Final
Restoration Plan and Environmental Assessment
for the
Bailey Waste Disposal Site, Orange County, Texas

Prepared by:
Texas Commission on Environmental Quality
Texas General Land Office
Texas Parks and Wildlife Department
National Oceanic and Atmospheric Administration and
the United States Fish and Wildlife Service on behalf of the
U.S. Department of the Interior

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1.0 Introduction

This Restoration Plan and Environmental Assessment (RP/EA) has been developed by the Texas General Land Office (TGLO), the Texas Commission on Environmental Quality (TCEQ; formerly known as the Texas Natural Resource Conservation Commission), the Texas Parks and Wildlife Department (TPWD), the National Oceanic and Atmospheric Administration (NOAA) of the U. S. Department of Commerce, and the United States Fish and Wildlife Service (USFWS) on behalf of the U.S. Department of the Interior (DOI), (collectively, "the Trustees") to address natural resources, including ecological services, injured, lost or destroyed due to releases of hazardous substances from the Bailey Waste Disposal Site ("Bailey Site" or "Site") in Orange County, Texas. The RP/EA identifies the restoration action(s) that the Trustees have selected to implement using natural resource damages that the Trustees jointly recovered for natural resource injuries attributed to the Bailey Site. Such damages were recovered by the Trustees on behalf of the public in United States v. Browning-Ferris Chemical Services, Inc. et al, Civil No.1:00 CV - 386 (E.D. Tex. 2000), pursuant to a Consent Decree entered on September 5, 2000 (hereafter, "Consent Decree") and are being held in an account established within the Court Registry (hereafter, "Restoration Account"), pending the development of a restoration plan addressing those resource injuries and service losses. Under applicable laws and the terms of the Consent Decree, the damages recovered by the Trustees may only be used to plan, implement and oversee a plan providing for the creation or enhancement of estuarine wetlands in the Neches River basin as a means of restoring natural resources and services comparable to those injured or lost.

1.1 Authority

This RP/EA was prepared jointly by the Trustees pursuant to their respective authority and responsibilities as natural resource trustees under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9601 *et seq.*; the Federal Water Pollution Control Act, 33 U.S.C. §1251, *et seq.*) (also known as the Clean Water Act or CWA), and other applicable federal or state laws, including Subpart G of the National Oil and Hazardous Substances Contingency Plan (NCP), at 40 C.F.R. § § 300.600 through 300.615, and regulations at 43 C.F.R. Part 11 (NRDA regulations) which provide guidance for this restoration planning process under CERCLA.

1.2 NEPA Compliance

Actions undertaken by the Trustees to restore natural resources or services under CERCLA and other federal laws are subject to the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 *et seq.*, and the regulations guiding its implementation at 40 C.F.R. Part 1500. NEPA and its implementing regulations outline the responsibilities of federal agencies under NEPA, including for preparing environmental documentation. In general, federal agencies contemplating implementation of a major federal action must

produce an environmental impact statement (EIS) if the action is expected to have significant impacts on the quality of the human environment. When it is uncertain whether a contemplated action is likely to have significant impacts, federal agencies prepare an environmental assessment (EA) to evaluate the need for an EIS. If the EA demonstrates that the proposed action will not significantly impact the quality of the human environment, the agency issues a Finding of No Significant Impact (FONSI), which satisfies the requirements of NEPA, and no EIS is required. For a proposed restoration plan, if a FONSI determination is made, the Trustees may then issue a final restoration plan describing the selected restoration action(s).

In accordance with NEPA and its implementing regulations, this RP/EA summarizes the current environmental setting, describes the purpose and need for restoration action, identifies alternative actions, assesses their applicability and potential impact on the quality of the physical, biological and cultural environment, and summarizes the opportunity the Trustees provided for public participation in the decision-making process. This information was used to make a threshold determination as to whether preparation of an EIS was required prior to selection of the final restoration action. Based on the EA integrated into this RP/EA, the federal Trustees – NOAA and USFWS – have determined that neither of the proposed restoration actions have potential impacts requiring preparation of an EIS and, on that basis, have issued a FONSI addressing the selected restoration action, as described in Section 6.0.

1.3 Public Participation

Public review of a restoration plan is an integral and important part of the restoration planning process and is consistent with all applicable state and federal laws and regulations, including NEPA and its implementing regulations, and the guidance for restoration planning found within 40 C.F.R. Part 11.

The Trustees made a draft of this RP/EA (Draft RP/EA) available for review and comment by the public for a period of 30 days, beginning on October 18, 2002, and ending on November 18, 2002. A notice announcing the availability of the Draft RP/EA and the public comment period was published in the Texas Register on October 18, 2002. 27 Tex. Reg. 9782. The Trustees received no comments on the Draft RP/EA.

2.0 PURPOSE AND NEED FOR RESTORATION

This section generally describes the Site, summarizes the response actions which were undertaken, summarizes the Trustees' assessment of resource injuries and compensation requirements related to the Site, including the relationship of that assessment to the September 2000 natural resource damages settlement and the restoration objective identified in this RP/EA, and provides more detailed information on the physical, biological and cultural environments in the area affected by releases of hazardous substances from the Site.

2.1 Overview of the Site

The Bailey Site is an inactive waste disposal facility situated within a tidal marsh along the Neches River, approximately 5 km (3 miles) southwest of Bridge City in Orange County, Texas. The Site (Figure 2-1) included two rectangular ponds, Pond A (52 hectares) and Pond B (30 hectares) that were originally constructed in the early 1950's for recreational freshwater fishing as part of the Bailey Fish Camp. The ponds were created by dredging marsh sediments to form the ponds' perimeter levees. The fish camp was active until September 1961 when Hurricane Carla introduced saline waters into the ponds, which killed the freshwater fish. The Site, including the two ponds, encompassed a total of approximately 280 acres. The Site is surrounded by salt marsh wetlands that are part of the productive Sabine Lake/Neches River Estuarine ecosystem.

Figure 2-1. The Bailey Waste Superfund Site, Orange County, Bridge City, Texas

Industrial (e.g., sludge from local petrochemical industries) and municipal waste disposal at the Site began in the 1950's. Industrial waste disposal was discontinued in the late 1960's, but municipal and construction wastes were accepted until about 1971. Wastes were deposited in a series of pits that were excavated along the northern and eastern levees of pond A, and in a drum disposal area on the southern levee of pond A.

In 1986, the United States Environmental Protection Agency ("EPA") acted to add the Site to the National Priorities List ("NPL") based on the release or threatened release of hazardous substances, making it a priority Site for investigation and potential clean-up under CERCLA. The remedial investigation/feasibility study for the Site ("RI/FS") was completed in 1988. The RI/FS confirmed the presence of CERCLA-designated hazardous substances in soils along the Site's levees, including a wide variety of volatile organic compounds ("VOCs") (e.g., ethylbenzene, styrene, benzene), polycyclic aromatic hydrocarbons ("PAH"), and heavy metals (e.g., lead, arsenic, copper, cadmium, chromium, zinc). The volume of such wastes was estimated to be about 156,000 cubic yards. Neither the available information on wastes deposited at the Site nor the RI/FS sampling results indicated hazardous wastes were deposited directly into the ponds. Response planning focused on the identification of actions that would

remove, neutralize or isolate the hazardous substances present at the Site in order to protect humans and the environment from the risk of harm. These investigations and the response actions that followed were carried out by or on behalf of the Bailey Site Settlors Committee (BSSC), a group of companies who had been identified by EPA as among those considered potentially responsible for the Site contamination.

2.2 Summary of Response Actions (Primary Restoration)

In a June 1988 Record of Decision ("ROD"), EPA selected a remedy requiring *in-situ* stabilization of identified wastes. Implementation of the remedy began in 1993. The ROD was amended twice in 1996, in part to address hazardous wastes (hereafter, the "tarry mass") later discovered to have migrated from a waste pit (Pit B) in the Site's north levee into an area of adjacent marsh. Under these amendments, contaminated sediments from this North Marsh area and about 12,000 cubic yards of wastes from Pit B were removed for off-site disposal. The BSSC completed all on-site remedial construction activities by August 1997. The final remedy also included waste consolidation; grading and light capping within the Site's waste areas; installation of controls to manage and treat storm water run-off from inactive and completed remedy areas; and adjustments to dike elevations and slopes necessary to construct the cap, address areas with excessive settlement and protect against future erosion (Figure 2-2).

As implemented, the remedy selected to address the contamination at the Site is expected to protect natural resources in the vicinity of the Site from further or future harm and to allow natural resources to return to pre-injury or baseline conditions within a reasonable period of time. These actions, however, did not address or otherwise seek to compensate the public for any injuries or losses of natural resources caused by the Site contamination, particularly any losses or reductions in resource services pending recovery or losses caused by the remedy undertaken.

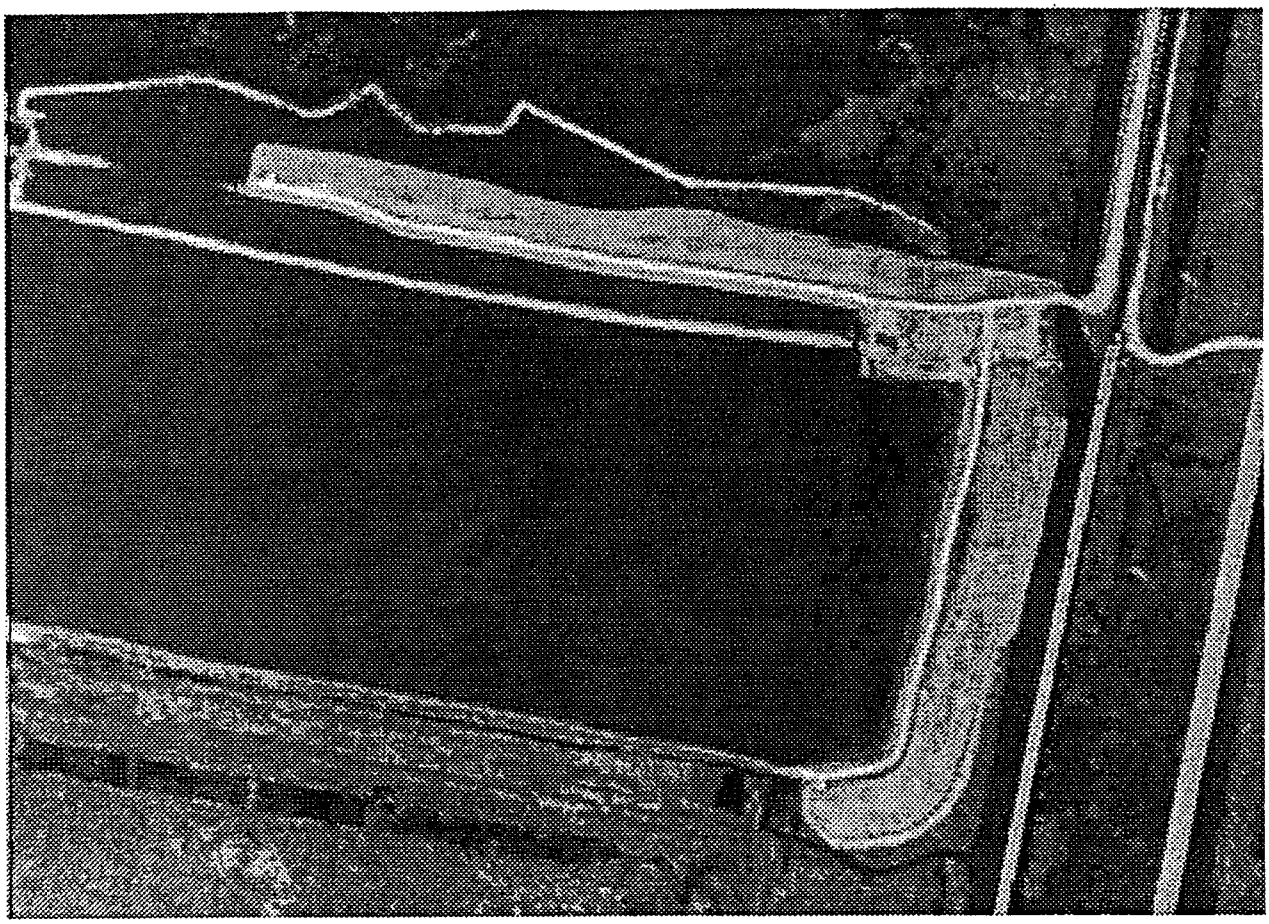

Figure 2-2. Completed remedial construction, Bailey Waste Disposal Superfund Site, Orange County, Texas.

2.4 Assessment of Resource Injuries and Compensation Requirements

2.4.1 Injury Determination and Quantification

The Trustees' assessment of resource injuries focused on identifying the injuries or losses of natural resources which were likely or known to have resulted from the Site contamination, including due to the remedy undertaken. PAHs and VOCs were the primary contaminants of concern at the Site for natural resource damage assessment purposes. These hazardous substances were found in sediments of the salt marsh adjacent to the Site. In addition, metals were detected in estuarine surface water at concentrations exceeding EPA ambient water quality criteria (AWQC) for the protection of marine organisms.

Using data and other information developed as part of the RI/FS process, as well as information on these contaminants in the existing scientific literature and their own knowledge of and experience in Texas estuarine ecosystems, the Trustees assessed (i) the area of each habitat type covered by wastes containing hazardous substances,

covered by the migration of wastes containing hazardous substances or disturbed by remedial activities, (ii) whether habitat service losses in these areas were total or partial, (iii) whether the service losses in these areas were permanent or would recover with time, and (iv) the duration of any service losses. The Trustees then used this information to estimate the total potential loss of wetland acre-years represented by the natural resource injuries associated with the Site.

The Trustees found that resources or resource services were lost due to the placement of hazardous substances in certain areas of the Site, were injured due to the migration of hazardous substances into the North Marsh, were likely harmed by exposure to surface waters contaminated by Site releases, and were injured or lost as a result of the excavation and capping undertaken as part of the remedy. For areas where hazardous substances were present, the Trustees were able to identify the habitats (and/or component resources) with the greatest potential to have been injured by historic and ongoing exposure to these substances. Because resource injury was indicated to be closely associated with the VOCs and PAHs, the Trustees used analytical chemistry results for samples collected during the RI to determine the nature and extent of VOC and PAH contamination in soils and sediments in various habitats within the Site. All together, the Trustees identified seven types of habitats across the Site with reduced or diminished ecological service flows due to the hazardous substances released at the Site. These habitats included subtidal unvegetated benthic habitats, estuarine and freshwater marsh habitats, and terrestrial habitats. The Trustees also identified areas of these habitats that were adversely affected, temporarily or permanently, by response actions undertaken at the Site.

The Trustees used habitat mapping to determine the number of injured acres of each habitat type at the Site. For each habitat area identified as injured, the Trustees estimated the interim percent loss of services (LOS) to be 100% in the areas where remediation was required. Additionally, these habitats were permanently altered from the natural condition, so the future LOS was determined to be 100%.

Table 2.2 summarizes the results of this process. For each area of the Site, it identifies the acres of each habitat type determined to be injured based on the concentrations of contaminants and the corresponding level of service reduction determined by the Trustees.

Table 2.2 - Areas (acres) injured by hazardous substances or by remedial activities broken down by habitat type within remediation areas for the Bailey Waste Site, Orange Co., TX

	Tidal Marsh	High Marsh	Fresh Marsh	Ponds (A&B)	Ditch	Upland	Road	**Total**
E. Waste Area	0.00	3.26	0.00	0.32	0.00	0.67	0.25	**4.50**
Facilities Area	0.00	0.41	0.00	0.00	0.00	1.19	0.80	**2.40**
N. Waste Area	1.60	0.00	0.00	0.50	0.71	4.06	0.53	**7.40**
N. Marsh Area	1.79	0.00	0.00	0.00	0.00	0.00	0.00	**1.79**
Disposal Cell A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
S. Waste Area	0.00	0.00	0.29	0.00	0.00	0.16	0.08	**0.53**
Pit B Area	0.00	0.00	0.00	0.00	0.80	0.00	0.00	**0.80**
Bulk Waste Area	0.00	0.00	0.00	0.00	0.00	1.06	0.00	**1.06**
Total	3.39	3.67	0.29	0.82	1.51	7.14	1.66	**18.48**

Service losses associated with the impacts to high marsh, fresh marsh, pond, ditch, and upland habitats were 'normalized' to estuarine marsh losses for restoration scaling purposes. This process involved converting the areas of the 7 habitat types injured (as identified in Table 2.2) into an estimated equivalent in estuarine marsh losses, using cross-habitat conversion factors identified using a workgroup comprised of 6 wetland scientists with knowledge of Texas estuarine systems (3 participating on behalf of the BSSC and 3 on behalf of the Trustees). Using a process known as multiple attribute decomposition, each workgroup scientist scored each of the 7 habitat types based on its resource functions relative to estuarine marsh, taking into account functions such as primary productivity, habitat value, nutrient export, etc. These scores were then combined, averaged and adjusted or "normalized" to the estuarine marsh standard to create the habitat normalization factors ("Normalized Average") exhibited in Table 2.3. These factors were then applied to their corresponding habitat acres identified in Table 2.2 to calculate their equivalent in marsh losses (in acres), with the results set forth in Table 2.4 (e.g., 3.26 acres of high marsh in E. Waste Area in Table 2.2 multiplied by factor of .607 in Table 2.3 to yield acreage equivalent in estuarine marsh of 1.98). The results of this process are summarized in Tables 2.3 and 2.4.

Table 2.3 - Method and values used to "normalize" all habitat impacts to estuarine marsh losses.

Habitat Type	Score 1	Score 2	Score 3	Score 4	Score 5	Score 6	Average	**Normalized Average**
Brackish Tidal Marsh	10.0	9.3	10.0	10.0	10.0	9.7	9.833	**1.000**
High Marsh	5.0	6.5	6.0	5.0	7.0	6.3	5.967	**0.607**
Fresh Marsh	9.0	7.3	7.6	8.0	7.0	7.7	7.767	**0.790**
Ponds A&B	6.0	4.5	6.3	6.0	5.0	5.2	5.500	**0.559**
Ditch	5.0	3.5	4.6	3.0	5.0	4.3	4.233	**0.431**
Upland	2.0	5.3	4.0	4.0	6.0	2.7	4.000	**0.407**
Road	0.3	2.0	0.6	0.0	1.0	1.0	0.817	**0.083**

Table 2.4 - Calculated marsh equivalents (acres) used to develop and apply the HEA.

	Tidal Marsh	High Marsh	Fresh Marsh	Ponds (A&B)	Ditch	Upland	Road	**Total**
E. Waste Area	0.00	1.98	0.00	0.18	0.00	0.27	0.02	**2.45**
Facilities Area	0.00	0.25	0.00	0.00	0.00	0.48	0.07	**0.80**
N. Waste Area	1.60	0.00	0.00	0.28	0.31	1.65	0.04	**3.88**
N. Marsh Area	1.79	0.00	0.00	0.00	0.00	0.00	0.00	**1.79**
Disposal Cell A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
S. Waste Area	0.00	0.00	0.23	0.00	0.00	0.07	0.01	**0.31**
Pit B Area	0.00	0.00	0.00	0.00	0.34	0.00	0.00	**0.34**
Bulk Waste Area	0.00	0.00	0.00	0.00	0.00	0.43	0.00	**0.43**
Total	3.39	2.23	0.23	0.46	0.65	2.90	0.14	**10.00**

Using this approach, the Trustees determined 10 acres of tidal marsh equivalents were injured (at 100% LOS) at the Bailey Site. The Trustees then used this information to estimate restoration requirements using the Habitat Equivalency Analysis (HEA) method. HEA is recognized to be a valid and appropriate method for defining the scale of restoration actions needed to restore or replace ecological services comparable in value to resource services lost.

2.4.2 Restoration Strategy

Estuarine marsh creation or enhancement was identified as the preferred restoration strategy. This strategy was adopted because estuarine marsh was the most significant habitat type injured (@ 7 acres), was the only habitat type injured which naturally occurs in the impacted area and because the array of ecological services which it provides are inclusive of the types of ecological services lost due to injury to other habitats (i.e., fresh marsh, pond, and upland habitats). A single habitat strategy for restoration also simplified the assessment since it required only one type of HEA, rather than a unique, technically supported analysis for each injured habitat. Because the impacts to the other habitats were small, the use of a single method represented the most cost-effective assessment strategy.

2.4.3 Restoration Scaling

The HEA method was used to estimate the scale of estuarine marsh creation needed to offset the 10 acres of assessed tidal marsh losses (at 100% LOS). This approach estimates the total loss of wetland acre-years represented by the 10 acres of assessed tidal marsh losses (at 100% LOS) and identifies the amount of estuarine marsh creation necessary to compensate for that loss. In this instance, the analysis covered several injury/restoration scenarios (to account for uncertainty associated with certain technical issues), which yielded a range estimate of the wetland compensation required of approximately 13 to 28 acres. Absent information necessary to further refine the analyses, the Trustees proceeded conservatively, relying on the HEA analysis which indicated that approximately 28 acres of estuarine marsh habitat would have to be created to adequately compensate for the natural resource injuries and service losses attributed to the Bailey Site. A summary of this HEA result is presented in Table 2.5. The full array of input values used in this HEA are included at Appendix A. The Trustees then used available information on the potential costs to implement this type and scale of restoration in the vicinity of the Bailey Site as a basis for negotiating settlement[1].

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[1] Similar projects in Texas were reviewed in order to estimate typical costs to create estuarine wetlands in this area, on a cost per acre basis. Costs of geotech surveys, detailed work plans, permitting, construction activities (i.e., levee construction and planting costs), performance monitoring, trustee restoration planning costs and oversight, and both construction and corrective action contingencies were factored into development of per acre costs.

Table 2.5. - Summary of HEA results: Tidal Marsh Habitat required for compensation.

Remediation Sub-Area	Marsh Equivalents Injured (acres)	Marsh Acres Required (acres)
East Waste Area	2.45	8.76
Facilities Area	0.80	2.00
North Waste Area	3.88	13.87
North Marsh Area	1.79	2.55
South Waste Area	0.30	0.18
Pit B Area	0.34	0.50
Bulk Waste Area	0.43	0.31
Total	10.00	**28.17**

2.5 Summary of Settlement

The Trustees and the BSSC were able to agree on cash settlement terms sufficient, in the judgment of the Trustees, to support the restoration of 28 acres of estuarine marsh habitat in the affected watershed. This settlement is embodied in a Consent Decree entered by the U. S. District Court, Eastern District of Texas on September 5, 2000 in U.S. and Texas v. Browning-Ferris Industries, et al, Case No. 1:00CV-386.

Under the settlement, the Trustees received $605,000.00. Of that amount, $522,065.85 was paid in a Court Registry Account. These funds, together with any interest thereon, must be used to plan, implement, oversee and monitor, one or more projects to create or enhance estuarine wetlands in the Neches River basin, the estuary or watershed encompassing the Site, in order to compensate for the natural resource injuries and losses attributed to the Bailey Site. The Consent Decree specifies that expenditures of the funds recovered to implement this restoration are to be determined based on a restoration plan to be developed by the Trustees, in accordance with applicable federal and state laws, including the opportunity for public review and comment on proposed restoration actions as required by CERCLA and NEPA. The remaining funds were paid to trustee agencies to reimburse past assessment costs.

3.0 The Affected Environment

This subsection provides additional information on the physical, biological and cultural environments in the area affected by releases of hazardous substances from the Bailey Site and in which restoration action(s) contemplated in this RP/EA would occur.

3.1 The Physical Environment

Sabine Lake is Texas' easternmost estuary, covering some 90,000 acres. It is largely co-owned and regulated by Texas and Louisiana. It lies in a river valley formed during the last glacial period. The lake receives its primary freshwater influx from the Sabine River and the Neches River, which enter near Port Arthur. Bayous entering Sabine Lake include Lighthouse, Fourge, Greens, Madame Johnson, Johnsons, Willow, and Black. With the Sabine River, the lake forms the boundary between Louisiana and Texas. The Sabine Lake ecosystem has five times more marshland than the Galveston Bay complex.

Except for a few miles near its head, the Neches River serves as a boundary stream, forming the county lines between Van Zandt and Smith, Smith and Henderson, Henderson and Cherokee, Cherokee and Anderson, Cherokee and Houston, Houston and Angelina, Angelina and Trinity, Angelina and Polk, Angelina and Tyler, Tyler and Jasper, Jasper and Hardin, Hardin and Orange, and Orange and Jefferson counties.

The Sabine River starts in Hunt County and forms the boundary lines between Rains and Van Zandt, Van Zandt and Wood, Wood and Smith, and Smith and Upshur counties. After crossing most of Gregg County, the river forms portions of the county lines between Gregg and Harrison, Harrison and Rusk, and Harrison and Panola counties before it bends more sharply across Panola County. At the thirty-second parallel in the southeastern corner of Panola County the Sabine becomes the state boundary between Texas and Louisiana, and thus the eastern boundary of Shelby, Sabine, Newton, Orange, and Jefferson counties.

The Sabine River flows for 555 miles. Its total drainage basin area is 9,756 square miles, of which 7,426 is in Texas and the remainder in Louisiana. Average annual precipitation is between thirty-seven inches at its source and fifty inches at its mouth. It discharges the largest volume of water at its mouth of all Texas rivers. Average runoff within 97 percent of the Sabine River basin during the 1941-67 period was about 640 acre-feet per square mile.

The Neches River has a drainage area estimated at 10,011 square miles. Abundant rainfall in the basin results in a flow of some 6,000,000 acre-feet per year. Major tributaries include the Angelina River, which drains one-third of the basin area, Bayou La Nana, Ayish Bayou, Pine Island Bayou, Village Creek, Kickapoo Creek, and Flat Creek.

3.2 The Biological Environment

The wetlands of the Sabine Lake/Neches River Estuary contribute nutrients to and enhance productivity of Sabine Lake as well as serve as important nursery and adult habitat for a variety of oligohaline and marine fish and invertebrate species. Sabine Lake is a low-salinity, estuarine embayment of the Gulf of Mexico and is characterized by shallow, productive waters. The Neches River in the vicinity of the Site is tidally influenced and is part of the Sabine Lake/Neches River Estuary. Phytoplankton, zooplankton, and aquatic invertebrates living in these habitats provide food web support for a diversity of fish and bird species. Marine species utilizing the marsh include, but are not limited to, spotted seatrout (*Cynoscion nebulosus*), sand seatrout (*Cynoscion arenarius*), Atlantic croaker (*Micropogonius undulatus*), red drum (*Scienops ocellatus*), black drum (*Pogonius cromis*), sheepshead (*Argosargus probatocephalus*), blue crab (*Callinectes sapidus*), white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and southern flounder (*Paralichthys lethostigma*).

The waters of the Sabine Lake/Neches River Estuary support species important for commercial and recreational usage and provide habitat for the following organisms: white shrimp) and brown shrimp, blue crab, eastern oyster (*Crassostrea virginica*), spotted seatrout , sand seatrout, Atlantic croaker, red drum, black drum, southern kingfish (*Menticirrhus americanus*), Gulf kingfish (*Menticirrhus littoralis*), sheepshead, southern flounder, striped mullet (*Mugil cephalus*), sea catfish (*Galeichthys felis*), Gulf menhaden (*Brevoortia patronus*), and gafftopsail catfish (*Bagre marinus*). In addition, numerous other estuarine and marine resources are found in Sabine Lake/Neches River Estuary including bay anchovy *(Anchoa mitchilli*), silver perch (*Bairdiella chrysoura*), bull shark (*Carcharhinus leucas*), sheepshead minnow (*Cyprinodon variegatus*), gizzard shad (*Dorosoma cepedianum*), Gulf killifish (*Fundulus grandis*), code goby (*Gobiosoma robustum*), pinfish (*Lagodon rhomboides*), spot (*Leiostomus xanthurus*), silversides (*Menidia* spp.), Gulf flounder (*Paralichthys albigutta*), bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*), bay squid (*Lolliguncula brevis*), hard clam (*Mercenaria mercenaria*), grass shrimp (*Palaemonetes pugio*), and common rangia (*Rangia cuneata*).

The sediments within the Estuary support benthic organisms, including annelid worms, small crustaceans (amphipods, isopods, copepods, juvenile decapods), mollusks, and other small bottom-dwellers in salt marshes and unvegetated subtidal sediments. Among these benthic organisms are herbivores (eating algae or other live plant material), detritivores (feeding on decaying organic matter in surface sediments or sediment-bound nutrients and organic substances that are not generally available to epiphytic or pelagic organisms), carnivores (preying on other benthic organisms), and omnivores (a combination). These organisms provide the nutritional base for developing stages of many finfish and shellfish and, thus, affect all trophic levels in the Sabine Lake/Neches River Estuary. The activities of benthic organisms are important in conditioning wetlands and subtidal habitats and in the decomposition and nutrient cycling that occurs in these areas. In sum, benthic communities provide important

ecological services primarily related to food production, decomposition and energy cycling that affect nearly all organisms within an estuarine system. A potential adverse impact on benthic populations has the potential to impact biota in nearly all trophic levels of the Sabine Lake/Neches River Estuary.

The Sabine Lake/Neches River Estuary is home to a variety of plant species that are typical of species found in estuarine wetlands including cordgrasses (*Spartina alterniflora* and *S. patens*), saltwort (*Batis maritima*), glass wort (*Salicornia virginica*), seashore saltgrass (*Distichlis spicata*), saltmarsh bulrush (*Scirpus maritimus*), sea oxeye (*Borrichia frutescens*), and marsh elder (*Iva frutescens*).

3.3 Endangered/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. Numerous endangered and threatened species are seasonal or occasional visitors to the Sabine Lake/Neches River Estuary coastal ecosystem.

Endangered and threatened species known to occur in the Texas Gulf Coast Prairies and Marshes Ecoregion or adjacent marine waters are listed in Table 3.1 (Texas Parks and Wildlife Department 1997). Fifteen of these species- including the brown pelican (*Pelecanus occidentalis*), reddish egret (*Egretta rufescens*), white-faced ibis (*Plegadus chihi*), wood stork (*Mycteria americana*), whooping crane (*Grus americana*), bald eagle (*Haliaeetus leucocephalus*), Arctic peregrine falcon (*Falco peregrinus tundrius*), piping plover (*Charadrius melodus*), Eskimo curlew (*Numenius borealis*), green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempi*), loggerhead sea turtle (*Caretta caretta*), Texas tortoise (*Gopherus berlandieri*), scarlet snake (*Cemophora coccinea*), and South Texas siren (*Siren* sp.) - have been documented in or are believed to utilize the Estuary. Most species would be present in the Estuary incident to migration through the area. None of these species were considered to be exposed or at risk of injury due to hazardous substance releases at the Site. The Estuary's habitats provide general support for any threatened and endangered species migrating through or utilizing these communities.

Table 3.1. Federal and State Endangered or Threatened Species in Coastal Texas

Common Name	Scientific Name	Status
Mammals		
West Indian manatee	*Trichechus manatus*	FE, SE
White-nosed coati	*Nasua narica*	ST
Birds		
Brown pelican	*Pelecanus occidentalis*	FE, SE
Reddish egret	*Egretta rufescens*	ST
White-faced ibis	*Plegadus chihi*	ST
Wood stork	*Mycteria americana*	ST
Whooping crane	*Grus americana*	FE, SE
Swallow-tailed kite	*Elanoides forficatus*	ST
Bald eagle	*Haliaeetus leucocephalus*	FT, ST
White-tailed hawk	*Buteo albicaudatus*	ST
Peregrine falcon	*Falco peregrinus*	FE, SE
Arctic peregrine falcon	*Falco peregrinus tundrius*	FE, ST
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	FE, LE
Piping plover	*Charadrius melodus*	FT, LT
Eskimo curlew	*Numenius borealis*	FE, SE
Sooty tern	*Sterna fuscata*	ST
Botteri's sparrow	*Aimophila botteri*	ST
Reptiles		
Green sea turtle	*Chelonia mydas*	FT, LT
Kemp's ridley sea turtle	*Lepidochelys kempi*	FE, SE
Loggerhead sea turtle	*Caretta caretta*	FT, ST
Alligator snapping turtle	*Macroclemy temminckii*	ST
Texas tortoise	*Gopherus berlandieri*	ST
Scarlet snake	*Cemophora coccinea*	ST
Indigo snake	*Drymarchon corais*	ST
Northern cat-eyed snake	*Leptodeira septentrionalis*	ST
Smooth green snake	*Liochlorophis vernalis*	ST
Timber (canebrake) rattlesnake	*Crotalus horridus*	ST
Amphibians		
Black-spotted newt	*Notophthalmus meridionalis*	ST
South Texas siren (large form)	*Siren sp.*	ST
Houston toad	*Bufo houstonensis*	FE, SE
Fish		
Blue sucker	*Cycleptis elongatus*	ST
River goby	*Awaous tajasica*	ST
Plants		
Black lace cactus	*Echinocereus reichenbachii*	FE, SE
South Texas ambrosia	*Ambrosia cheiranthifolia*	FE, SE
Slender rush-pea	*Hoffmannseggia tenella*	FE, SE

3.4 Cultural and Human Use Environment

The Texas coast enjoys a rich history, dating back thousands of years. Early inhabitants of the region included the Eyeish and Atacapa Indians. The Spanish began populating Texas in the early 1700s and German immigration to some parts of the Texas coast was prevalent during the 1800s, although the Neches River area was not among the earliest areas affected by these migrations. The Neches River/Sabine Lake area cultural environment was influenced by immigration of Anglo-American settlers from neighboring Louisiana.

During the Civil War, Sabine Pass, at the south of Sabine Lake, was a major center for the shipment and trade of cotton in exchange for vital supplies, arms, and medicine for the Confederate Army. Union ships actively sought to blockade harbors and disrupt shipments along the Gulf Coast. In a small but notable victory, Confederate forces repelled an attempted 1863 invasion of Texas by Union naval gunboats convoying Union soldiers at Sabine Pass near Port Arthur. Sabine Pass Battleground State Historical Park, a 57.6-acre park located in Jefferson County to the south, encompasses lands and resources that were part of this historic period.

In addition to being part of Texas' cultural history, the Sabine Lake/Neches River Estuary supports both recreational and commercial fishing. Recreational fishing occurs throughout the Estuary, including in the salt marshes in the vicinity of the Site and in the drainage channel east of pond A. Species fished in the Estuary include blue crab, red drum, black drum, spotted sea trout, southern flounder, Atlantic croaker, striped mullet, and sea catfish. Sabine Lake is also a popular area for recreational fishing, with red and black drum, sea trout, sheepshead, and flounder being the most commonly harvested species. The Sabine Lake/Neches River Estuary supports several important commercial fisheries. Large numbers of blue crab are harvested in the lake, as well as in the surrounding salt marshes and throughout the rest of the Estuary. White shrimp and brown shrimp are economically important species found in the Sabine Lake system. Commercial harvest of finfish also occurs at low levels. These human activities are dependent upon the condition of the coastal and marine habitats.

4.0 RESTORATION PLANNING PROCESS

4.1 Restoration Objective

The overall objective of the restoration planning process is to identify restoration alternatives that are appropriate to restore, rehabilitate, replace or acquire natural resources and their services equivalent to natural resources injured or lost as a result of releases of hazardous substances. The restoration planning process may involve two components: primary restoration and compensatory restoration. Primary restoration actions are actions designed to assist or accelerate the return of resources and services to their pre-injury or baseline levels. In contrast, compensatory restoration actions are actions taken to compensate for interim losses of natural resources and services, pending return of the resources and their services to baseline levels.

In this instance, remedial actions undertaken at the Site (removal of the waste in the marsh, wastes consolidation and capping of the terrestrial areas) are expected to protect natural resources in the vicinity of the Site from further or future harm and allow natural resources to return to pre-injury or baseline conditions within a reasonable period of time. Under these circumstances, it was unnecessary for the Trustees to consider or plan for primary restoration actions. Accordingly, this RP/EA only addresses the need for compensatory restoration action.

The objective of restoration under this RP/EA is provided by the underlying assessment and specified in the Consent Decree: to use the recovered funds to provide for the creation of at least 28 acres of estuarine marsh habitat in the Neches River basin to compensate for the natural resource injuries and service losses attributed to hazardous substance releases at the Bailey Site.

In accordance with NRDA regulations, the Trustees identified and evaluated a reasonable range of project alternatives that could be used to create estuarine marsh habitat in the Neches River basin. These projects were identified from the results of other recent marsh project searches in the same watershed, including as identified in an inventory of coastal projects in Texas developed for and submitted to the Texas Coastal Coordination Council in June 2000[2]. The Trustees reviewed available information on these projects and consulted with individuals with knowledge of specific projects or of the benefits and feasibility of the alternatives, based on project design. In identifying and evaluating these alternatives, the Trustees also sought to ensure the restoration action selected would be capable of providing multiple benefits or services to ensure the action(s) undertaken provide the greatest overall benefit to the public. The restoration project alternatives so identified were considered carefully by the Trustees based on the criteria outlined below. Each project alternative, the results of

2 This inventory of projects (GLO Contract No 99-123R) was developed with public input, including as obtained at a public meeting in the Beaumont/Port Arthur area held on May 24, 2000.

that evaluation and the restoration action(s) that the Trustees have selected on the basis of that evaluation are identified in Section 5.0 of this RP/EA.

4.2 Selection Criteria

In accordance with the NRDA regulations, the following criteria were used to evaluate restoration project alternatives and identify the project(s) selected for implementation under this plan:

- *The extent to which each alternative is expected to meet the Trustees' restoration goals and objectives*: The primary goal of any compensatory restoration project is to provide a level and quality of resources and services comparable to those lost. In this plan, that goal is met through the stated restoration objective: to provide for the creation of at least 28 acres of estuarine marsh habitat in the Neches River basin to compensate for the natural resource injuries and service losses attributed to hazardous substance releases at the Bailey Site. The Trustees consider the potential relative productivity of restored habitat and whether the habitat is being created or enhanced. Future management of the restoration site is also a consideration because management issues can influence the extent to which a restoration action meets its objective.
- *The cost to carry out the alternative*: The benefits of a project relative to its cost are a major factor in evaluating restoration alternatives. Additionally, the Trustees consider the total cost of the project, and the availability of matching funds. Factors that can affect and increase the costs of implementing the restoration alternatives may include project timing, access to the restoration site (for example with heavy equipment), acquisition of state or federal permits, and acquisition of the land needed to complete a project and the potential liability from project construction. Although a monitoring program does increase the cost of an alternative, the presence of an adequate monitoring component is considered a positive attribute because documenting project performance is important.
- *The likelihood of success of each project alternative*: The Trustees consider technical factors that represent risk to either successful project construction, successful project function or long-term viability of the restored habitat. For example, high rates of subsidence at a project site are considered a risk to long-term existence of constructed habitats. Alternatives that are susceptible to future degradation or loss through contaminant releases or erosion are considered less viable. The Trustees also consider whether difficulties in project implementation are likely and whether long-term maintenance of project features is likely to be necessary and feasible. Sustainability of a given restoration action is a measure

of the vulnerability of a given restoration action to natural or human-induced stresses following implementation and the need for future maintenance actions to achieve restoration objectives.

- *The extent to which each alternative will avoid collateral injury to natural resources as a result of implementing the alternative*: Restoration actions should not result in additional losses of natural resources, and should minimize the potential to affect surrounding resources during implementation. Projects with less potential to adversely impact surrounding resources are generally viewed more favorably. Compatibility of the project with the surrounding land use and potential conflicts with any endangered species are also considered.
- *The extent to which each alternative benefits more than one natural resource or service*: This criterion addresses the interrelationships among natural resources, and between natural resources and the services they provide. Projects that provide benefits to more than one resource and/or yield more beneficial services overall, are viewed more favorably. For example, although recreational benefits are not an explicit objective in RP/EA, the opportunity for a restoration project to enhance recreational use of an area was considered favorably.
- *The effect of each alternative on public health and safety*: Projects that would negatively affect public health or safety are not appropriate.

The NRDA regulations give the Trustees discretion to prioritize these criteria and to use additional criteria as appropriate. In developing this RP/EA, the first criterion listed has been a primary consideration, since it is key to ensuring the restoration action funded by the Trustees will compensate the public for injuries to resources attributed to Site releases, consistent with the assessment of compensation requirements for the Site and the Consent Decree. The evaluation of projects according to the criteria involves a balancing of interests in order to determine the best way to meet the restoration objective. The Trustees have approached restoration planning with the view that the injured natural resources/lost services are part of an integrated ecological system and that the Sabine Lake system in the vicinity of the Bailey Site (Lower Neches River/Sabine Lake) represents the relevant geographical area for siting restoration actions. Areas outside of this are considered less geographically relevant as restoration alternatives. This helps to ensure the benefits of restoration actions are related, or have an appropriate nexus, to the natural resource injuries and losses at the Site. The Trustees also recognized the importance of public participation in the restoration planning process, as well as the acceptance of the projects by the community. Alternatives were considered more favorably if complementary with other community development plans/goals.

NEPA and the NRDA regulations required the Trustees to evaluate the "No Action" alternative, which for compensatory restoration equates to "No Compensation." Under this alternative, the Trustees would take no action to compensate for interim losses associated with the resources in question.

5.0 RESTORATION PLAN

The Trustees considered the following seven restoration alternatives in developing this RP/EA:

- Marsh Creation via beneficial use of lower Neches River dredge material at Nelda Stark Unit of the Lower Neches Wildlife Management Area (WMA) ("Bessie Heights Dredge Material Project")
- Marsh Creation via Terracing in the Nelda Stark Unit of the Lower Neches WMA ("Bessie Heights Terracing Project")
- Marsh Creation via beneficial use of lower Neches River dredge material in the old Rose Hill Oil Field
- Marsh Enhancement via Hydraulic Restoration of Keith-Clam Lake Complex Using Constructed Water Control Structure
- Marsh Enhancement via Restoration of Freshwater Flow between Salt Bayou and Star Lake Using Constructed Inverted Siphon System
- Marsh Creation via Terracing in Old River Unit of Lower Neches WMA
- No Action

The project location associated with the first six restoration alternatives is shown in Figure 5-1.

This Section identifies the restoration project alternative(s) selected for use to restore the natural resource services that were injured or lost due to the Bailey Site based on the Trustees' evaluation of the above alternatives in light of the restoration objective of this plan, the selection criteria listed in Section 4.2 and, consistent with its role as an EA under NEPA, information relating to the restoration setting and factors such as the potential environmental, social, and economic consequences of each project. Information supporting the Trustees' project selection is provided throughout the remainder of this section as well as in Section 6.0.

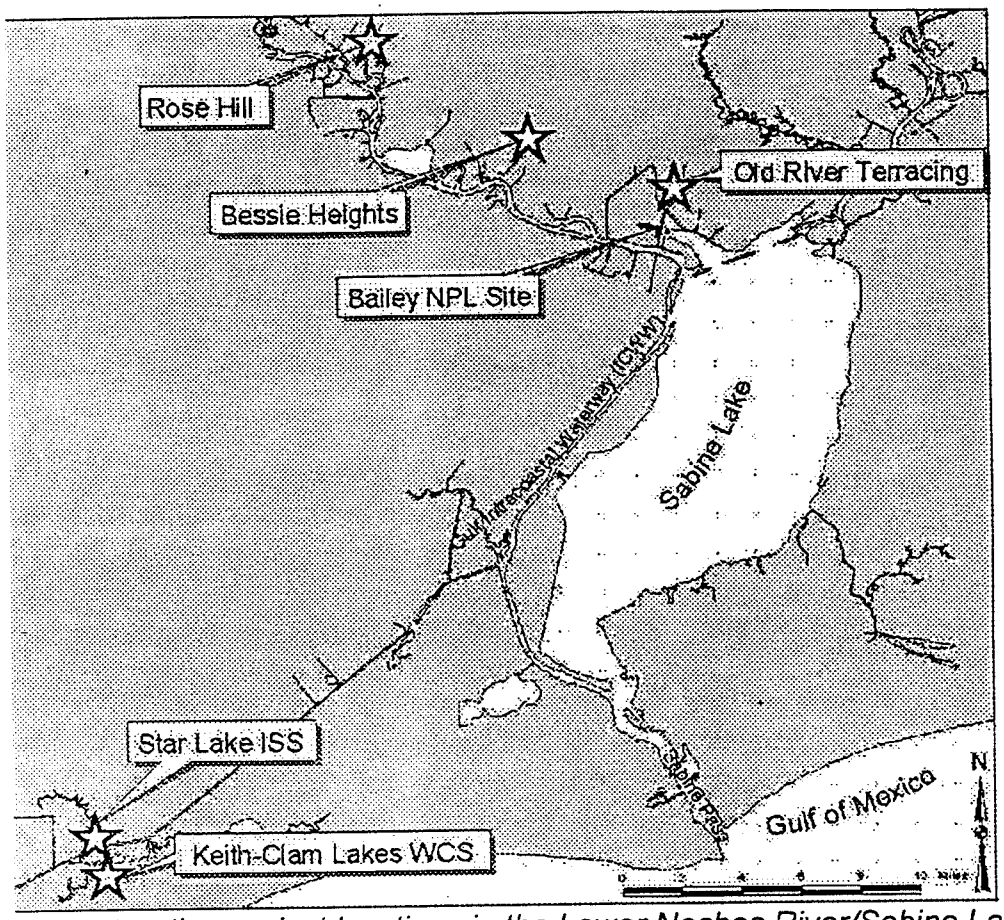

Figure 5-1. Restoration project locations in the Lower Neches River/Sabine Lake system

The Trustees have selected Marsh Creation in the Nelda Stark Unit of the Lower Neches WMA via the beneficial use of lower Neches River dredge material provided by the U S. Army Corps of Engineers (USCOE) ("Selected Restoration Alternative") to create a minimum of 28 acres of estuarine marsh. As indicated in 5.1 below, however, the anticipated timing of the USCOE dredging project needed to carry out this restoration action is a key factor in its selection in this RP/EA. There is a possibility that necessary work and, therefore, the opportunity to implement the Selected Restoration Alternative could be substantially delayed. In recognition of this risk, the Trustees have also selected an alternate restoration project: creating the specified minimum marsh acreage through the construction of vegetated terraces at the same site within the Nelda Stark Unit of the Lower Neches WMA ("Selected Restoration Alternative-Contingent"). As set forth in this RP/EA, this restoration alternative would only be implemented in the event the Selected Restoration Alternative is significantly delayed. Pre-selection of this alternate restoration project, under the condition stated, affords the Trustees flexibility to ensure that appropriate restoration and its attendant benefits to public resources, will be achieved as expeditiously as possible under this RP/EA.

5.1 Selected Restoration Alternative: Marsh Creation via beneficial use of lower Neches River dredge material at Nelda Stark Unit of the Lower Neches WMA (the "Bessie Heights Dredge Material Project")

This project is selected for implementation under this RP/EA. This project involves the construction of 28 acres of coastal marsh habitat in the Nelda Stark Unit in the Lower Neches WMA by hydraulically placing lower Neches River maintenance dredge material in subsided areas to elevations (approximate sea level) conducive to the support of emergent, intertidal marsh vegetation. The project will incorporate channels and include hand planting of indigenous estuarine species [likely a mix of cordgrasses, California bulrush (*Scirpus californicus),* saltmarsh bulrush (*Scirpus robustus*), and/or bulltongue (*Sagittaria lancifolia*)] in these elevated areas. These species occur either in or near the vicinity of the project site and, as such, are adapted to and should withstand the range of salinities that occurs within the Bessie Heights area. The created habitat is expected to result in approximately 70% marsh to 30% open water areas. The habitat types that would be created include supra-tidal marsh, emergent intertidal marsh along channels, intertidal mudflats, and isolated pockets of deeper water.

The project area was historically an uninterrupted low salinity tidal marsh with little open water. Subsidence due to oil and gas extraction and saltwater intrusion caused much of the marsh to be converted to open water. Currently, the area is predominately open water with some isolated or intermittent patches of mixed emergent fresh and brackish marsh. Significant portions of the area are presently too deep to support tidal marsh vegetation or to allow use by sediment probing birds, making it a lesser quality habitat for estuarine finfish, invertebrates, wading and shore birds. The shallower open water areas are subject to higher water temperatures and wind-induced turbidity, which also diminishes their habitat and foraging value to resources. The Lower Neches WMA is owned and managed by the Texas Parks and Wildlife Department (TPWD).

This project also currently represents the earliest opportunity for the Trustees to implement and achieve restoration. This is based on the expected timing of the associated dredging project by the USCOE (anticipated to start January 2003) and the status of the USCOE's planning necessary to initiate and complete this dredging project within the upcoming dredge cycle for the project area.

5.1.1 Evaluation of Alternative

The project area is within the Sabine Lake system, approximately 5.1 miles from the Bailey Site (see Figure 5.1), and provides numerous opportunities for estuarine marsh creation and enhancement though the reestablishment of elevations needed to support marsh vegetation. Hydraulic placement of dredge material is a proven, cost effective technique for creating marsh wetlands along the Texas coast. Examples of marshes created by this method are numerous in southeast Texas and monitoring of these created wetlands has shown these restoration efforts have been successful in establishing functional low salinity habitat. The technique also recovers valuable

wetland soil material often lost to the local sediment budget.

The dredge material to be used in the project is to be produced by the USCOE incident to scheduled maintenance dredging of existing navigation channels in the area and is available at a minimal cost to the Trustees. This represents a significant cost savings to the Trustees and a very cost-effective approach to effecting marsh restoration. The Trustees will be responsible only for cost-sharing of any additional costs the USCOE may incur over and above those associated with its routine dredge material disposal practice (i.e., to pump the dredge material farther and to move the pipe during the process) as well as the sharing of costs incident to subsequent planting activities and development of channels to enhance tidal exchange, marsh productivity and species utilization of the restored area.

The beneficial use of the dredge material also avoids potential effects or disruptions to other habitats or resources as the fill material needed to restore marsh does not involve mining of soils or productive sediments from other areas. Some benthic organisms will be covered when the material is placed within the restoration site, but such organisms can be expected to rapidly recolonize the restored areas (~ 0.5 -2 years). Some short term impacts to natural resources may be associated with on-site placement of dredge material and channel creation, such as temporary turbidity or other localized effects on surface water quality, but these are generally minimized through measures identified in planning and carried out during implementation.

Because the restoration site is owned by TPWD, marsh restoration can be implemented without additional land acquisition costs. Siting in the WMA allows the project to be included in a larger, contiguous area of undeveloped and protected habitat. This strategy increases the likelihood of restoration success, yields greater benefits to fish and wildlife, enhances the public values associated with this conservation area, and is generally preferable to implementing restoration in smaller, isolated or non-contiguous areas. Siting restoration within the WMA will result in a larger area of protected, heterogeneous habitat than would be possible at other locations. Further, as a designated WMA, the area is already dedicated and managed by TPWD for the long-term preservation and conservation of natural resources, including estuarine habitats, a management framework that is fully consistent with the Trustees' restoration goal. Under these ownership, management and ecological conditions, the created marsh will be self-sustaining, require limited or no active intervention following construction and initial plantings to achieve functional success and will provide an uninterrupted flow of services into the future. The nature of the project and the setting for construction would present no human health or safety issues beyond those met by standard procedures for safe construction. TPWD supports this restoration effort and no public opposition to this project has been apparent during scoping by the Trustees, or incident to the USCOE processes for the proposed dredging.

As noted above, this restoration project currently provides the earliest opportunity for the Trustees to implement and achieve restoration contemplated by this RP/EA (anticipated to start January 2003). The USCOE is working diligently to complete the

planning, consultations and reviews required to undertake its dredging project, including the beneficial use of its dredge material, in the vicinity of the Bessie Heights area as planned, however, it is possible all processes may not be completed in time to allow the USCOE to carry out this project as planned in the current cycle. If that occurs, the restoration project under this alternative would be delayed for as much as 7 years.

This project alternative is similar in many key respects to the project listed as Marsh Creation via Terracing in the Nelda Stark Unit of the Lower Neches WMA (Bessie Heights Terracing) described at 5.2 below. Indeed, when considered in relation to the restoration selection criteria, the Bessie Heights Dredge Material and the Bessie Heights Terracing projects are fairly comparable. Both projects would occur within the same existing public ownership and management framework, both would be in the same proximity to the Bailey Site, and both would provide the opportunity to perform restoration to offset losses earlier than the other project alternatives. If the restoration project is significantly delayed as outlined above, however, the weight of the Trustees' evaluation shifts in favor of selection of Bessie Heights Terracing Project under this RP/EA because delaying restoration for as much as 7 years would be unreasonable where other feasible and cost-effective alternatives for achieving the objectives of this restoration plan exist. Such a delay would render the Bessie Heights Dredge Material Project unacceptable. If that restoration project is significantly delayed, the Bessie Heights Terracing Project would then provide the most expeditious opportunity close to the Bailey Site to implement appropriate and cost-effective restoration under this plan. Therefore, if the USCOE work required to implement the Bessie Heights Dredge Material Project is significantly delayed, the Bessie Heights Terracing Project is selected in this RP/EA for implementation in lieu of the Bessie Heights Dredge Material Project to ensure restoration under this plan will be achieved expeditiously.

5.1.2 Ecological and Socio-Economic Impacts

This restoration is expected to increase habitat diversity, increase and enhance utilization of the area by fish and wildlife, and help stop the loss of emergent marsh habitat in the vicinity of the restoration site. This project will re-establish bottom conditions necessary for the growth of emergent plant communities, decrease the rate of water flow across the site, decrease the rate of sediment loss, and increase the rate of sediment accretion. The habitat types that will be created include supra-tidal marsh (supporting Gulf cordgrass (*Spartina spartinae*) and saltmeadow cordgrass (*S. patens*)), emergent intertidal marsh along edges, intertidal mudflats, and isolated pockets of deeper water.

Numerous resources will use the habitat created and improved under this alternative, including fishery resources such as redfish, speckled trout, killifish, fish, shrimp, and crabs, avian resources (e.g., migratory, wading and shore birds), and other wildlife (e.g. mink and muskrat). Increasing the habitat value of this area would be expected to enhance the carrying capacity and biological productivity of the system and to result in increased numbers of fish and shellfish available for harvest. These ecological effects

will indirectly benefit humans by contributing to opportunities for recreation and enjoyment of the project area and the Lower Neches WMA through activities such as boating, bird watching and fishing. Implementation of the project will involve the temporary use of equipment or activities that will increase noise and the level of human activity in the project area for a short period of time. No other negative socio-economic effects are expected due to this project.

5.2 Selected Restoration Alternative (Contingent): Marsh Creation via Terracing in the Nelda Stark Unit of the Lower Neches WMA (the "Bessie Heights Terracing Project")

This project alternative involves the construction of 28 acres of coastal marsh habitat in the Nelda Stark Unit in the Lower Neches WMA through the construction of earthen terraces using existing on-site material. This material would be supplied by mining of adjacent, barren sediments. Terrace surfaces would be hand planted with indigenous plant species [likely a mix of smooth cordgrass (*S. alterniflora*), salt meadow cordgrass, California bulrush, saltmarsh bulrush, and/or bulltongue]. These species occur either in or near the vicinity of the project site and, as such, are adapted to and should withstand the range of salinities that occurs within the Bessie Heights area. The project would be undertaken immediately adjacent to the site of the Bessie Heights Dredged Material project described in Section 5.1. The project site is owned and managed by TPWD.

This alternative differs from the Bessie Heights Dredged Material Project primarily in the method that would be used for marsh construction. For this project, local material would be excavated and "stacked" to construct terraces (ridges) averaging 12 inches above the mean high water line. The terraces are generally designed in square cells that form a checkerboard pattern. The cells are not connected at the corners to allow for water movement and fisheries access. Individual cells will be approximately one acre in size. Individual terraces will be approximately 160 feet in length, 14 feet across from toe to toe and will be constructed at the center of each side to provide for a hydrological connection at the corners of each cell.

Significant portions of the area are currently too deep to support tidal marsh vegetation or to allow use by sediment probing birds, making it a lesser quality habitat for estuarine finfish, invertebrates, wading and shore birds. Wind-induced turbidity also reduces the value of the shallow open water areas as habitat for aquatic organisms.

5.2.1 Evaluation of Alternative

Terracing is another cost effective technique for creating marsh wetlands. It has been utilized in recent years with greater frequency along the Texas coast and examples of marshes successfully created by this method exist in southeast Texas. Terracing is effective because the elevation of the submerged substrate is raised to a level that will allow emergent vegetation growth and, once established, the terraces promote the

deposition and retention of suspended sediments, allowing for continued expansion of emergent marshes. The design maximizes the edge effects of the vegetation and, despite the "cell" design, the marsh created by this method has a very natural appearance.

Fill material is needed to create the terraces and under this project alternative that material would be supplied by mining of adjacent undisturbed, unvegetated sediments. The costs of producing and moving this material to create terraces is an additional component cost of this restoration action, making this a slightly higher cost option for the Trustees to implement when compared to both the Bessie Heights Dredge Material and Rose Hill Projects, where the fill material is generated at a minimal cost to the Trustees.

Some shallow water habitat and associated benthic organisms will be lost when borrow material is stacked within the restoration site to support emergent vegetation, but the increased productivity of the created habitat will offset these losses. The removal and on-site placement of sediment material to create the terraces will involve additional impacts such as temporary turbidity or other localized effects on surface water quality, but these are generally minimized through measures identified in planning and carried out during implementation and, if they occur, will be of short duration (a few days). Also, in terrace creation, these impacts are usually much less than those associated with building marsh with hydraulically placed dredge material.

A terracing project identical to that described in this section is currently underway at the project site so the Bessie Heights Terracing Project would represent an expansion of an on-going restoration effort in this area. Initial cursory sediment testing was performed by scientists from Prairie View A&M with more detailed testing and analysis performed by Professional Services Industries, Inc. The testing and analysis conducted for the current project indicates that adjacent sediments will support terraces for the proposed Project. A one-acre pilot study was recently initiated at the site to provide further evaluation of the quality and stability of these sediments and information from the current project indicates the Bessie Heights Terracing Project is technically feasible and has the potential to successfully restore marsh. Further, information from the work underway, including the pilot project, will be invaluable in directing the construction of the Bessie Heights Terracing Project and ensuring its long-term success.

Because the restoration site is owned by TPWD, marsh restoration can be implemented without additional land acquisition costs. Siting in the WMA allows the project to be included in a larger, contiguous area of undeveloped and protected habitat. This strategy increases the likelihood of restoration success, yields greater benefits to fish and wildlife, enhances the public values associated with this conservation area, and is generally preferable to implementing restoration in smaller, isolated or non-contiguous areas. Siting restoration within the WMA will result in a larger area of protected, heterogeneous habitat than would be possible at other locations. Further, as a designated WMA, the area is already dedicated and managed

by TPWD for the long-term preservation and conservation of natural resources, including estuarine habitats, a management framework that is fully consistent with the Trustees' restoration goal. Under these ownership, management and ecological conditions, the created marsh will be self-sustaining, require limited or no active intervention following construction and initial plantings to achieve functional success and will provide an uninterrupted flow of services into the future. The nature of the project and the setting for construction would present no human health or safety issues beyond those met by standard procedures for safe construction. TPWD supports this restoration effort and a public meeting held to evaluate public interest in the terracing project underway has indicated no opposition to a project of this type in the Bessie Heights area.

If the Bessie Heights Dredged Material Project is significantly delayed as outlined in 5.1, the Trustees' evaluation shifts in favor of selecting the Bessie Heights Terracing Project for implementation under this RP/EA as the Terracing Project would then provide the most expeditious opportunity to implement appropriate and cost-effective restoration. In the event, then, that the Bessie Heights project is significantly delayed as described in 5.1 above, the Bessie Heights Terracing Project will be implemented under this RP/EA in lieu of the Bessie Heights Dredged Material Project to ensure that restoration under this plan will be achieved expeditiously

5.2.2 Ecological and Socio-Economic Impacts

The project area is within the Sabine Lake system, approximately 5.2 miles from the Bailey Site (see Figure 5.1), and provides numerous opportunities for estuarine marsh creation and enhancement though the reestablishment of elevations needed to support marsh vegetation. Construction of vegetated terraces is a proven, cost effective technique for creating marsh wetlands along the Texas coast. Examples of marshes created by this method are numerous in southeast Texas and monitoring of these created wetlands has shown these restoration efforts have been successful in establishing functional low salinity habitat.

This restoration is expected to increase habitat diversity, increase and enhance utilization of the area by fish and wildlife, and reduce the loss of emergent marsh habitat in the vicinity of the restoration site. This project will create terraces suitable for the growth of emergent plant communities, decrease the rate of water flow across the site, decrease the rate of sediment loss, and increase the rate of sediment accretion. The habitat types that will be created include supra-tidal marsh (supporting Gulf cordgrass and salt meadow cordgrass) on ridges, emergent intertidal marsh along edges, and isolated pockets of deeper water along borrow areas.

Numerous resources will use the habitat created and improved under this alternative, including fishery resources such as red drum , spotted seatrout, killifish, fish, shrimp, and crabs, avian resources (e.g., migratory, wading and shore birds), and other wildlife (e.g. mink and muskrat). Increasing the habitat value of this area would be expected to

enhance the carrying capacity and biological productivity of the system and to result in increased numbers of fish and shellfish available for harvest. These ecological effects will indirectly benefit humans by contributing to opportunities for recreation and enjoyment of the project area and the Lower Neches WMA through activities such as boating, bird watching and fishing.

Implementation of the project will involve the temporary use of equipment or activities that will increase noise and the level of human activity in the project area for a short period of time. No other negative socio-economic effects are expected due to this project.

5.3 Marsh Creation via beneficial use of lower Neches River dredge material in the old Rose Hill Oil Field (the "Rose Hill Project") (Non-Selected Alternative)

This project involves the construction of a minimum of 28 coastal marsh habitat acres within an area commonly known as the old Rose Hill Oil Field by hydraulically placing lower Neches River maintenance dredge material in subsided areas to elevations appropriate to support emergent marsh vegetation (approximately sea level). The project would incorporate channels and include planting with appropriate marsh vegetation. The habitat types that would be created include supra-tidal marsh, emergent intertidal marsh along channels, intertidal mudflats, and isolated pockets of deeper water.

The Rose Hill project area was historically a forested wetland that declined in ecological value due to the cumulative effects of past land uses. The area was heavily logged after the turn of the 20th century. Canals were created to float out the large bald cypress logs. Subsequent to this period of heavy logging, subsidence of the area occurred due to oil and gas extraction and saltwater intrusion (possibly facilitated by the logging canals), causing much of the remaining wetland to be converted to open water. Currently, about 650 acres of the area are predominately open water with some isolated or intermittent patches of mixed emergent fresh and brackish marsh. Significant portions of the area are presently too deep to support tidal marsh vegetation or to allow use by sediment probing birds, making it a lesser quality habitat for estuarine finfish, invertebrates, wading and shore birds. High water temperatures and wind-induced turbidity also reduce the value of the shallow open water areas as habitat for aquatic resources. The site is privately owned.

The dredging to support implementation of the Rose Hill project is currently being planned by the USCOE.

5.3.1 Evaluation of Alternative

The Rose Hill Project area is within the Sabine Lake system, approximately 11.4 miles from the Bailey Site (see Figure 5.1). Although within the Neches River watershed, the site is further removed from the Bailey site than the restoration action(s) selected to

occur in the Bessie Heights area of the system. Like the Bessie Heights projects' site, the Rose Hill Project location provides numerous opportunities for low salinity estuarine marsh/wetland creation and enhancement through the reestablishment of elevations needed to support marsh vegetation. However, the Rose Hill site was previously a freshwater, forested environment. Restoration of the site through construction of emergent marsh would benefit the environment, but would not serve to restore the site to original ecological conditions.

The Rose Hill project would also be implemented using the same cost effective technique for creating marsh wetlands along the Texas coast: hydraulic placement of maintenance dredge material. The technique also recovers valuable wetland soil material often lost to the local sediment budget. As noted previously, examples of marshes created by this method are numerous in southeast Texas and monitoring of these created wetlands has shown these restoration efforts have been successful in establishing functional low salinity habitat. As with the Bessie Heights Dredge Material Project alternative, the dredge material to be used in the Rose Hill Project would be produced by the USCOE incident to scheduled maintenance dredging of existing navigation channels in the area and is available at a minimal cost to the Trustees. The Trustees would be responsible for any additional costs the USCOE might incur over and above those associated with its routine dredge material disposal practice (i.e., to pump the dredge material farther and to move the pipe during the process). The beneficial use of such dredge material again means the restoration fill material could be provided without causing effects or disruptions to habitats or resources associated with mining of soils or productive sediments from other areas. Some benthic organisms would be smothered when the material is placed within the restoration site, but such organisms would be expected to rapidly recolonize these areas (~ 0.5 -2 years). Other short term impacts to natural resources might be associated with on-site placement of dredge material and channel creation, such as temporary turbidity or other localized effects on surface water quality, but these would generally be minimized through measures identified in planning and carried out during implementation.

Marsh restoration in the Rose Hill project area would not require the Trustees to incur land acquisition costs. However, since the site is privately owned, the Trustees' ability to ensure the restoration site and its services would be appropriately protected and managed consistent with this restoration plan is presently uncertain. The landowner has indicated an interest in working with the Trustees to restore habitats on the project site, including a willingness to accept restrictions such as via a conservation easement, however, the issues and mechanisms needed to accomplish this have not yet been worked out and this represents an added component (and cost) of restoration for this project alternative. Further, active oil and gas fields exist at the site and the owner of the mineral estate has indicated plans to expand exploration for oil and gas at the project site. This interest adds greater uncertainty to the future management of the project and its compatibility with surrounding land use, would complicate the process of establishing adequate future protection of the project area for public restoration purposes, and likely significantly add to the time and cost to ensure restoration plan objectives would be met under this project alternative.

Maintenance dredging for the Neches River in the vicinity of the Rose Hill project area is scheduled for 2004. As such, the Rose Hill project alternative does not currently represent as timely an opportunity for the Trustees to implement and achieve restoration as the selected restoration action(s).

5.3.2 Ecological and Socio-Economic Impacts

This restoration, by achieving greater plant species diversity at lower elevations, would be expected to increase habitat diversity, increase and enhance utilization of the area by fish and wildlife, and stop the loss of emergent marsh habitat in the vicinity of the restoration site. This project would re-establish bottom conditions necessary for the growth of emergent plant communities, decrease the rate of water flow across the site, decrease the rate of sediment loss, and increase the rate of sediment accretion. The established plant community would be expected to trap large amounts of fine material and should result in accumulation of additional silt layers.

The habitat types that would be created include supra-tidal marsh (supporting saltmeadow cordgrass), emergent smooth cordgrass intertidal marsh along edges, intertidal mudflats, and isolated pockets of deeper smooth cordgrass.

Numerous aquatic resources would use the habitat created and improved under this alternative, including fishery resources such as largemouth bass, panfish, red drum, spotted seatrout, killifish, fish, shrimp, and crabs. Wildlife that could be expected to use the created habitats include alligators, clapper rails, nesting terns, and migratory shorebirds and waterbirds.

Increasing the habitat value of this area would be expected to enhance the carrying capacity and biological productivity of the estuarine system and to result in increased numbers of fish and shellfish. These ecological effects would indirectly benefit humans by contributing to opportunities for recreation and enjoyment of the Lower Neches River/Sabine Lake area through activities such as boating, bird watching and fishing. Implementation of the project will involve the temporary use of equipment or activities that will increase noise and the level of human activity in the project area for a short period of time. It would also involve establishing restrictions on private land use, albeit with the consent of both the landowner and owner of the underlying mineral interests, which could potentially affect property interests or values within the state and local revenue base. No other potentially negative socio-economic effects would be expected due to this project.

5.4 Marsh Enhancement via Hydraulic Restoration of Keith-Clam Lake Complex Using Constructed Water Control Structure (Non-Selected Alternative)

This project alternative involves construction of a single water control structure in the McFaddin WMA along the ICW and adjacent to the Keith-Clam Lake Complex marsh complex to aid in the control of salinity fluxes from the Sabine-Neches and Gulf Inter-

coastal Waterways (ICWs) in order to improve the Keith-Clam Lake Complex marsh complex through salinity management.

The Keith-Clam Lake Complex is within the Sabine Lake system, approximately 29 miles from the Bailey Site (see Figure 5.1). It is located south of (below) the Inter-Coastal Waterway (ICW), adjacent to the McFaddin WMA marsh complex managed by the USFWS. It is currently characterized by tidally-influenced brackish marsh, with little net water outflow. The system historically received freshwater from the Salt Bayou watershed and functioned as part of the upper estuary within the Sabine Lake estuarine ecosystem, i.e., the tidal, low salinity portion. Construction of the ICW in 1930 prevented the further flow of freshwater from Salt Bayou (through Star Lake) and into the Keith-Clam Lake Complex. The only freshwater that enters the Keith-Clam Lake Complex now is from local rainfall. To compound the situation, the ICW also serves as a conduit for saltwater. Saltwater intrusion into the marsh areas north of the ICW has caused serious degradation and interference with the ecological function of these areas.

The USFWS manages the adjacent McFaddin WMA marsh complex to preserve and protect low salinity wetlands. This is achieved through the use of water control structures and levees established to allow water managers to mimic the system's historic hydrology. Four water control structures were used in the past. Two of these were located on the ICW and served as freshwater outlets and brackish water inlets. Erosion along the ICW has caused the loss of these two structures. Two water control structures remain on Star Lake to manage freshwater outflow into Clam Lake and then into Keith Lake. Currently, these structures are used only as freshwater outlets.

The overall goal of water management of the area is to restore or maintain the historic hydrologic conditions across the upper part of the estuarine system. These goals are presently hampered by a lack of freshwater and the poor condition or loss of the water control structures that are key tools in management of salinity conditions (i.e., target water elevations and salinities). The inability to meet these goals has adversely impacted the vegetation structure of the marsh complex and impaired its function and value as estuarine wetlands.

5.4.1 Evaluation of Alternative

Better management of water conditions in the Star-Keith-Clam Lake Complex is needed to reverse declines in marsh quality across the upper estuary. Water control structures are essential tools in this process. An adequate number of functional structures is needed to allow for water management which will address the present salinity-stressed system, reverse its transition from low salinity habitat, and help restore the historic vegetative community. This restoration project alternative would permit hydraulic modifications to achieve creation or enhancement of estuarine marsh services.

The Keith-Clam Lake Complex's location adjacent to the McFaddin WMA is beneficial as it would provide a larger area of protected, heterogeneous habitat. The area of marsh that would benefit from this alternative, however, is privately owned. Provisions for the future protection and management of this area would need to be established in order for the public benefits of restoration under this alternative to realized. A management plan would have to be developed which provides guidance for the full complex in order to prevent further degradation and improve the marshes of the Keith-Clam Lake Complex and McFaddin WMA. This additional requirement would be expected to add significantly to the time and cost to ensure restoration objectives would be met if this project were used.

Construction of the water control structure contemplated here is technically feasible and its role in effective water management for marsh preservation and enhancement is generally recognized. To preserve the integrity and function of the structure over time, periodic maintenance or repair would likely be required. This is a project disadvantage where other, more self-sustaining options are available. Construction of a single structure probably cannot influence the entire 31,000 acre system but likely would influence and improve salinity conditions and result in a corresponding increase or enhancement of marsh functions over a sizable area. The potential increase in or enhancement of marsh services may be equal to or greater than the service equivalent to be gained by restoration under this plan but the area and degree of improvement attributable to management actions involving a single structure are more difficult to predict. In this instance, there is less certainty as to whether this project would achieve the goal of this plan. The utility of construction of a single structure would also be less where other measures are still needed to effectively meet the management goal.

5.4.2 Ecological and Socio-Economic Impacts

Construction of an appropriately sized and placed water control structure would allow more intensive management of stressed wetlands by the USFWS and, through that management, enhance low salinity habitats in its area of influence. Implementation of this project would be expected to improve the ecology of the wetlands in this area. It would be expected to greatly increase or improve the service of the area of influence as nursery habitat for estuarine resources and to benefit a wide variety of fish and wildlife, including those of recreational and commercial importance. Salinity could be maintained within ranges appropriate for estuarine dependant decapods (shrimp and crabs) via timely operation of the structure and, if appropriately designed, the structure could allow migration of decapods and fish between the system and the greater estuary.

Owing to its distance from highways and recreational waterways, these benefits would occur in areas without ready public access. Benefits to human would accrue more directly from the ecological service flows as they extend, albeit in a reduced manner, to areas allowing the public better access or opportunities to take advantage of the resources. Increases in organism availability should result in enhancement of the

public's benefits, e.g., more fish should mean more fish caught by fishers. Construction may disturb or displace resources within the footprint and immediate vicinity of the project area, but these impacts would be minimal, largely temporary and result in no long term effects other than the positive effects associated with the intended future use of the structure. No negative socio-economic effects would be expected due to this project.

5.5 Marsh Enhancement via Restoration of Freshwater Flow between Salt Bayou and Star Lake Using Constructed Inverted Siphon System (Non-Selected Alternative)

This project alternative involves construction of a system of inverted siphons under the ICW to re-establish freshwater flow from the Spindletop watershed to the Star Lake marsh complex south of the ICW (see Figure 5.1). The inverted siphon system would provide a source of freshwater to be directed or diverted from Salt Bayou into the Star Lake marsh complex in the McFaddin WMA.

Frequent inundation of the Star Lake marsh complex by seawater during high tides or storms has introduced high salinities into the marsh complex and resulted in both vegetation shifts and losses. In addition, a documented drought spanning the last ten years has reduced the freshwater available to the Star Lake marshes. The degradation of this system has become more serious in the last few years due to the long-term drought and periodic tropical storms, which extremes have combined to significantly alter the salinities in the area.

The Star Lake marsh complex is another component of the larger area, as discussed in 5.4, needing better water management to restore or maintain the historic hydrologic conditions across the upper part of the estuarine system. As already noted, these goals are presently hampered by a lack of freshwater and the poor condition or loss of the water control structures that are key tools in management of salinity conditions (i.e., target water elevations and salinities). The inability to meet these goals has adversely impacted the vegetation structure of the marsh complex and impaired its function and value as wetlands. For the Star Lake marsh complex, the extended drought period has severely compromised the ability to achieve target elevations and salinities with existing management tools. This has adversely affected the overall ecological health of the Star Lake marshes.

5.5.1 Evaluation of Alternative

As discussed, better water management across the Star-Keith-Clam Lake Complex is needed to reverse the decline in quality of the estuarine marshes in these areas and help to restore the historic vegetative community in these marshes. This alternative would rely on hydraulic modification or manipulation of the system to create or restore estuarine marsh services.

The resource improvements and benefits of this project would generally occur within the McFaddin WMA. As such, this alternative would contribute to improvement of a larger area of protected, heterogeneous habitat, which is an advantage in wetlands restoration. To be effective at preventing further degradation and improving the marshes within the McFaddin WMA, use of the inverted siphon system would need to be recognized and integrated in a broader plan developed to provide management guidance for the larger marsh complex. This additional requirement under this project alternative would be expected to add significantly to the time and cost to ensure restoration objectives would be met if this project were used. The project site is privately owned and, in this case, the ability to implement this project and realize its benefits to the McFaddin marshes into the future is less certain. Legal protections or measures to ensure this flow of services into the future would have to be established and the relationship between private property owners and another federal agency (government landowner for Big Hill Strategic Petroleum Reserve) has seen a divergence of private and public interests in recent years.

As with the single water control structure, the construction of this siphon system alone probably cannot influence the entire 31,000 acre system. Nonetheless, it likely could influence and improve salinity conditions and result in a corresponding increase or enhancement of marsh functions over a sizable area. The marsh service increases or enhancements under this alternative might be equal to or greater than the service equivalent required to achieve the objective of this restoration plan but the area of influence and degree of improvement attributable to the siphon system alone are more difficult to predict. The likelihood of restoration success under this plan would, likewise, be more difficult to access than other options. Similarly, its utility as a standalone measure would also be less where other activities are also needed to effectively meet the overall management goal for the system. The project appears to be technically feasible, but costs associated with constructing the siphons and levees would likely to be higher than for other restoration alternatives considered in this RP/EA. Future maintenance and repairs may also be needed. The cost of the full project may exceed what is available from the Trustees to implement restoration under this plan and, particularly, to achieve service enhancements sufficient to meet the 28-acre project minimum could be prohibitive.

5.5.2 Ecological and Socio-Economic Impacts

Construction of an appropriately sized and placed inverted siphon system under the ICW would allow more intensive management of wetlands by the USFWS. Together with appropriate management, this alternative would enhance low salinity habitats in its area of influence, thereby providing improved habitat for low salinity dependant species and, if salinity is maintained within the ranges appropriate for estuarine dependant decapods (shrimp and crabs), potentially increase recruitment of species such as brown and white shrimp and blue crabs. Implementation of this project would be expected to improve services from the area for a wide variety of fish and wildlife.

Like the Keith-Clam Lake project alternative discussed in 5.4, public access to the area to be improved by this project is limited due to the distance from highways and recreational waterways. The benefits to the public would be from ecological benefits extending, albeit in a reduced manner, into areas where the public has more ready access to resources and can take advantage, recreationally or commercially, of any increased numbers of fish and shellfish. Construction of this system might also disturb or displace resources within the footprint and immediate vicinity of the project area, but these impacts would be minimal, largely temporary and result in no long term effects other than the positive effects associated with the intended future use of the siphons. No negative socio-economic effects would be are expected due to this project.

5.6 Marsh Creation via Terracing in Old River Unit of Lower Neches River (Non-Selected Alternative)

This project alternative involves the construction of 28 acres of coastal marsh habitat in the Old River Unit of the Lower Neches WMA, through the construction of earthen terraces using existing on-site material. The project site is owned and operated by TPWD.

This alternative differs from the Bessie Heights Dredge Material and Rose City Project alternatives in the method that would be used for marsh construction. Like the Bessie Heights Terracing Project, the method of construction would excavate and "stack" local material to construct terraces (ridges) averaging 12 inches above the mean high water line, in water with an average depth of 18 inches, the terraces would be designed to maximize edge effects of the vegetation, and the terrace surfaces would be planted with appropriate marsh vegetation.

The candidate project area was historically an uninterrupted low salinity tidal marsh with little open water. Subsidence due to logging, sulfide poisoning and saltwater intrusion caused much of the marsh to be converted to open water. The project area is predominately open water with some isolated or intermittent patches of mixed emergent fresh and brackish marsh. Significant portions of the area are currently too deep to support tidal marsh vegetation or to allow use by sediment probing birds, making it a lesser quality habitat for estuarine finfish, invertebrates, wading and shore birds. High water temperatures and wind-induced turbidity also reduce the value of the shallow open water areas as habitat for aquatic organisms.

5.6.1 Evaluation of Alternative

This project area is within the Neches River watershed, approximately 1.5 miles from the Bailey Site (see Figure 5.1), and provides numerous estuarine marsh creation and enhancement opportunities. Like the Bessie Heights Terracing Project, the restoration site is owned by TPWD, so restoration under this option could be implemented without

additional land acquisition costs and the area is already dedicated and managed by TPWD for the long-term protection, preservation and conservation of natural resources, which is fully consistent with the Trustees' restoration goal. The project site would also benefit from being part of a larger, contiguous area of undeveloped and protected habitat, which increases the likelihood of restoration success, yields greater benefits to fish and wildlife, enhances the public values associated with this conservation area, and is generally preferable to implementing restoration in smaller, isolated or non-contiguous areas. Further, the project would restore marsh through terracing, the same method used in the Bessie Heights Terracing Project to restore marsh. As the Bessie Heights Terracing Project evaluation described, terracing is a cost effective and feasible technique for creating marsh wetlands, used with success in recent years along the Texas coast .

Under this alternative, restoration would occur closer to the Bailey Site than any other project alternative, however, public access to the restoration area is significantly restricted at this site via Hwy 73. Some parts of the area are open to the public for day use via access permits and there are no park facilities or potable water. Restoration at this site, therefore, offers less opportunity to provide other beneficial services to the public, such as for non-consumptive (e.g., bird and wildlife viewing, photography and boating) and consumptive (e.g. hunting and fishing) recreational activities.

The fill material needed to create the terraces under this project alternative would also involve mining of adjacent, undisturbed sediments, making this a slightly higher cost option for the Trustees to implement when compared to both the Bessie Heights Dredge Material and Rose Hill Projects, where the fill material is generated at minimal additional cost to the Trustees. Further, excavating fill material in this manner will disrupt sediment communities to a greater degree than the production of fill material through the routine dredging of sedimentation found in deeper navigation channels. Benthic organisms would be lost as a result of sediment removal and would be smothered when the material is placed within the restoration site, but these effects would be more localized and confined to more concise areas and such organisms – both at the excavation and fill sites – would be expected to rapidly recolonize these areas (~ 0.5 -2 years). The removal and on-site placement of sediment material to create the terraces would involve additional impacts such as temporary turbidity or other localized effects on surface water quality, but these are generally minimized through measures identified in planning and carried out during implementation. TPWD recognizes the value of restoration at this site and no public opposition to this project was apparent during scoping by the Trustees.

5.6.2 Ecological and Socio-Economic Impacts

This restoration would be expected to increase habitat diversity, increase and enhance utilization of the area by fish and wildlife, and stop the loss of emergent marsh habitat in the vicinity of the restoration site. This project would re-establish bottom conditions

necessary for the growth of emergent plant communities, decrease the rate of water flow across the site, decrease the rate of sediment loss, and increase the rate of sediment accretion. The habitat types created would include supra-tidal marsh on ridges, emergent intertidal marsh along edges, intertidal mudflats, and isolated pockets of deeper water.

Numerous resources would use the habitat created and improved under this alternative, including fishery resources such as red drum, spotted seatrout, killifish, fish, shrimp, and crabs, avian resources (e.g., migratory, wading and shore birds), and other wildlife (e.g. mink and muskrat). Implementation of the alternative would be expected to enhance the carrying capacity and biological productivity of the estuarine system and to result in increased numbers of fish and shellfish. These effects will, in turn, contribute to opportunities for recreation and enjoyment of the Lower Neches River/Sabine Lake area. As noted above, however, the restoration project area has significantly restricted public access, which limits recreational use and enjoyment of the area by the public. Implementation of the project would involve the temporary use of equipment or activities that will increase noise and the level of human activity in the project area for a short period of time. No other negative socio-economic effects would be expected due to this project.

5.7 No Action (Non-Selected Alternative)

Under this alternative, the Trustees would take no action to create or restore estuarine marsh services to compensate for the resources losses attributed to the Bailey Site.

5.7.1 Evaluation of Alternative

As outlined in Section 2.0, the Trustees determined that resources or resource services were lost due to the placement of hazardous substances in certain areas of the Site, were injured due to the migration of hazardous substances into the North Marsh, were likely harmed by exposure to surface waters contaminated by Site releases, and were injured or lost as a result of the excavation and capping undertaken as part of the remedy. As a result of these impacts, the Trustees identified seven habitats with reduced or lost ecological services due to the hazardous substances released at the Site. While the remedy addressed the actions needed to allow injured resources to recover, it did not compensate for these resources service losses. Such compensation serves to make the public whole for the full harm done to its natural resources by the hazardous substances releases at the Site.

Under laws applicable to those releases, the Trustees sought and recovered compensation for these interim losses on behalf of the public and these same laws require that the Trustees use these funds to implement actions that restore, replace, or provide services equivalent to those lost. For the Bailey Site, the amount recovered by the Trustees represents the estimated costs of implementing restoration for that

purpose. Under the "No Action" alternative, restoration actions needed to make the environment and the public whole for its losses would not occur. This is inconsistent with the laws applicable to the Trustees, the Consent Decree settlement, and the compensation objective of this restoration plan. Thus, the Trustees have determined that the "no action" alternative (*i.e.*, no compensatory restoration) must be rejected on that basis.

Table 5-1: Summary - Trustees' Evaluation of Restoration Alternatives

Restoration Alternative	Consistency with Restoration Objective (incl. future management)	Likelihood of Success (incl. technical feasibility)	Cost of Restoration	Avoid/Minimize Resource Injury	Maximize Resource Benefits	Effect on Public Safety
Marsh Creation/Bessie Heights Dredge Project, (SELECTED)	+	+	+	+	+	0
Marsh Creation/Bessie Heights Terracing Project (SELECTED/ CONTINGENT[1])	+	+	+	+	+	0
Marsh Creation/Rose Hill Project	0	+	0	+	+	0
Marsh Enhancement/Keith-Clam Lakes Water Control Structure	0	+	-	+	+	0
Marsh Enhancement/Salt Bayou-Star Lake Inverted Siphon	0	+	-	+	+	0
Marsh Creation via Terracing, Old River Unit	+	+	+	+	-	0
No action	-	+	+	-	-	0

[1] *To be implemented if opportunity to perform Bessie Heights Dredge Project significantly delayed, as described in Section 5.1.*

6.0 NEPA: Analysis of Significance of Impacts; Finding of No Significant Impact

As noted in Section 1.2, NEPA requires federal agencies to produce an environmental impact statement (EIS) if they are contemplating implementation of a major federal action expected to have significant impacts on the quality of the human environment. NEPA defines the human environment comprehensively to include the "natural and physical environment and the relationship of people with that environment." 40 C.F.R. Section 1508.14. All reasonably foreseeable direct and indirect effects of implementing a project, including beneficial effect, must be evaluated. 40 C.F.R. Section 1508.8. Federal agencies prepare an environmental assessment (EA) to consider these effects and evaluate the need for an EIS.

In accordance with NEPA and its implementing regulations, an EA was integrated into this RP/EA. The main body of this RP/EA summarizes the environmental setting, describes the purpose and need for restoration, identifies the alternatives considered, assesses their applicability and potential environmental consequences and

summarizes the opportunity the Trustees provided for public participation in the development of this RP/EA. This section of the document specifically addresses the minimum criteria and factors outlined in the NEPA regulations, at Section 1508.27, for evaluating the potential significance of proposed actions.

The regulations explain that significance embodies considerations of both context and intensity. In the case of site-specific actions, such as those proposed and pending selection in this RP/EA, the relevant context for considering significance of action is local, as opposed to national or worldwide.

With respect to intensity of the impacts of proposed actions, the NEPA regulations suggest consideration of ten factors:

(1) likely impacts of the proposed project;

(2) likely effects of the project on public health and safety;

(3) unique characteristics of the geographic area in which the project is to be implemented;

(4) controversial aspects of the project or its likely effects;

(5) degree to which possible effects of implementing the project are highly uncertain or involve unknown risks;

(6) precedential effect of the project on future actions that may significantly affect the human environment;

(7) possible significance of cumulative impacts from implementing this and other similar projects;

(8) effects of the project on National Historic Places, or likely impacts to significant cultural, scientific or historic resources;

(9) degree to which the project may adversely affect endangered or threatened species or their critical habitat;

(10) likely violations of environmental protection laws.

40 C.F.R. Section 1508.27. These factors, along with the federal Trustees' conclusion concerning the likely significance of impacts associated with the selected restoration actions, are reviewed below.

6.1 Marsh Habitat Restoration via the Dredge Project and the Terracing Project in the Nelda Stark Unit of the Lower Neches WMA

(1) Nature of Likely Impacts

Both of these restoration actions involve the restoration of marsh habitat through marsh creation. For the Bessie Heights Dredge Project, marsh creation would be accomplished by hydraulic placement of lower Neches River maintenance dredge

material in subsided areas in the Lower Neches WMA to establish elevations (approximate sea level) appropriate to support emergent marsh vegetation. For the Bessie Heights Terracing Project, marsh would be created via the construction of earthen terraces by excavation and stacking of on-site material. Both would incorporate channels (via managed distribution of fill for the Dredge Material Project; by cell design and arrangement in the Terracing Project) and hand plantings of indigenous marsh vegetation.

Both projects can be expected to have both direct and indirect effects. Under either approach to marsh creation, the proposed actions will have direct effects of both a temporary and longer term nature. For either construction method, marsh creation may have direct negative impacts on some resources in localized areas in the short term. Such impacts would primarily be the death or disruption of benthic organisms at the points where sediment dredging/excavation occurs and fill is deposited but such organisms are expected to rapidly recolonize restored areas (~ 0.5 -2 years). The created marsh habitat will incorporate unvegetated open water bottoms habitats (~ 30%) for utilization by benthic communities. Additional impacts would be to water quality and species utilization in the immediate vicinity of marsh construction activities from additional turbidity associated with dredge and fill activities and the noise and/or presence of equipment and humans during implementation. These effects, if they occur, would occur only during the active construction phase, in localized areas and are generally minimized through measures identified in planning, specified in project permits, and carried out during implementation. Construction activities would also temporarily displace or reduce the quality of other potential human uses of the immediate area (i.e., for recreation), this effect would also be transient and likely de minimus given that alternate recreation sites are readily available in the vicinity of Bessie Heights. The short term impacts, while negative, will be minimal.

Under either project approach, the direct longer term effects of the marsh restoration actions are overwhelmingly beneficial. The created marsh habitat will provide increased nursery, foraging, and cover habitat for species that inhabit the area, help mitigate wave energy which contributes to subsidence and erosion, and provide an increased flow of organic material that will benefit the Neches River ecosystem generally by providing a source of organic carbon which supplies energy supporting the estuarine food web. Although marsh restoration provides most of the same services as unvegetated sub-tidal sediments, marsh is a more productive habitat and its creation would increase these same services at the restoration site. The increased habitat for birds, fish and other wildlife species will also enhance species productivity in the system. The increase in habitat and enhanced species productivity is expected to produce indirect environmental benefits by enhancing the future value and use of the area for both consumptive (fishing; hunting) and non-consumptive (boating; bird watching) recreational activities.

Neither of the proposed restoration projects involves any activity that could potentially result in the introduction or spread of a non-indigenous species as all planting material

will be selectively culled from existing areas of estuarine vegetation in or near the project site.

(2) Effects on public health and safety

The Trustees do not expect the creation of marsh through either project to have any impacts on public health and safety. The creation of marsh, by either approach, would neither present nor result in any unique physical hazards to humans. No pollution or toxic discharges would be associated with marsh creation, acquisition, or enhancement.

(3) Unique characteristics of the geographic area

For both projects, the proposed restoration would be undertaken in an area of the Lower Neches WMA that is today predominately open water with unvegetated sediments and some isolated or intermittent patches of mixed emergent fresh and brackish marsh. The area was historically an uninterrupted low salinity tidal marsh with little open water; its present condition and characteristics reflect the substantial loss of this ecologically productive habitat due to subsidence from oil and gas extraction and saltwater intrusion. Large portions of the area are presently too deep to support tidal marsh vegetation. The proposed restoration actions would increase sediment elevations in the area to restore historic habitat conditions to the area. The restoration activities will affect only the unvegetated sediment areas. No unique or rare habitat would be affected due to the restoration of marsh to previous areas of marshland.

(4) Controversial aspects of the project or its effects

The Trustees do not expect any controversy to arise in connection with marsh creation with respect to either project approach. Marsh creation has been implemented, both by making beneficial use of USCOE dredge material and the terracing method, by these and other Trustees in Texas and Louisiana, with no adverse reaction from the public. Current governmental policy supports creating marshes along the Gulf Coast of Texas. The Trustees anticipate that the citizens of Texas would support either of the marsh restoration projects.

(5) Uncertain effects or unknown risks

Both marsh creation methods have been used by the Trustees and others and been shown to be a proven, cost effective technique for creating functional low salinity marshes along the Texas coast. Given their collective past experience with marsh creation and familiarity with both methods, the Trustees do not believe there are uncertain effects or unknown risks to the environment associated with implementing either of these restoration actions. Further, identified effects or risks have or will be minimized incident to planning and environmental permitting processes. Implementation of the project will not proceed prior to the further surveys, engineering analyses or consultations needed to identify and address any significant uncertainties, particularly those that will be key to ensuring restoration success.

(6) Precedential effects of implementing the project

The Trustees have pursued marsh restoration projects to compensate for other natural resource damages claims in Texas. Marsh restoration projects are regularly implemented along the Texas coast to protect against erosion, address sediment losses, and to preserve or restore coastal habitats and such projects have used both beneficial use of USCOE dredge material and the terracing method. The proposed restoration actions, therefore, set no precedents for future actions of a type that would significantly affect the quality of the human environment.

(7) Possible, significant cumulative impacts

Project effects will be cumulative in the sense that the creation of marsh will provide resource services into the future. The Trustees, however, know of no impacts to the environment to which the proposed restoration actions would contribute that, cumulatively, would constitute a significant impact on the quality of the human environment. Both projects would only restore a habitat type – low salinity marsh – that originally existed and naturally occurred in the area. Further, the actions proposed in this RP/EA are intended to restore habitat services to offset the natural resource loss of equivalent habitat services attributable to the Bailey Site. The restoration of these services is designed to make the public whole, i.e. compensation. The proposed restoration actions also are not part of any systematic or comprehensive program or plan to address the conditions along the Texas coast or in the Bessie Heights area.

(8) Effects on National Historic Sites or nationally significant cultural, scientific or historic resources

The Trustees are aware of no previously recorded archeological sites located in the area of the proposed projects. Further, as a fairly remote aquatic environment, the topographical setting of the area has a low potential for resources of cultural or historic significance. This is consistent with archeological survey information utilized by the USCOE for an area immediately adjacent to the restoration project site. See USCOE Statement of Findings; Permit Application SWG-01-27-004. The Trustees believe the proposed restoration actions will not affect any designated National Historic Site or any nationally significant cultural, scientific, or historic resources.

(9) Effects on endangered or threatened species

The Trustees know of no direct or indirect impacts of the proposed restoration actions on threatened or endangered species, or their designated critical habitats. The general locale where the restoration actions would be sited is not critical habitat for any listed species.

(10) Violation of environmental protection laws

The proposed restoration actions do not require nor do the Trustees anticipate any violation of federal, state or local laws, designed to protect the environment incident to or as a consequence of the implementation of either of the proposed actions. The

restoration actions proposed can be implemented in compliance with all applicable environmental laws.

6.2 Preliminary Conclusion & Finding of No Significant Impact on the Quality of the Human Environment

Based on the analysis in this Section and the other information and analyses included throughout the RP/EA as part of the environmental review process for the proposed restoration actions, the federal Trustees conclude that neither the Bessie Heights Dredge Material project ("Selected Restoration Alternative") nor the Bessie Heights Terracing Project ("Selected Restoration Alternative - Contingent") will, if implemented, result in any significant impacts on the quality of the human environment. Significant impacts were not revealed through the public review and comment process. Thus; thus, no environmental impact statement will be prepared for either of the restoration actions outlined herein.

A Finding of No Significant Impact (FONSI) based upon this Environmental Assessment, following the opportunity that the federal Trustees provided for public input on their analyses prior to project selection and implementation, will fulfill and conclude all requirements for compliance with NEPA by the federal Trustees.

7.0 COMPLIANCE WITH OTHER STATUTES, REGULATIONS, AND POLICIES

Clean Water Act (CWA), 33 U.S.C. § 1251 *et seq.*
The CWA is the principal law governing pollution control and water quality of the nation's waterways. Section 404 of the law authorizes a permit program for the beneficial uses of dredged or fill material. The Army Corps of Engineers (Corps) administers the program. In general, restoration projects, which move significant amounts of material into or out of waters or wetlands, for example, hydrologic restoration of marshes, require 404 permits. A CWA 404 permit will be obtained, as required, in order to implement any restoration action selected in this RP/EA.

Rivers and Harbors Act, 33 U.S.C. § 401 *et seq.*
The Rivers and Harbors Act regulates development and use of the nation's navigable waterways. Section 10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests the Corps with authority to regulate discharges of fill and other materials into such waters. Restoration actions that must comply with the substantive requirements of Section 404 must also comply with the substantive requirements of Section 10. Any such permit would be obtained, as required, in order to implement any restoration action selected in this RP/EA.

Coastal Zone Management Act (CZMA), 16 U.S.C. § 1451 *et seq.*, 15 C.F.R. Section § 923

The goal of the CZMA is to encourage states to preserve, protect, develop, and, where possible, restore and enhance the nation's coastal resources. Under Section 1456 of the CZMA, restoration actions undertaken or authorized by federal agencies within a state's coastal zone are required to comply, to the maximum extent practicable, with the enforceable policies of a state's federally approved Coastal Zone Management Program. NOAA and the USFWS found the restoration actions identified in this RP/EA to be consistent with the Texas Coastal Zone Management Program and submitted that determination to the appropriate state agencies for review in parallel to the release of the Draft RP/EA. The state agencies have concurred in that determination.

Endangered Species Act (ESA), 16 U.S.C. § 1531 *et seq.*, 50 C.F.R. Parts 17, 222, & 224

The ESA directs all federal agencies to conserve endangered and threatened species and their habitats to the extent their authority allows. Protection of wildlife and preservation of habitat are central objectives in this effort. Under the ESA, the Department of Commerce (through NOAA) and the Department of the Interior (through USFWS) publish lists of endangered and threatened species. Section 7 of the Act requires federal agencies to consult with these departments to minimize the effects of federal actions on these listed species. The restoration actions described in this RP/EA are not expected to adversely impact any threatened or endangered species. The actions would create or enhance habitats beneficial to supporting ecosystems for such species. Informal consultation procedures have been initiated with the USFWS and with the National Marine Fisheries Service (NOAA Fisheries) in order to ensure the restoration action is implemented in accordance with applicable provisions of the ESA.

Fish and Wildlife Conservation Act, 16 U.S.C. § 2901 *et seq.*

The restoration actions described herein will encourage the conservation of non-game fish and wildlife.

Fish and Wildlife Coordination Act (FWCA), 16 U.S.C. § 661 *et seq.*

The FWCA requires that federal agencies consult with the U.S. Fish and Wildlife Service, NOAA Fisheries, and state wildlife agencies regarding activities that affect, control, or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat utilizing these aquatic environments. Coordination is taking place by and between NOAA Fisheries, the USFWS and TPWD, the appropriate state wildlife agency. This coordination is also incorporated into compliance processes used to address the requirements of other applicable statutes, such as Section 404 of the CWA. The restoration actions described herein will have a positive effect on fish and wildlife resources.

Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1801 *et seq.*

The Magnuson-Stevens Fishery Conservation and Management Act provides for conservation and management of the Nation's fishery resources within the Exclusive Economic Zone (from the seaward boundary of every state to 200 miles from that baseline). The management goal is to achieve and maintain the optimum yield from U.S. marine fishery resources. The Act also includes a program to promote the protection of Essential Fish Habitat (EFH) in the planning of federal actions. The Trustees have initially determined that the proposed restoration actions will have no adverse effect on any EFH designated or pending designation under the Act. NOAA Fisheries is being consulted regarding this determination.

Marine Mammal Protection Act, 16 U.S.C. §1361 *et seq.*

The Marine Mammal Protection Act provides for the long-term management of and research programs for marine mammals. It places a moratorium on the taking and importing of marine mammals and marine mammal products, with limited exceptions. The Department of Commerce is responsible for whales, porpoise, seals, and sea lions. The Department of the Interior is responsible for all other marine mammals. The restoration actions described in this RP/EA will not result in any adverse effect to marine mammals.

Migratory Bird Conservation Act, 126 U.S.C. § 715 *et seq.*

The proposed restoration action will have no adverse effect on migratory birds that are likely to benefit from the establishment of new marsh habitat.

Archeological Resources Protection Act, 16 U.S.C. § 470 *et seq.*

The Trustees know of no known cultural or historic resources within or in the vicinity of the proposed restoration site. The state Office for Historic Preservation was consulted regarding another restoration project in the Bessie Heights project area and no known cultural resources in the area and no known sites or properties listed on or eligible for listing on the National Register of Historic Places were identified. The Office will be separately consulted with respect to the restoration projects described herein prior to implementation, but a similar result is anticipated.

Information Quality Guidelines issued pursuant to Public Law 106-554

Information disseminated by federal agencies to the public after October 1, 2002, is subject to information quality guidelines developed by each agency pursuant to Section 515 of Public Law 106-554 that are intended to ensure and maximize the quality of such information (i.e., the objectivity, utility and integrity of such information). The RP/EA, upon release as a draft, was identified as an information product covered by information quality guidelines established by NOAA and DOI for this purpose. The information contained herein complies with applicable guidelines.

Executive Order 12898 (59 Fed. Reg. 7629) - Environmental Justice
This Executive Order requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. EPA and the Council on Environmental Quality (CEQ) have emphasized the importance of incorporating environmental justice review in the analyses conducted by federal agencies under NEPA and of developing mitigation measures that avoid disproportionate environmental effects on minority and low-income populations. The Trustees have concluded that there are no low income or ethnic minority communities that would be adversely affected by either of the restoration projects identified herein.

Executive Order Number 11514 (34 Fed. Reg. 8,693) - Protection and Enhancement of Environmental Quality
An Environmental Assessment is integrated within the RP/EA. Environmental analyses and coordination have taken place as required by NEPA.

Executive Order Number 11990 (42 Fed. Reg. 26,961) - Protection of Wetlands
The selected restoration actions will not result in adverse effects on wetlands or the services they provide, but rather will provide for the enhancement and protection of wetlands and wetland services.

Executive Order Number 12962 (60 Fed. Reg. 30,769) - Recreational Fisheries
The selected restoration actions will not result in adverse effects on recreational fisheries but will help ensure the enhancement and protection of such fisheries.

8.0 List of Preparers

National Oceanic and Atmospheric Administration	Ron Gouguet Stephanie Fluke
Texas Commission on Environmental Quality	Richard Seiler
Texas Parks and Wildlife Department	Don Pitts Raenell Silcox Andy Tirpak
Texas General Land Office	William Grimes Rita Setzer
Fish and Wildlife Service, United States Department of the Interior	Ken Rice

9.0 List of Persons/Agencies Consulted

U. S. Army Corps of Engineers	Paula Wise
National Oceanic and Atmospheric Administration	Robert A. Taylor Gail Siani Rusty Swafford
Texas Commission on Environmental Quality	C. Sweeney
Texas Parks and Wildlife Department	Woody Woodrow M. Wezsutek
Texas General Land Office	Jeb Boyt
Fish and Wildlife Service, United States Department of the Interior	John Huffman

10.0 Trustee Council Signatures

In accordance with the Bailey Waste Disposal Site Settlement Funds Management Agreement among the Texas Natural Resource Conservation Commission, the Texas Parks and Wildlife Department, the Texas General Land Office, the National Oceanic and Atmospheric Administration, and the United States Fish and Wildlife Service, acting on behalf of the United States Department of the Interior, executed August 20, 2002, the following indicate by signature below their agreement to concur, in its entirety, with this Restoration Plan/Environmental Assessment for use to compensate for the natural resource injuries attributed to the Bailey Site and to govern the use of the funds recovered to implement such restoration.

For TCEQ: Richard Seiler 12-9-02

Richard Seiler, Team Leader
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Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

For TPWD: _____ _____

Don Pitts
Trustee Assessment & Restoration Program
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744

For TGLO: _____ _____

William Grimes
Natural Resource Damage Assessment
Texas General Land Office
P.O. Box 12873
Austin, TX 78711-2873

For NOAA: _____ _____

Ron Gouguet
NOAA Coastal Resource Coordinator
c/o U.S. EPA Region VI
1445 Ross Ave. (6H-MA)
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For TGLO: William D. Grimes 9 Jan 2003

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For NOAA: _____ _____

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For USFWS: _____ _____

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APPENDIX A: Summary of injury parameter values used in Bailey Site HEA.

	E. Waste Area	Facilities Area	N. Waste Area	N. Marsh Area	S. Waste Area	Pit B Area	Bulk Waste Area
Total Acres of Tidal Marsh or Tidal Marsh Equivalent Injured:	2.45	0.80	3.88	1.79	0.30	0.34	0.43
Year of Initial Injury:	1981	1993	1981	1981	1981	1981	1981
Current Year (at time of calculation):	1997	1997	1997	1997	1997	1997	1997
Percent of Resource Services Lost in Initial Period	100%	100%	100%	100%	50%	100%	50%
Recovery Function (with remediation):							
Functional form of recovery function	N/a	n/a	n/a	Linear	Linear	Linear	Linear
Years to full recovery following restoration activities	N/a	n/a	n/a	2	2	2	2
Year in which remedial construction project expected to be completed	Perpetuity	Perpetuity	Perpetuity	1996	1993	1997	1997
"Maturity" Function with Active Restoration:							
Functional form of recovery function	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Years to full maturity following restoration activities	5	5	5	5	5	5	5
Relative Productivity of Created to Natural Habitat	50%	50%	50%	50%	50%	50%	50%
Time Horizon for Service Production of Created Habitat	Perpetuity	Perpetuity	Perpetuity	Perpetuity	Perpetuity	Perpetuity	Perpetuity
Year in Which Compensatory Habitat Creation Project is Completed	1999	1999	1999	1999	1999	1999	1999
Real Discount Rate	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%