DAMAGE ASSESSMENT AND RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT

TEXACO PIPELINE INC. CRUDE OIL DISCHARGE

LAKE BARRE, LOUISIANA May 16, 1997

Prepared by:

Louisiana Oil Spill Coordinators Office
Louisiana Department of Environmental Quality
Louisiana Department of Natural Resources
Louisiana Department of Wildlife and Fisheries
National Oceanic and Atmospheric Administration
United States Fish and Wildlife Service

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INTRODUCTION AND SUMMARY CHAPTER 1

This Draft Damage Assessment and Restoration Plan/Environmental Assessment (Draft DARP/EA) has been prepared by state and federal natural resource Trustees to address the restoration of natural resources and resource services injured by the Texaco Pipeline Company Lake Barre oil spill on May 16, 1997 (the "incident"). This Draft DARP/EA is intended to inform members of the public and solicit their comments on the results of natural resource injury studies and proposed restoration actions. Comments received by the Trustees will be considered when developing the Final Restoration Plan. This Draft DARP/EA also serves as an Environmental Assessment as defined under the National Environmental Policy Act (NEPA) 42 U.S.C. 4321 et seq., and addresses the potential impact of proposed restoration actions on the quality of the physical, biological, and cultural environment.

The Trustees and Texaco have considered the injuries resulting from this incident, evaluated restoration alternatives suggested by the public and local scientists and other interested parties, ranked the alternatives according to established criteria, and selected a preferred alternative. The Trustees believe that the process undertaken to evaluate injuries to natural resources and services and select the preferred restoration alternative to make the public and the environment whole for losses resulting from this incident has been consistent with regulatory requirements. However, the findings set forth in this Draft DARP/EA are preliminary and may change as a result of comments received regarding the injury assessment and restoration alternative development and selection process. Public input is essential to the restoration process; therefore you are invited to provide comments on the proposed restoration action and on the National Environmental Policy Act (NEPA) required analysis of significance of impact. If it is determined that the proposed restoration project is not likely to have significant impacts on the environment, the NEPA process will conclude following this comment process.

1.1 OVERVIEW OF THE INCIDENT

At around 4:00 PM CDT on May 16, 1997, a release from a sixteen inch crude oil transmission pipeline was discovered by Texaco Pipeline Inc. (hereafter "Texaco") in Lake Barre, Louisiana. The release was caused by a 34" long gash in the pipeline, which had been buried five to eight feet below the sediment surface. The site of the pipeline rupture was at 29^{o} 14.8' N latitude, 90^{o} 29.3' W longitude, which is approximately 27 miles southeast of Houma, in Terrebonne Parish. Texaco estimated that approximately 6,561 barrels (275,562 gallons) of crude oil were discharged as a result of the pipeline rupture. Oil skimming and booming operations began on May 17, 1997 in an effort to control surface oil, remove oil from the environment, and protect sensitive estuarine and marsh ecosystems.

State and federal agency personnel along with Texaco responded, as part of the unified command to the spill and observed potential indications of biological injury from the effects of the incident.

Extensive areas of marsh were observed to have been exposed to black oil or sheen, birds were observed to have been oiled, and dead shrimp were collected in a Louisiana Department of Wildlife and Fisheries trawl from Lake Barre. Small dead fish and invertebrates were observed in areas where oil was trapped in shallow water in the marsh. As a result of public health concerns associated with the consumption of potentially contaminated oysters, Lake Barre was closed to oyster harvesting on May 19, 1997 and reopened on August 1, 1997, after 74 days.

Pursuant to Section 1006 of the Oil Pollution Act of 1990 (OPA), designated natural resource Trustees have conducted a damage assessment to evaluate potential injuries to natural resources and services, and to determine the need for and scale of restoration actions required. Texaco, the Responsible Party for this incident, participated actively in the damage assessment with the Trustees, including involvement in the design and implementation of some studies completed through the Cooperative Assessment Group (CAG). Information collected by all participants in the CAG was shared, as were the results of those analyses that were undertaken independently by the Trustees and Texaco.

1.2 NATURAL RESOURCE INJURIES

The Trustees reviewed the information gathered as a result of response activities as well as that collected specifically for injury assessment. Based on this work, the Trustees believe that the incident caused injuries to biota in the Lake Barre estuarine and marsh environments, including a variety of birds.

Approximately 4,327 acres of marsh were exposed to oil resulting from the incident. Most of the exposed marsh was determined to be fully functioning or recovering to full functioning within four months after the release. Marsh function in approximately 162 acres was affected for a longer period but was expected to be fully recovered two years following the incident, except for a total of 0.28 acres that lost virtually all above-ground biomass. The 0.28 acres is recovering slowly and is expected to eventually recover to full functioning. Based on field observations conducted in cooperation with Texaco, the Trustees estimate that a total of approximately 75 discounted acre-years of marsh service may have been lost as a result of the impacts from the incident. (An acre-year of marsh service is the amount of ecological function provided by one acre of marsh over one year). The Trustees used a modeling approach to estimate that approximately 7,465 kilograms of finfish and shellfish biomass (direct kill and production foregone) were lost as a result of the incident. A modeling approach was also used to estimate direct mortality to birds and wildlife. The model estimates that approximately 333 birds were killed from exposure to oil, and predicts that no mammals, amphibians, or reptiles were killed. Texaco has not agreed with the Trustee estimates for finfish, shellfish, or bird injuries, but made an offer for marsh restoration as compensation for these injuries. These faunal injuries were translated into marsh service acre-year equivalents, as described in Section 5.3.2.4.

Boat-based recreational shrimping and fishing was a public human-use activity that was affected during the incident. The public was asked to stay out of the area during the response activities, although the area was not officially closed. However, due to the limited duration of the active phase of the response actions, and the numerous nearby alternative sites for recreational shrimping

and fishing, the recreational loss was judged by the Trustees to be relatively small. The cost of conducting studies to assess what appears to be a relatively small potential loss of recreational services was judged by the Trustees to be out of proportion to the potential value of the loss. However, restoration alternatives for other injuries were evaluated based on whether or not they provided benefits to recreational shrimpers and fishermen in addition to other criteria so as to provide some degree of compensation for the potential recreational loss.

1.3 PROPOSED RESTORATION ALTERNATIVES

Restoration actions under OPA are termed primary or compensatory. Primary restoration is any action taken to accelerate the return of injured natural resources and services to their baseline condition. Trustees may elect to rely on natural recovery rather than primary restoration actions in situations where feasible or cost-effective primary restoration actions are not available, or where the injured resources will recover relatively quickly without human intervention.

Compensatory restoration is any action taken to compensate for interim losses of natural resources and services pending recovery. The scale of the required compensatory restoration will depend both on the magnitude of initial resource injury and how quickly each resource and associated service returns to baseline. Primary restoration actions that speed resource recovery will reduce the requirement for compensatory restoration.

Based on observations made during the injury assessment studies, the Trustees determined that no active primary restoration actions were required to return injured natural resources and services to baseline (see Section 5.3.1). Therefore the natural recovery alternative was chosen for primary restoration. The Trustees evaluated more than 43 compensatory restoration alternatives with the potential to provide additional resources to compensate for the losses pending environmental recovery. As indicated in Exhibit 1-1 the Trustees propose compensatory restoration actions directed at marsh services, aquatic fauna, and birds.

Exhibit 1-1

PREFERRED RESTORATION ALTERNATIVES

Injured Resource/ Service	Primary Restoration	Compensatory Restoration
Aquatic Fauna	Natural Recovery	Marsh enhancement
Birds	Natural Recovery	Marsh enhancement
Marsh habitat	Natural Recovery	Marsh enhancement
Human Use	Natural Recovery	Achieved through benefits to recreational fishing resulting from ecological restoration actions (marsh enhancement)

1.4 PLAN OF THIS DOCUMENT

The remainder of this document presents further information about the natural resource injury studies and proposed restoration actions for the Lake Barre Oil Spill.

Chapter 2 briefly summarizes the spill incident, the legal authority and regulatory requirements of the Trustees, and the role of the Responsible Party and the public in the damage assessment process.

Chapter 3 provides a brief description of the physical and ecological environments affected by the spill, as required by NEPA (42 U.S.C. Section 4321, et seq.), and of the cultural and economic importance of Lake Barre estuarine and marsh natural resources.

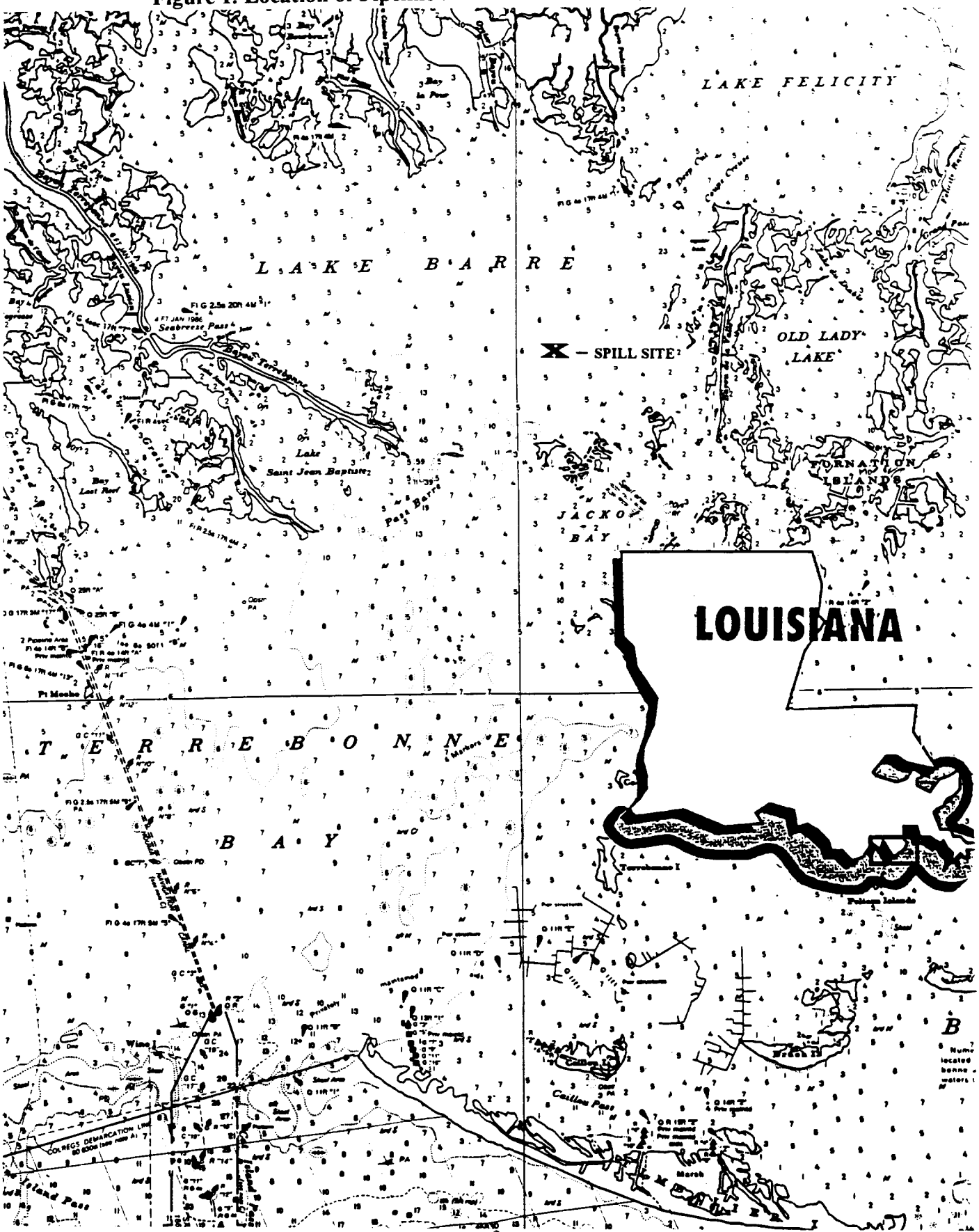
Chapter 4 describes and quantifies the injuries caused by the spill, including an overview of Preassessment activities, a description of assessment strategies employed by the Trustees, and a presentation of assessment results.

Chapter 5 provides a discussion of restoration options, and determines the appropriate scale of preferred options based on the nature and extent of injury presented in Chapter 4.

Appendix A provides a list of the documents submitted to the Administrative Record as of the printing of this Draft DARP/EA.

Appendix B presents a list of applicable environmental laws that have been considered by the Trustees in conducting the assessment and planning restoration for this incident.

Figure 1. Location of Pipeline Break in Lake Barre, Louisiana.



PURPOSE OF AND NEED FOR RESTORATION CHAPTER 2

2.1 THE LAKE BARRE OIL SPILL: SUMMARY OF INCIDENT

At approximately 4:00 PM CDT on May 16, 1997, a drop in pressure was noted on a Texaco sixteen inch crude oil pipeline. The operators notified the platforms that pumped into the line, and oil flow into the line was stopped. At 5:50 PM the pipeline valves were closed, halting the release. There are approximately 34 miles of pipeline between the valves, in the section of the pipeline where the rupture occurred. South Louisiana crude oil, with an API gravity of approximately 31, was released from the buried pipeline up through the water column to the surface of Lake Barre. The first volume estimate, based on the pipeline metering, was that around 5,000 BBL of oil had been released, and Texaco notified its spill response team based on this estimate. The volume estimate was revised downward to approximately 277 BBL after an overflight at 5:40 PM, based on visual observation of the slick and API spill chart specifications. On May 19, the estimated volume released had been raised to 2,500 BBL. By May 20, 1997 it became clear that the initial metering estimate was more correct, and the spill volume was upgraded to 5,000-7,500 BBL. The final estimate is that approximately 6,561 BBL of oil were released.

The slick was initially located at approximately 29^{o} 14.8' N latitude, 90^{o} 29.3' W longitude, in Lake Barre, Louisiana, which is at the northern end of the Timbalier-Terrebonne Bay system. Light east winds at the time of the release initially pushed the oil westward, keeping the slick in open water for the initial several hours following the release. On May 17, 1997, the winds switched to SSE, pushing oil into the marshes in the north and northwest portions of Lake Barre. Texaco responded to the release by placing thousands of feet of containment and absorbent boom around islands and in front of shorelines, and using several skimmers to collect oil from the water surface. In addition to the oil collected by skimmers and absorbent boom, some oil dispersed into the water column and evaporated into the air.

The Louisiana Department of Health and Hospitals issued a precautionary closure of oyster harvesting in the affected area on May 19, 1997. An area of about 94 square miles was closed for 74 days. A dead oiled tern was found on May 21, 1997 and a dead oiled mottled duck was collected on May 22, 1997. A variety of live birds were observed to have been oiled including clapper and king rails, gulls, great and snowy egrets, plovers, sandpipers, and herons. Tri-State Bird Rescue was hired by Texaco to assist in rehabilitating oiled birds, but oiled birds appeared relatively active, and none were captured for rehabilitation. Some brown shrimp collected in a Louisiana Department of Wildlife and Fisheries regular trawl sampling were found dead, which was very unusual. Additionally, dead juvenile blue crabs were found in traps located in the West Cove area. Adult crabs and fish in these traps were alive. Based on the studies and observations made by response personnel, Texaco representatives, and the Trustees, it is estimated that 4,165

acres of vegetated marsh was exposed to light oiling or sheen, and approximately 162 acres of vegetated marsh were exposed to heavy oiling.

2.2 AUTHORITY AND LEGAL REQUIREMENTS

This Draft DARP/EA has been prepared jointly by the Louisiana Oil Spill Coordinator's Office (LOSCO), the Louisiana Department of Wildlife and Fisheries (LDWF), the Louisiana Department of Natural Resources (LDNR), the Louisiana Department of Environmental Quality (LDEQ), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of the Interior (DOI) which is represented by the United States Fish and Wildlife Service (USFWS) (collectively, "the Trustees"). Each of these agencies is a designated natural resource Trustee under the Oil Pollution Act of 1990 (OPA), 33 U.S.C. Section 2706(b), and the National Contingency Plan, 40 CFR Section 300.600, for natural resources injured by the Lake Barre incident. As a designated Trustee, each agency is authorized to act on behalf of the public under state and/or federal law to assess and recover natural resource damages, and to plan and implement actions to restore natural resources and resource services injured or lost as the result of a discharge of oil.

2.2.1 Overview of OPA Requirements

A natural resource damage assessment, as described under Section 1006 of OPA (33 U.S.C. Section 2706(c)) and the regulations for natural resource damage assessments under OPA at 15 CFR Part 990, consists of three phases: 1) Preassessment; 2) Restoration Planning; and 3) Restoration Implementation. The Trustees may initiate a damage assessment provided that an incident has occurred; the incident is not from a public vessel or an onshore facility subject to the Trans-Alaska Pipeline Authority Act; the incident is not permitted under federal, state or local law; and Trustee natural resources may have been injured as a result of the incident. Injury is defined as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service" (15 CFR Section 990.30).

Based on early available information collected during the Preassessment Phase, Trustees make a preliminary determination whether natural resources or services have been injured and/or are threatened by ongoing injury. Through coordination with response agencies (e.g., the USCG), Trustees next determine whether response actions will eliminate injury or the threat of ongoing injury. If injuries are expected to continue, and feasible restoration alternatives exist to address such injuries, Trustees may proceed with the Restoration Planning Phase. Restoration planning also may be necessary if injuries are not expected to continue but are suspected to have resulted in interim losses of natural resources and services from the date of the incident until the date of recovery.

The purpose of the Restoration Planning Phase is to evaluate potential injuries to natural resources and services, and use that information to determine the need for and scale of restoration actions. Natural resources are defined as "land, fish, wildlife, biota, air, ground water, drinking

water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state or local government or Indian tribe" (15 CFR Section 990.30). This phase provides the link between injury and restoration and has two basic components: injury assessment and restoration selection. The goal of injury assessment is to determine the nature and extent of injuries to natural resources and services, thus providing a factual basis for evaluating the need for, type of and scale of restoration actions. As the injury assessment is being completed, the Trustees develop a plan for restoring the injured natural resources and services. The Trustees must identify a reasonable range of restoration alternatives, evaluate and select the preferred alternative(s), develop a Draft Restoration Plan presenting the alternative(s) to the public, solicit public comment on the Plan, and consider comments when developing a Final Restoration Plan.

During the Restoration Implementation Phase, the Final Restoration Plan is presented to the Responsible Parties to implement or to fund the Trustees' costs of implementing the plan, thus providing the opportunity for settlement of damage claims without litigation. Should the Responsible Parties decline to settle a claim, OPA authorizes Trustees to bring a civil action against Responsible Parties for damages, or to seek disbursement from the Oil Spill Liability Trust Fund equal to the value of the damages. Components of damages are specified in sections 1002(b) and 1001(5) of OPA and include the costs of damage assessment.

2.2.2 NEPA Compliance

Any restoration of natural resources under OPA must comply with the NEPA (40 CFR Section 1500, et seq.) and the Council on Environmental Quality (CEQ) regulations implementing NEPA. In compliance with NEPA and the CEQ regulations this Draft DARP/EA summarizes the current environmental setting, describes the purpose and need for action, identifies alternative actions, assesses their applicability and environmental consequences, and summarizes opportunities for public participation in the decision process. This information was used in making a threshold determination as to whether preparation of an Environmental Impact Statement (EIS) is required prior to the selection of the final restoration action (i.e., is the proposed action a major federal action that may significantly affect the quality of the human environment?). Based on the EA integrated in this plan, it was determined that the proposed restoration action does not meet the threshold requiring an EIS. Furthermore, as discussed in Section 5.4.2, the specific project identified as the preferred restoration alternative had already undergone NEPA analysis and received a Finding of No Significant Impact.

2.3 COORDINATION WITH THE RESPONSIBLE PARTY

The OPA regulations require the Trustees to invite Responsible Parties to participate in the damage assessment process. Although the Responsible Party may contribute to the process in many ways, final authority to make determinations regarding injury and restoration rests solely with the Trustees.

Accordingly, the Trustees delivered a formal invitation pursuant to the OPA regulations for participation in the damage assessment, then in the preassessment phase, to Texaco on June 9, 1997. Texaco responded that it wished to participate in the cooperative process in a letter dated June 20, 1997. The designated technical representatives of Texaco participated actively in the damage assessment following the spill; they were involved in the design and implementation of many studies completed as part of this assessment. They also participated actively in Cooperative Assessment Groups (CAGs), which were created to design and interpret the studies and evaluate potential injuries. Coordination between the Trustees and Texaco helped reduce duplication of studies, increase the cost-effectiveness of the assessment process, increase sharing of information and experts, and is expected to decrease the likelihood of litigation. Input from Texaco was sought and considered, when provided, throughout the damage assessment process.

2.4 PUBLIC PARTICIPATION

Public review of the Draft DARP/EA is an integral component of the restoration planning process. Through the public review process, the Trustees seek public comment on the analyses used to define and quantify natural resource injuries and the methods being proposed to restore injured natural resources or replace lost resource services. The Draft DARP/EA provides the public with current information about the nature and extent of the natural resource injuries identified and restoration alternatives evaluated.

Following a public notice, the Draft DARP/EA will be available to the public for a 30-day comment period. Comments received during the public comment period will be considered by the Trustees before finalizing the document. Public review of the Draft DARP/EA is consistent with all state and federal laws and regulations that apply to the natural resource damage assessment process, including Section 1006 of OPA, the regulations for Natural Resource Damage Assessment under OPA (15 CFR Part 990), NEPA (42 USC Section 4371, et seq.) and the regulations implementing NEPA (40 CFR Part 1500, et seq.)

The deadline for submitting written comment on the Draft DARP/EA will be specified in one or more public notices issued by the Trustees to announce the document's availability for public review and comment. An additional opportunity for public review will be provided in the event that significant changes to the plan are required. Comments on this draft should be sent to Warren Lorentz at the address provided below.

Louisiana Oil Spill Coordinator's Office
625 N. Fourth Street, Suite 800
Baton Rouge, LA 70802

2.4.1 Administrative Record

The Trustees developed records documenting the information considered by the Trustees as they planned and implemented assessment activities and addressed restoration and compensation issues and decisions. These records have been compiled into an administrative record, which is now available for public review at the addresses given below. Although the record is still being added

to, it presently contains the information that the Trustees relied upon to make the decisions described in the DARP/EA. The administrative record facilitates public participation in the assessment process and will be available for use in future administrative or judicial review of Trustee actions to the extent provided by federal or state law. A list of those documents submitted to the administrative record through July 9, 1999 is attached as Appendix A to this document. Additional information and documents, including public comments received on the Draft DARP/EA, the Final DARP/EA and restoration planning documents will be included when completed.

Documents within the administrative record can be viewed at:

Louisiana Oil Spill Coordinator's Office
625 N. Fourth Street, Suite 800
Baton Rouge, LA 70802

Arrangements should be made in advance to review the record, or to obtain copies of documents in the record by contacting Warren Lorentz at the listed address or calling him at (225) 219-5810.

Or at:

Terrebonne Parish Consolidated Government Offices
337 Highway 57
Houma, LA 70363

Arrangements should be made in advance to review the record, or to obtain copies of documents in the record by contacting Earl J. Eues, Jr. at the listed address or calling him at (504) 873-6739.

AFFECTED ENVIRONMENT CHAPTER 3

This chapter presents a brief description of the physical and biological environment affected by the Lake Barre incident, as required by NEPA (40 U.S.C. Section 4321, et. seq.). The physical environment includes the marine waters of Lake Barre and associated coastal salt marsh, rookery island, oyster reef, and mudflat habitat. The biological environment includes a wide variety of fish, shellfish, birds and other organisms.

Lake Barre and its natural resources are part of the large Barataria-Terrebonne estuary system (BTES). Commercial fishing, aquaculture, recreational fishing, hunting, and wildlife viewing provide contributions to the economy of Terrebonne, Lafourche, Plaquemines, and Jefferson parishes within the BTES. The wetlands in the BTES also provide ecosystem services such as protection from wind and storm surge damage and wastewater treatment. These benefits depend on a healthy marine and coastal ecosystem in the BTES, including the Lake Barre region. The Barataria-Terrebonne Bay complex is included in the National Estuary Program (BTNEP).

3.1 PHYSICAL ENVIRONMENT

The state of Louisiana is located along the north-central coast of the Gulf of Mexico. Lake Barre is located along the northern edge of the BTES. The surrounding land is classified as Gulf Coast Marsh and was created as a series of overlapping delta lobes of the Mississippi River during the past 10,000 years. The climate of the area is humid subtropical with abundant precipitation. Rainfall in May and June averages 4.8 and 6.7 inches, respectively. Summers are hot and winters are mild, with mean monthly temperatures of about 82^{o}F and 57^{o}F, respectively. The area is subject to tropical storms and hurricanes.

Lake Barre is protected from the open Gulf of Mexico by a series of barrier islands to the south, including Isles Dernieres, Timbalier Island, and East Timbalier Island. The shoreline in the Lake Barre area is predominantly saltmarsh. The edges of some marsh areas are armored with oyster reefs. Organic and shell beaches are also present. The land in this area is subsiding, due to low influx of sediment, with land loss occurring so rapidly that 1995 maps were not easily used by response or assessment personnel for the May 16, 1997 spill. The subsidence and resultant erosion of marsh has resulted in a very complex shoreline with a number of small islands and isolated patches of saltmarsh remaining in front of the main current shoreline. Numerous bayous, cuts, and canals in the shoreline of Lake Barre allow exchange of water into interior portions of the marsh. Ponds are present in some areas of the marsh due to subsidence.

The site of the May 16, 1997 pipeline rupture is approximately 4.5 miles southeast of the nearest affected marsh island (“Big Island”), which is used by nesting birds, including terns. Water depth near the site of the release is around two meters, which is relatively constant in Lake Barre except near the shore where water depth is shallower and in channels where it is deeper. Oil from the

ruptured pipeline spread out over open water, beach, reef, and marsh habitats. The area exposed to oil or sheen ranges from just north and east of Bayou Charles Theriot to Bay La Fleur. Sheen penetrated through openings in the marsh and migrated northward into Madison Bay.

3.2 BIOLOGICAL ENVIRONMENT

Lake Barre contains a variety of habitats including intertidal mudflat/fringe marsh, high marsh, oyster reef, and open water that supports a large array of plant and animal species. Important habitats for many species include marsh areas and oyster beds. The predominant marsh plant species in the area is smooth cordgrass (*Spartina alterniflora*); black rush (*Juncus roemerianus*) and saltgrass (*Distichlis spicata*) are also present in some abundance. Phytoplankton, zooplankton, and benthic and epibenthic invertebrates support a diversity of fish and bird species.

Larger invertebrates found in much of Lake Barre include the blue crab, white shrimp, brown shrimp, American oyster, stone crab, mud crab, fiddler crab, and periwinkles. Fish species in Lake Barre include mullet, Gulf menhaden, sheepshead, Atlantic croaker, hardhead and gaftopsail catfish, striped sole, ocellated flounder, black drum, red drum, spotted seatrout, southern flounder, and anchovies. The above listed fish species have been found in the Lake Barre area during the spring in routine LDWF sampling conducted over many years. Several of these species are recreationally important along the Louisiana Gulf coast; others are important as components of the Lake Barre ecosystem.

Many species of birds inhabit Lake Barre and surrounding ecosystems. There are approximately 60 resident species of birds, and approximately 220 species of birds that regularly use the BTES for breeding or stopovers. Additionally, approximately 100 species are occasional visitors. Small marsh islands provide isolated nesting locations for several breeding bird species. Wading birds, gulls, shorebirds, waterfowl, diving birds, and raptors are among the types of birds that inhabit the area. Protected bird species that may be present in the area include bald eagles, ospreys, reddish egret, and brown pelicans. River otters, muskrat, mink, and nutria are among the mammal species that occur in the Lake Barre area.

Estuarine organisms of commercial, recreational, and ecological importance typically have inshore and offshore components to their life histories. Many species in Lake Barre spawn offshore or near passes to estuaries, and their larvae migrate into estuarine nursery areas to grow and develop prior to offshore migration and maturation. Gulf coastal wetlands, such as those in Lake Barre, act as nursery areas for a diversity of finfish, crustaceans, and mollusks, and are important to the life history requirements of over 90 percent of the Gulf's commercially important species (GMFMC, 1981). Other taxa such as birds use estuarine habitats for seasonal feeding, refuge, and/or reproduction.

3.3 ENDANGERED AND THREATENED SPECIES

The Endangered Species Act of 1973 instructs federal agencies to carry out programs for the conservation of endangered and threatened species and to conserve the ecosystems upon which these species depend. The Louisiana Department of Wildlife and Fisheries' Natural Heritage Program also lists species that are of special concern to the state. Exhibit 3.1 at the end of this chapter provides a list of federal and state recognized endangered or threatened species reported to reside in or migrate through south coastal Louisiana ecosystems.

3.4 CULTURAL ENVIRONMENT AND HUMAN USE

Ever since the early 1600's when the explorer Pierre Le Moyne, Sieur d'Iberville discovered the region for France, the BTES has been recognized as an area with an abundance of fish and wildlife resources (see the BTNEP website: http://www.epa.gov/nep/bt.htm). The BTES, including the Lake Barre area, is directly used for commercial and recreational crabbing, trapping and hunting, and fishing, and is also used for wildlife viewing ("Economic Value Assessment of the Barataria-Terrebonne Estuarine System", published research report 26, The Barataria-Terrebonne National Estuary Program). As discussed above, many of the commercially and recreationally important fish and shellfish species are dependent during at least part of their life-history on the habitats within the BTES. Ecotourism (primarily bird and wildlife viewing and hunting and fishing) is increasingly important to the area. The wetlands in Lake Barre also serve as protection from storms and saltwater intrusion, protecting both human development and freshwater supplies.

Exhibit 3.1

FEDERAL AND STATE ENDANGERED OR THREATENED SPECIES IN SOUTH COASTAL LOUISIANA

Common Name	Scientific Name	Status
MAMMALS		
Louisiana Black Bear	Ursus americanus luteolus	Threatened
Florida Panther	Felis concolor coryi	Endangered
REPTILES		
Kemp's Ridley Sea Turtle	Lepidochelys kempii	Endangered
Hawksbill Sea Turtle	Eretmochelys imbricata	Endangered
Leatherback Sea Turtle	Dermochelys coriacea	Endangered
Loggerhead Sea Turtle	Caretta caretta	Threatened
Green Sea Turtle	Chelonia mydas	Threatened
BIRDS		
Eskimo Curlew	Numenius borealis	Endangered
Bald Eagle	Haliaeetus leucocephalus	Threatened
Brown Pelican	Pelecanus occidentalis	Endangered
Piping Plover	Charadrius melodus	Threatened

INJURY DETERMINATION AND QUANTIFICATION CHAPTER 4

This chapter describes and quantifies the injuries caused by the Lake Barre incident. The chapter begins with an overview of data collected during the Preassessment Phase of the damage assessment process. The following section describes the Trustee's assessment strategy, including the approaches used to identify, determine, and quantify potential injuries. The remainder of the chapter presents the results of Trustee injury assessments for the specific resources affected by the Lake Barre incident. Chapter 5 addresses the identification, selection, and scaling of restoration options to restore injured resources and services.

4.1 OVERVIEW OF THE PREASSESSMENT-PHASE

Three requirements identified in the Oil Pollution Act of 1990 (OPA) must be met before Restoration Planning can proceed:

- Injuries have resulted, or are likely to result, from the incident;
- Response actions have not adequately addressed, or are not expected to address, the injuries resulting from the incident; and
- Feasible primary and/or compensatory restoration actions exist to address the potential injuries.

All of the information collected during the Preassessment Phase of the incident is contained in the Preassessment Data Report (ENTRIX, 1998). This information meets the three criteria listed above and confirms the need for restoration planning to address impacts resulting from the incident.

4.1.1 Aquatic Faunal Impacts

The release resulted in concentrations of polycyclic aromatic hydrocarbons (PAH) that were detected in some locations at concentrations known to be toxic to aquatic organisms in laboratory tests. Although there were no reports of large numbers of fish or shellfish mortalities observed as a result of the incident, there are indications that some mortality to aquatic fauna resulted. There were reports of some small fish being found dead in shallow water in the marsh area, as well as observations of dead invertebrates in some areas. Dead brown shrimp were collected in a LDWF trawl in Bay Bourbeaux, and dead juvenile blue crabs were reported from traps located in the West Cove area.

4.1.2 Bird Impacts

Two oiled birds (a mottled duck and a tern) were found dead in the first week following the incident. Additionally, response personnel and Trustee representatives surveyed around ten percent of the spill affected area (Conzelmann, USFWS, pers. comm.) and observed at least 58 living, but oiled, birds in the days following the incident.

4.1.3 Marsh Habitat Impacts

Approximately 4,327 acres of marsh were exposed to oil (including sheen) from the pipeline rupture. In small areas of the exposed marsh, oil streamers collected and resulted in a near total loss of above-ground biomass. In the vast majority of the marsh, the exposure to oil had less dramatic consequences, resulting in a partial loss of marsh services. The oil caused stress to the marsh plants, resulting in an increase in chlorosis and potential reductions in primary productivity. The habitat value of the oiled marsh was also reduced. Some other marsh services were also potentially affected, such as reductions in remineralization processes.

4.1.4 Human Use Impacts

The incident affected human use service in the Lake Barre area. Under OPA, the Trustees are responsible for evaluating and obtaining compensation for public (but not private) lost human use. The Louisiana Department of Health and Hospitals issued a precautionary closure of oyster harvesting in the affected area on May 19, 1997 to alleviate public health and seafood quality concerns. The closure, which affected private commercial and not public interests, was lifted on August 1, 1997. During the early stages of the cleanup, public access to the area was limited by cleanup activities, including boom placement across access points to the area. In the judgment of the Trustees, the effect of the incident on recreational uses of Lake Barre was relatively limited in duration and magnitude. Recreational use of the area is believed to have returned to baseline levels shortly after the response actions ended. Therefore, no specific actions were required for recreational use to return to baseline conditions, allowing natural recovery to be the preferred alternative for primary restoration for this injury category. Additionally, there are numerous nearby substitute sites for fishing and shrimping that were not directly affected by the incident. Thus, there was little potential for significant interim loss and, therefore, it did not warrant further evaluation. Instead the Trustees considered benefits to recreational uses as an additional criterion in determining preferred restoration alternatives for other injury categories.

4.2 ASSESSMENT STRATEGY

The goal of injury assessment under OPA is to determine the nature and extent of injuries to natural resources and services, thus providing a technical basis for evaluating the need for, type of, and scale of restoration actions. The assessment process occurs in two stages: injury determination and injury quantification.

Injury determination begins with the identification and selection of potential injuries to investigate. The OPA regulations allow the Trustees to consider, and the Trustees did consider, several factors when making this determination, including, but not limited to:

- The natural resources and services of concern;
- The evidence indicating exposure, pathway and injury;
- The mechanism by which injury occurred;
- The type, degree, spatial and temporal extent of injury;
- The adverse change or impairment that constitutes injury;
- Available assessment procedures and their time and cost requirements;
- The potential natural recovery period; and
- The kinds of restoration actions that are feasible.

A list of the potential injuries investigated for the Lake Barre incident is provided in the first column of Exhibit 4-1. As indicated in the exhibit, the Trustees evaluated possible injuries to four categories of ecological resources and recreational fishing losses. These categories were selected based on input from preassessment activities; local, state and federal government officials; the Responsible Party; and academic and other experts knowledgeable about the affected environment.

For each potential injury, the Trustees determine whether an injury has occurred, identify the nature of the injury and identify a pathway linking the injury to the incident. Injury is defined by the OPA regulations as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service" (15 CFR Section 990.30). The assessment methods used for the incident are described in the second column of Exhibit 4-1. Where feasible, the Trustees use simplified, cost-effective procedures and methods to document resource injuries.

In selecting appropriate assessment procedures, the Trustees consider: (1) the range of procedures available under section 990.27(b) of the OPA regulations; (2) the time and cost necessary to implement the procedures; (3) the potential nature, degree, and spatial and temporal extent of the injury; (4) the potential restoration actions for the injury; and (5) the relevance and adequacy of information generated by the procedures to meet information requirements of restoration planning. Accordingly, depending on the injury category, the Trustees rely on information and methodologies from the relevant scientific literature, literature-based calculations, and models and/or focused injury determination and quantification studies in assessing injury.

If the Trustees determine that a resource has been injured, the injury must be quantified. The injury quantification process determines the degree and spatial and temporal extent of injury

relative to baseline, and therefore forms the basis for scaling restoration actions. Baseline refers to the condition that the resource would have maintained but for the effects of the incident.

Exhibit 4-1

LAKE BARRE OIL SPILL: ASSESSMENT METHODS FOR POTENTIAL RESOURCE AND SERVICE INJURIES

Potential Injuries Assessed	Injury Assessment Method(s)
1. Aquatic Fauna	Preliminary estimates developed independently by Trustees and Texaco using a combination of field data, modeling of oil fate and transport, and literature toxicity information.
2. Birds	Preliminary estimates developed independently by Trustees and Texaco. Trustees used a combination of field data and modeling of oil fate and transport; Texaco used observations made during the response effort.
3. Marsh Function	Trustees and Texaco cooperatively performed a field study designed to obtain data allowing use of a Habitat Equivalency Analysis. Input parameters for the model were jointly developed based on the field observations.
4. Human Use	Trustees determined that no specific assessment was warranted.

4.3 SUMMARY OF INJURIES

A summary of injury assessment results is provided in Exhibit 4-2 and described in the following sections.

Exhibit 4-2

LAKE BARRE OIL SPILL: SUMMARY OF INJURY ASSESSMENT RESULTS

INJURED RESOURCE/SERVICE	INJURY QUANTIFICATION
1. Aquatic Fauna	The Trustees estimate that approximately 7,465 kg of fish, crabs, and shrimp were lost as a result of this incident; Texaco estimates that less than 500 kg of fish, crabs, and shrimp were lost.
2. Birds	The Trustees estimate that approximately 333 birds were killed as a result of this incident; Texaco estimates that less than 100 birds were killed.
3. Marsh Function	Trustees and Texaco cooperatively performed a field study designed to obtain data allowing use of a Habitat Equivalency Analysis. Input parameters for the model were jointly developed based on the field observations. The injury is estimated to represent 75.6 discounted service acre-years of lost marsh ecological service flows.
4. Human Use	Trustees determined that no specific assessment was warranted.

4.3.1 Summary of Assessment Methods

Injury quantification for aquatic fauna and bird resources begins with developing an estimate of the number of animals killed. Possible sublethal injuries to populations also are considered if the

Trustees have evidence that such effects might be important. Quantification of injury to marsh begins with an estimation of the amount of acreage affected, and the amount that marsh service flows are impacted.

Once the magnitude of injury is established, Trustees must estimate the recovery time required for the resource to return to baseline condition. The actual biological processes that determine recovery from an oil spill are complex and the knowledge and data to estimate recovery times precisely are rarely available. Both the magnitude of injury and recovery time must be considered when scaling compensatory restoration actions. For resources such as fish, under the specific circumstances of this incident, it is convenient for scaling to express the injury in terms of biomass lost. To include recovery time as part of the lost biomass estimate the Trustees calculate the growth foregone for animals killed by the incident during the recovery period. Growth foregone in each year after the incident is discounted at three percent per year, summed, and added to the injury in the year of the incident to generate an estimate of total injury. The discounting calculation accounts for differences in timing between the initial kill and later years when growth is foregone. After discounting, the total injury is expressed in present terms as of the date of the initial kill. The discount rate of three percent approximates society's rate of time preference. It reflects the greater value that people assign to goods and services now, compared to in the future. For additional discussion concerning discounting, please refer to the NOAA technical document on discounting (NOAA, 1999) which is available at the following website: http://www.darp.noaa.gov/darporg/publicat.htm. For marsh injury, the injury is quantified as acre-years of lost marsh services, and is discounted in a similar fashion as faunal injuries. An acre-year of services is the flow of benefits that one acre of marsh provides to the entire ecosystem over the time period of one year.

4.3.2 Summary of Results

An estimated total of 4,327 acres of marsh was exposed to oil as a result of this incident. The Trustees and Texaco conducted a joint field study and data analysis whose results indicated that approximately 75.6 discounted service acre-years of marsh services were lost as a result of the oiling of the marsh. Aquatic faunal (e.g., fish, shrimp, crabs, and other marine animals) and bird injuries were evaluated separately by Texaco and the Trustees. The Trustees estimated that the number of birds killed through direct exposure to oil in the first days after the release was approximately 333 birds. Texaco independently estimated that bird mortality was probably fewer than 100 birds. The Trustees estimated that aquatic faunal injury was approximately 7,465 kg of direct mortality and production foregone. Texaco's estimate of aquatic faunal injury, which includes direct mortality and considers production foregone, was less than 500 kg of lost biomass. Reaching consensus on bird and aquatic faunal injury was not required in the cooperative process since Texaco made an offer for marsh restoration that was deemed sufficient by the Trustees to satisfy restoration needs for the Trustee estimate of bird and aquatic faunal injury, as described in Chapter 5. Aquatic fauna and bird injuries were translated into marsh service acre-year equivalents, as described in Section 5.3.2.4, to allow marsh restoration to compensate for the bird and aquatic fauna injuries to be scaled.

4.4 INJURIES TO SPECIFIC RESOURCES

The following sections of this chapter describe the results of the injury determination and quantification efforts for the incident that were conducted subsequent to the preassessment phase. Potential injuries are organized into four categories: aquatic fauna, birds, marsh, and human use (recreation).

4.4.1 Aquatic Fauna

4.4.1.1 Determination of Injury

The Lake Barre area is known to be used by aquatic fauna, including blue crabs, shrimp, and other invertebrates, and numerous species of fish. The LDWF has conducted trawl sampling in this area for many years, which documents this use. Oil from the incident was documented to cover thousands of acres of surface waters. Water samples collected near the time of the spill indicate that polycyclic aromatic hydrocarbons (PAHs) were present in the water column for a short period of time in the vicinity of the pipeline break at levels known to be toxic to aquatic organisms in laboratory tests. Additionally, possible injury from the incident is evidenced by the collection of some dead shrimp in a trawl taken by LDWF, and dead juvenile crabs in a crab pot. A few dead forage fish were also observed shortly following the spill.

4.4.1.2 Injury Quantification Strategy

The Trustees and Texaco did not agree on a common method to quantify aquatic injuries. However, both parties agreed that the cost of conducting a large field study to investigate aquatic faunal injuries was not warranted, given the specific circumstances of this incident. A field effort designed to quantify injuries to fish, shellfish, and other aquatic organisms would be very expensive, and the natural variability that exists in the plankton of the Gulf of Mexico region would have made it difficult to detect the magnitude of injuries that the Trustees believed were present. Although some aquatic mortalities were observed, as noted above, there were not any dramatic fish kills or strandings of large numbers of organisms as sometimes occurs following releases of petroleum products (e.g., *Exxon Valdez* oil spill, *North Cape* oil spill, and others). Given the visual evidence suggesting that the magnitude of injury to aquatic organisms was relatively small, the Trustees decided to use a modeling approach.

The Trustees decided to develop a site-specific modeling approach, using some algorithms from the Natural Resource Damage Assessment Model for Coastal and Marine Habitats (Version 2.4, April 1996), some new algorithms to account for the specific circumstances of the incident, and some new data for habitats and aquatic fauna. The habitat data was developed from aerial photography taken after the incident, and the aquatic fauna data was provided by LDWF and derived from their long-term sampling efforts in the Lake Barre area. A preliminary model run was performed using two different estimates for the release volume: 5,000 BBL and 7,000 BBL. These input parameters for volume were chosen since the size of the release had been estimated to lie between these figures (the final release estimate was 6,561 BBL). Extrapolating from the results of the modeling effort suggest that approximately 7,465 kg of fish, decapods, and other

invertebrates were lost as a result of the release from impacts to water column fauna (Kern, 1999). These figures include the direct predicted mortality as well as an estimate of the lost somatic growth that would have been expected.

This injury category, as evaluated by the model approach utilized by the Trustees, estimates the aquatic injury that resulted from death due to exposure to predicted concentrations of low molecular weight PAHs in the water column in the early days following the incident. It also estimates the resulting loss in growth of the organisms predicted to have died from exposure to PAHs. It does not account for a reduction in aquatic faunal production that resulted from reductions in marsh service flows supporting aquatic fauna. Losses due to a reduction in marsh services supporting aquatic organisms are accounted for in the assessment of injury to marsh. In the judgment of the Trustees, assessing direct mortality to aquatic fauna and considering indirect aquatic faunal injuries through reductions in marsh service flows does not result in significant double-counting of aquatic faunal injuries, under the specific circumstances of this incident.

Although the Trustees and Texaco disagreed on the magnitude of estimated aquatic fauna losses, they agreed to move forward with selecting an appropriate restoration option and scaling the amount of restoration needed to compensate for these losses. The selection of the preferred restoration option and the scaling approach is discussed in Chapter 5. The Trustees' did not finalize the model using the final release estimate, 6,561 BBL, since an agreement on restoration was reached that, in the judgment of the Trustees, was clearly sufficient to provide adequate compensation for this injury. Therefore, there was no need for the Trustees to incur the additional expense of further modeling efforts.

4.4.2 Birds

4.4.2.1 Determination of Injury

The Lake Barre area is used by a variety of bird species, including mottled ducks, snowy egrets, great egrets, Louisiana herons, sandpipers, rails, gulls, and terns, all of which were observed to have been oiled by the pipeline incident. Although only two dead birds were recovered, the Trustees believe that additional birds were killed as a result of direct exposure to the oil in the first week following the incident. Oil from the release was documented to cover thousands of acres of surface waters and marsh in which numerous birds were observed.

4.4.2.2 Injury Quantification Strategy

The large area affected and the extensive marsh in which dead birds would be difficult to find, were practical obstacles in determining bird injury. Rather than try to conduct an extensive field survey that would be unlikely to produce accurate results, the Trustees decided to use a site-specific modeling approach. This approach used some algorithms from the Natural Resource Damage Assessment Model for Coastal and Marine Habitats (Version 2.4, April 1996), some new algorithms to account for the specific circumstances of the incident, and some new data for habitats. The habitat data was developed from aerial photography taken after the incident. The

bird species composition and abundance data used in the model was from the Natural Resource Damage Assessment Model for Coastal and Marine Habitats (Version 2.4, April 1996) for species present in Lake Barre in spring. A preliminary model run was performed using two different estimates for the release volume: 5,000 BBL and 7,000 BBL. These input parameters for volume were chosen since the size of the release had been estimated to lie between these figures (the final release estimate was 6,561 BBL). The Trustees' model estimated that 333 birds were lost as a result of the incident from impacts due to oil released from the pipeline break (Kern, 1999). These figures include the estimated direct mortality that the model predicts for the first week of the spill. In this model, birds that are "oiled" in the model run by contact with the slick are assumed to have been killed. This is a conservative assumption in that it is possible that some of the oiled birds did not die. The Trustees believe, however, that a significant proportion of the birds that were exposed to oil likely died. It is not unexpected that only a small proportion of expected bird mortalities were found, since dead birds can be subject to predation, sinking, or could have been hidden in the thick marsh vegetation.

This injury category, as evaluated by the Trustees' modeling approach, estimates the bird injury that the Trustees believe resulted from death due to exposure to surface slicks that were present in the early days following the incident. It does not estimate the potential reduction in bird production that resulted from reductions in marsh service flows supporting birds. Losses due to a reduction in marsh services supporting birds are accounted for in the assessment of injury to marsh. In the judgment of the Trustees, assessing direct mortality of birds in the first few days of the incident and considering longer-term indirect injury to birds through reduction in marsh services to birds does not result in significant double-counting of bird injuries, under the specific circumstances of this incident.

Although the Trustees and Texaco disagreed on the magnitude of estimated bird losses, they agreed to move forward with selecting an appropriate restoration option and scaling the amount of restoration needed to compensate for these losses. The selection of the preferred restoration option and the scaling approach is discussed in Chapter 5. The Trustees' did not finalize the model using the final release estimate, 6,561 BBL, since an agreement on restoration was reached that, in the judgment of the Trustees, was clearly sufficient to provide adequate compensation for this injury. Therefore, there was no need for the Trustees to incur the additional expense of further modeling efforts.

4.4.3 Marsh

4.4.3.1 Determination of Injury

The trajectory of the oil into the marsh and the extent of oiling were documented on a frequent basis during the initial response using overflights and on-water surveys. Overflights occurred on at least a daily basis from May 17, 1997 through May 28, 1997. Trustees participated in surveys and field observations in May, June, July, and October 1997, and June 1998. It is estimated that approximately 4,165 acres of marsh were exposed to light oiling (including sheen) and 162 acres of marsh were exposed to heavy oiling. In limited areas, oil streamers hit the shoreline and oil accumulated on the sediment

surface, resulting in a virtually total loss of above-ground plant biomass. Some of these areas had significant regrowth, but approximately 0.28 acres remained with little above-ground biomass in June 1998. In other areas, marsh services (e.g., habitat services) were affected for a period of time, but the above-ground vegetation was not lost in these areas.

4.4.3.2 Injury Quantification Strategy

The Trustees, in cooperation with Texaco, conducted a field study designed to determine the loss of marsh services resulting from the May 16, 1997 incident. Data on oiling, vegetative status, use of the area by invertebrates, and other factors was measured at specific locations in oiled and unoiled areas of marsh in July and October 1997 and June 1998. Photographic documentation was also used. These data were used to estimate the reduction in marsh service flows from the time of the incident until recovery to baseline could be estimated. These estimates of loss of marsh function were based on the observations made during this assessment (including comparisons to unoiled reference marshes), comparisons with the effects of other oil spills in similar environments, and the best professional judgement of the participants. The primary goals of the study were to determine the service reduction over time so that a total service loss calculation could be performed.

Based on the observations made during the response efforts and the marsh assessment field study, the CAG determined that the marsh exposed to oil showed four patterns of severity of injury and recovery. The estimates for recovery times and levels of service losses were developed based upon the analysis of available data and an evaluation of the types and magnitude of the natural resource service losses incurred as a result of the incident. The four scenarios are presented below:

1. *Light oiling with rapid recovery*: Approximately 4,165 acres of marsh were exposed to sheen or to light oiling that was not visible on the plants during the July 1997 field visit. Actual sheens were present at the water surface for approximately two weeks following the incident. The marsh in this category was estimated to have suffered an initial 10% loss in services that recovered to an estimated 5% loss during those two weeks following the incident. Recovery to full service flows from this marsh was estimated to have occurred by the October 1997 field visit (roughly four months following the spill. The estimated interim loss of marsh services in this category is 41.9 acre-years with no primary restoration actions other than natural recovery.

2. *Heavy oiling with moderate recovery*: Approximately 153.6 acres of marsh were exposed to heavier oiling than the first category, with a higher degree of service loss and slower recovery. These areas were estimated to have suffered an initial service loss of 40%. During the July 1997 site visit, there were indications of some recovery of services, with service losses estimated at 30%. In October 1997 and June 1998 there were substantial signs of recovery. The CAG estimates that recovery from the July 1997 estimate of 30% service losses to full recovery will occur within two years following the incident. The estimated interim loss of marsh services in this category is 26.5 acre-years with no primary restoration actions other than natural recovery.

3. *Heavy oiling with slow to moderate recovery*: Approximately 8.1 acres of marsh were exposed to heavier oiling than the first two categories, with a higher degree of service reduction and slower recovery. These areas were estimated to have suffered an initial service loss of 75%. During the July 1997 site visit, there were indications of some recovery of services, with service losses estimated at 65%. In October 1997 and June 1998 there were substantial signs of recovery, but service losses in June 1998 were estimated to be at 20%. The CAG estimates that recovery from the June 1998 estimate of 20% service losses to full recovery will occur within two years following the incident. The estimated interim loss of marsh services in this category is 4.6 acre-years with no primary restoration actions other than natural recovery.

4. *Heavy Oiling with slow recovery*: Approximately 0.28 acres of marsh were exposed to very heavy oiling, with the above-ground vegetation killed and slight signs of recovery in June 1998. Minimal marsh service flows were believed to be coming from these limited areas, with service flows gradually improving toward baseline service provision. Given the limited areal extent of this category, the CAG decided that it was not cost-effective to continue the field study to monitor the gradual recovery for such a small area. The Trustees and Texaco agreed to conservatively assume that full recovery for these 0.28 acres would not occur until 20 years following the incident for the purpose of calculating compensatory restoration needs, although the Trustees believe recovery will occur more quickly. As discussed in the following chapter, primary restoration actions to speed recovery to baseline was considered but ultimately rejected by the Trustees as not being necessary. The interim loss of marsh services in this category is estimated to be 2.6 acre-years with no primary restoration actions other than natural recovery.

This injury quantification approach attempts to take into account reductions in the entire flow of marsh services. It is intended to account for a reduction in bird production that resulted from reductions in marsh service flows supporting birds. Likewise, it is intended to account for a reduction in aquatic faunal production from reductions in marsh service flows supporting fish, shrimp, crabs, and other aquatic fauna. It is also intended to capture the loss of other marsh services. It is the judgment of the Trustees that accounting for reductions in marsh services with this approach does not result in significant double-counting of the bird and aquatic faunal injuries, under the specific circumstances of this incident.

This injury approach treats injury to marsh sediments as part of the overall loss of marsh services. That is, the effect of the oiling on the sediments was considered during the development of the estimates for loss of overall marsh services. Since affected sediments were virtually all in or adjacent to marsh, no separate injury assessment and restoration evaluation was performed for intertidal sediment injury. Chemistry results of subtidal sediment samples indicate that no significant injury occurred to this habitat. It is the judgment of the Trustees that consideration of intertidal sediment injury as part of the overall assessment of marsh injury was the most efficient approach to use under the specific circumstances of this incident.

4.4.4 Human Use

4.4.4.1 Determination of Injury

As mentioned previously, the Trustees have determined that the likely magnitude of lost recreational use as a result of this incident is small, and therefore have foregone specific assessment efforts for this category of injury. This determination was based on observations made at the time of the incident, as well as information provided by representatives of state agencies and fishing guides. A study conducted later by Louisiana State University concluded that there were modest, if any, effects on recreational users as a result of the incident (Pulsipher et. al., 1998).

RESTORATION ALTERNATIVES CHAPTER 5

5.1 RESTORATION STRATEGY

The goal of restoration under the Oil Pollution Act of 1990 (OPA) is to make the environment and public whole for injuries to natural resources and services resulting from the Lake Barre incident. Restoration actions under OPA are termed primary or compensatory.

Primary restoration is any action taken to accelerate the return of injured natural resources and services to their baseline condition. Natural recovery, in which no human intervention is taken to directly restore the injured natural resources and/or services to baseline conditions, is considered as a primary restoration alternative. Natural recovery is the appropriate restoration alternative in situations where feasible or cost-effective primary restoration actions are not available, or where the injured resources will recover relatively quickly without human intervention. Actual primary restoration actions (as opposed to natural recovery) are appropriate in situations where injured resources will not recover, or will recover slowly, without taking steps to bring about or speed recovery, and where feasible and cost-effective methods exist to assist recovery to baseline.

Compensatory restoration is any action taken to compensate for interim losses of natural resources and/or services pending recovery to baseline. The scale of the required compensatory restoration is dependent on both the initial size of the injury and how quickly each resource and/or service returns to baseline. Primary restoration actions that speed recovery will reduce the requirement for compensatory restoration.

To plan restoration for injuries resulting from the Lake Barre incident, the Trustees first consider possible primary restoration actions for each injury and determine whether primary restoration can and should be implemented. The Trustees then consider the type and scale of compensatory restoration that can best compensate for lost resources and/or services during the recovery period.

Restoration alternatives must be scaled to ensure that their size appropriately reflects the magnitude of injuries resulting from the incident. Where feasible, the Trustees employ a resource-to-resource scaling methodology. Under this approach, the Trustees determine the scale of restoration actions that will provide natural resources and/or services of the same type and quality and of comparable value to those lost. Here, equivalency is obtained between the resources and/or services lost and those to be provided through restoration.

If a reasonable range of alternatives providing natural resources and/or services of the same type and quality and comparable value to those lost cannot be identified, other compensatory restoration actions may be considered. These other compensatory restoration actions must, in the judgment of the Trustees, provide services of comparable type and quality as those lost. When restoration provides resources or services not of comparable value as those injured, the Trustees

must determine the appropriate trade-off between the injured resources and those provided by restoration.

The scaling calculations set forth in this chapter are based on straightforward methods combined with available data and the best professional judgment of the Trustees. More precise scaling calculations often are not possible due both to incomplete knowledge of the relevant physical and biological processes, and uncertainties about important project-specific scaling parameters. Out of necessity, the calculations use simplifying assumptions while seeking to fairly estimate the magnitude of restoration required as compensation for injuries resulting from the Lake Barre incident. Where necessary data are limited or unavailable, creating uncertainty in the true value for required inputs to the scaling calculations, the Trustees use conservative assumptions that will help ensure that the amount of restoration is sufficient.

The Trustees believe that more complex scaling calculations would be difficult and expensive to undertake and would not significantly improve the accuracy of the scaling results in this case. However, the Trustees invite public comment on the adequacy of these calculations and suggestions for cost-effective improvements to scaling for all restoration alternatives. Specific scaling assumptions and calculations are described later in this chapter. The Trustees assume that restoration alternatives will be implemented in the year 2000. In the event that actual implementation occurs after this date, the Trustees will appropriately revise the scaling calculations.

5.2 GENERAL RESTORATION ALTERNATIVES

In accordance with OPA regulations, the Trustees developed a reasonable range of restoration alternatives and selected a preferred alternative. For this incident, this was a two-step process. The Trustees first identified and evaluated general alternatives capable of serving as primary or compensatory restoration for the injured natural resources and/or services (Exhibit 5-1). As part of the effort to develop general restoration alternatives, the Trustees held public meetings on July 9, 1997 and November 10, 1997 in Houma, Louisiana, to discuss the NRDA process and to solicit restoration ideas from the local community. These meetings were noticed in the Houma Courier newspaper, and arranged by a representative of the Terrebonne Parish Consolidated Government (Earl J. Eues, Jr.). On February 13, 1998, the Trustees met with local scientists, and state agency personnel and a Terrebonne Parish representative (Al Levron) to get their perspective on the benefits and feasibility of various types of restoration alternatives. These efforts were important in assisting the Trustees in identifying projects that have the potential to be feasible, have strong net environmental benefits, be accepted by the local public, and meet restoration requirements to compensate for injuries resulting from the incident.

During the public meetings and afterwards the Trustees received restoration suggestions. These suggestions were considered for possible inclusion in the development of the list of potential restoration alternatives; most were ultimately determined to be impractical or inappropriate as restoration alternatives for this incident. One suggestion was that the Trustees should have Texaco pay for an oyster seed ground for commercial oystermen who had been affected by the closure. While construction of an oyster reef was considered as a type of restoration project (see

Sections 5.3.2.2 and 5.3.2.3), the construction of a seed ground for commercial harvesting would not be appropriate as compensation for public losses.

Another suggestion was that Texaco should fund long-term monitoring to assess the impact of oil on deltaic marshes, or fund experimentation with planting various species of plants, site characteristics, planting techniques, and mechanical structures to contribute to the state of knowledge concerning these topics. The Trustees and Texaco jointly conducted a field assessment in the impacted marsh, sufficient to be able to develop estimates of injury to the marsh. Further assessment studies beyond that required for injury quantification are not justified within the OPA regulations. Basic research in marsh planting techniques as a restoration alternative is similarly not consistent with regulations since it will not replace the injured natural resources and services to the public.

Another restoration suggestion, trying to reduce erosion of existing marsh in the Lake Barre area by plantings done in critical areas and by plugging breaches and tidal cuts, was considered by the Trustees. The experts consulted by the Trustees, including those attending the February 13, 1998 meeting, told the Trustees that loss of marsh was occurring in this area due to two phenomena. The first is the subsidence that is causing the loss of marsh from the interior, with ponding occurring as the water depth becomes too deep for marsh vegetation. Plugging of interior cuts and breaches would have little affect on the rate of subsidence. The Trustees were told that the only way to slow subsidence would be to pump large volumes of sediment out onto the marsh, which would be very expensive and would have the potential to cause injury to existing resources during the implementation. There is also the practical problem of where to obtain the large amounts of sediment that would be required.

The other cause of marsh loss is erosion along the edge of the marsh, primarily along the southern shoreline. Reducing erosion through shoreline armoring and plugging exterior cuts was one of the restoration options considered as a viable alternative. It was screened as an alternative, but ultimately rejected both because of cost required to reduce erosion sufficiently to compensate for losses and because of the potential for impacting oyster leases during implementation. Movement of equipment in the area could cause impacts to oyster leases in the area, which was a concern expressed by oystermen participating in the two public meetings. With respect to the suggestion of reducing erosion through planting in critical areas, the Trustees and Texaco did not observe any locations where they believed that vegetation could be established to reduce shoreline erosion and where it would remain for a sufficient period of time to justify this approach. The CAG did not receive additional input as to appropriate areas for planting despite attempts to get this information.

As shown in Exhibit 5-1, most of the general restoration alternatives considered are for compensatory restoration. This is because the assessment studies have shown that resources and resource services impacted by the incident are, in the judgment of the Trustees, recovering to baseline conditions within an acceptably short time period. Therefore there was little need to consider active primary restoration alternatives. The only injured resource that is expected to take longer than two or three years to recover is the 0.28 acres of most heavily impacted marsh. Marsh replanting was considered as a primary restoration alternative for this small area but, as

discussed in Section 5.3.1, the Trustees decided that it was not cost-effective to undertake actions to speed recovery for such a small area.

Exhibit 5-1
General Restoration Alternatives Considered for Each Injury Category Assessed[1]

Injured Resource/Service	Primary Restoration Alternatives	Compensatory Restoration Alternatives
Marsh	**Natural Recovery**	No Compensation Required
	Marsh Replanting	**Marsh Restoration**
Aquatic Fauna	**Natural Recovery**	No Compensation Required
		Oyster Bed Creation
		Marsh Restoration
Birds	**Natural Recovery**	No Compensation Required
		Nest Site Enhancement/Protection
		Oyster Bed Creation
		Marsh Restoration

[1]Preferred alternatives in bold

Some compensatory alternatives listed in Exhibit 5-1 would provide similar resources and/or services to those injured, while other alternatives would compensate by providing a comparable resource enhancement. The NRDA regulations require the Trustees to preferentially seek to restore injured natural resources in-kind (e.g., create new marsh to compensate for lost marsh function) and in the geographical vicinity affected, while working to maximize ecosystem benefit, benefit to human uses of the environment (such as fisheries), and cost-effectiveness of restoration as a whole. However in-kind restoration is not always possible and, in those instances enhancement of alternative resources that provide similar ecological benefits may be appropriate. Finally, increased benefits and improved cost-effectiveness may often be obtained by addressing several injured resources and/or services or classes of injury with a single restoration project. The logic for selecting alternatives that provide a different resource or service as compensation is described in detail in Section 5.3.

5.3 EVALUATION OF GENERAL RESTORATION ALTERNATIVES

Once a reasonable range of restoration alternatives is developed, the OPA regulations (CFR Section 990.54) require the Trustees to identify preferred restoration alternatives based on certain criteria. The following criteria, presented in the order given in the regulations, were used:

- The cost to carry out the alternative;
- The extent to which each alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses;

- The likelihood of success of each alternative;
- The extent to which each alternative will prevent future injury as a result of the incident, and avoid collateral injury as a result of implementing the alternative;
- The extent to which each alternative benefits more than one natural resource and/or service; and
- The effect of each alternative on public health and safety.

The regulations leave it up to the Trustees to consider how to prioritize the criteria, and allow additional criteria to be used. The key criterion for the Trustees is the second in the list, since it is the criterion that most clearly indicates whether the goal of making the public whole from losses resulting from the incident are met. The Trustees have, as indicated previously, also considered as an additional criterion the extent to which the restoration alternative will provide benefits to recreational uses (fishing and wildlife viewing).

Based on a thorough evaluation of a number of factors, including the criteria listed above, the Trustees have selected preferred restoration alternatives for primary and compensatory restoration of injured natural resources and/or services (highlighted in Exhibit 5-1). Information supporting the Trustees' selection of restoration alternatives is provided throughout the remainder of this chapter. In compliance with OPA and NEPA, the selection of restoration alternatives will be finalized following public review and comment on this DARP/EA.

5.3.1 Primary Restoration

Based on field indications of recovery, the Trustees and Texaco jointly determined that most of the impacted marsh only suffered a partial loss of services and expect that the areas will recover within 4 to 24 months of the incident. A small area, 0.28 acres, is expected to take much longer to recover. However, the Trustees determined that primary restoration actions to aid in the recovery of the marsh habitat were neither necessary nor cost-effective due to the very limited size of the slowly recovering area. Therefore, the No Action/Natural Recovery option is selected as the preferred primary restoration alternative for this resource.

In addition, based on the magnitude of the estimated injury and site conditions, the Trustees determined that no additional actions were necessary to aid in the recovery of aquatic fauna, birds, or recreational resources. Therefore, the No Action/Natural Recovery option is selected as the preferred primary restoration alternative for these resources. After determining the appropriate primary restoration alternative, the Trustees can proceed to determine the type and size of compensatory restoration to account for interim losses to injured resources and/or services (marsh, birds, aquatic fauna), which is addressed below.

5.3.2 Compensatory Restoration

5.3.2.1 Marsh

Because interim losses of marsh services occurred during the period of recovery and technically feasible alternatives exist to compensate for these losses, the Trustees determined that compensatory restoration is required for marsh injury, and the No Compensation alternative was rejected. As discussed in Section 5.2, the preference under OPA is for in-kind restoration where possible and otherwise consistent with restoration selection criteria. Since in-kind restoration as creation, enhancement, or protection of marsh is highly beneficial and technically feasible, the Trustees determined that the preferred compensatory restoration action for marsh injury was marsh restoration. In the discussion below, when marsh creation is discussed, it should be understood that the benefits apply to marsh restoration in general- including marsh creation, enhancement, and protection.

Marsh restoration is an alternative that is consistent with the criteria used by the Trustees to evaluate restoration alternatives. It will provide an outflow of organic material that will generally benefit the Lake Barre ecosystem by providing a source of organic carbon (energy supply supporting estuarine foodweb). Created marsh will provide services benefiting a wide range of resources, including benthic invertebrate species that inhabit marshes and the bird and fish species that feed on them. By providing critical nursery habitat for shrimp, fish, and other aquatic species, and nesting and foraging habitat for birds and other wildlife, created marsh will benefit recreational uses of the area by supporting increased populations of these species. Therefore, this alternative would have clear overall benefits to the environment. Marsh creation typically results in some impacts to existing habitats, such as subtidal sediments, on which it is created. Marsh creation projects typically have a high likelihood of success and tend to be very cost-effective to implement. Marsh creation is also consistent with Trustee policies and law.

The size of marsh restoration was determined using Habitat Equivalency Analysis (HEA), a resource-to-resource scaling approach that is used to determine compensation for lost services based on the quantification of incident-related natural resource injuries. HEA considers several project-specific factors in scaling restoration, including elapsed time from onset of injury to restoration implementation, relative productivity of restored habitats (that is, the proportional equivalence of ecological services provided by the compensatory restoration project relative to the baseline productivity of the injured habitat), the time required for restored habitats to reach full-function (i.e., maturity), and project lifespan. Therefore, selection of a preferred restoration project, with its own unique characteristics, was necessary before HEA could be applied. Section 5.4 discusses selection of the preferred restoration alternative and provides a detailed description of project scaling using HEA.

5.3.2.2 Aquatic Fauna

The Trustees feel that technically feasible and cost-effective alternatives exist to compensate for interim losses to aquatic fauna. Thus, the Trustees determined that compensation was necessary for this injury, rejecting the No Compensation alternative. The Trustees considered two other alternatives for compensatory restoration: creation/restoration of oyster beds and marsh restoration (i.e., creation, enhancement, or protection).

Creation of an oyster bed by depositing cultch would increase habitat for oysters and other animals that require a hard surface for attachment. A created oyster reef would serve as a substrate for increased secondary productivity, and would provide habitat and/or feeding areas for some fish. Oyster reef construction could benefit recreational use by creating a new fishing location where fishes may aggregate. However, construction of an oyster reef would reduce the amount of area available for shrimping, and would have the potential to interfere with trawls. It would adversely impact the area of benthic habitat on which it would be constructed. Additionally, although oyster reef construction is technically feasible, there are no unleased waterbottoms within the area that have the appropriate salinity to support an oyster reef. Any cultch planting in the area would need to be on privately leased waterbottoms, not in the public realm, and therefore the Trustees could not guarantee that the oyster reef would provide the ecological services to the public since it would potentially be subject to harvest by private leaseholders.

Salt marshes are widely recognized as providing a suite of critical services for aquatic life. Marshes serve as spawning and nursery areas for many species of juvenile fish and shellfish, export detritus (energy source for the aquatic food web) into the estuary, and can increase water quality by filtering sediments and other pollutants from the water column. In addition, marsh habitat provides many collateral benefits such as storm surge protection and habitat for birds and mammals. As already discussed, marsh creation will benefit recreational use of the area by increasing production of important recreational species and their prey items. Marsh restoration, creation, and/or protection can be successfully and cost-effectively implemented. The rapid loss of coastal marshes in Louisiana due to subsidence and erosion is a serious threat to the ecology and economy of Louisiana and efforts to increase the amount of marsh through creation projects and functioning of existing marsh through enhancement projects are widely supported throughout the state. In addition, marsh restoration is consistent with state and federal policies concerning wetlands and essential fish habitat.

The Trustees decided that, for this incident, restoration in the form of creation, enhancement, or protection of marsh habitat is more consistent with the restoration selection criteria as compensation for aquatic faunal injuries than is oyster reef creation. Therefore, marsh restoration was selected as the preferred compensatory restoration action for aquatic faunal injuries.

5.3.2.3 Birds

The Trustees feel that technically feasible and cost-effective alternatives exist to compensate for interim losses to birds. Thus, the Trustees determined that the No Compensation alternative was not appropriate compensatory restoration for this injury and considered three other alternatives for compensatory restoration: actions that would create, enhance, or protect bird nesting sites, oyster reef creation, and marsh restoration.

The Trustees considered several actions that would directly compensate for bird losses by creating, enhancing, or protecting bird nesting sites: fenced enclosures to reduce predation on eggs and young, shelters to reduce predation on chicks, and wooden rafts and platforms to provide additional nesting sites. The purpose of these actions would be to increase the number of

fledgling birds. In some cases, these types of actions have been successful in increasing survivorship and augmenting populations. However, in the studies considered by the Trustees in evaluating this restoration alternative, success was greatest when the actions were taken in response to known problems that were limiting the reproduction of a specific, targeted species. The Trustees carefully considered and discussed these options with state and federal bird experts, including managers of nearby LDWF and National Wildlife Refuges. The information provided to the Trustees suggests that reproduction by those bird species predicted to have been impacted by the incident does not appear to be limited by nest predation or the number or quality of nesting sites. Therefore, implementing these types of actions would not be an effective alternative for restoring bird resources lost as a result of this incident.

The Trustees also considered creation of an oyster reef as a restoration alternative to benefit birds. A created oyster reef would serve as a substrate for increased secondary productivity, would support fish, and therefore could provide feeding areas for some bird species. If constructed appropriately, it could provide an important resting area for birds during low tides. As discussed in Section 5.3.2.2, oyster reef creation would also have some very positive benefits to fish, other organisms, and recreational fishing. Although technically feasible in theory, creation of an oyster reef in the Lake Barre area is not practical since there are no available unleased waterbottoms with appropriate salinity and bottom strata characteristics. Therefore this alternative was not deemed viable for compensation for bird injuries.

The Trustees decided that the preferred compensatory restoration action for bird injury is marsh restoration either through creation, enhancement, or protection of marsh habitat. As discussed in Section 5.3.2.2, salt marshes provide many services including nesting, cover, and foraging habitat for a variety of bird species. In addition, marshes export detritus to the surrounding estuarine environment, which serves as a food source for prey organisms fed upon by birds. Given the importance of marsh as habitat for birds, and because of the many other collateral benefits marsh provides, the Trustees determined that creation, enhancement, or protection of existing marsh was the most beneficial and preferred compensatory restoration alternative for bird injuries resulting from the Lake Barre incident.

5.3.2.4 Scaling Restoration for Aquatic Fauna and Bird Injuries

Since marsh restoration was deemed an appropriate and probable restoration project to compensate for bird and aquatic fauna losses, the predicted bird and aquatic fauna losses were translated from number of birds and biomass of aquatic fauna to units of marsh production. The method used is described in Penn (1999). These calculations were performed for the model results for 5,000 and 7,000 BBL scenarios. For the 5,000 BBL model run, the estimated lost salt marsh equivalent was 3.21 acre-years of lost marsh production for aquatic losses and 26.99 acre-years for bird losses. For the 7,000 BBL model run, the estimated lost salt marsh equivalent was approximately 4.17 acre-years of lost marsh production for aquatic losses and approximately 27.65 acre-years for bird losses. Thus, the total estimated salt marsh equivalent for aquatic and bird losses was between 30.20 and 31.82 acre-years of marsh production.

Since each acre of marsh that is created will provide services such as primary production for a number of years, the number of acres that need to be created is less than the number of acre-years of marsh production presented above. These calculations are presented in Penn (1999). The Trustees estimated that the amount of marsh needed to be created in order to compensate for the aquatic fauna and bird losses lies between 3.18 and 3.35 acres. These values assume that the created marsh provide services for 25 years (assuming constant erosion beginning 3 years after creation).

As discussed in Chapter 4, Texaco did not agree with the method used by the Trustees to estimate aquatic faunal or bird losses nor with Trustee estimates of losses for these resources. Texaco also did not agree with the method used by the Trustees to translate aquatic faunal and bird losses into units of marsh production. However, Texaco offered four acres of marsh creation, or the ecological equivalent, as compensation for faunal injuries (both birds and aquatic organisms). The Trustees did not finalize or verify any model runs including runs using the final release estimate of 6,561 BBL, since the Texaco offer was clearly adequate as compensation for even a 7,000 BBL release.

5.3.2.5 Human Use

The No Action alternative is appropriate for compensatory restoration of recreational losses due to the small, anticipated magnitude of those losses. As discussed previously in Sections 1.2 and 4.4.4.1, the Trustees determined that, under the regulations and for the specific circumstances of this incident, the cost of conducting assessment studies to evaluate such a small potential injury was unjustified. However, the Trustees considered benefits to recreational uses as an additional criterion in determining the preferred restoration alternative so as to provide some degree of compensation for potential recreational losses.

5.4 EVALUATION OF MARSH RESTORATION ALTERNATIVES

The Trustees selected marsh restoration in the form of creation, protection, or enhancement as the preferred compensatory restoration project for all natural resource injuries. Since marsh restoration is a broad category that could include many types of actions and sites, the Trustees completed the second step of the selection process: the development of a range of project-specific marsh restoration alternatives and selection of a preferred alternative from this list. The selection process for these marsh restoration alternatives is described in greater detail below.

First, the Trustees compiled an initial comprehensive list of possible alternatives. The Trustees then conducted two "screenings" which narrowed the list to five alternatives. These five alternatives were then ranked in order of preference. For each screening and the ranking, two or more criteria, including the criteria listed in the OPA regulations, were applied to the list of alternatives. Section 5.4.1 describes the selection process. Sections 5.4.2 through 5.4.4 provide detailed information for the preferred alternative and the four alternate, and non-preferred alternatives.

5.4.1 Selection of Preferred Restoration Alternative

5.4.1.1 Preliminary List of Restoration Alternatives

The Trustees identified 43 marsh restoration alternatives potentially capable of compensating for the natural resources and services injured as a result of the Lake Barre incident. This list includes a variety of alternatives ranging in scope and design from sediment fencing projects to shoreline armoring to creation of marsh using dredge material. The list, including a brief description of each option, is provided in Exhibit 5-2.

The Trustees and Texaco compiled this preliminary list from a variety of sources. Many of the alternatives originated from Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, also known as the Breaux Act) priority lists. These lists identify restoration opportunities to address coastal wetland loss in Louisiana. They are compiled annually and are submitted for federal and state funding under the CWPPRA. In addition to using the CWPPRA lists, the Trustees and the RP actively solicited restoration ideas and input from appropriate staff within state and federal agencies and from other interested parties including landowners, local government officials, and regional restoration agencies/consortiums.

5.4.1.2 First Tier Screening

In order to pare down the large list of alternatives, the Trustees conducted a first tier screening to narrow the list and focus information-gathering efforts on the most likely alternatives. Two criteria were used in the first tier screening: similarity in attributes to the injured habitat and proximity to the affected area. These two criteria were used because they reflect important project attributes and could be applied in the absence of detailed, extensive project information. These two first tier screening criteria are defined below:

> *Similarity in Attributes to the Injured Habitat:* This criterion considered the nature and extent to which restoration alternatives addressed the natural resource injuries that occurred as a result of the incident. This includes the extent to which benefits of the action are in-kind, or are otherwise comparable in nature to the injured marsh habitat. Alternatives meet this criterion if they involve the enhancement, creation, and/or protection of salt or brackish marshes. Freshwater marsh options are not appropriate.
>
> *Proximity to Affected Area:* This criterion considered whether the alternative was located within the affected area or was within a reasonable distance of the affected area (i.e., same watershed). This criterion also considered the extent to which the option directly or indirectly benefited injured habitats or compensated for lost use within the affected area.

Twenty alternatives that did not meet one or both of the proposed criteria were removed from the list (Exhibit 5-3). Ten of the projects were dropped due to the lack of a strong similarity in attributes to the injuries from the Incident. Of these ten, nine of them were dropped due to the fact that the project would benefit freshwater resources, and the incident impacted estuarine and

Exhibit 5-2
Summary of Marsh Creation/Protection/Enhancement Alternatives[1]

#	Project Name	Project Type	Method of Implementation	Source
1	Lake Barre Shoreline Armoring Project	Marsh Protection	Plug Cuts/Shoreline Armoring	Trustees/Fina Oil and Chemical Company
2	**East Timbalier Island Planting Project**	**Marsh Enhancement**	**Planting at XTE-45 and/or XTE-67**	**Trustees**
3	East Timbalier Island Sediment Restoration Project (Phase 2) (TE-30/XTE-45/67b)	Marsh Creation	Fill with Dredged Material	CWPPRA[2]
4	East Timbalier Island Sediment Restoration Project (Phase 1) (TE-25/XTE-67)	Marsh Creation	Fill with Dredged Material	CWPPRA
5	Bayou Terrebonne Natural Levee Restoration Project	Marsh Enhancement/ Protection	Plug Cuts/Canals; Stabilize Levee	Trustees
6	Upper Bayou LaCache Project (TE-3)	Marsh Enhancement/ Protection	Berm, Water Control Structures	Trustees
7	Isles Dernieres (East Island) Planting Project	Marsh Enhancement	Planting or Supplemental Planting at TE-20	Trustees
8	Wine Island Eastward Expansion Project (XTE-62)	Marsh Creation	Fill with Dredged Material and Plant	CWPPRA
9	Lake Pelto/Isles Dernieres New Cut Project (TE-37/TE-11aii)	Marsh, Beach, and Dune Creation	Fill with Dredged Material and Plant	Trustees
10	Isles Dernieres (Trinity Island) Planting Project	Marsh Enhancement	Planting or Supplemental Planting at TE-24/TE-41/PTE-15a	Trustees
11	Lake Hatch Project	Marsh Enhancement	Plug Cuts/Canals	Trustees
12	Christmas Tree Sediment Fencing Project	Marsh Creation Technical Feasibility Study	Sediment Accretion Fencing	Trustees

#	Project Name	Project Type	Method of Implementation	Source
13	Isles Dernieres (Whiskey Island) Planting Project	Marsh Enhancement	Planting or Supplemental Planting at TE-27/PTE-15bi	Trustees
14	Whiskey Island Restoration Project (TE-27/PTE-15bi)	Marsh Enhancement	Structure/Fill with Dredged Material and Plant	CWPPRA
15	Raccoon Island Project (TE-DWF)	Marsh Creation	Fill with Dredged Material and Plant	Trustees
16	Poseiden Pipeline Mitigation Project	Marsh Enhancement	Water Control Structure/Other?	Trustees
17	Penchant Sub-Basin Drainage Project	Marsh Enhancement	Hydrologic Modifications	BTNEP[3]
18	Penchant Basin Natural Resources Plan, Increment 1 (TE-34/PTE-26i)	Marsh Enhancement/ Protection	Hydrologic Modifications	CWPPRA
19	Lake Boudreaux Wetland Project (TE-7)	Marsh Enhancement/ Protection	Hydrologic Modifications	BTNEP
20	Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management Project (Alternative B) (TE-32/TE-7f)	Marsh Enhancement/ Protection	Hydrologic Modifications	CWPPRA
21	L'Ours Ridge Restoration Project	Marsh Enhancement/ Protection	Plug Cuts/Canals	BTNEP
22	Central Basin Tidal Drag Project	Marsh Enhancement?	Hydrologic Modifications	BTNEP
23	GIWW to Clovelly Project	Marsh Enhancement?	Hydrologic Modifications	BTNEP
24	Little Lake Oil and Gas Project	Marsh Enhancement?	Hydrologic Modifications	BTNEP
25	Salt Water Barrier or Lock in Houma Navigation Channel	Marsh Enhancement/ Protection	Hydrologic Modifications	BTNEP
26	Avoca Island Lake Marsh Restoration Project	Marsh Creation	Sediment and Freshwater	BTNEP

#	Project Name	Project Type	Method of Implementation	Source
			Diversion/Water Control Structures	
27	Avoca Island Project (TE-35/CW-5i)	Marsh Creation	Fill with Dredged Material and Plant	CWPPRA
28	Empire Waterway and Belle Pass Project	Marsh Creation	Divert Sediment by Removing Jetties	BTNEP
29	Falgout Canal Demonstration Project (TE-17)	Marsh Enhancement/ Protection	Shoreline Armoring and Planting	CWPPRA
30	Lake Salvador Shoreline Protection Demonstration Project	Marsh Protection	Shoreline Protection	BTNEP
31	Barataria Bay Waterway Shore Protection (west side) Project	Marsh Protection	Shoreline Armoring	BTNEP
32	Floatant Marsh Fencing Demonstration Project (TE-31/XTE-54b)	Marsh Protection/ Enhancement	Fencing	CWPPRA
33	Lower Bayou LaCache Hydrologic Restoration Project (TE-19)	Marsh Enhancement/ Protection	Levee Reconstruction, Canal Plugs, Water Control Structures	CWPPRA
34	Timbalier Island Demonstration Planting Project (TE-18)	Marsh/Dune Enhancement	Sediment Fencing and Planting	CWPPRA
35	Bonnet Carre Freshwater Diversion Project	Marsh Creation?/ Enhancement	Sediment and Freshwater Diversion/Water Control Structures	CWPPRA
36	Bayou Lafourche Siphon Diversion Project (BA-25/PBA-20)	Marsh Creation?/ Enhancement	Sediment and Freshwater Diversion/Water Control Structures	CWPPRA
37	Brady Canal Hydrologic Restoration Project (TE-28/PTE-26b)	Marsh Enhancement	Levee Repair, Water Control Structures	CWPPRA
38	Lake Chapeau Sediment Input and Hydrologic Restoration Project (TE-26/PTE-23/26a/33)	Marsh Creation/ Enhancement	Plug Cuts/Canals, fill with Dredged Material, Water Control Structure	CWPPRA

#	Project Name	Project Type	Method of Implementation	Source
39	Point Au Fer Canal Plugs Project (TE-22/PTE-22/24)	Marsh Enhancement/ Protection	Plug Cuts/Canals, Shoreline Armoring	CWPPRA
40	Red Mud Demonstration Project (XTE-43)	Marsh Creation	Fill with Dredged Material and Plant	CWPPRA
41	Bay Chaland Planting Project	Marsh Enhancement	Planting	Trustees
42	West Belle Pass Headland Restoration Project (TE-23/PTE-27)	Marsh Creation/ Enhancement/Protection	Fill with Dredged Material, Plug Cuts/ Canals, Shoreline Armoring, Water Control Structures	Trustees
43	Houma Wastewater Facility Diversion Project	Marsh Enhancement	Wastewater Diversion	BTNEP

[1]Preferred Alternative is in bold

[2]Coastal Wetlands Planning, Protection & Restoration Act Comprehensive Plan

[3]Barataria-Terrebonne National Estuary Program Comprehensive and Management Plan

Exhibit 5-3
First Tier Screening of Preliminary List of Restoration Alternatives

#	Project Name	Strong Similarity In Attributes?	Strong Proximity To Affected Area?	Insufficient Information To Screen?	Project Eliminated From Further Evaluation?
1	**Lake Barre Shoreline Armoring Project**	Yes	Yes	No	No
2	**East Timbalier Island Planting Project**	Yes	Yes	No	No
3	**East Timbalier Island Sediment Restoration Project (Phase 2) (TE-30/XTE-45/67b)**	Yes	Yes	No	No
4	**East Timbalier Island Sediment Restoration Project (Phase 1) (TE-25/XTE-67)**	Yes	Yes	No	No
5	**Bayou Terrebonne Natural Levee Restoration Project**	Yes	Yes	No	No
6	**Upper Bayou LaCache Project (TE-3)**	Yes	Yes	No	No
7	**Isles Dernieres (East Island) Planting Project**	Yes	Yes	No	No
8	**Wine Island Eastward Expansion Project (XTE-62)**	Yes	Yes	No	No
9	**Lake Pelto/Isles Dernieres New Cut Project (TE-37/TE-11aii)**	Yes	Yes	No	No
10	**Isles Dernieres (Trinity Island) Planting Project**	Yes	Yes	No	No
11	Lake Hatch Project	No	Yes	No	Yes
12	Christmas Tree Sediment Fencing Project	No	Yes	No	Yes
13	**Isles Dernieres (Whiskey Island) Planting Project**	Yes	Yes	No	No
14	**Whiskey Island Restoration Project (TE-27/PTE-15bi)**	Yes	Yes	No	No
15	**Raccoon Island Project (TE-DWF)**	Yes	Yes	No	No
16	**Poseiden Pipeline Mitigation Project**	Yes	Yes	No	No
17	Penchant Sub-Basin Drainage Project	Yes?	No	No	Yes
18	Penchant Basin Natural Resources Plan, Increment 1 (TE-34/PTE-26i)	Yes?	No	No	Yes
19	**Lake Boudreaux Wetland Project (TE-7)**	Yes	Yes	No	No
20	**Lake Boudreaux Basin Freshwater**	Yes	Yes	No	No

#	Project Name	Strong Similarity In Attributes?	Strong Proximity To Affected Area?	Insufficient Information To Screen?	Project Eliminated From Further Evaluation?
	Introduction and Hydrologic Management Project (Alternative B) (TE-32/TE-7f)				
21	L'Ours Ridge Restoration Project	*	No	No	Yes
22	Central Basin Tidal Drag Project	*	No	No	Yes
23	GIWW to Clovelly Project	*	No	No	Yes
24	Little Lake Oil and Gas Project	*	No	No	Yes
25	**Salt Water Barrier or Lock in Houma Navigation Channel**	?	Yes	Yes	No
26	Avoca Island Lake Marsh Restoration Project	No	No	No	Yes
27	Avoca Island Project (TE-35/CW-5i)	No	No	No	Yes
28	**Empire Waterway and Belle Pass Project**	Yes	Yes	No	No
29	**Falgout Canal Demonstration Project (TE-17)**	Yes	Yes	No	No
30	Lake Salvador Shoreline Protection Demonstration Project	No	No	No	Yes
31	Barataria Bay Waterway Shore Protection (west side) Project	*	No	No	Yes
32	Floatant Marsh Fencing Demonstration Project (TE-31/XTE-54b)	No	No	No	Yes
33	**Lower Bayou LaCache Hydrologic Restoration Project (TE-19)**	Yes	Yes	No	No
34	**Timbalier Island Demonstration Planting Project (TE-18)**	Yes	Yes	No	No
35	Bonnet Carre Freshwater Diversion Project	No	No	No	Yes
36	Bayou Lafourche Siphon Diversion Project (BA-25/PBA-20)	No	No	No	Yes
37	Brady Canal Hydrologic Restoration Project (TE-28/PTE-26b)	No	Yes	No	Yes
38	Lake Chapeau Sediment Input and Hydrologic Restoration Project (TE-26/PTE-23/26a/33)	Yes	No	No	Yes
39	Point Au Fer Canal Plugs Project (TE-22/PTE-22/24)	Yes	No	No	Yes
40	Red Mud Demonstration Project (XTE-43)	*	No	No	Yes

#	Project Name	Strong Similarity In Attributes?	Strong Proximity To Affected Area?	Insufficient Information To Screen?	Project Eliminated From Further Evaluation?
41	**Bay Chaland Planting Project**	Yes	Yes	No	No
42	**West Belle Pass Headland Restoration Project (TE-23/PTE-27)**	Yes	Yes	No	No
43	Houma Wastewater Facility Diversion Project	No	Yes	No	Yes

Alternatives remaining after screening in bold

* indicates not determined when screened out due to lack of sufficient proximity to affected area

marine resources. The Christmas Tree Sediment Fence project was eliminated based on a low nexus to the injured resources. This project is designed to trap sediments, which might eventually lead to marsh development, but this possibility was judged by the Trustees as too remote to be considered further. The remaining projects that were dropped during this first screen were dropped due to location. They were judged as being located too far away from the area impacted by the incident to serve as appropriate locations for compensating the members of the public that were most affected.

5.4.1.3 Second Tier Screening

After the first tier screening was completed, the Trustees and Texaco collected additional, detailed information (e.g., project design, project status) on the remaining 23 alternatives. Once this information was assembled, a second set of screening criteria was applied and the list was narrowed to three alternatives: East Timbalier Island, Upper Bayou LaCache, and Raccoon Island. The Raccoon Island location was retained as an alternative, despite the lack of complete information at the time the secondary screen was conducted, due to its status as the most important rookery island off the Louisiana coast for brown pelicans, a threatened species in Louisiana. Although no brown pelicans were reported as being oiled or found dead, the results of the Trustee model suggests that some brown pelicans might have been killed. The Trustees therefore gave special consideration to this alternative, which would not have been the case in the absence of its importance to brown pelicans. The second tier screening criteria are described below, and the application of these criteria is shown in Exhibit 5-4.

Project Status - This criterion referred to the stage of the project. Projects that had already been completed, projects that were deauthorized under CWPPRA, and projects already fully funded from other sources were not considered for further evaluation.

Site Ownership - This criterion considered whether the site was publicly or privately owned and for private property, whether the landowner would agree to an appropriate conservation easement to ensure that the project would continue to provide benefits to the public far enough into the future to adequately fulfill compensation requirements.

Likelihood of Success of Each Alternative (Technical Feasibility) - This criterion considered whether a restoration project could be successfully implemented given currently available technology and expertise. Technically feasible alternatives were those that used proven methods, had a high rate of success as documented in the literature, and were well enough understood to characterize resulting natural resource service gains. This criterion also considered project and site-specific factors that may influence project success.

Logistical Considerations - This criterion considered issues directly related to project coordination, oversight, and implementation such as site access and availability of equipment and materials (including dredge materials). This criterion also considered project timing issues such as coordination with dredging schedules and coordination with agencies, project sponsors, and additional funding entities.

Cost to Carry Out the Restoration Alternative - This criterion considered the relationship of restoration project costs to natural resource benefits.

Cost Effectiveness – This criterion considered that, for projects with similar attributes except cost, the lower cost projects that provide equivalent restoration benefits are preferred over more costly, but otherwise similar projects.

Extent to Which Each Alternative Will Prevent Future Injury as a Result of the Incident and Avoid Collateral Injury as a Result of Implementing the Alternative (*Avoids Additional Injury*) - This criterion considered the potential for a restoration project to aggravate or cause additional natural resource or habitat injuries, including to resources or habitats that could be injured as a result of implementation of the project (e.g., such as to private oyster leases).

Extent to Which Each Alternative Benefits More Than One Natural Resource and/or Service (*Multiple Benefits*) - This criterion considered the ability of a restoration project to address more than one natural resource or habitat injury or loss. This criterion also considered whether the project provided public use opportunities (recreational, educational, and scientific) for the local community.

Social and Political Considerations - This criterion considered the extent to which a restoration project supported, or was consistent with, national, regional, and local restoration initiatives and mandates, local resource management plans, town ordinances, and the agendas of various community groups. This criterion also considered whether a given restoration project complied with applicable federal, state, and local laws, regulations, and policies.

Public Health, Safety, and Welfare - This criterion evaluated the potential for a given restoration project to negatively impact public health, safety, and welfare.

Eleven of the projects surviving the first tier screen were eliminated in the second tier screen because funding had already been secured for the project, or the project had already been implemented. These projects are: East Timbalier Island Sediment Restoration (Phase one and two); Isle Dernieres Planting Project (East Island, Trinity Island, and Whiskey Island); Wine Island Eastward Expansion Project; Whiskey Island Restoration Project; Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management; Falgout Canal Demonstration Project; Timbalier Island Demonstration Planting Project; and West Belle Pass Headland Restoration Project. Another six projects were eliminated primarily based on project status either because the project has been deauthorized or there is no current intent to implement the project (Salt Water Barrier in Houma Navigation Canal; Empire Waterway and Belle Pass Project; Lower Bayou LaCache Hydrologic Restoration Project), or the project has not been developed beyond the conceptual stage (Poseiden Pipeline Mitigation Project; Lake Boudreaux Wetland Project; Bay Chaland Planting Project). As previously mentioned, the Raccoon Island Project remained under consideration, despite its status (conceptual stage), because of its special status as the most important rookery island for brown pelicans in Louisiana.

The Lake Barre Shoreline Armoring Project had a number of problems that caused it to be eliminated from further consideration. Although the experts consulted during the meeting on February 13, 1998 told the Trustees that such a project should reduce shoreline erosion, a very long barrier would have to be created in order to reduce erosion sufficiently to provide sufficient compensation for the injuries resulting from the incident. This would mean that the cost would be prohibitively high. There were also concerns expressed about the technical feasibility of construction of such a barrier in an area that is experiencing a high rate of subsidence. One of the major concerns was the potential impacts to oyster leases and subtidal benthic communities during the implementation of the project. Implementation of this project would require the use of deep draft barges in shallow water, probably requiring channels to be dredged to allow access. Given the concerns expressed to the Trustees at both public meetings conducted in 1997 about the potential impacts to oyster leases from implementing restoration in the area, as well as the other concerns identified above, this project was eliminated.

The Lake Pelto/Isles Dernieres New Cut Project was eliminated based on the estimated cost of the project ($4-6 million). The benefits that would be derived from implementation of this project cannot justify this high expense, given the availability of other projects at significantly lower cost that would provide appropriate compensation to the public from the injuries to natural resources and services caused by the incident.

The Bayou Terrebonne Natural Levee Restoration Project was eliminated based on a number of concerns, but primarily on the cost. The first phase of the project is anticipated to cost $7.9 million, and the second phase $13.6 million. As with the Lake Pelto/Isles Dernieres New Cut Project, this is too costly to be a restoration alternative for this incident given the availability of other, more cost-effective projects that are sufficient to meet compensation needs.

Exhibit 5-5
Second Tier Screening of Restoration Alternatives

Project Name	Project Status	Site Owner-ship	Technical Feasibility	Logistical Consider-ations	Cost Effective-ness	Avoids Additional Injury	Multiple Benefits	Social and Political Consider-ations	Public Health, Safety, and Welfare
Lake Barre Shoreline Armoring Project			X		X	X			
East Timbalier Island Planting Project									
East Timbalier Island Sediment Restoration Project (Phase 2) (TE-30/TE-45/67b)	X								
East Timbalier Island Sediment Restoration Project (Phase 1) (TE-25/XTE-67)	X								
Bayou Terrebonne Natural Levee Restoration Project		X		X	X				
Upper Bayou LaCache Project (TE-3)									
Isles Dernieres (East Island) Planting Project	X								
Wine Island Eastward Expansion Project (XTE-62)	X								
Lake Pelto/Isles Dernieres New Cut Project (TE-37/TE-11aii)					X				
Isles Dernieres (Trinity Island) Planting Project				X					
Isles Dernieres (Whiskey Island) Planting Project				X					
Whiskey Island Restoration Project (TE-27/PTE-15bi)	X								
Raccoon Island Project (TE-DWF)									
Poseiden Pipeline Mitigation Project	X								
Lake Boudreaux Wetland Project (TE-7)	X								
Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management Project (Alternative B) (TE-32/TE-7f)	X								
Salt Water Barrier or Lock in Houma Navigation Channel	X								
Empire Waterway and Belle Pass Project	X								

Project Name	Project Status	Site Owner-ship	Technical Feasibility	Logistical Consider-ations	Cost Effective-ness	Avoids Additional Injury	Multiple Benefits	Social and Political Consider-ations	Public Health, Safety, and Welfare
Falgout Canal Demonstration Project (TE-17)	X								
Lower Bayou LaCache Hydrologic Restoration Project (TE-19)	X								
Timbalier Island Demonstration Planting Project (TE-18)	X								
Bay Chaland Planting Project	X								
West Belle Pass Headland Restoration Project (PTE-27)	X								

"X" denotes the project failed one or more criteria
Preferred projects are in bold

5.4.1.4 Ranking

Following the second tier screening, additional information concerning the Raccoon Island alternative was received, revealing that three separate projects were possible at this site: marsh creation, segmented breakwaters, and jetty construction. The list of alternatives was expanded to include these three projects at Raccoon Island. The Trustees then evaluated and ranked the three Raccoon Island restoration alternatives along with the other two alternatives (Exhibit 5-5). The criteria used to rank alternatives were those that served to emphasize project differences and were derived from the list of first and second tier criteria. For each criterion, alternatives were given a ranking of either plus (+) to indicate a good "fit" or a minus (-) to indicate a poor "fit" to the criterion, as explained in Exhibit 5-6. Based on the ranking, the Trustees determined that marsh enhancement (planting) on East Timbalier Island is the preferred marsh restoration alternative to compensate for injuries from the Lake Barre incident. The remainder of this section provides more detailed information on these five alternatives and the justification for selection of the East Timbalier Island Planting Project as the preferred alternative.

5.4.2 Preferred Alternative: Marsh Enhancement (Planting) at East Timbalier Island

5.4.2.1 Project Description

The preferred compensatory restoration alternative for the Lake Barre incident is planting salt marsh vegetation on East Timbalier Island (Figure 2). CWPPRA is conducting a restoration project on the island that consists of depositing dredged material to consolidate the island. When the CWPPRA project is completed, the new land formed by the dredge and fill operation will be unvegetated. Under the preferred compensatory restoration alternative for the Lake Barre incident, a portion of the bare ground created on East Timbalier Island will be planted with salt marsh vegetation. In the Environmental Assessment for the CWPPRA project on East Timbalier Island (GOTECH, 1998), marsh planting of the deposited material was included in the NEPA analysis since it had been hoped that funding might be available to plant this area. However, no funding to conduct planting was available, allowing the planting to be considered as a restoration alternative to compensate for injuries resulting from this incident. The result of the analysis of the consequences to the human environment from implementation of planting of the CWPPRA project, a Finding of No Significant Impact by NOAA (signed August 20, 1998), remains valid for implementation of this alternative under the NRDA process.

Exhibit 5-5
Ranking of Preferred Restoration Alternatives

Criterion	Upper Bayou LaCache Restoration Project	Raccoon Island Marsh Creation	Raccoon Island Segmented Breakwaters	Raccoon Island Stone Jetty/Groin	East Timbalier Island Planting Project
Site Location	+	+	+	+	-
Site Ownership	-	+	+	+	+
Similarity in Attributes to Injured Habitat	+	+	-	-	+
Project Stage	+	-	-	-	+
Project Timing	-	-	-	-	+
Recreational /Public Use Benefits	-	+	+	+	+

Exhibit 5-6
Explanation of Assigned Ranking

Criterion	Project Given a "+" Ranking if:	Project Given a "-" Ranking if:
Site Location	Project site within Terrebonne Parish	Project site outside of Terrebonne Parish
Site Ownership	Project implemented on public land or with appropriate conservation easements	Project located on private land without conservation easements arranged
Similarity in Attributes to Injured Habitat	Project will create or enhance brackish or salt marsh	Project is non-habitat based or will create other habitats
Project Stage	Detailed designs, studies, permitting, etc. have been completed	Project is in conceptual stage only; detailed designs or studies have not been completed
Project Timing	Project will not be subject to delays in implementation due to design issues, studies, permitting, landowner agreements, etc.	Project may be subject to delays in implementation due to design issues, studies, permitting, landowner agreements, etc.
Recreational/Public Use Benefits	Project will permit public access for recreational use opportunities	Project will not permit public access for recreational use opportunities

Figure 2. Location of Preferred Restoration Alternative Project Site

East Timbalier Island is a barrier island that lies at the mouth of Timbalier Bay just to the east of the Terrebonne Parish line. Part of the Bayou Lafourche barrier shoreline, the island is bordered by Timbalier Bay to the north, the Gulf of Mexico to the south, Little Pass to the west, and Raccoon Pass/Penrod Slip to the east. The island is comprised of vegetative communities typically found on Louisiana barrier islands including beach, low dunes, barrier grasslands, salt flats, and salt marshes (Ritchie, et al., 1995). Smooth cordgrass (*Spartina alterniflora*) is the dominant species in salt marshes on the island with marshhay cordgrass (*Spartina patens*) and seashore saltgrass (*Distichlis spicata*) making up a smaller portion of these areas. Black mangrove (*Avicennia germinans*) is also distributed across a large portion of the island (USDOC, 1993). In 1993, the total land area of East Timbalier Island was estimated as approximately 400 acres (GOTECH, 1998).

East Timbalier Island is part of a deteriorating barrier island system. The island is currently experiencing high rates of subsidence and shoreline erosion primarily due to an inadequate supply of sediments, high rates of relative sea level rise, and the impacts from periodic cold fronts, storms, and hurricanes (McBride and Byrnes, 1997). In 1992, Hurricane Andrew caused extensive breaching and erosion on East Timbalier Island resulting in a 25% decrease in the island's landmass. Breaching of the island and back levee was most extensive where the island was narrow or its width locally reduced as a result of bayside embayments. The recent extension of existing jetties at Belle Pass has also accelerated shoreline erosion by reducing the amount of new sediment supplied to East Timbalier. According to McBride et al. (1991), the island is currently experiencing average shoreline retreat rates of approximately 76 feet per year. The highest rates of loss are occurring in the island's central region (GOTECH, 1998).

Efforts to protect and restore East Timbalier Island have been ongoing since the mid-1960's and have included the construction of a bayside dirt levee, a gulfside rock revetment, and most recently, the creation of approximately 22 acres of smooth cordgrass marsh on dredge materials. A more detailed account of previous shoreline protection and restoration measures on the island is provided in GOTECH (1998). Without additional restoration efforts, however, it has been predicted that the island will disappear in as soon as three (Reed, 1995) to 25 (van Beek, 1993) years.

Current efforts by the National Oceanographic and Atmospheric Administration (NOAA) and the Louisiana Department of Natural Resource's Coastal Restoration Division to preserve the island are focused on creating approximately 250 acres of marsh and dune habitat as part of the East Timbalier Island Sediment Restoration Project. Dredge materials from Timbalier Bay will be placed in shallow water areas where the island was breached by Hurricane Andrew and where the island is narrow to increase its width (primarily in the central and eastern portion of the island). A rock revetment will be constructed on the gulfside where shoreline breakwaters have deteriorated, and dune habitat established northward of the revetment and gulf beach. The revetment and dunes will provide additional shoreline stabilization by reducing the frequency and magnitude of future washover events. Construction began on this project in April, 1999. It is projected that placement and consolidation of the dredge material will be completed by August, 1999. CWPPRA has funds for placement of the spoil material and the construction of the rock

revetment, but has no funding available for planting salt marsh vegetation. Planting of the marsh platform is conservatively anticipated to increase the lifespan of the project by over 33 percent.

The preferred restoration project for the Lake Barre incident consists of planting salt marsh vegetation on the newly-deposited dredge materials on East Timbalier Island. Marsh vegetation (smooth cordgrass [*Spartina alterniflora*] and marshhay cordgrass [*Spartina patens*]) will be planted on 18.6 acres of the approximately 170-acre marsh platform. Plants will be installed in strips consisting of multiple rows. Strips will be oriented parallel to the shoreline and will be separated by unplanted areas. Strips will serve as a source of seed, as well as vegetative material (rhizomes) for colonization of unplanted areas within the marsh platform. The general planting design is described below and is subject to modification based on actual field conditions prior to the beginning of the planting.

The first strip will be planted along the northern (bay) edge of the marsh platform to protect the platform against erosion. This strip will consist of nine rows of smooth cordgrass. The first four rows will be planted with container-grown, gallon plants. Gallon pots were selected because these plants have well-developed root and rhizome systems that will tightly bind soils, providing additional stabilization along this edge. Plants will be spaced four feet apart within each row and five feet apart between rows. The remaining five rows of smooth cordgrass will be plugs spaced three feet apart within each row and three feet apart between rows. Rows will be staggered within the strip to provide more complete coverage over the marsh platform.

The remaining strips will be planted with four-inch pots of marshhay cordgrass. Plants will be spaced six feet apart within rows and rows will be spaced six feet apart. Within each strip, rows will be staggered to provide more complete coverage over the marsh platform. A total of five rows will be planted per strip. These interior strips may be continuous or non-continuous, depending on site conditions and other factors to be determined prior to implementation.

The exact planting configuration (length, width, orientation of strips and the distance between strips) will depend on site conditions following the completion of the CWPPRA project. An as-built survey will be conducted to determine the final elevations within the platform and delineate planting zones. Plants will be installed within their optimal elevational range as determined by bio-benchmark surveys in existing marshes on East Timbalier Island. In general, smooth cordgrass will be planted along the bayside edge of the platform in areas that will experience daily inundation. Marshhay cordgrass will be planted in areas of the platform not likely to be inundated. Planting is anticipated to take place in the spring of 2000. In the event that planting is delayed until the spring of 2001, additional acreage will need to be planted to provide sufficient compensation, as calculated using HEA, to account for the delayed provision of ecological services.

5.4.2.2 Restoration Objectives

The primary goal of this proposed restoration project is to provide marsh habitat sufficient to compensate for lost marsh services and for bird and aquatic faunal injuries. An important benefit of this project is the ability of marsh to stabilize the newly-deposited dredge materials thereby increasing island longevity. These goals will be accomplished by planting marsh vegetation on

newly-deposited dredge materials. Although some natural colonization of marsh would be expected to occur even without active planting, much of the added area would likely erode away prior to stabilization by the colonizing plants. The amount of marsh that Texaco is required to plant, as explained in Section 5.4.2.3.2, was determined considering the natural colonization that would be expected, and is considered a marsh enhancement rather than a marsh creation project. This means that Texaco will be required to produce more marsh (through direct planting and vegetative spread) on the marsh platform on East Timbalier Island than they would have had to plant on a typical marsh creation project.

5.4.2.3 Restoration Scaling Approach

The scaling approach used to determine the extent of resource restoration required as compensation for natural resource injuries is based on Habitat Equivalency Analysis (HEA). HEA begins with the injury assessment and an identification of the habitat-specific resource services that were lost due to the incident. A "debit" is specified for the lost services for each type of resource habitat. The debit equals the loss in service-acre-years from the injury to the habitat, as a result of the incident, in present-value terms. For each debit, the scale of a compensatory restoration project is determined by calculating the credit, per acre, that the restoration project will generate over its lifespan. This credit is the present value of the ecological services provided by the project. Then, the size of the compensating project is calculated so as to equate the total credit to the debit. Both the debit and per-acre credit are measured by service-acre-years, as discussed in Section 4.3.1.

This scaling procedure is summarized by the following equation:

Debit = (Credit per acre from restoration project) X (Acres of restoration project)

The first component is the debit for the injured resource services. The second component is the credit per acre from implementing the restoration project. The credit is based on a set of input parameters to the HEA model. Given the debit, and the credit per acre for restoration, it is a simple task to solve the equation for the acres of the restoration project needed to equal the debit.

5.4.2.3.1 *HEA Debit*

The debit is composed of two parts. The first part corresponds to the reduction in the full set of marsh services from oiled marsh, including faunal support services. This part of the debit corresponds to the marsh injuries described in Chapter 4. The second part of the debit corresponds to the direct aquatic faunal and bird injuries described in Chapter 4, translated into marsh services, required to restore direct faunal losses. Indirect injuries to fauna due to losses in marsh services to fauna are included in the marsh debit. The debit and scale of restoration needed to compensate for these two injury categories have been determined separately.

Regarding the full marsh services, based on the marsh injury studies, as described in section 4.3.2, the marsh injury debit is 75.6 discounted service acre years (DSAYs).

The Trustees and Texaco did not agree on the faunal debit. Texaco offered four acres of marsh creation as compensation, and the Trustees independently confirmed that the faunal debit could be compensated for via four acres of marsh creation. Because the selected restoration project on East Timbalier Island is one of marsh enhancement rather than marsh creation, there is a need to translate the credit that would be generated by four acres of marsh creation into an amount of credit measured in DSAYs. Then, this amount of credit will be compensated with credits generated by marsh enhancement.

As discussed in detail in the technical scaling memorandum, produced jointly by the Trustees and Texaco (Tomasi and Penn, 1999) and available in the administrative record, a hypothetical created marsh generates 8.46 DSAYs per acre, focusing only on the faunal services. This calculation considers the time it takes for the planted area to reach maturity, the level of services provided by the planted area relative to a reference marsh area (one not oiled), and the lifespan of the marsh creation project. Multiplication of the 8.46 DSAYs per acre by four acres gives the total credit required to compensate for the direct faunal injuries equal to 33.84 DSAYs.

5.4.2.3.2 *HEA Credit Model*

The modeling approach to scaling the acres of marsh enhancement is the same for both the faunal and marsh injuries. The Trustees and Texaco cooperatively developed the credit modeling approach. The model must assume a planting design for the area to be planted. The final planting design will depend on the elevations of the marsh platform. The general planting design is discussed in Section 5.4.2.2. For purposes of scaling, it is assumed that plants will be planted in strips along the marsh platform. The planted strips will be separated by areas of the marsh platform that are not planted (gap areas). The planted strips will contribute to the colonization of the gap areas by marsh plants.

The model has two separate components to scale acres of marsh enhancement. The first component is for the planted strips. In the planted strips, marsh services are generated more quickly than would occur under natural colonization of the areas planted. The second component is for the nearby gap areas where planted strips will contribute to colonization of the marsh platform. The model assumes vegetative spread into the gap areas from the planted strips. This vegetative spread from the strip areas into the gap areas speeds up the provision of marsh services in the gap areas relative to the services generated by natural colonization alone.
In order to calculate the services generated on a per-acre basis, the model considers how long it takes for the marsh to reach maturity if it is planted, as well as the time to maturity if it is not planted and natural colonization via distant seed sources takes place. The model considers the ability of the marsh to produce ecological services relative to baseline (the injured marsh if not for the incident). The model also takes into account the rate of spread of plants from planted strips into gap areas.

The model incorporates the effects of erosion. In the absence of planting on the platform, the slow rate of colonization leaves the platform vulnerable to erosion. Planting of the platform reduces erosive forces, thereby extending the life of the marsh platform. The scaling approach takes both bayside erosion and more severe gulfside erosion of the island into account.

For both the planted strips and the gap areas, the credit is calculated as the difference between the marsh services generated if the strips are planted and the services that would be generated if only natural colonization via distant seed sources occurs. That is, credits are calculated according to the formula:

Credit DSAYs = (DSAYs with planting) - (DSAYs without planting).

The scaling model and the parameters used are discussed in detail in the technical scaling memorandum (Tomasi and Penn, 1999) that is available in the administrative record. Based on all the considerations discussed above, the required area to plant in strips to compensate for the faunal debit is 3.7 acres. The required area to compensate for the marsh debit is 14.9 acres. Therefore, the total area to be planted is 18.6 acres. The total area enhanced (either planted in strips or more rapidly colonized because of the strips) is computed as 58.0 acres.

5.4.2.4 Probability of Success

Planting salt marsh vegetation on dredge materials is a feasible and proven technique with well-developed methodologies and well-documented results. This technique has been used successfully at a number of sites along the Gulf coast including Grand Isle, and Wine, Raccoon, and East Islands. For the East Timbalier Island Planting project to be successful, it is important that smooth cordgrass and marshhay cordgrass are planted within the appropriate elevational range. The optimal elevational range for each of these species will be determined by measuring the elevational range of healthy and robust populations of smooth cordgrass and marshhay cordgrass in existing natural marshes on the island.

Several additional measures will be taken to improve the likelihood of project success. Plants will be contract-grown in Louisiana by a Louisiana licensed nursery grower. Most of the specified plants will be container-grown (potted). Bare-root plugs will also be used. Container-grown plants have well-developed root systems that have superior drought resistance. Smooth cordgrass pots and plugs will be *Spartina alterniflora* cv. *Vermillion*, a cultivated variety that is resistant to infection by the fungus *Rhizoctonia solani*. *Rhizoctonia* infections are prevalent in native stands of smooth cordgrass along the Gulf coast. Pots and plugs will also be acclimated to the local climate and habitat conditions found on East Timbalier Island for at least 90 days prior to installation. Planting will not be conducted during stormy weather or prior to predicted storms to avoid plant loss.

Detailed planting guidelines will be developed and the Trustees will carefully monitor plant handling and installation to ensure that the guidelines are being followed. All plant materials will be inspected to ensure that they are healthy and vigorous and will be protected during mobilization from drying and physical damage. Planting will occur in spring to allow adequate time for plant establishment before the onset of drier summer conditions. Container-grown plants will be treated with a slow-release fertilizer at the time of planting. In addition, container-grown smooth cordgrass planted along the bayside edge of the new land will be anchored to prevent them from washing away. Other measures are under consideration by the Trustees to increase

project success, including dune planting or the installation of sediment fence along the dunes to prevent the smothering of marsh plants by wind-borne sand.

5.4.2.5 Performance Criteria and Monitoring

Post-implementation monitoring is an essential component of any restoration project and will be performed for this project. The monitoring program for this restoration effort is designed to objectively determine whether the project goals and objectives have been achieved. Information gathered during monitoring will help the Trustees assess the performance, viability, and stability of the restoration project. It will allow the Trustees and Texaco to determine whether corrective actions are required to meet the goals and objectives.

5.4.2.5.1 *Monitoring Methods*

Monitoring will consist of both qualitative and quantitative assessments of plant survival and percent cover. Qualitative monitoring will be conducted using low-level aerial photographs and ground photographs taken from fixed photo-monitoring stations. Aerial and ground photographs will provide a record of site changes such as excessive erosion, breaching, or plant mortality that may affect project success or require closer evaluation. Quantitative vegetation monitoring will consist of measuring the survival of planted vegetation and vegetative percent cover over time.

5.4.2.5.2 *Monitoring Schedule*

Monitoring will be conducted annually for 3 years to provide an assessment of project progress and allow implementation of corrective actions early in the project, if warranted. Project performance will be assessed at 60-days following the conclusion of all planting and at 3-years from the completion of the 60-day assessment. Aerial photographs will be taken once annually at the time of field monitoring. Ground photo-monitoring will be conducted prior to project implementation to document pre-project site conditions, during planting, and at the 60 day and annual monitoring events. Vegetation monitoring will take place at the 60-day monitoring event to determine plant survival and then once annually to measure percent cover for the remainder of the monitoring program. Texaco must provide advance notice of monitoring events to the Trustees so Trustee representatives may attend and oversee the performance of the monitoring work.

5.4.2.5.3 *Performance Criteria*

Project performance will be assessed by comparing quantitative monitoring results to pre-determined performance standards. Performance standards are criteria developed by the Trustees that define the minimum physical or structural conditions of an enhancement project deemed to represent normal and acceptable growth and development. Performance criteria will be developed for percent survival at the 60-day (planted areas only) and percent cover at the 3-year (planted and gap areas) monitoring events. Performance criteria for planted areas will consider the results from similar marsh restoration projects on Timbalier and East Timbalier Islands. If the performance criteria are satisfied at the 3-year monitoring event, the Trustees are confident, based

on previous experience, that the project will be successful and no further monitoring will be required.

5.4.2.5.4 *Corrective Actions*

In the event that the performance standards are not achieved at the 60-day or 3-year monitoring, or if the interim monitoring suggests unsatisfactory project progress, corrective actions may be implemented by Texaco. Corrective actions may include, but are not limited to, the following:

- Allowing additional time for site to develop (no action);
- Replanting/seeding same species in same area;
- Replanting/seeding same species in different areas;
- Replanting/seeding different species; and
- Applying fertilizer.

5.4.2.5.5 *Reporting*

Texaco will prepare and submit monitoring reports to the Trustees after the 60-day monitoring event and following each annual monitoring event. Monitoring reports will contain the results of all annual monitoring events that will be presented in a cumulative fashion. Following receipt of the monitoring reports and based on observations made in the field, the Trustees will coordinate with Texaco regarding the performance of the project, including any need to perform corrective actions.

5.4.2.6 Environmental and Socioeconomic Impacts

Planting marsh vegetation on East Timbalier Island is not expected to have any significant adverse environmental or economic impacts. Any impacts to existing habitats from project implementation are expected to be temporary. [Impacts to subtidal sediments by placement of dredge material are due to the CWPPRA project and not due to planting- but even these impacts were judged to be insignificant relative to the benefits of restoring the island (GOTECH, 1998)]. All planting should be completed prior to the onset of the bird-nesting season in May. If any nest sites are found within the project area, they will be mapped and flagged prior to planting to limit disturbance. Four threatened and endangered bird species were identified in an Environmental Assessment of East Timbalier Island as occurring in the vicinity of the project area: piping plover, brown pelican, least tern, and bald eagle (GOTECH, 1998). None of these species are known to nest on East Timbalier Island and therefore should not be impacted by the project.

Planting activities will not disturb existing infrastructure including oil and gas pipelines, oil wells, and other facilities or cause adverse impacts to economic resources. In addition, no impacts to

historical or archaeological resources or to the public health and safety are anticipated. There are no oyster leases in the vicinity of East Timbalier Island.

Short-term impacts to recreational activities may occur from restrictions on public use of planted areas during project implementation. However, East Timbalier Island is remote and recreation is generally limited to fishing, bird watching, and potentially camping (GOTECH, 1998). Furthermore, the long-term benefits of the project to recreation will far outweigh any negative impacts during project implementation.

Planting marsh vegetation will have several positive environmental and economic benefits. Planting will accelerate the development of a mature marsh system on the newly-created land. Planting vegetation oriented in strips will increase habitat diversity by creating open areas interspersed with dense stands of marsh grasses. This type of habitat is favored by a number of shore and seabird species for resting and nest areas. As the marsh matures, open areas will gradually be replaced by vegetation. Many sea and shorebirds use sandbars, barrier beaches, and marsh islands to nest (GOTECH, 1998). The natural expansion of vegetation will decrease the amount of unvegetated open habitat on the island. However, bird nesting habitat is not known to be limited on East Timbalier Island. Erosion of the bayside containment levee over time is expected to result in the formation of tidal channels and low-lying pools on the new marsh platform. Channels and pools will provide spawning and nursery areas for a variety of aquatic organisms including fish and shellfish, and a foraging area for birds. Finally, planting salt marsh vegetation will stabilize the new marsh platform and provide protection to oil and gas infrastructure, coastal communities, and habitats (interior marshes) in the BTES from storm surges.

5.4.2.7 Evaluation

Marsh enhancement at East Timbalier Island is a cost-effective means of replacing resources and resource services substantially similar to those lost as a result of the incident. Planting salt marsh vegetation will provide habitat for aquatic fauna and bird species, as well as increase the longevity of the island by stabilizing newly-deposited dredge materials. Salt marshes are very productive natural systems and serve as important links between terrestrial and marine environments. They provide spawning, feeding, and nursery areas for a variety of aquatic species, including recreationally and commercially important finfish and shellfish. Salt marshes also serve as valuable foraging areas for migratory and resident birds, including many threatened or endangered bird species. The island is an important stopover area for migratory birds and large numbers of trans-gulf migrants seek refuge on elevated vegetation (GOTECH, 1998). Barrier islands are critical habitat for resting and feeding stops by migrating birds traveling between summer and winter ranges. The export of detritus - decomposed organic matter - to the BTES will be an important function of the planted salt marsh and will provide additional energy for the estuarine detrital food web in the local area. This increased food supply and increased nursery habitat will support increases in shrimp, crab, fish, and bird populations, thereby indirectly benefiting recreational users in the BTES. Direct recreational opportunities in salt marshes include fishing, bird watching, hunting, and nature study. For these reasons, the Trustees have determined that, compared to all other potential restoration alternatives investigated, marsh enhancement at East

Timbalier Island best fits the OPA restoration selection criteria. This alternative best addresses the injuries to marsh habitat, aquatic fauna, and birds from the Lake Barre incident and is therefore the preferred alternative.

Another important benefit of marsh enhancement at East Timbalier Island is sediment stabilization. Planted vegetation will stabilize newly deposited dredge materials by binding sediments with an extensive system of roots and rhizomes, dampening wave and current velocities during overwash events, and increase sedimentation through trapping wind-borne sediments. Although East Timbalier Island will still be susceptible to subsidence, erosion, and the impacts of storms and hurricanes, stabilizing sediments by planting vegetation will prolong the life expectancy of the island. Protection and stabilization of barrier islands is of particular importance to the Lake Barre Trustees because of scientific concern over the deterioration of Louisiana's barrier islands and strong public support for barrier island restoration projects. In fact, barrier island restoration is a key component of Louisiana's coastal restoration program (van Heerden and DeRouen, 1997). Additionally, restoration and maintenance of the Timbalier and Isle Dernieres barrier island chains is a strategic goal of the Coast 2050 project (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority, 1998), a project that was developed with federal, state, and local agency, as well as community input.

The loss of Louisiana's barrier island system would have significant environmental and economic consequences. Barrier islands serve as the last defense for inland areas, protecting them against the destructive forces of hurricanes, storm surges, and saltwater intrusion (van Heerden and DeRouen, 1997). If the barrier island system were lost, inland bays and estuaries would be converted to less productive open water areas which would likely result in the diminishment of Louisiana's recreational and commercial fishing industries (GOTECH, 1998; van Heerden and DeRouen, 1997). Increased exposure of inland coastal areas to the physical influence of the open waters of the Gulf of Mexico would threaten navigational waterways, shipping routes, artificial levees, and other infrastructure (van Heerden and DeRouen, 1997).

The Lake Barre incident occurred in Terrebonne Parish, and the Trustees considered the benefits to Terrebonne Parish in all restoration alternatives considered. Although East Timbalier Island lies in Lafourche Parish, just east of the Terrebonne Parish boundary, it provides protection for inland marshes and coastal communities in the Terrebonne/Timbalier Bay system of both parishes. Over the past century, East Timbalier Island has endured several direct hits from hurricanes and tropical storms (GOTECH, 1998). East Timbalier Island also protects about 400 oil and gas wells (Miller, 1994) and numerous pipelines (GOTECH, 1998) in Timbalier Bay. These wells and pipelines were not designed to withstand open ocean conditions and exposure to these conditions would increase the risk of a major oil spill. Therefore, stabilization of the barrier islands will help reduce the chance of future oil spill incidents.

5.4.3 Non-Preferred Alternative: Marsh Enhancement (Hydrologic Modifications) at Upper Bayou LaCache

5.4.3.1 Project Description

Upper Bayou LaCache is a marsh impoundment located in southern Terrebonne Parish. The site encompasses approximately 4,400-acres and is bounded by Bayou Petit Caillou to the west, Bayou Terrebonne to the east, Bush Canal to the south, and a Parish forced drainage area to the north. The South Terrebonne Parish Tidewater Management and Conservation District (Tidewater District) manages the property which is owned by approximately 30-40 private landholders. The Upper Bayou LaCache basin is experiencing a rapid conversion of marsh habitat to open water due to saltwater intrusion, wind and wave erosion, and subsidence. Currently, the basin is primarily open water with some fresh and brackish emergent vegetation, mostly in the northern portion of the basin.

Hydrologic enhancement would be achieved by actively managing water and salinity levels within the basin. Two components of the project - closing breaches and installation of a water control structure at Bush Canal - were completed in 1996. Two additional components - installation of a water control structure in the northern portion of the basin and construction of a low-lying berm around the perimeter of the site - are proposed. These components would increase freshwater retention within the basin and provide flood protection for residential areas in the lower Bayou Petit Caillou and Bayou Terrebonne ridges, respectively.

5.4.3.2 Environmental and Socioeconomic Impacts

There are no significant environmental or economic impacts associated with implementing the additional components of the enhancement plan for Upper Bayou LaCache. Because the Upper Bayou LaCache basin is privately owned, the economic consequences of not implementing the project will be limited to the basin landowners.

5.4.3.3 Evaluation

The Upper Bayou LaCache project would protect and enhance existing marsh habitat within Terrebonne Parish. The project site is adjacent to the area impacted by the spill and there is support for the project from the landowners. The Tidewater District and LDNR CRD have completed all engineering studies and secured permits for the proposed project components.

A variety of practical problems, however, may adversely affect project implementation or the likelihood of success. Subsidence rates within the Upper Bayou LaCache area are high. While installation of a water control structure will facilitate sediment deposition within the basin, deposition rates may not be sufficient to overcome marsh loss due to subsidence. In other words, the site may continue to subside despite implementation of the project.

Private ownership of the site and the number of landholders raise some additional concerns. Although the landowners currently support the project, right-of-way agreements have not been secured. Coordinating with landowners could cause delays in project implementation or possibly result in the cancellation of the project. In addition, it is difficult to establish the connection between the benefits of berm construction and the direct replacement of lost ecological services.

This difficulty in establishing, and therefore quantifying, the benefits of this project would make it difficult for the Trustees to determine if the benefits would provide adequate compensation. Furthermore, because the site is privately owned and access is limited, there will likely be little or no direct recreational opportunities for the public.

Finally, Upper Bayou LaCache is an active marsh management project. The Tidewater District operates existing water control structures and pump stations in accordance with an approved Army Corps of Engineer's Operations and Maintenance Plan. The Trustees are concerned that site management goals may not necessarily coincide with NRDA restoration goals. For these reasons, the Upper Bayou LaCache project is not a preferred restoration alternative.

5.4.4 Non-Preferred Alternative: Raccoon Island Restoration Projects

5.4.4.1 Site Description

Raccoon Island is a 114-acre barrier island located in Caillou Bay in southwestern Terrebonne Parish. It is the western most island of the Isles Dernieres barrier island chain which extends from Raccoon Point to the west to Wine Island Pass to the east. Raccoon Island has been designated as part of the Terrebonne Barrier Islands Refuge along with Whiskey and Wine Islands. The island is owned by the State of Louisiana and managed by the LDWF. Raccoon Island is rapidly eroding. In 1992, Hurricane Andrew destroyed large portions of the island.

Restoration has been ongoing since the LDWF assumed management of the island in 1992. In 1993, dredged materials were used to plug breaches and create marsh and dune habitat. More recently, eight offshore, segmented breakwaters were installed along the eastern end of the island to reduce wave energy and trap longshore sediments. Three restoration projects are currently proposed for Raccoon Island: marsh creation, installation of additional breakwaters, and construction of a jetty.

5.4.4.2 Salt Marsh Creation on Raccoon Island

5.4.4.2.1 *Project Description*

Salt marsh would be created using dredged materials from a borrow area north of the island in Caillou Bay. Dredge materials would be used to create either a series of elevated lobes extending from the northern shoreline into the bay or placed on top of and behind the sand spit on the western end of the island. Following placement and consolidation of materials, the area would be planted with both salt marsh vegetation and mangroves.

5.4.4.2.2 *Environmental and Socioeconomic Impacts*

Creation of a salt marsh at this site would require dredging in designated areas of Caillou Bay. Environmental impacts from dredging include disturbance of the sub-tidal benthic habitat in the dredge area, and in areas where the dredge is placed for marsh creation. These impacts would likely be temporary until recolonization of benthic communities occurs. Marsh creation would

increase recreational opportunities such as bird watching, nature study, and fishing. The project would not have any significant adverse economic impacts.

5.4.4.2.3 *Evaluation*

Marsh creation at Raccoon Island would benefit both the environment and the public. These benefits have been discussed in detail in previous sections. Marsh creation would also increase the life expectancy of Raccoon Island by increasing its width and making it more resistant to impacts from storms and hurricanes. A lobe design would increase edge habitat, as well as act as a barrier to longshore sediment drift. Created wetlands would also protect other island habitats (mangroves and dunes) from shoreline erosion. The technology is available to create marsh through the use of dredged materials and marsh creation using this method has been demonstrated at a number of sites along the Gulf coast.

The Trustees have identified several major concerns with this project that may adversely affect implementation or reduce the likelihood of project success. To date, the project has not advanced beyond the conceptual design stage. There have been no detailed biological or engineering surveys to determine project feasibility. Moreover, the quantity needed and availability of suitable dredge materials are unknown. All of these factors may cause delays in project implementation. In addition, the need for additional studies and the costs associated with the dredging component of the project will make marsh creation at Raccoon Island significantly more expensive than marsh enhancement at East Timbalier Island, with no identifiable difference in benefits. For these reasons, the Raccoon Island marsh creation project is not a preferred restoration alternative.

5.4.4.3 Offshore Segmented Breakwaters on Raccoon Island

5.4.4.3.1 *Project Description*

This project would extend the existing offshore segmented breakwaters either along the Gulf or bayside of the island. Breakwaters along the Gulf side of the island would be installed 300 feet from the shoreline at intervals of 300 feet, while breakwaters along the bayside of the island would be installed 400 feet from the shoreline at 150-foot intervals. Breakwaters could be constructed of rock similar to existing breakwaters or using a concrete panel system.

5.4.4.3.2 *Environmental and Socioeconomic Impacts*

Breakwater construction would substantially alter the bottom characteristics of the offshore environment. Breakwaters most likely would be located on a sandy, featureless bottom, thereby displacing the existing flora and fauna that depend on that type of habitat and replacing them with ones that rely upon a hard substrate. The environmental benefits of breakwaters include perching sites for birds, attachment sites for aquatic macroinvertebrates, and a source of cover and food for fish. In addition, by attracting fish, the breakwaters would provide increased recreational opportunities for local anglers.

5.4.4.3.3 *Evaluation*

Extending breakwaters along the Gulf and/or bayside of Raccoon island will slow beach erosion by reducing wave energy and enhancing net sediment deposition, as well as protect the island during severe weather conditions. The existing breakwaters are used as sites for recreational fishing, and increasing the number of breakwaters would increase fishing opportunities for the public. Furthermore, there is strong public support for barrier island projects.

To date, however, the project has not advanced beyond the conceptual design stage. There have been no detailed engineering surveys to determine project feasibility. The success of the existing breakwater project is still being evaluated and the Trustees consider the use of breakwaters for habitat restoration to be too experimental at this point in time to justify its selection over the preferred alternative. Additional studies may cause delays in project implementation or reveal the project to be infeasible or not cost-effective. In addition, scaling this project to determine the appropriate number of breakwaters would be difficult. Although the breakwaters will protect existing beach, mangrove, and marsh habitats, it is difficult to establish the connection between the benefits of breakwater construction and the direct replacement of lost services. For these reasons, the Trustees have determined that breakwater construction is not a preferred project.

5.4.4.4 Jetty at Raccoon Island

5.4.4.4.1 *Project Description*

This project would construct a rock jetty at the western end of Raccoon Island at Raccoon Point. The jetty would extend 650-800 feet into the Gulf of Mexico. The purpose of the jetty would be to trap and retain sediments within the island system and build up the western end of the island. The jetty would be similar in design to the rock breakwaters, although oriented perpendicularly to the axis of the island rather than parallel.

5.4.4.4.2 *Environmental and Socioeconomic Impacts*

Jetty construction would substantially alter the bottom characteristics of the offshore environment. The jetty most likely would be located on a sandy, featureless bottom, thereby displacing the existing flora and fauna that depend on that type of habitat and replacing them with ones that rely upon a hard substrate. The environmental benefits of a jetty include a perching site for birds, attachment sites for aquatic macroinvertebrates, and a source of cover and food for fish. In addition, by attracting fish, the jetty would provide increased recreational opportunities for local anglers.

5.4.4.4.3 *Evaluation*

Construction of a rock jetty at Raccoon Point would benefit Raccoon Island by trapping sediments entrained in the longshore current that otherwise would move out of the system. To date, however, the project has not advanced beyond the conceptual design stage. There have

been no detailed engineering surveys to determine project feasibility. As with the breakwaters alternative, additional studies will cause delays in project implementation and may reveal the project to be infeasible or cost-prohibitive.

It is difficult to establish the connection between the benefits of jetty construction and the direct replacement of lost services. Installation of the jetty will result in the creation of a sand spit to the east of the jetty. Although the spit may eventually accumulate enough sediment for marsh to form, the time needed for this to occur makes this project impractical. Furthermore, preliminary project scaling has indicated that more than one jetty would be required to restore the injury. Therefore, the Trustees have determined that jetty construction is not feasible or practical at the scale required to restore the injury.

5.5 RESTORATION SUMMARY

Exhibit 5-7 summarizes the restoration alternatives for the Lake Barre incident. As indicated in this exhibit, the Trustees selected marsh enhancement on East Timbalier Island as the preferred restoration project to compensate for injuries to salt marsh, aquatic fauna, and birds. The Trustees selected this project from a broad range of general and site-specific alternatives that included marsh creation, enhancement, and protection alternatives.

Exhibit 5-7
Summary of Injuries and Restoration Alternatives for the Lake Barre Incident

Injured Resource	Restoration Alternative	Scale of Restoration
Aquatic Fauna	**Marsh Restoration (Enhancement as Planting)**	0.6 acres planted as rows of *Spartina alterniflora* along the bayside edge of the marsh platform, increasing in size due to vegetative spreading
	Oyster Reef Creation	N/A
	No Action	N/A
Birds	**Marsh Restoration (Enhancement as Planting)**	3.1 acres planted as rows of *Spartina alterniflora* along the bayside edge of the marsh platform, increasing in size due to vegetative spreading
	Nest Enhancements/ Protection	N/A
	Oyster Bed Creation	N/A
	No Action	N/A
Marsh	**Marsh Restoration (Enhancement as Planting)**	14.9 acres planted as rows of *Spartina alterniflora* or *patens* (species planted in given area varying with local elevation) across the marsh platform, increasing in size due to vegetative spreading
	No Action	N/A

Preferred Alternative in bold
N/A = not applicable

The selected project will, in the judgment of the Trustees, provide more than sufficient compensation to make the public and the environment whole for injuries resulting from the Lake Barre incident. The amount of planting to be implemented under this preferred alternative was determined through calculations based solely on the benefits of the planting and subsequent vegetative spread on East Timbalier Island itself. This is sufficient to directly compensate for the injuries to marsh function, and loss of birds and aquatic fauna. Although the available information suggests that there was little lost recreational use associated with this incident there will be benefits to recreational fishing and wildlife viewing through the increased populations that the newly created habitat will support. Therefore the chosen alternative will, in the judgment of the Trustees, provide adequate compensation for the limited public lost human use associated with this incident.

There are additional benefits to this project that are not considered in the calculation of how much planting is required. The longevity of East Timbalier Island will be increased through stabilization of the dredged material and the capture of sediments by the planting. This will, in turn, decrease the rate of loss of interior marsh in the Lake Barre area since storm surge and wave heights are reduced by the presence of barrier islands. It will also serve to protect coastal communities in Terrebonne Parish as well as the oil and gas infrastructure that are not designed for open gulf conditions. Considering these additional benefits for which Texaco has not received credit in the scaling calculations, the Trustees are confident that this restoration alternative provides more than sufficient compensation for injuries resulting from this incident.

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1	5-16-97	DEQ spill report
2	5-19-97	USCG POLREPS
3	5-19-97	Unified Command Center spill report
4	5-19-97	Spill notification to Governor Mike Foster
5	5-19-97	Notification of Closure of Molluscan Shellfish Waters
6	5-21-97	USCG POLREPS
7	5-23-97	Preliminary results from the Texaco Pipeline spill samples
8	5-30-97	USCG POLREPS
9	6-6-97	Biological sampling near oil spill site
10	6-9-97	LOSCO inviting Texaco to participate in co-op NRDA assessment
11	6-19-97	Meeting with Entrix and Es2 (for Texaco) and Trustees 6-17-97
12	6-20-97	Notice of Intent to Perform a NRDA
13	6-24-97	1) Tri-State Bird Rescue and Research, Inc., Final Bird Species List 2) Estimated Bird Mortalities/Oilings 3) Tri-State Bird Rescue and Research, Inc., Final Report
14	7-10-97	Lake Barre oil spill public meeting-report
15	7-11-97	July 1 meeting with FINA representatives
16	7-23-97	Follow-up of requests from 6-14-97 meeting
17	8-97	Texaco agreeing to fund NRDA preassessment phase costs
18	8-15-97	NOAA “HOTLINE” chronological spill reports of incident
19	10-24-97	Publishing of a notice of public meeting in Houma Courier
20	10-22-98	Marsh Assessment Study Plan Eugene Island Pipeline Incident
21	10-22-98	Data Summary Section for Inclusion in Pre-Assessment Screen Report
22	2-12-98	Notes on L. Barre Coordination Meeting of 2-12-98
23	5-18-98	Notification of Property Access
24	6-24-98	Draft Marsh Injury Assessment Workbook
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	6-24,25-97	Summary of CAG meeting and activities
	9-21-97	Summary of CAG meeting and activities
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Additional Material

Letter	Date	Description of Contents
A	5-17-23-97	Color Oblique Aerial Photographs
B	10-2-97	Color Infrared Aerial Photography of Lake Barre Spill
C	5-10-98	Color Infrared Aerial Photography of Lake Barre Spill

D	4-26-99	Literature Review

Appendix B COMPLIANCE WITH KEY STATUTES, REGULATIONS AND POLICIES

Oil Pollution Act of 1990 (OPA), 33 USC 2701, *et seq.*, 15 CFR Part 990

OPA establishes a liability regime for oil spills which injure or are likely to injure natural resources and/or the services that those resources provide to the ecosystem or humans. OPA provides a framework for conducting sound natural resource damage assessments that achieve restoration. The process emphasizes both public involvement and participation by the Responsible Party(ies). The Trustees have followed the regulations in this assessment.

National Environmental Policy Act (NEPA), 42 USC 4321, *et seq.,* 40 CFR Parts 1500-1508

An Environmental Assessment (EA) has been prepared for the East Timbalier Island Restoration Project funded through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, 16 USC 3951 *et seq*.) and implemented by the NOAA National Marine Fisheries Service and the Louisiana Department of Natural Resources (GOTECH, 1998). This EA evaluated the affects of implementing the dredging project that is reestablishing the structural integrity of the island. A Finding of No Significant Impact (FONSI) was signed August 20, 1998. The present draft document is evaluating the affects of the proposed vegetative planting restoration project on East Timbalier island for compensation from the Lake Barre oil spill.

Clean Water Act (CWA), 33 USC 1251, *et seq.*

A Section 404 permit was obtained for the CWPPRA East Timbalier Island Restoration Project (Permit No. EC-19-980-0794). No permit will be required for the proposed vegetative planting restoration project.

Coastal Zone Management Act (CZMA), 16 USC 1451, *et seq.*, 15 CFR 923

The proposed restoration project will be consistent with the Louisiana CZMA program.

Endangered Species Act (ESA), 16 USC 1531, *et. seq.*, 50 CFR Parts 17, 222, 224

The proposed restoration project will not have an adverse effect on endangered species. Consultation has been completed for the CWPPRA East Timbalier Island Restoration Project (GOTECH, 1998).

Fish and Wildlife Conservation Act, 16 USC 2901, *et seq.*

The proposed restoration project will encourage the conservation of non-game fish and wildlife.

Fish and Wildlife Coordination Act (FWCA), 16 USC 661, *et seq.*

The proposed restoration project will have a positive effect on fish and wildlife resources. Coordination has taken place between NOAA National Marine Fisheries Service and the U.S. Fish and Wildlife Service.

Magnuson Fishery Conservation and Management Act, 16 USC 1801 *et seq.*

The proposed restoration project will have a positive affect on fish resources and will promote the protection of essential fish habitat (EFH).

Marine Mammal Protection Act, 16 USC 1361 *et seq.*

The proposed restoration project will not have an adverse effect on marine mammals. Consultation has been completed for the CWPPRA East Timbalier Island Restoration Project (GOTECH, 1998).

Migratory Bird Conservation Act, 126 USC 715 *et seq.*

The proposed restoration project will have no adverse affect on migratory birds which are likely to benefit from the establishment of new marsh habitat.

Archeological Resources Protection Act, 16 USC 470 *et seq.*

The Louisiana State Historical Preservation Office was consulted on the CWPPRA East Timbalier Island Restoration Project. The Office reported no known cultural resources in the area and no known cites or properties listed on or eligible for listing on the National Register of Historic Places (GOTECH, 1998).

Executive Order Number 11514 (34 FR 8693) - Protection and Enhancement of Environmental Quality

A draft Environmental Assessment has been prepared and environmental coordination is taking place as required by NEPA.

Executive Order Number 11990 (42 FR 26961) - Protection of Wetlands

The proposed restoration project will help ensure the protection of wetlands and the services they provide.

Executive Order Number 12962 (60 FR 30769) - Recreational Fisheries

The proposed restoration project will help ensure the protection of recreational fisheries and the services they provide.