DAMAGE ASSESSMENT AND RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT FOR THE POINT COMFORT/LAVACA BAY NPL SITE

ECOLOGICAL INJURIES AND SERVICE LOSSES

PREPARED BY

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This Damage Assessment and Restoration Plan and Environmental Assessment for Ecological Injuries and Service Losses (DARP/EA) has been prepared by state and federal natural resource trustees to address natural resources injured and ecological services lost due to releases of hazardous substances from the Alcoa Point Comfort/Lavaca Bay NPL Site (henceforth 'Lavaca Bay Site' or 'Site'). The designated natural resource trustee agencies involved in the development of this document are the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce, the Texas Natural Resource Conservation Commission (TNRCC), the Texas General Land Office (TGLO), the Texas Parks and Wildlife Department (TPWD), and the Fish and Wildlife Service (USFWS) on behalf of the U.S. Department of the Interior (DOI) (collectively, 'the Trustees'). It is being issued as the Final DARP/EA following the public comment period on the Draft DARP/EA, which began July 14, 2000 and ended August 14, 2000, and the July 27, 2000 public meeting in Port Lavaca, Texas. No written comments were received on the Draft DARP/EA, and reaction to the proposed restoration plan at the July 27, 2000 public meeting was wholly positive. The restoration actions proposed in the Draft DARP/EA are, therefore, selected herein as the means of obtaining compensation for ecological injuries at the Site.

In the assessment process underway for this Site, the Trustees have adopted a staged approach to restoration planning. The first stage was focused on recreational fishing service losses and was covered by a Draft DARP/EA for Recreational Service Losses released on September 28, 1999 and a Revised Draft DARP/EA for Recreational Service Losses released on May 12, 2000, which reflected consideration of public comments received on the initial draft. The present document represents the second stage of restoration planning and is focused on natural resource injuries and service losses of an ecological nature. Chapters 4 through 7 of this document describe the assessment of ecological injuries and service losses (other than for terrestrial resources), including the analysis and scaling of restoration alternatives to address those losses, resulting from Site contamination and response actions initiated through 1999. More specifically, the analyses presented in Chapters 4 through 7 cover the effects of known Site contamination and initiated response actions through the end of 1999 to most natural resources. The remaining ecological injuries and losses, i.e., terrestrial resource injuries and losses after 1999, including their corresponding restoration requirements, are evaluated in Chapter 8 based on the Trustees' understanding of the final remedy that they expect EPA to select. If the final remedy does not differ materially from the remedy anticipated by the Trustees, then the evaluation in Chapter 8 will be definitive of these residual losses and compensation requirements. This information was included for public review in the Draft DARP/EA for Ecological Injuries and Service Losses that was released for public review on July 14, 2000 to allow the Trustees to complete the assessment and restoration planning process for this Site at the earliest possible time[1]. In the event the actual final remedy differs materially from that which the Trustees' have anticipated, then the analysis may not be appropriate and a third and final stage Draft DARP/EA may be required.

The second stage Draft DARP/EA was intended to inform members of the public and to solicit their comments on the Trustees' assessment of the natural resource injuries and service losses described therein and on the restoration actions which the Trustees identified to compensate for those losses. The Draft DARP/EA also served as an Environmental Assessment pursuant to the National Environmental Policy Act (NEPA) 42 United States Code (U.S.C.) Section 4321 et seq., and regulations guiding its implementation at 40 Code of Federal Regulations (C.F.R.) Part 1500. Accordingly, the Draft DARP/EA addressed the purpose and need for the proposed restoration actions, the restoration alternatives considered, and the potential impact of restoration actions on the quality of the physical, biological, and cultural environment. Since no written comments were received, the Trustees have selected the restoration actions identified as preferred in the Draft DARP/EA as the means of obtaining compensation for the ecological injuries addressed in that document.

[1] Chapter 8 discusses the restoration requirements that would be required if the currently anticipated remedy is chosen. If the Trustees' understanding concerning the remedy is correct, and no additional information is received that would affect the restoration alternatives analysis and scaling, a third stage DARP/EA will be unnecessary.

1.1 OVERVIEW OF THE SITE

Alcoa began operations at its Point Comfort, Texas facility (PCO) in 1948 on 3,000 acres of land on the eastern shore of Lavaca Bay. Between 1948 and the present, Alcoa has constructed and operated several types of manufacturing processes at this location, including alumina refining, aluminum smelting, carbon paste and briquette manufacturing, gas processing, and chlor-alkali processing.

The Site was added to the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), on March 25, 1994 (59 Fed. Reg. 8794, February 23, 1994). The listing was primarily based on levels of mercury found in several species of finfish and crabs in Lavaca Bay, a fisheries closure imposed by the Texas Department of Health (TDH) in 1988 due to mercury levels found in fish, and levels of mercury detected in bay sediments adjacent to the Alcoa facility (TDH, 1988). Alcoa, the State of Texas and the U.S. Environmental Protection Agency (EPA) signed an Administrative Order on Consent (AOC) under CERCLA in March 1994 for the conduct of a Remedial Investigation and Feasibility Study (RI/FS) for the Site.

The Trustees are responsible for evaluating potential injuries to natural resources and resource service losses resulting from releases of hazardous substances from the PCO facility pursuant to Section 107(f) of CERCLA, the Federal Water Pollution Control Act, 33 U.S.C. Section 1251 et seq., (also known as the Clean Water Act or CWA) and other applicable Federal or State law, including Subpart G of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Sections 300.600 - 300.615, and regulations at 43 C.F.R. Part 11 which are applicable to natural resource damage assessments (NRDA) under CERCLA. The cost of actions appropriate to restore, replace or acquire resources or resource services equivalent to those lost is a primary basis for compensating the public for injuries to natural resources under these authorities.

The Trustees and Alcoa entered into a Memorandum of Agreement (MOA), effective January 14, 1997, which has allowed the evaluation of potential natural resource injuries and service losses attributable to the Site and restoration planning to address those losses to proceed on a focused and expedited basis. The goal of this process is to identify and implement restoration actions that will make the environment and public whole for resource injuries or losses that have been caused by releases of hazardous substances from the PCO facility.

1.2 STAGED APPROACH TO RESTORATION PLANNING

The Trustees adopted a staged approach to restoration planning for this Site. A staged approach allows restoration decisions for particular injury or loss categories to be made as soon as that injury or loss category can be reliably quantified, using available remedial and assessment information. This staged approach will allow the Trustees to seek implementation of restoration actions as quickly as possible following the quantification of specific resources injuries and/or service losses. Where restoration actions can be expedited, restoration services (and public compensation credit) will begin to flow upon implementation, even before completion of the remedial process. Any resource injuries or losses that are dependent upon or residual to the choice of final remedy, if materially different than described in Chapter 8, can be addressed in a final stage damage assessment and restoration plan. The staged approach facilitates early implementation of restoration actions. Absent a staged approach to restoration planning, all restoration actions would be deferred until after final remedial decisions for a particular site had been made.

In the assessment underway for this Site, the first restoration planning stage focused on recreational fishing service losses attributable to releases of hazardous substances from the PCO facility and was covered by the Final DARP/EA for Recreational Service Losses dated June 21, 2001. The present DARP/EA represents the second stage of restoration planning. It considers natural resource injuries and ecological service losses caused by Site contamination through the end of 1999 and natural resource injuries or service losses attributable to response actions initiated before the end of 1999 (excluding injuries/losses to terrestrial resources). The quantification of resource injuries due to these known response actions covers these natural resource losses into the future.

Chapter 8 of this second stage DARP/EA focuses on terrestrial resource injuries and losses and all other natural resource injuries and service losses of an ecological nature occurring after 1999 through their recovery to baseline, including those which may result from expected future response actions at the Site. Terrestrial resource injuries are included in Chapter 8 because they are largely linked to known or anticipated response actions, more so than to Site contamination, and can be definitively assessed only by taking into account all response actions. The Trustees have worked closely with EPA and TNRCC response personnel and, as a result, have anticipated future response actions which may occur under the final remedy. Chapter 8 describes these anticipated actions and evaluates the residual resource losses and corresponding restoration requirements based thereon. Until the final remedy is selected, there will remain some uncertainty about what, if any, further response actions will be required at the Site and, as a result, about the quantification of the remaining resource injuries and losses, and the restoration actions required to compensate for such losses. If future response actions are as anticipated in Chapter 8, however, a third restoration planning stage will be unnecessary. If the actual final remedy differs materially from that which the Trustees have anticipated, then a third and final stage Draft DARP/EA may be developed to describe the additional residual resource injuries and losses and any further restoration actions needed for public compensation.

1.3 NATURAL RESOURCE INJURIES

In evaluating the potential for injuries to natural resources and resource services in Lavaca Bay, the primary contaminants of concern are mercury and polycyclic aromatic hydrocarbons (PAHs). Mercury and PAHs from Alcoa's facility have been detected in Lavaca Bay, primarily in shallow sediments and fauna close to the PCO facility (Alcoa, 1995). Elevated levels of contaminants have also been found in ground water and soils at the facility. Available data and information indicate that surface water, ground water, habitats, and fauna associated with habitats surrounding the PCO facility are the resources likely to be at risk of injury from these hazardous substances. Habitats in this area include tidal flats, salt marshes, oyster reefs, shallow soft-bottom sediments, and terrestrial uplands associated with islands and shorelines.

Mercury has been shown to be directly toxic and to cause injury to benthic fauna at high concentrations. It can also affect animals at higher trophic levels that feed on contaminated prey items. Mercury bioaccumulates through the sediment-based food web in fish species that feed on benthic organisms near the Site (Evans and Engel, 1994). This has resulted in mercury concentrations in the tissues of fishes and crabs sufficient to cause TDH to issue a closure order prohibiting the taking of finfish and crabs for consumption in the portion of Lavaca Bay adjacent to the PCO facility (TDH, 1988). Additional exposure pathways for mercury in sediments exist for shorebirds and wading birds, primarily in tidal mudflats and fringe marsh habitat near the PCO facility.

PAHs have been detected at elevated concentrations in scattered areas in the vicinity of the PCO facility. Although some invertebrates accumulate PAHs, fish metabolize PAHs, which prevents these substances from biomagnifying up the food web. For PAHs, the primary risk of resource injury is from direct exposure to PAHs in the sediments of bay habitats found in scattered locations near the PCO facility. In addition to mercury and PAHs, the Trustees evaluated the potential for other Site contaminants to cause injury to natural resources or resource services, but found no others with sufficient potential to cause resource injury to warrant further analysis in the assessment process.

Using data and other information developed as part of the RI/FS process, the Trustees were able to identify the types of habitats, their component resources, and the habitat or resources services with the greatest potential to have been injured by historic and ongoing releases of mercury and PAHs from the PCO facility. These include subtidal unvegetated soft-bottom benthic habitats, estuarine marsh habitats, oyster reefs, ground water resources, terrestrial habitats, and human uses of these resources. Some animals living in these habitats, such as shellfish, fish, and birds, may have suffered lethal effects (increased mortality) or sublethal effects (reduced growth, reduced fecundity, etc.) as a result of exposure to mercury and/or PAHs. Additionally, some areas of habitat have been adversely affected, temporarily or permanently, by response actions undertaken at the Site through the end of 1999. These impacts to habitats from response actions also constitute natural resource injuries or services losses and are appropriate for the Trustees to consider in this assessment. As indicated above, most resource injuries or losses associated with response actions initiated through the end of 1999, and the restoration actions selected to compensate for these injuries, are addressed in this DARP/EA in Chapters 4 through 7. Injury to terrestrial resources and analysis of restoration requirements for that injury, based on the expected remedy, is covered in Chapter 8 as are post-1999 injuries and restoration requirements for other resources.

1.4 RESTORATION UNDER CERCLA

In general, restoration actions for natural resource injuries and service losses under CERCLA can be termed as primary or compensatory. Primary restoration is any action taken to enhance the return of injured natural resources and services to their baseline condition, i.e., the condition or level that would have existed had the hazardous substance releases not occurred. Compensatory restoration actions compensate for resource injuries and services losses during the interim period, until recovery to baseline occurs.

Removal and remedial actions (collectively, ‘response actions’) are conducted by EPA or State response agencies and focus on controlling exposure to released hazardous substances, by removing, neutralizing, or isolating them in order to protect human health and the environment from the threat of harm. Although response actions can reduce the need for restoration, the two types of actions are separate and distinct. Trustees may elect to rely on natural recovery as the best alternative for achieving primary restoration in situations where feasible or cost-effective primary restoration actions are not available, where response actions are sufficient to allow for recovery of injured resources, or where the injured resources can otherwise be expected to recover within a reasonable period of time without human intervention.

Under the integrated assessment process for this Site, the Trustees are considering the extent to which actions undertaken as part of the remedial process may be sufficient to allow natural resources and services to return to their baseline condition without further primary restoration actions. The Trustee’s determination of what, if any, primary restoration actions may be appropriate will be based on EPA’s Record of Decision (ROD) for the Site, as the final remedy decision will need to be taken into account in evaluating any further primary restoration needs and action alternatives. Any additional primary restoration determinations (other than those discussed in Chapter 8) will be documented in a DARP/EA for the third and final restoration planning stage, if necessary.

The scale of the required compensatory restoration depends both on the scale of the resource injuries and how quickly each resource and associated service returns to baseline. Remedial actions that facilitate or speed resource recovery reduce interim losses and the compensatory restoration required to offset those losses. Resource injuries and service losses caused by implementation of remedial actions are also losses that may be compensated through appropriate restoration actions. As noted previously, Chapters 4 through 7 of this DARP/EA address compensatory restoration requirements for natural resource injuries and ecological service losses caused by Site contamination through the end of 1999, and also natural resource injuries and service losses attributable to response actions initiated before the end of 1999. For these response actions, compensatory restoration requirements in this DARP/EA address these losses into the future. Chapter 8 discusses primary restoration for all ecological injuries, and compensatory restoration for ecological injuries not covered in earlier chapters, based on the expected remedy.

1.5 PLAN OF THIS DOCUMENT

The remainder of this document presents further information about the natural resource injuries and losses covered in this stage of the assessment and the restoration actions that the Trustees have selected for use to compensate for the interim loss of these resources.

Chapter 2 briefly summarizes the release history associated with this Site, the legal authorities and regulatory requirements of the Trustees, and the role of Alcoa (the Potentially Responsible Party or PRP), and the public in the damage assessment and restoration process.

Chapter 3 provides a brief description of the physical and biological environment potentially affected by the hazardous releases from the PCO facility and describes the cultural environment surrounding natural resources in Lavaca Bay, in accordance with NEPA (42 U.S.C. Section 4321, et seq.).

Chapter 4 describes the potential injuries and ecological service losses caused by hazardous substance releases and the assessment strategies used by the Trustees to address these injuries and losses.

Chapter 5 describes the resource injuries caused by response actions initiated before the end of 1999 and the assessment strategy used to address these losses.

Chapter 6 evaluates restoration options for the various injury and ecological service loss categories outlined in Chapters 4 and 5, and identifies the restoration alternatives selected for use to compensate for these losses.

Chapter 7 describes the method used by the Trustees to determine the scale of each of the restoration actions necessary to compensate for assessed losses.

Chapter 8 describes the anticipated future natural resource injuries and service losses and required restoration for these losses based on the current understanding of the future response actions to be undertaken at the Site.

Appendix A is a list of the documents in the Administrative Record as of the date of issuance of this Final DARP/EA.

Appendix B is a list of Key Statutes, Regulations, and Policies.

This chapter explains the release history of the site, and describes the legal authority under which Trustees act on behalf of the public. It explains the requirement for involvement of the PRP (here, Alcoa) and the opportunities for public participation in the NRDA process.

2.1 THE ALCOA POINT COMFORT/LAVACA BAY NPL SITE - SUMMARY OF RELEASE HISTORY

The Site is located in Point Comfort, Calhoun County, Texas and encompasses releases from Alcoa's PCO facility. The PCO facility has been in continuous service since 1948. The PCO facility began operation as an aluminum smelter. The smelting operation utilized alumina as the raw material and produced aluminum metal through an electrolytic process. Smelter construction began in 1948 and the unit operated until 1980. The alumina refining operation began in 1959 and continues to operate today. The alumina refining operation utilizes bauxite ore to produce alumina. Since the initial construction of the aluminum smelting plant, the PCO facility has developed into an integrated complex of operations that currently include bauxite refining, an aluminum fluoride plant, and a carbon paste plant. Past operations conducted at the facility that have been dismantled and removed include the aluminum smelter, a cryolite plant, and a chlor-alkali processing unit.

The PCO facility currently comprises approximately 3,500 acres (up from 3,000 acres in 1948) and is located adjacent to Lavaca Bay on the west and Cox Creek/Cox Lake on the east. The Dredge Island is an island in Lavaca Bay, west of the facility buildings, that is approximately 375 acres. It has been historically used for the disposal of dredge material, gypsum, and waste water from the chlor-alkali processing unit.

From 1966 to 1970, the PCO facility discharged mercury-containing wastewater into Lavaca Bay from its chlor-alkali processing operations. Alcoa terminated the direct discharge of this wastewater into the bay in 1970 after the Texas Water Quality Board notified Alcoa of potential adverse environmental impacts associated with this discharge. In April 1988, the TDH issued a 'closure order' prohibiting the taking of finfish and crabs for consumption from a specific area of Lavaca Bay due to elevated mercury concentrations found in these species. This 1988 'closed' area is shown in Figure 2-1. The closed area was recently modified (TDH, 2000), to reopen Cox Bay to the taking of finfish and crabs. The Site was placed on the CERCLA's NPL in 1994. The listing was primarily based on levels of mercury found in several species of finfish and crabs in Lavaca Bay, the fisheries closure imposed by TDH in 1988, and levels of mercury detected in bay sediments in areas of the bay adjacent to the PCO facility. Alcoa, the State of Texas and EPA signed an AOC under CERCLA in March 1994 for the conduct of a RI/FS for the Site. The RI undertaken for the Site demonstrated an ongoing release of mercury-contaminated ground water from the PCO facility into Lavaca Bay.

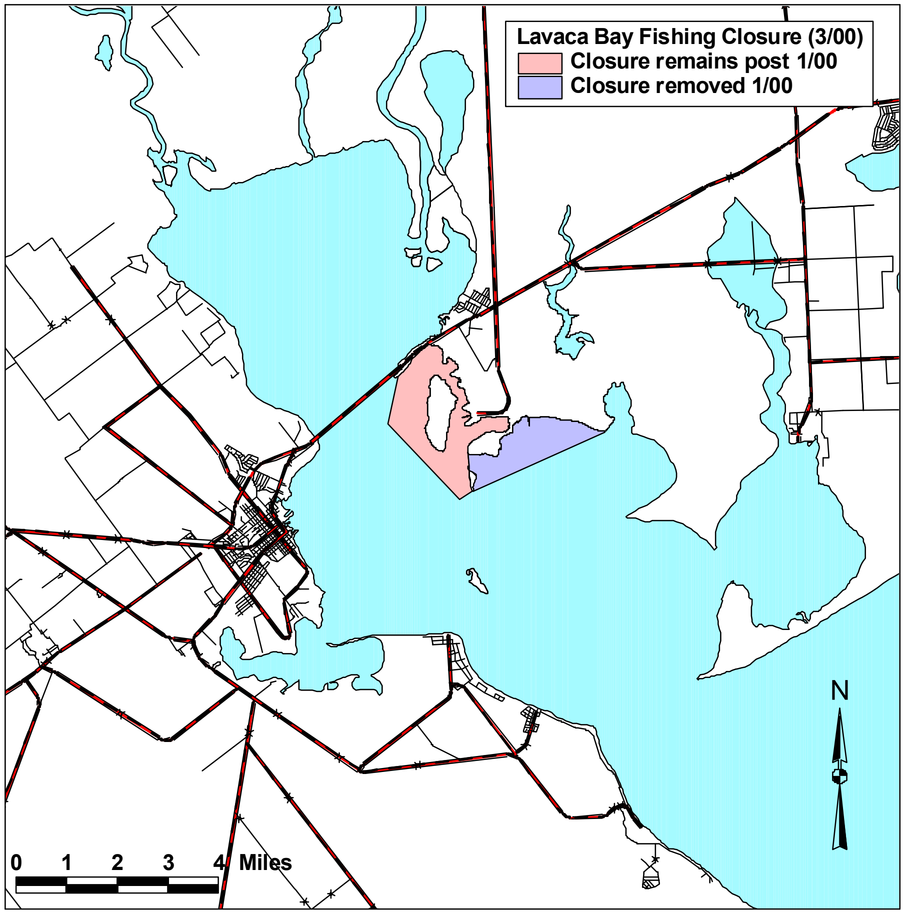

Figure 2.1 – Lavaca Bay

2.2 AUTHORITY AND LEGAL REQUIREMENTS

This DARP/EA has been prepared jointly by NOAA, TNRCC, TGLO, TPWD, and USFWS. Each of these agencies is a designated natural resource trustee under Section 107(f) of CERCLA, Section 311 of the CWA, 33 U.S.C. Section 1321, and other applicable Federal or State law, including Subpart G of the NCP, 40 C.F.R. Sections 300.600 - 300.615. As a designated Trustee, each agency is authorized to act on behalf of the public to assess and recover natural resource damages where natural resources and resource services are injured, lost or destroyed as a result of releases of hazardous substances designated pursuant to CERCLA or the CWA.

2.2.1 Overview of CERCLA Assessment Procedures

Damages recovered by Trustees for natural resource injuries or service losses due to hazardous substances releases must be used to restore, replace or acquire natural resources or services equivalent to those lost. 42 U.S.C. 9607(f)(1). The costs of actions appropriate to restore, replace or acquire such resources or resource services (hereafter collectively referred to as 'restoration') are a preferred measure of natural resource damages under CERCLA and the CWA.

DOI has developed regulations providing procedures for assessing natural resource damages under CERCLA and the CWA. These procedures are found at 43 C.F.R. Part 11 (1995), as amended (61 Fed. Reg. 20609, May 7, 1996) (hereafter, 'the DOI regulations'). These regulations recognize that such 'damages' are to be based on the cost to restore injured resources, including interim lost resource services. Consistent with CERCLA Section 107, however, the DOI regulations also allow, at the discretion of the Trustees, 'damages' to include, for all or a portion of the interim service losses, the value (in monetary terms) of the loss to the public. 43 C.F.R. Section 11.80.

The DOI regulations outline a phased approach[2] to the assessment of natural resource damages. Under the phased approach, the Trustees make an early determination, based on available information, as to whether natural resources have been or are likely to be injured by releases of hazardous substances, and whether such actual or potential injuries are sufficient to warrant an assessment of damages. Information considered by the Trustees at this early time may include information collected during the RI, existing injury studies, and other relevant studies or bodies of scientific work. The Trustees also consider the extent to which response actions will remedy present or future injuries to natural resources. After determining that further assessment is appropriate, the Trustees then proceed with actions to establish and quantify those injuries during the Assessment Plan phase. This phase focuses on planning and implementing methods for determining the nature and extent of any injuries to natural resources, including their baseline condition, recovery period, and any reduction in service levels pending recovery to baseline conditions. The Damage Determination phase is used to establish the appropriate compensation for the natural resource injuries identified and measured pursuant to the Assessment Plan. This phase contemplates development of a Restoration and Compensation Determination Plan as a basis for determining the amount of money to be sought from the PRP(s) as compensation for the assessed resource injuries and service losses. Damages determined in accordance with the final plan are presented to the PRP for payment at the conclusion of the assessment process. 43 C.F.R. Section 11.91. If not paid, they may be sought in litigation.

Under the expedited NRDA process underway in cooperation with Alcoa, the Trustees determined it to be preferable to use an assessment approach that directly facilitates the identification and scaling (e.g., sizing) of restoration actions for all natural resource injuries and service losses. Where injury assessment and restoration planning components occur in parallel, assessment methods can be used which support the identification and scaling of restoration actions directly, rather than seeking to assess the dollar value of the service losses to the public. In this way, projects capable of restoring injured resources or lost services can be identified earlier in the assessment process. Further, in a cooperative assessment, this expedites the opportunity for restoration actions selected by the Trustees to be implemented by the PRP, under Trustee oversight. In addition to significantly expediting the restoration of injured natural resources or services, this early focus on restoration planning can substantially reduce transaction costs. This restoration-based assessment approach is consistent with DOI regulations, which allows restoration planning to be included as part of the Assessment Plan phase where available data are sufficient to support their concurrent development. 43 C.F.R. Section 11.31.

Consistent with this expedited NRDA approach, this DARP/EA describes both the injury assessment and restoration plan to address interim losses of ecological injuries and services through the end of calendar year 1999 and predictable injuries resulting from response actions initiated prior to the end of 1999 into the future. Future ecological injuries due to contamination and anticipated response actions and past losses based on terrestrial resource injuries are also evaluated. The goal of the injury assessment is to determine the effect of hazardous substances on natural resources and services in Lavaca Bay, thus providing a factual basis for evaluating the need for, type of, and scale of restoration actions, including the extent to which considered restoration alternatives would provide ecological service benefits comparable to assessed losses. This document incorporates and presents the plan for restoring ecological services developed by the Trustees. It identifies and evaluates a reasonable range of restoration alternatives, and identifies the restoration actions selected for use after the public comment period for the Draft DARP/EA. The Trustees have determined that the selected restoration actions will fully compensate for ecological injuries and service losses through 1999, including effects of response actions through that date. Absent a material difference in the final remedy decision, the Trustees have also determined that the restoration actions outlined in Chapter 8 will fully compensate for all ecological injuries.

2.2.2 NEPA Compliance

Any restoration of natural resources under CERCLA must comply with the NEPA, 42 U.S.C. Sections 4321, et seq and the Council on Environmental Quality (CEQ) regulations implementing NEPA at 40 CFR Section 1500, et seq.

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[2] Different from the 'staged' approach to restoration planning for this case, which refers to the separate injury assessments that are described and made public in damage assessment and restoration plans (see Section 1.2 for a description of the 'staged' approach in this case).

In accordance with NEPA and the CEQ regulations, the Draft DARP/EA summarized the current environmental setting, described the purpose and need for action, identified alternative actions, assessed their applicability and environmental consequences, and summarized opportunities for public participation in the decision process. This information was used in making a determination that the preparation of an Environmental Impact Statement (EIS) was not required prior to the selection of the final restoration actions identified herein (i.e., is the proposed action a major federal action that may significantly affect the quality of the human environment?). The EA integrated in this plan supports a determination that the identified restoration actions do not meet the threshold requiring an EIS. The NEPA process for these restoration actions concludes with a Finding of No Significant Impact (FONSI) by NOAA and DOI, the federal agencies participating in the restoration planning for this Site.

2.3 COORDINATION WITH POTENTIALLY RESPONSIBLE PARTIES

The DOI regulations require Trustees to invite PRPs to participate in the natural resource damage assessment process. 43 C.F.R. Section 11.32(a) (2) (iii). A PRP may contribute to an assessment in many ways, however, the nature and extent of such participation is subject to substantial agency discretion and final authority to make determinations regarding injury and restoration rests solely with the Trustees. Coordination between Trustees and PRPs can help avoid duplication of studies, increase the cost-effectiveness of the assessment process, facilitate the sharing of information and expertise, and decrease the likelihood of litigation. Input from the PRPs is sought and considered throughout the damage assessment process.

The Trustees' expedited assessment and restoration planning process for this Site has been aided and supported by Alcoa, pursuant to the cooperative planning process outlined in the January 1997 Trustees/Alcoa MOA. The natural resource injuries and service losses assessed in this DARP/EA, including the restoration plan outlined herein, result from this cooperative assessment process. Alcoa has committed to implement restoration actions selected by the Trustees through this cooperative approach.

2.4 PUBLIC PARTICIPATION

Public review of the Draft DARP/EA is an integral component of the assessment and restoration planning process. Through the public review process, the Trustees sought public comment on the methods used to define and quantify natural resource injuries and service losses and the actions proposed for use to restore injured natural resources or replace lost resource services. The Draft DARP/EA provided the public with information about the nature and extent of the natural resource injuries identified and the restoration alternatives evaluated.

Public review of the Draft DARP/EA was consistent with all state and federal laws and regulations that apply to the natural resource damage assessment process, including the DOI regulations, NEPA, and the regulations implementing NEPA at 40 C.F.R. Part 1500. The Draft DARP/EA was available for review and comment by the public for 30 days. The comment period ran from July 14, 2000 to August 14, 2000, and no written comments were received. A public meeting was held in Port Lavaca on July 27, 2000 at which the Trustees presented the results of the assessment process and the restoration actions that were proposed to compensate for injuries to those natural resources covered in the Draft DARP/EA. A transcript of the public meeting is included in the Administrative Record.

2.4.1 <u>Administrative Record</u>

The Trustees have maintained records to document the information considered by the Trustees as they have planned and implemented assessment activities and addressed restoration and compensation issues and decisions. These records are compiled in an Administrative Record, which is available for public review at the addresses listed below. The Administrative Record facilitates public participation in the assessment process and is available for use in future administrative or judicial review of Trustee actions to the extent provided by federal or state law. A list of those documents included in the Administrative Record to date is included as Appendix A to this document. Additional information and documents, including any future Draft DARP/EAs that may be needed to complete the assessment and restoration planning process for this Site and other restoration planning documents, will be included when completed.

Documents within the Administrative Record can be viewed in the offices of:

Mr. Richard Seiler
Texas Natural Resource Conservation Commission
Technical Park Center, Building D
12118 North I-35, Austin, TX 78753
Tel. 512-239-2523

Gladys Hunt
MFG, Inc.
Alcoa Information Center
320 E. Main
Port Lavaca, Texas 77979
Tel. (361) 552-8839

Arrangements must be made in advance to review the record, or to obtain copies of documents in the record, by contacting the listed persons by letter or telephone.

This chapter presents a brief description of the physical and biological environment potentially affected by the releases of hazardous substances from the PCO facility, as required by NEPA. 40 U.S.C. Section 4321, et. seq.. The physical environment includes the Lavaca-Matagorda Bay system and adjacent shoreline habitats; however, existing data on contaminant concentrations indicate that resource injuries/service losses are confined to the vicinity of the PCO facility on the eastern side of Lavaca Bay. The biological environment includes a wide variety of finfish, shellfish, birds, and other organisms. The natural resources of the Lavaca-Matagorda Bay system are of significant economic and cultural importance, such as for travel, tourism, and commercial and recreational fishing. These activities depend on a healthy coastal ecosystem. Basic information on the Lavaca-Matagorda Bay system is found in publications by Armstrong (1987), Ward and Armstrong (1980), and Weixelman and Dailey (1997). Unless otherwise noted, these publications provide much of the information discussed in the following sections.

3.1 PHYSICAL ENVIRONMENT

Lavaca Bay is located in the Coastal Prairies province of the Gulf Coast Plain physiographic region in North America. Climate in the region is humid subtropical with hot summers. Annual precipitation in the vicinity of the Site is approximately 106 cm or 42 inches. The prevailing wind direction is southeast.

Lavaca Bay is part of the larger Matagorda Bay system, which also includes Carancahua Bay, Turtle Bay, and Tres Palacios Bay, as well as smaller waterbodies like Powderhorn Lake and Oyster Lake. The Lavaca Bay system consists of Lavaca Bay and several smaller bays such as Cox, Keller, and Chocolate Bays (see Figure 2-1). Located in Calhoun and Jackson Counties, the Lavaca Bay system covers an area of 155 square kilometers or 60 square miles (approximately 16,200 hectares or 40,000 acres). It is a shallow bay, with an average depth of 1.2 meters (4 feet). The combination of wind-induced surface waves and fine sediment creates a high level of turbidity.

The Site is situated west of the Cox Creek drainage (also referred to as Huisache Creek). This drainage is part of the larger Colorado-Lavaca Coastal Basin hydrogeologic unit, which spans approximately 2435 square kilometers or 940 square miles, and is described as the flat coastal plain between the Colorado and the Lavaca Rivers that drain into Tres Palacios Bay, Carancahua Bay, and Lavaca Bay. The Colorado-Lavaca Coastal Basin is drained primarily through Palacios Creek, East and West Carancahua Creeks, Keller Creek, and Cox Creek.

Other tributaries outside the Colorado-Lavaca Coastal Basin contribute flow to the bays in the vicinity of the Site. The largest of these tributaries is the Lavaca-Navidad River system. A number of smaller streams also drain directly into Lavaca Bay or into bayous adjoining the bay including Chocolate Bayou, Sixmile Creek, Placedo Creek, Agula Creek, Kentucky Mutt Creek, Garcitas Creek, and Venado Creek.

3.2 BIOLOGICAL ENVIRONMENT

Lavaca Bay contains a variety of habitats, including intertidal mudflat, fringe marsh, high marsh, oyster reef, and open water, which support a large array of plant and animal species. Submerged vegetation is generally absent from Lavaca Bay, but shoalgrass (*Halodule wrightii*) and wigeongrass (*Ruppia maritima*) have been found on the southern shoreline of Keller Bay (Adair et al., 1994). Important habitats for many species include perimeter salt marshes, oyster beds, and freshwater marshes found in upper Lavaca Bay, Cox Bay, and Chocolate Bay. Smooth cordgrass (*Spartina alterniflora*) is prevalent around the northern section of the Dredge Island and along parts of the shoreline in proximity to the PCO facility. It also occurs in mixed stands with other marsh grasses in upper Lavaca Bay near the mouth of the Lavaca River, and in portions of Cox Cove and Keller Bay. Marsh-hay cordgrass (*Spartina patens*) is found in the upper reaches of Keller Bay. Other marsh plants, such as shoregrass (*Monanthochloe littoralis*), saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), saltwort (*Batis maritima*), and glassworts (*Salicornia* spp.) are found along the shores and inland reaches of upper Lavaca Bay.

Phytoplankton, zooplankton, and aquatic invertebrates living in these habitats provide food web support for a diversity of fish and bird species. In addition to providing food, these habitats provide nesting services for birds such as the seaside sparrow (*Ammodramus maritima*), black rail (*Laterallus jamaicensis*), and yellow rail

(*Coturnicops noveboracensis*). There are also extensive oyster reefs in Lavaca Bay that provide habitat and food for a number of fish and invertebrate species. Oysters also provide services such as water filtration.

Prominent aquatic invertebrates in river-influenced areas include the bivalve *Rangia cuneata*, chironomid insect larvae, oligochaetes, and the polychaete *Streblospio benedicti* (Gilmore et al., 1974). The upper portion of Lavaca Bay contains benthic assemblages of invertebrates typified by brackish water species of mollusks, amphipods, and polychaetes while the bivalves *Macoma mitchelli* and *Mulinia lateralis* and the polychaetes *Mediomastus californiensis*, *Glycinde solitaria*, and *Paraprionospio pinnata* are abundant in the more saline parts of the bay (Kalke and Montagna, 1991). Dominant organisms found during the Prey Item Study for Lavaca Bay were the polychaetes *Mediomastus ambiseta*, *Capitella capitata*, *Parandalia fauveli*, *Laeonereis culveri*, and *Neanthes succinea.* and the bivalve *Tagelus plebeius* (Alcoa, 1998a). Larger invertebrates found in much of Lavaca Bay include blue crab (*Callinectes sapidus*), white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), American oyster (*Crassostrea virginica*), stone crab (*Menippe adina*), mud crabs (family Xanthidae), fiddler crabs (*Uca* spp.), lightning whelk (*Busycon sinistrum*), Atlantic brief squid (*Lolliguncula brevis*), and cabbage head jellyfish (*Stomolophus meleagris*). The first four of these invertebrate species are important to commercial and recreational fishing (Robinson et al., 1997).

A wide variety of fish species are found in Lavaca Bay. The most abundant species include Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), bay anchovy (*Anchoa mitchilli*), hardhead catfish (*Arius felis*), gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), killifishes (*Fundulus* spp.), sheepshead minnow (*Cyprinodon variegatus*), and sand seatrout (*Cynoscion arenarius*). Fish species of commercial and recreational importance include Atlantic croaker, menhaden, sand seatrout (*Cynoscion arenarius*), gafftopsail catfish (*Bagre marinus*), spotted seatrout (*Cynoscion nebulosus*), sheepshead (*Archosargus probatocephalus*), black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), and southern flounder (*Paralichthys lethostigma*) (Campbell et al., 1991; Robinson et al., 1997).

Approximately 300 bird species inhabit Lavaca Bay ecosystems. Several waterbird colonies have been identified and monitored on or near the Site, including wading birds such as the roseate spoonbill (*Ajaia ajaja*), great blue heron (*Ardea herodias*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), willet (*Catoptrophorus semipalmatus*), and black-necked stilt (*Himantopus mexicanus*); floating and diving birds such as the white pelican (*Pelecanus erythrorhynchos*) and double-crested cormorant (*Phalacrocorax auritus*); and aerial-searching birds such as the Forster's tern (*Sterna forsteri)*, black skimmer (*Rhynchops niger*), royal tern (*Sterna maxima*), and laughing gull (*Larus atricilla*). Many species, particularly grebes, loons, ducks and geese, use the bay habitats during the winter but migrate north during the remainder of the year. Small dredge islands created by channel maintenance in the bay provide isolated nesting locations for several breeding bird species.

Estuarine organisms of commercial, recreational, and ecological importance typically have inshore and offshore components to their life histories (exceptions include the American oyster with an entirely estuarine life cycle). Many species in the Lavaca Bay estuary spawn offshore or near estuary passes, and their larvae migrate into estuarine nursery areas to grow and develop prior to offshore migration and maturation. Other taxa such as birds use estuarine habitats for seasonal feeding, refuge, and/or reproduction.

3.3 ENDANGERED AND THREATENED SPECIES

The Endangered Species Act of 1973 instructs federal agencies to carry out programs for the conservation of endangered and threatened species and to conserve the ecosystems upon which these species depend. Numerous endangered and threatened species are seasonal or occasional visitors to the Lavaca-Matagorda Bay 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. 1) - have been documented in Calhoun County (Campbell, 1995; Poole and Riskind, 1987; Texas Parks and Wildlife Department 1988, 1993). The largest nesting colony of the Federally-endangered brown pelican is located on Sundown Island in the southern portion of Matagorda Bay, and the birds occasionally are observed feeding and resting throughout the vicinity of the PCO facility in Lavaca Bay. Local occurrence of the other 14 species is variable. Most of these species would be present in Lavaca Bay only during migration through the area. This results in a lower level of exposure and risk of injury, for these species than for the resident sensitive species that were evaluated during the injury assessment process. By targeting restoration options to habitats supporting the various wildlife communities of the area, restoration projects selected will also provide supporting habitat for the threatened and endangered species within these communities.

Table 3-1. Federal and State Endangered or Threatened Species in Coastal Texas

	Common Name	Scientific Name	Status [3]
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

[3] The following symbols are used for status: "FE" for Federal Endangered, "FT" for Federal Threatened, "SE" for State Endangered, and "ST" for State Threatened. Texas Parks and Wildlife Department (1997).

	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
Amphibian	Black-spotted newt	*Notophthalmus meridionalis*	ST
	South Texas siren (large form)	*Siren* sp.	ST
	Houston toad	*Bufo houstonensis*	FE, SE
Fishes	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 ENVIRONMENT AND HUMAN USE

The Texas coast enjoys a rich history, dating back thousands of years. Archaeological remains indicate that Calhoun County was inhabited by the Karankawa people as early as 6000 B.C. (Hester, 1975). These people relied on some marine resources (oysters, roots of underwater plants) for sustenance but did not appear to travel beyond sight of land (Uecker and Kelly, 1979).

European contact in this area was initiated by Rene-Robert Cavelier, Sieur de La Salle, who landed on the west shore of Lavaca Bay in 1685. The Spanish began populating Texas in the early 1700s. In 1831, Juan J. Linn, a member of the De Leon Colony, established Linnville, near the present-day town of Port Lavaca. German immigration to this part of Texas was prevalent during the 1800s. In 1844, the port town of Indianola was established as the eastern terminus of the Indianola Railroad, which later became part of the Southern Pacific system.

In 1863, federal troops captured Indianola, following the Battle of Matagorda Bay. The only Civil War battle actually fought in Calhoun County was on Christmas Eve in 1863 at Norris Bridge. This port town flourished until its destruction by two hurricanes (in 1875 and 1886). Although the town was re-built following the first hurricane, it was abandoned following the second storm.

In addition to being a valuable cultural resource due to its history, the Lavaca Bay system supports significant amounts of recreational fishing. It is a popular spot for saltwater anglers, offering numerous fishing access points in Point Comfort, upper Lavaca Bay, Port Lavaca, Chocolate Bay, Magnolia Beach, and Keller Bay. These sites differ from one another in terms of facilities, access, aesthetics, and available species of fish. These human activities are dependent upon the condition of the coastal and marine habitats[4].

4 The effects of, and restoration requirements for, the recreational fishing closure related to the Site are addressed in the first stage restoration planning process (Final DARP/EA for Recreational Fishing Service Losses, June 21, 2001).

This chapter describes potential natural resource injuries and quantifies potential service losses of an ecological nature caused by releases of hazardous substances (primarily mercury and PAHs) from the PCO facility. The chapter begins with an overview that describes the Trustees' assessment strategy. The remainder of the chapter presents the results of the Trustees' assessments for the specific resources affected by releases of mercury and PAHs from the Site, including the approaches and methods used to determine injuries and potential service losses. Chapter 5 addresses the losses due to response actions initiated through the end of 1999.

4.1 ASSESSMENT STRATEGY

The goal of this assessment is to determine the nature and extent of injuries to natural resources and to quantify the resulting resource and service losses, thus providing a technical basis for evaluating the need for, type of, and scale of restoration actions. As described above in Section 2.2.1, this assessment process is guided by DOI's NRDA regulations under CERCLA. 43 C.F.R. Part 11. For this Site, the Trustees pursued an assessment approach that is closely linked to the ongoing RI/FS at the Site. This integration is advantageous because much of the data needed for the RI/FS process are useful in evaluating injuries. The integrated approach permits data sharing, resulting in time and/or cost savings. Moreover, integration explicitly recognizes that RI/FS remediation decisions and NRDA primary restoration decisions are interdependent. Remedial decisions can affect the need for, amount and type of primary restoration required to address natural resource injuries at the Site. Thus, the integrated approach promotes efficiency in the overall process.

This assessment was designed for injury assessment and restoration planning to occur in parallel, an approach that is termed a "restoration-based approach". Under a restoration-based approach, the focus of the assessment is on quantifying the injuries and/or losses in natural resources and services in ways that facilitate the identification and scaling of restoration actions that will provide to the public the same level, type, and quality of resource services that were lost. (The identification of appropriate restoration actions is further described in Chapter 6 of this DARP/EA.)

This injury assessment process occurs in two stages: injury evaluation and resource or resource service loss quantification. To evaluate potential injuries to natural resources, the Trustees reviewed existing information, including: RI/FS data, published and unpublished technical reports (from the U. S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Texas Parks and Wildlife Department); theses and dissertations from Texas A&M University and other regional universities; scientific literature; and studies conducted for this assessment (e.g., Alcoa 1995). Based on information from all these sources and with an understanding of the functioning of Lavaca Bay ecosystems, the Trustees evaluated the potential for injuries to natural resources. The Trustees considered several factors when making this evaluation, including, but not limited to:

- The natural resources and services of concern;
- The evidence indicating exposure, pathway, and injury;
- The mechanism by which injury occurred;
- The type, degree, spatial and temporal extent of injury; and
- The types of restoration actions that are appropriate and feasible.

For each resource category (either a group of organisms or a habitat type) potentially affected, the Trustees determined whether an injury is likely to or has occurred, identified the nature of the injury, and identified a pathway linking the injury to the Site contaminants. In order to undertake this effort, an understanding of the important contaminants is necessary at the outset. The evaluation of the potential contaminants of concern is described in the next section. Following the identification of these important contaminants, those resources that could be adversely affected by those contaminants in Lavaca Bay are evaluated.

4.1.1 Contaminants of Concern

In the RI/FS process undertaken for the Site, one of the early steps was to identify contaminants of concern (COCs). The Trustees participated in this analysis with respect to the potential for contaminants to pose risk to ecological receptors as part of the RI/FS process. This served as the basis for consideration, by the Trustees, of the potential for contaminants to cause injury to natural resources or losses of resource services. The available data reveal that mercury is the most widespread Site contaminant in the bay at elevated levels and is, therefore, the primary COC. Mercury was found at concentrations above background in sediments and associated biota in the vicinity of the PCO facility. The principal organic form of mercury is methyl mercury (MeHg) which bioaccumulates in tissues and can be biomagnified (increase in concentration) as it passes to higher trophic levels through the food chain. Potential natural resource injuries from mercury contamination are largely the result of this biomagnification. Organisms that feed on fishes and invertebrates in areas with contaminated sediments or soils may have reduced reproductive success as a result of mercury bioaccumulation. Predators, especially top carnivores, are at risk for toxic and reproductive injuries as a result of bioaccumulation and biomagnification through the food web.

Polycyclic aromatic hydrocarbons (PAHs) are also present in more restricted locations within the general area of mercury contamination. A review of the scientific literature for effects of PAHs suggests that direct exposure to Lavaca Bay sediments in those areas containing high levels of PAHs could result in injury to benthic organisms. PAHs do not biomagnify like mercury and are, therefore, most likely to produce direct, adverse effects to benthic (bottom dwelling) organisms in direct contact with contaminated sediments. Birds and aquatic organisms that are not closely associated with contaminated sediments are unlikely to have direct, adverse effects from PAHs. However, the resulting reduction in invertebrate populations could adversely affect other components of the food web that depend on these organisms, causing indirect effects. PAHs were selected as a second COC for evaluating injury.

Other potential COCs, including polychlorinated biphenyls (PCBs), were found at relatively low levels, or were otherwise determined not to pose a significant risk of injury to resources in Lavaca Bay. The results of the screening of these contaminants as potential COCs are explained more fully in Alcoa (1996)**.**

4.1.2 Identification of Potentially Injured Resources

Based on known effects of these contaminants found in the scientific literature, the evaluation of receptors in the Ecological Risk Assessment (ERA) of the RI/FS, discussions with experts, and experience from other sites, the Trustees were able to identify those resources that required evaluation for potential injury. The results of this initial assessment screening revealed that the following resources were injured or were likely to have been injured due to releases at this Site, and required further evaluation in the NRDA process:

- Benthic communities, including those located in unvegetated subtidal areas, marsh, and oyster reefs
- Finfish and motile shellfish
- Wading birds and shorebirds
- Terrestrial resources (discussed in Chapter 8)
- Ground water
- Water column

4.1.3 General Injury Quantification Approach

The second phase of the injury assessment process is the quantification of injury. The Trustees decided early in the process to use the Habitat Equivalency Analysis (HEA) method for scaling the size of restoration actions to compensate the public for potential injuries to natural resources, and losses of resource services. HEA, described more fully in Chapter 7, considers the loss or reduction in services provided by resources as the injury “measure”. Therefore, the Trustees sought to estimate how the identified COCs could influence the ability of resources to provide ecological services.

The concept of using ecological services as the injury measure is relatively complex. One key concept underlying that approach is that natural resources in an ecosystem are interrelated through the services upon which they depend or provide. Ecological services can be defined as “the functions performed by a natural resource for the benefit of another natural resource and/or the public". 15 C.F.R. Section 990.30[5]. Thus, benthic invertebrates provide a "food" service to fish which consume them, and fish in turn provide a "recreational fishing" service to the public. Connections among physical resources, between physical and biological resources, and services they provide for Lavaca Bay marshes are depicted in Figure 4-1.

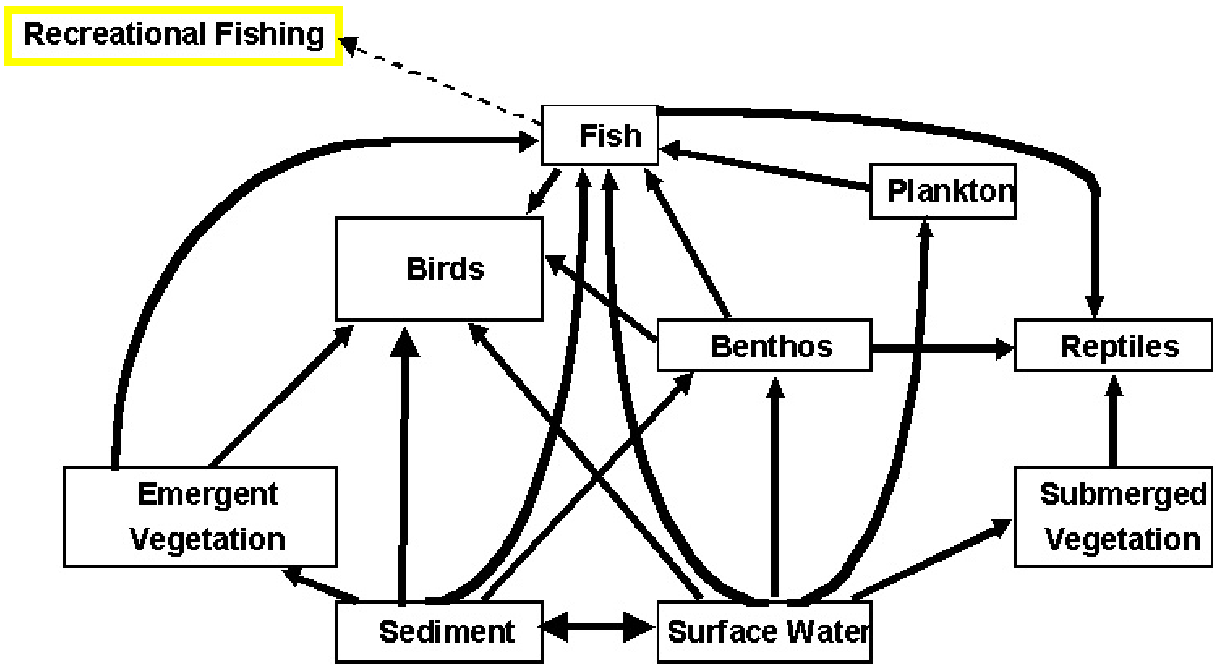

Figure 4-1. Natural resource services for a Lavaca Bay marsh.

The interrelationships among natural resources in the Lavaca Bay ecosystem are the cornerstone of this assessment. The Trustees considered the effect of contamination in a habitat on resources dependent upon that habitat by determining reductions in likely service flows from that habitat, rather than by trying to directly assess injury to the dependent resources. This approach is consistent with a restoration-based assessment, where the focus is on the restoration of resources and services. Thus, the results of the service loss quantification phase for ecological services are estimates of injured acres for specific habitat types lost for a specified number of years. These "lost acre-years" are used to determine the acreage needed to restore, replace, or provide for the equivalent of these losses. An acre-year of ecological services from a habitat is the amount of ecological functions that an acre of that habitat provides to other natural resources in one year.

The interrelationships among natural resources and resource services are important for a number of reasons. First, these interrelationships provide the basis for contaminant fate and transport and receptor exposure to contaminants in the environment. Thus, the interrelationships provide another link to the integration of the RI/FS and NRDA processes. In addition, focusing on the interconnections ensures that potential resource injuries and services losses are properly identified and accounted for in the assessment (e.g., reduces the risk of double-counting injuries). Some resources and/or services may be affected to such a limited extent that they cannot be meaningfully quantified. If any of these injuries/services losses have occurred, they are related to other components of the ecosystem, which means that they are implicitly included in the analysis. Understanding these interrelationships also provides an opportunity for developing restoration options which appropriately and cost effectively restore injured

[5] This citation is to the NRDA regulations promulgated pursuant to the Oil Pollution Act of 1990 (OPA), 33 U.S.C. 2701 et seq., to guide NRDAs associated with oil spills. Although OPA is not directly applicable to NRDA for this Site, OPA and CERCLA have a common goal, i.e. the restoration of injured resources or services. Because the OPA regulations more directly outline planning appropriate to support restoration-based compensation decisions, the Trustees considered these regulations a useful reference in implementing restoration-based compensation planning in this CERCLA context.

resources/service losses. Moreover, recognizing the interrelationships permits identification of restoration options that benefit more than one natural resource, which is also consistent with a restoration-based approach. 15 C.F.R. Section 990.54. This approach can lead to early restoration, thereby quickly providing the public with compensatory natural resource services.

4.2 INJURIES TO SPECIFIC RESOURCES

As part of the cooperative assessment process underway for the Site, the Trustees and Alcoa agreed to first examine historical data sources and data from the RI/FS, in conjunction with relevant published studies on effects of contaminants, prior to consideration of site-specific injury studies. Using this approach, the Trustees and Alcoa reached agreement on Reasonable Worst Case (RWC) estimates of the potential resource injuries and losses, forgoing actual injury studies, by using available information with conservative assumptions (RWC Technical Memorandum, 2000). The assumptions are considered conservative because through their use, injury is assumed where the potential for injury is likely, but not demonstrated. These assumptions are protective of natural resources (i.e., assumptions that would tend to increase the size of a needed restoration action). The resulting estimates are ones that, in the judgement of the Trustees, would lead to restoration actions that would, at a minimum, offset the lost ecological services resulting from hazardous substance releases from the PCO facility. They represent the outcome of an efficient and cost-effective process appropriate for a restoration-based resolution of natural resource damage claims at this Site.

It should be understood that the values for individual parameters (such as percent loss of ecological service) put forward in this assessment are intended to be used for this assessment alone and are not intended for use outside of the context of the entire assessment for this Site. That is, the Trustees were aware of the specific circumstances of this Site when making judgements about the values of individual injury (and restoration) parameters used in the assessment.

The following sections of this chapter describe the results of this assessment approach for the releases of hazardous substances from the PCO facility. Potential injuries are organized into five resource service loss categories: benthos (in soft-bottom benthic habitat, marsh benthic habitat, and oyster reef), birds, finfish, ground water, and water column. Injuries to terrestrial resources, as mentioned previously, are addressed in Chapter 8.

4.2.1 Injury to Benthic Populations

Benthic organisms (also referred to as “benthos”) include annelid worms, small crustaceans (amphipods, isopods, copepods, juvenile decapods), molluscs, and other small bottom-dwellers in Lavaca Bay’s marshes, unvegetated subtidal sediments, and in oyster reefs. Benthic organisms may be 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), or omnivores (a combination). Benthic organisms provide the nutritional base for the developing stages of many finfish and shellfish and thus affect all trophic levels in the bay system. The activities of benthic organisms are important in conditioning these 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 which 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 bay system.

The injury assessment for benthos resulting from contamination used a RWC approach (RWC Technical Memorandum; Appendix A: Analysis for Benthos, 2000). That is, comprehensive NRDA-specific field studies were not performed to measure benthic injury in Lavaca Bay. The RWC assessment approach for benthos used analytical chemistry results for samples collected during the RI to determine the nature and extent of mercury and PAH contamination in Lavaca Bay sediments. However, some additional NRDA–specific sediment chemistry sampling was done to refine the areas adequately for PAHs. The next step in determining benthic injury was to develop contamination concentration benchmarks that are known or suspected injury thresholds for benthic resources based on the results of RI/FS studies and on the results of studies presented in scientific literature.

Laboratory bioassays and benthic macroinvertebrate studies were conducted for the RI/FS to determine whether any relationship exists between mercury concentrations in surficial sediments and observed effects on survival, growth, and reproduction for benthic populations within Lavaca Bay. The scientific literature for mercury effects on benthic resources was also reviewed. Benthic surveys/bioassays were not conducted in areas with PAH contamination in sediment. To assess potential injury to benthos from PAH contamination the Trustees depended on scientific literature. Therefore, conclusions regarding potential injury from PAHs were based on a comparison of the Site sediment concentration data to the results of studies conducted at other locations with PAH contamination and laboratory studies.

Results from the RI mercury Sediment Quality Triad (SQT) study indicate that sediments with surficial mercury concentrations below 4.6 ppm were not correlated with adverse effects on growth or survival of test species or on benthic community indices (Alcoa, 1998b). However, the Trustees recognized that the SQT study may not have addressed all of the potential service losses related to benthic exposure to mercury. A review of applicable literature was conducted to identify sediment benchmarks for mercury that may pose both "potential" and "probable" service losses to benthos. A similar approach was used to identify sediment benchmarks for PAHs that may pose both "potential" and "probable" service losses (RWC Technical Memorandum; Appendix A: Analysis for Benthos, 2000).

For benthos, injury from contamination was considered to occur from direct adverse effects on survival, growth, or reproduction of benthic populations. Such adverse effects can result in shifts in the diversity and composition of benthic communities and/or in the overall abundance of organisms. Shifts in either diversity or abundance can reduce the viability and productivity of the overall estuarine system. For the benthos RWC injury assessment, ecological risk screening sediment benchmarks were selected and used as thresholds for varying levels of injury to benthic resources. Based on the literature for mercury effects on these endpoints, it was concluded that at a mercury sediment concentration of 0.7 ppm (Effects Range-Median or ERM for mercury), injury to unvegetated subtidal and fringe marsh (including contiguous mudflats) benthos was possible and injury was calculated to begin at this mercury concentration. The range for probable injuries to benthos was estimated to occur at mercury levels > 2.1 ppm (Apparent Effects Threshold or AET), and a higher level of injury was assigned. The range for probable injuries to oyster reef benthos began at mercury concentrations > 0.59 ppm (AET for oysters). The Trustees' use of the screening guidelines, as described above, to suggest potential and probable injury to benthos from mercury is conservative (e.g., protective of the environment) given the lack of observed adverse effects seen in the site-specific SQT study results, and is appropriate in a RWC injury assessment approach.

Literature-based benchmark concentrations for PAHs associated with adverse effects are highly variable, encompassing more than one order-of-magnitude. This uncertainty relates to the variation of the source and type of PAHs, sediment type, the physical environmental conditions of the water bodies studied, and/or a range of different organisms tested. Most studies from the literature were either from sites having different sources of PAHs, co-occurring contaminants (non-PAH), or different environmental settings, which can affect the bioavailability of PAHs and their toxicity. Issues related to the bioavailability and toxicity of PAHs associated with an aluminum smelter in an estuarine system were recently described by Paine et al. (1996), who found limited bioavailability/toxicity of PAHs in an SQT study. Given these uncertainties, reasonably conservative benchmark criteria and concentration ranges were chosen for the assessment of injury from direct exposure to PAHs. Concentrations of total PAHs (TPAHs), as well as high molecular weight PAHs (HPAHs) and low molecular weight PAHs (LPAHs) were considered in the evaluation of injury to benthos. A range of PAH concentrations was established to represent those levels of PAHs likely to create a lesser, potential reduction in benthic services, and another range of PAH concentrations was developed to represent those levels which were likely to cause a more significant, probable reduction in services. The range of concentration of PAHs in surficial sediment that the literature suggests could potentially reduce services from benthos is TPAHs > 4.022 ppm (Effects Range Low or ER-L for TPAH) and HPAHs < 9.6 ppm (ER-M for HPAHs). The range of concentrations likely to cause probable service losses for benthos is HPAHs > 9.6 ppm. The PAH concentrations where probable service losses for oyster reef benthos is likely is LPAHs > 5.2 ppm (oyster AET for LPAHs) or HPAHs > 17 ppm (oyster AET for HPAHs).

To quantify interim service losses, the Trustees determined how the combination of different concentration ranges of mercury and PAHs would result in different levels of service reductions. For each concentration range, service losses were estimated that approximated the reduction in ecological services provided by the benthic community in each habitat type. Percent loss of service estimates were derived based on a weight-of-evidence approach using results of the mercury SQT, available scientific literature, and familiarity with Texas estuarine ecosystems using the knowledge and experience of the Trustees. For each concentration range, the Trustees assigned a level of severity of the injury, which corresponds to the percent of services reduced, based on the type of endpoint affected and the degree of effect indicated in the studies reviewed. The Trustees conservatively assumed that the level of injury from mercury and PAHs were fully additive, based on a study in which the toxicity due to mercury and one PAH compound (fluoranthene) was slightly less than additive (Swartz et al., 1988). For low levels of contamination, the reduction in services is relatively small. For higher concentrations, the percent of services lost is higher. Through habitat mapping and contaminant sampling performed as part of the RI, the Trustees determined the number of affected acres of benthic habitat at each of the injury thresholds.

Table 4-1 below contains the different concentrations of the contaminants, the corresponding level of service reduction, and the number of affected acres. For fringe marsh and unvegetated subtidal benthic habitats where the mercury was less than 0.71 ppm and TPAHs less than 4.022 ppm, no service losses were assigned. This is also true for areas of oyster reef habitat where mercury was less than 0.59 ppm and LPAH was less than 5.2 ppm and HPAH less than 17 ppm.

Table 4-1. Service Loss Quantification for Benthos, Direct Effects

Concentration of Hg and PAHs (ppm)	Services Lost	Number of Affected Acres
Fringe Marsh Benthic Habitats:		
Mercury < 0.71 & 4.022 < TPAH , HPAH < 9.6	10%	5.67
Mercury < 0.71 & HPAH > 9.6	25%	3.75
0.71 < Mercury < 2.1 & TPAH < 4.022	10%	0.21
0.71 < Mercury < 2.1 & 4.022 < TPAH, HPAH < 9.6	20%	4.91
0.71 < Mercury < 2.1 & HPAH > 9.6	35%	13.22
Mercury > 2.1 & TPAH < 4.022	25%	0
Mercury > 2.1 & 4.022 < TPAH, HPAH < 9.6	35%	0
Mercury > 2.1 & HPAH > 9.6	50%	0.05
Total Affected Acres		**27.81**
Unvegetated Subtidal Benthic Habitats:		
Mercury < 0.71 & 4.022 < TPAH , HPAH < 9.6	10%	137.22
Mercury < 0.71 & HPAH > 9.6	25%	66.30
0.71 < Mercury < 2.1 & TPAH < 4.022	10%	179.48
0.71 < Mercury < 2.1 & 4.022 < TPAH, HPAH < 9.6	20%	37.23
0.71 < Mercury < 2.1 & HPAH > 9.6	35%	47.24
Mercury > 2.1 & TPAH < 4.022	25%	6.35
Mercury > 2.1 & 4.022 < TPAH, HPAH < 9.6	35%	0
Mercury > 2.1 & HPAH > 9.6	50%	3.86
Total Affected Acres		**477.68**
Oyster Reef Benthic Habitats:		
Mercury < 0.59 & LPAH > 5.2 or HPAH > 17	25%	3.11
Mercury > 0.59 & LPAH < 5.2, HPAH <17	25%	14.95
Mercury > 0.59 & LPAH > 5.2 or HPAH > 17	50%	3.97
Total Affected Acres		**22.03**

A total of 477.68 acres of unvegetated subtidal soft-sediment habitat was determined to be injured in this analysis. Fringe marsh, including adjacent mudflats, had 27.81 acres exceeding the benchmarks for mercury and/or PAHs, and these acres are considered injured in the RWC approach. A total of 22.03 acres of oyster reefs exceeded the benchmarks for one or both of the COCs; these acres are considered injured under this analysis. In this injury evaluation component, the Trustees quantified injury from the COCs for benthos (and other categories, where appropriate) from 1981 until the end of 1999. The Trustees examined historical data and determined that there were no significant changes in the sediment levels of mercury over this time period, so the injury levels assigned based on RI/FS data were assumed to be constant from 1981 through 1999. Channel areas that are dredged periodically according to existing permits were excluded from the injury analysis. The Trustees chose to do this in recognition that dredged channels have severe service reductions due to the physical effects of the dredging, making estimation of injury due solely to releases from the PCO facility problematic.

Injuries in a HEA are calculated as Discounted Service-Acre Years (DSAYs). A service-acre year is the amount of services provided by an acre of a given habitat in a period of one year. These are discounted to adjust for time preference (see Trustees, 2000a, for more information). The interim losses associated with injury to benthos in subtidal unvegetated sediments, fringe marsh, and oyster reefs is 1,897.90 DSAYs, 175.08 DSAYs, and 162.72 DSAYs of lost ecological services, respectively. Chapter 7 contains a discussion of how DSAYs were calculated in the HEA.

4.2.2 Injury to Finfish and Shellfish

Lavaca Bay provides significant diversity and abundance of finfish and motile shellfish (hereafter, "fish") populations throughout the year. In an estuarine system, these populations are a very important functional group in ecological food webs. The primary ecological services provided by fish populations include food, production, and energy cycling. In Lavaca Bay, injury to fish populations can occur as a result of direct exposure to mercury in sediments and surface water or through ingestion of contaminated prey as a result of bioaccumulation or biomagnification of mercury or methyl mercury in aquatic food webs. It is believed that ingestion of contaminated prey items associated with the benthos in subtidal unvegetated sediments, fringe marshes, and oyster reefs is the major mechanism by which fish are exposed to mercury, with the resulting potential for being injured.

PAHs also can potentially injure fish. However, PAHs are quickly metabolized and eliminated by fish, which makes estimating injury from PAHs to fish difficult. The Trustees recognized that areas with elevated levels of PAHs are generally co-located with elevated levels of mercury in Lavaca Bay and that the geographical extent of potential fish injury from mercury is larger than that from PAHs. Additionally, information needed to estimate potential injury to fish as a result of mercury contamination is more available than that for PAH contamination. Therefore, the Trustees decided to focus the injury assessment for fish on mercury. It is the judgment of the Trustees that this decision, under the circumstances that exist for this Site, and with the use of a RWC approach to injury from mercury, is appropriate.

The assessment approach used to address potential injury to fish was designed to facilitate scaling of restoration alternatives using HEA. The Trustees recognized that the exposure route to fish was primarily through contaminated prey associated with benthic habitats in unvegetated sediments, fringe marshes, and oyster reefs. Therefore the Trustees treated injury to fish as an injury to the benthic habitats where these contaminated prey were located (i.e. as a reduction in benthic clean food provision), which could be incorporated within a HEA scaling approach. This loss of service is in addition to any direct injury to benthos calculated in the previous section, although the level of overall service loss (direct injury to benthos plus indirect injury to fish through "dirty" food) cannot exceed 100% in these calculations.

The RWC approach utilized to evaluate potential injury to fish is presented in detail in the RWC Analysis for Finfish (RWC Technical Memorandum; Appendix B: Analysis for Finfish, 2000), but is briefly discussed here. Tissue data for fish and prey items were collected as part of the RI/FS (Alcoa, 1998a; Alcoa, 1998b). These data, together with the results of studies in the literature linking mercury tissue levels and adverse impacts, were the major sources of information utilized by the Trustees. Additionally, a food web model was developed for Lavaca Bay prior to the Site being placed on the NPL (Evans and Engel, 1994), and this was also considered in the evaluation of potential injury.

Appropriate mercury tissue benchmark concentrations were developed through a review of the scientific literature. The literature on effects of mercury on fish indicates that the most sensitive time period for exposure is during early life-stages. Therefore, resident fish species would be expected to have a greater potential for injury than migratory fish. The types of adverse effects documented in the literature include alterations in behavior (swimming ability, predator avoidance, feeding ability), reductions in growth, decreased reproductive output, and death. The degree of injury assigned to different tissue concentration benchmarks was based on best professional judgment, taking into account the type of effect observed at a given tissue concentration.

The evaluation of injury for fish was based on representative species utilizing the three different benthic habitats used in the analysis. Red drum were chosen as the representative species for subtidal unvegetated sedimentary benthic habitats. Killifish were chosen to represent small non-migratory fishes inhabiting marsh habitats and feeding on organisms associated with marsh sediments. Gobies were chosen to represent small non-migratory fish associated with oyster reef benthic habitats. The relationship between concentration of mercury in fish tissue and that in the sediments of these habitats was developed as part of the RI/FS studies and is consistent with the results of the Evans and Engel food web model. For each habitat, the relationship was used to determine the areas where contamination would lead to fish tissue concentrations likely to cause injury. The results of this analysis are presented in Table 4-2.

Table 4-2. Service Loss Quantification for Fish

Habitat	Mercury in Tissue (ppm)	Mercury in Sediments (ppm)	1999 Injury Level (%)	Affected Acres
Marsh	<0.5	<0.7	0	N/A
	0.5-1.0	0.7-1.3	10	15.40
	1.0-2.0	1.3-2.7	20	3.28
	2.0-3.0	2.7-4.0	30	0
	>3.0	>4.0	40	0
Oyster Reef	<0.5	<0.8	0	N/A
	0.5-1.0	0.8-1.7	10	3.13
	1.0-2.0	1.7-3.3	20	1.09
	2.0-3.0	3.3-5.0	30	0
	>3.0	>5.0	40	0
Subtidal Sediments	<2.0	<2.0	0	N/A
	2.0-3.0	2.0-3.0	20	9.58
	>3.0	>3.0	30	2.50

However, fish tissue concentrations of mercury were higher in the past than current levels. Mercury fish tissue concentration data from the TDH studies over the years show that mercury levels were approximately twice as high in 1981 as they were in 1999 (RWC Technical Memorandum; Appendix B: Analysis for Finfish, 2000). The Trustees, therefore, adjusted the injury levels so that the injury levels associated with given areas of habitat in 1981 are twice that estimated for 1999. The 9.58 acres of subtidal unvegetated sediments that have been assigned an injury value of 20% for lost food provision to fish services in 1999 are thus estimated to have had an injury level of 40% in 1981. Injury levels were linearly decreased from 1981 levels to those of 1999. The result of this analysis for interim losses for these habitats is a loss of 82.97 DSAYs of marsh, 20.50 DSAYs of oyster reef, and 101.63 DSAYs of subtidal unvegetated sediment services in addition to that found for direct injury to these habitats.

4.2.3 Injury to Birds

Lavaca Bay provides diverse habitats for a variety of resident bird species throughout the year. In addition, Lavaca Bay hosts significant numbers of migratory waterfowl and shorebirds. Numerous islands constructed of dredge materials support large rookeries for several species of colonial waterbirds. Birds are an important functional group in ecological food webs. The primary ecological services provided by birds include food, production, and energy cycling. In addition, birds in general provide important secondary services, such as pollination and seed dispersal and human recreation.

In Lavaca Bay, injury to bird populations can occur as a result of direct exposure to mercury. Potential exposure routes include incidental ingestion of mercury and methyl mercury in sediments while feeding and/or preening and ingestion of contaminated prey as a result of bioaccumulation or biomagnification of mercury or methyl mercury in aquatic food webs. The Trustees followed a similar approach to evaluating potential injury to birds as was done for fish. That is, potential injury was evaluated as a loss in service from the habitats in which birds feed. In contrast to the literature for fish, most of the studies evaluating adverse effects to birds report the dose of mercury in the food rather than tissue levels in the birds themselves and the effect produced. The prey item tissue data from the RI/FS were converted to a representative dose for the particular birds chosen as representative species for the habitats studied (tern for open water, willet for marsh/mudflats, and tri-colored heron for marsh/oyster reefs).

A preliminary analysis was conducted using the lowest No Observed Adverse Effects Limit (NOAEL) and the smallest Lowest Observed Adverse Effects Limit (LOAEL) for both organic and inorganic mercury from the literature. Conversion to a dietary Toxicity Reference Value (TRV)- the mercury prey concentration that would result in a dose exceeding the NOAEL or LOAEL- was calculated for each of three representative bird species (RWC Technical Memorandum; Appendix C: Analysis for Birds, 2000). The maximum detected mercury concentrations of individual prey species were below the NOAEL and LOAEL TRVs. Therefore the potential for injury to birds is relatively low.

The Trustees had previously decided that injury due to "dirty" food from a particular area of habitat would be determined from injury to either birds or fish, whichever was greatest. Because the RWC analysis for birds indicated that injury to birds was lower than that to fish, further analysis of the injury to birds was unwarranted. Further, even if the Trustees' analysis of the potential injury to birds is lower than that actually present, the injury to fish was substantially larger, and the restoration actions taken to compensate for loss of clean food to fish should provide more than enough ecological services to compensate for bird injury.

4.2.4 Injury to Ground Water

Ground water can provide services to both humans (for drinking and agriculture, for example) and to the environment (as it discharges to the surface or surface waters). The Trustees evaluated potential losses of service both to humans and the environment in a RWC approach using information gathered during the RI (RWC Technical Memorandum; Appendix E: Analysis for Ground Water, 2000).

The ground water under the PCO facility is classified into four zones: Y, A, B, and C. Zone Y is the water-bearing material that has been used as fill at the Site. Zones A and B are shallow sand-rich zones separated by clay deposits. Zone C, a deeper sand-rich zone, is separated from zones A and B by additional clay deposits. Additional information on the hydrogeology of the Site can be found in the RI Report (Alcoa, 1999).

Ground water investigations performed as part of the RI found that zones A and B were contaminated at concentrations exceeding standards for ground water. However, high levels of total dissolved solids (TDS) also were identified in the ground water in these zones, independently limiting its use for drinking water purposes. Although water from zones A and B may have other uses (e.g., industrial cooling water), given the direction of flow of ground water in zones A and B in this area toward the bay, Alcoa is the only ground water user that could be affected by contamination under the PCO facility itself. Therefore, the contamination of zones A and B does not cause a public loss of natural resource services.

The deeper zone C was sampled for contamination as part of the RI, and no evidence of mercury contamination was found. Results from monitoring wells were not distinguishable from the laboratory blanks, indicating that if any mercury is present in zone C, it is far below drinking water standards. The result of the RWC analysis for potential ground water public service losses from zone C indicates that no compensation or further assessment is warranted.

The Trustees have considered injuries to bay resources resulting from contamination contributed via the ground water pathway to the bay. Injuries resulting from the introduction of mercury or other contaminants from ground water to resources in the Lavaca Bay system are captured in the separate analyses for these resources. Therefore, potential ground water service losses to Lavaca Bay resources are accounted for in the Trustees' bird, benthos, water column, and fish analyses.

4.2.5 Injury to the Water Column

The Trustees investigated the potential for injury to the water column as a habitat for those organisms that inhabit the surface waters of Lavaca Bay. These organisms are termed "plankton"- a diverse group of organisms inhabiting the water column that is transported by water movement and lacks the ability to move against currents. The injury assessment for this category used a RWC approach. That is, comprehensive field studies were not performed to measure injury to these resources in Lavaca Bay. Analytical chemistry samples were collected during the RI/FS to determine the nature and extent of mercury contamination in the water column of Lavaca Bay. These data, and those that had been collected historically, were compared with the results of studies conducted for other sites and with promulgated water quality criteria. Texas Water Code Section 307.6. The RI/FS data indicate that even the highest levels of mercury detected in the water column in Lavaca Bay do not approach the Texas mercury ambient chronic water quality criterion designed to protect aquatic organisms. The RWC analysis therefore concludes that there is little potential for injury to the water column as habitat for plankton (RWC Technical Memorandum; Appendix D: Analysis for Surface Water, 2000) and no further analysis was conducted.

This chapter describes the additional injuries caused by response actions initiated at the Site through 1999. Response actions (both removal and remedial actions) are conducted by EPA, state response agencies, or PRPs (under agency oversight) and focus on controlling exposure to released hazardous substances, by removing, neutralizing or isolating them in order to protect human health and the environment from the threat of harm. Response actions are separate and distinct from the damage assessment process. However, at times, response actions can cause additional injuries to natural resources. When such injuries result from response actions, the additional injuries can be included in the damage assessment. 43 C.F.R. Section 11.15.

Section 5.1 describes the response actions initiated through 1999 at the Site. To evaluate the effects of these actions as part of the injury assessment, the Trustees utilized the same habitat types as those used in the injury assessment process described in Chapter 4. Section 5.2 summarizes the effects of response actions on oyster reefs, marsh, and unvegetated subtidal sediments. Section 5.3 discusses the ramifications of response actions undertaken to control the discharge of contaminated ground water into the bay. The effect of anticipated future response actions (i.e., initiated after 1999) on natural resources is discussed in Chapter 8.

5.1 INITIATED RESPONSE ACTIONS THROUGH 1999

The response actions covered in this Chapter include the pilot dredging study, bridge construction dredging, and the Dredge Island stabilization project. Implementation of all of these projects began prior to the end of 1999. Phase I of the pilot dredging study occurred in 1998 and resulted in the removal of mercury-contaminated sediments adjacent to the former chlor-alkali facility. Alcoa currently uses the majority of the dredged area for the mooring of barges although a small portion of the total area adjacent to the shoreline is not actively used for this purpose.

Phase II of the pilot dredging study involved the removal of mercury-contaminated sediments adjacent to the northeast end of Dredge Island. This work was completed by February 1999. The dredged area included a shallow mudflat adjacent to the grass flats bordering Dredge Island.

In support of the construction of a timber bridge to Dredge Island, a channel was dredged parallel to the centerline of the bridge in 1999. This channel is approximately 90 feet wide and 420 feet long and dredged to a depth of approximately 4 feet. The channel was dredged in an area that included both shallow water habitat and oyster reef habitat.

The Dredge Island stabilization project includes removal of mercury-contaminated soils/sediments outside the current impoundment areas on the island. This removal includes areas of high marsh, low marsh and terrestrial habitats on and bordering the current footprint of the island. The removal is being conducted via dredging, which began in 1998. This project is still underway, but the scope of this project has been determined, and the total injury expected from this action is included in the analysis below.

5.2 HABITAT INJURIES FROM INITIATED RESPONSE ACTIONS

Table 5-1 below summarizes the habitat losses associated with response actions initiated through 1999. Some of the habitats affected by response actions are permanently lost. For example, this assessment assumes that the dredging of oyster reef habitat results in a permanent loss of oyster reef habitat services. In addition, the Dredge Island Stabilization requires the removal of some marshes on the northern end of the island.

For other habitats, the service losses associated with response actions are temporary. Open water habitat, for example, is only temporarily affected by dredging. The recovery of benthos from dredging depends on numerous factors, including the time of year relative to that of larval recruitment. Although some studies suggest that benthic recovery can sometimes occur within a few months to around a year (Swartz et al., 1980; Kenny and Rees, 1994; Van Dolah et al., 1984), the Trustees recognized that recovery may take longer. Three years was chosen as a conservative estimate for full recovery of the benthos from dredging.

Table 5-1. Habitat Losses Associated with Initiated Response Actions

Habitat Loss Component	Subtidal Unvegetated Sediments	Oyster Reef	Dredge Island Marsh	Other Marsh
Number of acres permanently lost	N/A	1.79	17.00	0.13
Date that permanent losses begin	N/A	1998	1999	1999
Number of acres temporarily affected	17.86	N/A	N/A	NA
Dates of temporary effects	1998-2000	N/A	N/A	NA
Discounted Acre-Years	36.08	61.51	566.67	4.33

5.3 EVALUATION OF POTENTIAL INJURY FROM GROUND WATER RESPONSE ACTIONS

The Trustees considered possible injury to the bay from response actions that affected flow of ground water into the bay (RWC Technical Memorandum; Appendix E: Analysis for Ground Water, 2000). Discharge from zone B ground water in the Chlor-Alkali Processing Area (CAPA) had been identified in the RI as a continuing source of mercury contamination to Lavaca Bay. As part of the cleanup strategy for the Site, control measures have been instituted to eliminate this discharge of contaminated ground water to the bay. These controls reduce ground water inflow rates to Lavaca Bay, potentially affecting the salinity in the bay. In Lavaca Bay, natural seasonal and interannual variations in salinity range from freshwater (0 practical salinity units or PSU) to that of full strength seawater (35 PSU). For evaluation of potential ecological service losses, the Trustees considered the effect of response actions that would limit ground water flow into Lavaca Bay, thereby potentially affecting the normal range of salinity in the bay.

An upper bound estimate (i.e., RWC) of the reduction in ground water inflow was calculated to be approximately 3.8 gallons per minute. This value represents approximately 0.003 percent of the pre-remediation combined river and ground water inflow rates to Lavaca Bay. Thus, cutting off the inflow from the portion of zone B underlying CAPA results in less than a 0.003 percent change in salinity (approximately 0.0002 - 0.001 PSU) compared to the pre-response action condition. Such a small change in the salinity is not expected to have ecologically relevant effects in the Lavaca Bay system. Therefore, the Trustees concluded that there is no compensable injury to the bay resulting from the response actions taken to control the discharge of contaminated ground water into Lavaca Bay.

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 those injured or lost as a result of releases of hazardous substances. These actions make the public "whole" by providing in-kind compensation for injuries and losses. The restoration planning process has two steps: evaluation of primary and compensatory restoration. The scope of this restoration plan is limited in that it focuses on compensatory restoration alternatives. Compensatory restoration is any action taken to compensate for interim losses of natural resources and services, pending return of the resources and their services to baseline level. In contrast, primary restoration actions are actions designed to speed the recovery of resources and services to their baseline levels (i.e., the level that would exist if the releases had not occurred). Primary restoration decisions will be considered in conjunction with response actions undertaken at the Site, which have not yet been finalized. However, the potential need for primary restoration actions, based on the Trustees' understanding of likely future response actions, is discussed in Chapter 8.

This chapter lays out the restoration screening and selection process undertaken by the Trustees. Section 6.1 describes the process for developing general restoration alternatives, and Section 6.2 provides an evaluation of the general alternatives. Section 6.3 describes the potential locations where the restoration alternatives could be implemented. Sections 6.4 and 6.5 evaluate the potential locations for marsh restoration and oyster reef restoration, respectively, which were selected as the restoration actions to compensate for the injuries covered in this stage.

6.1 GENERAL RESTORATION ALTERNATIVES

In accordance with NRDA regulations, the Trustees developed a reasonable range of restoration alternatives, identified preferred alternatives in the Draft DARP/EA, and, after providing the opportunity for public comment, selected restoration actions to address resource injuries and service losses. The Trustees used a two-step process to screen restoration alternatives. The Trustees first identified and evaluated general alternatives capable of serving as compensatory restoration for the injured natural resources and/or services (Section 6.2). As part of the effort to develop general restoration alternatives, the Trustees consulted with local scientists and state agency personnel to get their perspective on the benefits and feasibility of various types of restoration alternatives. These efforts were important in assisting the Trustees in identifying restoration actions that have the potential to be feasible, have strong net environmental benefits, and meet restoration requirements to compensate for injuries resulting from Site contamination. The second step, discussed in Sections 6.3-6.5, was to select locations for implementing the restoration actions.

Some compensatory restoration alternatives considered by the Trustees would provide similar resources and/or services to those injured, while other alternatives would compensate by providing a comparable resource or service. The Trustees preferentially seek in-kind restoration (e.g., the creation of a new marsh to compensate for lost marsh services) in the geographical vicinity affected, while working to maximize the benefit to the ecosystem and to human uses of the environment (such as fisheries), in a cost-effective manner. However in-kind restoration is not always possible or feasible, or may not otherwise fit the restoration selection criteria. In those instances, restoration or enhancement of other resources providing similar ecological benefits may be appropriate. Finally, increased benefits and improved cost-effectiveness may often be obtained by addressing several injured resources and/or services or classes of injury with a single restoration project.

Table 6-1 contains the list of general restoration alternatives considered by the Trustees and identifies those selected after considering public comment on the Draft DARP/EA. The logic for selecting alternatives that provide an out-of-kind resource or service as compensation for an injured resource or service is described in detail in Section 6.2.

Table 6-1 General Restoration Alternatives Considered for Each Injury

Injured Resource/Service	Compensatory Restoration Alternative[a]
Marsh[b]	No Compensation
	Marsh Restoration
Oyster Reefs[b]	No Compensation
	Oyster Reef Creation
Subtidal Benthic Habitat (Open Water Sediments)[b]	No Compensation
	Marsh Restoration
	Oyster Reef Creation
	Subtidal Benthic Habitat Creation
Water Column	**No Compensation**
Ground water	**No Compensation**

[a]Selected Restoration Alternatives are in bold
[b]Injury to fish is included here as a loss of service from this habitat

6.2 EVALUATION OF GENERAL RESTORATION ALTERNATIVES

Once a reasonable range of restoration alternatives is developed, the NRDA regulations require the Trustees to identify preferred restoration alternatives in a Draft DARP/EA based on certain criteria. The following regulatory criteria were used:

- *The cost to carry out the alternative*: The benefits of a project relative to its cost are a major factor in evaluating restoration alternatives. In addition, the Trustees consider the total cost of the project. Factors that can affect and increase the costs of implementing the restoration alternatives may include project timing, access to the project site (for example with heavy equipment), obtaining state or federal permits, acquiring the land needed to complete a project, and potential liability arising from project construction. Although a monitoring program does increase the cost of an alternative, the presence of an adequate monitoring component is necessary as knowledge of the status of early restoration project actions is critical in determining the need for any maintenance needs and mid-course corrections to ensure that long-term project goals will be attained.

- *The extent to which each alternative is expected to meet the trustees' goals and objectives in compensating for interim losses*: The fundamental goal of any compensatory restoration project is to provide resources and services, of the same quality, that were lost. Thus, the ability of the restoration project to provide comparable resources and services is an important consideration in the project selection process. To quantify the provision of resources and services, the Trustees must consider the potential relative productivity of restored habitat. Finally, future site management issues and the opportunity for conservation easements are also considered because they can influence the extent that the project meets objectives.

- *The likelihood of success of each alternative*: The Trustees consider technical factors that represent either risk to the success of project construction or the long-term viability of the resources and services involved. For example, project sites with high subsidence rates are problematic due to concerns about the long-term existence of constructed habitats. Restoration alternatives that are susceptible to future degradation or loss through contaminant releases or erosion are considered less viable. Sites that require long-term maintenance of project features are less feasible.

- *The extent to which each alternative will prevent future injury as a result of the release and will avoid collateral injury as a result of implementing the alternative*: Restoration actions should not cause injury and, if possible, should prevent future injury. Restoration projects should not contaminate the surrounding area nor conflict with the viability of endangered species populations. Projects should be compatible with surrounding land use.

- *The extent to which each alternative benefits more than one natural resource or service*: This concept is related to the interrelationships among natural resources and between natural resources and the services they provide (see Figure 4-1). Projects that provide benefits to more than one resource and/or service yield more benefits. For example, certain types of marsh restoration projects could improve fish habitat such that anglers might experience higher catch rates[6].

- *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 allow the Trustees to prioritize these criteria, and to use additional criteria as appropriate. The second criterion is a key criterion for the Trustees because it is the criterion that most clearly indicates whether the goal of making the public whole for losses resulting from the release is met.

In addition to the listed criteria, the Trustees also considered public access and recreational opportunities provided by a restoration project as positive attributes. An additional factor considered by the Trustees is the acceptance of the potential projects by the community. Restoration alternatives that are complementary with other community development plans/goals are considered more favorably. The Trustees held public meetings in Port Lavaca in February and November 1998 to solicit public input prior to the development of the Draft DARP/EA, and also on July 27, 2000 following its release to present the Trustees' preferred restoration actions to the community.

NEPA requires the Trustees to evaluate the "No Action" alternative, which for compensatory restoration equates to "No Compensation". Under this alternative, the Trustees would take no direct action to obtain compensation for interim losses associated with the injured resource and/or service in question. After undertaking a RWC analysis, the Trustees determined that no compensation is required for water column (RWC Technical Memorandum; Appendix D: Analysis for Surface Water, 2000) and ground water (RWC Technical Memorandum; Appendix E: Analysis for Ground Water, 2000). However, because the RWC analyses for the three types of benthic habitats (subtidal unvegetated sediments, oyster reef, and marsh) and finfish indicates that interim losses due to hazardous substance releases and response actions have occurred (RWC Technical Memorandum; Appendix A: Analysis for Benthos, 2000; RWC Technical Memorandum; Appendix B: Analysis for Finfish, 2000), restoration actions to compensate for these losses is required.

Based on a thorough evaluation of a number of factors, including the criteria listed above, the Trustees selected restoration alternatives for compensatory restoration of injured natural resources and/or services for marsh, oyster reef, subtidal sediment benthic habitat, and fish (Table 6-1). Information supporting the Trustees' selection of these restoration alternatives is provided throughout the remainder of this chapter.

6.2.1 Marsh

As discussed in Section 6.1, the Trustees prefer in-kind restoration where possible and otherwise consistent with restoration selection criteria. Since in-kind restoration of marsh, by creation and enhancement, is highly beneficial and technically feasible, the Trustees determined that the appropriate compensatory restoration action for marsh injury is marsh restoration.

Restoration of marsh is consistent with the criteria used by the Trustees to evaluate restoration alternatives. Marsh restoration will provide a wide array of resources and services. It will provide an increased outflow of organic material that will generally benefit the Lavaca Bay ecosystem by providing a source of organic carbon (the energy supply supporting estuarine food webs). Created or enhanced marsh will provide services benefiting a wide range of resources, including benthic invertebrate species that inhabit marshes and the bird and fish species that feed on them. By providing critical nursery habitat for shrimp, fish, and other aquatic species, and nesting and foraging habitat for birds and other wildlife, created or enhanced marsh will benefit recreational uses of the area by supporting increased populations of these species. Therefore, this alternative would have clear overall benefits to the environment.

[6] Although recreational benefits are not explicitly evaluated in this DARP/EA, the opportunity for a restoration alternative to provide benefits of this nature was considered a positive feature of the alternative.

Marsh creation typically results in some impacts to existing habitats, such as subtidal sediments or terrestrial habitat, on which it is created. Marsh enhancement projects will often have fewer impacts due to implementation, but it may be difficult to quantify the benefits of enhancement projects. Additionally it may be difficult to get permits necessary to implement marsh enhancement projects since permitting agencies are reluctant to approve projects where marsh currently exists. Marsh creation and enhancement projects typically have a high likelihood of success and tend to be very cost-effective to implement. Marsh creation and enhancement projects are also generally consistent with state and federal policies and law.

6.2.2 Oyster Reefs

As discussed in Section 6.1, the Trustees' prefer in-kind restoration where possible and otherwise consistent with restoration selection criteria. Since in-kind restoration through oyster reef creation is highly beneficial and technically feasible, the Trustees determined that the best compensatory restoration action for oyster reef injury is oyster reef creation.

Creation of an oyster reef as a restoration alternative fits the restoration criteria and policies. A created oyster reef would serve as a substrate for increased secondary productivity, would support fish, and therefore could provide feeding areas for some bird species. If constructed appropriately, it could provide a loafing area for birds during low tides. Oyster reef creation would also have some very positive benefits to fish, other organisms, and recreational fishing. Since creation of an oyster reef is feasible, and would provide the same services as those lost due to the injury to oyster reefs near the PCO facility, oyster reef construction is the appropriate restoration alternative for this injury category.

6.2.3 Subtidal Benthic Habitat (Open Water Sediments)

The Trustees considered three restoration alternatives for use to compensate for injuries to subtidal benthic habitat: 1) creation of subtidal benthic habitat; 2) marsh restoration (i.e., creation, enhancement); and 3) creation of oyster reef habitat.

Creation of subtidal benthic habitat is possible by grading down terrestrial habitat and allowing it to be flooded by seawater. This alternative is technically feasible, although the disposal of the large amount of removed soil could be problematic. It would closely replace the same ecological services as those lost due to injury. Although this alternative would represent in-kind restoration, which is normally preferred when feasible, it conflicts with current governmental policy. Land loss along the Gulf of Mexico coastal zone is a severe problem, with many square miles being lost each year. Implementation of this alternative would exacerbate this problem. Additionally, marsh restoration or oyster reef creation would provide more benefits on a per-acre basis to the Lavaca Bay ecosystem than would creation of additional unvegetated subtidal benthic habitat. Therefore creation of subtidal benthic habitat was not selected as the restoration alternative for this injury category.

The benefits and other features of marsh restoration have been discussed above. Although marsh restoration is not an in-kind restoration alternative for subtidal benthic habitat, it does provide most of the same services as well as additional ones and is a much more ecologically productive habitat overall than unvegetated subtidal sediments. This restoration alternative was judged to be appropriate as compensation for injuries to subtidal benthic habitats in Lavaca Bay.

The benefits and other features of oyster reef construction have been discussed above. Although oyster reef creation is not an in-kind restoration alternative for subtidal benthic habitat, it does provide many of the same services as well as additional ones and is a more ecologically productive habitat than unvegetated subtidal sediments. Oyster reef creation in this part of Texas is more costly than marsh creation and is not as productive as marsh in providing services of the sort lost due to injury to unvegetated subtidal benthic habitat. For these reasons marsh restoration, not oyster reef creation, was selected as the best compensatory restoration alternative for injuries to subtidal benthic habitats in Lavaca Bay.

6.3 EVALUATION OF RESTORATION PROJECT LOCATIONS

As described above, the overall objective of the restoration process is to make the environment and public whole for injuries to natural resources and/or service losses resulting from the releases at the Site. To meet that objective, the benefits of restoration actions must be related, or have an appropriate nexus, to the natural resource injuries and service losses at the Site. The relationships that must be considered include the following:

- Equivalency of created or enhanced resources or services to those potentially affected by the hazardous substance releases, and
- Potential for restoration at or near the area where natural resource injuries/service losses occurred

To ensure restoration actions would achieve these fundamental objectives, the Trustees determined that the identified restoration alternatives must have an ecological and a geographical relationship to the injured resources and service losses. The Trustees approached restoration planning with the view that the Lavaca/Matagorda Bay system represents the relevant geographical area for siting restoration actions because the injuries and losses occurred in that area. Areas outside of the tidal Lavaca/Matagorda Bay system are considered less geographically relevant as restoration alternatives.

Many possible sites exist for marsh and oyster reef restoration in the vicinity of Lavaca Bay, Texas. The Trustees identified 22 possible marsh and/or oyster reef restoration locations (Figure 6-1). The potential restoration sites were identified from a myriad of sources, including United States Geological Service topographical maps of the region, available aerial photographs, state and federal agency personnel familiar with the region, two publications of the U.S. Fish and Wildlife Service (USFWS 1977, 1993), and public input. Suggestions for restoration sites were actively solicited from local citizens during a public meeting held in Port Lavaca in February 1998. The suitability of potential restoration sites was evaluated through site visits, aerial overflights, and ground surveys.

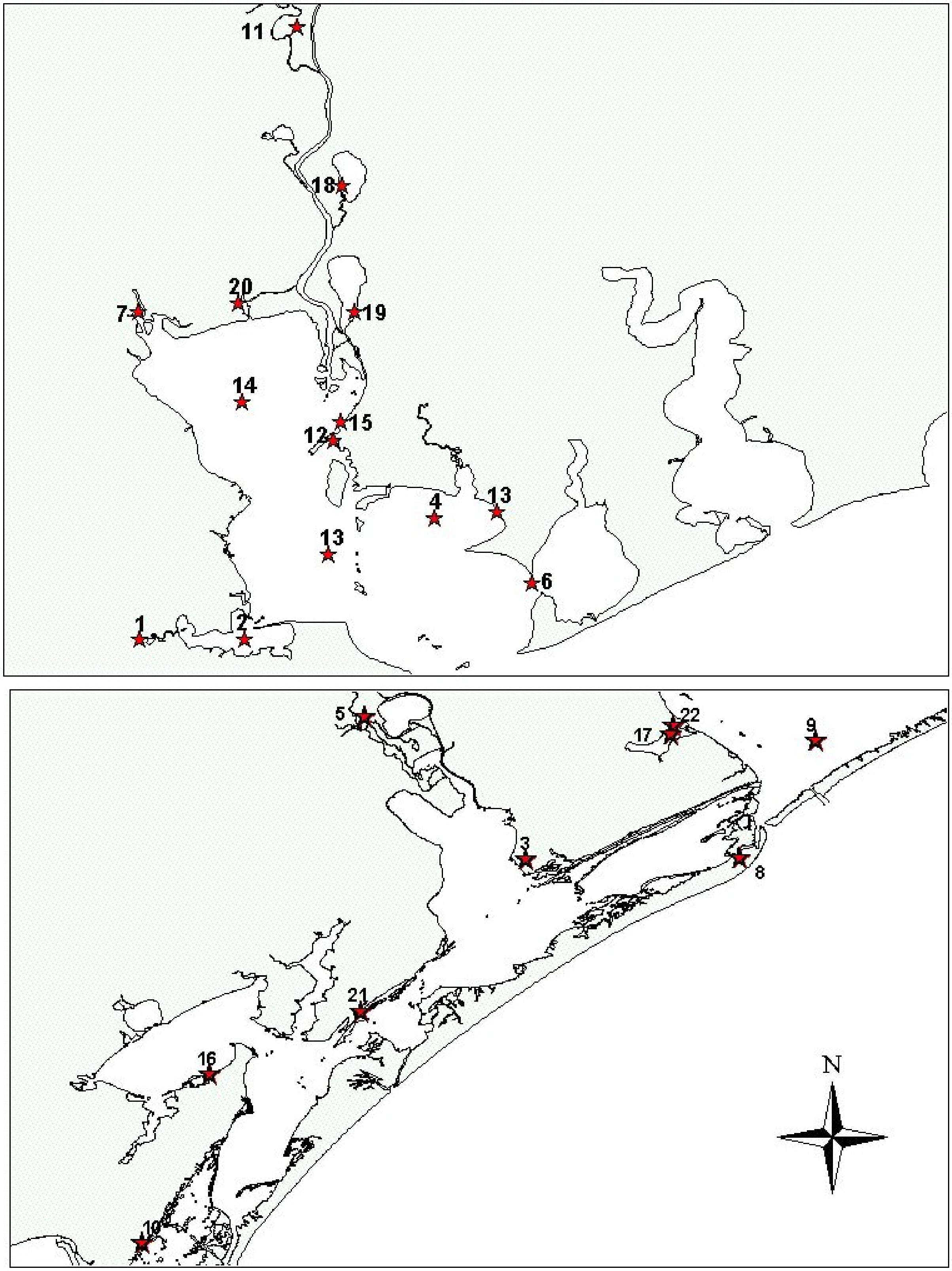

Figure 6-1. Map With Locations of Potential Projects

The Trustees used a two-tiered process to identify the preferred sites presented in the Draft DARP/EA. From the initial list of possible alternative sites for restoration, the Trustees conducted two “screenings” which are described in more detail below.

6.3.1 First Tier Screening

In order to pare down the large list of alternative locations and focus information-gathering efforts on the most likely alternatives, the Trustees conducted a primary screening to narrow the list. Two criteria were used in the primary screening: proximity to the affected area and similarity in attributes to the injured habitat. These two criteria were used because they reflect important project attributes and could be applied without needing to gather detailed, extensive project information for all locations. These two primary screening criteria are defined below.

> *Proximity to Affected Area:* This criterion considered whether the alternative was located within the affected area or was within a reasonable distance of the affected area. Locating the restoration near the affected area ensures that the service flows from the restoration actions are concentrated in the same vicinity as the service losses, benefiting those members of the public who were most affected by the impacts from the PCO releases. The Trustees decided to limit consideration of projects to areas located in GLO map numbers 47, 48, 48A, 49, 54, 55, 56, 59, and 60 (TGLO, 1985), corresponding to USGS 7.5 minute topographic quad maps Olivia, Point Comfort, Lolita, Kamey, Keller Bay, Port Lavaca East, Port Lavaca West, Decros Point, Port O’Connor, and Seadrift NE, respectively.
>
> *Similarity in Attributes to the Injured Habitat:* This criterion considered the nature and extent to which restoration alternatives are similar to the natural resource injuries and service losses that occurred as a result of the impacts from PCO releases. This considers the habitat type being enhanced or created, and the potential relative productivity of that habitat for injured resources or service losses. Estuarine locations will provide benefits that are more closely associated with the injured habitats (salt marsh, oyster reef, and subtidal unvegetated estuarine sediments) and the specific resources that depend on these habitats (finfish, shellfish, and birds) than freshwater locations.

Seven potential marsh project locations met both of the first tier criteria and were carried forward for further analysis: Big Chocolate Bayou, Cox Bay, Keller Bay, north Dredge Island and Alcoa Shoreline, Point Comfort Shoreline, Powderhorn Lake, and the Myrtle Foester Whitmire Division of the Aransas National Wildlife Refuge hereafter referred to as ANWR. Six other potential marsh project locations were outside of the geographical boundaries that the Trustees had decided were appropriate and were not evaluated further: Butterfield Slough-Sartwelle Marsh, Guadalupe River Bottom, Matagorda Island, McCampbell Slough, Port Bay Marsh, and Welder Flats. Five potential marsh restoration locations were within the boundaries selected by the Trustees as being appropriate, however the habitat at these sites is only marginally equivalent to those affected by Alcoa’s releases due to their proximity to freshwater sources. These five locations are: Lavaca/Navidad River Delta, Menefee Flats, Redfish Lake, Swan Lake, and Venado Lakes.

Seven locations were evaluated further as potential sites for oyster reef creation: Chocolate Bay, Cox Bay, Keller Bay, lower Lavaca Bay, upper Lavaca Bay, Matagorda Bay, and Powderhorn Lake. These seven were judged to have met the first tier criteria sufficiently for further analysis.

Table 6-2
First Tier Screening of Potential Restoration Locations[a]

Potential Restoration Locations	**Figure 6-1 reference number**	**Proximity to Affected Area**		**Similar Habitat Attributes**	
		Proximate (Map #)	Not Proximate	Saltwater	Freshwater
Big Chocolate Bayou	**1**	#56		X	
Chocolate Bay	**2**	#55, 56		X	
Butterfield Slough-Sartwelle marsh	3		X	X	
Cox Bay	**4**	#48, 54		X	
Guadalupe River Bottom	5		X	X	
Keller Bay	**6**	#47, 54		X	
Lavaca/Navidad River Delta	7	#48			X
Matagorda Island	8		X	X	
Matagorda Bay	**9**	#54, 59		X	
McCampbell Slough	10		X	X	
Menefee Flats	11	#48A			X
North Dredge Island and Alcoa Shoreline	**12**	#48		X	
Lower Lavaca Bay	**13**	#48, 54, 55		X	
Upper Lavaca Bay	**14**	#48		X	
Point Comfort	**15**	#48		X	
Port Bay Marsh	16		X	X	
Powderhorn Lake	**17**	#54, 55, 60		X	
Redfish Lake	18	#48A			X
Swan Lake	19	#48			X
Venado Lakes	20	#48			X
Welder Flats	21		X	X	
Whitmire Division of Aransas National Wildlife Refuge	**22**	#60		X	

[a]Locations meeting first tier screening are in bold.

6.3.2 Second Tier Screening

After the first tier screening was completed, a second set of screening criteria was applied to the remaining restoration project locations. The criteria used to rank these alternatives were those that served to emphasize project differences and were derived from the list of primary and secondary criteria. The five criteria utilized in the second tier screening are:

Future Management - This criterion considered whether the potential project location was publicly or privately owned and, for private property, whether the landowner would agree to a conservation easement or other appropriate land management restrictions to ensure that the project would continue to provide benefits far enough into the future to fulfill compensation requirements. Without an understanding of the future management of the specific property under consideration, the Trustees cannot estimate future service flows and, therefore, cannot determine what size a project would have to be to provide sufficient compensation.

Technical Feasibility **-** This criterion considered site-specific factors that may influence project success, including whether there will be residual contamination remaining in the vicinity that could negatively affect resources and whether there is sufficient available acreage that is amenable for project implementation.

Cost to Carry Out the Restoration Alternative **-** This criterion considered the cost associated with implementation of the restoration project at the prospective location. This includes any costs associated with purchasing the property or appropriate easements, as well as specific considerations concerning the cost of implementation. Everything else being equal, projects that cost less than other alternatives are preferred.

Extent to Which Each Location will Maximize Benefits to Resources **-** This criterion considered the potential for a restoration site to maximize benefits to natural resources. In this criterion, factors such as whether it is possible to integrate a restoration project with other projects to increase the ecological benefits of the project are considered.

Adjacent Land Use **-** This criterion considered the current uses of land adjacent to the proposed restoration location. Adjacent lands that are less developed (e.g., have more natural habitat) are preferred because locating a project next to developed areas would tend to lessen the likelihood that a restoration project would provide the intended or additional benefits.

For each criterion, alternatives were given a ranking of either plus (+) to indicate a good "fit", a zero (0) to indicate a fair "fit", or a minus (-) to indicate a poor "fit" to the criterion. Table 6-3 provides the results of the ranking. Based on the ranking, the Trustees determined that two sites were appropriate for marsh restoration: the Powderhorn Lake property and the ANWR. One alternative, lower Lavaca Bay, was selected for oyster reef restoration. The remainder of this section provides more detailed information on the screening process, including the justification for selection of these restoration sites. The non-selected locations are also discussed, with the rationale for not selecting them.

Table 6-3. Application of Second Tier Screening Criteria

Location[a]	Future Management	Technical Feasibility	Cost to Carry Out Restoration	Maximize Benefits to Resources	Adjacent Land Use
Potential Marsh Restoration Locations					
Big Chocolate Bayou	0	0	-	-	0
Cox Bay	0	+	0	-	+
Keller Bay	0	+	-	-	+
North Dredge Island/Alcoa Shoreline	0	-	+	-	-
Point Comfort	0	-	+	-	-
Powderhorn Lake	+	+	+	+	+
Whitmire Division of Aransas National Wildlife Refuge	+	+	+	+	+
Potential Oyster Reef Restoration Locations					
Chocolate Bay	+	+	+	+	0
Cox Bay	+	-	-	+	0
Keller Bay	+	-	-	+	0
Lower Lavaca Bay	+	+	+	+	0
Upper Lavaca Bay	+	-	+	+	0
Matagorda Bay	+	-	+	+	0
Powderhorn Lake	+	+	-	+	+

[a]Project locations meeting second tier criteria are in bold

6.4 SELECTION OF MARSH RESTORATION LOCATIONS

The Trustees identified two locations that are appropriate for marsh restoration within the appropriate geographic and salinity zones and that best fit the second tier site selection criteria: Powderhorn Lake and the ANWR.

6.4.1 Evaluation of Powderhorn Lake: Co-selected Site

The Powderhorn Lake site is located southwest of the town of Indianola and adjacent to Powderhorn Lake and the ANWR. This property provides numerous estuarine marsh creation and enhancement opportunities. Its distance from the residual mercury contamination ensures that the mercury will not affect the natural resource services provided by restoration undertaken at this site. This distance offers an advantage over other potential areas that are closer to the residual mercury. Additionally, if the property is donated to the ANWR, then the future management by the U.S. Fish and Wildlife Service would guarantee the flow of marsh services uninterrupted into the future. Even if the property does not become part of the ANWR and instead is under some form of conservation easement or other appropriate management restrictions, its location adjacent to the Refuge will be beneficial because it will provide a larger area of protected, heterogeneous habitat than would be possible at other locations. Larger areas of undeveloped protected habitat are more beneficial to fish and wildlife than are smaller, non-contiguous areas, so implementation of restoration actions at this location would be enhanced by the proximity to the Refuge. The property is currently owned by a company associated with Alcoa, Murphy Properties, and, with Alcoa's agreement, could be utilized for a restoration project without additional acquisition costs.

6.4.2 Evaluation of Myrtle Foester Whitmire Division of Aransas National Wildlife Refuge: Co-selected Site

The ANWR consists of 3,440 acres adjacent to the Powderhorn Lake site. It provides many of the same marsh enhancement and creation opportunities provided by the Powderhorn Lake site. Restoration could be implemented on this Division of ANWR without having to purchase the property, and ecological services provided by the restoration would flow uninterrupted under the current management. Surrounded by the protected habitats in the Refuge, a marsh restoration project here would maximize the potential benefits due to its location.

6.4.3 Evaluation of Big Chocolate Bayou: Non-selected Site

Big Chocolate Bayou is not selected as a marsh restoration site primarily due to the limited opportunities for marsh creation and enhancement available there. Much of the area is already high quality marsh, and much of the remaining acreage is residential or industrial. Additionally, there would be added cost associated with the purchase of suitable property. Future management at this location would be more problematic than at the ANWR or Powderhorn Lake alternatives, since there is currently not an entity identified, as the USFWS is for the ANWR and probably the Powderhorn Lake property, to undertake the management role.

6.4.4 Evaluation of Cox Bay: Non-selected Site

Cox Marsh, adjacent to the eastern boundary of the PCO facility, already provides high quality habitat, and there is little opportunity to perform enhancement. There would be a risk to the existing ecological service flows if restoration actions were performed here. As with the Big Chocolate Bayou alternative, future management at this location would be more problematic than at the ANWR or Powderhorn Lake alternatives. Alcoa owns part of Cox Marsh, and would have to purchase the remaining acreage to implement marsh restoration here. The cost associated with purchasing this property weighs against this alternative, given the availability of the Refuge and the Powderhorn Lake alternatives, where appropriate restoration could be implemented without having to purchase property.

6.4.5 Evaluation of Keller Bay: Non-selected Site

There is an undeveloped block of property adjacent to Keller Bay and Cox marsh, east of the PCO facility. Marsh creation on this property could provide many of the same services as those in Cox Marsh. However, there would be the added expense of purchasing this property, which does not apply to the ANWR and the Powderhorn sites. Additionally, this property does not offer the same advantages with respect to future management, as do the selected alternatives since there is no identified public agency or entity to undertake the management of the project.

6.4.6 Evaluation of Dredge Island/Alcoa Shoreline: Non-selected Site

Marsh restoration could be implemented fairly inexpensively at this location, because property would not have to be purchased. However, this property does not offer the same advantages with respect to future management as do the ANWR and the Powderhorn sites since there is no identified agency or entity to undertake the management of the project. More importantly, resources utilizing marsh created here would be exposed to higher levels of mercury in the near-term, than would resources utilizing marsh restoration at the selected locations.

6.4.7 Evaluation of Point Comfort: Non-selected Site

The Point Comfort location (also known as the Bean Property) consists of 85 acres bordered on the north and west by Lavaca Bay, on the south by State Highway 35, and on the east by the city of Point Comfort. Fringe marsh and mudflats exist along the shoreline. A manmade cove, dredged to allow barge access, provides open water habitat. Marsh restoration opportunities are possible at this location. This property is owned by Alcoa, so restoration could occur here without having to purchase property. One disadvantage of this alternative is its proximity to a highly industrialized area. Parts of the property itself were once in industrial service and there would be significant costs incurred in removing the former industrial structures prior to restoration. Future management at this location would be more problematic than at the ANWR or Powderhorn Lake alternatives for the same reasons as the other non-selected locations. The more remote and pristine locations (the ANWR and Powderhorn Lake alternatives) were therefore chosen.

6.5 SELECTION OF OYSTER RESTORATION SITE

The Trustees evaluated a number of potential oyster reef locations within the Lavaca-Matagorda Bay system and selected lower Lavaca Bay as the location for creating oyster reef habitat.

6.5.1 Evaluation of Lower Lavaca Bay: Selected Site

Lower Lavaca Bay has extensive oyster reefs, indicating that oyster reef creation within this portion of the bay is feasible. The exact location for, and design of, reef construction in Lavaca Bay will need to be carefully chosen to minimize the effect, in the near-term, of residual contamination near the PCO facility. However, there are available sites within lower Lavaca Bay that are sufficiently far from elevated levels of mercury to preclude adverse effects from mercury. Alternatively, it may be possible to construct oyster reef on top of clean material laid over mercury-contaminated sediments, thus isolating the reef from contamination. It is more cost-effective to create oyster reef in the bay proper, than in Powderhorn Lake, Cox Bay, Keller Bay, or Chocolate Bay since, unlike these other locations, barge access to implement restoration will not be a problem. Most of the open water bottoms in lower Lavaca Bay are owned by the state and managed by TGLO. Although much of Lavaca Bay's shoreline is developed, there are sufficient locations far enough from developed areas so that the created oyster reef would not be adversely affected.

The specific location for the created oyster reef will be determined after examining water depths for barge access, firmness of the sediment, and other factors. A preliminary evaluation indicated that the area to the west of the mouth of Keller Bay would be appropriate. However, the Trustees will evaluate the possibility of locating the reef on top of clean material, dredged by another entity and placed on top of currently contaminated sediments southwest of Dredge Island. This would allow beneficial usage of spoil to help cap these sediments and reduce the chance of re-mobilization of mercury due to storm events. The possibility of using dredged material from an independent project would depend on the timing of that dredging and the willingness of that party to participate in this effort.

6.5.2 Evaluation of Upper Lavaca Bay: Non-selected Site

Upper Lavaca Bay was eliminated from further consideration based primarily on technical feasibility issues. Dr. Sammy Ray (Texas A&M University at Galveston), the oyster expert consulted by the Trustees, believes that the salinity of the bay north of Highway 35 is too low and variable to allow consistent oyster production. This factor alone is sufficient to warrant a finding that this is a poor location for an oyster reef restoration project.

6.5.3 Evaluation of Powderhorn Lake: Non-selected Site

Powderhorn Lake is an estuarine lake located off the southwestern shore of Lavaca Bay. Dr. Ray visited Powderhorn Lake and judged it as a good site for oyster reef creation based on salinity, bottom type, and the presence of oysters. It is located far from residual mercury in Lavaca Bay and would be located near the marsh restoration locations on the ANWR and the Powderhorn Lake property, which would help to maximize the benefits of both types of projects by increasing the heterogeneity of the restoration project. Open water bottoms in Powderhorn Lake are owned by the state, and managed by TGLO. The adjacent shoreline is largely undeveloped. However, it would be very costly to build an oyster reef in this location, compared to the open water areas of lower Lavaca Bay, due to the restricted access at the mouth, shallow water within the lake, and the remote location. Small barges would have to be used which would be prohibitively expensive with any additional ecological benefits unlikely to offset that additional cost.

6.5.4 Evaluation of Chocolate Bay: Non-selected Site

Chocolate Bay already has a significant amount of oyster reef in the areas where oyster reef creation would be feasible. It would be difficult gaining access into the bay proper due to the shallow water depth and the presence of the existing reefs at the mouth of the bay. This potential restoration site meets the remaining criteria fairly well, but it would be costly to construct reef in this location due to barge access issues.

6.5.5 Evaluation of Keller Bay: Non-selected Site

Keller Bay might be a good location for oyster reef creation but for the problem of accessibility through the mouth of the bay. In this regard, it is similar to Chocolate Bay and Powderhorn Lake. Additionally, much of the bottom in the bay is composed of relatively soft sediments, which would limit the availability of feasible oyster reef locations.

6.5.6 Evaluation of Cox Bay: Non-selected Site

Cox Bay has very soft sediments, making successful oyster reef creation problematic because the reef materials would tend to sink into the sediment. Additionally, there may be a problem with siltation from Calhoun County Navigation District dredging operations. The bay is also very shallow, which would make it difficult to get barges of rock to potential locations, increasing the cost of undertaking restoration at this site.

6.5.7 Evaluation of Matagorda Bay: Non-selected Site

Matagorda Bay was not appropriate for oyster reef restoration because its high salinity would be conducive to oyster predators, such as drills. Additionally, high salinity areas are prone to Dermo infections. The higher risks of both disease and predation make potential areas in Matagorda Bay technically infeasible for selection as the site for oyster reef creation.

Chapters 4 and 5 addressed the injuries to natural resources and services from both contamination and response actions undertaken to control contamination. The injuries are the interim losses that occurred from 1981 through 1999 and the losses due to response actions initiated through 1999. In Chapter 6, the compensatory restoration alternatives were identified, evaluated, and selected, including the locations for salt marsh and oyster reef creation.

The focus of the present chapter is the determination of the size or scale of these restoration projects. The scale of the projects must be sufficient to offset the value of the losses. The process of determining the size of restoration is termed ‘restoration scaling’.

Restoration scaling requires a framework for quantifying the value of losses and for quantifying the benefits of restoration so the losses and benefits can be compared. The Trustees used HEA as the framework for quantifying losses and benefits. The process of scaling using HEA for this Site is summarized below. The HEA process is described in more detail in the Lavaca Bay Injury Quantification and Restoration Determination Technical Memorandum (Trustees, 2000a).

7.1 DESCRIPTION OF HABITAT EQUIVALENCY ANALYSIS

Habitat equivalency analysis is an approach to restoration scaling that has been used successfully for scaling restoration actions at a number of locations around the country. Losses are quantified as lost habitat resources and services. The restoration projects are to provide comparable habitat resources and services. The appropriate scale (size) of the restoration projects is that which provides equivalency between the lost and restored habitat resources and services. Restoration habitat of the same type, quality, and of comparable value should be provided to compensate for the resource and service losses so that the value of the total losses equals the value of restoration benefits.

The HEA method requires the development of injury parameters to quantify lost habitat resources and services. The parameters needed to estimate losses within the HEA framework include the area of habitat injury, the degree of injury within that habitat, and how that degree of injury changes over time. The degree of injury is determined by the condition of key or representative resources or services in the habitat (for example, primary production or macrofaunal density). The losses are quantified by year as lost service acre-years, where a service acre-year is the loss of one acre of habitat and its associated resources and services for one year. Because the losses occur in different time periods, they are not directly comparable. To make the losses that occur in different time periods comparable, a discount factor is applied to the losses to determine discounted service acre-years[7].

Other parameters are necessary to quantify the benefits of restoration actions in a HEA. They include when the habitat restoration project begins, the time until the habitat provides full services, the level of services provided between the time when the project begins and when it provides full services, and the relative services of the created or enhanced habitat compared to the injured habitat before the incident. Given the size of a project and the discount rate, these parameters define the discounted service acre-year benefits that result from the restoration action. The task is to determine the size of the projects such that the discounted service acre-year benefits just offset the discounted losses.

7.2 QUANTIFICATION OF HABITAT LOSSES

Typically, the HEA framework is used to quantify losses by habitat type. In the Lavaca Bay assessment, injuries to three types of habitats were identified: estuarine low marsh, oyster reef, and subtidal unvegetated sediments (soft-bottom benthic habitat). Further descriptions of the assessment of injuries to these habitats is provided in the RWC Analysis for Benthos (2000).

[7] The Lavaca Bay Injury Quantification and Restoration Determination Technical Memorandum (Trustees, 2000a) contains further information on the principles of discounting and additional references on the subject.

Injuries to these habitats occur as injuries resulting from both effects of contamination and effects of response actions. The interim habitat service losses due to contamination are quantified here as the degree of direct injury to benthos, and as reductions in provision of food supporting fish populations. The response habitat losses are being quantified by the amount of habitat that is permanently removed or suffers some period of additional service losses in the course of controlling contamination.

Figure 7-1 shows the process for estimating the habitat losses. The figure shows two tracks, one representing interim losses due to contamination, and the other representing response action losses. Some of the specific steps in this process merit explanation. For example, the magnitude and extent of the injury may have changed over the assessment period. Incorporating a slope accounts for a change in conditions over time at the site. Similarly, some of the response actions can result in year-to-year differences in the level of service losses. For example, remedial dredging temporarily disturbs open bay bottom habitats. For habitat services that are only temporarily affected, the recovery path indicates how soon these services will recover. The two tracks come together when the interim and response action losses are added together to get annual habitat losses by type. The discounted service losses are determined after applying a three-percent discount rate to the annual losses (Lind, 1982; Freeman, 1993; NOAA, 1999).

Table 7-1 summarizes the discounted acre-years of service losses by habitat type. There are two types of estuarine low marsh habitat incorporated into the analysis. The distinction between these two marsh types is related to differences in the quality of services provided by these habitats. The Dredge Island marsh was established on spoil material, is relatively young and therefore is expected to provide a similar quality of services to the marsh that will be created as restoration. The remaining marsh injured by releases from the PCO facility is expected to be relatively more productive than the Dredge Island marsh since it is a more ‘natural’ marsh than the one that formed on Dredge Island and is, therefore, expected to be more productive in providing services than the created marsh. Because the quality of services is different, different amounts of restoration will be required. The interim service losses are calculated from 1981 through 1999. The response losses are calculated for response actions initiated through the end of 1999. Some response action losses are permanent; other injuries are interim losses that will recover within two to three years of the response action (Trustees, 2000a).

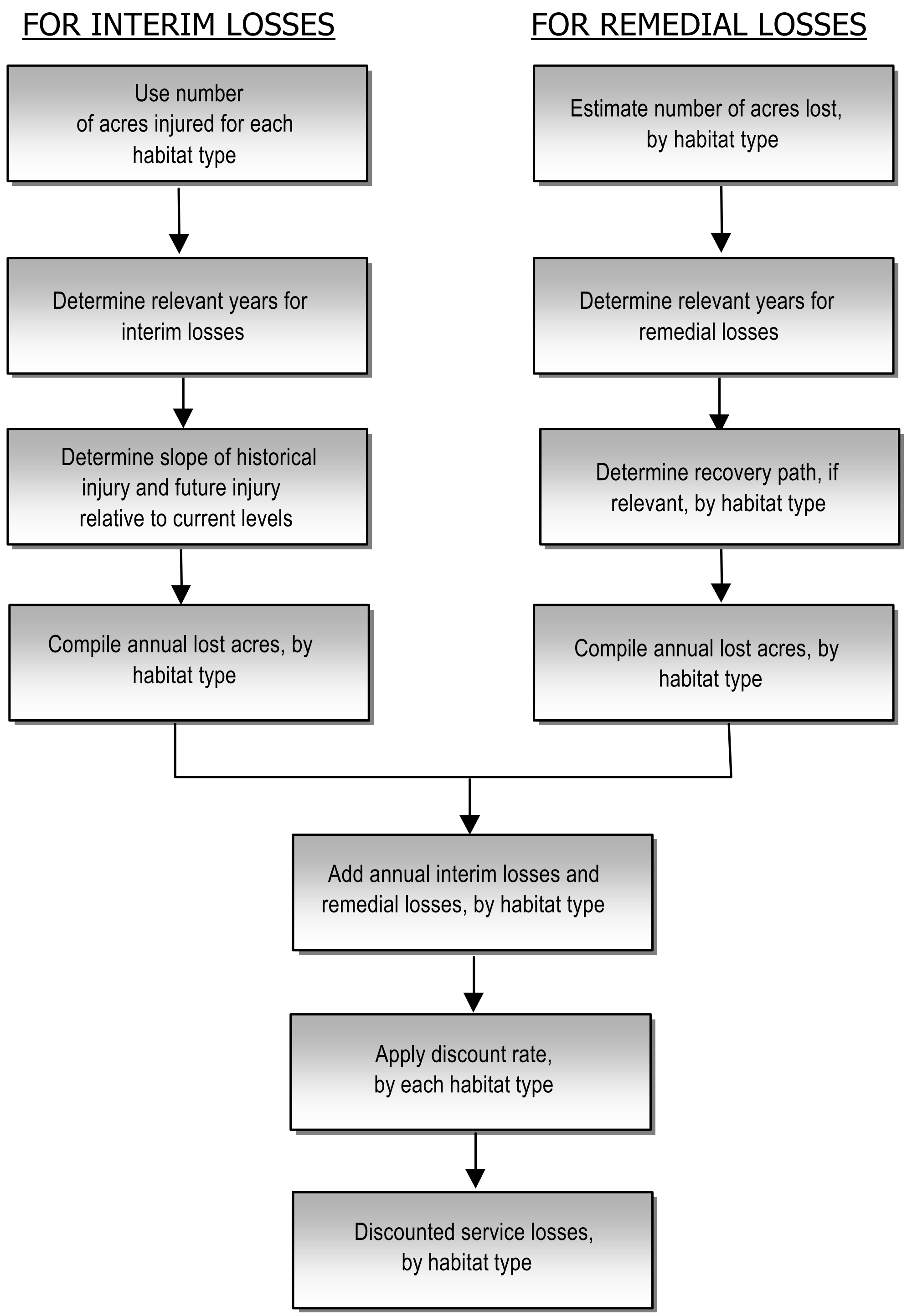

Figure 7-1.
Process for Estimating Habitat Losses

Table 7-1. Discounted Habitat Losses

Habitat	Discounted Acre-years
Open-bay bottom	2035.61
Other Marshes	81.93
Dredge Island Marshes	747.12
Oyster Reefs	244.72

7.3 HABITAT RESTORATION

The Trustees selected two types of habitat restoration projects: oyster reef creation and estuarine low marsh creation/enhancement. These projects directly offset the losses to oyster reefs and marshes, respectively. For losses to subtidal unvegetated sediments, as described in Section 6.2.3, the nature of the Lavaca Bay site is such that direct restoration of subtidal unvegetated sediment services is not desirable. The Trustees determined that marsh restoration is an appropriate restoration alternative to compensate for injuries to subtidal unvegetated sediments.

The Trustees worked with experts familiar with Texas marshes and estuaries to develop a habitat exchange rate between marsh services and open-bay bottom services in order to stay within the HEA framework, i.e., provide habitat services of the same kind that were lost. This exchange rate accounts for differences in services and the quality of services provided by uninjured subtidal unvegetated soft-sediment benthic habitat relative to natural marsh habitat. After considering the opinions of the scientific experts, the Trustees developed an exchange rate of 5:1 (Trustees, 2000b). That is, the value of ecological service flows from five acres of subtidal unvegetated soft-sediment benthic habitat in Lavaca Bay is equivalent to the value of service flows provided by one acre of natural Lavaca Bay marsh. This analysis was specific to the habitats in the Lavaca Bay system and was based on the habitat services that the Trustees judged to be most important given the types of habitats affected.

Table 7-2 contains the habitat loss results after applying the subtidal sediments-marsh exchange rate[8]. The discounted losses associated with subtidal unvegetated soft-sediment benthic habitat have been converted and added to the discounted marsh losses.

Table 7-2. Discounted Habitat Losses After Exchange

Habitats	Discounted Acre-years	Discounted Acre-Years After Exchange
Open-bay bottom	2035.61	--------
Other Marshes	81.93	489.05
Dredge Island Marshes	747.12	747.12
Oyster Reefs	244.72	244.72

With the losses in habitats expressed in terms of the kind that are to be provided through restoration, the next steps are to estimate the benefits of restoration projects and determine the restoration project scale to just offset these losses.

Figure 7-2 shows the process for estimating habitat benefits. The process is similar to calculating habitat losses. The process starts with the number of quality-adjusted acres for each restoration project. The quality adjustment accounts for the fact that the restoration site in its initial state can vary in the services it provides and the fact that the

[8] The HEA scaling calculations are not affected by the timing of the 5:1 conversion between the subtidal unvegetated soft-sediment benthic habitat and marsh. The conversion was done at this step for ease of calculation.

project's services can differ in productivity from the lost services. The third and fourth boxes in Figure 7-2 focus on how the restoration habitat services change over time and how long it takes the restoration project habitat to provide full services. These parameters determine the services provided per year by habitat type. Applying the discount rate results in the discounted service benefits of the restoration projects.

Finally, the HEA method was used to determine the scale of the oyster reef and marsh projects. For created oyster reefs constructed in 2001, the HEA results indicate that 9.3 acres of oyster reef are needed to offset the losses described above. For marsh restoration completed in 2001, the analysis indicates 31.94 acres of created marsh are necessary to offset the losses associated with the Dredge Island marshes. An additional 29.32 acres of created marsh are required to offset the losses associated with injures to subtidal unvegetated sediments and other marsh habitat. The amount of marsh to be created totals 61.3 acres. For additional details concerning the scaling calculations, see the Lavaca Bay Injury Quantification and Restoration Determination Technical Memorandum (Trustees, 2000a).

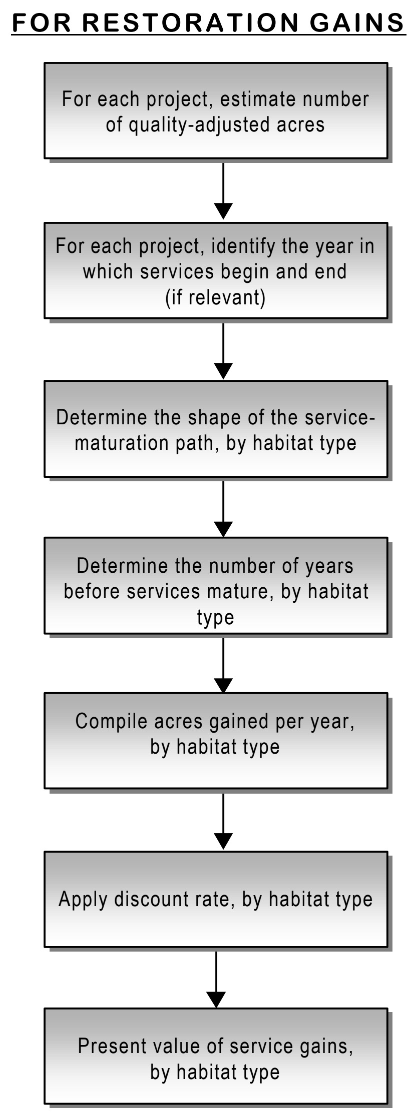

Figure 7-2
Process for Estimating Habitat Benefits

7.4 DESCRIPTION OF SELECTED PROJECTS

As noted previously, the type and scale of restoration actions needed to compensate the public for interim ecological losses from contamination and response actions initiated through the end of 1999, are the creation of at least 9.3 acres of oyster reef and at least 61.3 acres of marsh. The Trustees will seek implementation of the final restoration project selections by Alcoa or funds from Alcoa to enable the Trustees to implement these restoration actions. The selected oyster reef and marsh projects are discussed below.

7.4.1 Marsh Restoration Project

Intertidal marsh will be created along the north shore of Powderhorn Lake. Under this alternative, property on the ANWR will be utilized, and possibly the Powderhorn Lake site, and a shallow subtidal section of Powderhorn Lake adjacent to these two properties. The marsh will be created by scraping down an area of approximately 31 acres of existing land to appropriate elevations for planting marsh and creating tidal channels. The dirt from the 31 acres will be placed into Powderhorn Lake to create approximately 39 additional acres of marsh. A breakwater will be constructed on the southern edge of the newly created marsh to protect against erosion.

Once the construction has been completed and the area is ready for planting, *Spartina alterniflora* plugs will be planted where the elevations are appropriate for this species. *Spartina patens* may be planted at higher elevations. The marsh will contain both primary and secondary channels and open water areas up to 25 percent of the total marsh area for that portion constructed on currently existing land and up to 40 percent for that portion constructed on currently existing water areas. The marsh will be constructed so that there will be no planted marsh areas more than 10 meters from a primary or secondary channel, to maximize its function. Details concerning the design of the marsh and project monitoring plan will be developed prior to construction.

Regardless of whether any of the marsh creation is actually constructed on the Powderhorn Lake property itself, it is anticipated that this property will be protected to help ensure full ecological service flows from the marsh constructed on the adjacent ANWR property. The anticipated marsh project, as currently envisioned, would provide additional ecological benefits by increasing the circulation in the existing marsh on the Powderhorn Lake property by creating channels from the new marsh into the old marsh, thereby enhancing the existing marsh's ecological function. The breakwater and new marsh would also serve to protect some of the existing marsh from erosion, which is presently reducing the existing marsh.

7.4.2 Oyster Reef Restoration Project

The Trustees are considering two different options for creating oyster reef habitat in lower Lavaca Bay. The first would involve the construction of at least 9.3 acres of oyster reef that would be expected to function at a very high level similar to natural oyster reefs. The specific project location for this first oyster reef restoration option within lower Lavaca Bay has not been selected, but it will be at a location where water depth, salinity, and substrate firmness are suitable for oyster reefs. Under this option, a foundation of rock would be placed on the sediment and a shell, or other material suitable for oyster and mussel settlement, layer would be placed on this base. Details concerning the construction and monitoring of this reef will be developed if this restoration option is chosen.

The second option is to create a much larger area of oyster reef, constructed on clay-rich spoil material that would be placed on top of mercury contaminated sediments southwest of the Dredge Island. This option is the preferred option provided that some other entity is conducting dredging in an uncontaminated area and is willing to use the spoil material in a beneficial manner to cover the contaminated sediment. This clay-rich sediment layer would serve as a foundation upon which a thin layer of appropriate substrate would be placed for oyster and mussel settlement.

The Trustees prefer the second option, if it is feasible and timely, since it would serve to further isolate mercury contaminated sediments and greatly reduce the possibility that future hurricanes or other events could uncover the buried mercury layers. Although modeling has suggested that it is unlikely that such an event could occur (HydroQual, 1998), the construction of a reef in this area would make it far more unlikely. Although the expected level of function of this type of reef would initially be lower than for the first option on a per unit basis, it is likely that such a reef would provide more overall ecological services due to its larger size. On a longer- term basis, the Trustees expect that this reef would provide ecological services on a per unit basis similar to that of the other reef design option. Details concerning the required size of a reef under this alternative and the monitoring for this restoration action, will be developed if this option is determined to be feasible and is selected for implementation.

The compensatory restoration requirements described in Chapter 7 address interim losses for most natural resources in the period beginning 1981 through the end of 1999 plus losses attributable to response actions taken through 1999 (including future losses incurred due to response actions begun before the end of 1999). Restoration requirements for resource injuries occurring after 1999 due to residual contamination and due to post-1999 response actions can be estimated based on the Trustees' current understanding of what is likely to be included in the final ROD. This chapter presents the Trustees' evaluation of this future likely injury and the resulting restoration requirements, based on the anticipated final remedy. If the remedy selected by EPA is consistent with the description in Section 8.1, and no new information that changes the validity of the injury and restoration scaling calculations presented in this DARP/EA is discovered, then the final restoration requirements will be as indicated below in Section 8.5. In that event, the selection of the restoration actions described in Section 8.5 of this document will conclude the assessment and restoration planning process for this Site without the need for a third stage DARP/EA.

8.1 EXPECTED REMEDY

Much of the remedy that EPA is likely to include in the ROD has already been initiated, as detailed in Chapter 5. Future response actions, anticipated to be part of the ROD include the capping of 0.86 acres of marsh in the Witco area (part of the PCO facility), capping (and permanent alteration to upland habitat) of 3.0 acres of subtidal unvegetated sediments, and thin-layer capping of an additional 50 acres of subtidal unvegetated sediments. Dredging of the Witco Channel (covered by an existing permit) is also expected to be part of the ROD, but this action will have no NRDA implications (see Section 4.2.1 for an explanation of the exclusion of dredged channels from the assessment).

8.2 INJURY QUANTIFICATION APPROACH

The preceding chapters of this DARP/EA do not address those injuries to fish, unvegetated subtidal sediment benthic habitat, marsh, and oyster reef after 1999 caused by residual contamination, until the contamination declines through natural processes to non-injurious levels. The effect of response actions initiated after 1999 to these resources is also not addressed in the preceding chapters. Furthermore, injury to terrestrial resources, from 1981 into the future, due both to the effects of contamination and response actions, is not addressed above. Quantification for all injuries not previously described, and the restoration requirements to compensate for them, are presented below based on the anticipated final remedy.

8.2.1 Marsh, Oyster Reef, and Unvegetated Subtidal Benthos and Fish Injury

The levels of mercury and PAHs in the surficial unvegetated and marsh sediments and in oyster reefs are expected to gradually decrease to non-injurious levels in the areas not scheduled for future response actions. The evaluation in the RI/FS predicts that it will take no longer than ten years for this to occur, even in the most heavily contaminated areas (Alcoa, 1998c). However, the Trustees and Alcoa have conservatively agreed to use 15 years as the estimate for the recovery time to baseline (i.e., non-injurious) conditions in the HEA calculations. Under the assessment approach utilized here, injury levels for a given area are modeled to decrease linearly over a 15-year period. Therefore, an area that is estimated to have had a 25 percent injury level in 1999 would have a 23.33 percent injury level in 2000, a 21.67 percent level in 2001, and so on.

A similarly conservative approach is used to quantify interim losses for fish injury due to contaminated habitats not providing full service supporting fish populations (i.e., from consumption of contaminated prey items in these areas). The injury levels estimated for a given area in 1999 are estimated to linearly decrease for a 15-year period until 2014. The HEA calculations for post-1999 interim losses to the three benthic habitats and fish are described more fully in Section 6.0 of the Lavaca Bay Injury Quantification and Restoration Determination Technical Memorandum (Trustees, 2000a). The additional interim losses of unvegetated subtidal sediment services (including those to fish as a result of contamination of prey in portions of this habitat) from 2000 to 2014 is estimated to be 441.13 DSAYs. The corresponding injury estimates for Dredge Island marsh, other marsh, and oyster reefs are 2.24, 16.52, and 40.18 DSAYs, respectively.

The 0.86 acres of marsh that will be capped is considered permanently lost. This is estimated to result in a loss of 27.02 DSAYs (Trustees, 2000a). The Trustees and Alcoa have agreed to use some simplifying assumptions to deal with the 3.0 acres of subtidal unvegetated sediments that will be capped and permanently lost as benthic habitat and the 50 acres of this same habitat that will have a thin-layer cap. For both of these areas the injury is being calculated as if these response actions did not occur- that is, as if these areas gradually increased in service flows to full function in 2014. The losses associated with these 53 acres of subtidal unvegetated sediments are, therefore, included in the 441.13 DSAY loss estimate for this habitat presented in the preceding paragraph. The Trustees believe that the conservatism used in estimating injury to remaining subtidal sediment benthic habitat more than accounts for the loss of the three acres. In addition, the response actions undertaken for Dredge Island resulted in the restoration of approximately 60 acres of subtidal unvegetated sediments that is not otherwise being considered. The 50 acres that will get the thin cap, but remain as subtidal benthic habitat, would be expected to recover full service flows within a three-year period, similar to dredged areas, but under the present approach will be considered to have some degree of injury until 2014. Alcoa and the Trustees have agreed not to seek a refinement of this analysis since this effort would be very time-consuming and result in additional assessment costs.

8.2.2 <u>Terrestrial Injury</u>

Injury to terrestrial resources results from two causes. The first is from the response actions undertaken at the Site. Through 1999, approximately 52 acres of high marsh and 8.6 acres of shrubland/grassland were lost as a result of implemented response actions on Dredge Island (where approximately 60 acres of what was formerly part of Dredge Island has been converted back to subtidal unvegetated benthic habitat as a result of the Dredge Island stabilization project).

The second cause of terrestrial injury is the effect of contamination. Potential injury due to contamination throughout the terrestrial portion of the Site is estimated, to a large extent, from the results of the ecological risk assessment conducted as part of the RI/FS process (Alcoa, 1998b). Ecological risk assessments determine potential ecological risk to resources, but do not directly measure injury. Since an ecological risk can be found even where injury has not occurred, using the results of the ecological risk assessment to indicate potential injury provides a very conservative basis for estimating service losses. Another factor that the Trustees considered in determining potential injury to terrestrial resources is that the baseline level of ecological services provided by the contaminated terrestrial portion of the Site is relatively low because of the industrial nature of this area. The terrestrial sampling in the RI/FS predominantly sampled the areas likely to be most heavily contaminated, so the level of injury for the area as a whole is less than would be expected based solely on these sample results. Using this conservative approach, the Trustees determined that 13.95 acres of terrestrial habitat are contaminated at a level sufficient to possibly injure terrestrial organisms. After reviewing the risk assessment results and the relevant scientific literature, a ten percent injury level was assigned to these 13.95 acres of terrestrial habitat to account for potential injury due to the effects of contamination (Draft RWC Analysis for Terrestrial Resources, 2000).

8.3 RESTORATION ALTERNATIVES ANALYSIS

The compensatory restoration analysis for the three benthic habitats (including injury to fish from contaminated prey) presented in Chapter 6 is equally applicable to restoration for the post-1999 injuries described in Section 8.2.1. Therefore, the restoration actions that address post-1999 injuries to these resources are the same as those described in Chapter 6. The evaluation of compensatory restoration alternatives for terrestrial resource injuries and consideration of primary restoration for all resources is discussed below.

8.3.1 <u>Primary Restoration</u>

The goal of a primary restoration action is to facilitate recovery or otherwise assist an injured natural resource or service return to baseline conditions. Trustee agencies may rely on natural recovery processes where injured resources or services will recover within a reasonable period without further intervention, or in situations where feasible or cost-effective primary restoration actions are not possible. Primary restoration actions that require human intervention are appropriate when injured resources will not recover, or will recover slowly, and when feasible and cost-effective methods exist to assist recovery to baseline.

Chapter 6 of this DARP/EA did not consider primary restoration needs because the final remedy for the Site has not been selected and, since the evaluation of future injuries until recovery to baseline is linked to this decision, a definitive analysis cannot be made at this time. However, if the final remedy is as described in Section 8.1 (above), return to baseline conditions for all affected resources and services is expected to occur within ten years[9], without any active primary restoration. For this Site, the RI/FS process has served as a means for investigating and determining intervention actions which are necessary or appropriate to eliminate unacceptable risks to the public and natural resources due to the contamination present. Through the technical assistance which they have provided to response agencies during that process, the Trustees have sought to ensure the final remedy would both protect and facilitate the recovery of injured resources. In this instance, based on the response actions initiated to date and anticipated as part of the final remedy, the Trustees believe that the final remedy will be appropriate to assist in resource recovery. Therefore, the Natural Recovery (No Action) alternative for primary restoration is appropriate if EPA's preferred remedy is the final remedy chosen for the Site.

8.3.2 Compensatory Restoration

Compensatory restoration is required for interim resource service losses not considered in Chapter 4. The No Action (e.g., no compensatory restoration) alternative for these injuries is inappropriate for the same reasons given in Section 6.2. The compensatory restoration alternatives analyses (see Sections 6.2 and 6.3) for injuries to those resources considered in Chapter 4 is also valid for injuries to these resources after 1999. Therefore, these same analyses are appropriate to compensate for resource injuries of the same nature occurring after 1999. This determination applies to injuries to fish, marsh, oyster reef, and unvegetated subtidal sediment habitats.

Injury to terrestrial habitats from response actions and contamination requires compensatory restoration. The No Action (e.g., no compensatory restoration) alternative is inappropriate since these injuries have occurred and restoration actions to compensate for these injuries are possible. However, if the restoration actions proposed in Chapter 7 of this DARP/EA are implemented, including protection of the Powderhorn Lake property, ecological services of a similar quality and more than sufficient quantity will be provided to compensate for terrestrial injuries (Draft RWC Analysis for Terrestrial Resources, 2000). The terrestrial resource services lost, including interim losses from 1981 until recovery to baseline as well as those permanent losses resulting from past and anticipated future response actions, will be offset by service gains from two sources. The first source of service flows results from the protection and enhancement (through a change in management practices) of several hundred acres of terrestrial habitat (the Powderhorn Lake property). The second source will come from the high marsh formed in the transition zone between the newly constructed low marsh and adjacent uplands.

The Trustees have prepared a Draft RWC Analysis for Terrestrial Resources (2000) providing further details about the above analysis. Because the appropriateness of this analysis cannot be confirmed until the final remedy decision, this document will remain as a draft until a final ROD is issued. However, a copy of the draft document is available as part of the Administrative Record, until a final RWC analysis is completed.

8.4 RESTORATION SCALING

Restoration scaling for resource injuries addressed in this chapter utilized HEA, and the process is, therefore, similar to that explained in Chapter 7. Details concerning the restoration scaling process are presented in Section 6.0 of the Lavaca Bay Injury Quantification and Restoration Determination Technical Memorandum (Trustees, 2000a).

Restoration requirements for the post-1999 period as well as those required for injuries through 1999 are presented in Table 8-1. The area of marsh that must be created to cover anticipated post-1999 injuries is 8.0 acres; an additional 1.53 acres of oyster reef (for the first oyster reef creation option) is required to compensate for anticipated post-1999 oyster reef injury.

[9] Note that although full recovery for injury to finfish and the benthic habitats is expected within ten years, based on the RI (Alcoa, 1998c) the injury estimate for future interim losses to these resources assumes that recovery will take 15 years. Terrestrial resource recovery to baseline was also estimated at 15 years.

Table 8-1: Restoration Requirement Summary

	Number of Restoration Acres Attributable to:			
Injury[a] to:	Total Losses From 1981 - 1999	Post-1999 Interim Losses	Post-1999 Response Losses	Total Losses
Open Bay-Bottom and Other Marsh[b]	29.32	0.096	1.62	31.04
Dredge Island Marsh[b]	31.94	6.28	--	38.22
Oyster Reef[c]	9.34	1.53	--	10.9

[a]Includes consideration of injury to fish from contaminated prey in these habitats.
[b]All restoration acres are in marsh creation.
[c]All restoration acres are in oyster reef creation.

8.5 RESTORATION SUMMARY

The creation of 61.3 acres of salt marsh is required as compensation for direct injury to subtidal unvegetated benthic habitat and marsh habitat, for fish injury resulting from reduction in food quality, and for injury from response actions initiated through 1999. Injury to oyster reef habitat for this same period requires the creation of either 9.3 acres of reef constructed with a rock foundation and a shell cap (option one) or a larger reef constructed with a clay-rich spoil material foundation (option two). The exact size of the oyster reef under option two will be determined later, if it is selected for implementation, based on the expected performance. The size of the marsh restoration project assumes construction during 2001. In the event that implementation is significantly delayed, the size may be increased to account for this delay.

Interim losses from 2000 to 2014, when full recovery to baseline for ecological injuries is expected to occur, and losses due to anticipated post-1999 response actions will require additional compensatory restoration actions to make the environment and the public whole. If the ROD is finalized according to EPA's currently preferred remedy, an additional 8.0 acres of marsh will be required (overall total of 69.3 acres), as will an additional 1.53 acres of oyster reef (overall total of 10.9 acres) under the first option (see Section 7.4.2). The additional amount of oyster reef to be created under option two will be determined based on the expected performance of that project's design. The size of these projects also assumes implementation in 2001, and delays may result in an increase in the amount of restoration to account for the delay. However, the Trustees will not require an increase in the size of the first (10.9 acre) option oyster reef if the delay in implementation is solely the result of waiting to determine if the second oyster reef creation option is viable.

If the final remedy selected is consistent with the anticipated remedy, full compensation for ecological injuries would occur through the creation of 69.3 acres of estuarine low marsh (with its associated high marsh) and 10.9 acres of oyster reef[10], and the protection and enhancement of the Powderhorn Lake property. Under this scenario, a third stage DARP/EA will not be required to complete the assessment and restoration planning process for this Site. Alternatively, if the remedy differs materially from what is anticipated, then a third and final stage DARP/EA may be needed.

[10] This acreage is for the first oyster reef creation option; the acreage under the second option would be larger.

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RWC Analysis for Injury to Finfish, Appendix B to RWC Technical Memorandum, 2000.

RWC Analysis for Direct Injury to Birds, Appendix C to RWC Technical Memorandum, 2000.

RWC Analysis for Injury to Surface Water, Appendix D to RWC Technical Memorandum, 2000.

RWC Analysis for Injury to Ground Water, Appendix E to RWC Technical Memorandum, 2000.

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FINDING OF NO SIGNIFICANT IMPACT

Having reviewed the attached environmental assessment and the available information relative to the restoration actions proposed in Lavaca Bay, Texas, the undersigned have determined that there will be no significant environmental impacts from the proposed actions. Accordingly, preparation of an environmental impact statement on these issues is not required by Section 102 (2) (c) of the National Environmental Policy Act or its implementing regulations.

William T. Hogarth ______________ Date 12-28-00

for Penelope D. Dalton
Assistant Administrator for Fisheries
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U. S. Department of Commerce

______________________________ Date ____________

Nancy M. Kaufman
Regional Director, Region 2
Fish and Wildlife Service
U. S. Department of the Interior

FINDING OF NO SIGNIFICANT IMPACT

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________________________________ Date ____________

Penelope D. Dalton
Assistant Administrator for Fisheries
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U. S. Department of Commerce

Nancy M. Kaufman Date FEB 15 2001

Nancy M. Kaufman
Regional Director, Region 2
Fish and Wildlife Service
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TRUSTEE COUNCIL SIGNATURES

In accordance with the Memorandum of Agreement among the National Oceanic and Atmospheric Administration (NOAA) of the U. S. Department of Commerce, the Fish and Wildlife Service (FWS) of the U. S. Department of the Interior, the Texas Natural Resources Conservation Commission (TNRCC), the Texas Parks and Wildlife Department (TPWD), and the Texas General Land Office (GLO), executed January 14, 1997, the following indicate by signature below their agreement to concur, in its entirety, with this Restoration Plan/Environmental Assessment for Ecological Injuries and Service Losses in its entirety on behalf of their respective agencies.

For NOAA ______________________ Date 3/5/01

Mr. Ron Gouguet
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For FWS Allan M. Strand Date 03/08/01

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For TNRCC Richard Seiler Date 3-5-01

Mr. Richard Seiler, Team Leader
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For TPWD David Sager Date 3/5/01

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For TGLO ______________________ Date 27 March 2001

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Appendix A: List of documents submitted to the administrative record to date

Filing Structure for Lavaca Bay

Classification # ***Classification Name***

1. ADMINISTRATIVE RECORD INDEX

1 Filing Structure for Lavaca Bay. (May 2001), 10
Document ID *1674*

2. TRUSTEE/RESPONSIBLE PARTY AGREEMENTS

2.01 Funding Agreements

1 Funding Agreement 2/16/96
Document ID *1657*

2 Funding Agreement (DOI/ALCOA) 2/16/96
Document ID *1655*

2.02 Memorandum of Agreement (MOA)

1 Memorandum of Agreement 1/14/97
Document ID *1658*

2.02.1 Attachments to MOA

1 MOA Attachment 97-01 9/3/97
Document ID *1654*

2 MOA Attachment 98-01 3/9/98
Document ID *1669*

3 MOA Attachment 99-01 9/9/99
Document ID *1677*

4 MOA Attachment 2000-01 6/21/00
Document ID *1926*

5 MOA Attachment 2000-02 10/4/00
Document ID *1944*

2.02.1.1 Annual Funding Actions

1 Stephanie W. Fluke, to Ron Weddell, 4/25/97, Letter on Funds Request -- 1997
Document ID *1653*

2 Stephanie W. Fluke, to Ron Weddell, 1/12/98, Letter on Funds Request -- 1998
Document ID *1652*

3 Stephanie W. Fluke, to Ron Weddell, 1/19/98, Letter on Funds Request --1998
Document ID *1651*

4 Stephanie W. Fluke, to Ron Weddell, 1/21/99, Letter on Funds Request -- 1999
Document ID *1670*

5 Stephanie W. Fluke, to Ron Weddell, 10/23/00, Letter on Funds Request -- 2000
Document ID *1943*

3. INJURY ASSESSMENT PHASE

3.01 EPA Remedial Process
(NOTE: These Documents are not included in this file; however, they are available in other locations at the TNRCC and MFG Inc. Administrative Record repository sites. Please see Richard Seiler or Gladys Hunt for more information.)

1 Preliminary Site Characterization Report for ALCOA (Point Comfort)/Lavaca Bay Superfund Site. ALCOA, (7/28/95)

Document ID *1938*

2 Draft Technical Memorandum, Bay System Phase 2A Data Assessment, ALCOA (Point Comfort)/Lavaca Bay Superfund Site. ALCOA, (12/1/96)
Document ID *1937*

3 Draft Fish and Bird Prey Item Investigation Study Data Report. ALCOA, (3/1/98)
Document ID *1936*

4 Draft RI Workplan for the ALCOA (Point Comfort)/Lavaca Bay Superfund Site Volume B3: Sediment Transport Study: Radiochemistry Study, Data Report. ALCOA, (3/1/98)
Document ID *1934*

5 Development and Application of a Modeling Framework to Evaluate Hurricane Impacts on Surficial Mercury Concentrations in Lavaca Bay. Hydroqual Inc. (4/1/98)
Document ID *1932*

6 Baseline Risk Assessment Report, ALCOA (Point Comfort)/Lavaca Bay Superfund Site. ALCOA, (8/1/98)
Document ID *1935*

7 Final Remedial Investigation Report, ALCOA (Point Comfort)/Lavaca Bay Superfund Site. ALCOA, (11/1/99)
Document ID *1933*

8 Phase 2A: Bay System Data Report (Phase 2A Data Assessment Report) ALCOA. (3/16/00)
Document ID *1960*

9 Draft Radiochemistry Study Data Report (ALCOA Radiochemistry Study Report). (3/16/00)
Document ID *1959*

3.02 Benthos (Soft Bottom)

1 MOA Attachment 2000-01 Appendix A Reasonable Worst Case Analysis Direct Injury to Benthos. Trustees, ALCOA (6/21/00), 22
Document ID *1925*

3.03 Birds

1 Survey of Willet and Tri-Colored Heron Populations and Habitats in the Potentially Affected Area Adjacent to the ALCOA Point Comfort Operations in Lavaca Bay, Texas. Trustees, ALCOA (3/1/00), 63
Document ID *1927*

2 MOA Attachment 2000-01 Appendix C Reasonable Worst Case Analysis Direct Injury to Birds. Trustees, ALCOA (6/21/00), 26
Document ID *1924*

3.04 Fish/Shellfish

1 MOA Attachment 2000-01 Appendix B Reasonable Worst Case Analysis Injury to Finfish. Trustees, ALCOA (6/21/00), 16
Document ID *1923*

3.05 Groundwater/Water Column

1 MOA Attachment 2000-01 Appendix D Resonable Worst Case Analysis Injury to Surface Water. Trustees, ALCOA (6/21/00), 4
Document ID *1922*

2 MOA Attachment 2000-01 Appendix E Reasonable Worst Case Analysis Injury to Ground Water. Trustees, ALCOA, (6/21/00), 4
Document ID *1921*

3.06 Marsh

1 MOA Attachment 2000-01 Appendix A Reasonable Worst Case Analysis Direct Injury to Benthos. Trustees, ALCOA (6/21/00), 22
Document ID *1925*

3.07 Oyster Reef

1 MOA Attachment 2000-01 Appendix A Reasonable Worst Case Analysis Direct Injury to Benthos. Trustees, ALCOA (6/21/00), 22
Document ID 1925

3.08 Terrestrial Habitats (including High Marsh)

1 Draft Technical Memorandum: Reasonable Worst Case Analysis Terrestrial Resources. Trustees, ALCOA, (6/1/00), 11
Document ID 1920

3.09 Lost Recreational Use

3.09.1 Technical Reports

1 Recreational Fishing Assessment Technical Memorandum (includes restoration scaling information). Trustees and Alcoa, (11/30/98), 230
Document ID 1664

3.09.2 Technical Comments

1 Tony Penn, to Bill Desvousges, 2/8/99, Memorandum on Follow-up Dissussion of Peer Reviewer Comments
Document ID 1659

2 Doug MacNair, Janet Lutz, to Ron Gouguet, Tony Penn, David Chapman, Don Pitts, Ron Weddell, Kirk Gribben, 2/22/99, Letter on Technical Memorandum
Document ID 1663

3.09.3 Peer Review

1 Adamowicz Peer Review Comments. Vic Adamowicz, (Department of Rural Economy, University of Alberta)(12/29/98), 18
Document ID 1662

2 Parsons Peer Review. George R. Parsons, (12/1/98), 9
Document ID 1661

3 V. Kerry Smith, to David J. Chapman, Douglas MacNair, 12/30/98, Letter on Smith Peer Review Comments
Document ID 1660

4. ASSESSMENT/RESTORATION PLAN DEVELOPMENT - Lost Recreational Use

4.01 Public Participation - Restoration Scoping

1 Port Lavaca Bayfront Masterplan. BRW, Inc., G & W Engineering, Gignac & Associates, (1/1/96), 61
Document ID 1656

4.01.1 Notices

1 Public Meeting Annnouncement -- 17 February 1998. Alcoa and Trustees, (2/1/98), 3
Document ID 1650

2 Public Meeting Announcement -- 5 November 1998. Alcoa and Trustees, (11/1/98),
Document ID 1641

4.01.2 Meetings

1 Public Meeting Summary -- 17 February 1998. Ronald Weddell, (3/1/98), 13
Document ID 1649

2 Public Meeting Summary -- 5 November 1998. Kristy Mathews, (11/9/98), 2
Document ID 1640

4.01.3 Public Comments

1 Public Feed Backforms. The Public, (2/17/99), 34
Document ID 1648

2 C. Elaine Giessel, to Peter Sheridan, 2/18/98, Letter on Public Comment
Document ID 1646

3 Thomas J. Blazek, to Dr. Pete Sheridan, 2/19/98, Letter on Public Comment

Document ID *1642*

4 Gary Cunningham, to Dr. Pete Sheridan, 2/23/98, Letter on Public Comment
Document ID *1644*

5 Jack P. Traylor, to Peter Sheridan, 2/24/98, Letter on Public Comment
Document ID *1643*

6 Leroy Belk, to Dr. Pete Sheridan, 3/1/98, Letter on Public Comment
Document ID *1647*

7 J.C. Melcher, Jr., to Dr. Pete Sheridan, 3/1/98, Letter on Public Comment
Document ID *1645*

8 Leroy Belk, to Dr. Pete Sheridan, 5/11/98, Letter on Public Comment
Document ID *1667*

9 Thomas J. Blazek, to Dr. Peter F. Sheridan, 9/21/98, Letter on Public Comment
Document ID *1665*

10 Patricia H. Suter, to Dr. Peter Sheridan, 10/19/98, Letter on Public Comment
Document ID *1666*

11 Ted Dodson, to Dr. Pete F. Sheridan, 11/8/98, Letter on Public Comment
Document ID *1639*

12 Linda Reese, to Dr. Sheridan, 11/30/98, Letter on Public Comment
Document ID *1638*

13 Thomas Blazek, to Dr. Peter F. Sheridan, 12/18/98, Letter on Public Comment
Document ID *1637*

4.02 Draft Assessment/Restoration Plan

1 Draft DARP/EA for the Point Comfort/Lavaca Bay NPL Site Recreational Fishing Service Losses. Trustees, (9/28/99), 59
Document ID *1679*

2 Revised Draft DARP/EA for the Point Comfort/Lavaca Bay NPL Site Recreational Fishing Service Losses. Trustees, (5/12/00), 18
Document ID *1911*

4.02.1 Notice of Availability

1 Newspaper Announcement, Notice of Availability and Request for Comments on Draft Damage Assessment and Restoration Plan/Environmental Assessment for Recreational Fishing Service Losses, Port Lavaca Wave. Trustees, (9/20/99)
Document ID *1682*

2 Notice of Availability and Request for Comments on Draft Damage Assessment and Restoration Plan/Envir. Assessment for Rec. Fishing Service Losses, 64 Fed. Reg. 52,294 (Sept. 28, 1999)
Document ID *1680*

3 Notice of Availability and Request for Comments on Draft Damage Assessment and Restoration Plan/Environmental Assessment for Recreational Fishing Service Losses, 24 Tex. Reg. 8,635 (Oct. 1, 1999)
Document ID *1681*

4 Trustees, Newpaper Announcement, Notice of Availability of Revised Restoration Plan for Recreational Fishing Service Losses in Lavaca Bay Available for Comment, Port Lavaca Wave, 5/10/00,
Document ID *1913*

5 Notice of Availability and Request for Comments on Revised Draft Damage Assessment and Restoration Plan/Environmental Assessment for Recreational Fishing Service Losses, 25 Tex. Reg. 4,379 (May 12, 2000)
Document ID *1914*

6 Notice of Availability and Request for Comments on a Revised Draft Damage Assessment and Restoration Plan/Environmental Assessment for Recreational Fishing Service Losses, 65 Fed. Reg. 30,565 (May 12, 2000)

Document ID *1912*

4.02.2 Public Comments

1 Transcript From the ALCOA Public Meeting Held September 28, 1999, 33
Document ID *1958*

2 Don McCarn, 10/12/99, Public Comment
Document ID *1687*

3 Elizabeth Rodriguez, 10/14/99, Public Comment
Document ID *1702*

4 Richard Barton, 10/14/99, Public Comment
Document ID *1688*

5 Ken Lester, Jr., 10/14/99, Public Comment
Document ID *1689*

6 Claughton Johnson, 10/14/99, Public Comment
Document ID *1690*

7 Ralph Wall, 10/14/99, Public Comment
Document ID *1691*

8 David Harg (sic), 10/14/99, Public Comment
Document ID *1692*

9 Tamara Hoelch (sic), 10/14/99, Public Comment
Document ID *1693*

10 Caren Ghiselin (sic), 10/14/99, Public Comment
Document ID *1694*

11 David Ouley (sic), 10/14/99, Public Comment
Document ID *1695*

12 Karl A Marno (sic), 10/14/99, Public Comment
Document ID *1696*

13 Fo H L (sic), 10/14/99, Public Comment
Document ID *1697*

14 Steven Jaschke, 10/14/99, Public Comment
Document ID *1698*

15 Darron J Gann (sic), 10/14/99, Public Comment
Document ID *1699*

16 Glenis King (sic), 10/14/99, Public Comment
Document ID *1701*

17 Debbie Fisher, 10/14/99, Public Comment
Document ID *1703*

18 Osan A Lu (sic), 10/14/99, Public Comment
Document ID *1704*

19 Mary Johnson (sic), 10/14/99, Public Comment
Document ID *1705*

20 Barbara Gibson, 10/14/99, Public Comment
Document ID *1706*

21 Dennis Reddy (sic), 10/14/99, Public Comment
Document ID *1707*

22 Faith Garza, 10/14/99, Public Comment
Document ID *1708*

23 Russell Cain, 10/14/99, Public Comment
Document ID *1709*

24 Lawrence J Matyu (sic), 10/14/99, Public Comment
Document ID *1700*

25 Tommy Hargrove, 10/15/99, Public Comment
Document ID *1710*

26 Thomas A Innes, 10/18/99, Public Comment
Document ID *1712*

27 Thomas Blazek, 10/18/99, Public Comment
Document ID *1713*

28 Tiney Browning, 10/18/99, Public Comment
Document ID *1714*

29 Lorraine Fabrygel, 10/19/99, Public Comment
Document ID *1711*

30 Michael Balajka, 10/19/99, Public Comment
Document ID *1715*

4.03 Final Assessment/Restoration Plan

4.03.1 Notice of Availability

4.04 NEPA Compliance Documents

1 Draft DARP/EA for the Point Comfort/Lavaca Bay NPL Site Recreational Fishing Service Losses. Trustees, (9/28/99), 59
Document ID *1679*

2 Revised Draft DARP/EA for the Point Comfort/Lavaca Bay NPL Site Recreational Fishing Service Losses. Trustees, (5/12/00), 18
Document ID *1911*

4.05 Coastal Zone Consistency Determination

1 Tony Penn, Tom Schultz, to Richard Seiler, 9/24/99, Letter on Coastal Zone Consistency Determination
Document ID *1678*

2 Tony Penn, Allan Strand, to Richard Seiler, 5/5/00, Letter on Coastal Zone Consistency Determination
Document ID *1915*

3 Richard Seiler, to Tony Penn, 6/30/00, Letter on State Review of Coastal Zone Consistency Determination
Document ID *1919*

4.06 Other Compliance Documents

1 Tom Moore, to Rusty Swafford, 5/18/00, Memorandum on EFH Evaluation of Restoration Projects
Document ID *1957*

2 Allan Strand, to Thomas D. Serota, 5/25/00, Memorandum on Endangered Species Act Consultation
Document ID *1942*

5. ASSESSMENT/RESTORATION PLAN DEVELOPMENT **-** Ecological Injuries/Service Losses

5.01 Public Participation **-** Restoration Scoping

5.01.1 Notices

1 Public Meeting Annnouncement -- 17 February 1998. Alcoa and Trustees, (2/1/98), 3
Document ID *1650*

2 Public Meeting Announcement -- 5 November 1998. Alcoa and Trustees, (11/1/98),
Document ID *1641*

5.01.2 Meetings

1 Public Meeting Summary -- 17 February 1998. Ronald Weddell, (3/1/98), 13
Document ID *1649*

2 Public Meeting Summary -- 5 November 1998. Kristy Mathews, (11/9/98), 2
Document ID *1640*

5.01.3 Public Comments

1 Public Feed Backforms. The Public, (2/17/99), 34
Document ID *1648*

2 C. Elaine Giessel, to Peter Sheridan, 2/18/98, Letter on Public Comment
Document ID *1646*

3 Thomas J. Blazek, to Dr. Pete Sheridan, 2/19/98, Letter on Public Comment
Document ID *1642*

4 Gary Cunningham, to Dr. Pete Sheridan, 2/23/98, Letter on Public Comment
Document ID *1644*

5 Jack P. Traylor, to Peter Sheridan, 2/24/98, Letter on Public Comment
Document ID *1643*

6 J.C. Melcher, Jr., to Dr. Pete Sheridan, 3/1/98, Letter on Public Comment
Document ID *1645*

7 Leroy Belk, to Dr. Pete Sheridan, 3/1/98, Letter on Public Comment
Document ID *1647*

8 Leroy Belk, to Dr. Pete Sheridan, 5/11/98, Letter on Public Comment
Document ID *1667*

9 Thomas J. Blazek, to Dr. Peter F. Sheridan, 9/21/98, Letter on Public Comment
Document ID *1665*

10 Patricia H. Suter, to Dr. Peter Sheridan, 10/19/98, Letter on Public Comment
Document ID *1666*

11 Ted Dodson, to Dr. Pete F. Sheridan, 11/8/98, Letter on Public Comment
Document ID *1639*

12 Linda Reese, to Dr. Sheridan, 11/30/98, Letter on Public Comment
Document ID *1638*

13 Thomas Blazek, to Dr. Peter F. Sheridan, 12/18/98, Letter on Public Comment
Document ID *1637*

5.02 Injury Assessment and Restoration Scaling

1 Ron Gouguet, to Administrative Record File, 6/13/00, Memorandum on Expert Scores for Relative Habitat Service Provision
Document ID *1930*

2 Natural Resource Trustees, to Administrative Record File, 6/14/00, Relative Habitat Service Provision Exercise
Document ID *1929*

3 Natural Resource Trustees, to Administrative Record File, 6/15/00, Memorandum on Created Marsh Function and Maturity
Document ID *1928*

4 Lavaca Bay Injury Quantification and Restoration Determination. Natural Resource Trustees, (7/7/00), 20
Document ID *1931*

5.03 Draft Assessment/Restoration Plan

1 Draft Damage Assessment and Restoration Plan for Ecological Injuries and Service Losses. Natural Resource Trustees, (7/14/00)
Document ID *1939*

5.03.1 Notice of Availability

1 Notice of Availability and Request for Comments on a Draft Damage Assessment and Restoration Plan/Environmental Assessment for Ecological Injuries & Service Losses, 65 FedReg 43739 (July 14, 2000)
Document ID *1941*

2 Notice of Availability and Request for Comments on Draft Damage Assessment and Restoration Plan/Environmental Assessment for Ecological Injuries and Service Losses, 25 TexReg 6843 (July 14, 2000)
Document ID *1940*

3 Newspaper Announcement, Notice of Proposed Restoration Plan for Ecological Resources in Lavaca Bay Public Meeting at Bauer Community Center, Port Lavaca Wave (7/22/00 & 7/26/00). Trustees
Document ID *1948*

4 Newspaper Announcement, Notice of Proposed Restoration Plan for Ecological Resource in Lavaca Bay, Public Meeting at Bauer Community Center, Victoria Advocate (7/25/00 & 7/27/00).
Document ID *1949*

5.03.2 Public Comments

1 Transcript from the ALCOA Public Meeting Held Thursday, July 27, 2000 in Port Lavaca, Texas at the Bauer Community Center
Document ID *1946*

5.04 Final Assessment/Restoration Plan

5.04.1 Notice of Availability

5.05 NEPA Compliance Documents

1 Draft Damage Assessment and Restoration Plan for Ecological Injuries and Service Losses. Natural Resource Trustees, (7/14/00)
Document ID *1939*

5.06 Coastal Zone Consistency Determination

1 Ron Gouget, Allan Strand, to Richard Seiler, 7/12/00, Letter on Coastal Zone Consistency Determination
Document ID *1947*

2 Richard Seiler, to Tony Penn, 8/24/00, Letter on State Trustee Consistency Review of Natural Resource Damage Assessment Restoration Plan
Document ID *1945*

5.07 Other Compliance Documents

1 Tom Moore, Ron Gouget, to Chuck Oravetz, 10/27/00, Memorandum on Endangered Species Act Consultations
Document ID *1956*

2 Tom Moore, Ron Gouget, to Rusty Swafford, 10/27/00, Memorandum on Essential Fish Habitat Evaluation
Document ID *1955*

3 Kenneth Rice, to Allan Strand, 3/23/01, Memorandum on Endangered Species Act Consultation
Document ID *1972*

6. ASSESSMENT/RESTORATION PLAN DEVELOPMENT - Resource Injuries/Service Losses Residual to Final ROD

1 Draft Technical Memorandum: Reasonable Worst Case Analysis Terrestrial Resources. Trustees, ALCOA, (6/1/00), 11
Document ID *1920*

2 Draft Damage Assessment and Restoration Plan for Ecological Injuries and Service Losses (See Chapter 8). (7/14/00)
Document ID *1961*

Appendix B: Compliance with Key Statutes, Regulations, and Policies

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 U.S.C. 9601 *et seq.*

CERCLA is the principle statute applicable to sites contaminated with hazardous substances. The statute establishes liability for site cleanup, prescribes a procedure for identifying and ranking contaminated sites, provides funding for site cleanups, establishes cleanup procedures that provide protection for humans and the environment, establishes liability for the injury to, destruction of or loss of natural resources caused by releases of hazardous substances and provides for the restoration of injured natural resources through provisions administered by designated natural resource trustees.

CERCLA provides a framework for conducting sound natural resource damage assessments that achieve restoration of natural resources or resource services. The process emphasizes both public involvement and participation by the PRP(s). For the Point Comfort/Lavaca Bay NPL Site, CERCLA is a primary statute supporting the assessment and restoration planning process which has been undertaken by the Trustees. This Draft DARP/EA is consistent with all applicable CERCLA provisions.

National Environmental Policy Act (NEPA), 42 U.S.C. 4321, *et seq.*, 40 C.F.R. Parts 1500-1508

In considering and identifying restoration actions described herein for ecological injuries and service losses, the DARP/EA integrated the elements of an Environmental Assessment (EA) in accordance with NEPA. Thus, this DARP/EA evaluated the effects of the restoration actions identified herein (marsh enhancement/creation and oyster reef creation). This evaluation was found to support a Finding of No Significant Impact (FONSI), which finding is incorporated in this document.

Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)), 33 U.S.C. 1251, *et seq.*

The Clean Water Act (CWA) Section 311 is also a source of authority for seeking natural resource damages at this Site. Like CERCLA, NRDA claims under the CWA are also based on appropriate restoration actions and are addressed under the DOI regulations.

Section 404 of the law authorizes a permit program for the disposal of dredged or fill material into navigable waters. 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 Section 404 permit will be obtained, if required, in implementing any of the selected restoration actions.

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

The goal of the CZMA is 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 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 DOI reviewed the Draft DARP/EA for consistency with the Texas Coastal Zone Management Plan and found the restoration actions proposed therein are consistent with that plan. As required by the CZMA, NOAA and DOI submitted this determination to appropriate state agencies for review by letter dated July 12, 2000. These state agencies concurred with this finding.

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 assist in the conservation of threatened and endangered species to the extent their authority allows. Protection of wildlife and preservation of habitat are the central objectives in this effort. 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 that federal agencies consult with these departments to minimize the effects of federal actions on these listed species.

The restoration actions described in this DARP/EA are not expected to adversely impact any species listed under the ESA. The Trustees have initiated consultation with the United States Fish and Wildlife Service and the National Marine Fisheries Service pursuant to the ESA to ensure that the restoration actions selected are in accordance with all applicable provisions. Correspondence with the United States Fish and Wildlife Service and the National Marine Fisheries Service is included in the administrative record.

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

The selected restoration projects are expected to benefit 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 Services, the National Marine Fisheries Service, and state wildlife agencies for 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. This consultation is generally incorporated into the process of complying with Section 404 of the Clean Water Act, NEPA, or other federal permit license or review requirements. The Trustees consulted with the USFWS, the National Marine Fisheries Service, and state wildlife agencies pursuant to this statute for guidance in the designs of the restoration actions. Additional guidance will be received when necessary permits are sought.

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

The Magnuson Fishery Conservation and Management Act provides for stewardship of the nation's fishery resources within the Exclusive Economic Zone, covering all U.S. coastal waters out to a boundary at 200 miles. The resource management goal is to achieve and maintain the optimum yield from U.S. marine fisheries. The Act also establishes a program to promote the protection of Essential Fish Habitat (EFH) in the planning of federal actions. After EFH has been described and identified in fishery management plans by the regional fishery management councils, federal agencies are obligated to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any EFH.

The Trustees do not believe that the selected restoration alternatives will adversely impact any EFH as designated in the Act. A determination of this finding and correspondence with the National Marine Fisheries Service is included in the administrative record.

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

The Marine Mammal Protection Act provides for long-term management 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, porpoises, seals, and sea lions. The Department of the Interior is responsible for all other marine mammals. The selected restoration actions will not have an adverse effect on marine mammals.

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

The selected restoration projects will have no adverse effect on migratory birds.

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

The Texas State Historical Preservation Officer will be consulted prior to project implementation to ensure that there are no known cultural resources in the project area and no known sites or properties listed on or eligible for listing on the National Register of Historic Places.

Rivers and Harbors Act of 1899, 33 U.S.C. 403, *et seq.*, Section 10

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 require Section 404 Clean Water Act permits are likely also to require permits under Section 10 of the Rivers and Harbors Act. However, a single permit usually serves for both. Any permits under this Act, if required, will be obtained prior to implementing any selected restoration actions.

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

An Environmental Assessment was prepared and environmental coordination took place as required by NEPA.

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

The selected restoration activities will not adversely effect wetlands or the services they provide.

Executive Order Number 12898 – 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 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 the selected restoration projects.

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

The restoration projects will not adversely affect recreational fisheries and the services they provide.