mississippi River and Tributaries project, diverts up to 250,000 cubic feet per second of flow from the Mississippi River upstream of New Orleans, Louisiana, during major Mississippi River floods. Approximately 10 percent or less of inflows to Lake Pontchartrain are discharged through the IHNC and the upper reach of the Mississippi River-Gulf Outlet. The estimated peak tidal flows in the Mississippi River-Gulf Outlet are 13,000 cubic feet per second during the flood tide period and 18,000 cubic feet per second during the ebb tide period.

Salinities. Salinities in the Mississippi River-Gulf Outlet are influenced primarily by flows from Lake Pontchartrain and by tidal exchange between Lake Pontchartrain and other estuaries and the Gulf of Mexico. Salinities in Lake Pontchartrain average 1.5 parts per thousand and range seasonally from a low of about 0.45 ppt in the late spring to a high of about 5.3 ppt in the late fall, reflecting seasonal variations in freshwater inflow. In Lake Pontchartrain at Little Woods, near the Inner Harbor Navigation Canal, the salinities have averaged 5.0 ppt since the construction of the Mississippi River-Gulf Outlet and range from 3.5 ppt in late spring to 6.7 ppt in late fall. Lake Borgne salinities range from 3 to 15 ppt, with the freshest areas on the north and west due to freshwater flows from Lake Pontchartrain and the Pearl River. Seasonal salinities in Breton and Chandeleur Sounds range from 6 to 21 ppt while those in the Gulf of Mexico average 35 ppt.

Currents. Currents in the Mississippi River-Gulf Outlet are influenced by the stages and freshwater inflows to Lake Pontchartrain. During periods of low stages and inflows, July through November, surface ebb and bottom flood velocities average about 0.8 and 1.7 feet per second, respectively, and both may exceed 2 feet per second. The mean annual velocity in the channel is about 0.6 feet per second. Flood and ebb velocities predominate at the lake and gulf end of the channel, respectively. In Breton Sound, current velocities average about 0.3 feet per second annually and about 0.7 feet per second during the period July through November. During hurricanes, velocities may exceed 4.4 feet per second.

Sea Level Rise. The water and land resources of the study area are affected by the Gulf of Mexico. The gulf is influenced by the global rise in sea level caused by global warming which results in the thermal expansion of water and the melting of glaciers. The estimated historical rate of sea level rise in the gulf is 0.5 foot per century.

Water Quality. Wastewater and polluted stormwater runoff from developed areas enter the Mississippi River-Gulf Outlet from many sources. The Forty Arpent Canal, the Florida Walk Canal, and Bayou Bienvenue transport significant amounts of treated municipal and industrial wastewater from the developed areas within the Chalmette Area levee to the Mississippi River-Gulf Outlet. Bayou Bienvenue also carries pumped stormwater from Orleans Parish to the Mississippi River-Gulf Outlet, and stormwater from upper St. Bernard Parish is transported by the Forty Arpent and Florida Walk Canals. Each of these waterways enters the Mississippi River-Gulf Outlet between miles 50 and 60.

The water quality gaging station at Bayou Dupre (mile 53) near its confluence with the Mississippi River-Gulf Outlet is most representative of this reach. Measured dissolved oxygen (DO) levels have consistently exceeded the minimum state standard and Environmental Protection Agency criteria. With rare exceptions, the pH measurements have also been within the desirable range of 6.5 to 9.0. Both total and fecal coliform, which are indicators of bacterial pollution, have consistently exceeded the applicable criteria of 70 and 14 counts/100 milliliters, respectively. The proximity of this station to oyster beds in Lake Borgne and adjacent areas is cause for concern, since contaminated shellfish may not be harvested and sold for human consumption. Coliform levels observed at other locations along the Mississippi River-Gulf Outlet have usually exceeded the criteria, indicating a widespread area of water and wetlands that is subject to bacteria pollution.

Toxic substances, including heavy metals and synthetic organics, have occasionally been measured above U. S. Environmental Protection Agency criteria levels, but no patterns of consistently exceeding the criteria for particular substances have been observed. Tidal currents promote mixing and dispersion in the upper water column of the Mississippi River-Gulf Outlet, but density stratification as a result of the migrating saltwater wedge in the deep channel produces oxygen deficits and other associated water quality problems at deeper levels. These waters ordinarily remain confined to the Mississippi River-Gulf

Outlet channel, and only indirectly influence the adjacent, relatively shallow areas during periods of intense mixing.

Bayou Bienvenue crosses the Mississippi River-Gulf Outlet at mile 60 near the GIWW. It carries pumped stormwater from New Orleans, and contributes to intermittent periods of lowered DO levels in the Mississippi River-Gulf Outlet and adjacent water bodies, including Lake Borgne. Bacterial contamination risks generally increase in the northernmost reaches of the Mississippi River-Gulf Outlet following storm periods, but tidal circulation normally helps to restore more desirable conditions within reasonable time periods.

GEOMORPHOLOGY

Most of the lands in the study area are remnants of the St. Bernard delta of the Mississippi River which was active during a period approximately 1,700 to 2,800 years ago. Bayou La Loutre was a major distributary for sediment-laden flows which formed a network of distributaries bordered by natural levees and interdistributary troughs. In the troughs, extensive swamps and marshes developed. After the St. Bernard subdelta was abandoned, it began to retreat due to compaction, subsidence, and erosion; and lakes, bays, and sounds formed.

Human activities accelerated land loss in the St. Bernard delta. The Mississippi River levees have cut off seasonal sediment-laden overflow that once nourished the areas near the river. The construction of the MR-GO, the GIWW, and numerous other small channels converted large areas of land to open water and increased salinities in the area. The Mississippi River-Gulf Outlet navigation channel has a more significant effect on salinities because it is a deep-draft channel cut through the Bayou La Loutre alluvial ridge to the Gulf of Mexico. Higher salinities cause swamps and marshes to convert to more saline vegetation types which are less robust and more susceptible to erosion.

Most of the Mississippi River-Gulf Outlet is experiencing severe erosion along its unleveed banks. The erosion is a result of both man-induced and natural forces, including combinations of channelization, ship and wind generated waves, storm activity, and subsidence. Associated with subsidence is eustatic sea level rise that has been estimated at 0.5 feet per century (Nummendal, 1983). Subsidence and sea level rise intensify saltwater intrusion and erosion.

The marshes along the north bank of the Mississippi River-Gulf Outlet have been especially hard hit by these forces and are disappearing at an alarming rate. Because erosion is steadily widening the Mississippi River-Gulf Outlet, the channel's north bank along Lake Borgne between channel miles 38 and 43 is dangerously close to being breached. Once the bank is breached, the following could occur: sediment from Lake Borgne might flow into the channel resulting in increases in dredging costs to maintain the channel; development to the southwest would be exposed to direct hurricane attacks from Lake Borgne; the rich habitat around the area would be converted to open water, and more marsh would be exposed to higher salinity water.

ECONOMY

Because of its unique location near the mouth of the Mississippi River, New Orleans is the natural gateway to the entire Mississippi Valley. Waterborne commerce is of major importance to the Greater New Orleans area and the state. Waterborne commerce statistical data for 1989 indicated that the Port of New Orleans was the nation's largest port in terms of tonnage handled including tonnage dedicated to foreign trade. The 1989 report showed that 22 percent of all grain exported from the United States was loaded at the port. Nearly 4,200 ships called at its docks.

Ports and industrial development along the Mississippi River between Head of Passes and Baton Rouge, serve as transhipment terminals for shallow-draft commerce utilizing the vast network of inland waterways formed by the river, its tributaries, and connecting streams of the nation's mid-section.

Within the Port of New Orleans, facilities are spread over three waterways: the Mississippi River, the Inner Harbor Navigation Canal, and the Mississippi River-Gulf Outlet.

In recent years, the growth of port and harbor activities, commerce, tourism, and mineral production have tended to overshadow the historic cultural and economic significance of commercial fishing industries. Nevertheless, National Marine Fisheries Service reports indicate that in 1992 Louisiana ranked second only to the state of Alaska in total pounds and value of commercial landings. Louisiana had total landings of 1,013,575,000 pounds with a gross value to the fishermen of $295 million. Menhaden, a species of fish used for industrial purposes, accounted for the largest volume landed in Louisiana. Other important species normally include shrimp, crabs, oysters, and catfish.

HUMAN RESOURCES

The primary parishes directly or indirectly impacted by this project, and their populations, are shown in Table 4.

The 1980 census estimated that about 12 percent of the employed people living in the study area were engaged in transportation, communication, and utility activities. The Louisiana Department of Labor has reported that study area employment in similar categories accounted for about 10 percent in 1991. A more significant factor influencing the area's employment opportunities, and economic trends in general, has been the decline of oil production in recent years. The unemployment rate in the New Orleans market area of Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist, and St. Tammany Parishes, however, appears to have improved recently. The rate has declined from 11.5 percent in August of 1986 to 6.9 percent in May 1993.

Table 4 Population of Affected Parishes, 1950 - 1990

Parish	Land Area (Sq. Mi.)	Populations 1950	1960	1970	1980	1990
Jefferson	331	103,873	208,769	337,568	454,592	448,306
Orleans	205	570,445	627,525	593,471	557,482	496,938
St. Bernard	514	11,087	32,186	51,185	64,079	66,631
Plaquemines	1,030	14,239	22,545	25,225	26,049	25,575
TOTALS	2,080	699,644	891,025	1,007,449	1,102,202	1,037,450

ENVIRONMENTAL RESOURCES

Wetlands. The study area is characterized by a variety of habitats including estuarine marshes, scrub/shrub habitat, shallow open water ponds, and the Mississippi River-Gulf Outlet waterway. The estuarine marshes are composed of both brackish and saline vegetation. Dominant species of vegetation in the saline marsh areas include saltmarsh cordgrass and saltmeadow cordgrass, where subdominant species include blackrush, saltgrass, and saltwort. The brackish marshes are dominated by saltmeadow cordgrass with other species present such as saltgrass, saltmarsh cordgrass, blackrush, and three-cornered grass. Vegetation within the confined dredged material disposal areas of the MR-GO consists of brackish marsh species. Once these areas are initially drained, rainwater accumulation tends to result in the establishment of vegetation associated with reduced salinities.

Scrub/shrub habitat is present on the natural ridges and on previously used dredged material disposal locations. The elevation at these locations is generally higher which allows for reduced periods of saltwater inundation during extreme high water events. Marsh elder is the dominant salt-tolerant vegetation in scrub/shrub habitats. Other species of scrub/shrub vegetation which are not tolerant of long periods of saltwater inundation include palmetto, wax myrtle, and live oak.

Shallow estuarine pond habitat is located within the interior marsh areas. These habitats are composed of water averaging 1.0 foot deep and a bottom made up of organic detritus, sand, and silt sediments. Portions of these peat-like sediments are saturated with water and are 6 to 8 feet deep. The salinity within these shallow ponds varies from 5 to 25 parts per thousand depending upon the distance from the Gulf of Mexico and the time of year. The level of water in these estuarine ponds depends on wind direction, rainfall, and lunar tides. Submerged aquatic vegetation, composed of dwarf spikerush, widgeon grass, and coontail, provides food and habitat for both resident and transient species.

The MR-GO outlet channel provides a direct route for saltwater to enter the estuarine marsh system as well as a route for freshwater to exit the estuarine system and enter the Gulf of Mexico. Bayou La Loutre was once the only direct waterway between these marshes of St. Bernard Parish and the Gulf of Mexico. Since the construction of the MR-GO, the amount of saline marsh has increased and fresh marshes have been converted to brackish marshes and some intermediate marsh.

Wildlife. Resident and migratory species of wildlife in these marshes reflect the change of vegetation attributable to the changed salinity levels. Historically, the study area in St. Bernard and Plaquemines Parishes has been one of the top fur producing areas in the world. The muskrat was the primary reason for this position. Muskrats reach highest populations in brackish marshes where three-cornered grass often produces extensive stands. The current population of muskrat in the marshes adjacent to the MR-GO is low. Nutria populations are usually much higher in fresh marshes than in the brackish marshes, but the brackish marshes of the MR-GO area tend to have an over-abundance of nutria. Mink populations are greater in areas where brush piles, scrub/shrub vegetation, or other forms of cover are abundant. The dredged material disposal areas along the MR-GO provide excellent mink habitat, along with numerous potential den sites. During the construction and past maintenance of the MR-GO, the dredged material was placed along portions of the south bank of the MR-GO. This has created abundant upland habitats for white-tailed deer, swamp rabbits, and wild hogs.

Species of waterfowl which provide hunting opportunities include gadwalls, blue-winged teal, green-winged teal, mallards, mottled ducks, widgeon, and lesser scaup. The mottled duck is the only duck commonly nesting in the area. No wading bird nesting colonies are known to exist in the MR-GO area; however, birds such as ibises, herons, egrets, shorebirds, rails, bitterns, and skimmers are common inhabitants of these marshes.

Fisheries. Recreationally and commercially important finfish and shellfish in the waters of the area include brown shrimp, white shrimp, blue crabs, oysters, menhaden, red drum (redfish), spotted seatrout (speckled trout), black drum, striped mullet, Gulf flounder, Gulf kingfish, and Atlantic croaker. Some of these species (spotted seatrout and black drum) spawn in the MR-GO and in the deep bayous which enter the MR-GO. However, most estuarine species spawn offshore, and the larvae migrate either freely or by currents into the estuarine marshes. Once inshore the larvae reside in the saline, intermediate, or brackish marshes depending on the species' salinity tolerance and food availability. The interface between the marsh and the water's edge creates a habitat where larval and juvenile fishes can find cover, food, and favorable environmental conditions (water depth, temperature, dissolved oxygen, current speed, and turbidity). The interior marsh provides a stable habitat which resists fluctuating water levels, salinity, temperature, and water movement.

This stable nursery habitat allows species to maintain their position in the estuary until they become adults. The larvae of many species which spawn during the fall and winter months remain in the estuary throughout the spring and summer months. During the warmer months, larval and juvenile fish and shellfish species experience the most rapid growth. The marshes are critical to the successful completion of the life cycle of these species. Additionally, the detritus provided by these marshes forms the basis of the food chain for many fish and shellfish species.

The shallow estuarine open water pond habitat along the MR-GO provides an interior habitat essential to fish, shellfish, and wildlife species. This area represents the nursery habitat for estuarine-dependent species which utilize shallow open water for nursery grounds. Fish species such as menhaden favor shallow open water to flooded marsh for nursery grounds in their larval and juvenile life stages. Much of the shallow estuarine open water offers refuge to fish, crabs, and shrimp when the water level drops causing these species to retreat from the flooded marsh to the remaining open water.

Many of the shallow estuarine ponds are isolated from adjacent water bodies. These ponds resist the fluctuating water levels, salinity, and temperature reflected in the adjacent water body. The salinity and temperature extremes experienced in isolated ponds, due to evaporation, rainfall, and sun radiation, however, may be much greater than those experienced by ponds which are connected to the adjacent water bodies by small natural marsh channels.

The MR-GO channel has created an increase in the number of access points into the marshes for estuarine species. The increase in brackish marsh habitat has benefitted estuarine species, but the conversion of brackish and saline marsh to open water has reduced the amount of estuarine nursery habitat. Many larval fish and shellfish species travel this corridor from the Gulf of Mexico to the interior marsh habitats.

Erosion along the banks of the MR-GO has been caused by water movement from tidal fluctuation and ship wakes. Bank erosion along the north bank of the MR-GO has increased the number of shallow estuarine marsh ponds which become directly connected to the MR-GO, further increasing the width of the channel. Interior marsh breakup is a result of increased water movement and subsidence. As the interior marsh breaks up, the amount of edge habitat available to estuarine species increases. However, as the breakup converts the interior marsh to open water, estuarine marsh habitat decreases.

Threatened and Endangered Species. Threatened (T) or endangered (E) species which might be found in the vicinity of the proposed action include the bald eagle (E), brown pelican (E), gulf sturgeon (T), Arctic peregrine falcon (T), and the Kemp's ridley (E), hawksbill (E), green (T), and loggerhead (T) sea turtles. These species may occasionally occur in the study area, but none is a permanent resident of the area. The American alligator, listed as a threatened species under the Similarity of Appearance clause of the Endangered Species Act, is commonly found in the less saline habitats of the study area.

Bald eagles might occasionally forage in the shallow water areas along the MR-GO, but none nests in the vicinity of the proposed project. The Arctic peregrine falcon might occasionally be seen in the project vicinity during winter migration. The brown pelican is a common resident of the coastal waters of Louisiana. Brown pelicans are expected to occur along the MR-GO during their feeding activities.

Gulf sturgeon have been recorded from Lakes Pontchartrain and Borgne and the rivers flowing into these lakes. Review of the scientific literature concerning the gulf sturgeon indicates that adults and juveniles may seasonally inhabit the portion of Lake Borgne in the vicinity of the proposed action.

Green sea turtles are occasionally observed in offshore waters of Louisiana and have been reported from inshore areas, west of the Mississippi River. Leatherbacks are apparently uncommon in the offshore waters of Louisiana, since very few strandings have been reported and live leatherbacks are seldom seen. They have not been reported from inshore waters of Louisiana. Kemp's ridley sea turtles appear to prefer habitats in the inshore areas of the Gulf of Mexico. Members of this genus are characteristically found in waters of low salinity, high turbidity, high organic content, and where shrimp are abundant. Kemp's ridleys in the Gulf of Mexico tend to be concentrated around the major river mouths, specifically the Rio Grande and the Mississippi. Kemp's ridleys do not nest in Louisiana. Prior to the dramatic decline in their population, they were quite common in Louisiana waters. The possibility exists that ridleys may occur in the vicinity of the proposed project. Hawksbill sea turtles do not nest in Louisiana, and the few sightings and captures that have been recorded from Louisiana waters have all been offshore.

Table 5 presents the basis for significance of resources in the study area, and Table 6 provides information on how Congress, government agencies and the public have recognized these resources.

Cultural Resources. In the past, various marsh types and cypress swamps were present in the study area. The subtropical climate of the study area is not significantly different from the area's climate in the past.

At present there are 30 known cultural resource locations along and near the MR-GO. These range in age from at least the Poverty Point period (1000 B.C.) to the Historic 19th Century. Sites range in type from shell middens to historic fortifications. One of these sites, Fort Proctor, is listed on the National Register of Historic Places, and several others have been determined eligible for inclusion in this National Register.

A boat and pedestrian survey of the MR-GO channel, dredged material disposal access canal, and disposal area retaining dikes was conducted in September and October 1978 (Wiseman, et. al., 1979). This survey located five new sites and five isolated finds. Three of the located sites were considered eligible for the National Register of Historic Places. In addition to the field survey, an extensive background literature search and review of previous archaeological work in the study area was conducted. Visits were made to many of the sixteen previously recorded sites located within one mile of the MR-GO. This survey covered the area immediately adjacent to the MR-GO channel and did not intensively survey the area located outside the then designated dredged material disposal areas.

Some researchers have felt that very few intact midden sites would be located in this coastal region, but this assumption has been proven invalid by a recent archaeological survey of a newly proposed dredged material disposal area located between the south shore of Lake Borgne and the MR-GO around the Bayou Dupre area (Earth Search, Inc. 1992). This survey not only located several previously unrecorded prehistoric sites, but also found significant intact prehistoric remains at three sites. All three of the sites were determined eligible for inclusion to the National Register of Historic Places.

Prehistoric and historic sites in the area tend to cluster around major bayous, relict channels, and along the shore of Lake Borgne. Analysis of the eastern side of the Mississippi River delta (St. Bernard) paleogeography suggests that while many sites in the area have probably been lost due to subsidence and alluviation, some intact sites still remain. Sites along the MR-GO cannot be considered in a vacuum, but rather must be seen in the light of the natural environmental and settlement systems of the times. The early establishment and continued importance of Shell Beach Bayou, Bayou Dupre, Shell Beach, and Doullut's Canal appear to have been due to their positions on main routes of travel between Lake Borgne and points west. This area remained favorably located with

Table 5. Attributes of Significant Resources in the Vicinity of the Mississippi River- Gulf Outlet

Resource	Ecological Attributes	Cultural Attributes	Esthetic Attributes
WETLANDS	Provide nursery grounds for larval and juvenile fishes. Detrital output is a basic element of the food web.	Estuarine-dependent fisheries support traditional extractive economy of coastal Louisiana.	Typical Louisiana coastal wetlands setting.
WILDLIFE	Study area is utilized by numerous species of wildlife.	Supports traditional consumptive recreational activities (hunting) as part of our cultural heritage.	Viewing wild animals in their natural setting is esthetically pleasing.
FISHERIES	Fish and shellfish provide food source for many levels of the food chain.	Fish and shellfish gathering activities are valuable part of our cultural heritage.	Esthetically pleasing to view waters with large numbers of fish.
THREATENED AND ENDANGERED SPECIES	Rarity enhances significance of these species.	N/A	Individuals enjoy viewing of rare and endangered species.
RECREATION RESOURCES	The recreational harvest of fish and wildlife is an important ecological component.	Association with outdoors is part of culture of area.	Outdoor recreational activities flourish in areas of high esthetic quality.
CULTURAL RESOURCES	N/A	Indicators of history and previous inhabitants.	Many cultural resources have high esthetic value.

Table 6. Recognition of Significant Resources in the Vicinity of the Mississippi River- Gulf Outlet

Resource	Institutional Recognition	Technical Recognition	Public Recognition
WETLANDS	Coastal Zone Mgmt. Act of 1972, Estuary Protection Act, Clean Water Act of 1977, EO 11990, EO 11988, Fish and Wildlife Coordination Act.	Habitat for 14 species of special emphasis (USFWS). Louisiana is losing about 30 square miles of marsh per year.	Environmental organizations and the public support preservation of this habitat.
WILDLIFE	Clean Water Act of 1977, La Water Control Act, Fish and Wildlife Coordination Act, Coastal Zone Mgmt Act of 1972, La State & Local Coastal Resources Mgmt Act of 1978.	USFWS, NMFS, LDWF, LDNR, & USACE recognize value of waterfowl and wading bird habitat.	Environmental organizations and the public support the preservation of habitat for waterfowl and wading birds.
FISHERIES	La Water control Act, Fish/Wildlife Coordination Act, Coastal Zone Mgmt Act of 1972, La State & Local Coastal Resources Mgmt Act of 1978, EO 11988, EO 11990.	USFWS, NMFS, LDWF, & USACE recognize value of fisheries and good water quality.	Environmental organizations and the public support the preservation of water quality and fishery resources.
THREATENED AND ENDANGERED SPECIES	Endangered Species Act, Bald Eagle Act.	USFWS, NMFS, LDWF, & USACE cooperate to protect these species, Audubon Blue List recognizes rare species.	Public supports the preservation of rare or declining species.
RECREATION RESOURCES	Land and Water Conservation Fund Act of 1965.	Many fishing and hunting man-days are provided in study area.	Public makes high demands on recreation areas.
CULTURAL RESOURCES	National Historic Preservation Act of 1966, Archaeological Resource Protection of 1979.	Sites are present in the vicinity of the proposed action.	Preservation groups support protection and enhancement of historical resources.

respect to several biotic zones for many centuries. The southeastern end of what is now the MR-GO became an important area for settlement from the Coles Creek period onward.

The area is especially rich in archaeological resources. William McIntire, who cored throughout the eastern delta as part of his research relating sites to delta development, discovered evidence of scores of sites having no surface expression. It should be recognized that any dredging activity and dredged material disposal beyond the current limits of the MR-GO channel have a high probability of uncovering buried cultural resources.

The known distributions of sites in the vicinity of the MR-GO suggest that certain sections are high probability areas for site occurrence. These are the Bayou La Loutre natural levees, Bayou Yscloskey, a probable distributary between Violet and Proctor Point, the junction of the GIWW and the MR-GO at channel mile 60 of the MR-GO, Bayou Pointe-en-Pointe to Grace Point, and the Shell Beach Bayou area.

Recreation Resources. The value of the MR-GO area for recreational resources is as high as the majority of coastal marshes. Numerous commercial boat launching areas that allow sportsmen access into the MR-GO and adjacent marsh areas are located in the vicinity of Yscloskey and Shell Beach. Consumptive recreational activities taking place in the study area include fishing, small game hunting, large game hunting, and waterfowl hunting, sport shrimping, and sport crabbing. Non-consumptive activities include boating, observation of nature and wildlife, and a minimal amount of water skiing.

The nearby state-operated Biloxi Wildlife Management Area is located north of the study area between Lake Borgne and Chandeleur Sound. Numerous bayous, sloughs, and potholes make this wildlife management area an excellent producer of fish, shrimp, and crabs; and good habitat for waterfowl. Besides hunting and fishing, other forms of recreation available include boating, crabbing, shrimping, skiing, and camping.

FUTURE WITHOUT-PROJECT CONDITIONS

The most probable future conditions if no Federal action is taken are estimated by projecting conditions that will prevail in the study area over the planning horizon, 2000 through 2050. The composite of these scenarios serves as the base condition to which all action plans were compared to assess the effects of each plan.

WATER RESOURCES

Future improvements in the treatment of wastewater before discharge to receiving waters are expected to more than compensate for anticipated increases in wastewater discharge rates. Consequently, future improvements to general water quality in the MR-GO are expected. The Bonnet Carré Freshwater Diversion Project was assumed to be in place under without-project conditions. This project would provide slight freshening in the the study area.

LAND RESOURCES

The buffering marsh between the MR-GO and Lake Borgne is eroding at approximately 15 feet per year, and this reach of the MR-GO north bank is dangerously close to being breached. However, only a 3.5-mile section of the MR-GO north bank includes erosion protection measures. Consequently, the vast majority of bank continues to erode rapidly. At the current average rate of bank retreat, approximately 55 acres of intermediate/brackish marsh, adjacent to the north bank of the MR-GO, are being converted to open water annually. MR-GO bank erosion, if left unchecked, will result in the loss of approximately 2,700 acres of coastal marsh between the years 2000 and 2050. The projected location of the MR-GO north bank by the year 2050 is shown on Plate 2.

As the marsh within the project area diminishes, significant losses to marsh dependent fish and wildlife species will also occur. Increases in water levels, resulting from the general rise in sea level and subsidence of the land will enlarge land/water interface, and accelerate saltwater intrusion. The precise effects of vessel traffic on channel erosion were not considered in this study.

ECONOMY AND HUMAN RESOURCES

In the future, the Port of New Orleans will likely continue to be a dominant factor in the economy of the New Orleans area and that of the state as a whole. The Port has added millions of dollars annually to the state's treasury and provided thousands of jobs through the many services needed to carry on domestic and foreign trade. Overall economic and employment growth in domestic and foreign trade activities in the study area are expected to continue. Fish and wildlife harvests and recreational activities are expected to decline as a result of habitat losses. Without the buffering effect of the marsh, developed areas adjacent to the study area would be more susceptible to flooding. The increased flood hazards would restrict growth in the affected area.

TRAFFIC PROJECTIONS

Deep-draft traffic using the MR-GO is expected to increase at a 3.6 percent rate between 1990 and the year 2000 (from Wharton Econometric Forecasting Associates, Assessment of Maritime Trade and Technology, 1983). (Deep-draft vessels, in the case of the MR-GO, are considered to be vessels with drafts greater than 18 feet.) It should be noted that the 20-year period 1967-1987 saw an annual increase of over 6 percent in MR-GO deep-draft tonnage.

FUTURE MR-GO CHANNEL MAINTENANCE

Future channel shoaling rates are directly related to future land loss rates. The land loss rates were discussed on page 28 under LAND RESOURCES.

Three reaches (mile 54 to mile 56, mile 38 to mile 43, and mile 23 to mile 30) of the north bank have been identified as having critical erosion trends. If erosion continues in these reaches without corrective action, loss of the buffering marsh will allow the open water areas of Lake Borgne and Breton Sound to merge with the MR-GO. Once the buffering marshes are lost, dredging frequency and quantities in the vicinity of the breached bank area will increase significantly. The navigation channel will be exposed to storms, currents, and less attenuated tidal action from the north and northeast. Attendant sedimentation and shoaling problems are expected to occur.

A similar situation currently exists in the Breton Sound reach between mile 15 and mile 20. This reach of the channel is exposed on the north and northeast and has an existing jetty on the south side only. Maintenance dredging records for this reach show a current average shoaling rate of 350,000 cu yd/mi/yr. Reaches where no jetties exist have shoaling rates that are considerably higher and average approximately 500,000 cu yd/mi/yr.

Analyses of past shoaling rates suggest that future maintenance dredging quantities between mile 23 and mile 60 could be approximately 50 percent greater than the current average annual quantity. The current average annual maintenance dredging requirement is between 2.7 and 2.8 million cubic yards per year. However, with the loss of the marsh buffer between the MR-GO and the open waters of Lake Borgne and Breton Sound, the average annual maintenance requirements are expected to reach approximately 4.0 million cubic yards per year by the year 2000.

ENVIRONMENTAL RESOURCES

Wetlands. The eventual loss of the buffering marsh adjacent to the MR-GO north bank will increase occurrences and the duration of periods of saltwater intrusion into the marsh surrounding Lake Borgne and that of the Biloxi State Wildlife Management Area. This would represent a significant loss of habitat to those species utilizing these marshes. The breaches through the marsh between Lake Borgne and the MR-GO and the greater amplitude of Breton Sound influences in the Lake Borgne area will result in more rapid change of the adjacent marshes from a brackish to a saline vegetation type. The dominant vegetation species in the brackish marsh, saltmeadow cordgrass, would be displaced by the more salt tolerant species, saltmarsh cordgrass. Correspondingly, species utilizing the predominant vegetation of these brackish marshes will be deprived of their natural food sources as these changes occur. Therefore, the change in marsh fauna will be accelerated also.

Interior marsh breakup will occur as a result of increased water movement if the problem of bank erosion is not addressed. As the interior marsh breaks up, the amount of edge habitat available to estuarine species begins to increase, but after a point the breakup would convert the interior marsh to open water.

The elevation of scrub/shrub habitats would decrease as subsidence takes place. These areas would be more susceptible to saltwater inundation during high tides. Scrub/shrub communities consisting of a variety of species, including palmetto, wax myrtle, and live oak, would be dominated by marsh elder.

Future erosion in the MR-GO project area would disrupt the shallow pond habitat within the interior marsh. The shallow estuarine pond habitat would increase in size and become more directly connected with the surrounding water bodies as erosion takes place. Pond depths would increase as more organic sediments are transported out of the marshes into adjacent water bodies. Without the addition of sediment, subsidence would cause the existing marsh to sink and become open water pond habitat. The salinity within the shallow ponds would increase due to more frequent inundation by high salinity gulf waters. Submerged aquatic vegetation would probably die off as interior ponds, which are only affected now by rainfall, break through and become susceptible to tidal fluctuation.

Wildlife. In the future without the proposed action, some wildlife would be displaced from their native communities to more favorable environments. As banks erode, marsh animals will move to adjacent areas where higher elevations exist. The carrying capacities for most species will most likely decrease in the study area. Animals which prefer food sources in a brackish marsh will migrate to areas where lower salinities exist.

Desirable migratory waterfowl species feeding on submerged aquatic vegetation would be displaced by undesirable waterfowl species which feed upon fish. In areas where three-cornered grass is replaced by saltmeadow and saltmarsh cordgrass, the muskrat will continue to be replaced by the nutria, which has already taken place throughout most of the study area.

Fisheries. In the future without the proposed action, the loss of an estimated 2,700 acres of marsh over the 50-year project life would also cause a reduction, through habitat loss and reduced detrital input, in productivity of the overall area for both fish and shellfish. Fish species which favor isolated, low-salinity, back-water ponds would be displaced to other areas. Larval and juvenile crabs and shrimp, which seek cover in the nearshore marsh edge, will be forced to open water where they would easily be consumed by predators.

As the marsh breaks up and the number of access channels leading into the marsh increases, the amount of edge habitat available to estuarine species increases. Until a critical marsh acreage is reached, this increase continues even as the total marsh area declines. Once reached, both the edge habitat and acres of marsh would decrease very rapidly. Eventually complete conversion of marsh to open water takes place. Increased open water reduces the amount of estuarine marsh habitat available to recreationally and commercially important finfish and shellfish species.

The increase in width caused by the erosion of the banks of the MR-GO would reduce the amount of marsh acreage in the study area. Because the MR-GO provides a direct route for saltwater from the Gulf of Mexico into the estuarine marshes, the increased width would allow more saltwater to enter the marsh. This would affect the species composition of the vegetation, wildlife, and fisheries.

Most of the material which is dredged to maintain the MR-GO is material which was sloughed off from the banks. In the future without the proposed action, increased maintenance dredging would disrupt fish and shellfish species which use the MR-GO for an access route and for spawning habitat.

Threatened and Endangered Species. In the future without the proposed action, the effects of maintenance dredging on threatened and endangered species would increase as the required maintenance dredging increases. The decrease in brackish marsh habitat, which is very likely in the future without the proposed action, would reduce the amount of feeding habitat available to the bald eagle, Arctic peregrine falcon, and the American alligator. Increased saltwater intrusion into the MR-GO project area would encourage sea turtles to enter inshore waters where they might be susceptible to pollutants occurring near urban outfalls.

Cultural Resources. In the future without the proposed action, cultural resources would continue to subside, degrade, and probably be further altered by wave-wash produced by vessel movements.

Recreation Resources. In the future without the proposed action, conversion of wetlands to open water would continue. The loss of ecologically important wetland habitat translates into a less productive habitat area for those species sought after by sportsmen. Losses due to increased salinities would result in a loss in the preferred habitat of the area and, in turn, a loss in the man-day usage by sportsmen hunting and fishing the area.

PROBLEMS AND OPPORTUNITIES

Since its completion in 1968, the top width of the 41 mile long land cut increased from 650 feet to an average of 1,500 feet, in 1987, due to erosion. This erosion results in significant increases in the maintenance dredging cost of the MR-GO navigation channel and in significant adverse environmental effects associated with marsh loss. Much of the bank erosion is caused by wave-wash and drawdown from large displacement vessel traffic. As discussed on page 9 under Current MR-GO Channel Maintenance Requirements, the MR-GO channel was designed for a relatively small general cargo vessel (freighter). However, ship sizes have increased and larger container vessels move over the MR-GO. As the vessels pass, the tremendous forces exerted by rapid and extreme water level fluctuations cause the relatively soft marsh adjacent to the channel to break up and be swept into the waterway. In some areas the banks have eroded beyond the limits of the channel right-of-way.

The MR-GO was constructed in recognition of the need for a shorter and safer outlet from the Mississippi River to the Gulf of Mexico and for the potential benefit of national defense. Maintenance of the outlet channel is required to assure that these needs of the shipping industry and the national defense continue to be satisfied. Unabated bank erosion will substantially increase channel maintenance requirements. Controlling bank erosion will provide an opportunity to minimize channel maintenance requirements and allow the channel's purpose and function to remain unimpaired.

Marshes in the study area provide nursery grounds for many species of fishes; these marshes are also utilized by numerous species of wildlife. The most easily quantified biological resource problem resulting from bank erosion is the continuing loss of highly productive habitat. The diminution of fish and wildlife resources is a less easily quantifiable, but equally important, consequence of unabated bank erosion. Such losses, in an area where many depend on these resources for their livelihood, suggest a problem requiring urgent attention. Erosion of the channel banks caused an average loss of 211 acres of marsh per year during the 20 year period between 1968 and 1987. Most of the lost acreage is marsh/estuarine area along the north bank. Overall fish and wildlife productivity and recreational hunting in the study area have been significantly diminished by the loss of this approximate 4,200 acres of marsh.

Saltwater intrusion also contributes significantly to marsh loss in the study area. Subsidence and lack of sediment deposition affect marsh loss to a lesser degree.

Erosion and break up of the banks of the MR-GO has created many additional routes for saltwater to intrude into formerly less saline interior marshes. Consequently, salinity in the marshes has increased significantly in the last 20 years. High salinity levels of recent years have reduced the amount of three-cornered grass and, thus, muskrat populations in the marshes adjacent to the MR-GO. Other wildlife species that prefer less saline conditions have declined as well. Winter waterfowl populations within the marshes have also declined because of increased salinities. The less saline vegetation which is most attractive to waterfowl and the recreational value of the overall area for waterfowl hunting has been greatly reduced by saltwater intrusion.

Measures to reduce bank erosion to the extent practicable would in turn reduce the rate of saltwater intrusion and the rate which marsh adjacent to the channel would be lost. The reduction in marsh loss would contribute to the preservation of fish and wildlife species that rely on wetlands habitat during at least part of their respective life cycles. Similarly, structural measures that include the creation of new vegetated wetlands would contribute to the restoration of fish and wildlife species that have experienced attrition due to the eroding marshes.

Measures to minimize the rate of marsh loss and, in some areas, create marsh afford an opportunity to preserve and also partially restore fish and wildlife outputs in the study area.

Minimizing bank erosion and marsh loss affords an opportunity to avoid the potential disturbance and loss of known and yet unidentified sites of historic significance. Much of the immediate study area is considered to have high probability for cultural resource site occurrence. The exposure of significant sites by the eroding away of marsh allows wave battering and the elements to exact a potentially heavy toll in terms of irretrievable cultural resources losses. The desirability of preventing such losses is apparent.

The loss of recreation opportunities is not easily quantified, but is nonetheless an important and apparent consequence of unabated bank erosion. Minimizing bank erosion and marsh loss affords an opportunity to limit the loss of recreational opportunities. Controlling bank erosion and marsh loss will benefit recreationalists utilizing the marshes adjacent to the MR-GO and those that derive livelihood from servicing recreation activities in the study area.

It is apparent that the identified current and potential future channel maintenance, biological, cultural, and recreation resources problems all follow from the ongoing bank erosion occurring along the MR-GO. Opportunities available for solution of the bank erosion problem will, to varying degrees, provide redress of other erosion-related problems experienced in the study area.

PLAN FORMULATION

Plan formulation is the process of conceiving and developing specific plan features to satisfy specific objectives. Combinations of measures are then integrated to form comprehensive alternative plans. Alternative plans consist of systems of structural and/or non-structural measures, strategies, or programs. These strategies are selected to alleviate specific problems or take advantage of specific opportunities associated with water and related land resources in the study area. The objective of plan formulation during the reconnaissance phase is to develop at least one plan that is in the Federal interest and which a non-Federal sponsor would be willing to share both in the cost of the feasibility phase and in the implementation of a potential Federal project.

Alternative plans that address bank erosion abatement and other erosion-related problems were developed, in recognition of the planning objectives, using appropriate analytical techniques.

PLANNING CONSTRAINTS

Legislative and executive authorities specify the range of impacts to be assessed and planning constraints and criteria that must be applied when evaluating alternative plans. Tangible and intangible benefits and costs, as well as effects on the ecological, social, and economic well-being of the region, are considered in developing plans. In the evaluation of benefits and costs of a water resources project, the benefits attributable to measures included in a project for the purpose of environmental quality, including improvement of the environment and fish and wildlife enhancements, shall be deemed to be at least equal to the costs of such measures (ER 1105-2-100, para. 4-36(d)). Therefore, Federal participation in a solution to an identified water resources problem requires that the monetary and non-monetary benefits associated with a project equal or exceed its costs. Additionally, plans must be complete, efficient, safe, environmentally acceptable, and consistent with local, regional, and state plans.

PLANNING OBJECTIVES

Planning objectives are the national, state, and local water and related land resource management goals to redress needs specific to a study area. These specific needs may be addressed under a given study authority. The following objectives have been developed based on the identified problems and opportunities, and the expressed concerns of public, state, and local interests:

- control bank erosion to minimize channel maintenance requirements,

• reduce the rate of loss of valuable coastal wetlands adjacent to the MR-GO channel, and

• restore, to the extent practicable, wetlands previously converted to open water as a result of bank erosion and saltwater intrusion.

PLAN FORMULATION RATIONALE

Both structural and non-structural measures were considered for reducing bank erosion and/or restoring adjacent wetlands along the MR-GO. Structural measures included the construction of bank protection structures, such as rock dikes, along the channel; and the enlargement of the channel to increase its cross-sectional area. Each of these measures would reduce effects of wave draw-down and subsequent run-up caused by deep-draft vessels. The bank stabilization measures would also provide a means for protecting maintenance dredged material to facilitate the creation of wetlands.

Non-structural measures include the closure of the MR-GO navigation channel to deep-draft navigation and the imposition of speed limits on vessels using the channel. Both of these non-structural measures would significantly reduce the erosion and thereby the maintenance requirements of the navigation channel, and would reduce the loss of wetlands, but they would not restore or facilitate the restoration of wetlands along the MR-GO navigation channel.

These structural and non-structural plans and the rationale on whether they were addressed further during the reconnaissance phase are discussed below.

STRUCTURAL MEASURES

Bank Protection Structures. Bank protection structures, such as rock dikes, could be constructed along limited reaches of the MR-GO navigation channel or along the entire channel. These structures could preclude most of the wave run-up and subsequent draw-down that causes the erosion of the channel bank and the associated higher maintenance dredging requirements and wetlands loss along the channel. They would also assist in the retention and protection of dredged material for creating wetlands by protecting the earthen dikes that will be constructed to retain dredged material during normal scheduled maintenance. Since bank protection structures address all three planning objectives and would not adversely affect navigation, they were further evaluated to determine their potential feasibility.

Enlargement of the MR-GO Navigation Channel. The enlargement of the cross-sectional area of the critical reaches of the MR-GO navigation channel would reduce the height of the wave pushed up in front of deep-draft vessels and thereby reduce the effects of vessel movements on the erosion of the banks of the MR-GO along these reaches. Because this measure would only partially address the planning objectives of reducing maintenance dredging and reducing the loss rate of wetlands and would not address the third objective of wetland restoration, it was not considered further.

NON-STRUCTURAL MEASURES

Closure of the MR-GO. The MR-GO could be closed to deep-draft vessel traffic which would address the bank erosion and consequent loss of wetlands resulting from vessel-generated wave wash. If this channel were closed to deep-draft traffic, the alternative courses of action would include 1) diverting this traffic to the Mississippi River, 2) diverting this traffic to an alternative port, and 3) constructing a deep-draft lock to connect the Mississippi River and the existing facilities along the MR-GO. In 1989, New Orleans District prepared an analysis of the economic feasibility of continued channel maintenance. Based solely on the costs of continued maintenance and the costs associated with the three alternatives, continued channel maintenance is economically justified as shown below; additional information is provided in Appendix C.

Option	Average Annual Cost ($1,000)
Continue Channel Maintenance	$9,319
Divert Traffic to Mississippi River	$13,384
Divert Traffic to an Alternative Port	$15,140
Construct a Deep-Draft Lock	$89,692

This option would not restore or facilitate the restoration of wetlands along the MR-GO navigation channel. Additionally, this option would not be supported by the navigation interests, the potential local sponsor for feasibility phase studies of this problem. Therefore, this alternative was not considered further in this reconnaissance phase study.

Speed Limits on Vessels. A speed limit alternative imposing a 10 mile per hour speed limit for large displacement vessel traffic within the 37 miles between mile 60 and mile 23 was previously evaluated. Currently, vessel transit speeds average about 14 miles per hour in this reach of the channel. A 10 mile per hour speed limit would diminish the wave-wash and drawdown effects produced by large displacement vessels that cause erosion of the unprotected channel banks.

Costs associated with this plan include increased vessel operating cost due to a reduction in average transit speed and speed limit enforcement costs. However, only vessel operating costs were considered in the evaluation of this plan.

Benefits of the speed limitation include the following:

- increased safety for small commercial and recreational craft
- reduced wave activity, and thus, a reduction in the rate of bank erosion and rate of marsh loss
- savings in average annual maintenance dredging for at least a portion of the planning horizon-2000 to 2050.

Shippers would face higher operating costs if forced to observe a speed limit of 10 statute miles per hour along the 37 mile portion of the waterway under study. For the without-project (i. e., no speed limit) condition, transit time for vessels averaging 14 statute miles per hour is 2.6 hours. Under with-project conditions (i. e., with a 10 mph speed limit), the transit time would be increased to 3.7 hours, a difference of 1.1 hours. Based on these data, the total incremental annual costs to shippers should a 10 mile per hour speed limit be imposed would be on the order of $2 million (with enforcement cost not quantified). Because this measure would only partially address the planning objectives of reducing maintenance dredging and reducing the loss rate of wetlands and would not address the third objective of wetland restoration, it was not considered further in this reconnaissance phase study. Additionally, this option would not be supported by the navigation interests, the potential local sponsor for feasibility phase studies of this problem. However, it is practicable to consider speed limit restrictions on vessels either separately or in combination with structural measures during the follow-on feasibility phase.

DEVELOPMENT AND DESCRIPTION OF PLANS

PLANS CONSIDERED FURTHER

As discussed in the plan formulation rationale section, bank protection structures were the only measures considered further in this reconnaissance phase study. Alternative locations of bank protection structures along the MR-GO were developed; alternative structural designs for the plans were developed, evaluated, and screened; and alternative plans were formulated and evaluated based on the results.

ALTERNATIVE BANK PROTECTION PLANS

Four options were developed for the protection of the banks along the MR-GO. A slight variation on one of the options was also considered; therefore, a total of five plans was evaluated. Each of the alternative plans was similar except for their location and the time frames for implementation. Each plan provided for the construction of a similar rock dike section along the -3-foot National Geodetic Vertical Datum (NGVD) contour of the MR-GO channel and for the placement of dredged material behind the dike during maintenance dredging of the MR-GO. The placement of earthen material specifically dredged to fill behind the rock dikes was considered as a feature of each plan, but was eliminated due to its high cost. The plans, their locations, and implementation times are described below. More detailed information on the rock dikes is presented in subsequent sections.

• Option 1--MR-GO Critical Reaches. Option 1 provides for bank protection for three reaches along the MR-GO which have been designated "critical" based on the potential for eminent loss of the buffering marsh between the MR-GO and Lake Borgne. They also include the most frequently maintenance dredged sections of the inland portion of the waterway. These reaches total about 10 miles and would take about one year to construct. Reach 1 extends approximately 2 miles along the north bank from mile 56 to 54. Structural protection was recently constructed along the north bank between miles 54 and 51. The second reach extends a total of approximately 3 miles along the north bank from mile 43 to mile 38.5 with a 1.5-mile gap between miles 40.5 and 39. The third reach extends from mile 29.5 to mile 23 with a 1.5-mile gap between miles 28.5 and 27. Bank protection would be placed on the north bank from mile 29.5 to mile 28.5 and on the south bank from mile 27 to mile 23. The critical reaches are indicated on Plate 3.

• Option 2--MR-GO North Bank mile 60 to mile 27, South Bank mile 27 to mile 23. Option 2 provides for the construction of bank protection dikes along the unprotected length of the north bank between miles 60 and 27, and the south bank from mile 27 to 23. The reason for locating the structure along the south bank for this 4-mile section is that for this reach the channel is significantly deeper along the north bank and the cost of placing a structure here would be correspondingly higher. The north bank currently has protection constructed from mile 54 to 51. Structural bank protection would be provided for a distance of roughly 34 miles as indicated on Plate 4. This option would take 5 years to construct. The bank protection structure would parallel the current bank as much as possible. Major streams and bayous would remain open; however, many small waterways which enter the marsh areas on the north bank of the MR-GO would be closed.

• Option 3--All Unleveed Reaches of the MR-GO. Option 3 would provide for the construction of bank protection structures along the north bank of the MR-GO from mile 60 to mile 23, with the exception of miles 54 to 51 which already have structural protection in place, and along the south bank from mile 47 to mile 23. This plan would essentially provide bank stabilization measures along both banks along the entire length of the MR-GO where erosion problems exist. The location of option 3 is shown on Plate 5. This option would take eight years to construct. The unleveed MR-GO south bank, from mile 47 to mile 23 fronts a dredged material disposal area which parallels the channel and is approximately 2,000 feet deep and approximately 6,000 total acres in area. Bank erosion on the south bank in this reach is less severe than on the north bank. The lower erosion rate of bank relative to the north bank results from the periodic placement of dredged material in the south bank disposal area. Because the northern side of the channel is significantly deeper from mile 27 to mile 23, an Option 3A which would not include structural protection along these four miles of the north bank was also evaluated.

• Option 4--MR-GO North Bank mile 60 to mile 27. This option would be the same as the north bank portion of Structural Option 2 and would take 5 years to construct. Option 4 would not include protection along the south bank. This option was considered because, although protecting miles 27 to 23 of the south bank would reduce the channel shoaling rate, it would not contribute to the reduction in marsh loss rates due to the distance between existing marsh and the channel bank in this area (Plate 6).

DESIGN OF BANK PROTECTION STRUCTURES

Five alternative bank protection structures were developed for this study. Each provided for the construction of a rock or a concrete block/rock dike adjacent to the bank of the MR-GO. Information on the development of the various designs is presented in the following paragraphs. For this reconnaissance-scope analysis, the alternative designs were evaluated and screened solely on the basis of cost-effectiveness. The engineering and design, construction, and maintenance costs for each alternative structure were converted to an equivalent present value, using the current interest rate for water resources development projects, to determine the most cost-effective design. Each of the designs was assumed to provide the same level of bank protection; therefore, the benefits associated with reduced channel maintenance, and the restoration and protection of wetlands were assumed to be the same.

Wind and and Wave Design Considerations. Wind-generated waves were found to be limited by the width of the channel except during extreme storm conditions such as hurricanes. By observation, it was determined that ship waves would control and that a 4.0-foot wave was appropriate for design conditions. Ships create large drawdowns with resulting return flows and are thus the most severe design criteria. These waves occur during normal stages and weather conditions along the MR-GO. Observation of large ships transiting the channel shows that the drawdown approaches 4 feet below the existing stage and that the return flow produces a rise in the existing stage of 2 feet. The total effect of the transverse ship wave which is perpendicular to the ship is a 6-foot change in water level traveling at about the speed of the ship. This produces velocities approaching 18 to 20 feet per second. Using the 4-foot wave criteria traveling along the stern of the ship in an oblique angle in a series of waves or using velocity criteria created by the transverse 6-foot ship wave (drawdown and return flow) will require graded stone design with a median weight of approximately 400 pounds.

Two of six structural designs previously tested showed satisfactory results. However, protection constructed along the south bank of the MR-GO using one of the two designs deteriorated rapidly. A heavier stone was used to maintain the dikes and has not exhibited excessive deterioration. This gradation of stone armor protection is recommended for revetment or dike construction and is listed below in Table 7. This gradation would require an armor thickness of 3 feet.

Table 7. Recommended Gradation of Stone Armor Protection for Dike Construction

Percent Lighter By Weight	Weight (in pounds)
100	900-2200
50	440-930
15	130-460

<u>Dike Alignment and Other Considerations</u>. The alignment of bank protection will be as parallel to the channel as practicable and will generally follow the -3.0-foot NGVD contour. All alternatives will require the excavation of a flotation channel to facilitate construction. They will also require settlement plates/marker pipes every 500 feet on center and at all points of inflection (P.I.'s). All alternatives presented include allowances for construction settlement and tolerance. A shell substitute, with similar lightweight properties, will be allowed whenever shell is specified.

The placement of dredged material from channel maintenance operations is a feature of each design. There are no increased costs associated with depositing material from maintenance dredging behind the bank protection structure in lieu of in the existing disposal areas. The typical marsh elevation along the MR-GO is approximately 1.5 feet NGVD. Dredged material would be placed to an elevation of 4.0 feet NGVD to allow for settlement to the existing marsh elevation.

Navigation gaps would be provided in the bank protection structure at the locations of major waterways, such as Bayous Dupre, Bienvenue, and Yscloskey. Wave action and surges from passing vessels will be transmitted into these natural bayous and material may be drawn into the MR-GO through the openings. Small waterways which enter the marsh would be closed off, but major streams and bayous would remain open so that some tidal exchange would occur.

Maintenance. To maintain the dike crown elevation, the dike will be supplemented 2 years after initial construction is completed because rapid settlement is anticipated. Subsequent maintenance will be based primarily on settlement rather than hydraulic (wave or flow-related) losses. The remaining maintenance cycles would be at years 5, 10, 20, 30, and 40 after initial construction. Total project life would be approximately 50 years.

The alternative bank protection structure designs are described below:

- Design 1. Concrete Block/Rock Armor High Profile Dike. This design includes the installation of a foundation filter fabric, placement of a shell core to an elevation of 2.0 feet National Geodetic Vertical Datum (NGVD) and covered by a separator filter fabric, and placement of a concrete block mat covered by a 3-foot armor stone layer (to elevation 5.0 feet NGVD). A design cross-section is shown on Plate 7.

- Design 2. Concrete Block/Rock Armor Low Profile Dike. This design is similar to Design 1, except that the crown of the dike will be to an elevation of only 2.5 feet NGVD. A design cross-section is shown on Plate 8.

- Design 3. All Rock-Armored Dike. This design includes the installation of a foundation filter fabric and placement of armor stone with a crown elevation at 3.0 feet NGVD. An internal filter fabric on the landside of the dike would prevent dredged fill from permeating through the dike. A design cross-section is shown on Plate 9.

- Design 4. Rock-Armored Shell Core Dike. This design includes the installation of a foundation filter fabric, placement of a shell core to an elevation of 2 feet NGVD, and placement of a 3-foot armor stone layer (to an elevation of 5 feet NGVD) over separator filter fabric. A design cross-section is shown on Plate 10.

- Design 5. Rock-Armored Shell Core Low Profile Dike. This design includes installation of a foundation filter fabric, placement of a shell core to an elevation of 0.0 NGVD, and placement of a 3-foot armor stone layer (to an elevation of 3.0 feet NGVD) over a separator filter fabric. A design cross-section is shown on Plate 11.

A summary of the analysis of the unit costs for the implementation and operation, maintenance, replacement, repair, and rehabilitation (OMRR&R) of the five designs is presented in Table 8. The most cost-effective was determined to be Design 5, the rock-armored, shell core low profile dike; therefore, it was selected as the basis for the development and evaluation of the alternative implementation plans. However, due to its low profile and minimum stone armor, the effectiveness of this design will require more scrutiny during the follow-on feasibility study.

Table 8. Cost Comparison of Alternative Structure Designs (in dollars per linear foot)

	First Cost [1]	OMRR&R Cost		Total Present Value [4]
		One Operation [2]	Present Value [3]	
Design 1	662	113	261	923
Design 2	591	56	130	721
Design 3	348	169	393	741
Design 4	688	149	345	1,033
Design 5	244	131	303	547

[1] First costs include construction costs, planning, engineering, and design costs, and supervision and inspection costs.

[2] Costs of each structure maintenance operation.

[3] Sum of present values of the costs of each structure maintenance operation conducted at years 2, 5, 10, 20, 30, and 40 based on an interest rate of 8-1/4 percent.

[4] Sum of the first cost (based on a 1-year implementation period) and the present value of maintenance.

COSTS OF ALTERNATIVE PLANS

A summary of the costs of each of the options considered is presented in Table 9. These costs are based on the construction of each of the plans (options) More detailed estimates of construction and real estate costs are presented in Appendixes D and E, respectively.

A cost estimate for a sixth design (Design 6) is provided in Appendix D for the relatively deep water reaches of the north bank between miles 23 and 27. This design, due to its high cost, is only practicable for this reach of the MR-GO and was used in Option 3 only.

Cost estimates include provisions to increase the current right-of-way by an additional 500 feet for construction of a bank protection structure and for placement of bank nourishment. Since including 200 feet of bank nourishment as a component of the initial structure construction would increase the various structure costs by from about 34 to 52 percent, bank nourishment during

Table 9. Summary of Costs of Alternative Plans
(In $1,000 Dollars)

	Option 1	Option 2	Option 3	Option 3A	Option 4
Base Year	2001	2005	2008	2008	2005
FIRST COSTS					
Real Estate	$109	$395	$668	$585	$356
Construction	12,900	43,860	131,860	69,660	38,700
Total First Cost	$13,009	$44,255	$132,528	$70,245	$39,056
Gross Investment 1/	$13,017	$52,857	$195,352	$95,125	$45,718
ANNUAL COSTS					
Interest	$1,074	$4,361	$16,117	$7,848	$3,772
Amortization	21	84	312	152	73
OMRR&R	1,356	5,470	19,575	9,892	4,725
Total Avg. Ann. Cost	$2,451	$9,915	$36,004	$17,892	$8,570

1/ Gross Investment includes Total First Cost plus Interest During Construction

construction does not appear to be feasible. The same objective will be accomplished at less cost by the productive use of material from periodic channel maintenance.

Project costs were analyzed with the cost of real estate easements, necessary for the first year of construction, incurred at the end of January of the first year of construction. Each option under study involves a similar amount of construction in the first year. All other real estate costs were assumed to be incurred at the end of the first year of construction.

Construction costs were proportioned according to the number of miles of construction which is scheduled to take place each year, as a proportion of the whole length of construction in miles.

In most cases, operation and maintenance and all other costs are discounted from the end of the year.

MAINTENANCE DREDGING QUANTITIES

Potential average annual maintenance dredging quantities under with- and without-project conditions are shown on Table 10 for each of the plans evaluated. These data provide a measure of the average annual quantities of material expected to be available for use as bank nourishment. It should be noted that a cubic yard of dredged material is not equivalent to a cubic yard of bank nourishment. Typically, pumping three to five cubic yards of dredged material might be required to obtain one cubic yard of relatively well drained material for bank nourishment. The MR-GO was used as borrow material for construction of the Lake Pontchartrain and Vicinity Hurricane Protection levees. This was considered when historical data were evaluated to determine future annual maintenance dredging requirements.

EVALUATION OF ENVIRONMENTAL EFFECTS OF PLANS

INTRODUCTION

As discussed in the preceding sections, several alternative bankline protection plans along the MR-GO have been evaluated in order to address the specific problems, opportunities, and planning objectives identified for this study. These plans consist of variations in both length of channel bank they protect (option) as well as the type of structure (design). The designs consist of various combinations and elevations of a filter fabric foundation, shell core, filter stone layer, armor stone layer, concrete block mat, and a separator filter fabric. For the purposes of this reconnaissance study, the environmental impact of each of the designs would be similar, except that some designs have a slightly larger

Table 10. Estimated Average Annual Maintenance Dredging Quantities

Reach	Length	Remarks	Present Without Project	Future Without Project	(----Future With Bank Protection 1/ 2/ Option 1 Critical Reaches	Option 2 North Bank and Partial South Bank	Option 3 North and South Banks	Option 3A North and South Banks	Option 4 North Bank ----)
56 to 60	4	non-critical	260,000	325,000	232,000	92,000	92,000	92,000	92,000
54 to 56	2	transitional	130,000	162,500	90,000	20,000	20,000	20,000	20,000
52 to 54	2	reach no. 1	130,000	162,500	26,000	26,000	26,000	26,000	26,000
51 to 52	1	transitional	65,000	81,250	45,000	10,000	10,000	10,000	10,000
47 to 51	4	non-critical	260,000	325,000	192,000	52,000	32,000	32,000	52,000
45 to 47	2	non-critical	100,000	125,000	86,000	16,000	16,000	16,000	16,000
43 to 45	2	transitional	100,000	125,000	82,000	12,000	12,000	12,000	12,000
42 to 43	1	reach no. 2C	50,000	62,500	6,000	6,000	6,000	6,000	6,000
41.5 to 42	0.5	transitional	25,000	31,250	20,500	6,000	3,000	3,000	6,000
40.5 to 41.5	1	reach no. 2B	85,000	106,250	23,000	23,000	18,000	18,000	23,000
39 to 40.5	1.5	transitional	127,500	159,375	52,500	9,000	9,000	9,000	9,000
38.5 to 39	0.5	reach no. 2A	42,500	53,125	11,500	11,500	9,000	9,000	11,500
38 to 38.5	0.5	transitional	42,500	53,125	17,500	3,000	3,000	3,000	3,000
30 to 38	8	non-critical	680,000	850,000	448,000	136,000	48,000	48,000	136,000
29.5 to 30	0.5	transitional	42,500	53,125	25,000	5,500	4,000	4,000	5,500
28.5 to 29.5	1	reach no 3B	85,000	132,813	23,000	23,000	10,000	23,000	23,000
27 to 28.5	1.5	transitional	127,500	239,063	75,000	31,500	16,500	31,500	31,500
23 to 27	4	reach no. 3A	400,000	1,000,000	624,000	624,000	224,000	624,000	1,000,000
Totals1	37		2,752,000	4,047,000	2,079,000	1,106,000	558,000	986,000	1,482,000

1/ Dredging quantities are in cubic yards. Totals are rounded to the nearest 1,000 yards.

2/ These rates are assumed to be achieved at the end of the construction period and maintained through the project life for each option.

footprint than others and that low level dikes would be more susceptible to wave overtopping than high level dikes. Among the alternatives, the environmental effects of the plans vary mostly by the length and location of bank they protect (option). Generally, the greater the extent of bank protection provided along the north bank, the greater the environmental beneficial effect. Bank protection along the south bank, while reducing erosion, does not provide significant environmental benefits. Nevertheless, the potential adverse environmental impacts of dike construction on either the north or south banks appear to be insignificant. A more detailed discussion of environmental effects and benefits is provided in Appendix B--Preliminary Environmental Evaluation.

For each alternative, the alignment of the bankline protection would be parallel to the channel and would follow the -3.0 foot NGVD contour. If necessary, flotation channels would be excavated between this contour and the MR-GO channel for barge access to place the rock. Bankline protection would prevent existing marsh from being eroded into the MR-GO. Approximately 18 acres of marsh on the north bank would be saved per mile of protection every 10 years. During future maintenance dredging, dredged material would be selectively placed between the eroded north bank and the bankline protection structure. This would create an average of 18 acres of marsh per mile of protection along the north bank of the MR-GO.

The overall effect of implementation of bank erosion abatement measures would be overwhelmingly positive. The measures would substantially reduce erosion and marsh loss and allow for restoration of marsh with dredged material during maintenance of the channel. Some minor adverse impacts are possible; for example, where structural bank protection measures are discontinuous, erosion could be intensified due to wave diffraction from the structures. During the feasibility phase study, consideration will be given to engineering the ends of the bank protection structures to counter this effect and reduce other potential adverse impacts.

WATER QUALITY

The implementation of bank erosion reduction measures along the MR-GO is not likely to significantly alter general water quality conditions. Temporary increases in turbidity and suspended solids concentrations would occur during construction. Temporary pH changes and dissolved oxygen deficits might also occur during construction. The future condition of the stabilized banks would significantly reduce rates of erosion, and result in lowered amounts of nonpoint pollution from that source, thereby improving water quality.

WETLANDS

The proposed alternatives would affect wetlands by reducing the current rate of bankline retreat which averages 15 feet per year. Bank protection would save approximately 18 acres of wetlands, per mile of protection, every 10 years. Dredged material would be selectively placed between the eroded north bank and the bankline protection structure. This would create an average of 18 acres of wetlands per mile along the north bank of the MR-GO and would partially alleviate the problem of subsidence.

Erosion of wetland habitats would not take place as rapidly because the bankline protection would reduce the water movement caused by diurnal tides, wind driven tides, and ship wakes. Subsidence of these wetlands would continue to occur, but not as rapidly because underlying sediments would not be lost to the MR-GO channel.

The deposition of maintenance dredged material would be beneficial to nourish the marsh and fill in open water areas. Although portions of the existing marsh would be covered by dredged material and the existing fauna buried or forced to evacuate the area, the additional sediment in this subsiding area would provide more diversity and increased habitat for a variety of species.

WILDLIFE

The proposed alternatives would directly benefit wildlife by reducing the current rate of bankline retreat. The reduction in bankline retreat would slow interior marsh break up and the conversion of wetlands to open water. Wildlife would benefit from the stabilization of brackish and saline marsh, as well as scrub/shrub habitats. Migratory waterfowl and wading birds, utilizing interior marsh ponds, would benefit from stabilized water levels and reduced saltwater inundation which would promote the growth of aquatic vegetation. The greater the extent of bank protection, the greater the beneficial effect on wildlife.

Interior marsh pond habitat would be partially isolated from fluctuating water levels caused by tidal and wind action because the bank protection would close off many of the small waterways which provide direct access to these interior ponds. Drastic salinity changes would be reduced and aquatic vegetation requiring low salinities would colonize. Many of the interior marsh ponds adjacent to the critical reaches could be dominated by freshwater from rainfall rather than saltwater from tidal fluctuation. Migratory waterfowl and wading birds, utilizing the interior marsh ponds, would benefit from stabilized water levels and the growth of aquatic vegetation.

Bankline retreat, that is occurring along the north bank of the MR-GO, causes scrub/shrub habitat to become marsh habitat and marsh habitat to become shallow open water habitat. The gradual reduction in habitats with higher elevations results from erosion and subsidence. Bank protection would retain sediments which would normally be carried into the MR-GO channel. Small waterways which enter the marsh would be closed off which would reduce the water movement, within the marshes and wetland habitats, caused by tidal fluctuation and ship wakes.

FISHERIES

The proposed alternatives would directly benefit fisheries by reducing the current rate of erosion of nursery fisheries habitat. The break-up of marsh and the conversion of marsh to open water creates more access routes, for larval and juvenile fishes, into the marsh. This process increases the nursery habitat available for estuarine species, but after prolonged marsh break-up and erosion, the amount nursery habitat decreases. Bank stabilization would reduce the bankline retreat rate which would slow interior marsh break-up and the conversion of wetlands to open water. Fisheries would benefit from the stabilization of brackish and saline marsh. Fish which utilize interior marsh ponds would benefit from stabilized water levels and reduced saltwater inundation. Fisheries access into nursery marsh habitats would be hindered by the closure of many of the small waterways which lead into the marsh; however, the reduction in water flow through the marsh would reduce the rate of marsh breakup and prolong the existence of the marsh.

Portions of the interior marsh pond habitat would be partially isolated from fluctuating water levels and saltwater influence. Drastic salinity fluctuations would be reduced and aquatic vegetation favoring lower salinities would colonize, creating cover for fish and shellfish species. Many of the interior marsh ponds would become isolated from estuarine species; however, the major streams and waterways would remain open for access by estuarine species. The construction of bank protection structures along the MR-GO would decrease the frequency of maintenance dredging and the associated minor turbidity increases. Less dredging corresponds to a decrease in the turbidity impacts to fisheries.

The construction of a bank stabilization structure would result in adverse impacts through coverage of existing benthic habitat. However, placement of rip-rap or similar materials would create numerous micro-environments similar to jetties that, particularly below the typical marsh level, are utilized by various marine organisms. Organisms using jetties commonly include the sea anemone, barnacle, and sea roach. Mollusks, such as periwinkles, slipper shells, dove shells, oyster drills, mussels, and oysters are present. Decapods, such as fiddler, hermit, stone, and blue crabs are common inhabitants of jetties. These organisms, which are all at an intermediate position in the marine food web, would be beneficially impacted by the rock placement as a construction feature. The excavation of flotation channels between the -3.0-foot NGVD contour and the MR-GO channel would disrupt benthic habitat for fish and shellfish species. The deposition of dredged material from the flotation channels would smother benthic habitat; however, recolonization would occur within a short period of time. The deposition of dredged material over a large area of open water would cause adverse impacts through coverage of existing habitat, but would also insure the existence of a quantity of the diminishing marsh resource and thus would be more positive than negative.

THREATENED AND ENDANGERED SPECIES

The proposed alternatives would benefit threatened and endangered species by decreasing the rate of bankline erosion and by improving wetlands habitat along the MR-GO. Bank protection would slow interior marsh break up and the conversion of wetlands to open water. Threatened and endangered species would benefit from the increased stabilization of brackish and saline marsh which act as productive feeding habitats for brown pelicans, Arctic peregrine falcons, and bald eagles.

While recognizing the possibility that some species of sea turtles forage in the proposed project area, the turtles should be able to escape any of the short term impacts that the project would produce. Short term impacts would include increased turbidity and a reduction in benthic habitat from the placement of the bankline protection and from the excavation of flotation channels. While these impacts could cause a temporary problem for benthic and planktonic organisms, mobile organisms such as sea turtles would be able to escape the area during dredging operations. Sea turtles are rare in Louisiana's inshore waters. Most reported occurrences of sea turtles in Louisiana are in offshore waters. The benefits of bankline protection include decreased shoaling rates and the creation of additional sea turtle foraging habitat from the placement of hard substrate along the bankline. Decreased shoaling rates correspond to less frequent dredging of the MR-GO. This would further reduce the minor potential for impacts on sea turtles and their prey items.

CULTURAL RESOURCES

Implementation of a structural alternative could affect existing and as yet unidentified cultural resources. Definition of project effects (both direct and indirect) must await selection of construction plans and impact zone definition. Project effects on Fort Proctor and other significant sites must be considered. The determination of whether project effects are adverse to cultural resources would be ascertained from construction plans and impact zones as well as cultural resource assessments of significance of archeological sites located in the project area. All cultural resource work will be conducted in consonance with Federal cultural resource laws and regulations such as the Natural Historic Preservation Act, as amended in 1992.

RECREATION RESOURCES

Alternatives that would reduce bank erosion or restore eroded marsh should benefit fish and wildlife and in turn, sport hunting and fishing activities that are dependent on marsh habitats. With the eventual placement of dredged material behind linear bank retaining dikes, marsh would be created. It is possible that areas would exist that would trap rainwater and form marsh impoundments of value to waterfowl and marsh-oriented wildlife. Development of these retaining dikes would reduce bank erosion and saltwater intrusion which are adversely affecting the recreational environment. Additional bank erosion and possible large breaches of the buffering marsh between the MR-GO and Lake Borgne would be prevented. Recreational hunting and fishing activities would benefit from the rebuilding of these productive marsh habitat types.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES

Based on a cursory review of aerial photography, the potential for the presence of hazardous, toxic, and radioactive waste (HTRW) along the MR-GO is low. While aerial photography reveals the presence of industry adjacent to the study area along the Inner Harbor Navigation Canal and in the Chalmette-Arabi area, no industry exists along the banks of the MR-GO in the areas where bank stabilization is proposed. These wetland areas do not appear to have historically undergone any industrial development. An initial assessment of HTRW will be conducted during the feasibility phase. The initial assessment will determine the likelihood of HTRW in the project area through an analysis of historical records, including any records of maritime accidents in the area which could have resulted in the release of hazardous, toxic, and radioactive wastes. The assessment will also include analysis of land use studies, and aerial photography.

BENEFIT CATEGORIES EVALUATED

This report contains an evaluation of benefits in three categories: maintenance savings, marsh creation, and marsh preservation. The monetary value of these benefits has been quantified and under the section EVALUATION OF ECONOMIC BENEFITS beginning on page 53. The non-monetary values of marsh creation and marsh preservation were also evaluated, and are described under the section entitled NON-MONETARY BENEFITS OF WETLANDS on page 51.

The maintenance savings were calculated simply by comparing with- and without-project maintenance costs. The monetary value of marsh creation and marsh preservation was taken from a previous study of coastal wetlands conducted by the U.S. Army Corps of Engineers, New Orleans District, entitled "Land Loss and Marsh Creation, St. Bernard, Plaquemines, and Jefferson Parishes, Louisiana" and dated May 1993. Non-monetary benefits for the creation and preservation of marsh were derived from the Wetland Value Assessment (WVA) procedure that has been developed by a team of Federal biologists. This procedure is a tool to determine the quality and quantity of wetlands protected or created by wetland restoration projects. Under this procedure, the quality and quantity of wetlands is displayed in Average Annual Habitat Units or AAHU's.

More details on the quantified non-monetary environmental benefits resulting from the alternatives are provided under the following sections of this report: NON-MONETARY BENEFITS OF WETLANDS (below) and Appendix B--Environmental Resources.

NON-MONETARY BENEFITS OF WETLANDS

Wetland Value Assessment. The Wetland Value Assessment (WVA) is a tool to determine the quality and quantity of wetlands protected or created by a wetland restoration project. It was developed by a team of Federal biologists led by the U. S. Fish and Wildlife Service. The following variables were assumed to characterize a typical marsh: percent vegetated wetlands, percent submerged aquatic vegetation, interspersion of marsh and water, percent equal to or less than 1.5 feet deep, salinity, and fishery access. A suitability graph for each variable expresses the relationship between the measured variable and a suitability index of 0 to 1.0. The suitability indices for each variable were then combined into a single value of habitat quality called Habitat Suitability Index (HSI). To determine the net benefits to vegetated wetlands, two scenarios, future conditions with and future conditions without the project, were compared. Predictions were made as to what model variables would be at various target years with and without the project. HSI were calculated for each target year for each scenario. These HSI's were multiplied by acres of the benefitted area to produce Habitat Units (HU's) for each target year. These HU's represent a combination of habitat quality (HSI) and quantity (acres). The HU's were annualized over the project life for each scenario, and then compared to determine the net benefit of the project in Average Annual Habitat Units (AAHU's). A detailed explanation of the calculations used by USFWS to compute AAHU's is contained in Appendix B.

The 1993 version of the WVA indicated that a net of 2,786 AAHU's would be produced by Options 2, 3, 3A, and 4, which protect at least 30 miles of bankline along the north bank of the MR-GO. As stated previously, the protection that

Option 3 would provide for the north bank from channel mile 23 to mile 27 would not preserve additional marsh. The WVA for Option 1 indicated that a net of 557 AAHU's would be created for 6 miles of bankline in the critical reaches of the MR-GO. These AAHU's represent a mixture of habitat quality and quantity.

Marsh Benefits. The greatest benefit provided by a marsh is probably the dead or decaying organic matter that is contributed to estuarine systems. Half of the organic matter, detritus, that is produced by a marsh is consumed within the marsh and half enters the water (Teal 1962, Golley et al. 1962). The detritus in an estuary can be separated into suspended material and material that has settled on the bottom, but this separation constantly fluctuates depending on the water turbulence (Day et al. 1973). In the case of the marsh along the MR-GO channel, this detritus eventually finds its way into larger inland water bodies and the Gulf of Mexico through the bayous and canals that drain the marshes. Studies have shown that biomass peaks of zooplankton, larval shrimp, and larval fishes are fueled by the high loss rate of detritus from the marsh (Kirby 1972). In the estuary and in the open gulf, productivity is increased in areas where detritus, carrying nutrients, enters the system. The entire food chain is dependent, in one way or another, on the marsh and the nutrients it produces.

Food Chain Benefits. Many of the lower trophic levels of the food chain are not measurable in terms of recreational, commercial, or esthetic contributions. The protection of wetlands and the creation of additional marsh along the MR-GO would contribute to the base of the food chain from which all higher trophic levels are dependent.

Wildlife Benefits. Migratory shorebirds, wading birds, ducks, and geese utilize marshes in the study area, enroute to northern breeding grounds and to Central and South American wintering grounds. Puddle ducks generally concentrate in fresh and intermediate marshes, although diving ducks prefer brackish and saline open water habitats. The only waterfowl species which is a permanent resident of the coastal marshes along the MR-GO is the mottled duck. Many nongame species of seabirds and wading birds, such as ibises, ospreys, hawks, and gulls establish nesting colonies in the brackish and saline marshes adjacent to the MR-GO. Bankline protection, which regulates the hydrological regime of an area, may seasonally diminish the abundance of some prey species and intensify both inter-specific and intra-specific competition for resources in adjacent unprotected bankline wetland areas.

Fisheries Benefits. The large expanse of saline, brackish, and intermediate marshes in the study area allows a buffer zone to develop between fresh water and high salinity gulf water where fish, shrimp, oysters, and crabs can find the proper salinity to live throughout their larval, juvenile, and sub-adult stages. The stability within the interior marsh provides a nursery habitat favorable to the production of estuarine organisms. Some species (spotted seatrout and black drum) spawn in the MR-GO and in the deep bayous which enter the MR-GO. The larvae of many offshore spawners (redfish, Atlantic croakers, blue crabs, and brown and white shrimp) migrate, either freely or by currents, into marshes to live and grow throughout their life stages. Marsh which is created along the MR-GO would prolong the abundance of certain species and create additional habitat for increased numbers of shrimp, fish, and crabs.

Other Environmental Benefits. Marshes provide hurricane and storm surge buffering capacity. Coastal wetlands absorb large amounts of wave energy and hold large quantities of water that would otherwise allow storms to do much more damage inland. The long-term climatic change which is expected to occur due to global warming will cause sea-level rising. Wetlands also provide natural flood control by detaining and by slowing floodwaters which reduces the intensity and destructiveness of flooding. Wetland vegetation anchors shorelines and reduces the amount of erosion that would normally take place along an unvegetated bankline.

EVALUATION OF ECONOMIC BENEFITS

METHODOLOGY

The period of analysis, or project life, used for each alternative is 50 years. Benefits and costs are discounted or compounded as appropriate to base years and then converted to average annual equivalent values using the current Federal discount rate of 8-1/4 percent. In every case, the first year of construction is taken to be the year 2000. Due to the different construction periods required for the various options, the base year for comparing them ranges from 2001 for Option 1 to 2008 for Options 3 and 3A.

Options 1, 2, 3, 3A, and 4 were analyzed first, in combination with each of the designs 1, 2, 3, 4, and 5. Design 6 was analyzed as part of Option 3 because it applied to a particular reach within the project area. As discussed in the previous section of this report, the most cost effective design was determined to be Design 5, the rock-armored, shell core low profile dike. Therefore, Design 5 was selected as the basis for evaluating the alternative implementation plans, and for the following presentation of economic benefits and costs. Supporting data for the economic benefit and cost analysis for the other designs are shown in Appendix D, Part II.

ECONOMIC BENEFIT CATEGORIES

The economic benefits analyzed are divided into three categories:

1) The monetary value of marsh saved from erosion by the reduction of wave action caused by passing ships.

2) The monetary value of marsh created on the north bank of the channel by placing dredged material on the marsh side of dikes.

3) Savings in maintenance dredging costs.

Due to the preliminary nature of this study, the monetary value of marsh created or saved by the plans was taken from the U. S. Army Corps of Engineers, New Orleans District's draft feasibility report entitled "Land Loss and Marsh Creation, St. Bernard, Plaquemines, and Jefferson Parishes, Louisiana" (LLMC), dated May 1993. A detailed reevaluation of marsh acre values will be conducted for the follow-on MR-GO feasibility study.

In the LLMC study, four components of marsh value were found to be readily quantifiable in economic (monetary) terms: commercial fisheries, real estate, recreation, and commercial wildlife. These four components make up the value of $4,471 used in the LLMC study for an acre of brackish marsh (1992 price levels). The value of saline marsh is similar. Commercial fisheries account for 87.4 percent of that value, commercial wildlife 1 percent, recreation 6 percent, and real estate accounts for 5.6 percent of the total value.

Table 11 displays the average annual marsh acres saved after construction is completed and the average annual value of this acreage.

The marsh acres created are specified in Table 12. The amount of open water available for marsh creation between the dike and existing marsh would average approximately 18 acres per mile of dike. For each channel reach the year marsh would be created is dependant on the year of the first required maintenance dredging of the reach subsequent to the dike construction. A lag time of two years was then applied to the first subsequent dredging cycle to account for the time it takes such land to become a fully functional wetland.

The savings in annual maintenance dredging costs which occur during and after construction are summarized in Table 13. Note in this table that the average annual dredging costs under without-project conditions are different for each option. The reason for the variation is as follows: 1) due to the varying lengths of construction periods, the base year ranges from 2001 for Option 1 to 2008 for Options 3 and 3A, 2) project lives are assumed to be 50 years subsequent to substantial completion of a project, in this case, the base year, 3) project costs and partial benefits that accrue from the first year of construction (2000) to the base year are compounded forward to the base year and included in the present values of costs and benefits for each option, 4) to keep the time frames of each option equal for comparison purposes, the without-project dredging costs between the year 2000 and the respective base year for each option are compounded forward to the base year and then amortized over the 50-year project life. Therefore, an increase in the project construction period increases the period of without project dredging compounded forward and the average annual without-project costs for that particular comparison.

A summary of total monetary benefits is in Table 14. Table 15 presents the totals of average annual costs and monetary benefits for Options 1, 2, 3, 3A, and 4. Note that in Table 15 the absolute value of the net benefits must be covered by the non-monetary benefits, in accordance with ER 1105-2-100, para. 4-36 (d) and Section 907, Public Law 99-662. The environmental value given to non-monetary project benefits is described in the succeeding sections of this report.

Table 11.

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH ACRES SAVED

RATE OF INTEREST= 8.25% 1992 VALUE PER ACRE= $4,471

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
ACRES SAVED PER YEAR AFTER CONSTRUCTION	10.8	54	54	54	54
AVERAGE ANNUAL VALUE	$48,287	$241,434	$241,434	$241,434	$241,434

Table 12

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH ACRES CREATED

RATE OF INTEREST= 8.25% 1992 VALUE PER ACRE= $4,471

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
SCHEDULE OF ACRES CREATED BY CONSTRUCTION & DREDGING WITH 2 YEAR LAG TIME					
YEAR					
2002	18	23.5	23.5	23.5	18.6
2004					74.5
2005	9				
2006		187.8	187.8	187.8	
2006	36				
2013		47.0	47.0	47.0	37.2
2015	18				
2017					28.0
2018	27				
2018		11.7	11.7	11.7	9.3
2019		35.2	35.2	35.2	28.0
2021		47.0	47.0	47.0	37.2
2022		35.2	35.2	35.2	
2023					9.3
2026					149.0
2026		93.9	93.9	93.9	74.5
2033		11.7	11.7	11.7	
2043					37.2
2048		47.0	47.0	47.0	37.2

Note: See next page for continuation of Table 12

Table 12 continued

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH ACRES CREATED

RATE OF INTEREST= 8.25% 1992 VALUE PER ACRE= $4,471

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
SCHEDULE OF DISCOUNTED ACRERAGE VALUES CREATED BY CONSTRUCTION & DREDGING					
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
YEAR BENEFIT IS TAKEN					
2002	$68,679	$123,006	$156,031	$156,031	$97,557
2004					$333,012
2005	$27,071				
2006		$716,646	$909,051	$909,051	
2006	$100,032		*		
2013		$102,861	$130,477	$130,477	$81,579
2015	$24,505				
2017					$44,707
2018	$28,978				
2018		$17,300	$21,945	$21,945	$13,721
2019		$47,945	$60,817	$60,817	$38,152
2021		$54,554	$69,201	$69,201	$43,267
2022		$37,797	$47,945	$47,945	
2023					$9,231
2026					$116,433
2026		$73,403	$93,111	$93,111	$58,217
2033		$5,268	$6,682	$6,682	
2043					$7,564
2048		$6,416	$8,139	$8,139	$5,508
TOTAL PRESENT VALUE	$249,265	$1,185,197	$1,503,398	$1,503,398	$848,948
AVERAGE ANNUAL VALUE	$20,963	$99,672	$126,432	$126,432	$71,394

* Benefits for this acreage do not begin to accrue to the project until two years after the marsh is created, due to the time needed for the marsh to become fully funtional. This marsh is created after the first dredging cycle in each reach on the north bank.

Table 13. Average Annual Maintenance Dredging Costs and Savings[1/]

	AVERAGE ANNUAL DREDGING COSTS W/O PROJECT	AVERAGE ANNUAL DREDGING COSTS W/PROJECT	AVERAGE ANNUAL DREDGING SAVINGS
Option 1	$4,865	$2,769	$2,096
Option 2	$6,722	$2,751	$3,971
Option 3	$8,541	$2,540	$6,001
Option 3A	$8,541	$3,368	$5,173
Option 4	$6,722	$3,278	$3,444

1/The without project average annual costs vary due to the different project period for each option. To keep the time frames equal to each option for comparison purposes, the without-project dredging costs between the year 2000 and the respective base year for each option are compounded forward to the base year and then amortized over the 50-year project life. Therefore, an increase in the project construction period increases the period of without-project dredging compounded forward and the average annual without-project costs for that particular comparison.

Table 14. Summary of Average Annual Benefits by Category
(1993 Price Levels, 8-1/4% Interest Rate)

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
Base Year	2001	2005	2008	2008	2005
SAVINGS IN AVERAGE ANNUAL MAINTENANCE DREDGING COSTS					
	$2,096,170	$3,970,672	$6,000,517	$5,172,993	$3,443,540
VALUE OF AVERAGE ANNUAL MARSH ACRES SAVED					
	$48,396	$241,979	$241,979	$241,979	$241,979
VALUE OF AVERAGE ANNUAL MARSH ACRES CREATED					
	$21,010	$99,897	$126,717	$126,717	$71,555
TOTAL AVERAGE ANNUAL BENEFITS					
	$2,165,576	$4,312,548	$6,369,213	$5,541,689	$3,757,074

Table 15. Summary of Average Annual Benefits and Costs (Design 5)

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
TOTAL AVERAGE ANNUAL COSTS					
	$2,451,000	$9,915,000	$36,004,000	$17,892,000	$8,570,000
TOTAL AVERAGE ANNUAL MONETARY BENEFITS					
	$2,166,000	$4,313,000	$6,369,000	$5,542,000	$3,757,000
NET MONETARY BENEFITS 1/					
	($286,000)	($5,603,000)	($29,636,000)	($12,351,000)	($4,814,000)
NET MONETARY BENEFITS--COMMON BASE YEAR (2010)					
	($584,000)	($8,328,000)	($34,728,000)	($14,473,000)	($7,156,000)

1/ The absolute value of the net monetary benefits reflects the magnitude of the average annual costs that must be covered by non-monetary benefits, in accordance with ER 1105-2-100, para 4-36 (d) and Section 907, Public Law 99-662.

CONSIDERATION OF A MORE AFFORDABLE PLAN--OPTION 4A

The purpose of considering this option is to evaluate a plan which would be more affordable to a potential non-Federal sponsor. This option would provide the same extent of channel protection as Option 4, that is the unprotected length of the north bank between miles 60 and 27. The north bank currently has protection constructed from mile 54 to mile 51. However, for Option 4A the planned construction period was extended from the 5 years scheduled for Option 4 to 10 years for this alternative. The base year would be 2010. As noted previously, Design 5 was determined to be the most cost effective design. A summary of the costs for this option is presented in Table 16.

Over the 50-year project life this option would reduce the average annual maintenance dredging cost by $4,367,000. As is the case with Option 4, implementation of Option 4A would result in the creation of 540 acres of marsh. Option 4A would preserve an additional 2,938 acres (including 238 acres preserved during the 10-year construction period) for a total of 3,478 acres of marsh created or preserved over the life of the project. As noted previously non-monetary benefits must cover the difference between total average annual project costs and total average annual benefits (see Table 15, page 59). The monetary benefits are summarized in Table 17.

Table 16. Summary of Costs for Option 4A, Design 5
(In $1,000)

FIRST COSTS

Real Estate	Construction	Total First Cost	Gross Investment
$356	$38,700	$39,056	$57,343

ANNUAL COSTS

Interest	Amortization	Operation & Maint.	Total Avg. Ann. Cost
$4,731	$92	$5,951	$10,773

Table 17. Option 4A, Design 5 Summary of Average Annual Benefits by Category

MONETARY BENEFITS	
Savings in Maintenance Dredging Costs	$4,367,200
Value of Acres of Marsh Saved	355,300
Value of Acres of Marsh Created	115,700
TOTAL MONETARY BENEFITS	$4,838,200
Rounded	$4,838,000

SUMMARY OF ECONOMIC AND ENVIRONMENTAL BENEFITS AND COSTS

The costs and benefits for a total of six options (Option 1, 2, 3, 3A, 4, and 4A) were evaluated to determine which, if any, should be carried over to a feasibility phase study. Each of the options would provide a degree of savings to maintenance dredging of the MR-GO navigation channel. Each of the options would also provide a degree of wetland restoration and preservation.

The monetary benefits due to maintenance savings as well as marsh restoration and preservation were analyzed. Since the marshes along the MR-GO channel also have an inherent non-monetary value, this value too was quantified. In order to measure the non-monetary quality and quantity of wetlands protected and restored by the plans, the Wetland Value Assessment (WVA) was used. Under the WVA, wetland values are expressed as Average Annual Habitat Units (AAHU's). These AAHU's were then compared to the average annual costs remaining after subtracting the value of the average annual monetary benefits. This remaining average annual cost is the cost that must be covered by non-monetary benefits. Table 18 displays a summary of the average annual cost, AAHU's , and cost per AAHU for the six plans.

The plans were then evaluated to determine: 1) the extent to which they would provide and account for all necessary investments or other actions to ensure the realization of planned effects, 2) the extent to which they would alleviate the problems of increased channel shoaling, maintenance dredging costs, and marsh loss, 3) the cost effectiveness of each plan in alleviating the specified problems and achieving the opportunities, and 4) their implementability in terms of identifying a local sponsor willing and able to share costs of further study and implementation of the recommended plan.

Table 18, Summary of Costs and Non-Monetary Benefits

Option	1	2	3	3A	4	4A
Partial Environmental Avg. Ann. Costs ($1,000)1/	$286	$5,603	$29,636	$12,351	$4,814	$5,935
AAHU's 2/	557	2,786	2,786	2,786	2,786	2,786
Partial Environmental Avg. Ann. Costs ($1)/AAHU	$510	$2,010	$10,640	$4,430	$1,730	$2,130

1/ Partial environmental average annual costs in this table reflect the absolute value of the net monetary benefits from Table 15, which is the magnitude of average annual costs that must be covered by non-monetary benefits.

2/ Except for Option 1, over a 50-year project life, each of the options considered would create an equal number of acres of marsh and would also preserve an equal number of acres of marsh. The time value of marsh is not considered in determining AAHU's; therefore, the length of the construction period does not impact the AAHU's that a project would generate.

Option 1 would provide protection along only 6 miles of the north bank of the MR-GO and would, therefore, only partially realize the objectives of reducing channel maintenance dredging costs and preserving the marsh. Options 3 and 3A would provide the most protection along the south bank. However, because of the distance between this bank and the existing marsh, the added protection would reduce the rate of channel shoaling but not increase AAHU's. Therefore, the cost per AAHU is significantly higher for these options.

Except for channel miles 27 to 23 along the north bank where structures would be prohibitively expensive due to the channel depth, Option 2 would provide a comprehensive solution to the problem of the eroding marsh. Deleting structural bank protection from miles 47 to 27 along the south bank would result in an increase in with-project channel dredging costs but no decrease in AAHU's provided by the project. Therefore, the cost per AAHU would be significantly less with this plan. Also, providing protection to the entire north bank from mile 60 to mile 27 would be more acceptable to local interests and provide the minimum desired magnitude of environmental outputs.

As noted previously, including protection along the south bank does not increase the AAHU's provided by an alternative. Therefore, Option 4 (no protection along the south bank) would provide the same environmental benefits as Option 2, 3, or 3A, but at a lower cost. This plan would be constructed over a period of 5 years and the first costs would be $39,056,000. The costs to a local sponsor payable over this period would be $5,858,000 (rounded). Therefore, Option 4A, which includes a 10-year construction period, was considered. The longer construction period would increase the cost of interest during construction and, therefore, the cost per AAHU. However, the payment during construction required of the local sponsor would decrease from approximately $1,172,000 to $586,000 per year. Table 19 shows the overall summary of economic and environmental benefits and costs.

REAL ESTATE SECTION

The most favorable plan, Option 4A, would require acquisition of a Rock Armored Structure Easement (also referred to as Bank Stabilization Easement in the cost estimates) and a Perpetual Disposal Easement. The Rock Armored Structure Easement would be placed on 912 acres of marshland on the banks of the Mississippi River Gulf Outlet; the Perpetual disposal Easement would be placed on 912 acres of adjacent marshland. Seventy ownerships are affected by construction of the project.

There are no improvements within the right-of-way. No compensable Interest Report has been written regarding utilities that may be located within the right-of-way. At this time, it is estimated that no P.L. 91-646 benefits are applicable.

The Real Estate Cost Estimates, the Initial Real Estate Cost Estimate report, and the Chart of Accounts are in Appendix E.

PRELIMINARY FINANCIAL ANALYSIS AND COST SHARING PROPOSAL

INTRODUCTION

As shown on Table 20, 40 percent of the quantifiable monetary benefits for Option 4 are due to savings in maintenance dredging costs for the MR-GO navigation project. Since the majority of the project monetary benefits are maintenance savings, and maintenance dredging costs of the MR-GO channel are borne 100 percent by the Federal government, a case could be made that the

Table 19. Summary of Economic and Environmental Costs and Benefits

Option	1	2	3	3A	4	4A [2/]
COSTS ($1,000)						
Total First Costs	$13,009	$44,255	$132,528	$70,245	$39,056	$39,056
Gross Investment	$13,017	$52,857	$195,352	$95,125	$45,718	$57,343
Total Average Annual Costs	$2,451	$9,915	$36,004	$17,892	$8,570	$10,773
BENEFITS ($1,000, unless otherwise indicated)						
Savings in Average Annual Maintenance Dredging Costs	$2,096	$3,971	$6,001	$5,173	$3,443	$4,367
Monetary Value of Average Annual Marsh Acres Saved	$48	$241	$241	$241	$241	$355
Monetary Value of Average Annual Marsh Acres Created	$21	$100	$126	$126	$71	$116
Total Average Annual Benefits	$2,165	$4,311	$6,368	$5,541	$3,756	$4,838
Net Monetary Benefits (Partial Environmental Average Annual Costs) [1/]	$286	$$5,603	$29,636	$12,351	$4,814	$5,935
Average Annual Habitat Units (AAHU's)	557	2,786	2,786	2,786	2,786	2,786
COST-BENEFIT COMPARISON OF NON-MONETARY ENVIRONMENTAL OUTPUTS						
Environmental Average Annual Costs ($1)/AAHU	$510	$2,010	$10,640	$4,430	$1,730	$2,130

1/ Partial environmental average annual costs in this table reflect the absolute value of the net monetary benefits from Table 15, which is the magnitude of average annual costs that must be covered by non-monetary benefits.

2/ The $1,082,000 difference in average annual benefits between Options 4 and 4A is partially due to the difference in base years (2005 for Option 4 and 2010 for Option 4A) and to $14,600,000 maintenance dredging required in 2009 under without project conditions. The lengthened construction period for Option 4A results in increased present worth for the acres of marsh saved and created during this period and also for the $14,600,000 without project dredging cycles.

feasibility phase study, project construction, and operation and maintenance of bank stabilization features should also be 100 percent Federal. However, at this point, project implementation cannot be assured based on the justification of maintenance savings alone; both monetary and non-monetary environmental benefits, as well as maintenance savings, are needed to justify further Federal involvement. Therefore, as described in the following section, it is proposed herein that cost sharing for the remaining phases of the project be based upon prorating the costs according to the project outputs of the most favorable plan identified in this report, as described in the following sections.

RECOMMENDED FEASIBILITY COST SHARING

The recommended feasibility phase cost sharing is based on the distribution of estimated project benefits for Option 4A. This plan is the minimum plan that is implementable and presents a sufficiently complete solution to the problem of bank erosion and marsh loss. The current estimate of benefits achievable from implementation of this bank protection measure falls in three basic categories: (1) maintenance savings to the existing Mississippi River-Gulf Outlet project due to reduced dredging requirements, (2) monetary benefits associated with environmental restoration and preservation, and (3) non-monetary benefits associated with environmental restoration and preservation. The total first cost of the plan is estimated to be $39,100,000, total average annual costs are $10,800,000, and total average annual monetary benefits are $4,800,000.

The average annual monetary benefits are comprised of savings in maintenance dredging ($4,370,000) and the value of marsh saved and created ($470,000) as a result of the bank stabilization measures. Non-monetary benefits cover approximately $6,000,000 in average annual costs. Total project benefits for the purpose of this calculation are equal to the sum of these values ($6,000,000 + $470,000 + $4,370,000 = $10,840,000). Consequently, the savings in maintenance cost represents approximately 40 percent of the total project benefits ($4,370,000/$10,840,000 = 0.4). Thus, sixty percent of the benefits would be related to environmental outputs (1 - 0.4 = 0.6), in accordance with ER 1105-2-100, para. 4-36 (d).

Costs associated with studies to determine the savings in project maintenance costs are to be borne 100 percent by the Federal government. The Federal share of study costs associated with environmental outputs would be 50 percent. Based on these criteria, the Federal and non-Federal cost sharing for the feasibility phase is recommended to be the following:

Federal Cost = 1.0 x 0.4 (Maintenance Savings Portion) +
0.5*0.6 (Environmental Benefits Portion) = 0.7, or 70 percent

Non-Federal Cost = 1.0 - 0.7 = 0.3, or 30 percent.

Up to one-half of the non-Federal share may be in-kind services (15 percent of the total study cost).

RECOMMENDED PROJECT IMPLEMENTATION AND OMRR&R COST SHARING

Similarly, project implementation and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) cost-sharing requirements would be based on the distribution of estimated project benefits.

The current estimate of monetary benefits achievable from implementation of structural bank protection measures fall in two basic categories: (1) benefits to navigation, and (2) environmental restoration/preservation. As is indicated in Table 20, for Option 4A, Design 5, about 40 percent of the project benefits would accrue to navigation and about 60 percent to environmental restoration/preservation. These benefit proportions are used in the preliminary assessment of how project implementation costs would be apportioned. Navigation costs are to be borne 100 percent by the Federal government. The Federal share of environmental restoration and preservation costs for initial construction would be 75 percent. The Federal share of costs associated with the OMRR&R of the bank stabilization structure would be 100 percent of maintenance savings costs and 0 percent of the environmental restoration/preservation costs. OMRR&R costs associated with channel dredging for the navigation project, however, would remain 100 percent federally funded. The Federal and non-Federal shares are estimated as follows:

Let X = Total Construction Costs

Then,

$$\text{Federal cost} = 1.0 * 0.4X + 0.75 * 0.6X = 0.85X, \text{ or } 85\%$$

$$\text{Non-Federal cost} = 1.0X - 0.85X = 0.15X, \text{ or } 15\%$$

Let Y = Total OMRR&R Costs (Per Maintenance Cycle)

Then,

$$\text{Federal cost} = 1.0 * 0.4Y + 0.0 * 0.6Y = 0.4Y, \text{ or } 40\%$$

$$\text{Non-Federal cost} = 1.0Y - 0.40Y = 0.6Y, \text{ or } 60\%$$

Lands, easements, relocations, and rights-of-way are to be obtained at Federal expense. The local sponsor shall hold and save the Government free from all damages arising from the construction, operation, and maintenance of the project, except for damages due to the fault or negligence of the Government or its contractors.

Preliminary results of the reconnaissance study, a draft feasibility cost-sharing agreement, and a draft initial project management plan have been provided to the potential non-Federal sponsor, the Port of New Orleans.

STUDY COORDINATION

A public notice was published in April 1987 announcing the initiation of the reconnaissance-scope studies of bank stabilization along the MR-GO. The notice was sent to approximately 300 correspondents: individuals; the print and electronic news media; libraries; local, state, and Federal government officials and agencies; and various interest groups. Subsequent to distribution of this notice, a reporter from WDSU TV Channel 6, New Orleans, interviewed the study manager concerning erosion and erosion-related problems in the study area. The interview was aired in June 1987. Two field trips were conducted during 1987 to meet with a representative of a land owner that would be affected by implementation of structural erosion abatement measures.

Several inter-agency meetings were held between the NOD and the Louisiana Department of Natural Resources (LDNR) to explore the level of interest and support of non-Federal interests in finding potential solutions to the bank erosion problems. Representatives of the LDNR were requested to review a preliminary draft of the reconnaissance report and comment on plan formulation, environmental and economic analyses, and the study findings. Comments of the LDNR were considered in the reconnaissance report and will be considered further in any future feasibility phase studies. The LDNR has expressed an interest in cost-sharing feasibility studies of bank erosion and erosion-related problems of the study area.

Study efforts have been closely coordinated with the U. S. Fish and Wildlife Service (USFWS). The USFWS has indicated support of the study efforts. The USFWS Planning Aid Letter is shown as Appendix F.

The status of this reconnaissance study was discussed at meetings held on the Pontchartrain Basin in connection with the Coastal Wetlands, Planning, Protection, and Restoration Act as well as at meetings involving St. Bernard Parish, State of Louisiana officials and the Federal Coast Pilot Association.

Table 20. Summary of Average Annual Benefits for Design 5 by Category

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4	OPTION 4A
NAVIGATION BENEFITS						
SAVINGS IN AVERAGE ANNUAL MAINTENANCE DREGING COSTS	$2,096,000	$3,971,000	$6,001,000	$5,173,000	$3,444,000	$4,367,000
PERCENT OF TOTAL	86	40	17	29	40	40
ENVIRONMENTAL RESTORATION AND PRESERVATION BENEFITS						
VALUE OF AVERAGE ANNUAL MARSH ACRES SAVED OR CREATED	$69,000	$341,000	$367,000	$367,000	$312,000	$471,000
AVERAGE ANNUAL COSTS COVERED BY NON-MONETARY BENEFITS	286,000	5,603,000	29,636,000	12,351,000	4,814,000	5,935,000
SUB-TOTAL	$355,000	$5,944,000	$30,003,000	$12,718,000	$5,126,00	$6,406,000
PERCENT OF TOTAL	14	60	83	71	60	60
TOTAL AVERAGE ANNUAL BENEFITS (100%)	$2,451,000	$9,915,000	$36,004,000	$17,891,000	$8,570,000	$10,773,000

REQUIREMENTS FOR FURTHER STUDY

A feasibility report and Environmental Impact Statement will be prepared to determine the level of Federal involvement in bank erosion control measures and comply with National Environmental Policy Act requirements. A detailed description of the feasibility study scope of work and schedule is provided in the Initial Project Management Plan (IPMP), developed as a companion document to this report. The feasibility report will: 1) provide a complete presentation of study results and findings so that readers can reach independent conclusions regarding the reasonableness of recommendations; 2) indicate compliance with applicable statutes, executive orders and policies; and 3) provide a sound and documented basis for decision makers at all levels to judge the recommended solution(s). The feasibility report will include baseline design and cost estimates of the recommended plan. Plans will first be optimized on monetary benefits associated with channel maintenance savings, marsh creation, and marsh preservation. Then, an incremental cost analysis of project costs and non-monetary benefits will be performed to ensure the identification of the most efficient, effective, and complete plan, in accordance with ER 1105-2-100, para. 4-36 (d). A baseline design and cost estimate would then be provided for the tentatively selected plan.

The incremental analysis will involve nine steps: 1) impact assessment and cost estimate, 2) identification of reasonably combinable environmental measures, 3) calculation of the outputs and costs for combinations of measures 4) elimination of economically inefficient combinations. (Plans that are not "least cost" for the same level of output will be eliminated. This step will also involve the ranking of combinations in ascending order of outputs and ascending order of costs.), 5) elimination of economically ineffective combinations (combinations will be deleted that will produce less output at equal or greater cost than subsequently ranked combinations), 6) graphically analyze output vs. cost relationships, 7) calculate per unit incremental cost, 8) graph incremental costs, and 9) interpret incremental cost graph to select a reasonably efficient, effective, and complete plan that is implementable. Note that this procedure will not necessarily result in the selection of the plan which has the lowest cost per unit of output or the lowest incremental cost per unit of output.

The feasibility study will also include hydraulic and hydrologic engineering, design and cost engineering, geotechnical investigations, socio-economic studies, biological resources studies, cultural resources studies, recreation resources studies, real estate investigations, plan formulation, public involvement, study management and coordination, and other miscellaneous investigation such as analyses of risk, uncertainty, and sensitivity of parameters and variables to outcomes.

Besides the rock dike designs evaluated in this reconnaissance study, the feasibility study will consider the alternative of placing dredged material, allowing the material to consolidate and later placing an armor stone layer over a foundation filter fabric. Other designs that will be considered in future studies include pile-panel walls, sheet pile walls, "Target" concrete blocks, and timber bulkheads.

CONCLUSIONS

The results of this preliminary analysis indicate that construction of bank stabilization measures along the MR-GO may be warranted. Based on an evaluation of project costs and monetary and non-monetary benefits, continuation into the feasibility phase is advisable.

The need for bank stabilization measures along the MR-GO is evident. Severe erosion is occurring along the banks of the channel. Without Federal action, the current bank erosion problem would produce large breaches in the rapidly dwindling marsh buffer between the navigation channel and the open waters of Lake Borgne and Breton Sound. The communication these breaches will create between the open water and the channel will significantly increase the cost of channel maintenance dredging in the future. Additionally, wave-wash and drawdown effects produced by large vessel traffic are causing highly productive marsh to be converted to open water.

Based on an analysis of the erosion problem, three objectives of constructing measures along the MR-GO were identified: 1) to control bank erosion to minimize channel maintenance requirements, 2) to reduce the rate of loss of valuable coastal wetlands adjacent to the channel, and 3) to restore, to the extent practicable, wetlands previously converted to open water as a result of bank erosion and saltwater intrusion.

In order to justify bank stabilization measures, consideration of both monetary and non-monetary project outputs is required. Early studies evaluated the costs and benefits of such measures, based solely on the National Economic Development benefits that would be generated by the reduced costs to maintain the channel. These measures were not economically justified. However, justification does exist when non-monetary benefits are incorporated. These non-monetary benefits are generated by restoring acres of marsh which have converted to open water and by preserving remaining marsh in the study area. The benefits are quantified using a Wetland Value Assessment and are described in Average Annual Habitat Units (AAHU's).

The most favorable plan identified in the reconnaissance study involves the construction of 30 miles of rock dike along the north bank of the MR-GO to provide protection against erosion (Option 4A, Design 5). Smaller plans may be more efficient at meeting the objectives, but are not supported by potential non-Federal sponsors or do not provide the desired magnitude of environmental outputs. The total first costs to construct this plan would be $39,056,000, and the total average annual costs, including approximately $5,951,000 for operation and maintenance, would be $10,773,000.

This plan would reduce the average annual costs of maintenance dredging by $4,367,000. Additionally, the implementation of this plan would result in the creation of 540 acres of marsh and would preserve an additional 2,938 acres for a total of 3,478 acres of marsh created or preserved over the life of the project. The average annual monetary value of this preservation and restoration is $357,000. When the Wetland Value Assessment is applied consistent with Coastal Wetlands Planning, Protection, and Restoration Act projects, the total non-monetary benefits are 2,786 AAHU's.

The results of the study also indicate that cost-sharing percentages for the feasibility study, project implementation, and project OMRR&R (operation, maintenance, repair, replacement, and rehabiliation), should be based on project outputs. Prorating the Federal and non-Federal shares according to project outputs for the most favorable plan yields Federal shares for these three phases, respectively, of 70 percent, 85 percent, and 40 percent.

RECOMMENDATIONS

I recommend this reconnaissance report be approved and that the study of bank protection measures along the Mississippi River-Gulf Outlet navigation channel be continued into the feasibility phase. In light of the unique mix of project outputs identified for these measures, involving both Federal maintenance savings and environmental restoration and preservation, I also recommend the consideration of the following exemptions to existing policy on water resources development projects: 1) that the cost sharing of the feasibility phase be 70 percent Federal and 30 percent non-Federal, with the provision that up to one-half of the non-Federal share may be in the form of in-kind services, 2) that the cost sharing of project construction be 85 percent Federal and 15 percent non-Federal, and 3) that the cost sharing for operation, maintenance, repair, replacement, and rehabiliation (OMRR&R) of the bank stabilization projects be 40 percent Federal and 60 percent non-Federal. I further recommend that item 1) above be approved along with the reconnaissance report and items 2) and 3) above be tentatively approved now, with the condition that cost sharing for both project construction and OMRR&R shall be adjusted according to the project outputs identified in the feasibility study and calculated in the manner described in this reconnaissance report.

Michael Diffley
Colonel, U. S. Army
District Engineer

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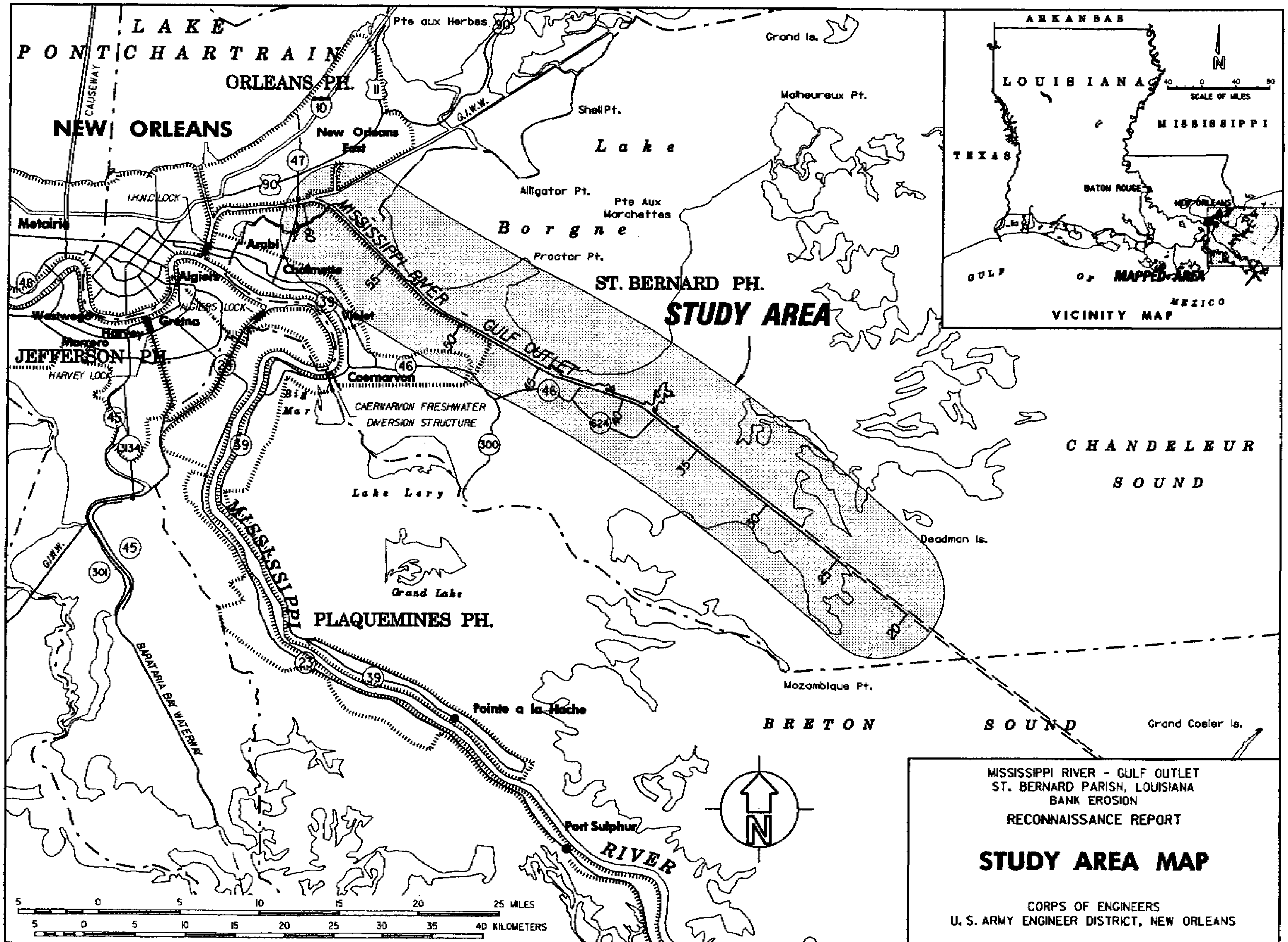
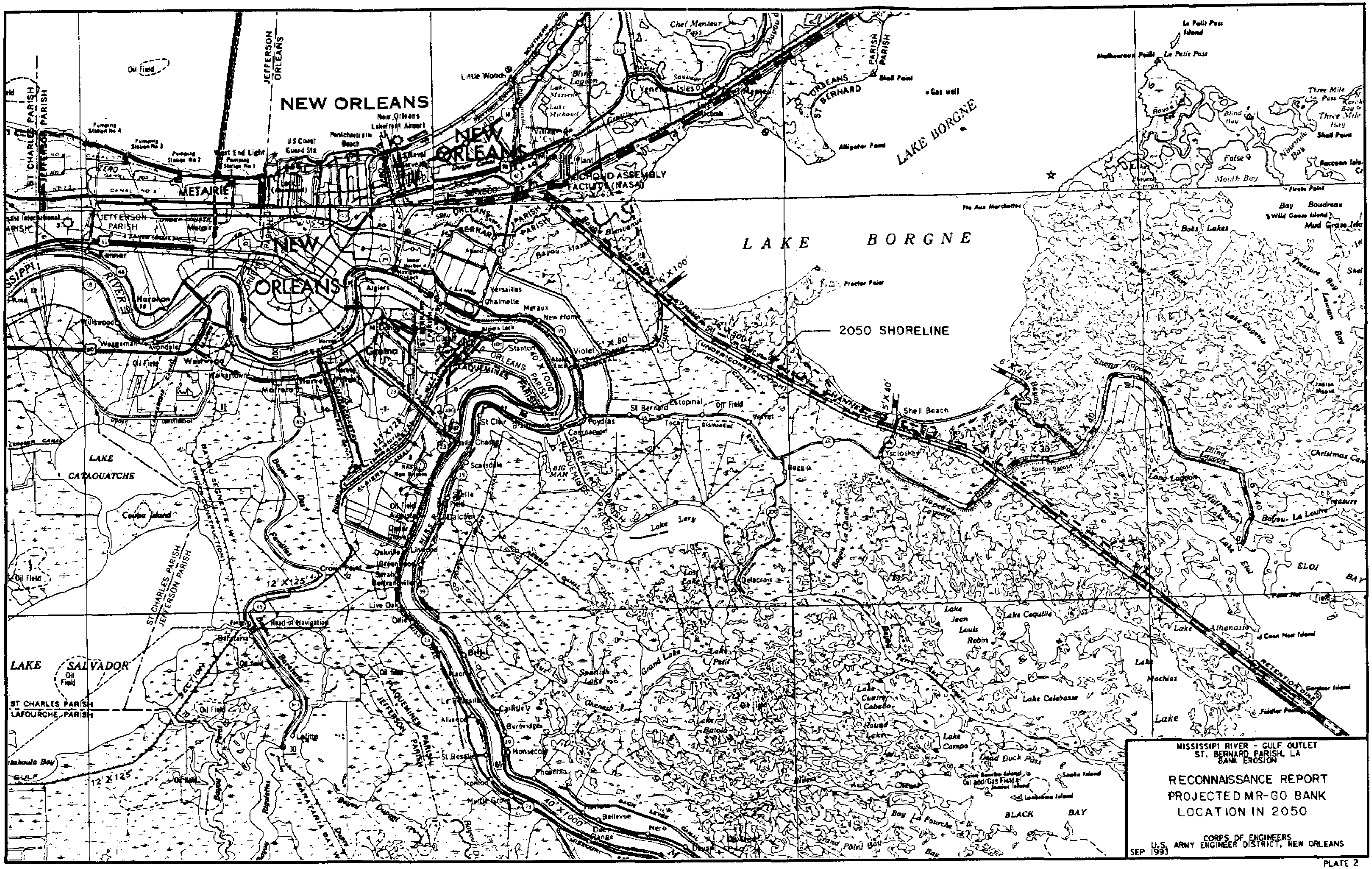


MISSISSIPPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LOUISIANA
BANK EROSION
RECONNAISSANCE REPORT
STUDY AREA MAP
CORPS OF ENGINEERS
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
LAKE PONTCHARTRAIN
ORLEANS PH.
NEW ORLEANS
JEFFERSON PH.
ST. BERNARD PH.
PLAQUEMINES PH.
STUDY AREA
MISSISSIPPI RIVER - GULF OUTLET
MISSISSIPPI RIVER
Lake Borgne
CHANDELEUR SOUND
BRETON SOUND
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Pte aux Herbes
Grand Is.
Malheureux Pt.
Shell Pt.
Alligator Pt.
Pte Aux Marchettes
Proctor Pt.
Deadman Is.
Mozambique Pt.
Grand Cosier Is.
New Orleans East
Metairie
Arabi
Chalmette
Algiers
ALGIERS LOCK
I.H.N.C. LOCK
Westwego
Harvey
Gretna
Marrero
HARVEY LOCK
Violet
Caernarvon
Big Mar
Lake Lery
Grand Lake
Pointe a la Hache
Port Sulphur
BARATARIA BAY WATERWAY
G.I.W.W.
CAUSEWAY
VICINITY MAP
ARKANSAS
LOUISIANA
MISSISSIPPI
TEXAS
BATON ROUGE
NEW ORLEANS
GULF OF MEXICO
MAPPED AREA
SCALE OF MILES
25 MILES
40 KILOMETERS
2tpmrgo.dgn

Plate 1

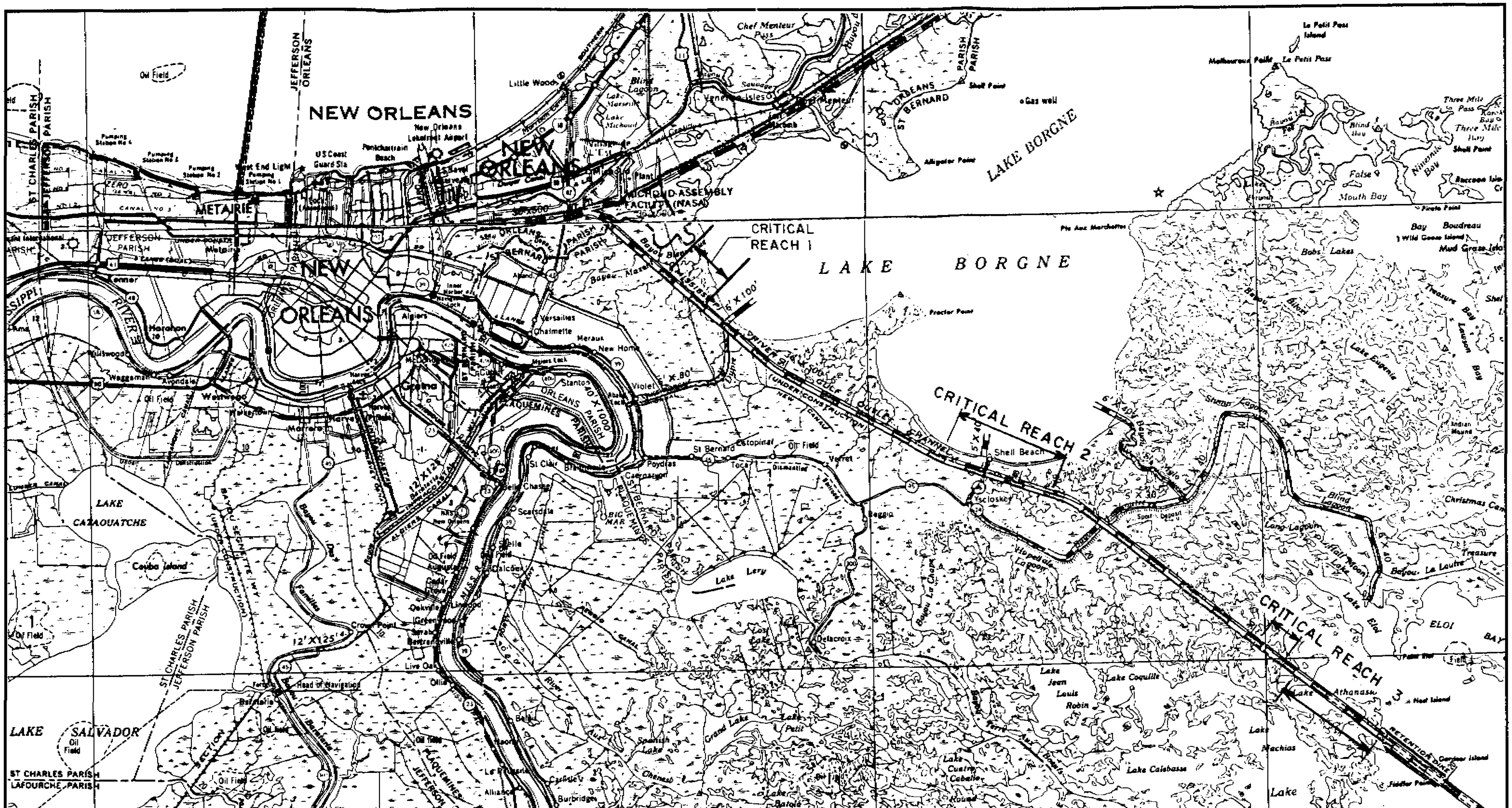


MISSISSIPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION

RECONNAISSANCE REPORT
PROJECTED MR-GO BANK
LOCATION IN 2050

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP 1993

PLATE 2



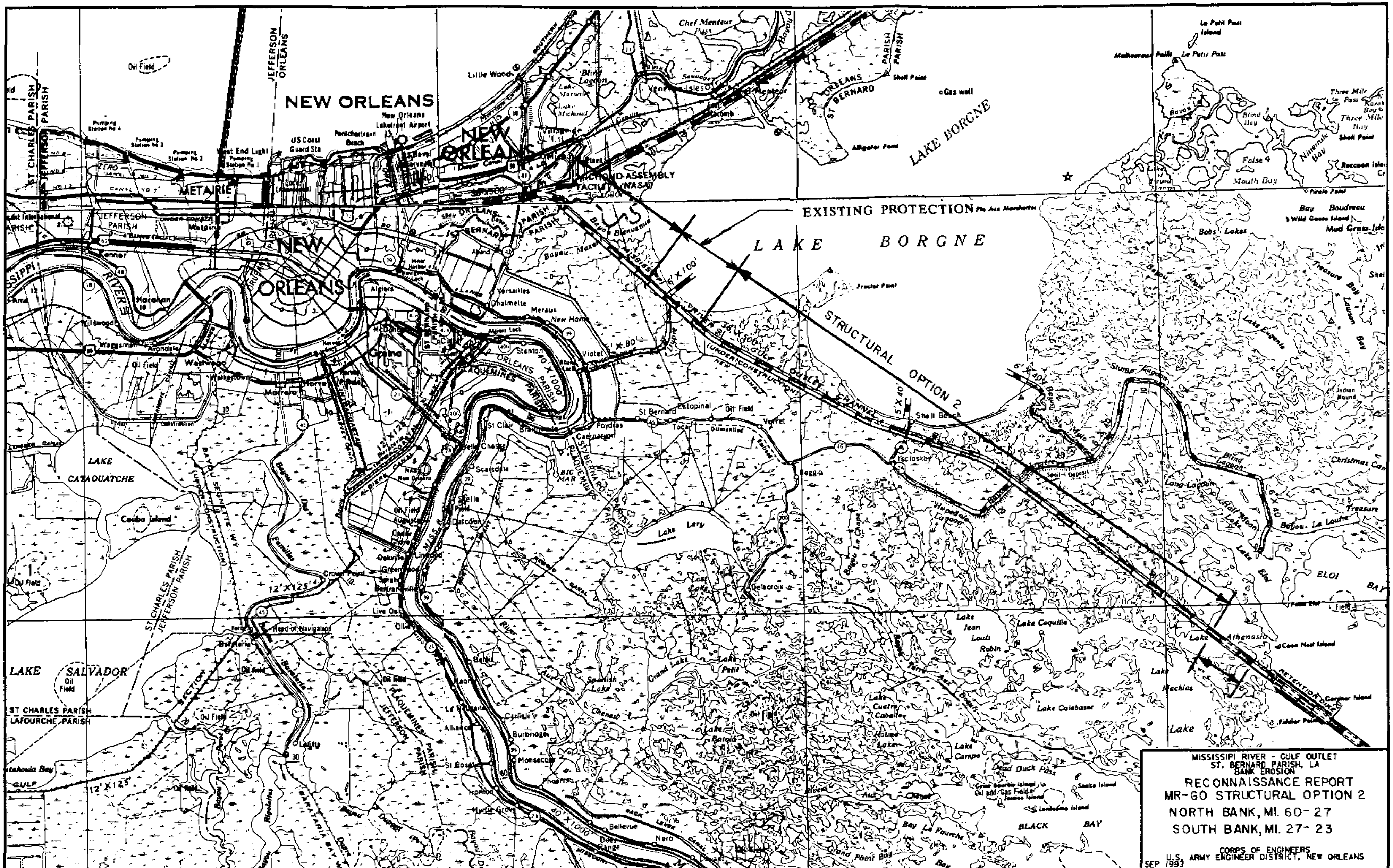
MISSISSIPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION

RECONNAISSANCE REPORT

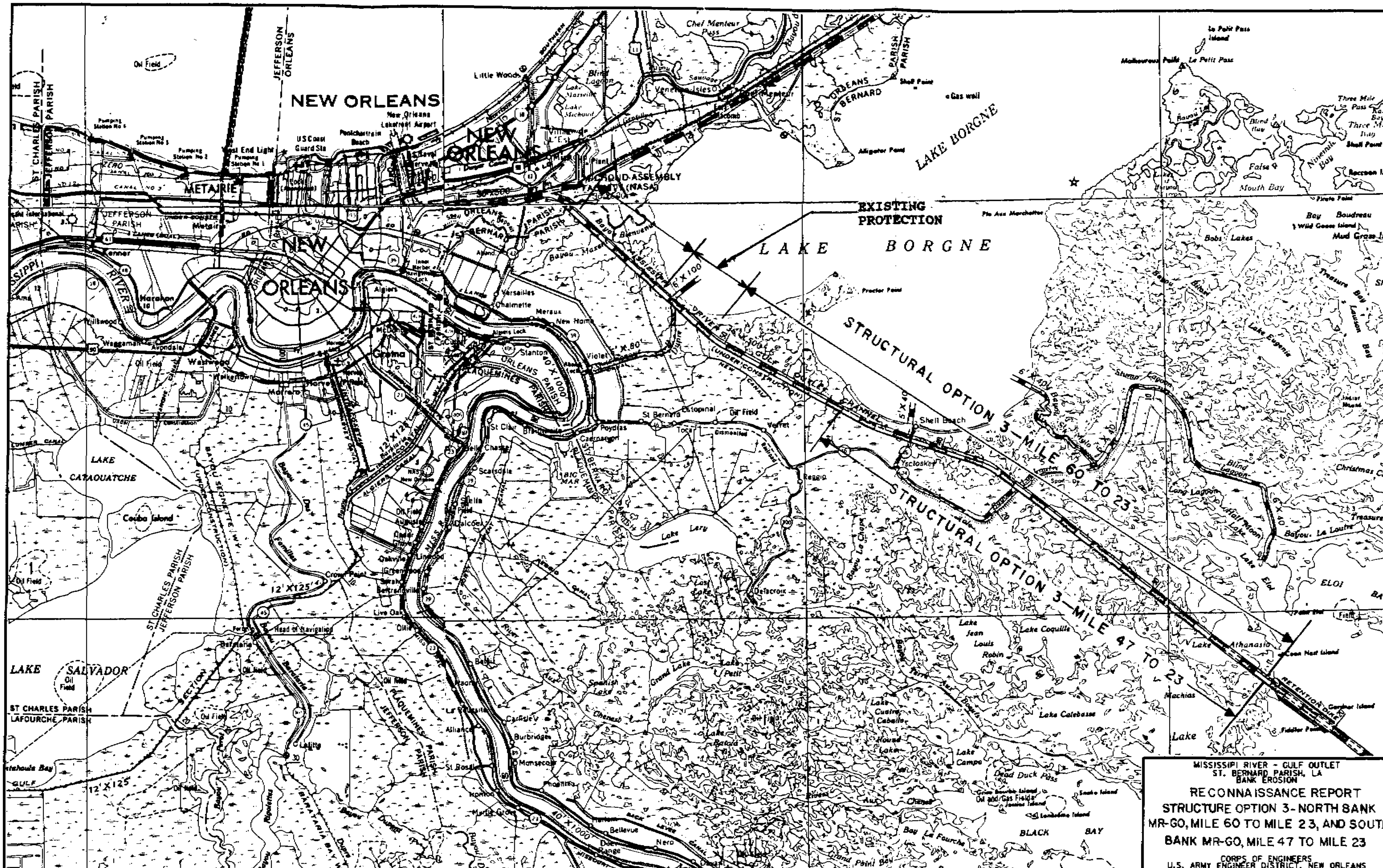
STRUCTURAL OPTION I—NORTH BANK
MR-GO REACHES OF CRITICAL EROSION

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP 1993

PLATE 3



MISSISSIPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT
MR-GO STRUCTURAL OPTION 2
NORTH BANK, MI. 60-27
SOUTH BANK, MI. 27-23
CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP 1993

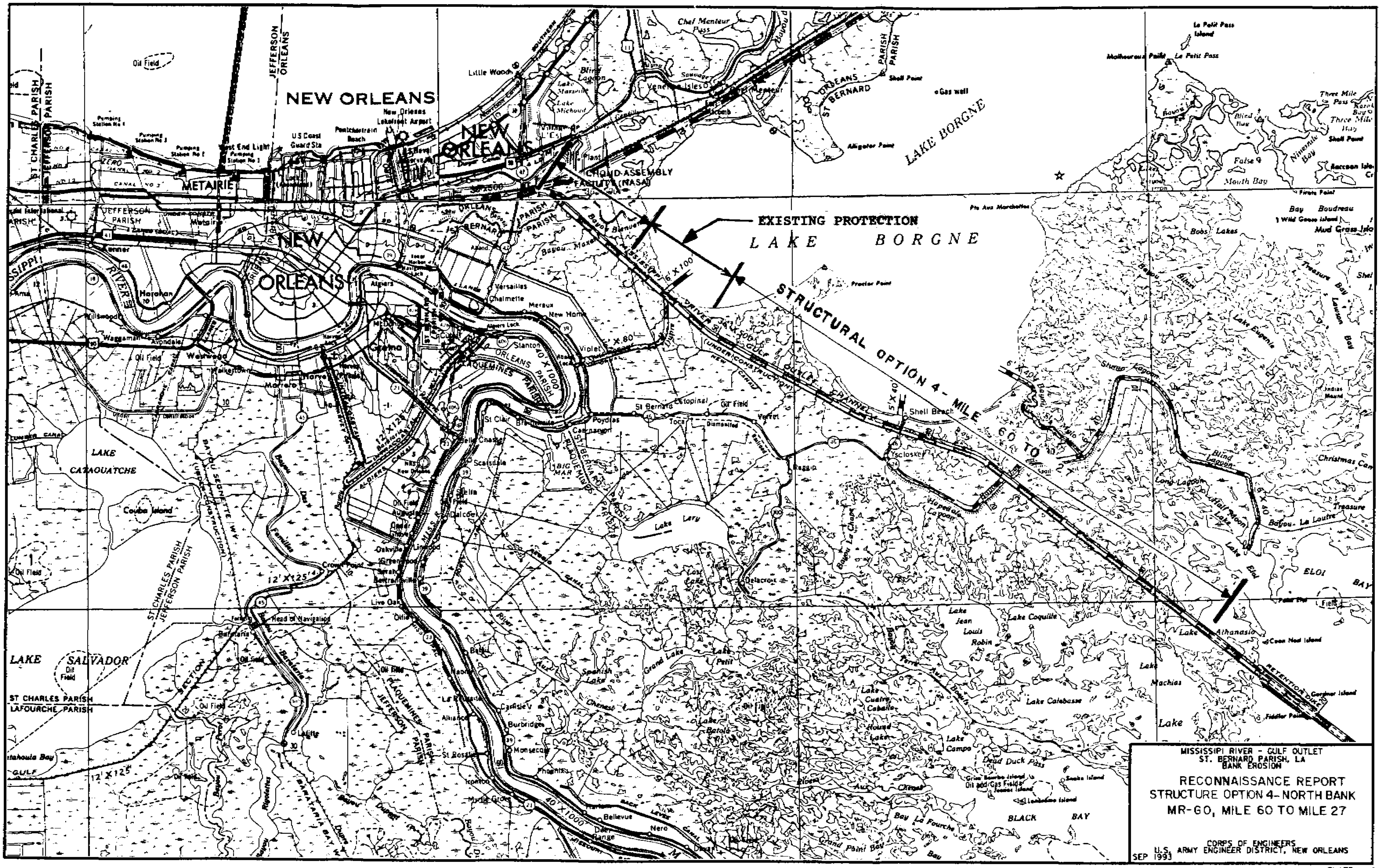


MISSISSIPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION

RECONNAISSANCE REPORT

STRUCTURE OPTION 3 - NORTH BANK MR-GO, MILE 60 TO MILE 23, AND SOUTH BANK MR-GO, MILE 47 TO MILE 23

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
SEP 1993



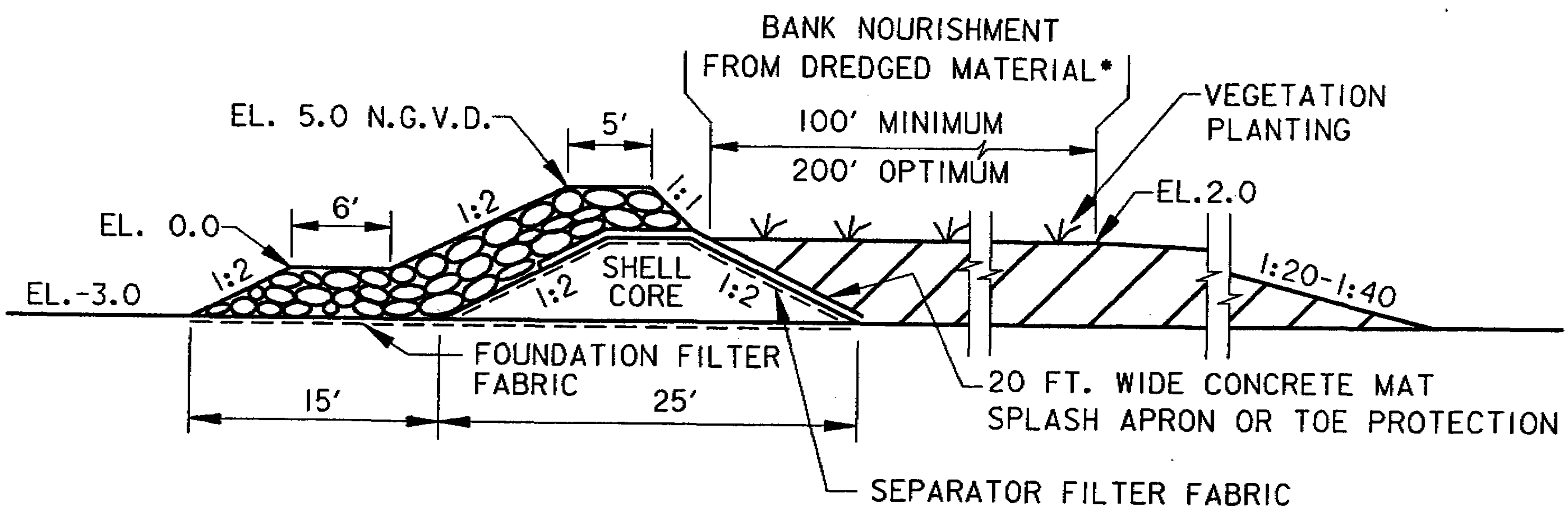
MISSISSIPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION

RECONNAISSANCE REPORT
STRUCTURE OPTION 4-NORTH BANK
MR-GO, MILE 60 TO MILE 27

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP 1993

PLATE 6

BANK PROTECTION STRUCTURE



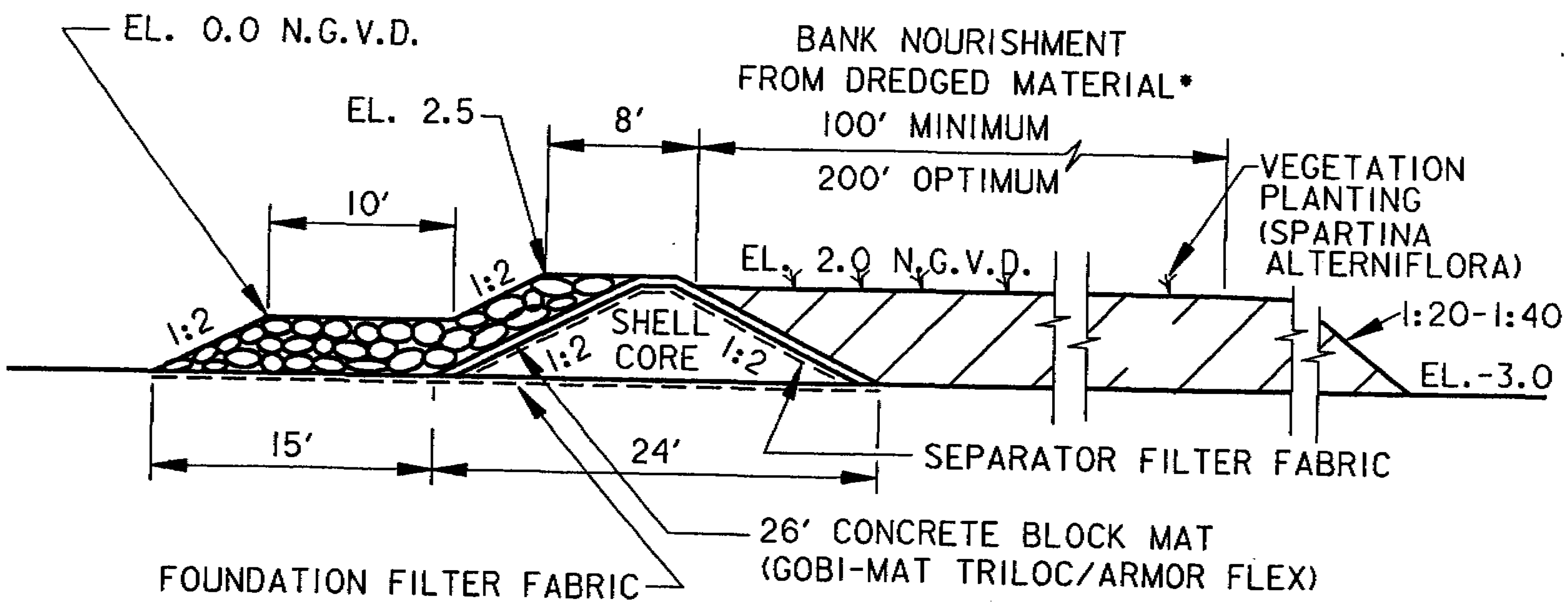
DESIGN I

MISSISSIPPI RIVE - GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

DESIGN I
CONCRETE BLOCK/ROCK ARMOR-
HIGH PROFILE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP. 1993

BANK PROTECTION STRUCTURE



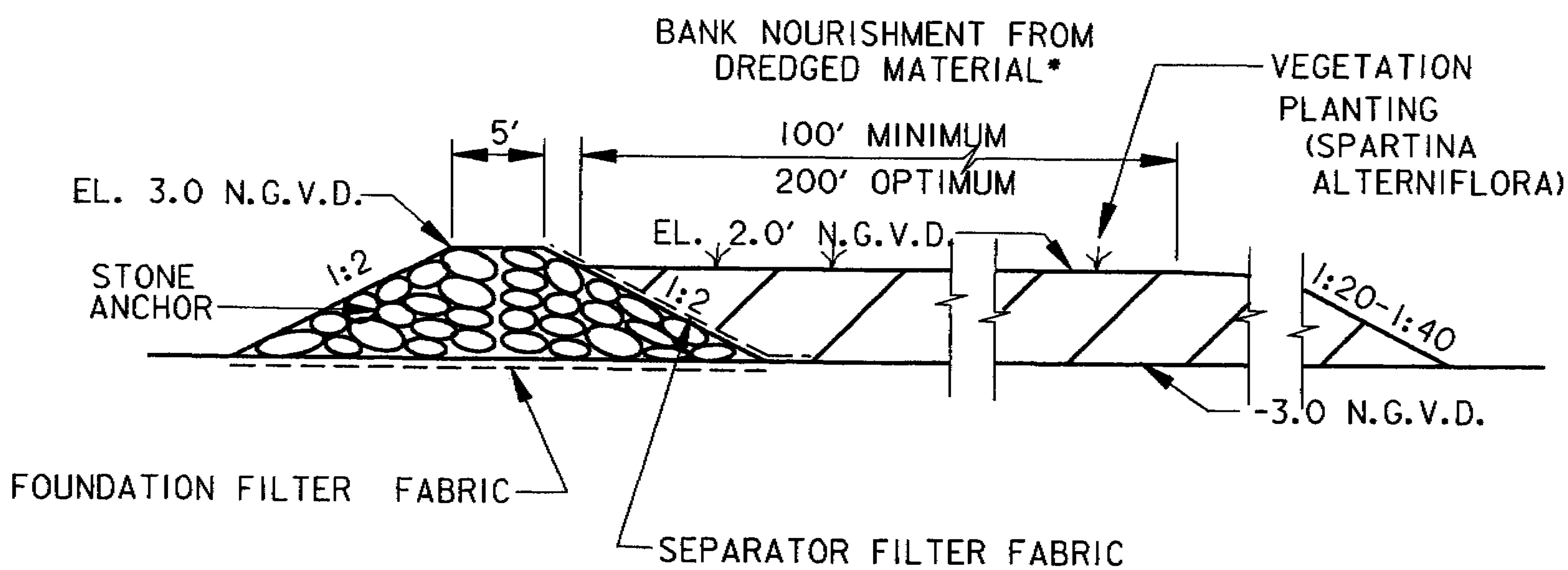
DESIGN 2

MISSISSIPPI RIVE - GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 2
CONCRETE BLOCK/ROCK ARMOR-
LOW PROFILE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP. 1993

BANK PROTECTION STRUCTURE



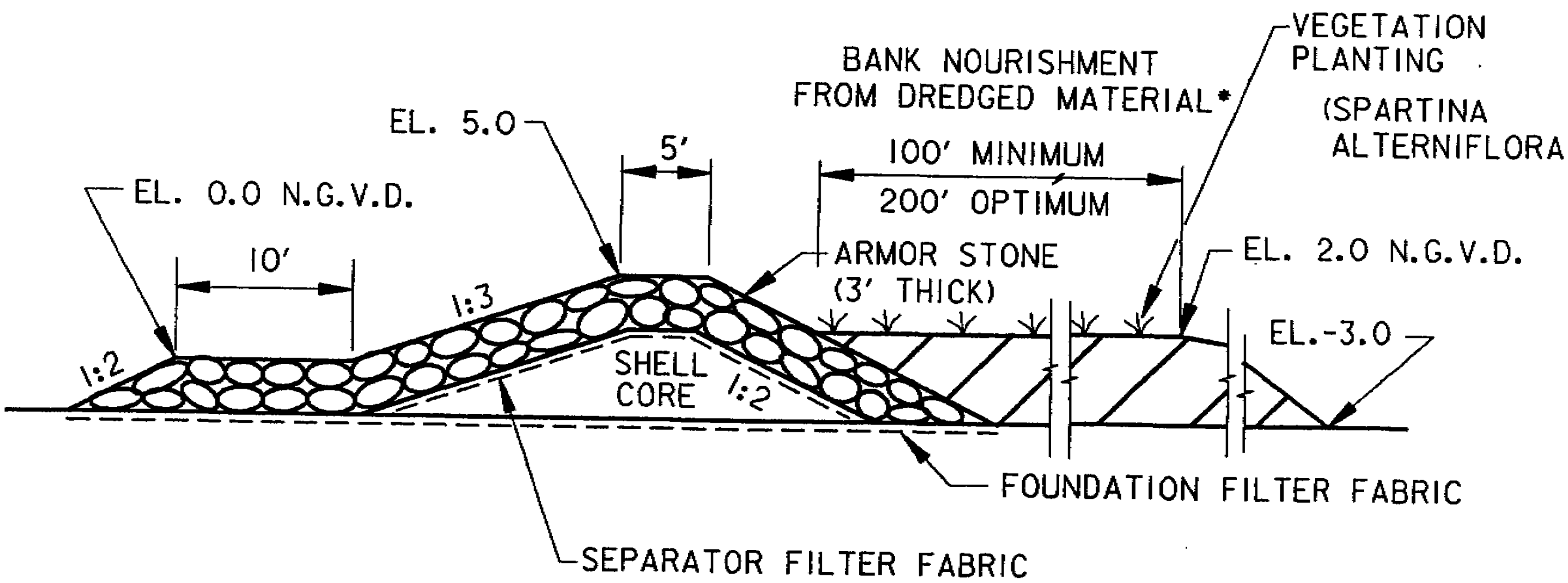
DESIGN 3

MISSISSIPPI RIVE - GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 3
ALL ROCK ARMORED DIKE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP. 1993

BANK PROTECTION STRUCTURE



DESIGN 4

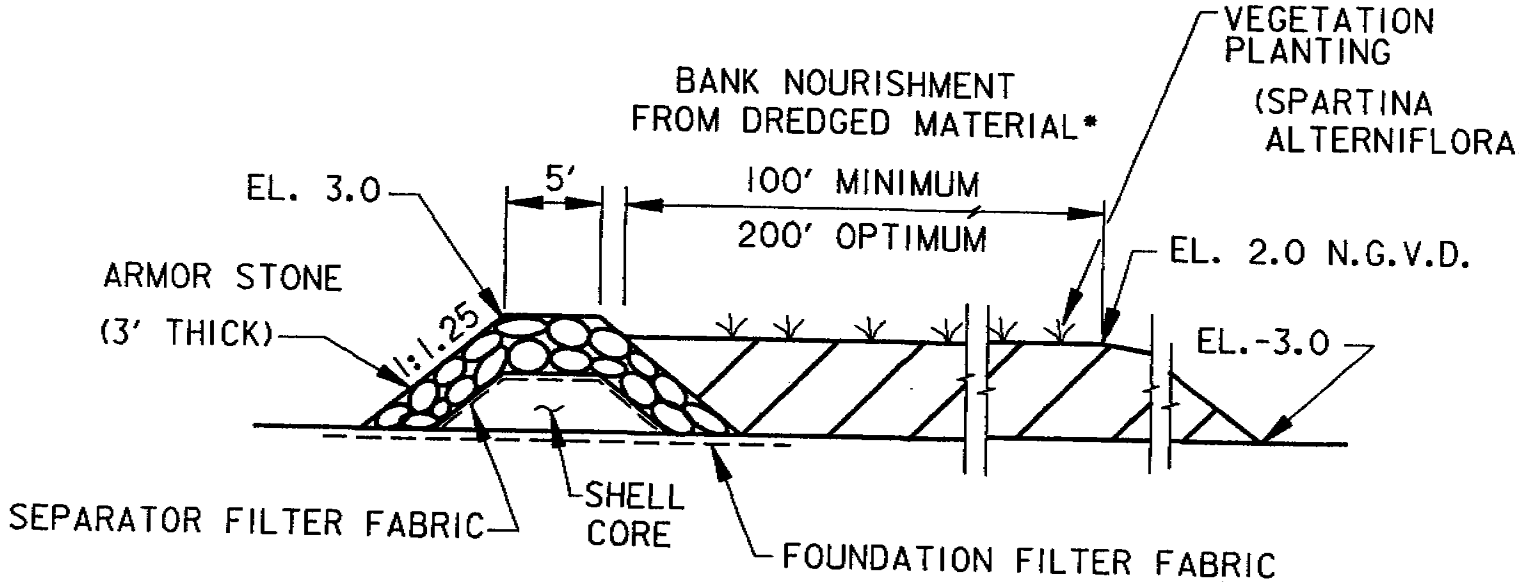
MISSISSIPPI RIVE - GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 4
ROCK ARMORED SHELL
CORE DIKE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP. 1993

PLATE 10

BANK PROTECTION STRUCTURE



DESIGN 5

MISSISSIPPI RIVE - GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 5
ROCK ARMORED SHELL CORE
LOW PROFILE DIKE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
SEP. 1993

Missisippi River-Gulf Outlet
St. Bernsard Parish, Lousiana
Bank Erosion
Reconnaissance Report

Appendix A

Climatologic and Hydrologic Data

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APPENDIX A

CLIMATOLOGIC AND HYDROLOGIC DATA

GENERAL CLIMATE

The climate of the study area is subtropical marine, with long humid summers and short moderate winters. Climatological data are contained in monthly and annual publications of the U.S. Department of Commerce, National Climatic Center, titled "Climatological Data for Louisiana," and "Local Climatological Data, New Orleans, LA."

Temperature records are available for New Orleans since 1870. The annual normal temperature for New Orleans at Audubon Park based on the period 1961-1990 is 69.5° F, with monthly normal temperatures varying form 52.7° F in January to 82.9° F in July.

The normal annual precipitation for New Orleans for the period 1961-1990 is 61.88 inches, as computed at the New Orleans Moisant Airport. Normal monthly precipitation totals vary from 3.05 inches in October to 6.17 inches in August.

WIND

Onshore wind records are available from 1949 at New Orleans Moisant Airport. The average wind velocity over the period 1971-1991 is 8.0 miles per hour (mph). The predominant wind directions are north-northeast from September through February and south-southeast from March through June.

Wind data at Boothville can be used to represent shoreline wind conditions for the lower part of the study area. Wind speed averages about 8.8 mph annually based on the period July 1971 through December 1978. Predominant wind directions are northeast from September through February and southeast from March through June.

Offshore winds have a mean annual speed of 13.6 mph, based on the Summary of Synoptic Meteorological Observations (SSMO) taken by the U. S. Naval Weather

In January 1983, a coastal storm hit the study area with very strong winds. The storm produced tides of three to six feet above normal along the MR-GO. High stages of 6.8 ft NGVD and 7.61 ft NGVD were recorded at Shell Beach and Paris Road Bridge, respectively.

TIDES

Tides in the Breton and Chandeleur Sound areas are of the daily or dirunal type. Tides in Breton Sound have a range of 1.4 feet. In Lake Borgne the tides have a range of 1.2 feet. Tidal ranges at several stations include 0.70 feet at Seabrook, 1.2 feet at Shell Beach, 1.1 feet at Paris Road bridge, 1.45 feet at Gardner Island, and 1.0 feet at Biloxi, MS.

In a shallow body of water such as Breton Sound, tidal effects other than the daily range are masked by meteorological conditions that cause predominant water level fluctuations. During the year the daily ranges of the tide are at a minimum in March and September and at a maximum in June and December.

WATER LEVELS

Mean stages, and maximum and minimum stages are provided in Table 1 of this appendix for several stations along the MR-GO. Table 2 lists the mean summations of the mean, maximum, and minimum daily stages, represented by the 8:00 am reading.

Table 2. Mean and Extreme Stages

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bayou Dupre at Floodgate (West) (LA) 76005														
	MEAN	0.57	0.55	0.72	0.86	1.07	1.04	0.95	1.24	1.67	1.53	1.31	0.92	1.04
1975-1992	MAX	2.20	2.49	2.77	3.29	2.79	2.40	2.73	2.85	2.97	3.28	2.45	2.53	3.29
	MIN	-1.30	-1.88	-1.23	-2.20	-0.82	-0.66	-0.33	0.07	0.80	0.12	-0.19	-0.53	-2.20
Bayou Dupre at Floodgate (East) (LA) 76010														
	MEAN	0.46	0.41	0.48	0.66	0.90	1.01	0.95	1.28	1.78	1.59	1.27	0.82	0.97
1975-1992	MAX	2.56	2.75	2.86	3.83	2.79	3.04	3.05	3.85	4.08	5.32	2.97	5.08	5.32
	MIN	-1.14	-1.85	-1.22	-2.20	-0.80	-0.74	-0.73	0.10	0.01	0.05	-0.39	-0.64	-2.20
Bayou Bienvenue at Paris Road (LA) 76020														
	MEAN	0.89	0.86	0.87	0.99	1.08	0.97	0.79	1.11	1.64	1.52	1.44	1.12	1.11
1974-1992	MAX	2.96	3.05	2.63	4.05	4.24	2.55	3.09	3.23	3.24	2.90	2.83	3.37	4.24
	MIN	-1.25	-1.65	-1.82	-2.70	-0.64	-0.34	-0.55	-0.33	0.55	0.31	-0.10	-1.67	-2.70
Bayou Bienvenue at Floodgate (West) (LA) 76024														
	MEAN	0.68	0.70	0.72	0.91	1.08	1.06	0.86	1.20	1.64	1.52	1.37	1.04	1.07
1975-1992	MAX	2.93	2.83	2.46	3.73	3.03	2.45	2.32	3.24	3.20	3.68	2.59	3.19	3.73
	MIN	-1.01	-1.33	-1.11	-2.00	-0.89	-0.32	-0.22	-0.20	0.03	0.36	-0.15	-1.00	-2.00
Bayou Bienvenue at Floodgate (East) (LA) 76025														
	MEAN	0.55	0.50	0.56	0.78	0.95	0.99	1.05	1.36	1.81	1.60	1.30	0.93	1.03
1974-1992	MAX	5.99	4.05	2.64	4.17	2.89	2.70	3.20	4.11	4.11	5.40	3.23	3.25	5.99
	MIN	-1.13	-2.37	-1.26	-2.80	-0.83	-0.77	-0.27	0.29	0.34	0.15	-0.47	-0.94	-2.80
Intracoastal Waterway near Paris Road Bridge, New Orleans, LA 76040														
	MEAN	1.04	0.96	1.03	1.21	1.41	1.48	1.50	1.89	2.38	2.16	1.74	1.37	1.52
1959-1992	MAX	7.14	4.43	3.93	4.82	4.90	4.43	4.08	4.89	7.16	5.00	4.09	5.04	7.16
	MIN	-1.00	-1.75	-1.42	-2.49	-0.53	-0.50	-0.88	-0.10	0.12	0.01	-0.55	-0.78	-2.49
Inner Harbor Navigation Canal Near Seabrook Bridge, New Orleans, LA 76060														
	MEAN	1.10	0.98	1.00	1.22	1.34	1.26	1.18	1.50	2.04	1.89	1.63	1.33	1.37
1962-1992	MAX	4.10	4.15	3.52	4.71	4.25	3.54	3.42	4.35	5.45	4.09	3.51	3.94	5.45
	MIN	-1.28	-1.16	-0.90	-1.44	-0.61	-0.23	-0.75	-0.35	0.43	0.31	-0.34	-0.61	-1.44
Mississippi River Gulf Outlet at Shell Beach, La. 85800														
	MEAN	0.65	0.59	0.79	1.06	1.31	1.40	1.36	1.67	2.12	1.86	1.30	0.87	1.25
1962-1992	MAX	6.80	4.05	3.25	3.97	4.09	3.83	3.46	4.52	9.17	4.62	3.74	4.51	9.17
	MIN	-1.28	-1.93	-1.09	-1.10	-0.47	-0.25	-0.51	-0.11	0.46	0.03	-0.88	-0.88	-1.93
Breton Sound near Gardner Island, LA 85850														
	MEAN	0.41	0.46	0.77	1.27	1.56	1.63	1.50	1.71	2.00	1.55	1.02	0.64	1.21
1960-1992	MAX	3.05	2.80	2.99	3.40	4.40	3.54	3.48	3.55	5.10	4.43	3.13	3.48	5.10
	MIN	-2.30	-2.80	-1.26	-2.75	-0.36	0.03	-0.21	0.14	0.30	-0.59	-1.88	-1.12	-2.80

Part I of this appendix presents a preliminary evaluation of the environmental resources in the study area. The environmental resources evaluated include wetlands, wildlife, fisheries, threatened and endangered species, and recreation resources.

Part II of this appendix includes a discussion of the Wetland Value Assessment (WVA) methodology of habitat assessment. The WVA concept, variables used to evaluate habitat quality, and formula used to determine a Habitat Suitability Index for the study area are presented in this section of the appendix.

Appendix B, Part 1

PRELIMINARY ENVIRONMENTAL EVALUATION

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PRELIMINARY ENVIRONMENTAL EVALUATION

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APPENDIX B, PART I

PRELIMINARY ENVIRONMENTAL EVALUATION

EXISTING CONDITIONS

ENVIRONMENTAL RESOURCES

Wetlands. The study area is characterized by a variety of habitats including estuarine marshes, scrub/shrub habitat, shallow open water ponds, and the Mississippi River-Gulf Outlet waterway. The estuarine marshes are composed of both brackish and saline vegetation. Dominant species of vegetation in the saline marsh areas include saltmarsh cordgrass and saltmeadow cordgrass, where subdominant species include blackrush, saltgrass, and saltwort. The brackish marshes are dominated by saltmeadow cordgrass with other species present such as saltgrass, saltmarsh cordgrass, blackrush, and three-cornered grass. Vegetation within the confined dredged material disposal areas of the MR-GO consists of brackish marsh species. Once these areas are initially drained, rainwater accumulation tends to result in the establishment of vegetation associated with reduced salinities.

Scrub/shrub habitat is present on the natural ridges and on previously used dredged material disposal locations. The elevation at these locations is generally higher which allows for reduced periods of saltwater inundation during extreme high water events. Marsh elder is the dominant salt-tolerant vegetation in scrub/shrub habitats. Other species of scrub/shrub vegetation which are not tolerant of long periods of saltwater inundation include palmetto, wax myrtle, and live oak.

Shallow estuarine pond habitat is located within the interior marsh areas. These habitats are composed of water averaging 1.0 foot deep and a bottom made up of organic detritus, sand, and silt sediments. Portions of these peat-like sediments are saturated with water and are 6 to 8 feet deep. The salinity within these shallow ponds varies from 5 to 25 parts per thousand depending upon the distance from the Gulf of Mexico and the time of year. The level of water in these estuarine ponds depends on wind direction, rainfall, and lunar tides. Submerged aquatic vegetation, composed of dwarf spikerush, widgeon grass, and coontail, provides food and habitat for both resident and transient species.

The MR-GO outlet channel provides a direct route for saltwater to enter the estuarine marsh system as well as a route for freshwater to exit the estuarine system and enter the Gulf of Mexico. Bayou La Loutre was once the only direct waterway between these marshes of St. Bernard Parish and the Gulf of Mexico. Since the construction of the MR-GO, the amount of saline marsh has increased and fresh marshes have been converted to brackish marshes and some intermediate marsh.

Wildlife. Resident and migratory species of wildlife in these marshes reflect the change of vegetation attributable to the changed salinity levels. Historically, the study area in St. Bernard and Plaquemines Parishes has been one of the top fur producing areas in the world. The muskrat was the primary reason for this position. Muskrats reach highest populations in brackish marshes where three-cornered grass often produces extensive stands. The current population of muskrat in the marshes adjacent to the MR-GO is low. Nutria populations are usually much higher in fresh marshes than in the brackish marshes, but the brackish marshes of the MR-GO area tend to have an over-abundance of nutria. Mink populations are greater in areas where brush piles, scrub/shrub vegetation, or other forms of cover are abundant. The dredged material disposal areas along the MR-GO provide excellent mink habitat, along with numerous potential den sites. During the construction and past maintenance of the MR-GO, the dredged material was placed along portions of the south bank of the MR-GO. This has created abundant upland habitats for white-tailed deer, swamp rabbits, and wild hogs.

Species of waterfowl which provide hunting opportunities include gadwalls, blue-winged teal, green-winged teal, mallards, mottled ducks, widgeon, and lesser scaup. The mottled duck is the only duck commonly nesting in the area. No wading bird nesting colonies are known to exist in the MR-GO area; however, birds such as ibises, herons, egrets, shorebirds, rails, bitterns, and skimmers are common inhabitants of these marshes.

Fisheries. Recreationally and commercially important finfish and shellfish in the waters of the area include brown shrimp, white shrimp, blue crabs, oysters, menhaden, red drum (redfish), spotted seatrout (speckled trout), black drum, striped mullet, Gulf flounder, Gulf kingfish, and Atlantic croaker. Some of these species (spotted seatrout and black drum) spawn in the MR-GO and in the deep bayous which enter the MR-GO. However, most estuarine species spawn offshore, and the larvae migrate either freely or by currents into the estuarine marshes. Once inshore the larvae reside in the saline, intermediate, or brackish marshes depending on the species' salinity tolerance and food availability. The interface between the marsh and the water's edge creates a habitat where larval and juvenile fishes can find cover, food, and favorable environmental conditions (water depth, temperature, dissolved oxygen, current speed, and turbidity). The interior marsh provides a stable habitat which resists fluctuating water levels, salinity, temperature, and water movement.

This stable nursery habitat allows species to maintain their position in the estuary until they become adults. The larvae of many species which spawn during the fall and winter months remain in the estuary throughout the spring and summer months. During the warmer months, larval and juvenile fish and shellfish species experience the most rapid growth. The marshes are critical to the successful completion of the life cycle of these species. Additionally, the detritus provided by these marshes forms the basis of the food chain for many fish and shellfish species.

The shallow estuarine open water pond habitat along the MR-GO provides an interior habitat essential to fish, shellfish, and wildlife species. This area represents the nursery habitat for estuarine-dependent species which utilize shallow open water for nursery grounds. Fish species such as menhaden favor shallow open water to flooded marsh for nursery grounds in their larval and juvenile life stages. Much of the shallow estuarine open water offers refuge to fish, crabs, and shrimp when the water level drops causing these species to retreat from the flooded marsh to the remaining open water.

Many of the shallow estuarine ponds are isolated from adjacent water bodies. These ponds resist the fluctuating water levels, salinity, and temperature reflected in the adjacent water body. The salinity and temperature extremes experienced in isolated ponds, due to evaporation, rainfall, and sun radiation, however, may be much greater than those experienced by ponds which are connected to the adjacent water bodies by small natural marsh channels.

The MR-GO channel has created an increase in the number of access points into the marshes for estuarine species. The increase in brackish marsh habitat has benefitted estuarine species, but the conversion of brackish and saline marsh to open water has reduced the amount of estuarine nursery habitat. Many larval fish and shellfish species travel this corridor from the Gulf of Mexico to the interior marsh habitats.

Erosion along the banks of the MR-GO has been caused by water movement from tidal fluctuation and ship wakes. Bank erosion along the north bank of the MR-GO has increased the number of shallow estuarine marsh ponds which become directly connected to the MR-GO, further increasing the width of the channel. Interior marsh breakup is a result of increased water movement and subsidence. As the interior marsh breaks up, the amount of edge habitat available to estuarine species increases. However, as the breakup converts the interior marsh to open water, estuarine marsh habitat decreases.

Threatened and Endangered Species. Threatened (T) or endangered (E) species which might be found in the vicinity of the proposed action include the bald eagle (E), brown pelican (E), gulf sturgeon (T), Arctic peregrine falcon (T), and the Kemp's ridley (E), hawksbill (E), green (T), and loggerhead (T) sea turtles. These species may occasionally occur in the study area, but none is a permanent resident of the area. The American alligator, listed as a threatened species under the Similarity of Appearance clause of the Endangered Species Act, is commonly found in the less saline habitats of the study area.

Bald eagles might occasionally forage in the shallow water areas along the MR-GO, but none nests in the vicinity of the proposed project. The Arctic peregrine falcon might occasionally be seen in the project vicinity during winter migration. The brown pelican is a common resident of the coastal waters of Louisiana. Brown pelicans are expected to occur along the MR-GO during their feeding activities.

Gulf sturgeon have been recorded from Lakes Pontchartrain and Borgne and the rivers flowing into these lakes. Review of the scientific literature concerning the gulf sturgeon indicates that adults and juveniles may seasonally inhabit the portion of Lake Borgne in the vicinity of the proposed action.

Green sea turtles are occasionally observed in offshore waters of Louisiana and have been reported from inshore areas, west of the Mississippi River. Leatherbacks are apparently uncommon in the offshore waters of Louisiana, since very few strandings have been reported and live leatherbacks are seldom seen. They have not been reported from inshore waters of Louisiana. Kemp's ridley sea turtles appear to prefer habitats in the inshore areas of the Gulf of Mexico. Members of this genus are characteristically found in waters of low salinity, high turbidity, high organic-content, and where shrimp are abundant. Kemp's ridleys in the Gulf of Mexico tend to be concentrated around the major river mouths, specifically the Rio Grande and the Mississippi. Kemp's ridleys do not nest in Louisiana. Prior to the dramatic decline in their population, they were quite common in Louisiana waters. The possibility exists that ridleys may occur in the vicinity of the proposed project. Hawksbill sea turtles do not nest in Louisiana, and the few sightings and captures that have been recorded from Louisiana waters have all been offshore.

Table 1 presents the basis for significance of resources in the study area, and Table 2 provides information on how Congress, government agencies and the public have recognized these resources.

Table 1. Attributes of Significant Resources in the Vicinity of the Mississippi River- Gulf Outlet

Resource	Ecological Attributes	Cultural Attributes	Esthetic Attributes
WETLANDS	Provide nursery grounds for larval and juvenile fishes. Detrital output is a basic element of the food web.	Estuarine-dependent fisheries support traditional extractive economy of coastal Louisiana.	Typical Louisiana coastal wetlands setting.
WILDLIFE	Study area is utilized by numerous species of wildlife.	Supports traditional consumptive recreational activities (hunting) as part of our cultural heritage.	Viewing wild animals in their natural setting is esthetically pleasing.
FISHERIES	Fish and shellfish provide food source for many levels of the food chain.	Fish and shellfish gathering activities are valuable part of our cultural heritage.	Esthetically pleasing to view waters with large numbers of fish.
THREATENED AND ENDANGERED SPECIES	Rarity enhances significance of these species.	N/A	Individuals enjoy viewing of rare and endangered species.
RECREATION RESOURCES	The recreational harvest of fish and wildlife is an important ecological component.	Association with outdoors is part of culture of area.	Outdoor recreational activities flourish in areas of high esthetic quality.
CULTURAL RESOURCES	N/A	Indicators of history and previous inhabitants.	Many cultural resources have high esthetic value.

Table 2. Recognition of Significant Resources in the Vicinity of the Mississippi River- Gulf Outlet

Resource	Institutional Recognition	Technical Recognition	Public Recognition
WETLANDS	Coastal Zone Mgmt. Act of 1972, Estuary Protection Act, Clean Water Act of 1977, EO 11990, EO 11988, Fish and Wildlife Coordination Act.	Habitat for 14 species of special emphasis (USFWS). Louisiana is losing about 30 square miles of marsh per year.	Environmental organizations and the public support preservation of this habitat.
WILDLIFE	Clean Water Act of 1977, La Water Control Act, Fish and Wildlife Coordination Act, Coastal Zone Mgmt Act of 1972, La State & Local Coastal Resources Mgmt Act of 1978.	USFWS, NMFS, LDWF, LDNR, & USACE recognize value of waterfowl and wading bird habitat.	Environmental organizations and the public support the preservation of habitat for waterfowl and wading birds.
FISHERIES	La Water control Act, Fish/Wildlife Coordination Act, Coastal Zone Mgmt Act of 1972, La State & Local Coastal Resources Mgmt Act of 1978, EO 11988, EO 11990.	USFWS, NMFS, LDWF, & USACE recognize value of fisheries and good water quality.	Environmental organizations and the public support the preservation of water quality and fishery resources.
THREATENED AND ENDANGERED SPECIES	Endangered Species Act, Bald Eagle Act.	USFWS, NMFS, LDWF, & USACE cooperate to protect these species, Audubon Blue List recognizes rare species.	Public supports the preservation of rare or declining species.
RECREATION RESOURCES	Land and Water Conservation Fund Act of 1965.	Many fishing and hunting man-days are provided in study area.	Public makes high demands on recreation areas.
CULTURAL RESOURCES	National Historic Preservation Act of 1966, Archaeological Resource Protection of 1979.	Sites are present in the vicinity of the proposed action.	Preservation groups support protection and enhancement of historical resources.

Cultural Resources. In the past, various marsh types and cypress swamps were present in the study area. The subtropical climate of the study area is not significantly different from the area's climate in the past.

At present there are 30 known cultural resource locations along and near the MR-GO. These range in age from at least the Poverty Point period (1000 B.C.) to the Historic 19th Century. Sites range in type from shell middens to historic fortifications. One of these sites, Fort Proctor, is listed on the National Register of Historic Places, and several others have been determined eligible for inclusion in this National Register.

A boat and pedestrian survey of the MR-GO channel, dredged material disposal access canal, and disposal area retaining dikes was conducted in September and October 1978 (Wiseman, et. al., 1979). This survey located five new sites and five isolated finds. Three of the located sites were considered eligible for the National Register of Historic Places. In addition to the field survey, an extensive background literature search and review of previous archaeological work in the study area was conducted. Visits were made to many of the sixteen previously recorded sites located within one mile of the MR-GO. This survey covered the area immediately adjacent to the MR-GO channel and did not intensively survey the area located outside the then designated dredged material disposal areas.

Some researchers have felt that very few intact midden sites would be located in this coastal region, but this assumption has been proven invalid by a recent archaeological survey of a newly proposed dredged material disposal area located between the south shore of Lake Borgne and the MR-GO around the Bayou Dupre area (Earth Search, Inc. 1992). This survey not only located several previously unrecorded prehistoric sites, but also found significant intact prehistoric remains at three sites. All three of the sites were determined eligible for inclusion to the National Register of Historic Places.

Prehistoric and historic sites in the area tend to cluster around major bayous, relict channels, and along the shore of Lake Borgne. Analysis of the eastern side of the Mississippi River delta (St. Bernard) paleogeography suggests that while many sites in the area have probably been lost due to subsidence and alluviation, some intact sites still remain. Sites along the MR-GO cannot be considered in a vacuum, but rather must be seen in the light of the natural environmental and settlement systems of the times. The early establishment and continued importance of Shell Beach Bayou, Bayou Dupre, Shell Beach, and Doullut's Canal appear to have been due to their positions on main routes of travel between Lake Borgne and points west. This area remained favorably located with respect to several biotic zones for many centuries. The southeastern end of what is now the MR-GO became an important area for settlement from the Coles Creek period onward.

The area is especially rich in archaeological resources. William McIntire, who cored throughout the eastern delta as part of his research relating sites to delta development, discovered evidence of scores of sites having no surface expression. It should be recognized that any dredging activity and dredged material disposal beyond the current limits of the MR-GO channel have a high probability of uncovering buried cultural resources.

The known distributions of sites in the vicinity of the MR-GO suggest that certain sections are high probability areas for site occurrence. These are the Bayou La Loutre natural levees, Bayou Yscloskey, a probable distributary between Violet and Proctor Point, the junction of the GIWW and the MR-GO at channel mile 60 of the MR-GO, Bayou Pointe-en-Pointe to Grace Point, and the Shell Beach Bayou area.

Recreation Resources. The value of the MR-GO area for recreational resources is as high as the majority of coastal marshes. Numerous commercial boat launching areas that allow sportsmen access into the MR-GO and adjacent marsh areas are located in the vicinity of Yscloskey and Shell Beach. Consumptive recreational activities taking place in the study area include fishing, small game hunting, large game hunting, and waterfowl hunting, sport shrimping, and sport crabbing. Non-consumptive activities include boating, observation of nature and wildlife, and a minimal amount of water skiing.

The nearby state-operated Biloxi Wildlife Management Area is located north of the study area between Lake Borgne and Chandeleur Sound. Numerous bayous, sloughs, and potholes make this wildlife management area an excellent producer of fish, shrimp, and crabs; and good habitat for waterfowl. Besides hunting and fishing, other forms of recreation available include boating, crabbing, shrimping, skiing, and camping.

FUTURE WITHOUT-PROJECT CONDITIONS

ENVIRONMENTAL RESOURCES

Wetlands. The eventual loss of the buffering marsh adjacent to the MR-GO north bank will increase occurrences and the duration of periods of saltwater intrusion into the marsh surrounding Lake Borgne and that of the Biloxi State Wildlife Management Area. This would represent a significant loss of habitat to those species utilizing these marshes. The breaches through the marsh between Lake Borgne and the MR-GO and the greater amplitude of Breton Sound influences in the Lake Borgne area will result in more rapid change of the adjacent marshes from a brackish to a saline vegetation type. The dominant vegetation species in the brackish marsh, saltmeadow cordgrass, would be displaced by the more salt tolerant species, saltmarsh cordgrass. Correspondingly, species utilizing the predominant vegetation of these brackish marshes will be deprived of their natural food sources as these changes occur. Therefore, the change in marsh fauna will be accelerated also.

Interior marsh breakup will occur as a result of increased water movement if the problem of bank erosion is not addressed. As the interior marsh breaks up, the amount of edge habitat available to estuarine species begins to increase, but after a point the breakup would convert the interior marsh to open water.

The elevation of scrub/shrub habitats would decrease as subsidence takes place. These areas would be more susceptible to saltwater inundation during high tides. Scrub/shrub communities consisting of a variety of species, including palmetto, wax myrtle, and live oak, would be dominated by marsh elder.

Future erosion in the MR-GO project area would disrupt the shallow pond habitat within the interior marsh. The shallow estuarine pond habitat would increase in size and become more directly connected with the surrounding water bodies as erosion takes place. Pond depths would increase as more organic sediments are transported out of the marshes into adjacent water bodies. Without the addition of sediment, subsidence would cause the existing marsh to sink and become open water pond habitat. The salinity within the shallow ponds would increase due to more frequent inundation by high salinity gulf waters. Submerged aquatic vegetation would probably die off as interior ponds, which are only affected now by rainfall, break through and become susceptible to tidal fluctuation.

Wildlife. In the future without the proposed action, some wildlife would be displaced from their native communities to more favorable environments. As banks erode, marsh animals will move to adjacent areas where higher elevations exist. The carrying capacities for most species will most likely decrease in the study area. Animals which prefer food sources in a brackish marsh will migrate to areas where lower salinities exist.

Desirable migratory waterfowl species feeding on submerged aquatic vegetation would be displaced by undesirable waterfowl species which feed upon fish. In areas where three-cornered grass is replaced by saltmeadow and saltmarsh cordgrass, the muskrat will continue to be replaced by the nutria, which has already taken place throughout most of the study area.

Fisheries. In the future without the proposed action, the loss of an estimated 2,700 acres of marsh over the 50-year project life would also cause a reduction, through habitat loss and reduced detrital input, in productivity of the overall area for both fish and shellfish. Fish species which favor isolated, low-salinity, back-water ponds would be displaced to other areas. Larval and juvenile crabs and shrimp, which seek cover in the nearshore marsh edge, will be forced to open water where they would easily be consumed by predators.

As the marsh breaks up and the number of access channels leading into the marsh increases, the amount of edge habitat available to estuarine species increases. Until a critical marsh acreage is reached, this increase continues even as the total marsh area declines. Once reached, both the edge habitat and acres of marsh would decrease very rapidly. Eventually complete conversion of marsh to open water takes place. Increased open water reduces the amount of estuarine marsh habitat available to recreationally and commercially important finfish and shellfish species.

The increase in width caused by the erosion of the banks of the MR-GO would reduce the amount of marsh acreage in the study area. Because the MR-GO provides a direct route for saltwater from the Gulf of Mexico into the estuarine marshes, the increased width would allow more saltwater to enter the marsh. This would affect the species composition of the vegetation, wildlife, and fisheries.

Most of the material which is dredged to maintain the MR-GO is material which was sloughed off from the banks. In the future without the proposed action, increased maintenance dredging would disrupt fish and shellfish species which use the MR-GO for an access route and for spawning habitat.

Threatened and Endangered Species. In the future without the proposed action, the effects of maintenance dredging on threatened and endangered species would increase as the required maintenance dredging increases. The decrease in brackish marsh habitat, which is very likely in the future without the proposed action, would reduce the amount of feeding habitat available to the bald eagle, Arctic peregrine falcon, and the American alligator. Increased saltwater intrusion into the MR-GO project area would encourage sea turtles to enter inshore waters where they might be susceptible to pollutants occurring near urban outfalls.

Cultural Resources. In the future without the proposed action, cultural resources would continue to subside, degrade, and probably be further altered by wave-wash produced by vessel movements.

Recreation Resources. In the future without the proposed action, conversion of wetlands to open water would continue. The loss of ecologically important wetland habitat translates into a less productive habitat area for those species sought after by sportsmen. Losses due to increased salinities would result in a loss in the preferred habitat of the area and, in turn, a loss in the man-day usage by sportsmen hunting and fishing the area.

EVALUATION OF ENVIRONMENTAL EFFECTS OF PLANS

INTRODUCTION

Several alternative bankline protection plans have been evaluated in order to address the specific problems, opportunities, and planning objectives identified for this study. These plans consist of variations in both length of channel bank they protect (option) as well as the type of structure (design). The designs consist of various combinations and elevations of a filter fabric foundation, shell core, filter stone layer, armor stone layer, concrete block mat, and a separator filter fabric. For the purposes of this reconnaissance study, the environmental impact of each of the designs would be similar, except that some designs have a slightly larger footprint than others and that low level dikes would be more susceptible to wave overtopping than high level dikes. Among the alternatives, the environmental effects of the plans vary mostly by the length and location of bank they protect (option). Generally, the greater the extent of bank protection provided along the north bank, the greater the environmental beneficial effect. Bank protection along the south bank, while reducing erosion, would not provide significant environmental benefits. Nevertheless, the potential adverse environmental impacts of dike construction on both the north and south banks appear to be insignificant. The environmental effects of nonstructural plans, including vessel speed limits and closure of the channel to navigation, were not evaluated in this report.

For each alternative, the alignment of the bankline protection would be parallel to the channel and would follow the -3.0 foot NGVD contour. If necessary, flotation channels would be excavated between this contour and the MR-GO channel for barge access to place the rock. Bankline protection would prevent existing marsh from being eroded into the MR-GO. Approximately 18 acres of marsh on the north bank would be saved per mile of protection every 10 years. During future maintenance dredging, dredged material would be selectively placed between the eroded north bank and the bankline protection structure. This would create an average of 18 acres of marsh per mile of protection along the north bank of the MR-GO.

The overall effect of implementation of bank erosion abatement measures would be overwhelmingly positive. The measures would substantially reduce erosion and marsh loss, and would allow for restorateion of marsh with material dredged during channel maintenance. Some minor adverse impacts are possible; for example, where structural bank protection measures are discontinuous, erosion could be intensified due to wave diffraction from the structures. During the feasibility phase study, consideration will be given to engineering the ends of the bank protection structures to counter this effect and reduce other potential adverse impacts.

Navigation gaps would be provided in the bank protection structure at the locations of major waterways, such as Bayous Dupre, Bienvenue, and Yscloskey. Wave action and surges from passing vessels will be transmitted into these natural bayous and material may be drawn into the MR-GO through the openings. Small waterways which enter the marsh would be closed off, but major streams and bayous would remain open so that some tidal exchange would occur.

The six options (including Options 3A and 4A) for the extent of bank protection that are under investigation are described below.

• Option 1--MR-GO Critical Reaches. Option 1 provides for bank protection for three reaches along the MR-GO which have been designated "critical" based on the potential for eminent loss of the buffering marsh between the MR-GO and Lake Borgne. They also include the most frequently maintenance dredged sections of the inland portion of the waterway. These reaches total about 10 miles and would take about one year to construct. Reach 1 extends approximately 2 miles along the north bank from mile 56 to 54. Structural protection was recently constructed along the north bank between miles 54 and 51. The second reach extends a total of approximately 3 miles along the north bank from mile 43 to mile 38.5 with a 1.5-mile gap between miles 40.5 and 39. The third reach extends from mile 29.5 to mile 23 with a 1.5-mile gap between miles 28.5 and 27. Bank protection would be placed on the north bank from mile 29.5 to mile 28.5 and on the south bank from mile 27 to mile 23.

• Option 2--MR-GO North Bank mile 60 to mile 27, South Bank mile 27 to mile 23. Option 2 provides for the construction of bank protection dikes along the unprotected length of the north bank between miles 60 and 27, and the south bank from mile 27 to 23. The reason for locating the structure along the south bank for this 4-mile section is that for this reach the channel is significantly deeper along the north bank and the cost of placing a structure here would be correspondingly higher. The north bank currently has protection constructed from mile 54 to 51. Structural bank protection would be provided for a distance of roughly 34 miles. This option would take 5 years to construct. The bank protection structure would parallel the current bank as much as possible. Major streams and bayous would remain open; however, many small waterways which enter the marsh areas on the north bank of the MR-GO would be closed.

• Option 3--All Unleveed Reaches of the MR-GO. Option 3 would provide for the construction of bank protection structures along the north bank of the MR-GO from mile 60 to mile 23, with the exception of miles 54 to 51 which already have structural protection in place, and along the south bank from mile 47 to mile 23. This plan would essentially provide bank stabilization measures along both banks along the entire length of the MR-GO where erosion problems exist. This option would take eight years to construct. The unleveed MR-GO south bank, from mile 47 to mile 23 fronts a dredged material disposal area which parallels the channel and is approximately 2,000 feet deep and approximately 6,000 total acres in area. Bank erosion on the south bank in this reach is less severe than on the north bank. The lower erosion rate of bank relative to the north bank results from the periodic placement of dredged material in the south bank disposal area. Because the northern side of the channel is significantly deeper from mile 27 to mile 23, an Option 3A which would not include structural protection along these four miles of the north bank was also evaluated.

• Option 4--MR-GO North Bank mile 60 to mile 27. This option would be the same as the north bank portion of Structural Option 2 and would take 5 years to construct. Option 4 would not include protection along the south bank. This option was considered because, although protecting miles 27 to 23 of the south bank would reduce the channel shoaling rate, it would not contribute to the reduction in marsh loss rates due to the distance between existing marsh and the channel bank in this area. To include a plan which would be more affordable to a potential non-Federal sponsor, Option 4A was evaluated. This plan would provide the same channel protection as Option 4; however, for Option 4A the construction period was extended from the 5 years scheduled for Option 4 to 10 years.

WATER QUALITY

The implementation of bank erosion reduction measures along the MR-GO is not likely to significantly alter general water quality conditions. Temporary increases in turbidity and suspended solids concentrations would occur during construction. Temporary pH changes and dissolved oxygen deficits might also occur during construction. The future condition of the stabilized banks would significantly reduce rates of erosion, and result in lowered amounts of nonpoint pollution from that source, thereby improving water quality.

WETLANDS

The proposed alternatives would affect wetlands by reducing the current rate of bankline retreat which averages 15 feet per year. Bank protection would save approximately 18 acres of wetlands, per mile of protection, every 10 years. Dredged material would be selectively placed between the eroded north bank and the bankline protection structure. This would create an average of 18 acres of wetlands per mile along the north bank of the MR-GO and would partially alleviate the problem of subsidence.

Erosion of wetland habitats would not take place as rapidly because the bankline protection would reduce the water movement caused by diurnal tides, wind driven tides, and ship wakes. Subsidence of these wetlands would continue to occur, but not as rapidly because underlying sediments would not be lost to the MR-GO channel.

The deposition of maintenance dredged material would be beneficial to nourish the marsh and fill in open water areas. Although portions of the existing marsh would be covered by dredged material and the existing fauna buried or forced to evacuate the area, the additional sediment in this subsiding area would provide more diversity and increased habitat for a variety of species.

• Option 1. Option 1 would place bankline protection along three reaches that have been determined to be critical locations on the MR-GO. This option would protect 6 miles of marsh bankline along the north bank and prevent 4 miles of bankline along the south bank from eroding into the channel. These locations are critical because they are adjacent to other major water bodies (Lake Borgne and Breton Sound) and continued bankline retreat would directly connect these water bodies to the MR-GO. These reaches are also critical because rapid bankline retreat is taking place and frequent channel maintenance is required to remove the material which is eroded from the banks. In addition, this alternative would enhance wetlands in the three critical locations by retaining sediments from the area which would normally be carried into the MR-GO channel.

With the alternative in place, the current erosion rate of 15 feet per year along critical reaches of the north bank would be stopped and approximately 540 areas of marsh would be saved over the 50 year life of the project. Maintenance dredging would create approximately 108 acres of wetlands along the north bank of the MR-GO. The wetlands along the MR-GO, that are not in the three critical reaches, would continue to erode at their present rate.

• Option 2. Like option 1, this alternative would reduce erosion of wetlands along the north bank by retaining sediments which would normally be carried into the MR-GO channel, except that it would involve an additional 24 miles of protection on the north bank. Bank protection would reduce the water movement, within the marshes and wetland habitats, caused by tidal fluctuation and ship wakes. Subsidence of these wetlands would continue to occur along the entire north bank of the MR-GO, but not as rapidly because underlying sediments would not be lost to the MR-GO channel.

The deposition of maintenance dredged material would be beneficial to nourish the marsh and fill in open water areas. Although portions of the existing marsh would be covered by dredged material and the existing fauna buried or forced to evacuate the area, the additional sediment in this subsiding area would provide more diversity and increased habitat for a variety of species.

This alternative would protect 30 miles of marsh bankline along the north bank and prevent 4 miles of bankline along the south bank from eroding into the channel. The current erosion rate of 15 feet per year along the north bank would be stopped and approximately 2,700 areas of marsh would be saved over the 50-year life of this project. Approximately 540 acres of wetlands along the north bank of the MR-GO would be created, through the placement of maintenance dredged material, between the eroded bankline and the bank protection structures.

• Option 3. Option 3 would protect the same reaches on the north and the south banks as Option 2, however, additional protection would be placed along the north bank from miles 23 to 27 and also along the unleveed portions of the south bank of the MR-GO from mile 27 to mile 47.

This alternative would reduce erosion of wetlands along the north bank to the same degree as Option 2. The additional protection from miles 23 to 27 would reduce the amount of channel shoaling but would not preserve additional marsh. Bank protection along the south bank of the MR-GO would reduce bank erosion by retaining sediments which would normally be carried into the MR-GO channel. However, this bank erosion would not result in a loss of wetlands due to the distance between the south bank and existing wetlands on the south side of the channel. Rock protection along the north bank from miles 23 to 27 would reduce the shoaling rate of the MR-GO, as well as reduce the wave fetch which is carried across Lake Athanasio and impacts the south bank of the MR-GO. Bank protection along the unleveed portions of the south bank would reduce the conversion of scrub/shrub habitats to marsh habitats and marsh habitats to open water habitats. Many areas along the south bank of the MR-GO which are influenced by pumping station outfalls in St. Bernard Parish would retain freshwater for longer periods of time because of the closure of many small waterways entering the marsh. Freshwater species of aquatic vegetation would colonize these open freshwater ponds.

This alternative would protect 30 miles of marsh bankline along the north bank and prevent 24 miles of bankline along the south bank from eroding into the channel. The current erosion rate of 15 feet per year along the north bank would be stopped and approximately 2,700 areas of marsh would be saved over the 50-year life of this project. Maintenance dredging would create approximately 540 acres of wetlands along the north bank of the MR-GO.

• Option 3A. Option 3A would protect the same reaches on the north and the south banks as Option 3; however, no protection would be provided between miles 23 and 27 on the north bank, due to its higher cost.

This alternative would protect 30 miles of marsh bankline along the north bank and prevent 24 miles of bankline along the south bank from eroding into the channel. The current erosion rate of 15 feet per year along the north bank would be stopped and approximately 2,700 areas of marsh would be saved over the 50-year life of this project. Maintenance dredging would create approximately 540 acres of wetlands along the north bank of the MR-GO.

• Option 4. Option 4 would protect the same reaches on the north bank as Option 2; however, no bank protection would be placed along the south bank of the MR-GO. This alternative would reduce erosion of wetlands along the north bank to the same degree as Option 2. This option would not reduce the conversion of scrub/shrub along the south bank to other habitat and subsequently to open water.

This alternative would protect 30 miles of marsh bankline along the north bank. The current erosion rate of 15 feet per year along the north bank would be stopped and approximately 2,700 areas of marsh would be saved over the 50-year life of this project. Maintenance dredging would create approximately 540 acres of wetlands along the north bank of the MR-GO.

• Option 4A. Option 4A would protect the same reaches on the north and south banks as Option 4. Therefore, once fully constructed, this plan would create an equal number of acres of marsh and would provide the same reduction in the erosion rate. However, due to the extended construction period, under this option an additional five years would be required to provide a fully functional project.

WILDLIFE

The proposed alternatives would directly benefit wildlife by reducing the current rate of bankline retreat. The reduction in bankline retreat would slow interior marsh break up and the conversion of wetlands to open water. Wildlife would benefit from the stabilization of brackish and saline marsh, as well as scrub/shrub habitats. Migratory waterfowl and wading birds, utilizing interior marsh ponds, would benefit from stabilized water levels and reduced saltwater inundation which would promote the growth of aquatic vegetation. The greater the extent of bank protection, the greater the beneficial effect on wildlife.

Interior marsh pond habitat would be partially isolated from fluctuating water levels caused by tidal and wind action because the bank protection would close off many of the small waterways which provide direct access to these interior ponds. Drastic salinity changes would be reduced and aquatic vegetation requiring low salinities would colonize. Many of the interior marsh ponds adjacent to the critical reaches could be dominated by freshwater from rainfall rather than saltwater from tidal fluctuation. Migratory waterfowl and wading birds, utilizing the interior marsh ponds, would benefit from stabilized water levels and the growth of aquatic vegetation.

Bankline retreat, that is occurring along the north bank of the MR-GO, causes scrub/shrub habitat to become marsh habitat and marsh habitat to become shallow open water habitat. The gradual reduction in habitats with higher elevations results from erosion and subsidence. Bank protection would retain sediments which would normally be carried into the MR-GO channel. Small waterways which enter the marsh would be closed off which would reduce the water movement, within the marshes and wetland habitats, caused by tidal fluctuation and ship wakes.

•Option 1. Option 1 would place bank protection along three reaches of the north and south banks that have been determined to be critical locations. The bankline retreat that is occurring in these reaches is converting scrub/shrub habitat to marsh habitat and marsh habitat to shallow open water habitat at a very rapid rate. Terrestrial species such as raccoons, swamp rabbits, white-tailed deer, and wild hogs would benefit through the protection of existing terrestrial habitats and through the creation of additional habitat using dredged material in the critical reaches. Because this alternative would benefit only portions of the bankline along the MR-GO, only minimal effects on saltwater intrusion from tidal fluctuation and wave action would be achieved.

• Option 2. Like Option 1, this alternative would provide beneficial effects to wildlife, except that the effects would extend along 30 miles of the north bank. Terrestrial species, like raccoons and swamp rabbits, which inhabit the higher scrub/shrub habitats along the entire north bank of the MR-GO would benefit from the reduction in bankline erosion. White-tailed deer and wild hogs which inhabit certain reaches of the north bank would benefit through the protection of existing terrestrial habitats and through the creation of additional habitat using dredged material.

• Option 3. This alternative would benefit wildlife along the north bank to the same degree as Option 2; however, additional wildlife benefits would be derived from the greater extent of bankline protection along the unleveed portions of the south bank of the MR-GO. During the construction and past maintenance of the MR-GO, the dredged material was placed along portions of the south bank of the MR-GO. This has created abundant upland habitats for white-tailed deer, swamp rabbits, and wild hogs. Bank protection along the unleveed portions of the south bank would reduce the conversion of scrub/shrub habitats to marsh habitats and marsh habitats to open water habitats. Many areas along the south bank of the MR-GO which are influenced by pumping station outfalls in St. Bernard Parish would retain freshwater for longer periods of time because of the closure of many small waterways entering the marsh. Freshwater species of vegetation would colonize creating food supplies for migratory and resident waterfowl.

• Option 3A. This alternative would benefit wildlife along the north and south banks to the same degree as Option 3.

• Options 4 and 4A. These alternatives would benefit wildlife along the north bank to the same degree as Option 2. No wildlife benefits would be derived along the south bank.

FISHERIES

The proposed alternatives would directly benefit fisheries by reducing the current rate of erosion of nursery fisheries habitat. The break-up of marsh and the conversion of marsh to open water creates more access routes, for larval and juvenile fishes, into the marsh. This process increases the nursery habitat available for estuarine species, but after prolonged marsh break-up and erosion, the amount nursery habitat decreases. Bank stabilization would reduce the bankline retreat rate which would slow interior marsh break-up and the conversion of wetlands to open water. Fisheries would benefit from the stabilization of brackish and saline marsh. Fish which utilize interior marsh ponds would benefit from stabilized water levels and reduced saltwater inundation. Fisheries access into nursery marsh habitats would be hindered by the closure of many of the small waterways which lead into the marsh; however, the reduction in water flow through the marsh would reduce the rate of marsh breakup and prolong the existence of the marsh.

Portions of the interior marsh pond habitat would be partially isolated from fluctuating water levels and saltwater influence. Drastic salinity fluctuations would be reduced and aquatic vegetation favoring lower salinities would colonize, creating cover for fish and shellfish species. Many of the interior marsh ponds would become isolated from estuarine species; however, the major streams and waterways would remain open for access by estuarine species. The construction of bank protection structures along the MR-GO would decrease the frequency of maintenance dredging and the associated minor turbidity increases. Less dredging corresponds to a decrease in the turbidity impacts to fisheries.

The construction of a bank stabilization structure would result in adverse impacts through coverage of existing benthic habitat. However, placement of rip-rap or similar materials would create numerous micro-environments similar to jetties that, particularly below the typical marsh level, are utilized by various marine organisms. Organisms using jetties commonly include the sea anemone, barnacle, and sea roach. Mollusks, such as periwinkles, slipper shells, dove shells, oyster drills, mussels, and oysters are present. Decapods, such as fiddler, hermit, stone, and blue crabs are common inhabitants of jetties. These organisms, which are all at an intermediate position in the marine food web, would be beneficially impacted by the rock placement as a construction feature. The excavation of flotation channels between the -3.0-foot NGVD contour and the MR-GO channel would disrupt benthic habitat for fish and shellfish species. The deposition of dredged material from the flotation channels would smother benthic habitat; however, recolonization would occur within a short period of time. The deposition of dredged material over a large area of open water would cause adverse impacts through coverage of existing habitat, but would also insure the existence of a quantity of the diminishing marsh resource and thus would be more positive than negative.

• Option 1. Estuarine species such as spotted seatrout (speckled trout), red drum (red fish), sheepshead, Atlantic croaker, silver perch, spot, blue crabs, and brown and white shrimp would benefit through the protection of existing wetland habitats and through the creation of additional marsh habitat using dredged material in the critical reaches.

Within the critical reaches, portions of the interior marsh pond habitat would be partially isolated from fluctuating water levels and saltwater influence. Drastic salinity changes would be reduced, and aquatic vegetation favoring lower salinities would colonize. Even though many of the interior marsh ponds would become isolated from estuarine species, sailfin mollys and gulf, bayou, and longnose killifish would probably colonize these ponds.

The minor turbidity increases associated with the frequent maintenance dredging and disposal operations in the critical reaches would be decreased with the placement of bank protection because dredging would occur less frequently. The decreased dredging corresponds to a decrease in the dredging impacts to fisheries. The presence of bank protection structures would benefit fisheries by increasing habitat diversity. The hard structures would provide surface areas for attachment by oysters and mussels, as well as hiding places for prey organisms (brown and white shrimp, blue and stone crabs, and various small fishes).

• Option 2. Like Option 1, estuarine fish and shellfish species would benefit from the protection of existing nursery habitats and from the creation of additional marsh habitat using dredged material, except that the effects would extend over 24 additional miles of the north bank. The presence of bank protection structures would benefit fisheries by increasing habitat diversity over a wider range than Option 1. The structures would provide hard surface areas for attachment by oysters and mussels, as well as small protected environments for prey organisms and juvenile stages of fish.

• Option 3. For miles 27 to 60, this alternative would benefit fisheries along the north bank to the same degree as Option 2. Significant additional fisheries benefits would be derived from placing hard protection structure in the open water of the north bank from miles 23 to 27. The water depth in this reach is 16 feet, and the presence of rock would create habitat similar to the rock jetties at the mouth of the MR-GO in Breton Sound. The existing fisheries habitat would be enhanced from protecting the bankline along the south bank from miles 23 to 47. Fisheries habitat would be created along the south bank by the placement of bankline protection. This structure would function as hard substrate for the attachment of oysters and mussels, and as juvenile fish and shellfish habitat which would be protected from predators.

• Option 3A. Option 3A would benefit fisheries along the same reaches on the south bank as Option 3; however, no protection would be provided between miles 23 to 27 on the north bank.

• Options 4 and 4A. These alternatives would benefit fisheries along the north bank to the same degree as Option 2; however, no fisheries benefits would be derived along the south bank.

THREATENED AND ENDANGERED SPECIES

The proposed alternatives would benefit threatened and endangered species by decreasing the rate of bankline erosion and by improving wetlands habitat along the MR-GO. Bank protection would slow interior marsh break up and the conversion of wetlands to open water. Threatened and endangered species would benefit from the increased stabilization of brackish and saline marsh which act as productive feeding habitats for brown pelicans, Arctic peregrine falcons, and bald eagles.

While recognizing the possibility that some species of sea turtles forage in the proposed project area, the turtles should be able to escape any of the short term impacts that the project would produce. Short term impacts would include increased turbidity and a reduction in benthic habitat from the placement of the bankline protection and from the excavation of flotation channels. While these impacts could cause a temporary problem for benthic and planktonic organisms, mobile organisms such as sea turtles would be able to escape the area during dredging operations. Sea turtles are rare in Louisiana's inshore waters. Most reported occurrences of sea turtles in Louisiana are in offshore waters. The benefits of bankline protection include decreased shoaling rates and the creation of additional sea turtle foraging habitat from the placement of hard substrate along the bankline. Decreased shoaling rates correspond to less frequent dredging of the MR-GO. This would further reduce the minor potential for impacts on sea turtles and their prey items.

• Option 1. The placement of bankline protection along the three critical reaches would protect a limited amount of scrub/shrub and marsh habitat. This alternative would increase feeding habitat in the shallow marsh pond habitats for brown pelicans, Arctic peregrine falcons, and bald eagles. The additional habitat which is created or preserved for fisheries and wildlife would benefit endangered species in the critical reaches of the MR-GO. Bankline protection along the south bank could increase the foraging habitat for sea turtles.

• Option 2. Bankline protection along the north bank of the MR-GO would protect scrub/shrub and marsh habitat from erosion and saltwater intrusion. This alternative would increase feeding habitat along the north side of the MR-GO for brown pelicans, Arctic peregrine falcons, and bald eagles. The additional habitat which is created or preserved for fisheries and wildlife would also benefit endangered species. Bankline protection along the south bank could increase the foraging habitat for sea turtles. Bankline protection would decrease the shoaling rate of the MR-GO which would increase the time period between maintenance dredging events. Fewer maintenance dredging cycles would decrease the potential effects on sea turtles.

• Option 3. For miles 27 to 60, this alternative would benefit endangered species along the north bank of the MR-GO to the same degree as Option 2. Additional benefits would be derived from placing protection in 16 feet of water between Lake Athanasio and the MR-GO (miles 23 to 27) and from protecting a greater amount of the bankline along the south bank of the MR-GO (miles 23 to 47)

• Option 3A. This alternative would benefit endangered species along the south bank of the MR-GO to the same degree as Option 3; however, no benefits to endangered species would be provided along miles 23 to 27 of the north bank.

• Options 4 and 4A. These alternatives would benefit endangered species along the north bank of the MR-GO to the same degree as Option 2; however, no bankline along the south bank of the MR-GO would be protected, and the benefits would be correspondingly reduced.

CULTURAL RESOURCES

Implementation of a structural alternative could affect existing and as yet unidentified cultural resources. Definition of project effects (both direct and indirect) must await selection of construction plans and impact zone definition. Project effects on Fort Proctor and other significant sites must be considered. The determination of whether project effects are adverse to cultural resources would be ascertained from construction plans and impact zones as well as cultural resource assessments of significance of archeological sites located in the project area. All cultural resource work will be conducted in consonance with Federal cultural resource laws and regulations such as the Natural Historic Preservation Act, as amended in 1992.

RECREATION RESOURCES

Alternatives that would reduce bank erosion or restore eroded marsh should benefit fish and wildlife and in turn, sport hunting and fishing activities that are dependent on marsh habitats. With the eventual placement of dredged material behind linear bank retaining dikes, marsh would be created. It is possible that areas would exist that would trap rainwater and form marsh impoundments of value to waterfowl and marsh-oriented wildlife. Development of these retaining dikes would reduce bank erosion and saltwater intrusion which are adversely affecting the recreational environment. Additional bank erosion and possible large breaches of the buffering marsh between the MR-GO and Lake Borgne would be prevented. Recreational hunting and fishing activities would benefit from the rebuilding of these productive marsh habitat types.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES

Based on a cursory review of aerial photography, the potential for the presence of hazardous, toxic, and radioactive waste (HTRW) along the MR-GO is low. While aerial photography reveals the presence of industry adjacent to the study area along the Inner Harbor Navigation Canal and in the Chalmette-Arabi area, no industry exists along the banks of the MR-GO in the areas where bank stabilization is proposed. These wetland areas do not appear to have historically undergone any industrial development. An initial assessment of HTRW will be conducted during the feasibility phase. The initial assessment will determine the likelihood of HTRW in the project area through an analysis of historical records, including any records of maritime accidents in the area which could have resulted in the release of hazardous, toxic, and radioactive wastes. The assessment will also include analysis of land use studies, and aerial photography.

NON-MONETARY BENEFITS OF WETLANDS

Wetland Value Assessment. The Wetland Value Assessment (WVA) is a tool to determine the quality and quantity of wetlands protected or created by a wetland restoration project. It was developed by a team of Federal biologists led by the U. S. Fish and Wildlife Service. The following variables were assumed to characterize a typical marsh: percent vegetated wetlands, percent submerged aquatic vegetation, interspersion of marsh and water, percent equal to or less than 1.5 feet deep, salinity, and fishery access. A suitability graph for each variable expresses the relationship between the measured variable and a suitability index of 0 to 1.0. The suitability indices for each variable were then combined into a single value of habitat quality called Habitat Suitability Index (HSI). To determine the net benefits to vegetated wetlands, two scenarios, future conditions with and future conditions without the project, were compared. Predictions were made as to what model variables would be at various target years with and without the project. HSI were calculated for each target year for each scenario. These HSI's were multiplied by acres of the benefitted area to produce Habitat Units (HU's) for each target year. These HU's represent a combination of habitat quality (HSI) and quantity (acres). The HU's were annualized over the project life for each scenario, and then compared to determine the net benefit of the project in Average Annual Habitat Units (AAHU's). A detailed explanation of the calculations used by USFWS to compute AAHU's follows in Part 2 of this appendix.

The 1993 version of the WVA indicated that a net of 2,786 AAHU's would be produced by Options 2, 3, 3A, 4 and 4A, which protect at least 30 miles of bankline along the north bank of the MR-GO. As stated previously, the protection that Option 3 would provide for the north bank from channel mile 23 to mile 27 would not preserve additional marsh. The WVA for Option 1 indicated that a net of 557 AAHU's would be created for 6 miles of bankline in the critical reaches of the MR-GO. These AAHU's represent a mixture of habitat quality and quantity.

Marsh Benefits. The greatest benefit provided by a marsh is probably the dead or decaying organic matter that is contributed to estuarine systems. Half of the organic matter, detritus, that is produced by a marsh is consumed within the marsh and half enters the water (Teal 1962, Golley et al. 1962). The detritus in an estuary can be separated into suspended material and material that has settled on the bottom, but this separation constantly fluctuates depending on the water turbulence (Day et al. 1973). In the case of the marsh along the MR-GO channel, this detritus eventually finds its way into larger inland water bodies and the Gulf of Mexico through the bayous and canals that drain the marshes. Studies have shown that biomass peaks of zooplankton, larval shrimp, and larval fishes are fueled by the high loss rate of detritus from the marsh (Kirby 1972). In the estuary and in the open gulf, productivity is increased in areas where detritus, carrying nutrients, enters the system. The entire food chain is dependent, in one way or another, on the marsh and the nutrients it produces.

Marshes are very efficient in the method in which carbon dioxide is utilized during photosynthesis to produce oxygen. Most of the plants in a brackish marsh, such as those found along the MR-GO channel, exhibit photosynthesis which follows the C4 biochemical pathway, whereas upland plants and scrub/shrubs use the C3 photosynthetic pathway. The C4 photosynthetic pathway is an advantageous adaptation which allows wetland plants, such as Spartina alterniflora, S. patens, and Distichlis spicata, to flourish during intense conditions of temperature, sunlight, and salinity.

Sediment retention is an important wetland attribute with valuable functions. Suspended clays, silts, and organic particles settle out in the brackish and intermediate marshes as a result of the mixing of fresh and salt water. This process occurs in the estuaries along the MR-GO. Brackish and intermediate marshes store these precipitated particles which contribute to future marsh growth and serve as input to the base of the food chain. These marshes also provide an area where contaminants can be assimilated by bacteria which naturally occur within an estuary. Marshes have the capacity to retard saltwater intrusion by creating a resistance to the constant fluctuation of water levels caused by tidal, wind, and wave action.

Over the 50-year life of the project Option 1 would prevent the loss of 540 acres of marsh along the 6 miles of the north bank of the MR-GO (see Table 3). Options 2, 3, 3A, 4, and 4A would prevent the loss of 2,700 acres of marsh along 30 miles of the north bank of the MR-GO. Although Option 3 would protect an additional 4 miles of the north bank (channel miles 23 to 27), it would not protect additional marsh due to the depth of the open water bordering this reach. Due to the distance between the existing marsh and the south bank, this bank is not expected to erode into the marsh over the project life; therefore, protecting this bank would not preserve additional acres of marsh. The three miles of rock dike built in 1993, from miles 51 to 54, would prevent bankline erosion for approximately 50 years. In addition to halting bankline erosion, the rock dike would reduce the ship-induced wave surge that moves up to 3/4 miles inland and causes loss of interior marsh.

Table 3

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH ACRES CREATED

RATE OF INTEREST= 8.25% 1992 VALUE PER ACRE= $4,471

SCHEDULE OF ACRES CREATED BY CONSTRUCTION & DREDGING WITH 2 YEAR LAG TIME

YEAR	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
2002	18	23.5	23.5	23.5	18.6
2004					74.5
2005	9				
2006		187.8	187.8	187.8	
2006	36				
2013		47.0	47.0	47.0	37.2
2015	18				
2017					28.0
2018	27				
2018		11.7	11.7	11.7	9.3
2019		35.2	35.2	35.2	28.0
2021		47.0	47.0	47.0	37.2
2022		35.2	35.2	35.2	
2023					9.3
2026					149.0
2026		93.9	93.9	93.9	74.5
2033		11.7	11.7	11.7	
2043					37.2
2048		47.0	47.0	47.0	37.2

Food Chain Benefits. Many of the lower trophic levels of the food chain are not measurable in terms of recreational, commercial, or esthetic contributions. The protection of wetlands and the creation of additional marsh along the MR-GO would contribute to the base of the food chain from which all higher trophic levels are dependent.

Marshes adjacent to the MR-GO contribute nitrogen (N), phosphorus (P), and carbon (C), obtained from sediments and the atmosphere, to the estuary in the form of leachates and detritus. These elements are utilized by the primary producers, including phytoplankton, diatoms, and marsh vegetation, which form the base of the food chain. Phytoplankton are essential to aquatic organisms because they are the primary organisms which convert carbon dioxide and water to carbohydrates and oxygen in the presence of sunlight, through photosynthesis. The next level of the food chain, zooplankton, is composed of small organisms that feed upon phytoplankton and suspended pieces of organic detritus. Organisms classified as zooplankton include the copepods, primarily Acartia tonsa, the larval crab stages (zoea and megalops), and the larval stages of brown and white shrimp. The next level of the food chain includes the plankton eaters, which filter feed throughout the water column, and larval fish, which may filter feed or selectively feed on zooplankton.

The sediments within the coastal wetlands adjacent to the MR-GO are composed primarily of dead organic matter. Small pieces of detritus, as well as the associated diatoms, bacteria, and minute flagellates are consumed by meiobenthic and macrobenthic organisms. The meiobenthos is composed of amphipods, harpacticoid copepods, ostracods, nematodes, and small polychaetes which inhabit submerged sediments. The macrobenthos is made up of those organisms which live on the substrate and includes clams, oysters, snails, small blue crabs, fiddler crabs, and mussels. These higher trophic levels would benefit from measures to protect and restore marsh along the MR-GO.

Wildlife Benefits. Migratory shorebirds, wading birds, ducks, and geese utilize marshes in the study area, enroute to northern breeding grounds and to Central and South American wintering grounds. Puddle ducks generally concentrate in fresh and intermediate marshes, although diving ducks prefer brackish and saline open water habitats. Birds are considered top carnivores in the estuarine system, although they will feed upon all levels of the trophic system. The diet of shorebirds consists of fish and shrimp, as well as macro and meiobenthic organisms, including small polychaetes and crustaceans. White pelicans feed almost exclusively on small fish with little commercial value, although menhaden do comprise a small portion of their diet (Palmer 1962). Puddle ducks feed almost entirely on submerged aquatic vegetation, but also consume emergent vegetation, snails, insects, and fish. However, diving ducks tend to take a larger proportion of animal material (Stieglitz 1966). The only waterfowl species which is a permanent resident of the coastal marshes along the MR-GO is the mottled duck. Many nongame species of seabirds and wading birds, such as ibises, ospreys, hawks, and gulls establish nesting colonies in the brackish and saline marshes adjacent to the MR-GO. Many species of birds serve an important function within wetlands by consuming a wide range of fish species, both live and dead. Birds convert animal protein to nutrients, which are especially important to marshes and barrier islands, which may be out of the normal nutrient and tidal exchange process. Bankline protection, which regulates the hydrological regime of an area, may seasonally diminish the abundance of some prey species and intensify both inter-specific and intra-specific competition for resources in adjacent unprotected bankline wetland areas.

Bank stabilization along the MR-GO would create an area between the bank protection structures and the eroded bankline for the deposition of dredged material. Maintenance dredged material would be used to create marsh along the eroded bankline and in open water ponds which have broken through the marsh and become confluent with the MR-GO waterway. This created marsh would thus benefit wildlife as described above.

Fisheries Benefits. The large expanse of saline, brackish, and intermediate marshes in the study area allows a buffer zone to develop between fresh water and high salinity gulf water where fish, shrimp, oysters, and crabs can find the proper salinity to live throughout their larval, juvenile, and sub-adult stages. The stability within the interior marsh provides a nursery habitat favorable to the production of estuarine organisms. Some species (spotted seatrout and black drum) spawn in the MR-GO and in the deep bayous which enter the MR-GO. The larvae of many offshore spawners (redfish, Atlantic croakers, blue crabs, and brown and white shrimp) migrate, either freely or by currents, into marshes to live and grow throughout their life stages. Once inshore the larvaė reside in the saline, brackish, or intermediate marshes depending on the species' salinity tolerance and food availability. The interior marsh provides a stable habitat which may resist changes in water levels, salinity, temperature, and water movement. The interface between the marsh and the water creates an edge habitat where larval and juvenile fishes can find cover, food, and favorable environmental conditions (water depth, temperature, dissolved oxygen, current speed, and turbidity). This stable nursery habitat allows species to maintain their position in the estuary until they become adults. The larvae of many species, which spawn during the winter months, such as spot and flounder, remain in the estuary throughout the spring and summer months. During the warmer months, larval and juvenile fish and shellfish species experience the most rapid growth. The marshes are critical to the successful completion of the life cycles for these species.

Most estuarine species of fish, shrimp, and crabs reproduce in extremely large numbers in which very little care is given to young. In an estuary, all species are vulnerable to predation within some stage of their life. The larval and juvenile stages of most estuarine species provide an important food source for other estuarine organisms. Wetlands increase the amount of habitat available for all estuarine species to find both food and protection from predators. Marsh which is created along the MR-GO would prolong the abundance of certain species and create additional habitat for increased numbers of shrimp, fish, and crabs.

Other Environmental Benefits. Marshes provide hurricane and storm surge buffering capacity. Coastal wetlands absorb large amounts of wave energy and hold large quantities of water that would otherwise allow storms to do much more damage inland. The long-term climatic change which is expected to occur due to global warming will cause sea-level rising. Wetlands also provide natural flood control by detaining and by slowing floodwaters which reduces the intensity and destructiveness of flooding. Wetland vegetation anchors shorelines and reduces the amount of erosion that would normally take place along an unvegetated bankline.

Wetlands are among the world's most biologically productive ecosystems and are crucial as habitats for fish and wildlife. The productivity of a wetland system, in terms of the organic material from which all aquatic food sources originate, is two to three times greater than the most fertile agricultural cropland (Coreil 1993). Wetlands on or near croplands have the capacity to remove fertilizer nutrients from runoff water, reducing the pollution of groundwater, lakes, rivers, and streams. Wetland plants have the ability to remove nitrogen and phosphorus from wastewater. Many species which are classified as threatened or endangered, such as the brown pelican and bald eagle, depend on wetlands for permanent residence or seasonal habitats during migration. The diversity of wetland systems supports many varieties of living organisms and the genetic variation within populations. This process is termed biodiversity, which is important to humans because of the contributions that different organisms make to medicine, agriculture, and a variety of sciences.

COASTAL WETLAND PLANNING, PROTECTION,

AND RESTORATION ACT

WETLAND VALUE ASSESSMENT METHODOLOGY AND COMMUNITY MODELS

Developed by the Environmental Work Group,
Coastal Wetland Planning, Protection, and Restoration Act
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COASTAL WETLAND PLANNING, PROTECTION AND RESTORATION ACT

Wetland Value Assessment Methodology and Community Models

I. INTRODUCTION

The Wetland Value Assessment (WVA) methodology is a quantitative habitat-based assessment methodology developed for use in prioritizing project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990. The WVA quantifies changes in fish and wildlife habitat quality and quantity that are projected to be brought about as a result of a proposed wetland enhancement project. The results of the WVA, measured in Average Annual Habitat Units (AAHU's), can be combined with economic data to provide a measure of the effectiveness of a proposed project in terms of annualized cost per AAHU gained.

The WVA was developed by the Environmental Work Group (Group) assembled under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee; the Group includes members from each agency represented on the CWPPRA Task Force. The WVA was designed to be applied, to the greatest extent possible, using only existing or readily obtainable data.

The WVA has been developed strictly for use in ranking proposed CWPPRA projects; it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. Some aspects of the WVA have been defined by policy and/or functional considerations of the CWPPRA; therefore, user-specific modifications may be necessary if the WVA is used for other purposes.

The WVA is a modification of the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 1980). HEP is widely used by the Fish and Wildlife Service and other Federal and State agencies in evaluating the impacts of development projects on fish and wildlife resources.

A notable difference exists between the two methodologies, however, in that HEP generally uses a species-oriented approach, whereas the WVA utilizes a community approach.

The WVA has been developed for application to the following coastal Louisiana wetland types: fresh marsh (including intermediate marsh), brackish marsh, saline marsh, and cypress-tupelo swamp. Future reference in this document to "wetland" or "wetland type" refers to one or more of those four communities.

II. WVA CONCEPT

The WVA operates under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines Suitability Index for each variable into a single value for wetland habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The Wetland Value Assessment models (Attachments 1-4) have been developed for determining the suitability of Louisiana coastal wetlands in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. Models have been designed to function at a community level and therefore attempt to define an optimum combination of habitat conditions for <u>all</u> fish and wildlife species utilizing a given marsh type over a year or longer. Earlier attempts to capture other wetland functions and values such as storm-surge protection, flood water storage, water quality functions and nutrient import/export were abandoned due to the difficulty in defining unified model relationships and meaningful model outputs for such a variety of wetland benefits. However, the ability of a Louisiana coastal wetland to provide those functions and values may be generally assumed to be positively correlated with fish and wildlife habitat quality as predicted through the WVA.

The output of each model (the HSI) is assumed to have a linear relationship with the suitability of a coastal wetland system in providing fish and wildlife habitat.

III. COMMUNITY MODEL VARIABLE SELECTION

Habitat variables considered appropriate for describing habitat quality in each wetland type were selected according to the following criteria:

1) the condition described by the variable had to be important in characterizing fish and wildlife habitat quality in the wetland type under consideration;

2) values had to be easily estimated and predicted based on existing data (e.g., aerial photography, LANDSAT, GIS systems, water quality monitoring stations, and interviews with knowledgeable individuals); and

3) the variable had to be sensitive to the types of changes expected to be brought about by typical wetland projects proposed under the CWPPRA.

Variables for each model were selected through a two part procedure. The first involved a listing of environmental variables thought to be important in characterizing fish and wildlife habitat in coastal marsh or swamp systems.

The second part of the selection procedure involved reviewing variables used in species-specific HSI models published by the U.S. Fish and Wildlife Service. Review was limited to models for those fish and wildlife species known to inhabit Louisiana coastal wetlands, and included models for 10 estuarine fish and shellfish, 4 freshwater fish, 12 birds, 3 reptiles and amphibians, and 2 mammals (Attachment 7). The number of models included from each species group was dictated by model availability.

Selected HSI models were then grouped according to the wetland type(s) used by each species. Because most species for which models were considered are not restricted to one wetland type, most models were included in more than one wetland type group. Within each wetland type group, variables from all models were then grouped according to similarity (e.g., water quality, vegetation, etc.). Each variable was evaluated based on 1) whether it met the variable selection criteria; 2) whether another, more easily measured/predicted variable in the same or a different similarity group functioned as a surrogate; and 3) whether it was deemed suitable for the WVA application (e.g., some freshwater fish model variables dealt with riverine or lacustrine environments). Variables that did not satisfy those conditions were eliminated from further consideration. The remaining variables, still in their similarity groups, were then further eliminated or refined by combining similar variables and/or culling those that were functionally duplicated by variables from other models (i.e., some variables were used frequently in different models in only slightly different format, such as percent marsh coverage, salinity, etc.).

Variables selected from the HSI models were then compared to those identified in the first part of the selection procedure to arrive at a final list of variables to describe wetland habitat quality. That list includes six variables for each of the marsh types and three for the cypress-tupelo swamp (Attachments 1-4).

IV. SUITABILITY INDEX GRAPHS

Suitability Index graphs were constructed for each variable selected within a wetland type. A Suitability Index (SI) graph is a graphical representation of how fish and wildlife habitat quality or "suitability" of a given wetland type is predicted to change as values of the given variable change, and allows the model user to numerically describe, through a Suitability Index, the habitat quality of a wetland area for any variable value. Each Suitability

Index ranges from 0.0 to 1.0, with 1.0 representing the optimum condition for the variable in question.

A variety of resources were utilized to construct each Suitability Index (SI) graph, including personal knowledge of Group members, the species HSI models from which the final list of variables was partially derived, consultation with other professionals and researchers outside the Group, and published and unpublished data and studies. An important "non-biological" constraint on SI graph development was the need to insure that graph relationships were not counter to the purpose of the CWPPRA, that is, the long term creation, restoration, protection, or enhancement of coastal vegetated wetlands. That constraint was most operative in defining SI graphs for Variable 1 under each marsh model (see discussion below).

The process of graph development was one of constant evolution, feedback, and refinement; the form of each Suitability Index graph was decided upon through consensus among Group members.

V. SUITABILITY INDEX GRAPH ASSUMPTIONS

Suitability Index graphs were developed according to the following assumptions:

1. Fresh/Intermediate Marsh Model

Variable V_1- Percent of wetland covered by persistent emergent vegetation (≥ 10 percent canopy cover). Persistent emergent vegetation plays an important role in coastal wetlands by providing foraging, resting, and breeding habitat for a variety of fish and wildlife species; and by providing a source of detritus and energy for lower trophic organisms that form the basis for the food chain. An area with no marsh (i.e., shallow open water) is assumed to have minimal habitat suitability in terms of this variable, and is assigned an SI of 0.1.

Optimum vegetation coverage in a fresh/intermediate marsh is assumed to occur at 100 percent persistent emergent vegetation cover (SI=1.0). That assumption is dictated primarily by the constraint of not having graph relationships conflict with the CWPPRA's purpose of long term creation, restoration, protection, or enhancement of coastal vegetated wetlands. The Group had originally developed a strictly biologically-based graph defining optimum habitat conditions at marsh cover values between 60 and 80 percent, and sub-optimum habitat conditions at 100 percent cover. However, application of that graph, in combination with the time analysis used later in the evaluation process, often reduced project benefits or generated a net loss of habitat quality through time with the project. Those situations arose primarily when: existing (baseline) emergent vegetation cover exceeded the optimum (> 80 percent); the project was predicted to maintain baseline cover values; and without the project the marsh was predicted to degrade, with a concurrent decline in percent emergent vegetation cover into the optimum range (60-80 percent). The time factor aggravated the situation when the without-project degradation was not rapid enough to reduce marsh cover values significantly below the optimum range, or below the baseline SI, within the 20-year evaluation period. In those cases, the analysis would show net negative benefits for the project, and positive benefits for letting the marsh degrade rather than maintaining the existing marsh. Coupling that situation with the presumption that marsh conditions are not static, and that Louisiana will continue to lose coastal emergent marsh; and taking into account the purpose of the CWPPRA, the Group decided that, all other factors being equal, the WVA should favor projects that maximize emergent marsh creation, maintenance, and protection. Therefore, the Group agreed to deviate from a strict biologically-based habitat suitability graph for V_1 by setting optimum habitat conditions at 100 percent marsh cover.

Variable V_2- Percent of open water area dominated (> 50 percent canopy cover) by aquatic vegetation. Fresh and intermediate marshes often support diverse communities of floating-leaved and submerged aquatic plants that provide important food and cover to a wide variety of fish and wildlife species. A fresh/intermediate open water area with no aquatics is assumed to have low suitability (SI=0.1). Optimum condition (SI=1.0) is assumed to occur when 100 percent of the open water is dominated by aquatic vegetation. Habitat suitability may be assumed to decrease with aquatic plant coverage approaching 100 percent due to the potential for mats of aquatic vegetation to hinder fish and wildlife utilization; to adversely affect water quality by reducing photosynthesis by phytoplankton and other plant forms due to shading; and contribute to oxygen depletion spurred by warm-season decay of large quantities of aquatic vegetation. The Group recognized, however, that those affects were highly dependent on the dominant aquatic plants species, their growth forms, and their arrangement in the water column; thus, it is possible to have 100 percent cover of a variety of floating and submerged aquatic plants without the above-mentioned problems due to differences in plant growth form and stratification of plants through the water column. Because predictions of which species may dominate at any time in the future would be tenuous, at best, the Group decided to simplify the graph and define optimum conditions at 100 percent aquatic cover.

Variable V_3- Marsh edge and interspersion. This variable takes into account the relative juxtaposition of marsh and open water for a given marsh:open water ratio, and is measured by comparing the project area to sample illustrations (Attachment 5) depicting different degrees of interspersion. Interspersion is assumed to be especially important when considering the value of an area as foraging and nursery habitat for freshwater and estuarine fish and shellfish; the marsh/open water interface represents an ecotone where prey species often concentrate, and where post-larval and juvenile organisms can find cover. Isolated marsh ponds are often more productive in terms of aquatic vegetation than are larger ponds due to decreased turbidities, and, thus, may provide more suitable waterfowl habitat. However, interspersion can be indicative of marsh degradation, a factor taken into consideration in assigning suitability indices to the various Interspersion Types.

A relatively high degree of interspersion in the form of stream courses and tidal channels (Interspersion Type 1, Attachment 5) is assumed to be optimal (SI=1.0); streams and channels offer interspersion, yet are not indicative of active marsh deterioration. Areas exhibiting a high degree of marsh cover are also ranked as optimum, even though interspersion may be low, to avoid conflicts with the premises underlying the SI graph for variable V_1. Without such an allowance, areas of relatively healthy, solid marsh, or projects designed to create marsh, would be penalized with respect to interspersion. Numerous small marsh ponds (Interspersion Type 2) offer a high degree of interspersion, but are also usually indicative of the beginnings of marsh break-up and degradation, and are therefore assigned a more moderate SI of 0.6. Large open water areas (Interspersion Types 3 and 4) offer lower interspersion values and usually indicate advanced stages of marsh loss, and are thus assigned SI's of 0.4 and 0.2, respectively. The lowest expression of interspersion (i.e., no emergent marsh at all within the project area) is assumed to be least desirable and is assigned an SI=0.1.

Variable V_4- Percent of open water area ≤ 1.5 feet deep in relation to marsh surface. Shallow water areas are assumed to be more biologically productive than deeper water due to a general reduction in sunlight, oxygen, and temperature as water depth increases. Also, shallower water provides greater bottom accessibility for certain species of waterfowl, better foraging habitat for wading birds, and more favorable conditions for aquatic plant growth. Optimum depth in a fresh/intermediate marsh is assumed to occur when 80 to 90 percent of the open water area is less than or equal to 1.5 feet deep. The value of deeper areas in providing drought refugia for fish, alligators and other marsh life is recognized by assigning an SI=0.6 (i.e., sub-optimal) if all of the open water is less than or equal to 1.5 feet deep.

Variable V_5- Mean high salinity during the growing season. It is assumed that periods of high salinity are most detrimental in a fresh/intermediate marsh when they occur during the growing season (defined as March through November, based on dates of first and last frost contained in Soil Conservation Service soil surveys for coastal Louisiana). Mean high salinity is defined as the average of the upper 33 percent of salinity readings taken during a specified period of record. Optimum condition in fresh marsh is assumed to occur when mean high salinity during the growing season is less than 2 parts per thousand (ppt). Optimum condition in intermediate marsh is assumed to occur when mean high salinity during the growing season is less than 4 ppt.

Variable V_6- Aquatic organism access. Access by aquatic organisms, particularly estuarine fishes and shellfishes, is considered to be a critical component in assessing the "quality" or suitability of a given marsh system to provide habitat to those species. Additionally, a marsh with a relatively high degree of access by default also exhibits a relatively high degree of hydrologic connectivity with adjacent systems, and therefore may be considered to contribute more to nutrient exchange than would a marsh exhibiting a lesser degree of access. The Suitability Index for V_7 is determined by calculating an "Access Value" based on the interaction between the percentage of the project area wetlands considered accessible by estuarine organisms during normal tidal fluctuations, and the type of man-made structures (if any) across identified points of ingress/egress (bayous, canals, etc.). Standardized procedures for calculating the Access Value have been established (Attachment 6). Optimum condition is assumed to exist when all of the study area is accessible and the access points are entirely open and unobstructed. A fresh/intermediate marsh with no access is assigned an SI=0.3, reflecting the assumption that, while fresh/intermediate marshes are important to some species of estuarine fishes and shellfish, such a marsh lacking access continues to provide benefits to a wide variety of other wildlife and fish species, and is not without habitat value.

2. Brackish Marsh Model

Variable V_1- Percent of wetland covered by persistent emergent vegetation ($\geq$ 10 percent canopy cover). Refer to the V_1 discussion under the fresh/intermediate marsh model for a discussion of the importance of persistent emergent vegetation in coastal marshes. The V_1 Suitability Index graph in the brackish marsh model is identical to that in the fresh/intermediate model.

Variable V_2- Percent of open water area dominated (> 50 percent canopy cover) by aquatic vegetation. Like fresh/intermediate marshes, brackish marshes have the potential to support aquatic plants that serve as important sources of food and cover for a wide variety of wildlife. However, brackish marshes generally do not support the amounts and kinds of aquatic plants that occur in fresh/intermediate marshes (although certain species, such as widgeon-grass, can occur abundantly under certain conditions). Therefore, a brackish marsh entirely lacking aquatic plants is assigned an SI=0.3. It is assumed that optimum open water coverage of aquatic plants in a brackish marsh occurs at 100 percent aquatic cover.

Variable V_3- Marsh edge and interspersion. The Suitability Index graph for edge and interspersion in the brackish marsh model is the same as that in the fresh/intermediate marsh model.

Variable V_4- Open water depth in relation to marsh surface. As in the fresh/intermediate model, shallow water areas in brackish marsh habitat are assumed to be important. However, brackish marsh generally exhibits deeper open water areas than fresh marsh due to tidal scouring. Therefore, the SI graph is constructed so that lower percentages of shallow water receive higher SI values relative to fresh/intermediate marsh. Optimum open water depth condition in a brackish marsh is assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep.

Variable V_5- Average annual salinity. The suitability index graph is constructed to represent optimum average annual salinity condition at between 6 ppt and 10 ppt. Average annual salinities below 3 ppt are not considered on the graph because salinities below that level effectively define an intermediate marsh. Similarly, average annual salinities greater than 16 ppt are assumed to be representative of those found in a saline marsh, and thus are not considered in the brackish marsh model.

Variable V_6- Aquatic organism access. The general rational and procedure behind the V_6 Suitability Index graph for the brackish marsh model is identical to that established for the fresh/intermediate model. However, brackish marshes are assumed to be more important as providers of habitat to estuarine fish and shellfish than fresh/intermediate marshes. Therefore, a brackish marsh providing no access is assigned an SI of 0.1.

3. Saline Marsh Model

Variable V_1- Percent of wetland covered by persistent emergent vegetation (≥ 10 percent canopy cover). Refer to the V_1 discussion under the fresh/intermediate marsh model for a discussion of the importance of persistent emergent vegetation in coastal marshes. The V_1 Suitability Index graph in the saline marsh model is identical to that in the fresh/intermediate and brackish models.

Variable V_2- Percent of open water area dominated (> 50 percent canopy cover) by aquatic vegetation. Refer to the V_2 discussion under the brackish marsh model for a discussion of persistent emergent vegetation in more saline coastal marshes. The V_2 Suitability Index graph in the saline marsh model is identical to that in the brackish model.

Variable V_3- Marsh edge and interspersion. The Suitability Index graph for edge and interspersion in the saline marsh model is the same as that in the fresh/intermediate and brackish marsh models.

Variable V_4- Open water depth in relation to marsh surface. The Suitability Index graph for open water depth in the saline marsh is similar to that for brackish marsh, where optimum conditions are assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep. However, at 100 percent shallow water, the saline graph yields an SI= 0.5 rather than 0.6 for the brackish model. That change reflects the increased abundance of tidal channels and generally deeper water conditions prevailing in a saline marsh due to increased tidal influences, and the importance of those tidal channels to estuarine organisms.

Variable V_5- Average annual salinity. The Suitability Index graph is constructed to represent optimum salinity conditions at between 12 ppt and 21 ppt. Average annual salinities below 9 ppt are not considered on the graph because average annual salinities below that level define a brackish marsh.

Variable V_6- Aquatic organism access. The Suitability Index graph for aquatic organism access in the saline marsh model is the same as that in the brackish marsh model.

4. Cypress-Tupelo Swamp Model

Variable V_1- Water regime. Four water regime categories are described for the cypress-tupelo swamp model. The optimum water regime for a cypress-tupelo swamp is assumed to be seasonal flooding (SI=1.0); seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. Semipermanent flooding is also assumed to be desirable, as reflected in the SI=0.8 for that water regime category. Permanent flooding is assumed to be the least desirable (SI=0.2).

Variable V_2- Water flow/exchange. This variable attempts to take into consideration the amounts and types of water inputs into a cypress-tupelo swamp. The Suitability Index graph is constructed under the assumption that abundant and consistent riverine input and water flow-through is optimum (SI=1.0), because under that regime the full functions and values of a cypress-tupelo swamp in providing fish and wildlife habitat are assumed to be maximized. Habitat suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. A swamp system with no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be least desirable, and is assigned an SI= 0.2.

Variable V_3- Average high salinity. Average high salinity is defined as the average of the upper 33 percent of salinity measurements taken during a specified period of record. Because baldcypress is salinity-sensitive, optimum conditions for baldcypress survival are assumed to occur at average high salinities less than 1 ppt. Habitat suitability is assumed to decrease rapidly at average high salinities in excess of 1 ppt.

VI. HABITAT SUITABILITY INDEX FORMULA

The final step in WVA model development was to construct a mathematical formula that combines all Suitability Indices for each wetland type into a single Habitat Suitability Index (HSI) value. Because the Suitability Indices range in value from 0.0 to 1.0, the HSI also ranges in from 0.0 to 1.0, and is a numerical representation of the overall or "composite" habitat quality of the particular wetland study area being evaluated. The HSI formula defines the aggregation of Suitability Indices in a manner unique to each wetland type depending on how the formula is constructed.

Within an HSI formula, any Suitability Index can be weighted by various means to increase the power or "importance" of that variable relative to the other variables in determining the HSI. Additionally, two or more variables can be grouped together into subgroups to further isolate variables for weighting.

In constructing HSI formulas for the marsh models, the Group recognized that the primary focus of the CWPPRA is on vegetated wetlands, and that some marsh protection strategies could have adverse impacts to estuarine organism access. Therefore, the Group made an *a priori* decision to emphasize variables V_1, V_2, and V_6 by grouping and weighting them together. Weighting was facilitated by treating the grouped variables as a geometric mean. Variables V_3, V_4, and V_5 were grouped to isolate their influence relative to V_1, V_2, and V_6.

For all marsh models, V_1 receives the strongest weighting. The relative weights of V_2 and V_6 differ by marsh model to reflect differing levels of importance for those variables between the marsh types. For example, the amount of aquatic vegetation was deemed more important in the context of a fresh/intermediate marsh than in a saline marsh, due to the relative contributions of aquatic vegetation between the two marsh types in terms of providing food and cover. Therefore, V_2 receives more weight in the fresh/intermediate HSI formula than in the saline HSI formula. Similarly, the degree of estuarine organism access was considered more important in a saline marsh than a fresh/intermediate marsh, and V_6 receives more weight in the saline HSI formula than in the fresh/intermediate formula.

As with the Suitability Index graphs, the Habitat Suitability Index formulas were developed by consensus among the Group members.

VI. BENEFIT ASSESSMENT

The net benefits of a proposed project are estimated by predicting future habitat conditions under two scenarios: with the proposed project in place and without the proposed project. Specifically, predictions are made as to how the model variables will change through time under the two scenarios. Through that process, HSI's are established for baseline (pre-project) conditions and for future-with- and future-without-project scenarios for selected "target years" throughout the expected life of the project. Those HSI's are then multiplied by the acreage of wetland type known or expected to be present in the target years to arrive at Habitat Units.

Habitat Units (HU's) represent a numerical combination of quality (HSI) and quantity (acres) existing at any given point in time. The "benefit" of a project can be quantified by comparing HU's between the future-with and future-without-project scenarios. The difference in HU's between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity <u>and</u> quality.

The HU's resulting from the future-with- and future-without-project scenarios are annualized, averaged out over the project life, and compared to determine the net gain in average annual HU's (AAHU's) attributable to the project. Net gain in AAHU's is then combined with annualized cost data to arrive at a cost per AAHU for the evaluated project. That figure is compared to the same figure from other projects in order to rank all proposed projects in order of cost per AAHU.

Revised June 2, 1993

WETLAND VALUE ASSESSMENT COMMUNITY MODEL

Fresh/Intermediate Marsh

Vegetation:

Variable V_1 — Percent of wetland area covered by emergent vegetation (≥ 10% canopy cover).

Variable V_2 — Percent of open water area dominated (> 50% canopy cover) by aquatic vegetation.

Interspersion:

Variable V_3 — Marsh edge and interspersion.

Water Depth:

Variable V_4 — Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.

Water Quality:

Variable V_5 — Mean high salinity during the growing season (March through November).

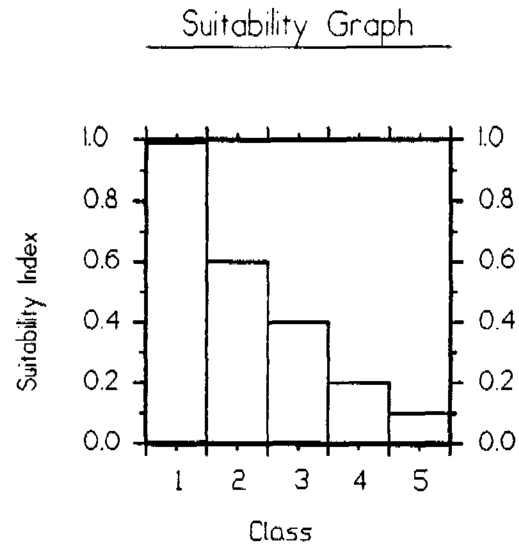
Aquatic Organism Access:

Variable V_6 — Aquatic organism access.

HSI Calculation:

$$HSI = \frac{\left[3.5 \times (SIV_1^{3} \times SIV_2^{1.2} \times SIV_6^{0.5})^{(1/4.7)}\right] + \left[\frac{(SIV_3 + SIV_4 + SIV_5)}{3}\right]}{4.5}$$

Variable V_3 Marsh edge and interspersion.

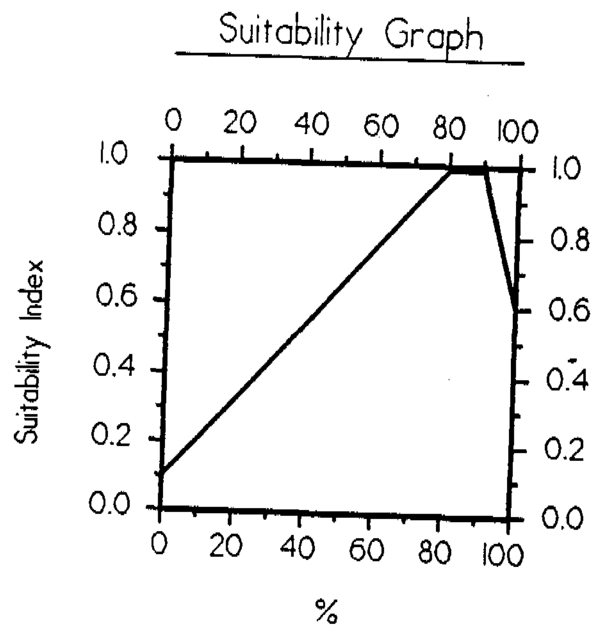


<u>Instructions for Calculating SI for Variable 3:</u>

1. Refer to Attachment 5 for examples of the different interspersion classes (=types).

2. Estimate percent of project area in each class and compute a weighted average to arrive at SIV_3. If the <u>entire</u> project area is solid marsh, assign an interspersion class #1 (SI=1.0). Conversely, if the <u>entire</u> project area is open water, assign an interspersion class #5 (SI=0.1).

Variable V_4 Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.



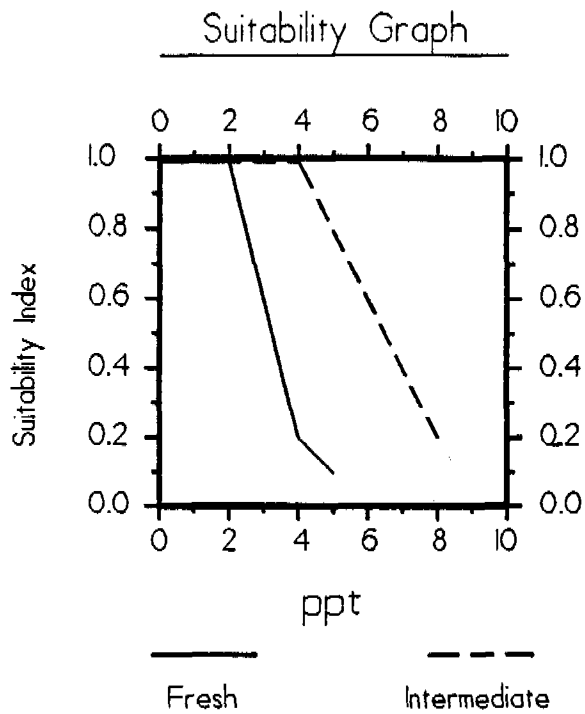
Line Formulas

If 0 ≤ % < 80, then SI = (0.01125 * %) + 0.1

If 80 ≤ % < 90, then SI = 1.0

If % ≥ 90, then SI = (-0.04 * %) + 4.6

Variable V_5 Mean high salinity during the growing season (March through November).



Line Formulas

Fresh Marsh:

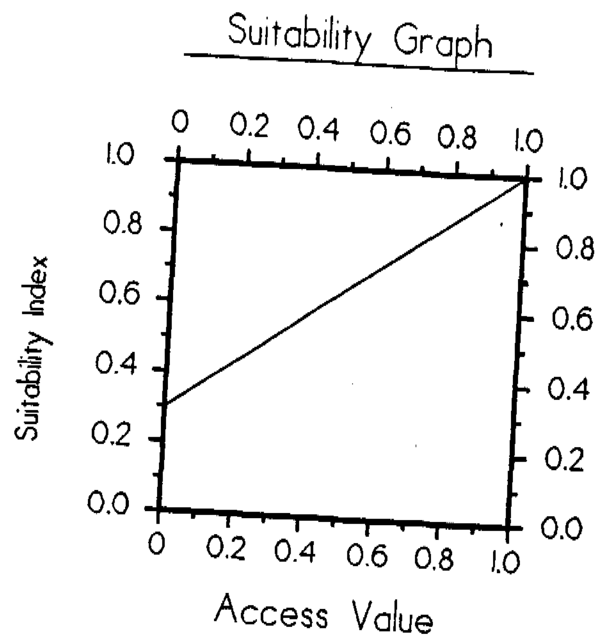
If 0 ≤ ppt < 2, then SI = 1.0
If 2 ≤ ppt < 4, then SI = (-0.4 * ppt) + 1.8
If 4 ≤ ppt ≤ 5 then SI = (-0.1 * ppt) + 0.6

Intermediate Marsh:

If 0 ≤ ppt < 4, then SI = 1.0
If 4 ≤ ppt ≤ 8, then SI = (-0.2 * ppt) + 1.8

NOTE: Mean high salinity is defined as the average of the upper 33 percent of salinity readings taken during the period of record.

Variable V_6 Aquatic organism access.



Line Formula

SI = (0.7 * Access Value) + 0.3

NOTE: Access Value = P * R, where "P" = percentage of wetland area considered accessible by estuarine organisms during normal tidal fluctuations, and "R" = Structure Rating.

Refer to Attachment 6 "Procedure For Calculating Access Value" for complete information on calculating "P" and "R" values.

Revised June 2, 1993

WETLAND VALUE ASSESSMENT COMMUNITY MODEL

Brackish Marsh

Vegetation:

Variable V_1 — Percent of wetland area covered by emergent vegetation (≥ 10% canopy cover).

Variable V_2 — Percent of open water area dominated (> 50% canopy cover) by aquatic vegetation.

Interspersion:

Variable V_3 — Marsh edge and interspersion.

Water Depth:

Variable V_4 — Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.

Water Quality:

Variable V_5 — Average annual salinity.

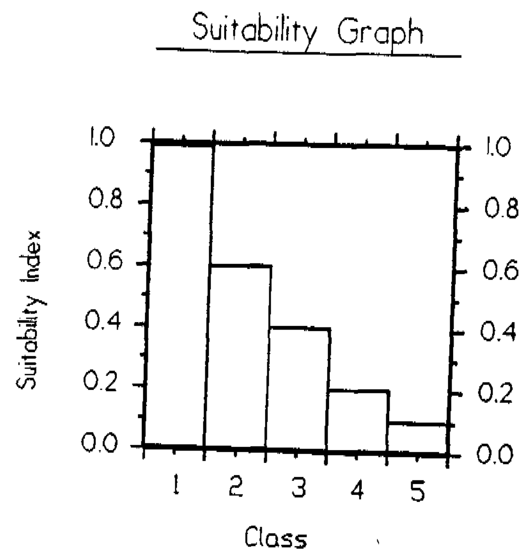
Aquatic Organism Access:

Variable V_6 — Aquatic organism access.

HSI Calculation:

$$HSI = \frac{\left[3.5 \times (SIV_1^{\,3} \times SIV_2 \times SIV_6)^{(1/5)}\right] + \left[\frac{(SIV_3 + SIV_4 + SIV_5)}{3}\right]}{4.5}$$

Variable V_3 Marsh edge and interspersion.

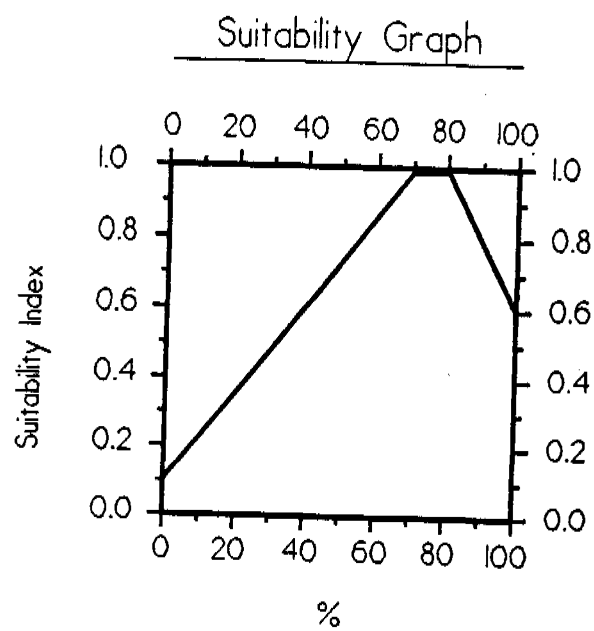


Instructions for Calculating SI for Variable 3:

1. Refer to Attachment 5 for examples of the different interspersion classes (=types).

2. Estimate percent of project area in each class and compute a weighted average to arrive at SIV_3. If the entire project area is solid marsh, assign an interspersion class #1 (SI=1.0). Conversely, if the entire project area is open water, assign an interspersion class #5 (SI=0.1).

Variable V_4 Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.



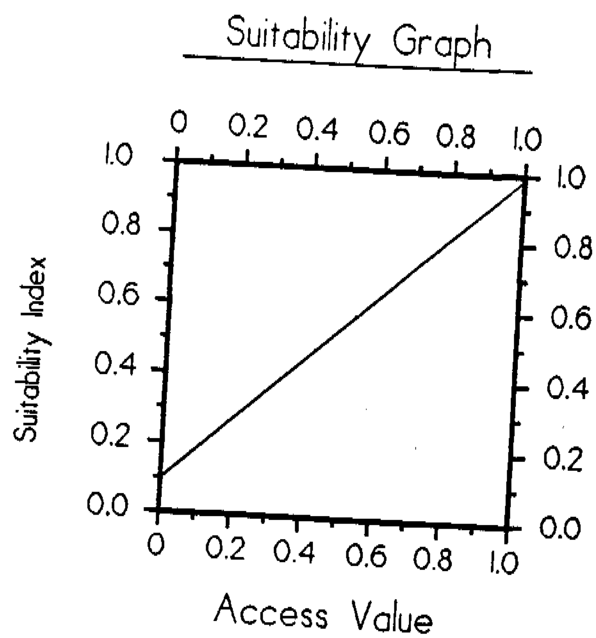
Line Formulas

If 0 ≤ % < 70, then SI = (0.01286 * %) + 0.1

If 70 ≤ % < 80, then SI = 1.0

If % ≥ 80, then SI = (-0.02 * %) + 2.6

Variable V_6 Aquatic organism access.



Line Formula

SI = (0.9 * Access Value) + 0.1

Note: Access Value = P * R, where "P" = percentage of wetland area considered accessible by estuarine organisms during normal tidal fluctuations, and "R" = Structure Rating.

Refer to Attachment 6 "Procedure For Calculating Access Value" for complete information on calculating "P" and "R" values.

WETLAND VALUE ASSESSMENT COMMUNITY MODEL

Saline Marsh

Vegetation:

Variable V_1 Percent of wetland area covered by emergent vegetation (≥ 10% canopy cover).

Variable V_2 Percent of open water area dominated (> 50% canopy cover) by aquatic vegetation.

Interspersion:

Variable V_3 Marsh edge and interspersion.

Water Depth:

Variable V_4 Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.

Water Quality:

Variable V_5 Average annual salinity.

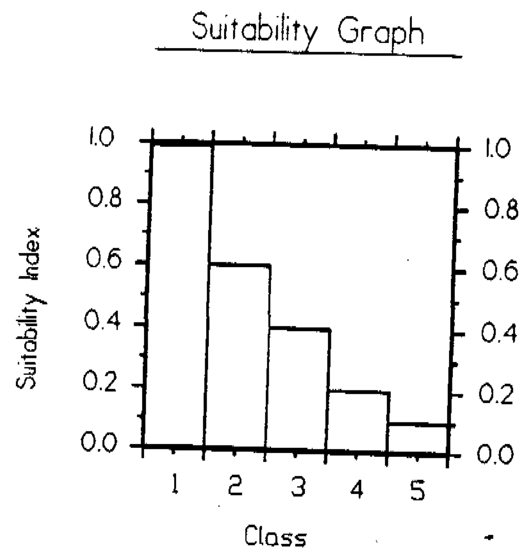
Aquatic Organism Access:

Variable V_6 Aquatic organism access.

HSI Calculation:

$$HSI = \frac{\left[3.5 \times (SIV_1^{3} \times SIV_2^{0.5} \times SIV_6^{1.2})^{(1/4.7)}\right] + \left[\frac{(SIV_3 + SIV_4 + SIV_5)}{3}\right]}{4.5}$$

Variable V_3 Marsh edge and interspersion.

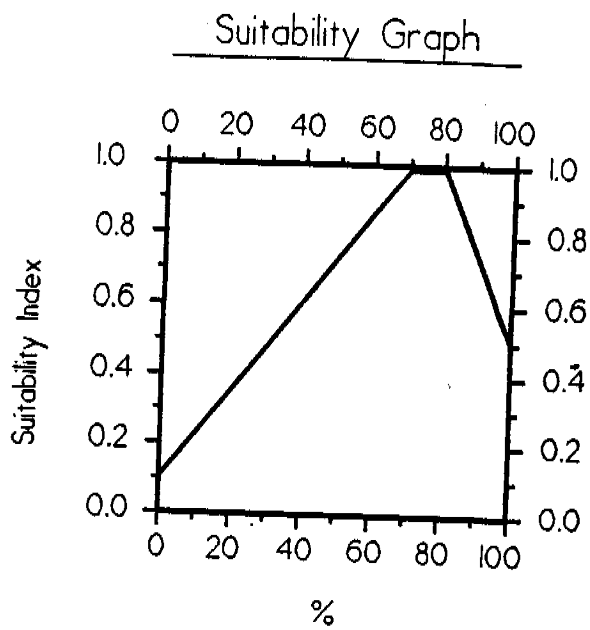


<u>Instructions for Calculating SI for Variable 3:</u>

1. Refer to Attachment 5 for examples of the different interspersion classes (=types).

2. Estimate percent of project area in each class and compute a weighted average to arrive at SIV_3. If the <u>entire</u> project area is solid marsh, assign an interspersion class #1 (SI=1.0). Conversely, if the <u>entire</u> project area is open water, assign an interspersion class #5 (SI=0.1).

Variable V_4 Percent of open water area ≤ 1.5 feet deep, in relation to marsh surface.



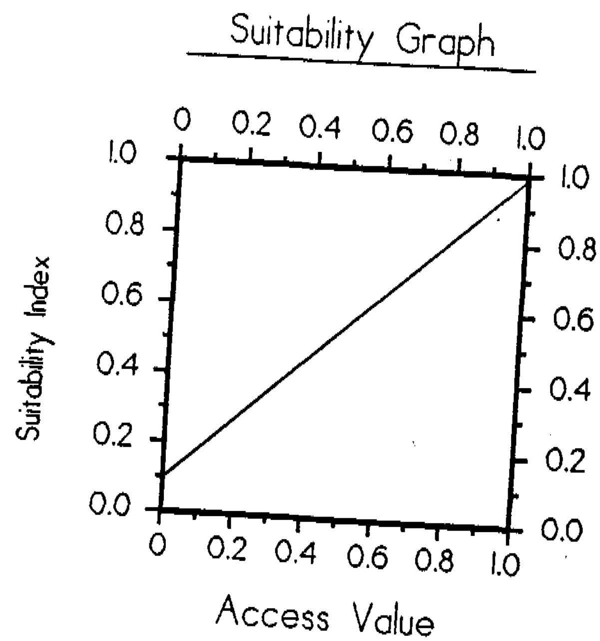
Line Formulas

If 0 ≤ % < 70, then SI = (0.01286 * %) + 0.1

If 70 ≤ % < 80, then SI = 1.0

If % ≥ 80, then SI = (-0.025 * %) + 3.0

Variable V_6 Aquatic organism access.



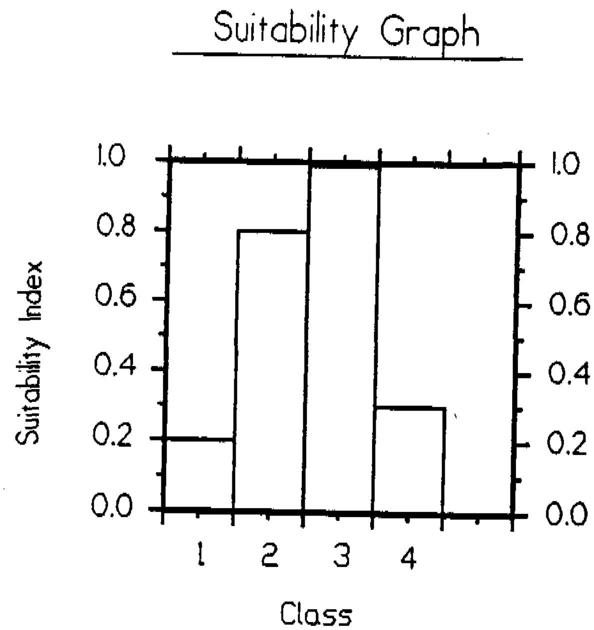
Line Formula

SI = (0.9 * Access Value) + 0.1

Note: Access Value = P * R, where "P" = percentage of wetland area considered accessible by estuarine organisms during normal tidal fluctuations, and "R" = Structure Rating.

Refer to Attachment 6 "Procedure For Calculating Access Value" for complete information on calculating "P" and "R" values.

Variable V_1 Water regime.



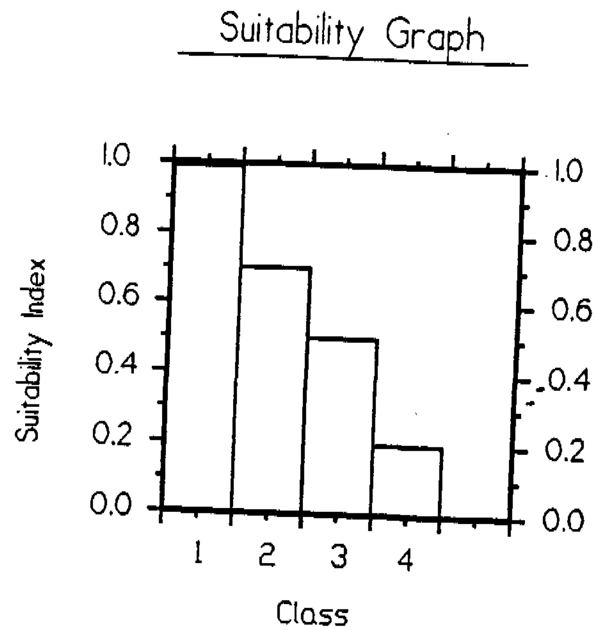
1 - Permanently Flooded: water covers the substrate throughout the year in all years.

2 - Semipermanently Flooded: surface water is present throughout the growing season in most years.

3 - Seasonally Flooded: surface water is present for extended periods, especially in the growing season, but is absent by the end of the growing season in most years.

4 - Temporarily Flooded: surface water is present for brief periods during the growing season, but the water table usually lies well below the surface for most of the season.

Variable V_2 Water flow/exchange.



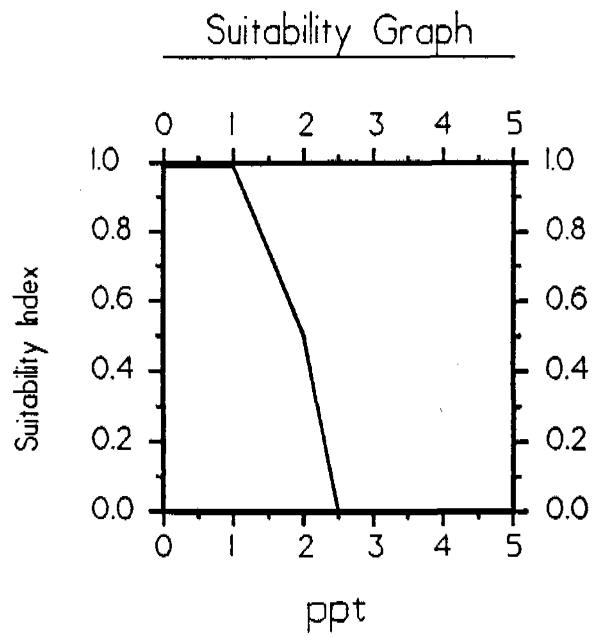
1 - Receives abundant and consistent riverine input and through-flow.

2 - Moderate water exchange, through riverine and/or tidal input.

3 - Limited water exchange, through riverine and/or tidal input.

4 - No water exchange (stagnant, impounded).

Variable V_3 Average high salinity.



Line Formulas

If $0 \leq ppt < 1$, then SI = 1.0

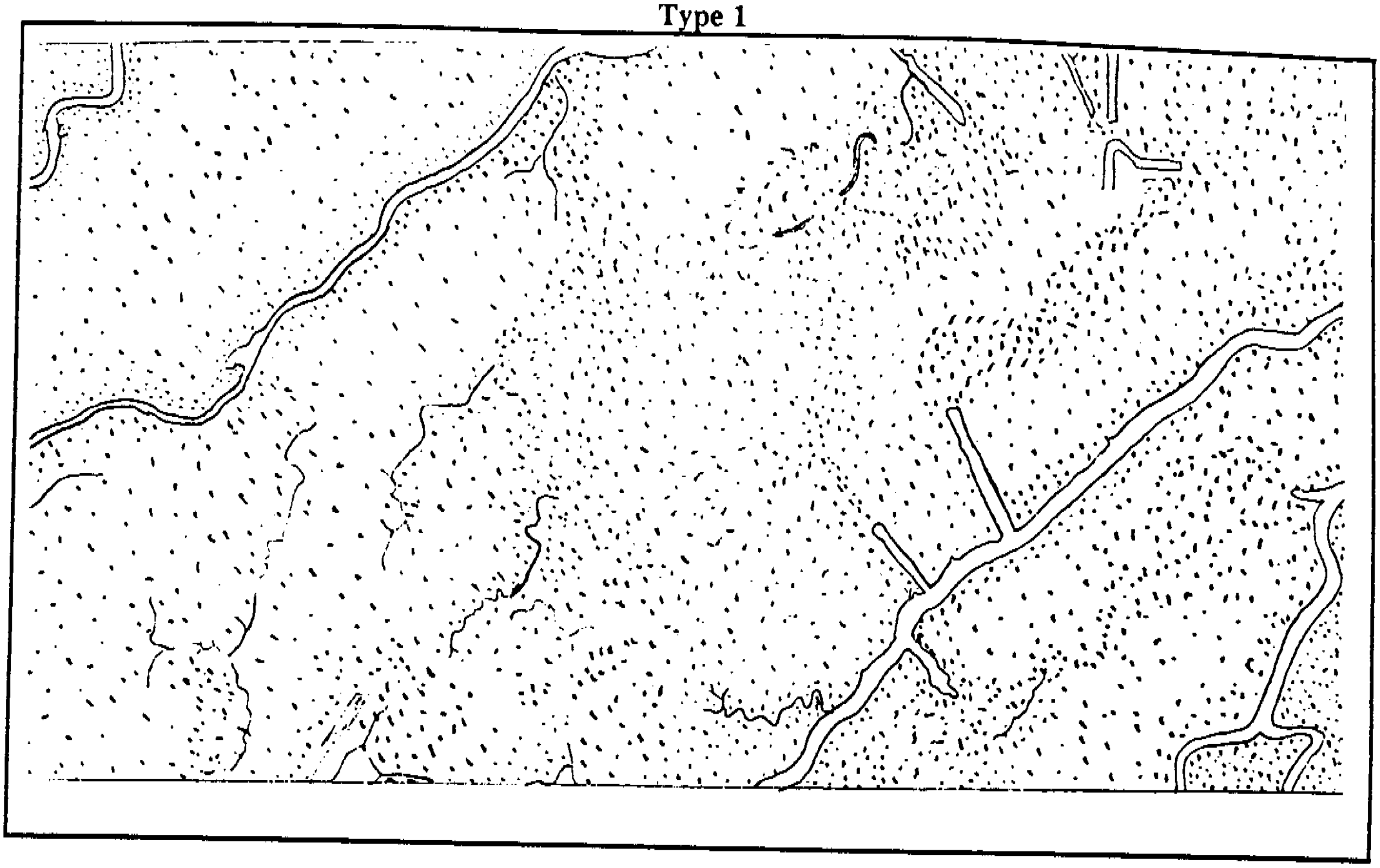
If $1 \leq ppt < 2$, then SI = (-0.5 * ppt) + 1.5

If $2 \leq ppt < 2.5$, then SI = (-1.0 * ppt) + 2.5

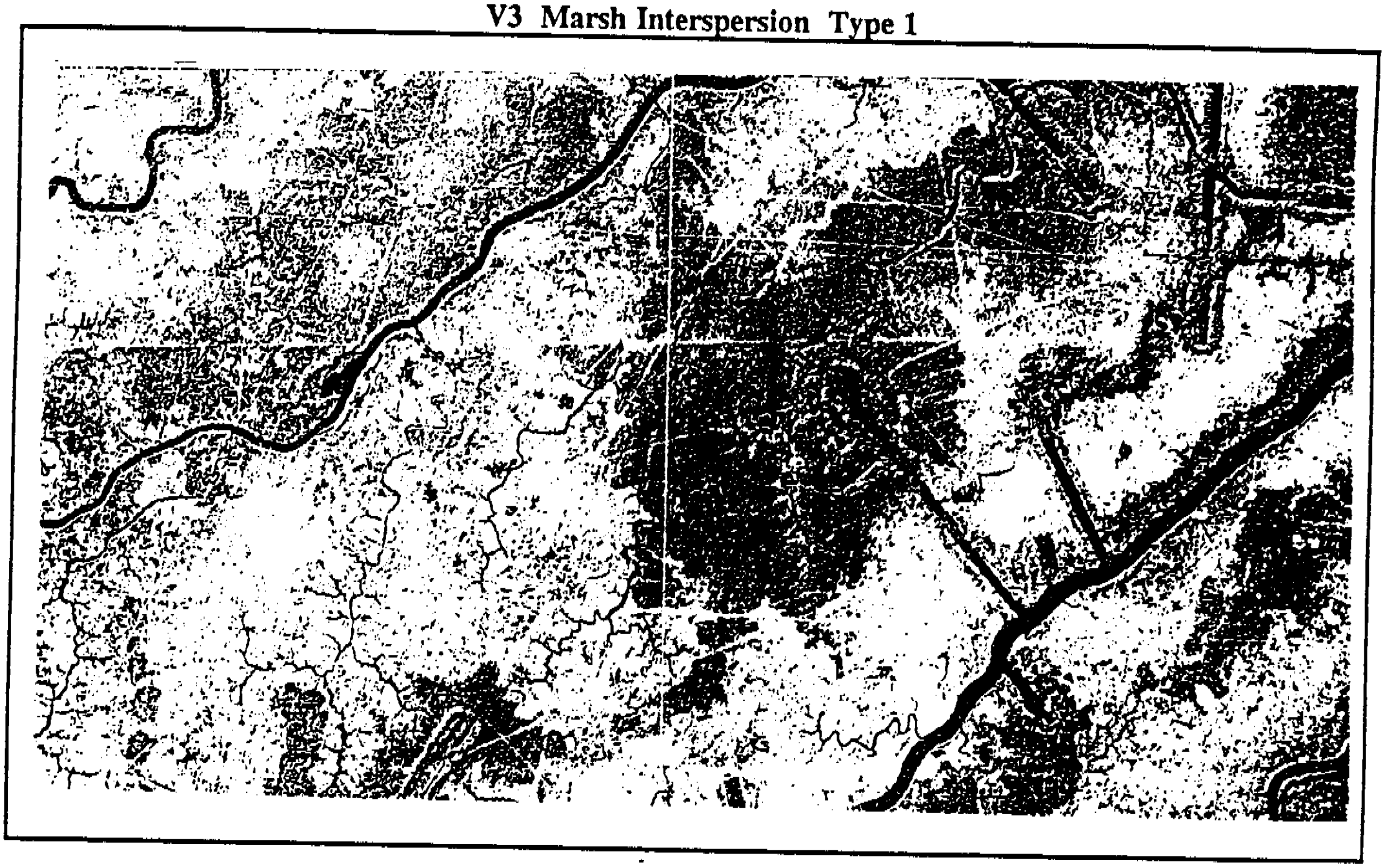
If $ppt \geq 2.5$, then SI = 0

Average high salinity is defined as the average of the upper 33 percent of salinity readings taken during the period of record.

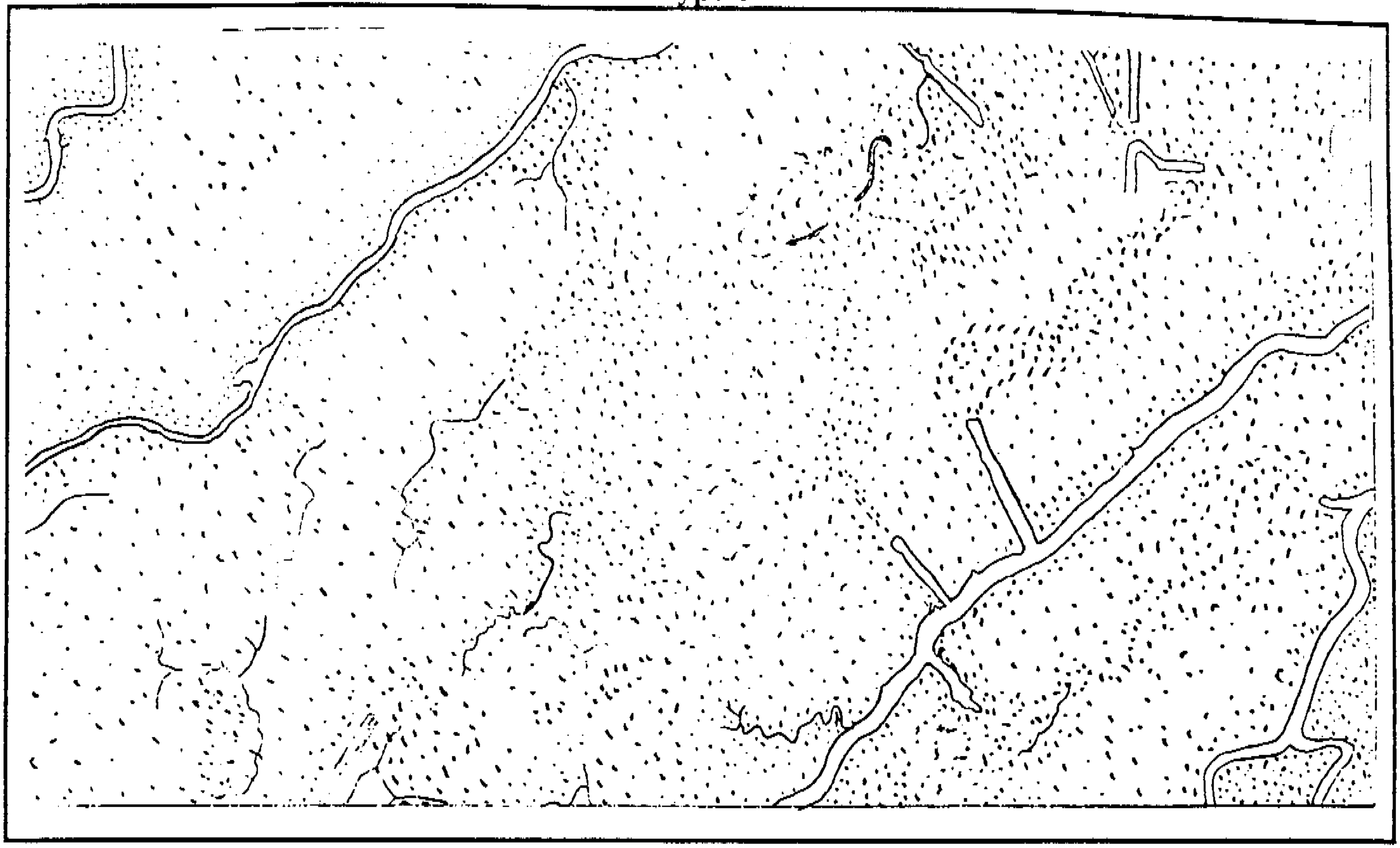
V3 Marsh Interspersion
Type 1



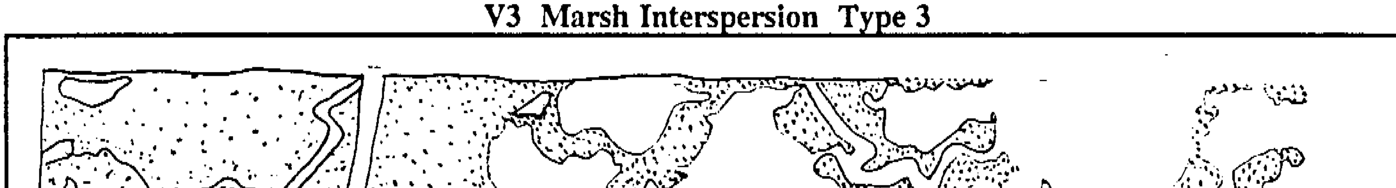
V3 Marsh Interspersion Type 1



V3 Marsh Interspersion
Type 1

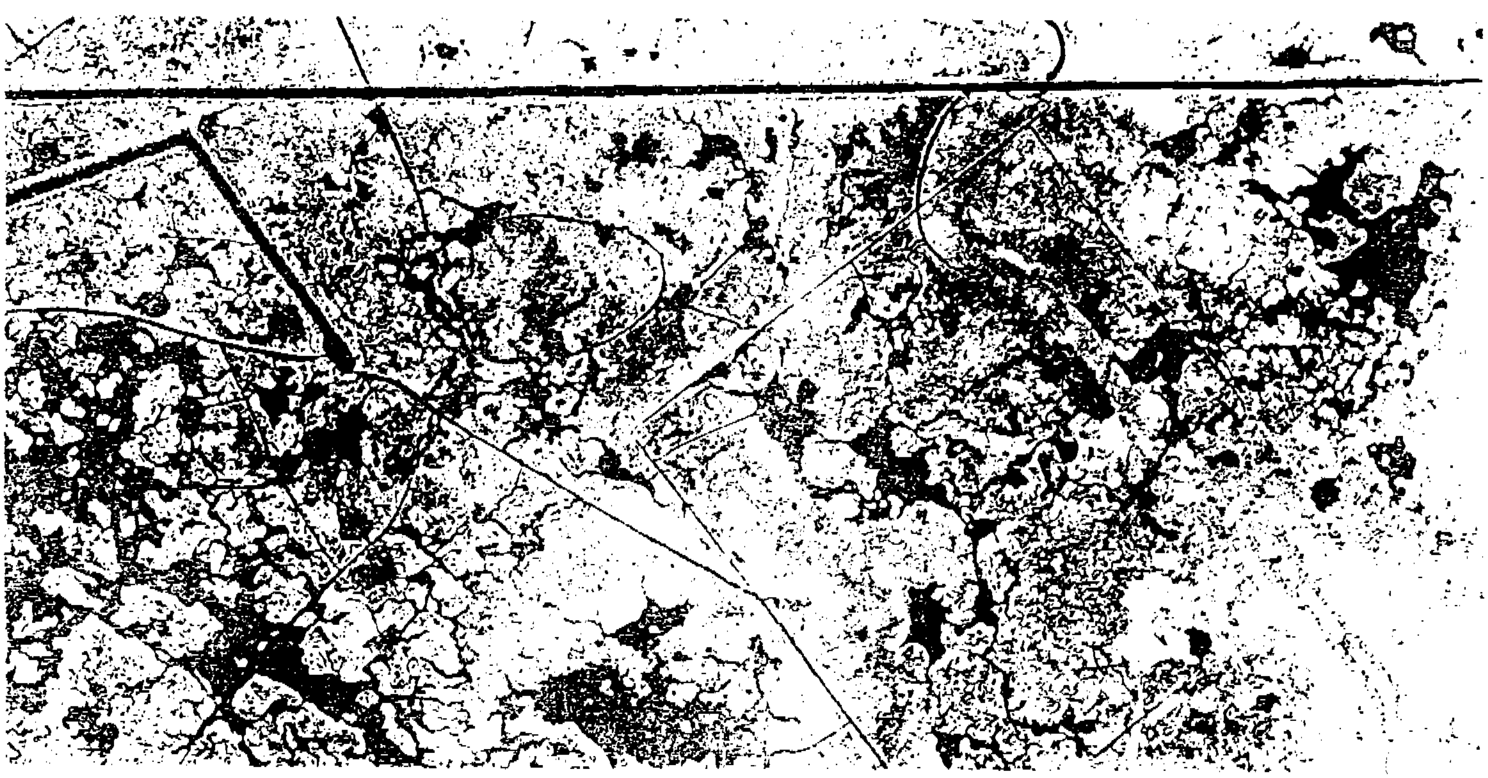


V3 Marsh Interspersion Type 3

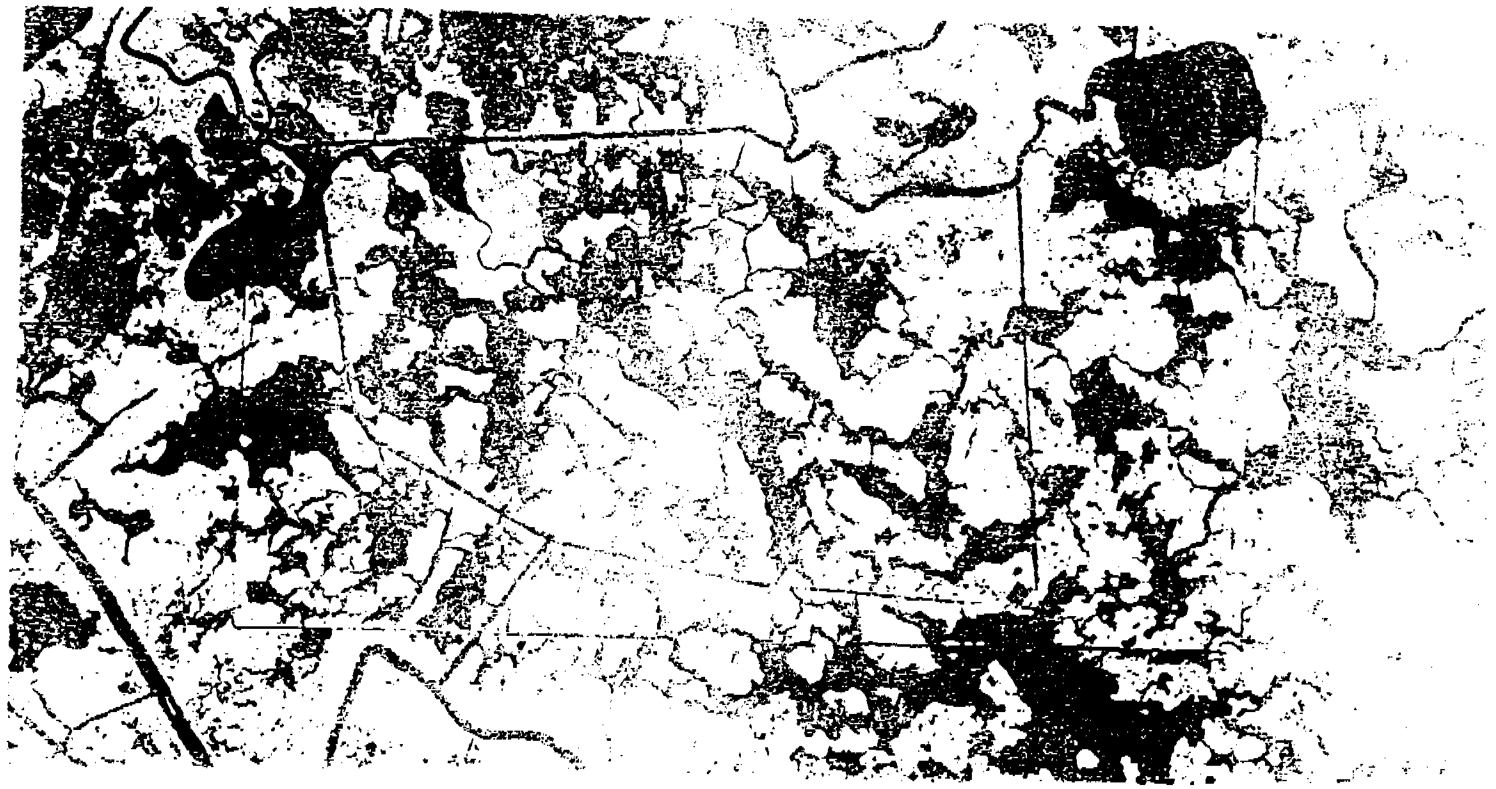


Variable 3-Marsh Interspersion Type 1
Scale 1" = 2000'

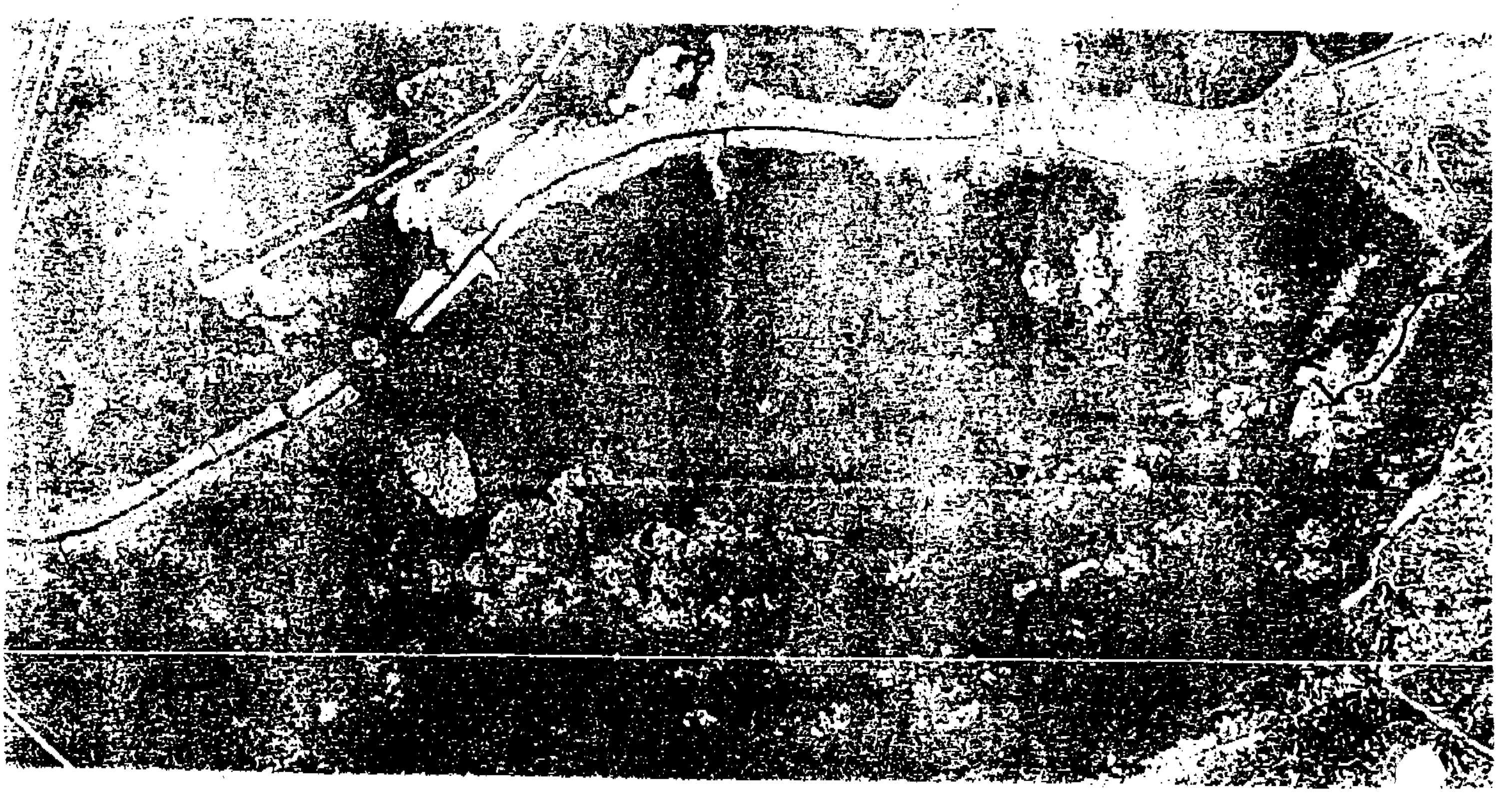
Variable 3 - Marsh Interspersion Type 2
Scale 1" = 2000'



Variable 3 - Marsh Interspersion Type 3
Scale 1" = 2000'



Variable 3 - Marsh Interspersion Type 4
Scale 1" = 2000'



PROCEDURE FOR CALCULATING ACCESS VALUE

1. Determine the percent of wetland area accessible by estuarine organisms during normal tidal fluctuations (P) for baseline (TY0) conditions. P may be determined by examination of aerial photography, knowledge of field conditions, or other appropriate methods.

2. Determine the Structure Rating (R) for each project structure as follows:

Structure Type	Rating
open system	1.0
rock weir set at 1ft BML[1], w/ boat bay	0.8
rock weir with boat bay	0.6
rock weir set at ≥ 1ft BML	0.6
slotted weir with boat bay	0.6
open culverts	0.5
weir with boat bay	0.5
weir set at ≥1ft BML	0.5
slotted weir	0.4
flapgated culvert with slotted weir	0.35
variable crest weir	0.3
flapgated variable crest weir	0.25
flapgated culvert	0.2
rock weir	0.15
fixed crest weir	0.1
solid plug	0.0001

For each structure type, the rating listed above pertains only to the standard structure configuration and assumes that the structure is operated according to common operating schedules consistent with the purpose for which that structure is designed. In the case of a "hybrid" structure or a unique application of one of the above-listed types (including unique or "non-standard" operational schemes), the WVA analyst(s) may assign an appropriate Structure Rating between 0.0001 and 1.0 that most closely approximates the relative degree to which the structure in question would allow ingress/egress of estuarine organisms. In those cases, the rational used in developing the new Structure Rating shall be documented.

3. Determine the Access Value. Where multiple openings <u>equally</u> affect a common "accessible unit", the Structure Rating (R) of

[1] Below Marsh Level

the structure proposed for the "major" access point for the unit will be used to calculate Access Value. The designation of "major" will be made by the Environmental Work Group. An "accessible unit" is a defined as a portion of the <u>total</u> accessible area that is served by one or more access routes (canals, bayous, etc.), yet is isolated in terms of estuarine organism access to or from other units of the project area. Isolation factors include physical barriers that prohibit further movement of estuarine organisms, such as natural levee ridges, and spoil banks; and dense marsh that lacks channels, trenasses, and similar small connections that would, if present, provide access and intertidal refugia for estuarine organisms.

Access Value should be calculated according to the following examples (<u>Note</u>: for all examples, P for TY0 = 90%. That designation is arbitrary and is used only for illustrative purposes; P could be any percentage from 0% to 100%):

a. One opening into area; no structure.

Access Value = P
= .90

b. One opening into area that provides access to the entire 90% of the project area deemed accessible. A flapgated culvert with slotted weir is placed across the opening.

Access Value = P * R
= .90 * .6
= .54

c. Two openings into area, <u>each</u> <u>capable</u> <u>by</u> <u>itself</u> of providing full access to the 90% of the project area deemed accessible in TY0. Opening #2 is determined to be the major access route relative to opening #1. A flapgated culvert with slotted weir is placed across opening #1. Opening #2 is left unaltered.

Access Value = P
= .90

<u>Note</u>: Structure #1 had no bearing on the Access Value calculation because it's presence did not reduce access (opening #2 was determined to be the major access route, and access through that route was not altered).

d. Two openings into area. Opening #1 provides access to an accessible unit comprising 30% of the area. Opening #2 provides access to an accessible unit comprising the remaining 60% of the project area. A flapgated culvert with slotted weir is placed across #1. Opening #2 is left open.

Access Value = weighted avg. of Access Values of the two accessible units

$$= ([P_1*R_1] + [P_2*R_2])/(P_1+P_2)$$
$$= ([.30*0.6] + [.60*1.0])/(.30+.60)$$
$$= (.18 + .60)/.90$$
$$= .78/.90$$
$$= .87$$

<u>Note</u>: $P_1 + P_2 = .90$, because only 90 percent of the study area was determined to be accessible at TY0.

e. Three openings into area, each capable of providing full access to the entire area independent of the others. Opening #3 is determined to be the major access route relative to openings #1 and #2. Opening #1 is blocked with a solid plug. Opening #2 is fitted with a flapgated culvert with slotted weir, and opening #3 is left open.

Access Value = P
= .90

<u>Note</u>: Structures #1 and #2 had no bearing on the Access Value calculation because their presence did not reduce access (opening #3 was determined to be the major access route, and access through that route was not altered).

f. Three openings into area, each capable of providing full access to the entire area independent of the others. Opening #2 is determined to be the major access route relative to openings #1 and #3. Opening #1 is blocked with a solid plug. Opening #2 is fitted with a flapgated culvert with slotted weir, and opening #3 is fitted with a fixed crest weir.

Access Value = $P * R_2$
= .90 * .6
= .54

<u>Note</u>: Structures #1 and #3 had no bearing on the Access Value calculation because their presence did not reduce access. Opening #2 was determined beforehand to be the major access route; thus, it was the flapgated culvert with slotted weir across that opening that actually served to limit access.

g. Three openings into area. Opening #1 provides access to an accessible unit comprising 20% of the area. Openings #2 and #3 provide access to an accessible unit comprising the remaining 70% of the area, and within that area, each is capable by itself of providing full access. However, opening #3 is determined to be the major access route relative to opening #2. Opening #1 is fitted with an open culvert, #2 with a flapgated culvert with slotted weir, and #3 with a fixed crest weir.

Access Value = $([P_1*R_1] + [P_2*R_3])/(P_1+P_2)$

= ([.20*.7]+[.70*.6])/(.20+.70)
= (.14 + .42)/.90
= .56/.90
= .62

h. Three openings into area. Opening #1 provides access to an accessible unit comprising 20% of the area. Opening #2 provides access to an accessible unit comprising 40% of the area, and opening #3 provides access to the remaining 30% of the area. Opening #1 is fitted with an open culvert, #2 a flapgated culvert with slotted weir, and #3 a fixed crest weir.

Access Value = $([P_1*R_1]+[P_2*R_2]+[P_3*R_3])/(P_1+P_2+P_3)$

= ([.20*.7]+[.40*.6]+[.30*.1])/(.20+.40+.30)
= (.14+.24+.03)/.90
= .41/.90
= .46

Published Habitat Suitability Index (HSI) Models Consulted for Variables for Possible Use in the Wetland Value Assessment Models

Estuarine Fish and Shellfish

pink shrimp
white shrimp
brown shrimp
spotted seatrout
Gulf flounder
southern flounder
Gulf menhaden
juvenile spot
juvenile Atlantic croaker
red drum

Reptiles and Amphibians

American alligator
slider turtle
bullfrog

Mammals

mink
muskrat

Freshwater Fish

channel catfish
largemouth bass
red ear sunfish
bluegill

Birds

clapper rail
great egret
northern pintail
mottled duck
coot
marsh wren
great blue heron
laughing gull
snow goose
red-winged blackbird
roseate spoonbill
white-fronted goose

Attachment 7

Missisippi River-Gulf Outlet
St. Bernsard Parish, Lousiana
Bank Erosion
Reconnaissance Report

Appendix C

MRGO Maintenance

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MRGO MAINTENANCE

Historic Maintenance Cost.

Maintenance costs on a "per ton of commerce" basis for the MRGO have fluctuated over the years as both tonnage and the volume of maintenance work have exhibited significant variation. Since its mid-year opening in 1960 commerce on the MRGO generally continued to grow until 1978 when an all-time high of 9.4 million tons was achieved. Traffic declined for the next several years through the early 80's until its rebound in the mid 80's with near record levels for current traffic. Table 1 displays the MRGO traffic history.

Maintenance costs, as opposed to traffic, have exhibited essentially no pattern or trend. Costs have fluctuated widely with the highest costs occurring in years when large quantities of material had to be removed from the bar channel. Along with a restatement of the last 20 years of traffic (1968-1987), Table 2 displays historic maintenance costs in both nominal dollars and constant 1988 dollars for 1968-1988.

The side by side presentation of historic tonnage and maintenance costs facilitates the display of per ton maintenance. Table 2 shows the year-by-year nominal per ton maintenance based on all traffic and for deep draft traffic only. However, due to the significant change in the general level of prices over the period, nominal costs are not particularly meaningful for current analysis. Therefore, 1988 constant dollar maintenance has been calculated. Constant dollar costs are calculated by inflating past year cost by an appropriate amount to account for the general price level increase that has occurred since that particular year. While individual year per ton costs are displayed, any given year can be entirely unrepresentative of the longer-term maintenance situation. Due to the significant yearly variation in maintenance expenditures it is necessary to develop a long-term average of constant dollar maintenance

TABLE 1
MRGO TONNAGE

YEAR	TOTAL TONS	FOREIGN TONS	COASTWISE TONS	TOTAL DEEP TONS
1987	7,702,792	5,086,504	960,177	6,046,681
1986	8,144,555	5,253,920	759,082	6,013,002
1985	6,916,446	4,761,972	713,826	5,475,798
1984	8,034,531	5,381,282	560,766	5,942,048
1983	5,434,613	3,485,000	579,120	4,064,120
1982	5,571,840	3,877,861	442,767	4,320,628
1981	5,794,760	4,343,946	397,446	4,741,392
1980	5,541,464	4,367,785	436,678	4,804,463
1979	8,227,225	6,272,419	518,657	6,791,076
1978	9,411,077	5,135,945	1,390,249	6,526,194
1977	8,780,667	4,202,837	1,675,730	5,878,567
1976	6,970,648	4,151,820	901,899	5,053,719
1975	5,386,829	3,212,687	936,602	4,149,289
1974	5,307,538	3,385,827	560,424	3,946,251
1973	4,938,305	3,190,105	279,276	3,469,381
1972	3,854,908	2,403,673	245,291	2,648,964
1971	3,982,015	2,116,369	201,359	2,317,728
1970	4,012,850	2,521,658	137,515	2,659,173
1969	3,094,164	1,842,832	97,032	1,939,864
1968	3,469,743	1,856,424	170,390	2,026,814
1967	2,785,568	1,362,487	427,353	1,789,840
1966	2,884,143	1,142,498	588,372	1,730,870
1965	2,091,888	757,379	383,333	1,140,712
1964	1,701,985	593,218	40,226	633,444
1963	1,194,882	434,847	65,149	499,996
1962	600,918	300,574	10,431	311,005
1961	342,629	42,030	0	42,030
1960	178,746	0	0	0

TABLE 2
HISTORIC MRGO MAINTENANCE

YEAR	TOTAL TONS	FOREIGN TONS	COASTWISE TONS	TOTAL DEEP TONS	MAINTENANCE ($)	$ PER TON	$ PER DEEP TON	1988 CONSTANT $ MAINTENANCE ($)	1988 CONSTANT $ PER TON	1988 CONSTANT $ PER DEEP TON	
1988					4,860,900			4,860,900			
1987	7,702,792	5,086,504	960,177	6,046,681	8,373,100	1.09	1.38	8,528,590	1.11	1.41	
1986	8,144,555	5,253,920	759,082	6,013,002	6,808,100	0.84	1.13	7,110,752	0.87	1.18	
1985	6,916,446	4,761,972	713,826	5,475,798	4,531,900	0.66	0.83	4,897,617	0.71	0.89	
1984	8,034,531	5,381,282	560,766	5,942,048	10,169,600	1.27	1.71	11,059,736	1.38	1.86	
1983	5,434,613	3,485,000	579,120	4,064,120	14,717,200	2.71	3.62	16,136,855	2.97	3.97	
1982	5,571,840	3,877,861	442,767	4,320,628	4,349,500	0.78	1.01	5,077,502	0.91	1.18	
1981	5,794,760	4,343,946	397,446	4,741,392	7,134,800	1.23	1.50	8,791,440	1.52	1.85	
1980	5,541,464	4,367,785	436,678	4,804,463	1,522,900	0.27	0.32	2,071,442	0.37	0.43	
1979	8,227,225	6,272,419	518,657	6,791,076	7,143,000	0.87	1.05	10,356,217	1.26	1.52	
1978	9,411,077	5,135,945	1,390,249	6,526,194	4,419,200	0.47	0.68	7,014,881	0.75	1.07	
1977	8,780,667	4,202,837	1,675,730	5,878,567	4,321,000	0.49	0.74	7,309,517	0.83	1.24	
1976	6,970,648	4,151,820	901,899	5,053,719	6,314,100	0.91	1.25	11,529,309	1.65	2.28	
1975	5,386,829	3,212,687	936,602	4,149,289	3,287,100	0.61	0.79	6,486,898	1.20	1.56	
1974	5,307,538	3,385,827	560,424	3,946,251	1,347,000	0.25	0.34	2,902,943	0.55	0.74	
1973	4,938,305	3,190,105	279,276	3,469,381	2,626,800	0.53	0.76	6,145,769	1.24	1.77	
1972	3,854,908	2,403,673	245,291	2,648,964	1,855,700	0.48	0.70	4,681,251	1.21	1.77	
1971	3,982,015	2,116,369	201,359	2,317,728	4,242,300	1.07	1.83	11,686,857	2.93	5.04	
1970	4,012,850	2,521,658	137,515	2,659,173	6,864,700	1.71	2.58	21,668,146	5.40	8.15	
1969	3,094,164	1,842,832	97,032	1,939,864	1,630,000	0.53	0.84	5,676,836	1.83	2.93	
1968	3,469,743	1,856,424	170,390	2,026,814	1,097,300	0.32	0.54	4,170,846	1.20	2.06	
68-87 AVG	6,028,849	3,842,543	598,214	4,440,758				7,913,614	1.31	1.78	20-YR AVG TONS WITH 68-88 AVG COST
85-87 AVG	7,587,931	5,034,132	811,028	5,845,160					1.04	1.35	3-YR AVG TONS WITH 68-88 AVG COST
83-87 AVG	7,246,587	4,793,736	714,594	5,508,330					1.09	1.44	5-YR AVG TONS WITH 68-88 AVG COST
80-87 AVG	6,642,625	4,569,784	606,233	5,176,017					1.19	1.53	8-YR AVG TONS WITH 68-88 AVG COST
78-87 AVG	7,077,930	4,796,663	675,877	5,472,540					1.12	1.45	10-YR AVG TONS WITH 68-88 AVG COST

NOTE: 1988 CONSTANT $ MAINTENANCE IS AVERAGED OVER 21.25 YEARS BECAUSE THE FY 1976 COSTS INCLUDE THE 1976 TRANSITION QUARTER COSTS ALSO.

expenditures to accurately view these costs. This long-term average maintenance expenditure is $7.9 million. With $7.9 million as the cost base the per ton cost has been calculated using a 3-yr, 5-yr, 8-yr, 10-yr, and 20-yr period as the traffic base. The 20-yr traffic base has been provided for display purposes only as the 1968 -1987 period includes much of the early project life when traffic was unrepresentatively low. Of interest are the fairly small differences in per ton costs when comparing the other traffic base periods. The 3-yr traffic base for deep draft traffic has been selected as most representative of existing conditions and has been used in future maintenance cost calculations.

<u>Projected Maintenance Costs.</u>

Maintenance expenditures, as described in the Mississippi River - Gulf Outlet Bank Erosion Reconnaissance Report, are projected to increase over the next 15 years if no action is taken to reduce the rate of bank erosion. The areas requiring the anticipated additional maintenance work are located between miles 23 and 60. Currently this area is estimated to have an annual requirement of $709,500. It is expected to grow to $1,982,500 by 1997 and ultimately to $3,965,000 by 2002. This represents more than a five fold increase. As previously calculated, current average maintenance for the entire channel, including miles 23-60, is $7,913,600. Since no additional maintenance work beyond current levels is expected for the channel outside of miles 23-60, total maintenance is projected to grow only by the amount associated with the 37 miles of problem erosion. Because miles 23-60 currently represent only 9 percent of total channel maintenance, the large relative increase for the problem area translates into a much smaller overall increase for the entire channel, about 41 percent. Table 3 displays the projected total and problem area maintenance costs.

Table 4 displays projected per ton maintenance costs under several traffic growth scenarios. All scenarios use the 3-yr 85-87 traffic base and a growth in total channel maintenance from $7,913,600 to $11,169,100. The

TABLE 4
FUTURE MRGO MAINTENANCE PER TON
CONSTANT 1988 DOLLARS

	MAINTENANCE	85-87 TRAFFIC BASE	0 GROWTH	MAINTENANCE PER TON $	0.01 GROWTH	MAINTENANCE PER TON $	0.015 GROWTH	MAINTENANCE PER TON $	0.02 GROWTH	MAINTENANCE PER TON $	0.025 GROWTH	MAINTENANCE PER TON $	0.03 GROWTH	MAINTENANCE PER TON $	0.036 GROWTH	MAINTENANCE PER TON $
1987	7,913,600	5,845,200	5,845,200	1.35	5,845,200	1.35	5,845,200	1.35	5,845,200	1.35	5,845,200	1.35	5,845,200	1.35	5,845,200	1.35
1988	8,040,900		5,845,200	1.38	5,903,652	1.36	5,932,878	1.36	5,962,104	1.35	5,991,330	1.34	6,020,556	1.34	6,055,627	1.33
1989	8,168,200		5,845,200	1.40	5,962,689	1.37	6,021,871	1.36	6,081,346	1.34	6,141,113	1.33	6,201,173	1.32	6,273,630	1.30
1990	8,295,500		5,845,200	1.42	6,022,315	1.38	6,112,199	1.36	6,202,973	1.34	6,294,641	1.32	6,387,208	1.30	6,499,480	1.28
1991	8,422,800		5,845,200	1.44	6,082,539	1.38	6,203,882	1.36	6,327,032	1.33	6,452,007	1.31	6,578,824	1.28	6,733,462	1.25
1992	8,550,100		5,845,200	1.46	6,143,364	1.39	6,296,940	1.36	6,453,573	1.32	6,613,307	1.29	6,776,189	1.26	6,975,866	1.23
1993	8,677,400		5,845,200	1.48	6,204,798	1.40	6,391,395	1.36	6,582,645	1.32	6,778,640	1.28	6,979,474	1.24	7,226,998	1.20
1994	8,804,700		5,845,200	1.51	6,266,846	1.40	6,487,265	1.36	6,714,297	1.31	6,948,106	1.27	7,188,859	1.22	7,487,169	1.18
1995	8,932,000		5,845,200	1.53	6,329,514	1.41	6,584,574	1.36	6,848,583	1.30	7,121,809	1.25	7,404,524	1.21	7,756,708	1.15
1996	9,059,300		5,845,200	1.55	6,392,809	1.42	6,683,343	1.36	6,985,555	1.30	7,299,854	1.24	7,626,660	1.19	8,035,949	1.13
1997	9,186,600		5,845,200	1.57	6,456,737	1.42	6,783,593	1.35	7,125,266	1.29	7,482,350	1.23	7,855,460	1.17	8,325,243	1.10
1998	9,583,100		5,845,200	1.64	6,521,305	1.47	6,885,347	1.39	7,267,772	1.32	7,669,409	1.25	8,091,124	1.18	8,624,952	1.11
1999	9,979,600		5,845,200	1.71	6,586,518	1.52	6,988,627	1.43	7,413,127	1.35	7,861,144	1.27	8,333,858	1.20	8,935,450	1.12
2000	10,376,100		5,845,200	1.78	6,652,383	1.56	7,093,457	1.46	7,561,389	1.37	8,057,673	1.29	8,583,873	1.21	9,257,126	1.12
2001	10,772,600		5,845,200	1.84	6,718,907	1.60	7,199,859	1.50	7,712,617	1.40	8,259,115	1.30	8,841,389	1.22	9,590,363	1.12
2002	11,169,100		5,845,200	1.91	6,786,096	1.65	7,307,856	1.53	7,866,870	1.42	8,465,592	1.32	9,106,631	1.23	9,935,637	1.12

first scenario shows how per ton costs will increase if the traffic base is held constant. This case results in the same 41 percent increase in per ton costs as that which occurs in overall channel maintenance. The second through sixth cases show traffic growth of 1 percent through 3 percent in one-half percent increments. Of interest is the 1.5 percent growth case. This scenario results in essentially no change in per ton costs through 1997, with small increases thereafter. Under this scenario traffic growth exactly offsets maintenance increases for 10 years. Traffic growth of 2.5 percent or greater results in future per ton costs which are lower than current per ton costs for the entire 15 year period.

The final growth scenario uses 3.6 percent. This is the composite annual growth from 1985 through 2000 for U.S. foreign trade for all trade sectors as developed by Wharton Econometric Forecasting Associates in their Assessment of Maritime Trade and Technology, 1983. This work by Wharton is the source used to project deep draft lockage demand in the Inner Harbor Navigation Canal Lock Replacement Study. This scenario results in an approximate decline of 17 percent in per ton costs. This is the growth rate used in the following calculations of continued maintenance feasibility. It may be worth noting that the 20-year period 1967-1987 saw an annual increase of over 6 percent in MRGO deep-draft tonnage.

Feasibility of Continued Maintenance.

To deny deep draft traffic access to the MRGO channel will result in increased cost to deep draft operations and additional costs overall to the full transportation cost of the commodities involved. This is true because it must be assumed, that all factors considered, use of the MRGO is associated with the lowest overall cost of transportation. The increase in cost the denied access would produce is the measure of transportation benefit associated with continued operation of the MRGO. If MRGO access is denied, there are two basic options, which conceptually are the same, available to the displaced deep draft users. The first would be to move operations to a site on the Mississippi River. The second would be to move to an entirely different port, presumably somewhere on the Gulf Coast.

Diversion to the Mississippi River. Traffic currently being handled by facilities on MRGO could be diverted to facilities on the Mississippi River with relatively small increases in ship line-haul costs. Changes in inland transportation costs to move the commodity to its ultimate destination (or from its origin) are unknown but likely not large. However, the availability of facilities to handle the diverted traffic presents some difficulties. While total deep draft tonnage on the MRGO is only a small fraction (7.4 percent in 1987) of deep draft tonnage in the Port of New Orleans, the specific facilities needed to accommodate the diverted MRGO are limited.

In 1986 2.7 million tons (360,000 twenty-foot equivalent units) of container cargoes were handled by the four main berths that make up the MRGO's 351-acre France Road Complex. This amounted to more than 80 percent of the port's total container traffic. While several container handling wharves exist on the river, their container capacity is limited. This is particularly true with respect to marshaling yard space. Diversion of France Road container traffic to the river could not be accommodated without substantial, costly improvements to river facilities.

The other major facilities, along with the France Road Complex, that handle the bulk of deep draft traffic on the MRGO are the Jourdan Road Terminal, the Public Bulk Terminal and the Galvez Street Wharf. Jourdan Road is designed for roll on - roll off (ro-ro), container and general cargo operations. The Public Bulk Terminal handles bulk cargoes and Galvez Street handles primarily general cargo. The feature all have in common is public access, and it is this characteristic that would make diversion of their tonnages to the river difficult. Approximately 35 percent of the port's tonnage over public general cargo wharves is handled by MRGO facilities and the Public Bulk Terminal represents one of only two public non-grain bulk facilities in the port.

An estimate of the full costs to expand facilities that could accommodate diverted MRGO traffic is not readily available. However, a look at the major facilities in place on the MRGO is a useful starting point. The Board of Commissioners of the Port of New Orleans has expended $137 million to construct the previously mentioned facilities. This includes a $5.3 million 32-acre expansion of the France Road yard currently underway. The $137 million represents historic expenditures, not current replacement values which would no doubt be greater. It does not include the cost of land or any private improvements. It also does not include costs for the four existing container cranes or the scheduled $7 million acquisition of an additional crane. Nor does it included the $20 - $30 million planned but yet unscheduled construction of another container wharf and intermodal facility at France Road. It primarily includes the historic costs of terminals, wharves, sheds and marshaling yard improvements.

As a measure of the relative costs of continuing to maintain the MRGO vs. diverting traffic to the river, $137 million can be used as a starting point for the cost of river facility improvements that would be required to accommodate the diverted traffic. Given what this figure does not include, it represents an extremely conservative minimum estimate. Amortizing $137 million at 8.875 percent for a 50-year period and assuming no interest during the construction period produces annual charges of approximately $12.3 million. Existing MRGO maintenance costs of $7.9 million are anticipated to increase to $11.2 million, or an annual equivalent value of $9.3 million. Continued maintenance is therefore, clearly a less costly proposition than diverting traffic to locations on the river.

In addition to deep draft vessels a significant number of other vessels also use the channel. Beyond shallow draft traffic (refer to Table 1), oil field service vessels and numerous recreation vessels use the MRGO. Over the 1983-1986 period, Waterborne Commerce data recorded an average of 205 oil field service vessels outbound on the MRGO. This is a conservative estimate of the number of vessels, given an area-wide problem with under-reporting of this type traffic. The Waterborne Commerce Statistics

Center has estimated that only about 35 percent of this traffic is reported Gulf wide. NOD investigation of the problem in the Bayou Lafourche - Lafourche Jump Waterway study suggests even a larger problem - only 20 percent reporting. These findings suggest that the average number of service vessels is significantly larger than that reported. It is difficult to quantify the cost of channel closure to this traffic given the absence of specific information (e.g. origins and destinations). Given what we do know about some movements an estimated range is possible, however.

Adjusting reported trips by the NOD estimate for under-reporting produces approximately 1,000 outbound trips. Using a range of hourly operating costs of \$100 - \$150 (180-foot and 220-foot vessels respectively) and one-way trip savings of 3 - 5 hours (assuming that vessels would alternately operate from Venice, Louisiana) generates a range of \$0.6 - \$1.5 million for the round-trip cost of channel closure.

The costs of this alternative are summarized in Table 12.

Diversion to Another Port. For this reconnaissance level effort it is not possible to consider all of the likely alternative ports. The alternative ports will vary with each different commodity. We can anticipate however, that the alternatives would be ports with similar orientation and capacity. For example, a port with limited capacity for handling containerized cargo would not be a reasonable candidate for an alternative port to handle France Road traffic, nor would a port that has primarily a bulk cargo orientation be reasonable to consider for handling general cargos.

Alternative ports, by definition, must be associated with higher overall transportation costs. It is relatively easy to select an alternative port and calculate the differential in line-haul ocean costs. Due to the lack of available data regarding the hinterland origins and destinations, as well as the inland mode of transit, it is more difficult to calculate this portion of the overall transit cost. It is possible however, to make informed speculation about the relative magnitude of these hinterland costs given some known relationships.

Houston represents a reasonable alternative port for essentially all traffic types on the MRGO. It is a major Gulf Coast and U.S. port and has been identified by one of the major MRGO container operators as the next best alternative if the MRGO were unavailable. For those movements that are involved in direct origin to destination ocean shipment (those without intermediate stops), the change in per ton ocean line-haul costs have been calculated assuming a diversion to Houston. Tables 5 and 6 show the one-way per ton increase for a range of vessel types and sizes by U.S. and foreign flag. Additional distance divided by speed equals additional time. Additional time multiplied by operating cost, divided by tons carried produces additional cost per ton. Table 6 shows the change assuming the vessel enters the Gulf via the Yucatan Channel, while Table 5 assumes Gulf entry via the Straits of Florida. All traffic entering the Gulf must use one of these routes. A weighted average increase for all tonnage was calculated to be about $1.00. The average dead weight tonnage used was 20,000 for containers, 11,000 for general cargo and 25,000 for dry bulk. Table 7 displays historic overall fleet distributions. Table 8 shows the vessel type distribution. For purposes of the weighted average the first three vessel types in Table 8 were treated as containers and the third and fourth as general cargo. It was assumed that gulf entry was split evenly between the Yucatan Channel and the Straits of Florida and that 50 percent of all vessels had an empty backhaul. The latter assumption doubles the one-way increase for those vessels. Table 9 shows calculation of the weighted line-haul differential.

As earlier mentioned, given available data, calculation of hinterland cost changes is more difficult. But the magnitude of such change can be determined if certain assumptions are made. If it is assumed that the hinterland for MRGO container and general cargo traffic is essentially the same hinterland served by the lower Mississippi River for bulk traffic, it is possible to extrapolate from previous work to draw conclusions.

TABLE 5
ADDITIONAL LINE-HAUL COSTS
STRAITS OF FLORIDA TO N.O. VIA MRGO
vs
STRAITS OF FLORIDA TO HOUSTON

ADDITIONAL ONE-WAY
DISTANCE (NAU. MI.): 237

U.S. CONTAINER

DWT		16000	20000	24000	28000	32000
$/HR @ SEA		1825	2218	2464	2640	2922
SPEED (KNOTS)		20	20	20	20	20
ADD. TIME (HRS)		11.85	11.85	11.85	11.85	11.85
ADD. $/TON (ONE-WAY)		1.42	1.38	1.28	1.18	1.14

FOREIGN CONTAINER

DWT	12000	16000	20000	24000	28000	32000
$/HR @ SEA	615	852	958	1107	1252	1421
SPEED (KNOTS)	18	20	20	20	20	20
ADD. TIME (HRS)	13.17	11.85	11.85	11.85	11.85	11.85
ADD. $/TON (ONE-WAY)	0.71	0.66	0.60	0.58	0.56	0.55

U.S. GEN CARGO

DWT	11000	14000	16000	20000	24000	30000
$/HR @ SEA	1744	1922	2106	2328	2457	2670
SPEED (KNOTS)	18	20	20	20	20	20
ADD. TIME (HRS)	13.17	11.85	11.85	11.85	11.85	11.85
ADD. $/TON (ONE-WAY)	2.20	1.71	1.64	1.45	1.28	1.11

FOREIGN GEN CARGO

DWT	11000	14000	16000	20000	24000	30000
$/HR @ SEA	503	570	640	731	787	932
SPEED (KNOTS)	15	15	16	16	16	16
ADD. TIME (HRS)	15.80	15.80	14.81	14.81	14.81	14.81
ADD. $/TON (ONE-WAY)	0.76	0.68	0.62	0.57	0.51	0.48

U.S. DRY BULK

DWT		25000	40000
$/HR @ SEA		1204	1373
SPEED (KNOTS)		15	15
ADD. TIME (HRS)		15.80	15.80
ADD. $/TON (ONE-WAY)		0.80	0.57

FOREIGN DRY BULK

DWT	15000	25000	35000
$/HR @ SEA	482	578	617
SPEED (KNOTS)	15	15	15
ADD. TIME (HRS)	15.80	15.80	15.80
ADD. $/TON (ONE-WAY)	0.53	0.38	0.29

TABLE 6
ADDITIONAL LINE-HAUL COSTS
YUCATAN CHANNEL TO N.O. VIA MRGO
vs
YUCATAN CHANNEL TO HOUSTON

ADDITIONAL ONE-WAY
DISTANCE (NAU. MI.): 169

U.S. CONTAINER

DWT		16000	20000	24000	28000	32000
$/HR @ SEA		1825	2218	2464	2640	2922
SPEED (KNOTS)		20	20	20	20	20
ADD. TIME (HRS)		8.45	8.45	8.45	8.45	8.45
ADD. $/TON (ONE-WAY)		1.01	0.99	0.91	0.84	0.81

FOREIGN CONTAINER

DWT	12000	16000	20000	24000	28000	32000
$/HR @ SEA	615	852	958	1107	1252	1421
SPEED (KNOTS)	18	20	20	20	20	20
ADD. TIME (HRS)	9.39	8.45	8.45	8.45	8.45	8.45
ADD. $/TON (ONE-WAY)	0.51	0.47	0.43	0.41	0.40	0.39

U.S. GEN CARGO

DWT	11000	14000	16000	20000	24000	30000
$/HR @ SEA	1744	1922	2106	2328	2457	2670
SPEED (KNOTS)	18	20	20	20	20	20
ADD. TIME (HRS)	9.39	8.45	8.45	8.45	8.45	8.45
ADD. $/TON (ONE-WAY)	1.57	1.22	1.17	1.04	0.91	0.79

FOREIGN GEN CARGO

DWT	11000	14000	16000	20000	24000	30000
$/HR @ SEA	503	570	640	731	787	932
SPEED (KNOTS)	15	15	16	16	16	16
ADD. TIME (HRS)	11.27	11.27	10.56	10.56	10.56	10.56
ADD. $/TON (ONE-WAY)	0.54	0.48	0.44	0.41	0.36	0.35

U.S. DRY BULK

DWT		25000	40000
$/HR @ SEA		1204	1373
SPEED (KNOTS)		15	15
ADD. TIME (HRS)		11.27	11.27
ADD. $/TON (ONE-WAY)		0.57	0.41

FOREIGN DRY BULK

DWT	15000	25000	35000
$/HR @ SEA	482	578	617
SPEED (KNOTS)	15	15	15
ADD. TIME (HRS)	11.27	11.27	11.27
ADD. $/TON (ONE-WAY)	0.38	0.27	0.21

TABLE 7
MRGO FLEET DISTRIBUTION
OUTBOUND VESSELS

DEADWEIGHT TONNAGE	1988 #	1988 %	1987 #	1987 %	1986 #	1986 %	1985 #	1985 %	1984 #	1984 %	1983 #	1983 %	1982 #	1982 %
UNDER 20,000	400	59.1	517	64.5	614	68.4	452	60.8	571	64.7	514	65.9	478	60.7
20,000 - 29,999	209	30.9	205	25.6	188	20.9	215	28.9	231	26.2	210	26.9	267	33.9
30,000 - 39,999	33	4.9	52	6.5	58	6.5	45	6.0	32	3.6	33	4.2	26	3.3
40,000 - 49,999	30	4.4	26	3.2	33	3.7	28	3.8	38	4.3	20	2.6	14	1.8
50,000 - 59,999	4	0.6	0	0.0	5	0.6	1	0.1	5	0.6	2	0.3	0	0.0
60,000 - 69,999	0	0.0	0	0.0	0	0.0	2	0.3	4	0.5	1	0.1	1	0.1
70,000 - 79,999	1	0.1	1	0.1	0	0.0	1	0.1	1	0.1	0	0.0	1	0.1
80,000 - 89,999	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0
TOTAL	677	100.0	801	100.0	898	100.0	744	100.0	883	100.0	780	100.0	787	100.0

TABLE 9
WEIGHTED LINE-HAUL DIFFERENTIAL
(ONE-WAY PER TON)

VESSEL TYPE	ONE-WAY DIFFERENTIAL VIA YUCATAN	U.S OR FOREIGN %	U.S./FOR. WEIGHTED COST	VESSEL TYPE %	ROUTE WEIGHTED COST	ROUTE %	OVERALL WEIGHTED COST
CONTAINER (20,000 DWT)	$0.99	0.35	0.3465				
	$0.43	0.65	0.2795				
		-----	-----				
		1.00	$0.6260	0.589	0.3687		
GEN CARGO (11,000 DWT)	$1.57	0.00	0.0000				
	$0.54	1.00	0.5400				
		-----	-----				
		1.00	$0.5400	0.280	0.1512		
DRY BULK (25,000 DWT)	$0.57	0.00	0.0000				
	$0.27	1.00	0.2700				
		-----	-----				
		1.00	$0.2700	0.131	0.0354		

					$0.5553	0.5	$0.2776
	ONE-WAY DIFFERENTIAL VIA ST. OF FL.						
CONTAINER (20,000 DWT)	$1.38	0.35	0.4830				
	$0.60	0.65	0.3900				
		-----	-----				
		1.00	$0.8730	0.589	0.5142		
GEN CARGO (11,000 DWT)	$2.20	0.00	0.0000				
	$0.76	1.00	0.7600				
		-----	-----				
		1.00	$0.7600	0.280	0.2128		
DRY BULK (25,000 DWT)	$0.80	0.00	0.0000				
	$0.38	1.00	0.3800				
		-----	-----				
		1.00	$0.3800	0.131	0.0498		

					$0.7768	0.5	$0.3884

							$0.6660

NOTE: ASSUMING 50 PERCENT EMPTY BACKHAULS DOUBLES THE PER TON COST FOR HALF THE TONS RESULTING IN AN OVERALL AVGERAGE OF $1.00 PER TON (50% @ $0.66 AND 50% @ $1.33)

For any "Mid-America" hinterland movement via barge, the MRGO has a substantial advantage over Houston in the range of $2.00 per ton (in fact a large MRGO advantage would clearly apply to all commodity types and not just bulk). However, hinterland movements via rail, which would be typical for containers, seem to exhibit a different pattern. The Multiport Analysis for Galveston Bay Area Navigation Study concluded that most rail rates for service to the areas in question are extremely competitive. The Galveston study dealt exclusively with bulk cargos. However, if the Galveston Bay study conclusion can be applied to MRGO general cargo and container traffic it can be inferred that differential hinterland costs (MRGO vs. Houston) are small and are assumed to be zero in this analysis.

The availability of the necessary facilities at Houston to handle diverted tonnage is not known. Given the volume of container cargoes, it is likely that some improvement to facilities would be required; however, the magnitude is not known.

The cost of channel closure to service vessels under this alternative would be the same as described under the first alternative.

As displayed in Table 12, the total costs of this alternative, assuming 3.6 percent annual growth in deep draft traffic and a 50-year project life, exceed the costs of continued channel maintenance.

Relationship to IHNC Lock Replacement Study.

The future of the MRGO is an important issue within the IHNC Lock Replacement Study. The MRGO requires consideration of deep draft lockage demand and the incremental justification of the additional investment required to accommodate deep draft vessels. Deep draft useage also requires consideration of displaced shallow draft capacity. Three cases regarding the future use of the MRGO and their respective impact on the IHNC study are considered below.

Continued Maintenance of the MRGO. Continued MRGO maintenance is the condition assumed in the IHNC study. As such, there are no conflicts and all estimates of deep draft lockage demand and displaced shallow draft capacity are consistent.

Discontinue Maintenance of the MRGO and Relocation of Deep Draft Activities. With no deep draft activity on the MRGO, consideration of all lock replacement alternatives with a deep draft component could be dropped. Dropping alternatives does not create any problems from an evaluation standpoint. However, shallow draft capacity of the existing lock, against which shallow draft improvements are measured, is calculated assuming a projected level of deep draft useage. While representing only a 2.2 percent reduction in base condition shallow draft capacity, deep draft lock useage represents an 11 percent reduction in shallow draft capacity by the end of project life. Additionally, even the so-called "shallow draft only" alternatives permit a low level of deep draft useage since the lock sills for these alternatives are -21 or -25 feet. Elimination of deep draft useage, therefore, results in an understatement of shallow draft capacity and some probable lowering of benefits for lock replacement.

Discontinue Maintenance of the MRGO and Construct a Deep Draft Lock. As an alternative to abandoning the MRGO entrance channel and diverting deep draft activities to another location, a deep draft lock connecting the Mississippi River and existing MRGO facilities could be constructed. The feasibility of this action is evaluated by comparing the costs of continued MRGO maintenance vs. the costs of providing access via a lock. The costs of MRGO access via a lock include: added vessel transit time (including lockage time), added tug assistance cost during lockage, deep draft induced cost to shallow draft traffic, and additional lock construction cost.

Vessels that currently use the MRGO channel for inbound and outbound transit would experience additional transit time to reach MRGO facilities if forced to use the Mississippi River and a deep draft lock. Measured to a common point in the sea lanes used for channel approach, use of the MRGO saves approximately 20 miles compared to use of the river. The combined effect of the extra distance and the relatively slower upstream and Southwest Pass speeds on the river makes for a 6.4 hour round-trip MRGO advantage. In addition to the underway travel time differences, a vessel using the river would require two lockages during round-trip transit, resulting in an overall MRGO advantage of 8.4 hours.

Travel time differential multiplied by an average vessel operating cost per hour represents the additional vessel transit cost associated with MRGO closure. This assumes ship queues never develop. Given future ship volume some queues will certainly occur, thereby increasing vessel costs. See Table 10.

Deep draft vessels will not be able to transit a lock without tug assistance. At $1,000 per tug and one tug per vessel, tug assistance cost would be as displayed in Table 10.

The additional deep draft lockages that would be induced by MRGO closure would impose significant losses to shallow draft traffic that would use the IHNC lock or its replacement. Table 11 summarizes these losses. As the number of deep draft lockages increase, the capacity for shallow draft traffic decreases. The deep draft induced cost to shallow draft activity represents the increase in delay time that processed tons would incur and/or the additional cost that diverted traffic would encounter when it switched to its next best alternative. For the case evaluated and presented in Table 11, induced delays are not significant through the year 2000. This occurs because available capacity is still large relative to tonnage processed. However, as shallow draft capacity is lost beyond the year 2030 all capacity is committed to deep draft lockages. In fact, not all deep draft lockages could be accommodated. A second lock would be required just to service deep draft vessels.

TABLE 11
DEEP DRAFT LOCKAGE INDUCED
SHALLOW DRAFT LOSSES
RESULTING FROM MRGO CLOSURE
(WITH 900 x 110 x 36 LOCK @ VIOLET)

YEAR	REQUIRED D.D. LOCKAGES (MRGO CLOSED)	S.D. KTONS PROCESSED (MRGO OPEN)	S.D. CAPACITY MRGO CLOSED (KTONS)	S.D. CAPACITY MRGO OPEN (KTONS)	S.D. DELAY MRGO CLOSED (HOURS)	S.D. DELAY MRGO OPEN (HOURS)	D.D. INDUCED COST TO S.D. ($1,000)	PERCENT OF S.D. CAPACITY LOST
BASE	1,584	21,700	51,400	62,500	0.4	0.3	126	17.8
1990	1,761	25,600	50,000	62,200	0.6	0.4	253	19.6
2000	2,509	28,600	44,000	61,500	1.1	0.5	799	28.5
2010	3,573	32,900	35,500	60,400	7.2	0.7	10,713	41.2
2020	5,089	38,800	23,300	58,700	LARGE	1.0	201,760	60.3
2030	7,248	45,400	6,000	57,600	LARGE	1.7	234,491	89.6
2050	14,703	52,000	0	54,400	LARGE	12.9	239,460	100.0

The amount of additional lock construction cost chargeable to MRGO closure depends in part on the incremental justification of the deep draft increment under the continued MRGO maintenance condition. If the deep increment is justified, the only additional construction cost creditable to MRGO closure would be the future cost to construct a second lock when necessary. If the deep increment is not justified the difference between the cost of a deep draft lock and the cost of the NED shallow draft lock would be chargeable to MRGO closure in addition to the cost of the future second lock. While the justification of the deep increment has not yet been determined (preliminary indications are negative), the range of present value first cost on the deep vs. shallow increment is approximately \$35 - \$75 million. The cost to construct a second lock would be in the range of \$250 - \$350 million.

The cost to service vessels under this scenario would be the same as described under channel closure and diversion of activity.

Considering all the costs associated with MRGO closure, it is clear that continued channel maintenance represents a less costly alternative. Without inclusion of induced costs to shallow draft activity or additional lock construction costs, the addition costs to deep draft vessels alone exceed the cost of continued maintenance.

Conclusions.

Of the three alternatives to using the MRGO channel that were considered, 1) diversion to the Mississippi River, 2) diversion to another port, and 3) use of the Mississippi River and a connecting deep draft lock to MRGO facilities, 1) and 3) clearly involve more cost than the cost of continued channel maintenance. The case for alternative two being more costly than channel maintenance can be made but not by the same margin as the other alternatives. Table 12 summarizes the cost of continued maintenance and the cost of channel closure for each alternative.

TABLE 12
SUMMARY OF COSTS
($1,000)

ACTION	1987	1997	2002	2037	AVG ANN 1/ 1987-2002	AVG ANN 1/ 1987-2037
CONTINUED MAINTENANCE						
DREDGING	7,914	9,187	11,169	11,169	8,987	9,329
DIVERT TO RIVER						
FACILITY CONSTRUCTION	137,000	0	0	0	16,870	12,334
COST TO SERVICE VESSELS 2/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	138,050	1,050	1,050	1,050	17,920	13,384
DIVERT TO ALT. PORT						
ADD. LINE-HAUL 3/	5,845	8,325	9,936	34,260	7,479	14,090
FACILITY CONSTRUCTION	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
COST TO SERVICE VESSELS 2/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	6,895	9,375	10,986	35,310	8,529	15,140
CONSTRUCT DEEP DRAFT LOCK						
ADD. VESSEL TRANSIT	6,926	9,988	11,899	43,099	8,928	17,378
TUG ASSISTANCE	1,584	2,285	2,722	9,857	2,042	3,975
S.D. LOSSES	126	635	2,782	236,230	553	60,289
ADD. CONST.- DEEP INCREMENT	50,000	0	0	0	6,157	4,502
ADD. CONST.- 2nd LOCK	0	0	0	300,000 4/	0	2,498
COST TO SERVICE VESSELS 2/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	59,686	13,958	18,453	590,236	18,730	89,692

NOTE: N.Q. = NOT QUANTIFIED

1/ ANNUAL VALUES CALCULATED WITH 8.875 PERCENT INTEREST RATE
2/ BASED ON MID-POINT OF ESTIMATED RANGE
3/ ASSUMES 50 PERCENT BACKHAULS
4/ ACTUALLY WOULD BE REQUIRED BY APPROXIMATELY YEAR 2015

The costs in Table 12 have been annualized over two time periods, 1987 - 2002 and 1987 - 2037. The period 1987 - 2002 is displayed because this is the period over which it will take maintenance dredging costs to stabilize. The period 1987 - 2037 is displayed because it represents the standard 50-year navigation project life. Over the shorter period the quantified annual costs of diversion to another port are slightly less than the annual cost of dredging. However, given the reasonable likelihood that at least limited facility expansion would be required at the alternative port and the unquantified impacts to MRGO shallow draft traffic, it is probable that annual diversion costs exceed maintenance costs over the 15-year period as well. Over the longer period, the annualized cost of diversion to another port readily exceeds the cost of maintenance. In this case traffic growth continues beyond 15 years, increasing the total cost of diversion, while maintenance costs level off.

Sensitivity.

The sensitivity of the conclusions to deep draft traffic growth is explored in Table 13. Table 13 summarizes the cost of continued maintenance and the cost of diversion to an alternative port assuming different levels of growth. Diversion to the river and construction of a deep draft lock are not evaluated. Given that both of these alternatives are more costly than continued maintenance based on existing traffic, the conclusion as to which is the least cost option is not sensitive to traffic growth.

In addition to restating the cost of diversion to an alternative port assuming 3.6 percent growth, Table 13 displays this alternative assuming annual growth of 1.5 and 2.0 percent. These two growth rates were selected because the cost of diversion to an alternative port using the rates brackets the cost of continued maintenance. In both the 1.5 and 2.0 percent growth cases the quantified average annual costs over the shorter 1987 - 2002 time frame are less than continued maintenance. However, for the standard 50-year time frame these two growth rates bracket the cost of

TABLE 13
TRAFFIC GROWTH SENSITIVITY
($1,000)

ACTION	1987	1997	2002	2037	AVG ANN 1/ 1987-2002	AVG ANN 1/ 1987-2037
CONTINUED MAINTENANCE						
DREDGING	7,914	9,187	11,169	11,169	8,987	9,329
DIVERT TO ALT. PORT (1.5 PERCENT GROWTH)						
ADD. LINE-HAUL 2/	5,845	6,784	7,308	12,306	6,573	7,878
FACILITY CONSTRUCTION	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
COST TO SERVICE VESSELS 3/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	6,895	7,834	8,358	13,356	7,623	8,928
DIVERT TO ALT. PORT (2.0 PERCENT GROWTH)						
ADD. LINE-HAUL 2/	5,845	7,125	7,867	15,733	6,772	8,888
FACILITY CONSTRUCTION	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
COST TO SERVICE VESSELS 3/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	6,895	8,175	8,917	16,783	7,822	9,938
DIVERT TO ALT. PORT (3.6 PERCENT GROWTH)						
ADD. LINE-HAUL 2/	5,845	8,325	9,936	34,260	7,479	14,090
FACILITY CONSTRUCTION	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
COST TO SERVICE VESSELS 3/	1,050	1,050	1,050	1,050	1,050	1,050
COST TO MRGO S.D.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.	N.Q.
TOTAL	6,895	9,375	10,986	35,310	8,529	15,140

NOTE: N.Q. = NOT QUANTIFIED

1/ ANNUAL VALUES CALCULATED WITH 8.875 PERCENT INTEREST RATE
2/ ASSUMES 50 PERCENT BACKHAULS
3/ BASED ON MID-POINT OF ESTIMATED RANGE

Part I of this appendix presents reconnaissance-scope cost estimates that reflect October 1993 price levels and the cost per foot of dike for the construction and maintenance of bank erosion protection projects along the Mississippi River-Gulf Outlet. The estimates do not include Engineering and Design (E&D) or Supervision and Administration (S&A) costs. In the main report, E&D and S&A costs of 6% and 8%, respectively, were added to the cost per foot of dike for each construction and maintenance alternative.

Part II of this appendix presents cost and monetary benefit summaries for plans according to both type of structure (design) and reach of channel bank they protect (option).

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 1, CONSTRUCTION					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.20	$2.20	$0.55	$2.75
09.0.4.B	Armor Stone	10.74	TON	$17.50	$187.95	$46.99	$234.94
09.0.4.B	Shell	5.70	CY	$20.00	$114.00	$28.50	$142.50
09.0.4.B	Filter Fabric	7.68	SY	$4.00	$30.72	$7.68	$38.40
09.0.4.B	Concrete Mat	20.52	SF	$5.60	$114.91	$28.73	$143.64
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.80	$0.80	$0.20	$1.00
				TOTALS	$464.58	$116.15	$580.73

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 2, CONSTRUCTION					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.20	$2.20	$0.55	$2.75
09.0.4.B	Armor Stone	7.04	TON	$17.70	$124.61	$31.15	$155.76
09.0.4.B	Shell	4.56	CY	$20.00	$91.20	$22.80	$114.00
09.0.4.B	Filter Fabric	7.22	SY	$4.00	$28.88	$7.22	$36.10
09.0.4.B	Concrete Mat	27.27	SF	$5.60	$152.71	$38.18	$190.89
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.80	$0.80	$0.20	$1.00
				TOTALS	$414.40	$103.60	$518.00

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 3, CONSTRUCTION					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.20	$2.20	$0.55	$2.75
09.0.4.B	Armor Stone	11.63	TON	$17.50	$203.53	$50.88	$254.41
09.0.4.B	Filter Fabric	4.84	SY	$4.00	$19.36	$4.84	$24.20
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.80	$0.80	$0.20	$1.00
				TOTALS	$239.89	$59.97	$299.86

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 4, CONSTRUCTION					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.20	$2.20	$0.55	$2.75
09.0.4.B	Armor Stone	16.97	TON	$17.30	$293.58	$73.40	$366.98
09.0.4.B	Shell	6.65	CY	$20.00	$133.00	$33.25	$166.25
09.0.4.B	Filter Fabric	9.76	SY	$4.00	$39.04	$9.76	$48.80
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.80	$0.80	$0.20	$1.00
				TOTALS	$482.62	$120.66	$603.28

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 5, CONSTRUCTION				DATE: 25 MAR 93	
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.20	$2.20	$0.55	$2.75
09.0.4.B	Armor Stone	5.56	TON	$17.70	$98.41	$24.60	$123.02
09.0.4.B	Shell	2.00	CY	$20.00	$40.00	$10.00	$50.00
09.0.4.B	Filter Fabric	3.94	SY	$4.00	$15.76	$3.94	$19.70
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.80	$0.80	$0.20	$1.00
				TOTALS	$171.17	$42.79	$213.97

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, MILES 23 TO 27, CONSTRUCTION				DATE: 8 SEP 93	
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$4.73	$4.73	$1.18	$5.92
09.0.4.B	Armor Stone (Retaining Dikes)	85.0	TON	$15.85	$1,347.25	$336.81	$1,684.06
09.0.4.B	Armor Stone (Dike Capping)	19.8	TON	$15.90	$314.82	$78.71	$393.53
09.0.4.B	Shell	18.7	CY	$20.00	$374.00	$93.50	$467.50
09.0.4.B	Filter Fabric	6.6	SY	$3.90	$25.74	$6.44	$32.18
09.0.4.B	Settlement Plate / Marker Pipes	Lump Sum	LS	$0.85	$0.85	$0.21	$1.07
				TOTALS	$2,067.40	$516.85	$2,584.25

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 4 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 1, MAINTENANCE				DATE: 25 MAR 93	
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.00	$2.00	$0.50	$2.50
09.0.4.B	Armor Stone	3.56	TON	$17.70	$63.01	$15.75	$78.77
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
				TOTALS	$79.01	$19.75	$38.77

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 2, MAINTENANCE				DATE: 25 MAR 93	
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.00	$2.00	$0.50	$2.50
09.0.4.B	Armor Stone	1.43	TON	$16.25	$23.24	$5.81	$29.05
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
				TOTALS	$39.24	$9.81	$49.05

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 3, MAINTENANCE				DATE: 25 MAR 93	
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.00	$2.00	$0.50	$2.50
09.0.4.B	Armor Stone	5.81	TON	$17.70	$102.84	$25.71	$128.55
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
				TOTALS	$118.84	$29.71	$148.55

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 4, MAINTENANCE					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.00	$2.00	$0.50	$2.50
09.0.4.B	Armor Stone	4.99	TON	$17.70	$88.32	$22.08	$110.40
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
				TOTALS	$104.32	$26.08	$130.40

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, DESIGN 5, MAINTENANCE					DATE: 25 MAR 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$2.00	$2.00	$0.50	$2.50
09.0.4.B	Armor Stone	4.28	TON	$17.70	$75.76	$18.94	$94.70
09.0.4.B	Flotation Channel	Lump Sum	LS	$14.00	$14.00	$3.50	$17.50
				TOTALS	$91.76	$22.94	$114.70

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 3 MILES OF DIKE.

COST ESTIMATE		MRGO RECONNAISSANCE, MILES 23 TO 27, MAINTENANCE					DATE: 8 SEP 93
Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
09.0.A.-	Mobilization and Demobilization	Lump Sum	LS	$4.73	$4.73	$1.18	$5.92
09.0.4.B	Armor Stone	59.40	TON	$16.90	$1,003.86	$250.97	$1,254.83
				TOTALS	$1,008.59	$252.15	$1,260.74

NOTE: THIS ESTIMATE PROVIDES A COST PER FOOT OF DIKE. MOBILIZATION AND DEMOBILIZATION IS BASED ON A CONTRACT FOR 4 MILES OF DIKE.

SUMMARY OF ECONOMIC DATA

Methodology

The period of analysis, or project life, used for each alternative is 50 years. Benefits and costs are discounted or compounded as appropriate to base years and then converted to average annual equivalent values using the current Federal discount of 8.25%. For the purpose of comparison the net monetary benefits are converted to a common point in time and displayed in Table D1.

Options 1, 2, 3, 3A, and 4 were analyzed first, in combination with each of the designs 1, 2, 3, 4, and 5. Design 6 was analyzed as part of Design 3 because it applied to a particular reach within the project area. Option 4A, Design 5 was analyzed and presented seperately from the other options, using the same methodology.

Benefits

Tangible benefits analyzed are divided into three categories:

1) Value of marsh saved from erosion by the reduction of wave action caused by passing ships.

2) The value of marsh created on the north bank of the channel by placing dredged material on the marsh side of dikes.

3) Savings in maintenance dredging costs.

For purposes of this reconnaissance study, an existing value for marsh acres is used from the Land Loss and Marsh Creation Study (LLMC), U.S. Army Corps of Engineers, New Orleans District - Feasibility Study, volume 1, September 1992. A detailed reevaluation of of marsh acre values will be conducted for the MRGO feasibility study.

In the LLMC study, four components of marsh value were found to be readily quantifiable. The four components of marsh value are: commercial fisheries, commercial wildlife, recreation, and real estate. These components make up the 1992 brackish marsh value of $4,471 used in the LLMC study. Commercial fisheries account for 87.4% of that value, commercial wildlife 1%, recreation 6%, and real estate accounts for 5.6% of the total value.

Table D2 displays the average annual marsh acres saved after construction is completed and the average annual value of this acreage. The marsh acres created during and after construction are specified in Table D3. Acres are distributed over time according to the percentage of north bank construction occurring each year. A lag time of two years was applied to the time distibution in order to account for the time it takes such land to become fully functional wetland. The amount proportioned over the length of construction is equal to the amount of marsh saved for the first ten years after construction is complete. The value of the marsh created is specified in Table D4. The present values in the table are based on the projected future average annual output of the marsh acres created.

The savings in annual maintenance dredging costs which occur during and after construction are summarized in Table D5. A summary of total monetary benefits is in Table D6.

Costs

Project costs were analyzed using an interest rate of 8.25% and a project life of 50 years. The year 2000 was used as the begining of the construction period. Initially, different base years resulted from the varied lengths of construction period for each option considered. To facilitate comparison, costs for each design and option were brought to a common base year (2010).

Each option under study involves a similar amount of construction in the first year. Real estate easements necessary for the first year of construction were assumed to be incurred at the end of January of that year. All other real estate costs are assumed to be incurred at the end of the first year of construction.

Construction costs were prorated according to the number of miles of construction scheduled to take place each year compared to the total length of construction. Operation & maintenance and all other costs of the structure are discounted at end of year, unless otherwise indicated by the construction schedule.

TABLE D1

SUMMARY AVERAGE ANNUAL BENEFITS AND COSTS
(1993 PRICE LEVELS 8.25% RATE OF INTEREST)
($1,000'S)

BASE YEAR EACH OPTION:	OPTION 1 2001	OPTION 2 2005	OPTION 3 2008	OPTION 3 2008	OPTION 4 2005	OPTION 4A 2010
TOTAL AVERAGE ANNUAL MONETARY BENEFITS FOR ALL DESIGNS	$2,165	$4,312	$6,368	$5,541	$3,756	$4,838
TOTAL AVERAGE ANNUAL COSTS						
DESIGN 1	$4,113	$16,658	$48,045	$30,015	$14,400	N/A
DESIGN 2	$3,223	$13,094	$41,557	$23,526	$11,294	N/A
DESIGN 3	$3,273	$13,239	$41,919	$23,888	$11,443	N/A
DESIGN 4	$4,624	$18,721	$51,772	$33,741	$16,182	N/A
DESIGN 5	$2,451	$9,915	$36,004	$17,892	$8,570	$10,773
NET MONETARY BENEFITS						
DESIGN 1	($1,948)	($12,346)	($41,677)	($24,474)	($10,644)	N/A
DESIGN 2	($1,058)	($8,782)	($35,189)	($17,985)	($7,538)	N/A
DESIGN 3	($1,108)	($8,927)	($35,551)	($18,347)	($7,687)	N/A
DESIGN 4	($2,459)	($14,409)	($45,404)	($28,200)	($12,426)	N/A
DESIGN 5	($286)	($5,603)	($29,636)	($12,351)	($4,814)	($5,935)
NET MONETARY BENEFITS COMMON BASE YEAR (2010)						
DESIGN 1	($3,976)	($18,351)	($48,837)	($28,679)	($15,821)	N/A
DESIGN 2	($2,159)	($13,054)	($41,235)	($21,075)	($11,205)	N/A
DESIGN 3	($2,261)	($13,269)	($41,659)	($21,499)	($11,426)	N/A
DESIGN 4	($5,019)	($21,418)	($53,205)	($33,045)	($18,470)	N/A
DESIGN 5	($584)	($8,328)	($34,728)	($14,473)	($7,156)	($5,935)

TABLE D2

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH ACRES SAVED

RATE OF INTEREST = 8.25%

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
AVERAGE ANNUAL ACRES SAVED AFTER CONSTRUCTION	10.8	54	54	54	54
AVERAGE ANNUAL VALUE	$48,396	$241,979	$241,979	$241,979	$241,979

TABLE D3

CONSTRUCTION & DREDGING MARSH ACRES CREATED*

RATE OF INTEREST= 8.25%

YEAR	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
2002	18	23.5	23.5	23.5	18.6
2004					74.5
2005	9				
2006		187.8	187.8	187.8	
2006	36				
2013		47.0	47.0	47.0	37.2
2015	18				
2017					28.0
2018	27				
2018		11.7	11.7	11.7	9.3
2019		35.2	35.2	35.2	28.0
2021		47.0	47.0	47.0	37.2
2022		35.2	35.2	35.2	
2023					9.3
2026					149.0
2026		93.9	93.9	93.9	74.5
2033		11.7	11.7	11.7	
2043					37.2
2048		47.0	47.0	47.0	37.2

*Displayed in the year they are functional.

TABLE D4

AVERAGE ANNUAL VALUE OF MARSH ACRES CREATED

RATE OF INTEREST= 8.25%

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
YEAR*					
2002	$68,834	$123,284	$156,383	$156,383	$97,777
2004					$333,764
2005	$27,132				
2006		$718,263	$911,103	$911,103	
2006	$100,258				
2013		$103,093	$130,771	$130,771	$81,763
2015	$24,561				
2017					$44,808
2018	$29,043				
2018		$17,339	$21,994	$21,994	$13,752
2019		$48,053	$60,955	$60,955	$38,238
2021		$54,677	$69,357	$69,357	$43,365
2022		$37,882	$48,053	$48,053	
2023					$9,252
2026					$116,696
2026		$73,569	$93,321	$93,321	$58,348
2033		$5,280	$6,697	$6,697	
2043					$7,581
2048		$6,431	$8,157	$8,157	$5,521
TOTAL PRESENT VALUE	$249,828	$1,187,871	$1,506,791	$1,506,791	$850,863
AVERAGE ANNUAL VALUE	$21,010	$99,897	$126,717	$126,717	$71,555

* Benefits for this acreage do not begin to accrue to the project until two years after the marsh is created, due to the time needed for the marsh to become fully funtional. This marsh is created after the first dredging cycle in each reach on the north bank.

TABLE D5

AVERAGE ANNUAL MAINTENANCE DREDGING COSTS AND SAVINGS *
(1993 PRICE LEVELS, 8.25% RATE OF INTEREST)

	AVERAGE ANNUAL DREDGING COSTS W/O PROJECT	AVERAGE ANNUAL DREDGING COSTS W/ PROJECT	AVERAGE ANNUAL DREDGING SAVINGS
OPTION 1	$4,865,000	$2,769,000	$2,096,000
OPTION 2	$6,722,000	$2,752,000	$3,970,000
OPTION 3	$8,541,000	$2,541,000	$6,000,000
OPTION 3A	$8,541,000	$3,368,000	$5,173,000
OPTION 4	$6,722,000	$3,279,000	$3,443,000

* The Without Project average annual costs vary due to the different project period for each option. For comparison purposes, the without-project dredging costs between the year 2000 and the respective base year for each option are compounded forward to the base year and then amortized over the 50 year project life.

TABLE D6

SUMMARY OF AVERAGE ANNUAL BENEFITS BY CATEGORY
(1993 PRICE LEVELS, 8.25% INTEREST RATE)

BASE YEAR:	OPTION 1 2001	OPTION 2 2005	OPTION 3 2008	OPTION 3A 2008	OPTION 4 2005
SAVINGS IN AVERAGE ANNUAL MAINTENANCE DREDGING COSTS					
	$2,096,170	$3,970,672	$6,000,517	$5,172,993	$3,443,540
VALUE OF AVERAGE ANNUAL MARSH ACRES SAVED					
	$48,396	$241,979	$241,979	$241,979	$241,979
VALUE OF AVERAGE ANNUAL MARSH ACRES CREATED					
	$21,010	$99,897	$126,717	$126,717	$71,555
TOTAL AVERAGE ANNUAL BENEFITS					
	$2,165,576	$4,312,548	$6,369,213	$5,541,689	$3,757,074

TABLE D7

SUMMARY OF FIRST COSTS BY DESIGN AND OPTION
(1993 PRICE LEVELS)

BASE YEAR:	OPTION 1 2001	OPTION 2 2005	OPTION 3 2008	OPTION 3A 2008	OPTION 4 2005
DESIGN 1					
REAL ESTATE	$109,000	$395,000	$668,000	$585,000	$356,000
CONSTRUCTION	$35,000,000	$119,000,000	$251,200,000	$189,000,000	$105,000,000
FIRST COSTS	$35,109,000	$119,395,000	$251,868,000	$189,585,000	$105,356,000
DESIGN 2					
REAL ESTATE	$109,000	$395,000	$668,000	$585,000	$356,000
CONSTRUCTION	$31,200,000	$106,080,000	$230,680,000	$168,480,000	$93,600,000
FIRST COSTS	$31,309,000	$106,475,000	$231,348,000	$169,065,000	$93,956,000
DESIGN 3					
REAL ESTATE	$109,000	$395,000	$668,000	$585,000	$356,000
CONSTRUCTION	$18,000,000	$61,200,000	$159,400,000	$97,200,000	$54,000,000
FIRST COSTS	$18,109,000	$61,595,000	$160,068,000	$97,785,000	$54,356,000
DESIGN 4					
REAL ESTATE	$109,000	$395,000	$668,000	$585,000	$356,000
CONSTRUCTION	$36,400,000	$123,760,000	$258,760,000	$196,560,000	$109,200,000
FIRST COSTS	$36,509,000	$124,155,000	$259,428,000	$197,145,000	$109,556,000
DESIGN 5					
REAL ESTATE	$109,000	$395,000	$668,000	$585,000	$356,000
CONSTRUCTION	$12,900,000	$43,860,000	$131,860,000	$69,660,000	$38,700,000
FIRST COSTS	$13,009,000	$44,255,000	$132,528,000	$70,245,000	$39,056,000

TABLE D8

SUMMARY OF COSTS BY DESIGN AND OPTION
(1993 PRICE LEVEL 8.25% RATE OF INTEREST)

	OPTION 1	OPTION 2	OPTION 3	OPTION 3A	OPTION 4
BASE YEAR EACH OPTION:	2001	2005	2008	2008	2005
DESIGN 1					
PRESENT VALUE OF COSTS *	$48,907,157	$198,077,662	$571,307,980	$356,903,679	$171,226,136
FIRST COSTS	$35,109,000	$119,395,000	$251,868,000	$189,585,000	$105,356,000
INTEREST DURING CONST.	$8,209	$23,066,345	$104,679,767	$66,735,775	$17,827,975
GROSS INVESTMENT***	$35,117,209	$142,461,345	$356,547,767	$256,320,775	$123,183,975
AVERAGE ANNUAL COSTS					
INTEREST **	$2,897,170	$11,753,061	$29,415,191	$21,146,464	$10,162,678
AMORTIZATION **	$56,093	$227,554	$569,514	$409,421	$196,762
OPERATION & MAINTENANCE	$1,159,697	$4,677,182	$18,060,754	$8,458,751	$4,040,216
TOTAL AVERAGE ANNUAL COST	$4,112,960	$16,657,797	$48,045,459	$30,014,636	$14,399,656
DESIGN 2					
PRESENT VALUE OF COSTS *	$38,329,047	$155,702,917	$494,151,993	$279,747,693	$134,292,230
FIRST COSTS	$31,309,000	$106,475,000	$231,348,000	$169,065,000	$93,956,000
INTEREST DURING CONST.	$8,209	$20,579,225	$97,482,835	$59,538,843	$15,908,012
GROSS INVESTMENT***	$31,317,209	$127,054,225	$328,830,835	$228,603,843	$109,864,012
AVERAGE ANNUAL COSTS					
INTEREST **	$2,583,670	$10,481,974	$27,128,544	$18,859,817	$9,063,781
AMORTIZATION **	$50,023	$202,944	$525,242	$365,149	$175,486
OPERATION & MAINTENANCE	$589,677	$2,409,278	$13,903,063	$4,301,060	$2,054,347
TOTAL AVERAGE ANNUAL COST	$3,223,369	$13,094,195	$41,556,849	$23,526,026	$11,293,614
DESIGN 3					
PRESENT VALUE OF COSTS *	$38,918,995	$157,430,555	$498,455,029	$284,050,729	$136,065,046
FIRST COSTS	$18,109,000	$61,595,000	$160,068,000	$97,785,000	$54,356,000
INTEREST DURING CONST.	$8,209	$11,939,755	$72,482,967	$34,538,975	$9,238,668
GROSS INVESTMENT***	$18,117,209	$73,534,755	$232,550,967	$132,323,975	$63,594,668
AVERAGE ANNUAL COSTS					
INTEREST **	$1,494,670	$6,066,617	$19,185,455	$10,916,728	$5,246,560
AMORTIZATION **	$28,939	$117,457	$371,454	$211,361	$101,580
OPERATION & MAINTENANCE	$1,749,374	$7,055,410	$22,361,814	$12,759,811	$6,094,563
TOTAL AVERAGE ANNUAL COST	$3,272,982	$13,239,485	$41,918,723	$23,887,900	$11,442,703

* Includes O&M Costs

**Of Gross Investment

***Gross Investment = First Cost + Interest During Construction

TABLE D8 continued

SUMMARY OF COSTS BY DESIGN AND OPTION
(1993 PRICE LEVEL 8.25% RATE OF INTEREST)

BASE YEAR EACH OPTION:	OPTION 1 2001	OPTION 2 2005	OPTION 3 2008	OPTION 3A 2008	OPTION 4 2005
DESIGN 4					
PRESENT VALUE OF COSTS *	$54,981,715	$222,606,958	$615,615,381	$401,211,080	$192,418,969
FIRST COSTS	$36,509,000	$124,155,000	$259,428,000	$197,145,000	$109,556,000
INTEREST DURING CONST.	$8,209	$23,982,653	$107,331,268	$69,387,276	$18,535,330
GROSS INVESTMENT***	$36,517,209	$148,137,653	$366,759,268	$266,532,276	$128,091,330
AVERAGE ANNUAL COSTS					
INTEREST **	$3,012,670	$12,221,356	$30,257,640	$21,988,913	$10,567,535
AMORTIZATION **	$58,329	$236,620	$585,825	$425,732	$204,600
OPERATION & MAINTENANCE	$1,552,815	$6,262,668	$20,928,127	$11,326,124	$5,409,781
TOTAL AVERAGE ANNUAL COST	$4,623,814	$18,720,644	$51,771,592	$33,740,769	$16,181,916
DESIGN 5					
PRESENT VALUE OF COSTS *	$29,144,436	$117,899,589	$428,119,496	$212,755,789	$101,902,776
FIRST COSTS	$13,009,000	$44,255,000	$132,528,000	$70,245,000	$39,056,000
INTEREST DURING CONST.	$8,209	$8,601,778	$62,823,927	$24,879,935	$6,661,875
GROSS INVESTMENT***	$13,017,209	$52,856,778	$195,351,927	$95,124,935	$45,717,875
AVERAGE ANNUAL COSTS					
INTEREST **	$1,073,920	$4,360,684	$16,116,534	$7,847,807	$3,771,725
AMORTIZATION **	$20,792	$84,428	$312,036	$151,943	$73,025
OPERATION & MAINTENANCE	$1,356,256	$5,469,925	$19,575,124	$9,892,437	$4,724,999
TOTAL AVERAGE ANNUAL COST	$2,450,968	$9,915,037	$36,003,694	$17,892,188	$8,569,748

* Includes O&M Costs

**Of Gross Investment

***Gross Investment = First Cost + Interest During Construction

TABLE D9

OPTION 4 DESIGN 5
SUMMARY OF AVERAGE ANNUAL BENEFITS AND COSTS BY CATEGORY
(1993 PRICE LEVELS, 8.25% RATE OF INTEREST)

	AVERAGE ANNUAL BENEFITS BASE YEAR 2010
SAVINGS IN MAINTENANCE DREDGING	$4,367,172
MARSH SAVED AND CREATED	$470,940
TOTAL AVERAGE ANNUAL BENEFITS	$4,838,112
	SUMMARY OF FIRST COSTS
REAL ESTATE	$356,000
CONSTRUCTION	$38,700,000
TOTAL FIRST COSTS	$39,056,000
INTEREST DURING CONSTRUCTION	$18,286,922
GROSS INVESTMENT ***	$57,342,922
TOTAL PRESENT VALUE OF COSTS *	$128,102,139
	AVERAGE ANNUAL COSTS
INTEREST **	$4,730,791
AMORTIZATION **	$91,594
OPERATION & MAINTENANCE	$5,950,659
TOTAL AVERAGE ANNUAL COST	$10,773,044
NET BENEFITS	($5,934,932)

* Includes O&M Costs

** Of Gross Investment

*** Gross Investment=First Cost + Interest During Construction

IDENTIFICATION
NUMBER 31014R

REVISED REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER GULF OUTLET
RECONNAISSANCE STUDY
(BANK EROSION)
ST. BERNARD PARISH, LOUISIANA

STRUCTURAL OPTION 1

North Bank (Mile 56 to 54; Mile 43 to 40.5; Mile 39 to 38; Mile 29.5 to 28.5) and South Bank (Mile 27 to 23)

Estimate of Costs (Date of Value - October 1993)

	Acres	Unit Value	Total Value
(a) Lands and Damages			
Bank Stabilization Easement			
Marshland	182	$250	$45,500
Existing Disposal Easement*	122	$250	30,500
Perpetual Disposal Easement			
Marshland	182	$250*25%	11,375
Improvements			0
Severance Damage			0
Total (R)			$87,000
(b) Contingencies 25% (R)			22,000
(c) Total Lands, Easements, Rights-of-Way, Relocations, and Damages			$109,000

Note:

* When this disposal easement was acquired, the deed stated that the landowner had the right to withdraw the easement at any time as long as he could provide other suitable land for disposal. Many landowners have requested the withdrawal of the easement, and the Government has abided. For this reason, the value of the property is the same as if title to the property were unencumbered.

IDENTIFICATION
NUMBER 31014R

This estimate is only for costs of the lands, easements, rights-of-way, relocations, and damages.

This estimate is based on plate 5, entitled Mississippi River-Gulf Outlet, St. Bernard Parish, LA, Bank Erosion, Reconnaissance Report, Structural Option 1 - North Bank, MR-GO Reaches of Critical Erosion, dated February 1988.

Judith Y. Gutiérrez
Judith Y. Gutiérrez
Appraiser
14 October 1993

Approved By:

Yvonne P. Barbier
Yvonne P. Barbier
Chief, Appraisal Branch
14 October 1993

IDENTIFICATION
NUMBER 31014R

REVISED REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER GULF OUTLET
RECONNAISSANCE STUDY
(BANK EROSION)
ST. BERNARD PARISH, LOUISIANA

STRUCTURAL OPTION 2

North Bank (Mile 60 to 54; Mile 51 to 27) and South Bank (Mile 27 to 23 - Existing Disposal Area)

Estimate of Costs (Date of Value - October 1993)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement			
	Marshland	912	$250	$228,000
	Existing Disposal Easement*	122	$250	30,500
	Perpetual Disposal Easement			
	Marshland	912	$250*25%	57,000
	Improvements			0
	Severance Damage			0
	Total (R)			$316,000
(b)	Contingencies 25% (R)			79,000
(c)	Total Lands, Easements, Rights-of-Way, Relocations, and Damages			$395,000

Note:

* When this disposal easement was acquired, the deed stated that the landowner had the right to withdraw the easement at any time as long as he could provide other suitable land for disposal. Many landowners have requested the withdrawal of the easement, and the Government has abided. For this reason, the value of the property is the same as if title to the property were unencumbered.

IDENTIFICATION
NUMBER 31014R

This estimate is only for costs of the lands, easements rights-of-way, relocations, and damages.

This estimate is based on plate 6, entitled Mississippi River-Gulf Outlet, St. Bernard Parish, LA, Bank Erosion, Reconnaissance Report, Structural Options 1 and 2, respectively, dated February 1988.

Judith Y. Gutiérrez
Appraiser
14 October 1993

Approved By:

Yvonne P. Barbier
Chief, Appraisal Branch
14 October 1993

IDENTIFICATION
NUMBER 31020R

REVISED REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER GULF OUTLET
RECONNAISSANCE STUDY
(BANK EROSION)
ST. BERNARD PARISH, LOUISIANA

STRUCTURAL OPTION 3

North Bank (Mile 60 to 23) and South Bank (Mile 47 to 23 - Existing Disposal Area)

Estimate of Costs (Date of Value - October 1993)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement			
	Marshland	1,125	$250	$281,250
	Existing Disposal Easement*	730	$250	182,500
	Perpetual Disposal Easement			
	Marshland	1,125	$250*25%	70,313
	Improvements			0
	Severance Damage			0
	Total (R)			$534,000
(b)	Contingencies 25% (R)			134,000
(c)	Total Lands, Easements, Rights-of-Way, Relocations, and Damages			$668,000

Note:

* When this disposal easement was acquired, the deed stated that the landowner had the right to withdraw the easement at any time as long as he could provide other suitable land for disposal. Many landowners have requested the withdrawal of the easement, and the Government has abided. For this reason, the value of the property is the same as if title to the property were unencumbered.

IDENTIFICATION
NUMBER 31020R

This estimate is only for costs of the lands, easements, rights-of-way, relocations, and damages.

This estimate is based on plate 7, entitled Mississippi River-Gulf Outlet, St. Bernard Parish, LA, Bank Erosion, Reconnaissance Report, Structural Option 3 - North Bank, MR-GO, Mile 60 to Mile 23, and South Bank MR-GO, Mile 47 to Mile 23, dated February 1988.

Judith Y. Gutiérrez
Appraiser
20 October 1993

Approved By:

Yvonne P. Barbier
Chief, Appraisal Branch
20 October 1993

IDENTIFICATION
NUMBER 31014R

REVISED REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER GULF OUTLET
RECONNAISSANCE STUDY
(BANK EROSION)
ST. BERNARD PARISH, LOUISIANA

STRUCTURAL OPTION 3A

North Bank (Mile 60 to 54; Mile 51 to 27) and South Bank (Mile 47 to 23 - Existing Disposal Area)

Estimate of Costs (Date of Value - October 1993)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement			
	Marshland	912	$250	$228,000
	Existing Disposal Easement*	730	$250	182,500
	Perpetual Disposal Easement			
	Marshland	912	$250*25%	57,000
	Improvements			0
	Severance Damage			0
	Total (R)			$468,000
(b)	Contingencies 25% (R)			117,000
(c)	Total Lands, Easements, Rights-of-Way, Relocations, and Damages			$585,000

Note:

* When this disposal easement was acquired, the deed stated that the landowner had the right to withdraw the easement at any time as long as he could provide other suitable land for disposal. Many landowners have requested the withdrawal of the easement, and the Government has abided. For this reason, the value of the property is the same as if title to the property were unencumbered.

IDENTIFICATION
NUMBER 31014R

This estimate is only for costs of the lands, easements, rights-of-way, relocations, and damages.

This estimate is based on plate 7, entitled Mississippi River-Gulf Outlet, St. Bernard Parish, LA, Bank Erosion, Reconnaissance Report, Structural Option 3 - North Bank, MR-GO, Mile 60 to Mile 23, and South Bank MR-GO, Mile 47 to Mile 23, dated February 1988.

Judith Y. Gutiérrez
Judith Y. Gutiérrez
Appraiser
14 October 1993

Approved By:

Yvonne P. Barbier
Yvonne P. Barbier
Chief, Appraisal Branch
14 October 1993

IDENTIFICATION
NUMBER 31014R

REVISED REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER GULF OUTLET
RECONNAISSANCE STUDY
(BANK EROSION)
ST. BERNARD PARISH, LOUISIANA

STRUCTURAL OPTION 4

North Bank (Mile 60 to 54; Mile 51 to 27)

Estimate of Costs (Date of Value - October 1993)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement Marshland	912	$250	$228,000
	Perpetual Disposal Easement Marshland	912	$250*25%	57,000
	Improvements			0
	Severance Damage			0
	Total (R)			$285,000
(b)	Contingencies 25% (R)			71,000
(c)	Total Lands, Easements, Rights-of-Way, Relocations, and Damages			$356,000

Note:

This estimate is only for costs of the lands, easements, rights-of-way, relocations, and damages.

This estimate is based on plate 6, entitled Mississippi River-Gulf Outlet, St. Bernard Parish, LA, Bank Erosion, Reconnaissance Report, Structural Option 2, North Bank MR-GO, Mile 60 to Mile 23, dated February 1988.

Judith Y. Gutiérrez
Judith Y. Gutiérrez
Appraiser
14 October 1993

Approved By:

Yvonne P. Barbier
Yvonne P. Barbier
Chief, Appraisal Branch
14 October 1993

CIVIL WORKS CHART OF ACCOUNTS
MRGO BANK EROSION (OPTION 4)

18 OCTOBER 1993

			(R)$603,000
01	LANDS AND DAMAGES		$602,960
01A	PROJECT PLANNING		580
01AX	CONTINGENCIES	120	
01B	ACQUISITIONS		175630
01B1	BY GOVT	1750	
01B2	BY LOCAL SPONSOR (LS)	136750	
01B3	BY GOVT ON BEHALF OF LS	0	
01B4	REVIEW OF LS	2000	
01BX	CONTINGENCIES	35130	
01C	CONDEMNATIONS		8750
01C1	BY GOVT	0	
01C2	BY LS	5000	
01C3	BY GOVT ON BEHALF OF LS	0	
01C4	REVIEW OF LS	2000	
01CX	CONTINGENCIES	1750	
01D	INLEASING		0
01D1	BY GOVT	0	
01D2	BY LS	0	
01D3	BY GOVT ON BEHALF OF LS	0	
01D4	REVIEW OF LS	0	
01DX	CONTINGENCIES	0	
01E	APPRAISALS		50750
01E1	BY GOVT (IN HOUSE)	0	
01E2	BY GOVT (CONTRACT)	0	
01E3	BY LS	35000	
01E4	BY GOVT ON BEHALF OF LS	5600	
01E5	REVIEW OF LS	0	
01EX	CONTINGENCIES	10150	
01F	PL 91-646 ASSISTANCE		0
01F1	BY GOVT	0	
01F2	BY LS	0	
01F3	BY GOVT ON BEHALF OF LS	0	
01F4	REVIEW OF LS	0	
01FX	CONTINGENCIES	0	

01G	TEMPORARY PERMITS		8750	
01G1	BY GOVT	1750		
01G2	BY LS	5250		
01G3	BY GOVT ON BEHALF OF LS	0		
01G4	REVIEW OF LS	0		
01G5	OTHER	0		
01G6	DAMAGE CLAIMS	0		
01GX	CONTINGENCIES	1750		
01H	AUDITS		0	
01H1	BY GOVT	0		
01H2	BY LS	0		
01H3	BY GOVT ON BEHALF OF LS	0		
01H4	REVIEW OF LS	0		
01HX	CONTINGENCIES	0		
01J	ENCROACHMENTS AND TRESPASS		0	
01J1	BY GOVT	0		
01J2	BY LS	0		
01J3	BY GOVT ON BEHALF OF LS	0		
01J4	REVIEW OF LS	0		
01JX	CONTINGENCIES	0		
01K	DISPOSALS		0	
01K1	BY GOVT	0		
01K2	BY LS	0		
01K3	BY GOVT ON BEHALF OF LS	0		
01K4	REVIEW OF LS	0		
01KX	CONTINGENCIES	0		
01L	REAL PROPERTY ACCOUNTABILITY		0	
01LX	CONTINGENCIES	0		
01R	REAL ESTATE PAYMENTS			358500
01R1	LAND PAYMENTS		285000	
01R1A	BY GOVT	0		
01R1B	BY LS	285000		
01R1C	BY GOVT ON BEHALF OF LS	0		
01R1D	REVIEW OF LS	0		
01R2	PL 91-646 ASSISTANCE PAYMENTS		0	
01R2A	BY GOVT	0		
01R2B	BY LS	0		
01R2C	BY GOVT ON BEHALF OF LS	0		
01R2D	REVIEW OF LS	0		
01R3	DAMAGE PAYMENTS		0	
01R3A	BY GOVT	0		
01R3B	BY LS	0		
01R3C	BY GOVT ON BEHALF OF LS	0		
01R3D	REVIEW OF LS	0		
01R9	OTHER		2500	
01RX	CONTINGENCIES		71000	

01S	REAL ESTATE RECEIPTS		0	
01S1	DISPOSAL RECEIPTS-REIMBURSEMENTS(CR)-LANDS	0		
01S2	DISPOSAL RECEIPTS-GENERAL FUND(CR)-LANDS	0		
01T	LERRD CREDITS		0	
01T1	LAND PAYMENTS	0		
01T2	ADMINISTRATIVE COSTS	0		
01T3	PL 91-646 ASSISTANCE	0		
01T4	ALL OTHER	0		
01TX	CONTINGENCIES	0		
				(R)$0
21	RECONNAISSANCE STUDIES			$0
21H	REAL ESTATE ACTIVITIES		0	
21V	FEASIBILITY COST SHARING AGREEMENT		0	
				(R)$4,000
22	FEASIBILITY STUDIES			$4,000
22H	REAL ESTATE PLAN		4000	
22S	REPORT PREPARATION		0	
22S1	REAL ESTATE ACTIVITIES	0		
22S9	ALL OTHER ACTIVITIES	0		
22U	REAL ESTATE DESIGN MEMORANDUM		0	
22V	REAL ESTATE PLANNING REPORT		0	
24	MISCELLANEOUS		0	
24A	REAL ESTATE ACTIVITIES	0		
24D	ALL OTHER	0		
25	COLLECTION AND STUDY OF BASIC DATA		0	
25A	REAL ESTATE ACTIVITIES	0		
25D	ALL OTHER	0		
26	RESEARCH AND DEVELOPMENT		0	
26A	REAL ESTATE ACTIVITIES	0		
26B	ALL OTHER	0		
27	REFORMULATION STUDIES		0	
27A	REAL ESTATE ACTIVITIES	0		
27D	ALL OTHER	0		

29	PROJECT COOPERATION AGREEMENTS (PCA)			(R)$4,000 $3,600
29A	DRAFT PCA		1200	
29A1	REAL ESTATE ACTIVITIES	1200		
29A9	ALL OTHER ACTIVITIES	0		
29B	FINAL PCA AND FINANCIAL PLAN		1200	
29B1	REAL ESTATE ACTIVITIES	1200		
29B9	ALL OTHER ACTIVITIES	0		
29C	PCA NEGOTIATIONS		1200	
29C1	REAL ESTATE ACTIVITIES	1200		
29C9	ALL OTHER ACTIVITIES	0		
29D	TRANSFER OF PROJECT SPONSOR		0	
51	OPERATION & MAINTENANCE DURING CONSTRUCTION			(R)$0 $0
51A	REAL ESTATE LEASING		0	
51A1	INLEASING	0		
51A2	RELOCATION ASSISTANCE	0		
51A3	DISPOSAL ASSISTANCE	0		
51A4	RELOCATION ASSISTANCE PAYMENTS (PL 91-646)	0		
51A5	RENTS, INITIAL ALTERATIONS AND RESTORATIONS	0		
51B	REAL ESTATE MANAGEMENT SERVICES			0
51B1	INSPECTIONS		0	
51B1A	COMPLIANCE	0		
51B1B	UTILIZATION	0		
51B2	OUTGRANTS		0	
51B2A	REGULAR	0		
51B2B	OIL AND GAS	0		
51B3	DISPOSALS		0	
51B4	ENCROACHMENTS AND TRESPASS		0	
51C	OTHER OPERATION & MAINTENANCE EXPENSES		0	
51D	REVENUES FROM OUTLEASES RETURNED TO U.S.		0	
51E	AUDITS		0	
51F	TIMBER HARVEST		0	

APPRAISAL REVIEW

PROJECT:	Mississippi River Gulf Outlet (Bank Erosion)
LOCATION:	Southeastern portion of Louisiana, northeasterly of Chalmette, LA in St. Bernard Parish
OWNER:	Estimated 70 ownerships
APPRAISER:	Ms. Judith Y. Gutiérrez, Staff Appraiser, Real Estate Division, New Orleans District
EFFECTIVE DATE OF APPRAISAL:	27 October 1993
ESTATES APPRAISED:	Perpetual Rock Armored Structure Easement and Perpetual Disposal Easement
HIGHEST AND BEST USE:	Commercial fishing, recreation/hunting and specualtive mineral development
VALUATION SUMMARY:	Lands and Damages $356,000
SCOPE OF REVIEW:	Desk review of an Initial Real Estate Cost Estimate
COMMENTS:	Based on the data presented in this report, the estimated value of $356,000, including contingencies of 25%, is deemed reasonable for lands and damages and is recommended for approval.

REVIEWER'S CERTIFICATION:

I certify that, to the best of my knowledge and belief:

The facts and data reported by the review appraiser and used in the review process are true and correct.

The analyses, opinions, and conclusions in this review report are limited only by the assumptions and limiting conditions stated in this review report, and are my personal, unbiased professional analyses, opinions, and conclusions.

I have no present or prospective interest in the property that is the subject of this report and I have no personal interest or bias with respect to the parties involved.

My compensation is not contingent on an action or event resulting from the analyses, opinions, or conclusions in, or the use of, this review report.

My analyses, opinions, and conclusions were developed and this review report was prepared in conformity with the Uniform Standards of Professional Appraisal Practice and the Uniform Appraisal Standards for Federal Land Acquisitions.

27 October 1993

Yvonne P. Barbier
Chief, Appraisal Branch

PURPOSE OF REPORT

This report serves as the reconnaissance level input for the proposed project.

ASSUMPTIONS AND LIMITATIONS

1. Title to the property is good and merchantable, and the property is free and clear of encumbrances other than easements.

2. The appraiser has made no survey of the subject property and assumes no responsibility in connection with such matters. Any sketch of the property included in this report is only for the purpose of assisting the reader to visualize the property.

3. This report is based on Structural Option 4A which is the alternative to be recommended for further study in the Feasibility Phase.

4. Inspection of the subject property was performed through aerial photography. The property is only accessible by boat or airplane. Due to the high cost of such transportation, the property was not physically inspected at this stage of the project. A physical inspection will be conducted when a more detailed report is written.

5. A 25% contingency is used due to the preliminary estimate of the acreage needed for project purposes and the preliminary title information currently available.

PROJECT DESCRIPTION AND LOCATION

The study area is generally located in St. Bernard Parish, Louisiana in the proximity of Townships 13 through 15 South and Ranges 13 through 17 East (See Exhibit A). The property is located northerly of the north bank of the Mississippi River Gulf Outlet (MRGO) between miles 60 and 54 and between miles 51 and 27. The property is estuarine marsh. It is only accessible by boat or airplane.

The purpose of this project is to prevent further erosion of the north bank of the MRGO and of the surrounding wetlands. At this time, buffering marsh between the MRGO and Lake Borgne is eroding at approximately fifteen feet per year. Once the buffering marsh is lost, dredging frequency and quantities in the vicinity of the breached bank area will increase significantly. The project consists of constructing a rock armored dike along thirty miles of the north bank of the MRGO and disposing dredged material north of the dike.

The MRGO was constructed in the 1960's to provide ships with a quicker, and more direct route from the Gulf of Mexico to the Port of New Orleans. At the time of construction, Perpetual Channel and

Disposal Easements were acquired by the local sponsor, the Port of New Orleans. However, the Perpetual Disposal Easement included a clause which gave the landowner the right to withdraw the easement at any time as long as he/she could provide other suitable disposal area. In recent years, many owners have withdrawn the easement from their land and the Government has accepted such actions.

NEIGHBORHOOD DATA

The neighborhood of the study area is characterized by a variety of habitats including estuarine marshes, scrub/shrub habitat, shallow open water ponds and the MRGO waterway. The estuarine marshes are composed of both brackish and saline vegetation. Vegetation within the dredged material disposal areas consists of brackish marsh species. Marsh elder is the dominant salt-tolerant vegetation in scrub/shrub habitats.

In the past, the study area led the nation as being one of the top fur producing areas in the world. The muskrat was the primary reason for this position. However, the current muskrat population in the area is very low. Presently, there is an overabundance of nutria. In the areas of the MRGO where dredged material was placed, abundant upland habitats have been created for white-tailed deer, swamp rabbits and wild hogs. This area can also provide excellent mink habitat.

There are seven species of waterfowl in the study area which provide hunting opportunities. Furthermore, there are four species of shellfish and eight species of finfish that provide recreational and commercial fishing opportunities. Other sources of recreation in the MRGO area, include boating, nature and wildlife observation, and some water skiing.

SPECIAL FEATURES

Timber

The subject area is wetland; there is no merchantable timber within the required right-of-way.

Minerals

Minerals will not be acquired; therefore, they are not evaluated in this report.

Improvements

There are no improvements located within the proposed right-of-way.

Zoning

Local zoning in the area is rural. However, coastal wetlands are also regulated by Section 10 of the Rivers and Harbors Act and

Section 404 of the Clean Water Act. Section 10 requires that a permit be obtained before any structures are placed or work commences in navigable waters of the United States. Section 404 requires that a permit be obtained in order to discharge dredged material in wetlands.

HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

There are no indications of hazardous, toxic or radiological waste located in the proposed right-of-way. However, it is recommended that an Initial Assessment Screening be conducted. Depending on the findings, this should be followed by a full HTRW investigation.

ESTATES

To construct the project, 912 acres of estuarine marsh will be acquired for a Rock Armored Structure Easement. Another 912 acres of adjacent marsh will be acquired for a Perpetual Disposal Easement. See exhibit B for a description of the estates. It is estimated that approximately seventy owners will be affected by construction of the project.

HIGHEST AND BEST USE

The highest and best use is that reasonable and probable use that supports the highest present value, as defined, as of the effective date of the appraisal. The land required for the project is classified as wetlands. Because of State and Federal wetland regulations, the owners would have to acquire permits from the State of Louisiana and the Federal Government before any construction activities could take place.

Under these circumstances, the highest and best uses of the project area are for commercial fishing, recreation/hunting, and speculative mineral development. Encumbering the land with the Rock Armored Structure Easement would prohibit all uses of the land except speculative mineral development. The Perpetual Disposal Easement, however, would change the highest and best uses of the land minimally. The highest and best uses of the land would be for recreation/hunting and speculative mineral development.

BASIS FOR VALUATION

The fair market value of the estates is estimated from the sales of comparable properties in the area. (Copies of the comparables used are in the project file.) Market research supports a fee value for marshland of $250 per acre.

The fair market value of an easement is the difference between the fair market value of the property before the imposition of the easement and the fair market value of the property after the imposition of the easement. In this appraisal, the "before and after" method is used in theory. Based on the highest and best use analysis, the value attributed to the Rock Armored Easement is 100% of the fee value. The value attributed to the Perpetual Disposal Easement is 25% of the fee value.

ESTIMATE OF VALUE

	Acres	Unit Value	Total Value
(a) Lands and Damages			
Rock Armored Easement Marshland	912	$250	$228,000
Perpetual Disposal Easement Marshland	912	$250*25%	57,000
Improvements			0
Severance Damage			0
Total (R)			$285,000
(b) Contingencies 25% (R)			71,000
(c) Total Lands, Easements, Rights-of-Way, Relocations and Damages			$356,000

CERTIFICATE

I certify that, to the best of my knowledge and belief the statements of fact contained in this report are limited only by the reported assumptions and limiting conditions, and are my personal, unbiased professional analyses, opinions, and conclusions.

I have no present or prospective interest in the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved. My compensation is not contingent upon the reporting of a predetermined value or direction in value that favors the cause of the client, the amount of the value estimate, the attainment of a stipulated result, or the occurrence of a subsequent event.

My analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the Uniform Standards of Professional Appraisal Practice. I have not made a personal inspection of the property that is the subject of this report. No one provided significant professional assistance to the person signing this report.

Judith Y. Gutiérrez
Judith Y. Gutiérrez
Appraiser
27 October 1993

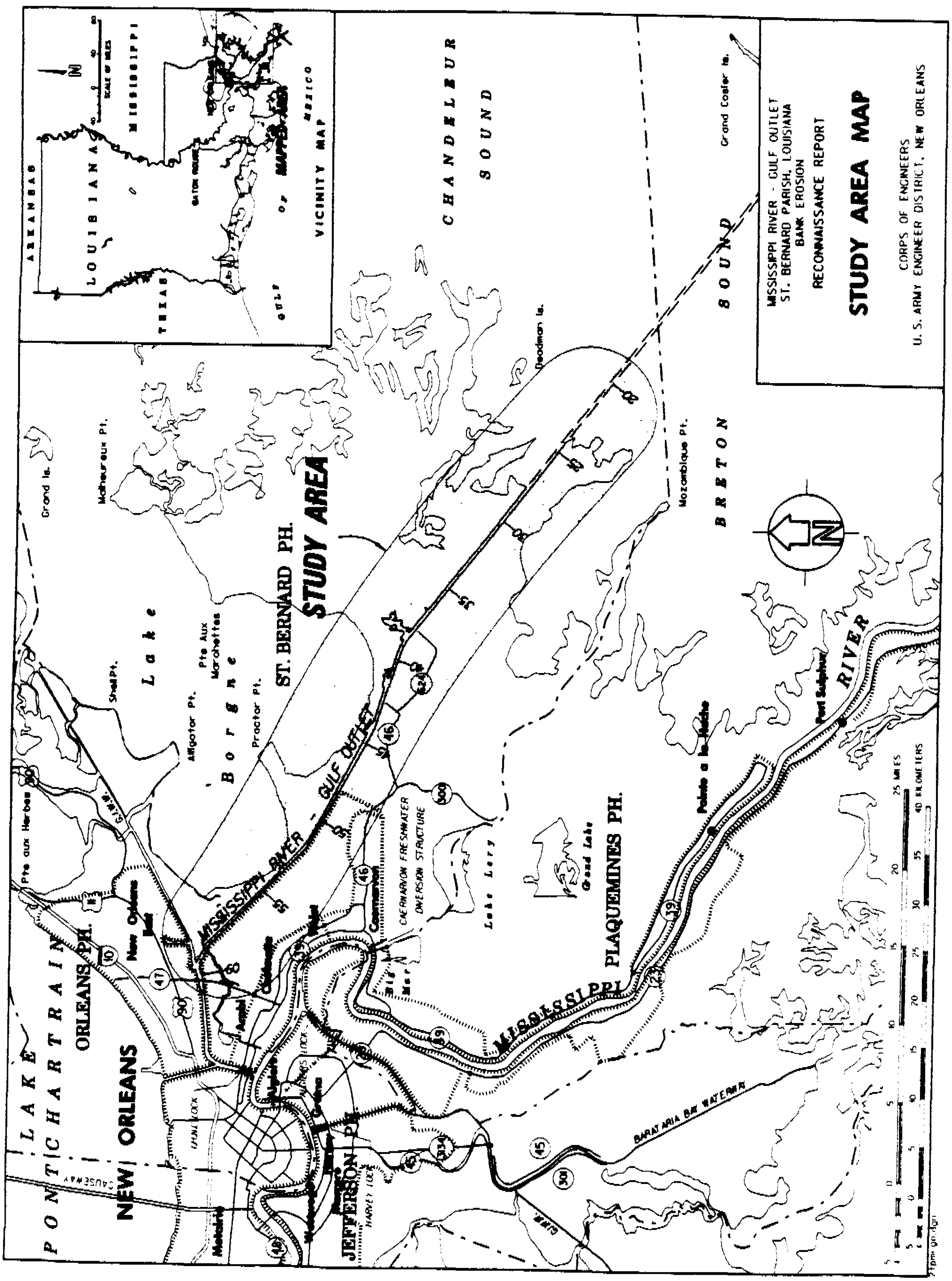
MISSISSIPPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LOUISIANA
BANK EROSION
RECONNAISSANCE REPORT
STUDY AREA MAP
CORPS OF ENGINEERS
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
VICINITY MAP
LOUISIANA
MISSISSIPPI
ARKANSAS
TEXAS
GULF OF MEXICO
MAPPED AREA
STUDY AREA
ST. BERNARD PH.
PLAQUEMINES PH.
ORLEANS PH.
JEFFERSON PH.
NEW ORLEANS
LAKE PONTCHARTRAIN
Lake Borgne
CHANDELEUR SOUND
BRETON SOUND
MISSISSIPPI RIVER - GULF OUTLET
MISSISSIPPI RIVER
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Lake Lery
Grand Lake
Grand Is.
Malheureux Pt.
Shell Pt.
Alligator Pt.
Proctor Pt.
Pte Aux Marchettes
Pte aux Herbes
Deadman Is.
Mozambique Pt.
Grand Cosier Is.
Port Sulphur
Pointe a la Hache
BARATARIA BAY WATERWAY
CAUSEWAY
HARVEY LOCK
Metairie
25 MILES
40 KILOMETERS

Exhibit A

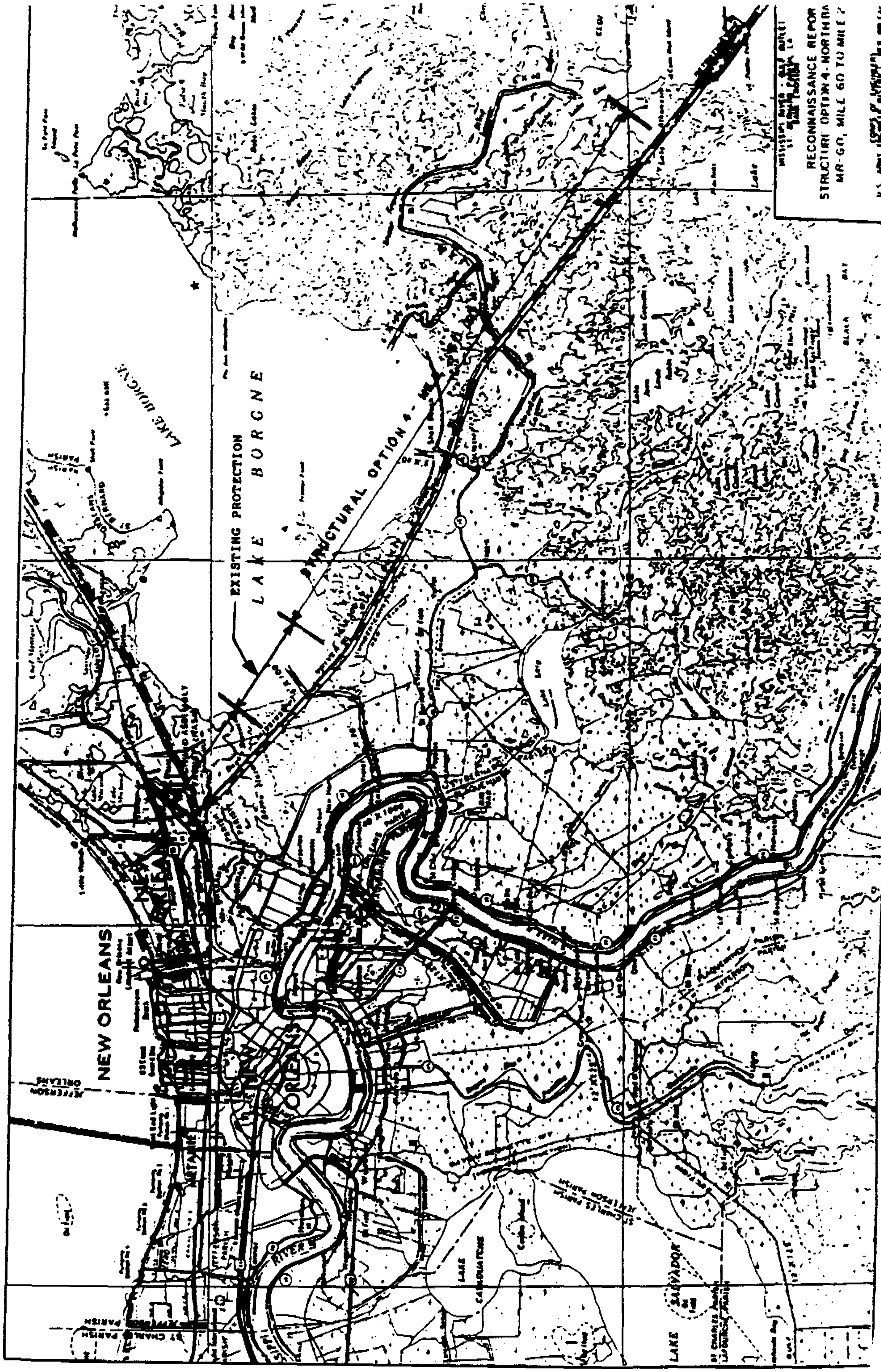
NEW ORLEANS
LAKE BORGNE
EXISTING PROTECTION
STRUCTURAL OPTION 4 - MR
LAKE SALVADOR
LAKE CATAOUATCHE
METAIRIE
RECONNAISSANCE REPOR
MR-GO, MILE 60 TO MILE

Exhibit A

ROCK ARMORED STRUCTURE EASEMENT

A perpetual, assignable right, servitude and easement to construct, maintain, repair, operate, patrol and replace a rock armored structure, including all appurtenances thereto, in, on, over and across those lands described in Schedule A, including the right to clear, trim, cut, fell, borrow, excavate and remove therefrom all trees, timber, underbrush, soil, dirt, obstructions and any other vegetation, structures, or obstacles as required in connection with said work; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with or abridging the use of the project for the purposes authorized by Congress or the rights, servitudes and easements hereby acquired.

DREDGED MATERIAL DISPOSAL EASEMENT

A perpetual, assignable and exclusive right, servitude and easement in on over and across those lands described in Schedule A, to construct, operate and maintain a dredged material disposal area on the land hereinafter described, including the right to construct dikes and to install, alter, relocate, repair or plug cuts in the banks of said dikes; to deposit dredged material thereon; to accomplish any alterations of contours on said land for the purpose of accommodating the deposit of dredged material as necessary in connection with such works; to clear, trim, cut, fell, and remove therefrom any or all trees, timber, underbrush, obstructions and any other vegetation, structures, or obstacles as required in connection with said work; to clear, borrow, excavate and remove therefrom all soil, dirt and any other materials, including dredged material, as required in connection with said work; to plant or cause the growth of vegetation on said land; and to undertake any management practices designed to enhance the use of or extend the life of said land for the deposit of dredged material or to create, restore, nourish and enhance the wetlands in, over, across and upon the said lands; provided that no structures for human habitation shall be constructed or maintained on the land, and that no other structures shall be constructed or maintained on the land without the prior written approval of the District Engineer of the U.S. Army Engineer District, New Orleans, or authorized representative, and that no excavation shall be conducted and no disposal of any kind placed on the land without such approval, including the location and method of excavation and/or placement of disposal; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the Grantor, its successors and assigns, all such rights and privileges as may be used and enjoyed without interfering with or abridging the use of the project for the purposes authorized by Congress or the rights, servitudes and easements hereby acquired.

Exhibit B

QUALIFICATIONS OF
JUDITH Y. GUTIERREZ

U. S. Army Corps of Engineers, NOD
Real Estate Division, Appraisal Branch
P. O. Box 60267
New Orleans, Louisiana 70160
(504)862-2575

Work Experience

I am employed as an appraiser with the U. S. Army Corps of Engineers. I began my professional career with the Corps in June 1987 under a two year Real Estate internship program. In June 1988 I began my appraisal training as a GS-07. I have been in my present position (Appraiser GS-12) since November 1992.

I appraise vacant and improved land classified as industrial, commercial, residential, agricultural, woodland and marsh. I appraise residences, commercial and industrial buildings, warehouses, wharfs, government quarters and boat slips. I appraise office space in office buildings and shopping centers for armed forces recruiting stations. I also appraise space in radio towers for government communication antennas.

These properties are acquired by the United States for different purposes; therefore, I have appraised various interest in the land such as: fee, leasehold (leases and licenses) and easements. The easements that I have appraised include levee/floodwall, access/road, construction, channel, disposal, borrow, flowage and utility/pipeline easements. I also appraise property for credit or reimbursement to the local sponsors.

Appraisal Certification

I received the General Appraiser certification from the State of Maryland in May 1993. Certification Number 6540.

Education

I received a Bachelor of Science degree in Marketing from the University of New Orleans, Louisiana in May 1987.

Exhibit C

I completed the following appraisal training:

American Institute of Real Estate Appraisers' Courses:
Real Estate Appraisal Principles, January 1988
Basic Valuation Procedures, March 1989
Residential Valuation, May 1989
Capitalization Theory and Techniques - A, February 1990
Capitalization Theory and Techniques - B, February 1990

American Society of Farm Managers and Rural Appraisers, Eminent Domain, February 1993

U. S. Army Corps of Engineers, Real Estate Appraisal and Leasing, June 1992

Marshall & Swift Valuation Service's Courses:
Residential Cost Handbook, January 1989
Marshall Valuation Service: Calculator Method, January 1989
Marshall & Swift's Computerized Cost Programs, January 1989

I completed the following real estate and management training:

U. S. Army Corps of Engineers Training Courses:
Real Estate Acquisition, July 1987
Real Estate Planning & Control, November 1987
Real Estate Management & Disposal, November 1987
Real Estate Relocation Assistance, July 1988

Professional Education Systems, Inc., LA Boundary Law and Adjoining Landowner Disputes, June 1987

International Right-of-Way Association, Property Descriptions, September 1988

U. S. Office of Personnel Management, Introduction to Supervision, April 1993

I received a diploma from Seton Academy High School, New Orleans, Louisiana in May 1983.

MISSISSIPPI RIVER-GULF OUTLET

ST. BERNARD PARISH, LOUISIANA (BANK EROSION)

RECONNAISSANCE STUDY

PLANNING-AID REPORT

OCTOBER 1993

OCT 26 1993

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II. Suite 102
Lafayette, Louisiana 70508

October 21, 1993

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Diffley:

Please refer to the "Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana, (Bank Erosion)" reconnaissance study. That study is being conducted in response to a resolution adopted by the Committee on Public Works and Transportation of the United States House of Representatives on September 23, 1982. The purpose of the investigation is to assess the erosion problems on the Mississippi River-Gulf Outlet and determine measures to improve or modify the existing unleveed banks and reduce the extensive erosion along that waterway. The U.S. Fish and Wildlife Service submits the attached report on a planning-aid basis to assist your staff in the preparation of the reconnaissance report for the above-referenced study; it does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

Should questions arise regarding this report, please have your staff contact Jane Ledwin of this office.

Sincerely,

David W. Frugé

David W. Frugé
Field Supervisor

cc: NMFS, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA

PLANNING-AID REPORT

ON

MISSISSIPPI RIVER-GULF OUTLET

ST. BERNARD PARISH, LOUISIANA (BANK EROSION)

RECONNAISSANCE STUDY

PREPARED BY

JANE M. LEDWIN

GENERAL BIOLOGIST

and

WILFRED B. KUCERA

FISH AND WILDLIFE BIOLOGIST (RETIRED)

ECOLOGICAL SERVICES

LAFAYETTE, LOUISIANA

U.S. FISH AND WILDLIFE SERVICE

SOUTHEAST REGION

ATLANTA, GEORGIA

OCTOBER 1993

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INTRODUCTION

The New Orleans District, Corps of Engineers (Corps), is conducting a reconnaissance study to assess the erosion problems on the Mississippi River-Gulf Outlet (MRGO), and to determine measures to improve or modify the existing unleveed banks to reduce erosion along that waterway. That study was authorized by a resolution adopted on September 23, 1982, by the Committee on Public Works and Transportation of the United States House of Representatives. The Fish and Wildlife Service (Service) has prepared this planning-aid report to assist the Corps in its preparation of a reconnaissance report for that study. This report: 1) describes existing and anticipated future fish and wildlife resources in the study area; 2) discusses fish- and wildlife-related problems, opportunities, and planning objectives; 3) briefly assesses the impacts of the project alternatives under consideration; 4) discusses Fish and Wildlife Coordination Act activities anticipated in the feasibility phase; and 5) provides tentative fish and wildlife conservation recommendations. This report does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

DESCRIPTION OF STUDY AREA

The study area lies wholly within St. Bernard Parish in southeastern Louisiana, and encompasses much of that portion of the MRGO that was excavated through marsh (Figure 1). On the north bank, the study area extends from mile 23 to mile 60. On the south bank, the study area extends from mile 23 to mile 47, thus excluding a segment bordered by a hurricane protection levee. The MRGO is a 76-mile-long, man-made waterway that extends from the Inner Harbor Navigation Canal at New Orleans to the Gulf of Mexico. This navigation canal was originally excavated to a depth of 36 feet below mean sea level and a 500-foot bottom width; it was completed in 1961. The primary purpose of the MRGO project was to provide a shorter, alternate route for ocean-going vessels between the Gulf of Mexico and the Port of New Orleans.

DESCRIPTION OF FISH AND WILDLIFE RESOURCES

Existing Conditions

Wicker et al. (1982) characterized an area largely coinciding with the present study area as approximately 61 percent marsh, 26 percent open water, 12 percent MRGO project rights-of-way, and 1 percent shrub and forest land. Since completion, the MRGO channel banks have experienced severe erosion; the waterway has continued to widen at a rate of about 15 feet per year. That erosion is believed to be caused primarily by large wakes of fast-moving ships. Between 1968 and 1987, approximately 4,200 acres of highly productive marsh were lost due to bank erosion [along the MRGO] (U.S. Army Corps of Engineers 1988). Before construction of the MRGO, the study area marshes ranged from relatively fresh to brackish. Salinity samples taken along the proposed route by Rounsefell (1964) in May and October 1960 showed

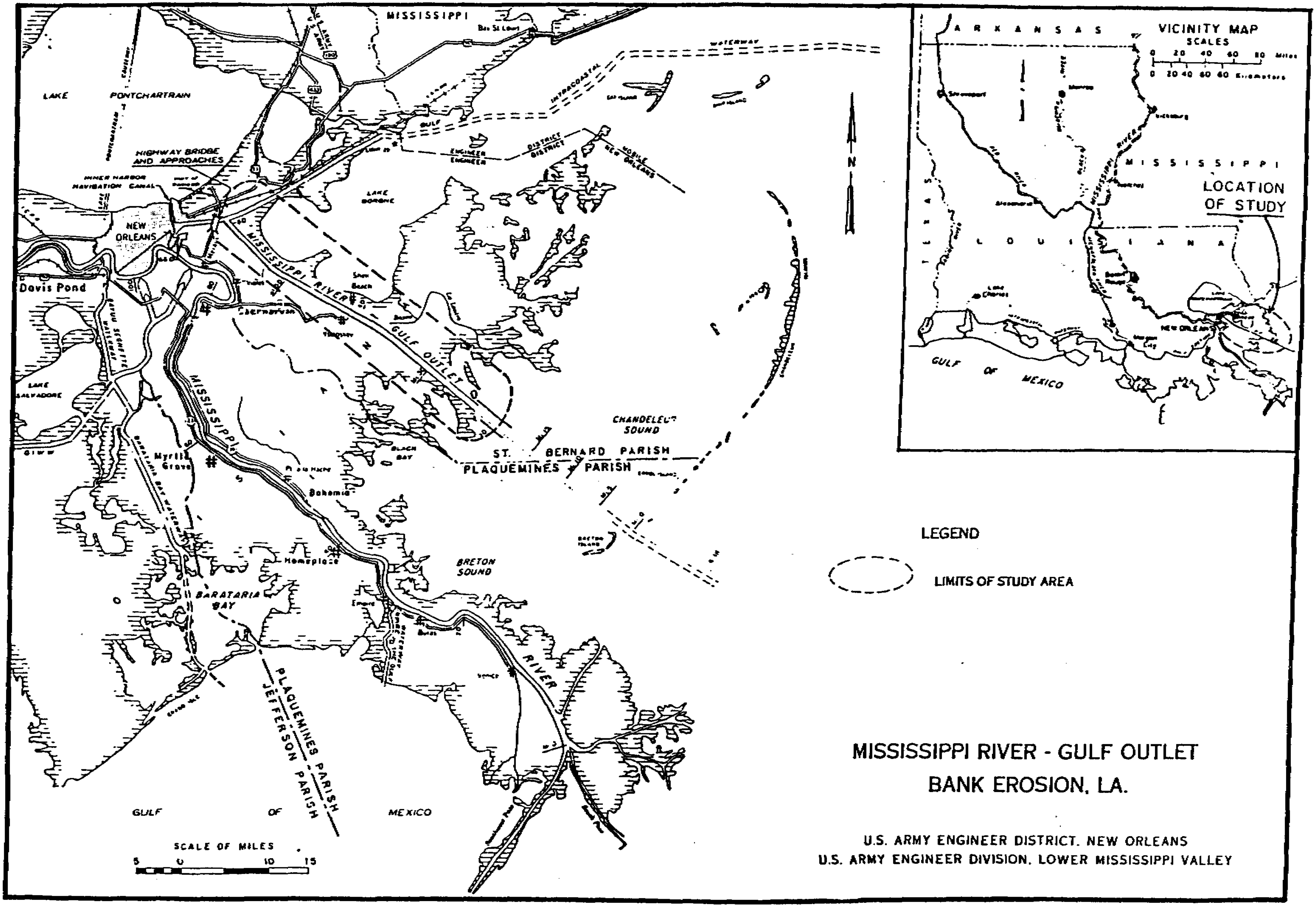

FIGURE 1. Mississippi River - Gulf Outlet Bank Erosion, Louisiana, Study Area

that average salinities were only 2.4 parts per thousand (ppt) and 3.85 ppt, respectively. When the Bayou La Loutre Ridge was breached during construction, saline waters from Breton Sound traveled the length of the waterway. In 1981, salinity levels of 35 ppt at the channel entrance to the Gulf of Mexico, and 10 ppt at the Inner Harbor Navigation Canal, were recorded (U.S. Army Corps of Engineers 1981). That study further suggested that no saltwater wedge exists in the MRGO and that salinities are uniform throughout the water column.

Increased salinity caused by the MRGO has significantly affected the type and extent of marshes in the study area, and the fish and wildlife species that occur there. Before construction of the MRGO, the study area was largely vegetated with saltmeadow cordgrass and three-cornered grass; widgeon grass was prevalent in nearly isolated open waters. Following project construction, saltwater intrusion killed the freshwater vegetation and much of the brackish marsh vegetation in the study area. Without vegetation to hold it, the organic marsh soils were subject to rapid erosion (i.e., faster than salt-tolerant vegetation could become established) and large areas of marsh were converted to open water. Sandy ridge and swamp soils protected by undecayed logs were somewhat more resistant to erosion. Anaerobic decomposition of the organic soil fraction also contributed to land loss after salt water intruded into the area because salt water neutralized the acids that tend to preserve organic matter.

Saline marsh occurs along the edge of the MRGO throughout the study area. This marsh type is vegetated with nearly homogeneous stands of saltmarsh cordgrass, especially near open water. Further inland there are also sizable expanses of black rush, while saltgrass vegetates the higher elevations. Vegetation in the remaining brackish marshes consists of saltmeadow cordgrass with occasional stands of three-cornered grass in the less-saline portions. Low-salinity brackish marshes are found within areas where water control is exercised by private land managers (via levees, weirs, and other water control structures), and within existing spoil impoundments along the MRGO. Spoil containment dikes serve to trap rainwater, thus fostering the growth of fresh marsh plants favored by waterfowl and furbearers.

Marshes in the study area dissipate tidal and wave energy, thereby helping to control erosion. Those marshes also serve as a sediment trap, wildlife habitat, and nursery area for estuarine-dependent organisms. The marshes are integral to maintenance of the estuarine ecosystem because their high rate of detrital production constitutes the basis of the food chain which supports the area's finfishes and shellfishes. Gunter (1967) believes the extremely high primary productivity of the Louisiana marshes is largely responsible for this portion of the Gulf of Mexico being called the "fertile fisheries crescent." These wetlands are becoming relatively scarce on a national basis and throughout coastal Louisiana. Due to their high productivity, increasing scarcity, and their ongoing conversion to open water, the saline and brackish marshes and associated shallow waters of the project area have been designated as Resource Category 2 habitats, as defined in the Fish and Wildlife Service Mitigation Policy (Federal Register, Vol. 46, No. 15, January 23, 1981). The

Service's mitigation goal for Resource Category 2 habitats is no net loss of "in-kind" habitat value.

The study area's limited populations of freshwater fish disappeared soon after construction of the MRGO. A post-construction inventory of the fishes of the study area revealed that spotted seatrout, Atlantic croaker, black drum, red drum, sheepshead, striped mullet, and menhaden were the most common sport and commercial fishes of the area (Fontenot and Rogillio 1970). Many other estuarine fishes are abundant in the area; while not recreationally or commercially important, those species play an important ecological role by serving as food for predatory species. Important prey species include bay anchovy, silversides, gobies, and various killifishes.

White shrimp and brown shrimp, the most valuable fishery products of the Gulf of Mexico, use the marshes and shallow open waters of the project area as nursery and foraging habitat. Although adults spawn offshore, postlarval shrimp migrate into the marshes and estuaries where they feed and find shelter from predators until nearly grown. Other crustaceans using the marshes include grass shrimp, mantis shrimp, and various amphipods, which serve as food organisms for many species important to man. The blue crab is another estuarine-dependent crustacean that supports an extensive commercial fishery. Adults spawn offshore and the larvae use the project-area marshes as nursery habitat. Other crabs in the study area that are of ecological importance include stone crab, fiddler crab, and hermit crab.

The study area also provides excellent habitat for the American oyster; some of the less saline canals and other open waters are regularly planted with seed oysters. These planted oysters, as well as naturally set oysters, support an important commercial fishery. Oyster reefs are also ecologically important because they provide food for such species as black drum and stone crab, substrate for invertebrates, and cover for numerous species of finfish and shellfish.

The diamondback terrapin and the Gulf saltmarsh snake are the only reptiles species that are commonly found in the salt marshes of coastal Louisiana. The American alligator is primarily an inhabitant of fresh and slightly brackish marshes, but occasionally wanders into inshore saline waters; its numbers in the project area are low due to the saline nature of the marshes. Five species of sea turtles occur off Louisiana in the Gulf of Mexico and may occasionally use the project area; these are listed in the subsequent section on endangered species.

The most common species of waterfowl that occur in the project area include gadwall, American wigeon, green-winged teal, blue-winged teal, mallard, pintail, shoveler, mottled duck, lesser scaup, and ring-necked duck. Of the above ducks, the mottled duck is the only species that nests in the study area. The overall value of the study area as over-wintering habitat for migratory waterfowl has been greatly reduced by saltwater intrusion and associated habitat degradation caused by the MRGO.

Clapper rails are year-round residents of the saline marshes, while coots use the less-saline habitats in the winter. King rails and gallinules are year-round residents of coastal Louisiana that also may be found in limited numbers in the study area's less-saline marshes. Virginia and sora rails may occasionally occur in the study area in the winter.

Non-game birds that use project-area habitats include various seabirds, wading birds, shorebirds, raptors, and songbirds. Seabirds expected to occur in the project area include herring gull, laughing gull, ring-billed gull, black skimmer, Forster's tern, royal tern, Caspian tern, and least tern. In fact, there is a gull/tern/skimmer colony adjacent to the Study area in Lake Athansio. Wading birds frequenting the study area include great egret, snowy egret, tricolored heron, green-backed heron, black-crowned night heron, great blue heron, white ibis, white-faced ibis, American bittern, and least bittern. Raptors observed in the study area include osprey, northern harrier, and American kestrel. The Arctic peregrine falcon often winters along Gulf Coast beaches and could occasionally be found in the area. Shorebirds found in the study area include various plovers and sandpipers, sanderling, willet, black-necked stilt, American oystercatcher, and killdeer. Some common songbirds are present in the project area year-round, while others are abundant only seasonally or during migration.

Swamp rabbit, white-tailed deer, and wild hogs are the principal game mammals found in the study area. Commercially important furbearers present include muskrat, raccoon, nutria, mink, and river otter. Non-game mammals frequenting the area include the nine-banded armadillo and the marsh rice rat.

Several endangered species may occur in the study area, but it is not critical habitat for them. The brown pelican, hawksbill turtle, Kemp's (Atlantic) ridley turtle, and the leatherback turtle are endangered species that may occasionally be present in the study area. The Arctic peregrine falcon, green turtle, and the loggerhead turtle are threatened species that occasionally occur in the study area. The American alligator, listed as a threatened species under the Similarity of Appearance clause of the Endangered Species Act, is commonly found in the less-saline habitats of the study area.

The nearby State-operated Biloxi Wildlife Management Area is located north of the study area, between Lake Borgne and Chandeleur Sound. That area provides public hunting opportunities (primarily for waterfowl, coot, rails, snipe, and rabbits) and supports a variety of non-consumptive recreational uses.

Future Without-Project Conditions

Since the MRGO was completed in 1961, that waterway has continued to widen about 15 feet per year in the study area. The Corps has estimated that in the next 50 years, 2,700 acres of ecologically important saline wetland habitat will be converted to open water on the north side of that waterway due to shoreline erosion. Additional wetlands in adjacent areas will be lost due to increased tidal surges and continued saltwater intrusion induced by construction of the MRGO project. Marsh loss will allow a greater and faster tidal exchange and higher storm surges, which will, in turn, further accelerate erosion of remaining marshes in and adjacent to the study area.

Loss of saline and brackish marshes will result in a loss of the primary productivity and habitat in those areas. Even though the amount of open water is expected to increase, the species of fish and shellfish using the study area are expected to remain relatively constant. The total production of estuarine-dependent finfishes and shellfishes is believed to depend on the total marsh acreage in a given estuarine system. Although shrimp, crab, fish, and other estuarine species will continue to be caught in the present and newly created open waters, the production of those organisms in the study area is expected to decrease as the marshes of the study area deteriorate further.

Loss of fresh/intermediate marshes and increased salinity is expected to result in continued habitat declines that will adversely affect certain rails, and many wading bird species found in the study area. Marsh loss will also result less habitat for white-tailed deer, wild hog, rabbit, various furbearers, alligator, and other reptiles.

FISH- AND WILDLIFE-RELATED PROBLEMS, OPPORTUNITIES AND PLANNING OBJECTIVES

The principal fish- and wildlife-related problem of the study area is continuing marsh loss due to shoreline erosion, saltwater intrusion, and subsidence. Almost any action that would reduce or eliminate shoreline erosion or restore eroded marsh would benefit fish and wildlife that are dependent on marsh habitats. Although there is very little intermediate and fresher brackish marsh habitat in the study area, most of the waterfowl, wading birds, furbearers, and alligators are concentrated in such areas. Those less-saline marshes occur in leveed water management areas and in isolated wetland pockets within diked spoil disposal areas. Those freshwater areas are important to many species of wildlife that also use the salt marshes, because many species depend on, or are attracted to, fresher water for drinking.

An opportunity exists to create fresh and intermediate marsh within designated spoil disposal areas through careful planning and design of retaining dikes and associated outflow structures. Such structures could be operated by landowners to trap rainwater to form marsh impoundments of significant value to migratory waterfowl and other marsh-associated wildlife. As indicated previously, such pockets of fresher marsh have been created incidentally as a result of spoil disposal activities along the MRGO. Presently it takes several years for spoil areas to recover to fresher habitats after being used. To prolong the life of these high quality wildlife habitats, spoil areas could be subdivided so that only a part of each spoil area would be used each maintenance dredging cycle. Thus, the time between spoil deposition on any particular area of marsh would be extended and the sub-impoundments would have more time to develop fresh marsh habitat. The Corps will implement one such project, under the Coastal Wetlands Planning, Protection and Restoration Act, to rehabilitate deteriorated back levees along a section of the MRGO to maintain fresh marsh habitat.

In view of the above considerations, the Service recommends that the Corps include the following planning objectives in this study:

1. Prevent or substantially reduce marsh erosion along the banks of the MRGO.

2. Restore as much of the marsh that has eroded since project construction as is feasible, using maintenance dredging material to build marsh.

3. Avoid burial of existing emergent marsh during spoil disposal.

4. Stop or reduce saltwater intrusion into as much of the study area as possible.

5. Reduce the velocity of tidal surges through the study area.

6. Preserve and increase the areas of relatively fresh marsh in the study area through careful planning of maintenance dredging spoil disposal and retention measures (e.g., retaining dikes, outflow weirs, etc.).

ALTERNATIVES UNDER CONSIDERATION

Based on discussions with your staff, we understand that the Corps is considering the following alternatives for erosion control:

Location(s) of Proposed Structural Protection

Alternative	North Bank (Channel Miles)	South Bank (Channel Miles)
1. North Bank (Critical Reaches)	28.5 to 29.5 38.5 to 39 40.5 to 43 54 to 56	23 to 27
2. North Bank	27 to 51 54 to 60	23 to 27
3. North and South Banks	23 to 51 54 to 60	23 to 47
3a. North and South Banks	27 to 51 54 to 60	23 to 47
4. North Bank	27 to 51 54 to 60	
5. No Federal action		

The Corps would use one of six structural designs for alternatives 1 through 4. Those designs would differ in the amount and type of material (i.e., concrete blocks, rock, or shell) to be used, and the height and width of the structure. The area between the structures and the existing bank would be filled with material from maintenance dredging to create marsh.

POTENTIAL SIGNIFICANT IMPACTS AND COMPARISON OF ALTERNATIVES

The "no action" alternative would not restore any marsh already lost along the MRGO banks and could allow another 2,700 acres of marsh along the banks to erode. An undetermined amount of additional marsh would also be lost due to saltwater intrusion, subsidence, and erosion from increased velocities of tidal and vessel-generated surges.

All the alternatives except "no action" entail structural protection and restoration of some or all of the marsh along the banks of the MRGO that has eroded since completion of the waterway. Therefore, all the structural alternatives, if properly implemented, could have similar effects (although they would differ in magnitude), could restore much of the approximately 270-foot-wide strip of bank that has eroded since completion of the MRGO. The bank protection work associated with those alternatives could restore between 108 and 540 acres of eroded bank and could protect between 540 to 2,700 acres from erosion over the next 50 years. Priority would be assigned to eroding segments along the MRGO that have a potential to break through to Lake Borgne, because such a break would increase tidal surges, erosion, and sedimentation. The proposed bank restoration alternatives would prevent bank erosion due to ship wakes and reduce the speed of tidal surges. The project would also reduce marsh erosion attributable to tidal scour in that portion of the study area not subject to wave action by passing ships.

Several alternatives would protect and restore the bank with rock or concrete block. Those forms of bank protection could benefit fisheries in the area by increasing habitat diversity. The porous structures would provide surface area for attachment by molluscs and other invertebrates, and refugia for prey organisms, crustaceans (e.g., stone crab, blue crab, and shrimp), and fish.

FISH AND WILDLIFE COORDINATION ACT ACTIVITIES FOR THE FEASIBILITY PHASE

Data Needs

If the Corps conducts a feasibility study for this project, the Service will need the following data to evaluate project impacts on fish and wildlife resources and formulate measures to conserve those resources.

1. Current detailed maps of the study area.

2. A detailed description of all alternatives being considered during the feasibility phase.

3. For each alternative considered, an estimate of saline marsh, brackish marsh, and open water acreages in the study area under future without-project and future with-project conditions for existing conditions and 10-year intervals over the period of analysis.

Tasks and Associated Cost Estimates

Should the study advance to the feasibility phase, the Service will require substantial funding to carry out review and reporting responsibilities under the Fish and Wildlife Coordination Act. We estimate that 1 biologist-month will be required to produce a planning-aid report evaluating the impacts of alternatives considered during the plan formulation stage. Two additional months will be required to prepare a draft Fish and Wildlife Coordination Act report, and another month to finalize the report. A detailed Scope of Work defining specific tasks and associated funding requirements for Service participation in the feasibility study should be prepared jointly by our respective staffs, should the reconnaissance study conclude that further Federal participation is warranted.

CONCLUSION AND RECOMMENDATIONS

In conclusion, the Service has documented significant, unmitigated losses of fish and wildlife resources resulting from the construction and continued erosion along the MRGO. This project could restore valuable marsh habitat, and protect against future losses from bank erosion. Therefore, the Service encourages the Corps to proceed with a feasibility study.

The Service provides the following recommendations in the interest of fish and wildlife conservation:

1. Further (i.e., feasibility stage) project planning should incorporate those planning objectives listed above.

2. Any action recommended for further consideration should include plans for restoration of marsh lost due to erosion of the MRGO, and preservation and management of the remaining marsh habitats to the greatest extent possible.

LITERATURE CITED

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