United States Department of the Interior
Fish and Wildlife Service
Texas Chenier Plain NWR Complex
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December 6, 2013

Dear Reviewer:

This letter is to provide notification of availability of a U.S. Fish and Wildlife Service *Environmental Assessment* for review and comment. The document addresses the construction of a *Beach Overwash Protection Berm* on McFaddin National Wildlife Refuge shoreline. Included in this *Environmental Assessment* is the required *Compatibility Determination* for the project.

The proposed project is located approximately 600-feet landward of the McFaddin NWR Gulf shoreline, in southeastern Texas, Jefferson and Chambers Counties, near the Louisiana border. The proposed project would extend approximately 14.3 miles and use a clay and sand berm to restore the degraded dune ridge in order to reduce the frequency and extent of sea water inundation of the interior marshes located within the McFaddin National Wildlife Refuge (NWR). McFaddin NWR lies 12 miles to the west of Sabine Pass, approximately 15 miles south of Port Arthur and 90 miles east of Houston.

Your comments on the enclosed *Environmental Assessment* would be appreciated. If you know of someone who should also provide comments in addition to yourself, hard copies of the document are available at the USFWS Office in Sabine Pass, Texas and the document can be reviewed at area libraries. You can also obtain copies from the Refuge website at http://www.fws.gov/refuge/mcfaddin/. Comments are requested in writing by 4 pm on January 6, 2014. Please send your comments to: Refuge Manager, McFaddin National Wildlife Refuge, PO Box 358, Sabine Pass, TX 77655. If you have any questions, contact Refuge Manager, Denise Ruffino at (409) 971-2909. Thank you.

Sincerely,

Tim Cooper
Project Leader

Enclosure

# DRAFT
# Environmental Assessment

## Construction of Overwash Protection Berm

**on**
**McFaddin National Wildlife Refuge**
**Jefferson County, Texas**

**December 2013**

**Prepared by**

**LJA Engineering Inc.**
**for**
**U.S. Fish and Wildlife Service**
**McFaddin National Wildlife Refuge**

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List of Acronyms (alphabetical)

| | |
|---|---|
| BMP | Best Management Practice |
| BPA | Beaumont-Port Arthur |
| CEQ | Council on Environmental Policy |
| CFR | Code of Federal Regulations |
| CIAP | Coastal Impact Assistance Program |
| CY | cubic yards |
| EA | Environmental Assessment |
| EFH | Essential Fish Habitat |
| FHWA | Federal Highway Administration |
| ESA | Endangered Species Act |
| FPPA | Farmland Protection Policy Act |
| ft | feet |
| GIWW | Gulf Intracoastal Waterway |
| GLO | General Land Office |
| GMFMC | Gulf of Mexico Fishery Management Council |
| mi | miles |
| mph | miles per hour |
| MSL | Mean Sea Level |
| NAVD | North American Vertical Datum |
| NEPA | National Environmental Policy Act |
| NRCS | National Resources Conservation Service |
| NWI | National Wetland Inventory |
| NWR | National Wildlife Refuge |
| ppt | parts per thousand |
| ROW | Right of Way |
| SEARCH | Southeastern Archeological Research, Inc |
| SH | State Highway |
| T&E | Threatened and Endangered |
| TCEQ | Texas Commission on Environmental Quality |
| TPWD | Texas Parks and Wildlife Department |
| USACE | U.S. Army Corps of Engineers |
| USDA | U.S. Department of Agriculture |
| USFWS | U. S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |

# *1.0 PURPOSE OF AND NEED FOR PROPOSED ACTION ALTERNATIVE*

## 1.1 *Introduction*

The United States Fish and Wildlife Service (USFWS) is proposing to build a 14.5-mile (mi) clay and sand berm to restore the degraded dune ridge in order to reduce the frequency and extent of sea water inundation of the interior marshes located within the McFaddin National Wildlife Refuge (NWR). This Environmental Assessment (EA) is being prepared to evaluate the effects associated with this proposal and complies with the National Environmental Policy Act (NEPA) in accordance with Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1509), Department of the Interior (516 Department Manual 8) and USFWS (550 FW 3) policies. NEPA requires examination of the effects of proposed actions on the natural and human environment.

## 1.2 *Location*

The proposed project is located approximately 600-feet landward of the McFaddin NWR Gulf shoreline, parallel to the remaining alignment of State Highway (SH) 87 in southeastern Texas, Jefferson and Chambers Counties, near the Louisiana border. McFaddin NWR lies 12 miles to the west of Sabine Pass, approximately 15 miles south of Port Arthur and 90 miles east of Houston. (*Appendix A*)

## 1.3 *Background*

The shoreface at the McFaddin NWR consists generally of clay overlain by a sand veneer (*Appendix B*). In recent history, the beach ridge separating the Gulf from interior marshes was sufficiently high to prevent sea water inundation from the Gulf of Mexico with the exception of storm surge episodes associated with significant tropical storms or hurricanes. The frequency of such inundation was on the order of years to a decade or more. Unlike that of a more typical sand beach, the upper portions of the clay shoreface above the water line cannot be regenerated by the action of non-storm waves.

The dune system has been decimated over the years by ongoing annual erosion and seasonal storm events, as well as hurricanes. Shoreline retreat has accelerated from historic rates around -20 feet per year to as much as -40 feet per year in places. Hurricane Ike flattened much of the remaining beach ridge separating the Gulf of Mexico from the interior marshes, moving a significant amount of sand outside the active profile—either seaward onto the submerged continental shelf or landward into the marsh. The loss of sand from the active beach system has reduced the dune crest elevation such that sea water now routinely inundates the formerly fresh and brackish marsh in the refuge interior. The results will be marsh loss on a massive scale and Gulf shoreline retreat measured in miles rather than in feet until it reaches one of the busiest segments of the Gulf Intracoastal Waterway (GIWW).

Through interagency coordination, including a Federal shoreline erosion feasibility study (U.S. Army Corps of Engineers [USACE]), *SH 87 Restoration Environmental Impact Statement* (Federal Highway Administration [FHWA]), and investigation of feasible shore protection alternatives to facilitate SH 87 restoration (Jefferson County, using 2001 Jefferson County Coastal Impact Assistance Program [CIAP] funds), a consensus project has emerged that will reduce the frequency of saltwater inundation of vast

areas of sensitive interior wetlands in the refuge. This solution involves the construction of a clay core dune landward of the existing dune ridge that would restore the historical protection afforded by the Chenier ridges.

With the passage of Hurricane Ike exacerbating the existing threats to the marsh, a protection project was developed by the USFWS, in conjunction with Jefferson County and the Texas General Land Office (GLO) to restore the dune ridge. The project will result in the construction of approximately 14.5 miles of sand covered clay core berm, roughly 500 to 700 feet landward of the Gulf shoreline. The project will immediately reduce the sea water inundation.

## 1.4 *Purpose and Need for Proposed Action*

The purpose of the Proposed Action is to reduce the frequency and the extent of sea water inundation in the interior marshes of the McFaddin NWR. McFaddin NWR consists of the largest remaining freshwater marsh on the Texas Coast and thousands of acres of intermediate to brackish marsh.

McFaddin NWR supplies important feeding and resting habitat for migrating and wintering populations of waterfowl. Meeting the habitat needs of McFaddin NWR's diversity of wetland dependent resident and migratory birds requires maintaining a range of coastal marsh habitat types and sequential stages of the plant community within these marsh types. Providing freshwater inflows and restricting saltwater intrusion are critical to maintaining the Chenier Plain's historic continuum of fresh, intermediate, and brackish saline marshes. Habitat values for waterfowl, shorebirds and many wading bird species are greatly enhanced in intermediate marshes with early successional plant communities containing several perennial and annual plant species (primarily grasses and sedges) which provide important food resources, and where disturbance reduces the height and/or density of vegetation.

A clay and sand berm is needed to reduce the frequency and extent of sea water inundation in interior marshes at the McFaddin NWR.

## 1.5 *Regulatory Compliance*

Pursuant to NEPA, as amended, this EA has been prepared for USFWS to evaluate the effects associated with this proposal and complies with NEPA in accordance with CEQ *Regulations for Implementing NEPA* [40 Code of Federal Regulations (CFR) Section (§) 1500-1508]. In January 1997, USFWS published the *NEPA Reference Handbook* (550 FW 3) and in May 2004, the Department of the Interior published Chapter 8 of the Department Manual, *Managing the NEPA Process* (516 DM 8). These publications provide guidelines for implementing procedures for all elements of NEPA within the USFWS.

The National Wildlife Refuge System Improvement Act of 1997 states that "the mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats with the United States for the benefit of present and future generations of Americans" (16 USC 668 dd [a]).

In addition, this EA represents compliance with applicable Federal statutes, regulations, Executive Orders, and other compliance documents, including the following:

- American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)
- Archaeological Resources Protection Act of 1979 (16 U.S.C. 470)
- Clean Air Act of 1972, as amended (42 U.S.C. 7401 *et seq.*)
- Clean Water Act of 1972, as amended (33 U.S.C. 1251 *et seq.*)
- Endangered Species Act (ESA) of 1973, (ESA) as amended (16 U.S.C. 1531 *et seq.*)
- Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 1979.
- Executive Order 11988, Floodplain Management, 1977.
- Executive Order 11990, Protection of Wetlands, 1977.
- Executive Order 12898, Federal Action Alternatives to Address Environmental Justice in Minority Populations and Low Income Populations, 1994.
- Executive Order 11593, Protection and Enhancement of the Cultural Environment, 1971.
- Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661 *et seq.*)
- National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 *et seq*.)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq.*)
- National Pollutant Discharge Elimination System, as amended (33 U.S.C. 1251 *et seq.*)
- National Wildlife Refuge System Improvement Act of 1997
- Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq*.)

Further, this EA reflects compliance with applicable State of Texas and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources.

## 1.6 ***Public Involvement and Issues Identified:***

On June 28th, 2013, the USFWS announced its intent to prepare an Environmental Assessment of alternatives for the design of an overwash protection berm to facilitate the reduction of the frequency and the extent of sea water inundation in the interior marshes of the McFaddin NWR. A 30-day scoping period is anticipated for July 2013 in which a Scoping Document will be made available for public comment.

It is anticipated that a 30-day comment period will be provided in December 2013. The USFWS will provide copies of the EA on their website and at field offices as well as publishing a news release and sending out letters and emails to potential interested parties announcing the public comment period for development of this EA.

Concurrent with the Draft Environmental Assessment, the USFWS will issue a DRAFT COMPATIBILITY DETERMINATION for the Construction of Overwash Protection Berm for public review and comment. National Wildlife Refuges are required to determine the compatibility of any proposed use with the mission of the National Wildlife Refuge System and the purpose for which a particular refuge was established. Hard copies of the Compatibility Determination are available at the USFWS Office in Sabine Pass, Texas or from the Refuge website at http://www.fws.gov/refuge/mcfaddin/.

# *2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION ALTERNATIVE*

## 2.1 *Project Criteria*

The primary goal of this project is to prevent saltwater intrusion into McFaddin NWR along the shoreline due to tides and storm water levels occurring more frequently than the 5 year return interval (20% chance of occurrence in a given year). Secondary goals include creating additional marsh habitat and increasing berm resiliency during storm events.

Considering the environmental purpose of McFaddin NWR, compatibility with potential future restoration activities, and budget constraints, structural alternatives such as bulkheads or similar vertical structures typically built of concrete or steel were eliminated in initial alternatives screening. Creation of a gently-sloping earthen berm emerged as the preferred approach for preventing sea water overwash into the refuge. The berm is described in various project documents as beach ridge restoration, dune ridge restoration, or seawater inundation prevention berm. No significance is attached to differences among these terms.

Alternatives considered and selection criteria were based on the following:

- alignment location
- crest elevation
- berm configuration
- foundation elevation
- stabilization method
- material type and source
- sand cover and planting alternatives
- drainage/compatibility with refuge purpose
- cost per foot of constructed berm

## 2.2 *Alternatives Considered and Selection Criteria*

### *Alignment*

A balance was sought between longevity of the project in the face of rapid shoreline retreat and the amount of marsh acreage to be left unprotected on the seaward side of the berm. The berm itself is not a shore protection measure. Its ability to remain functional depends, in part, on the maintenance of a shoreline located seaward of the berm such that the berm does not suffer frequent wave attack. Assuming a typical shoreline retreat rate of -30 feet per year, the minimum acceptable distance between the present shoreline and the berm was considered to be 300 feet, suggesting a 10-year functional life span without further intervention.

An alignment located as much as 1,000 feet landward was also explored. However, a combination of the increase in marsh acreage left unprotected along with increased unit cost of construction due to the lower foundation elevation at that location led to a middle-ground alternative. Survey data suggested

that the alignment could be located approximately 600 feet landward of the shoreline with approximately the same foundation elevation as alignments closer to the shoreline (*Appendices F* & *G*).

### *Crest Elevation*

Given the ability of McFaddin NWR marsh to recover from infrequent sea water inundation events that are a natural part of the coastal climate, it is undesirable to provide protection from severe storm events including tropical storms and hurricanes. The design criterion for crest elevation is intended to foster flushing and recovery of vegetation between inundation events. The water level associated with a 5-year return interval (20% chance of occurrence in a given year) was used for this purpose. At the project location this water level was determined to be 3.56 feet above Mean Sea Level (MSL). Combined with the effects of wave run-up, the water level to be withstood was determined to be 4.69 feet MSL or 5.36 feet NAVD88.

A series of model runs was executed using available Lidar topography for McFaddin NWR. These runs consisted of raising the open water sea level to the previously defined 5.36 feet NAVD88 and comparing the results with varying levels of berm height. It was shown that a berm with a crest elevation of greater than 5 feet NAVD88 was sufficient to adequately reduce the salt water inundation in the marsh. In addition, relative sea level rise is estimated to be about 2 feet per century. The selected crest elevation was chosen as a balance among initial level of protection, cost, consideration of sea level rise, and project footprint size.

Increases in the minimum berm crest elevation, while increasing the protection of McFaddin NWR against a more significant storm, significantly impacted both the berm footprint and the amount of material necessary for construction of the berm. With a finite amount of construction funding, the added material to increase the elevation of the berm comes at the cost of a reduction in the overall length of the berm and the area that can be protected. Consultation with the USFWS and other interested parties prioritized the length of the project over further increases in berm elevation so a berm crest elevation of 6 feet NAVD88 was selected over other alternatives (*Appendices G & H*).

### *Berm Configuration*

A berm configuration (cross sectional dimensions) was sought to maximize feasible height, length, and constructability while minimizing the footprint. To increase stability and reduce settling, the proposed construction calls for the removal of the top layer of sand and the construction of the clay berm either directly on top of the underlying clay layer or keyed into the clay layer in the event a sand lens is encountered within the alignment. Any overlying sand and organic material within the berm footprint will be placed on the seaward side of the berm after construction and augmented with up to 1.5 cubic yards (CY) of imported sand per foot of berm length to provide an additional layer of protection for the clay berm in the case of a storm event. If necessary, this local organic/imported sand layer will be planted using plant species, planting methodology, and plant spacing approved by McFaddin NWR personnel.

Additional alternatives to the berm shape were considered such as reducing crest height and side slope angle but these had detrimental impacts on berm resiliency and constructability and increased footprint

and construction materials required for berm construction, sand coverage, and planting. This increase in required material reduces the overall project length, negatively impacting the project's ability to satisfy the primary design criteria of comprehensive protection of McFaddin NWR shoreline.

The preferred design for the berm is a trapezoid shape, with a 12-foot crest width and 1V:3H side slopes (*Appendices G & H*).

### *Foundation and Stabilization*

Various data collection efforts showed that the top of the sub-surface clay layer occurred at a relatively constant elevation around +2 NAVD88 within 600 feet of the remnant dune crest and is relatively independent of the thickness of sandy organic material above it. The clay surface is slightly higher near the existing dune crest close to the shoreline and decreases toward the marsh interior.

Geotechnical investigation suggests that several inches of initial settlement should be expected following construction. Settlement can be reduced by stabilizing some or all of the material used to form the berm, such as by treatment with lime or other materials. Another alternative is to place additional material into the berm template to account for initial settlement while still achieving the design crest elevation after settlement. The latter approach was adopted due to difficult site access for imported stabilizing materials.

### *Material Type and Source*

Initial screening of alternative materials resulted in the recognition that sandy material was not suitable for the intended purpose. A clay material was needed to resist seepage and berm failure during high water episodes.

Three alternatives were considered when determining the material that will be used in the berm construction:

1. Importing the material from an offsite source.
2. Creating one, or several, large central borrow area(s) within McFaddin NWR to harvest the material.
3. Gathering the material from areas adjacent to the proposed berm alignment and transporting it a short distance to the berm alignment.

The first option had the most significant costs associated with it and therefore significantly impacted the overall length of the berm that could be constructed. Although the project footprint could be reduced by not having on-site borrow areas, the construction footprint could not be significantly reduced due to the need for construction vehicle access and work space.

The results of geotechnical investigation indicated that the on-site material was suitable for berm construction. McFaddin NWR staff supported the on-site borrow alternative and the next two alternatives were studied.

The creation of one, or several, central borrow areas within McFaddin NWR was considered. It was determined that this alternative would create a significant amount of traffic running through the Refuge

Complex to transport the material from the borrow areas. Impacts to the marsh would increase due to the increased truck travel, not only along the berm alignment corridor, but back and forth to the one, or multiple, borrow areas.

The creation of borrow areas on the landward side of the proposed berm alignment was then explored. The impacts to the marsh would be minimized by the ability to restrict the construction activities to the corridor between the borrow areas and berm. This would eliminate the traffic thoroughfare running to and from centrally located borrow areas. There would be more borrow areas but they would consist of smaller, shallower areas and therefore reduce the overall impact to the marsh (*Appendices F* & *G*).

The mitigation plan proposes to convert these borrow areas to shallow open water and estuarine emergent wetlands to provide an enhanced aquatic resource for McFaddin NWR. Borrow area configurations were determined in consultation with McFaddin NWR personnel to potentially be able to provide acceptable habitat conditions. In addition to depth and side slope considerations, the organic and sandy soil located inside the borrow area footprint would be stockpiled during excavation of the clay material and would be replaced within the borrow area to assist with the re-establishment of native plant species.

### *Sand Cover and Planting Alternatives*

The design template calls for 1.5 CY of imported sand cover per linear foot to be placed over the berm. This amount of sand is sufficient to achieve a depth of cover of 1 foot over the entire berm surface. A greater depth of cover was considered as an alternative, but the thickness of the sand layer would be prohibitive to the ability to cover the entire length of the berm. Coverage of the entire berm length was determined to be a desirable component for the establishment of vegetation and to reduce the erosional impacts of storm events acting directly on the clay berm surface.

To augment the imported sand, the top layer of sand and organics within the berm footprint would be removed prior to berm construction and set aside. This material would be replaced on the seaward side of the berm after construction to provide additional protection. It is assumed that some of the sand volume would likely migrate landward across the dune to naturally increase the cover on the crest and landward side (*Appendices G & H*).

Stockpiled material should be adequate to re-establish native vegetation. Additional planting may be implemented in consultation with McFaddin NWR staff if necessary.

### *Drainage Discharge Points*

Consideration was given to the need and ability to drain sea water back into the Gulf following major storm surge events. One method considered was to provide “weak links” in the berm where the clay crest was lowered to “train” flow to specific locations. These weak points would likely consist of some scour protection combined with the creation of a total or partial sand berm rather than the clay core berm typical to the rest of the project. Different locations for the drainage points were considered and it was determined that the optimal locations were located where flows were already concentrated alongside existing levees and borrow areas, as opposed to creating a new weak point and attempting to

divert flow elsewhere. A total of seven locations were determined for the length of the proposed berm (*Appendix F*). Each of the major drainage areas between the existing levees in McFaddin NWR has a discharge point. Using these points, the duration of the inundation can be reduced versus the impounding time should the entire Refuge Complex be forced to drain across the interior marshes into the GIWW. This alternative is also intended to reduce damage to other portions of the berm.

### *Cost*

Cost is primarily a function of excavation and placement quantities. The cost per foot of berm therefore depends primarily on the cross-sectional configuration of the berm.

## 2.3 *No Action Alternative*

The No Action Alternative will result in the conversion of tens of thousands of acres of refuge habitat into salt marsh and likely open water habitat. At current rates, more than 200 acres of marsh habitat are lost annually. Historically, it has required an entire growing season or longer for these marshes to recover following sea water inundation as subsequent rainfall helps flush the system and reduce salinities. Present conditions under which sea water continues to enter the marsh on a frequent basis will prevent such recovery, and accelerate the marsh die off. Increased salinities will have significant negative impacts to most coastal marsh species including estuarine fisheries species as water conditions deteriorate in what is part of the largest estuary on the Texas side of the Sabine River. Cascading effects includes the reduced biomass production, collapse of root zone leading to shallow surface subsidence, and loss of organic soils, leading to rapid conversion to open water. Aquatic habitats will decline in value as increased salinities levels remain, causing open water areas increase in size, leading to increased turbidity and loss of aquatic vegetative communities. As emergent marsh communities are lost in the conversion of marsh to open water, species utilizing the interior marshes will be displaced to more suitable habitat if available. In addition to the conversion of hundreds of acres per year of open water at the Gulf Shoreline, the interior of the marsh will open up and eventually connect to the Gulf of Mexico. Examples of this progression are evident only a few miles to the east in Southern Louisiana.

## 2.4 *Preferred Alternative*

The Preferred Alternative consists of a 36-foot wide, trapezoidal berm configuration with a crest elevation of +6 feet (ft) NAVD88 and +2 ft NAVD88 foundation elevation. The side slopes would be 1V:3H ft and the berm crest would be approximately 12 ft wide (*Appendices F, G & H*).

The total length of the berm is proposed to be 14.43 miles (76,207 ft) and impact approximately 63 acres. The berm would be located approximately 600 feet (varies 500 feet to 700 feet) inland and parallel to the current beach. The berm would be constructed from material excavated from 89 acres of onsite borrow areas. The clay material will be excavated from borrow areas parallel and approximately 60 ft landward of the berm segments. The borrow pits would consist of shallow, alternating areas that would be approximately four ft deep, 1,000 ft long and 75 ft wide.

The proposed berm would be augmented with approximately one foot of imported sand as well as sand and organics previously stripped from the berm footprint. This would optimize the establishment of

vegetation and reduce the erosional impacts of storm events acting directly on the clay berm surface. This sand covered, clay core berm will be vegetated as necessary per McFaddin NWR personnel.

The 89 acres for the borrow areas would be converted to shallow open water and estuarine emergent wetlands that would provide an enhanced aquatic resource for the Refuge. Estuarine emergent wetlands are recognized as nationally-declining wetland types (USFWS National Wetlands Inventory [NWI]) (*Appendix C*).

The proposed project would be constructed in approximately six to eight months and would avoid nesting season of the piping plover.

## *3.0 AFFECTED ENVIRONMENT*

The *Preferred Alternative* would reduce the frequency and the extent of sea water inundation in the interior marshes of the entire McFaddin NWR. McFaddin NWR is one of 540 refuges that comprise the National Wildlife Refuge System, a national network of lands and waters set aside for the benefit of wildlife. Established in 1980, the 59,000-acre NWR consists of the largest remaining freshwater marsh on the Texas Coast and thousands of acres of intermediate to brackish marsh. McFaddin NWR supplies important feeding and resting habitat for migrating and wintering populations of waterfowl. McFaddin NWR is part of the Salt Bayou marsh system which comprises the area west of Sabine Lake and the Sabine-Neches Waterway, and south of the GIWW. This system consists of a continuum of saline tidal to freshwater microtidal systems.

This refuge is located along SH 87 in the southeastern portion of Texas, near the Louisiana border. McFaddin NWR lies approximately 15 miles south of Port Arthur, 90 miles east of Houston, and 12 miles west of Sabine Pass. McFaddin NWR is bounded on the south by the Gulf of Mexico, on the east by Texas Parks and Wildlife Department (TPWD) Property and private land, on the west by private land near High Island, and both the GIWW and private property to the north.

McFaddin NWR lies within a bio-geographical region known as the Chenier Plain (Gosselink et al. 1979). Geographically, the Chenier Plain region extends from Vermillion Bay in southwestern Louisiana to East Galveston Bay in southeastern Texas. A distinguishing feature of the region is the presence of chenier ridges representing the ancient Gulf shorelines which are generally aligned parallel to the Gulf or as fan-shaped alluvial deposits at the mouths of rivers. The higher cheniers support woody vegetation, hence the name chenier, a French word which means “place of oaks”. Cheniers are more prevalent in Louisiana than in Texas, perhaps because of the alignment of the Gulf shoreline and its proximity to the Mississippi River, the Chenier Plain region’s primary sediment source. Given the region’s significant annual rainfall, wetlands isolated from the Gulf by the cheniers and ridges developed into highly productive and diverse freshwater coastal marsh habitats. The existing beach ridge on McFaddin NWR was produced by those alluvial deposits and is responsible for the existence of the freshwater marshes within Salt Bayou.

## 3.1 *Physical Environment*

### *Air Quality*

The Texas Commission on Environmental Quality (TCEQ) is the state agency responsible for regulating air quality in Texas. Non-attainment areas are areas that have failed to meet Federal standards for ambient air quality. McFaddin NWR is within Beaumont-Port Arthur (BPA) area which is designated as nonattainment for eight-hour ground-level ozone air quality standard for Texas. This BPA area includes Hardin, Jefferson, and Orange counties. The major sources of air pollution in this region are petroleum production, chemical production, shipping, and agriculture.

Burning is widely used as an agricultural management tool in the region to improve pasture and control undesirable vegetation. The TCEQ administers the Outdoor Burning Rule (Title 30, Texas Administrative Code, Sections 111.201 – 111.221), which regulates prescribed burning within the state. TCEQ is responsible for issuing authorization to prescribed burn, defining the conditions when burning will be permitted, and determining what materials may be burned.

### *Geology and Soils*

The Chenier Plain Region is part of a recent geologic plain. Most soils within McFaddin NWR are remnants of ancient floodplains and Gulf beaches and consist of old alluvium and marine sediment deposited by ancient streams and the Gulf. These deposits are mostly clayey and sandy soils and exhibit a wide range in textural differences due to their origin within historic floodplain systems (U.S. Department of Agriculture (USDA) 1976). McFaddin NWR is located within the 100-year floodplain. The soil types, both acidic and alkaline, are poorly drained with slow permeability, moderate to high salinity, and a high shrink-swell potential (USDA 1960, USDA 1976).

Coastal land soils are found on the lower slopes of the sandy ridges and along the Gulf. These soil types form the Sabine-Coastal land association. The shoreline of McFaddin NWR is made up of the Sabine-Coastal land association and the Saltwater marsh-Tidal association. Coastal soils generally consist of deep, dark colored and slightly acidic sands. As remains of ancient Gulf of Mexico beaches, they are relatively low in nutrients. Specifically, the coastal soils differ dramatically in pH, color, texture, available water capacity, and drainage. The Gulf beach within the McFaddin NWR is predominately exposed clay with a thin overlay of sand, reflecting a recent scarcity of sand. Clay outcroppings from the underlying strata are exposed along large areas following erosive events such as hurricanes, tropical storms, and winter frontal passages.

The U.S. Geological Survey (USGS) topographic quadrangle maps were reviewed to determine elevations and slopes within the project area. This project is located in the Mud Lake, Star Lake, South of Star Lake, Clam Lake, and Sabine Pass USGS 7.5-minute quadrangles (1:24000). The elevation in the proposed project area is approximately 0 to 5 feet above mean sea level. The following soil types are present within the proposed site area (*Appendix D*):

1) Barnett mucky peat (BcA), 0 to 1 percent slopes, frequently flooded, tidal
2) Barnett silty clay loam (BeA), 0 to 1 percent slopes, frequently flooded, tidal
3) Leerco muck (LvA), 0 to 1 percent slopes, frequently flooded, tidal

4) Veston fine sandy loam (VeA), 0 to 1 percent slopes, frequently flooded, tidal

### *Water Resources*

The historical pattern of hydrology in the Chenier Plain region was critical to the building processes that created and maintained the diversity of its coastal wetlands. Frequent flooding over low bayou banks and large volumes of rainwater sheet flowing slowly across coastal prairies and marshes provided nutrients, sediments, and freshwater to marsh systems. Natural drainage allowed a cyclic pattern of drying and flooding under which wetland plants evolved and adapted. Over the past 5,000 years, the Chenier Plain region was predominately a freshwater coastal marsh system, but contained a continuum of coastal marsh types associated with a natural salinity gradient. This continuum of freshwater, intermediate, brackish, and saline wetlands supported a diversity of floral and faunal communities.

Modifications to the natural hydrological systems have affected ecological and geological processes critical to the long-term integrity of coastal ecosystems in the Chenier Plain region. In general, the primary human induced activities that have affected coastal wetlands across the Chenier Plain in Texas include dredging of the Houston Ship Channel for navigation, canalization of the Trinity River, dredging of the Sabine River and Neches River to form the Sabine Neches Waterway, construction of the GIWW into Galveston Bay, as well as construction of smaller navigation canals and drainage canals, as well as oil, gas, and groundwater extraction. The consequences of these activities have resulted in various ecological responses, some of which are directly responsible for the onset of others (White and Tremblay 1995).

McFaddin NWR is located within the East Galveston Bay and Sabine Lake Watersheds. The existing hydrology of McFaddin NWR consists of a series of shallow ponds and tidal bayous, sloughs, and canals that drain primarily to the GIWW. Portions of the McFaddin NWR are subject to daily tidal flows, however, high storm tides and hurricanes are capable of flooding the entire area. Numerous marsh flats, small potholes, and shallow marsh ponds are found within the McFaddin NWR. McFaddin NWR contains water control structures, levees, and weirs.

## 3.2 *Biological Environments*

### *Vegetative Habitats*

Vegetative habitats within McFaddin NWR are primarily determined by soil type, hydrology and salinity. These vegetative habitats are important for waterfowl, shorebirds, wading birds, and other water birds wintering on or migrating through the upper Texas Gulf Coast.

#### Upland Habitats

Most upland habitats within the project area are comprised of prairies. Other upland habitats found in McFaddin NWR include beach ridges/dunes and small coastal woodlots located on the Chenier ridges or on elevated features (both natural and manmade), including bayou banks and levees. Upland habitats present within McFaddin NWR include salty prairies, remnant tall-grass prairies, and small remnant woodlands. Typical woody vegetation present in coastal woodland areas includes red mulberry, hackberry, Chinese tallow, live oak, southern wax myrtle, yaupon holly, and sweetgum. These woodlots

are heavily used rest areas during spring and fall migrations by neotropical migrant birds. Salty prairies occur as elevated ridges interspersed within marsh habitats. Remnant stands of tall-grass coastal prairies occur in the northern-most sections of the Anahuac NWR.

**Wetland Habitats**

McFaddin NWR consists of the largest remaining freshwater wetlands on the Texas Coast with tens of thousands of acres of intermediate to brackish wetlands. The entire area has degraded over the years, primarily due to saltwater intrusion and subsidence. This degradation has significantly reduced the amount of emergent vegetation that provides the foundation for fisheries, birds, amphibians, reptiles, and mammals inhabiting the marsh. Scouring storm surges and other impacts from recent hurricanes have further degraded this wetland complex. Once coastal wetlands lose their vegetation, their value to wetland-associated wildlife is also degraded.

The various wetland habitats within McFaddin NWR are classified as estuarine, palustrine, and lacustrine wetlands (USFWS, National Wetlands Inventory [NWI]) (*Appendix C*). Wetland habitats adjacent to the project area include coastal marshes, natural and man-made wetlands (livestock ponds), open waters and small tributaries.

A wetland delineation was conducted in November and December 2012. The emergent coastal marshes found within the project area were consistent with the USFWS NWI classification as estuarine emergent wetlands.

### *Wildlife Habitats*

The Chenier Plain region provides important habitats for numerous fish and wildlife species, including over three hundred documented avian species. According to TPWD, over 75 species of fresh water fish, and over 400 salt and brackish water species occur in the marshes, bays, bayous, and Gulf of Mexico waters on and adjacent to the McFaddin NWR.

**Wintering and Resident Waterfowl**

One of the primary objectives of McFaddin NWR is to provide quality habitat for wintering waterfowl. The McFaddin NWR is part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway, and some waterfowl from the Mississippi, Atlantic, and Pacific Flyways also winter here. The 2004 mid-winter waterfowl survey for the Central Flyway indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. The coastal marshes, wet prairies, rice fields and moist soil units of McFaddin NWR are used by 27 species of ducks and five species of geese.

The USFWS conducts aerial waterfowl surveys monthly from September through March on national wildlife refuges on the Texas Gulf Coast. The most common duck species observed were green-winged teal (*Anas crecca*), gadwall (*Anas strepera*), northern shoveler (*Anas clypeata*), blue-winged teal (*Anas discors*) and northern pintail (*Anas acuta*). Snow geese (*Chen caerulescens*) are the principal goose species found in McFaddin NWR. Other geese include greater white-fronted (*Anser albifrons*) and Ross's

geese (*Chen rossii*). "White-cheeked" type geese are commonly counted on McFaddin NWR, most of which are presumed to be cackling geese (*Branta hutchinsii*).

Several of the 27 species of waterfowl found on McFaddin NWR are listed by the USFWS' Migratory Bird Office as a "Game Bird Below Desired Condition" (USFWS 2004). They include: canvasback (*Aythya valisineria*), mallard (*Anas platyrhynchos*), mottled duck (*Anas fulvigula*), northern pintail, redhead (*Aythya americana*), ring-necked duck (*Aythya collaris*), greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), and wood duck (*Aix sponsa*). Snow goose and Ross's goose are listed as "Over Abundant".

Essentially non-migratory, the mottled duck is tied to coastal habitats for its entire life cycle. Mottled ducks are year-round residents in fresh, intermediate and brackish marshes as well as suitable agricultural areas near McFaddin NWR. They typically nest in gulf and marsh-hay cordgrass on dryer areas and utilize adjacent wetlands for raising broods. The Upper Texas Gulf Coast, including McFaddin NWR, has historically been considered the core of mottled duck habitat in Texas. Wetland and grassland habitats and rice agricultural lands continue to be extremely important to the Western Gulf Coast Mottled Duck population.

**Shorebirds, Wading Birds, Marsh, and Waterbirds**

The tidal flats, beaches, and marshes on McFaddin NWR provide shallow water feeding, breeding, and resting habitat for numerous shorebirds, wading birds, and other marsh and waterbirds. Thirty-two species of shorebirds regularly occur on McFaddin NWR, ten of which are considered 'highly imperiled' or of 'high concern' under the U.S. Shorebird Conservation Plan (*Brown et al. 2000*).

Shorebird counts are conducted along the Texas Coast between March 22 and May 17 during two week intervals. The most abundant species observed during the surveys are typically American avocet (*Recurvirostra americana*), western sandpiper (*Calidris mauri*), long-billed and short-billed dowitchers (*Limnodromus scolopaceus* and *L. griseus*, respectively), semipalmated sandpiper (*Calidris pusilla*), pectoral sandpiper (*Calidris melanotos*), black-bellied plover (*Pluvialis squatarola*), dunlin (*Calidris alpina*), sanderling (*Calidris alba*), willet (*Catoptrophorus semipalmatus*), semi-palmated plover (*Charadrius semipalmatus*), least sandpiper (*Calidris minutilla)*, and snowy plover (*Charadrius alexandrinus*). Common nesting shorebirds species within McFaddin NWR include the willet, killdeer (*Charadrius vociferus*) and black-necked stilt (*Himantopus mexicanus*).

Colonies of nesting birds including least terns (*Sterna antillarum)* and black skimmers (*Rynchops niger*) occur on beaches, washover terraces, and occasionally on man-made sites such as oil and gas well pads. Within McFaddin NWR, nesting wading, marsh and waterbird species include least bittern (*Ixobrychus exilis*), purple gallinule (*Porphyrula martinica*) common moorhen (*Gallinule Chloropus*), and pied-billed grebe (*Podilymbus podiceps*). All six North American species of rails occur in the marshes and wet prairie grasslands of McFaddin NWR. King and clapper rails (*Rallus elegans* and *R. longirostris*, respectively) nest here and are present year-round. The black rail (*Laterallus jamaicensis*) has not been documented as nesting on McFaddin NWR, but is also present year-round. Sora (*Porzana carolina*),

Virginia and yellow rails (*Rallus limicola and Coturnicops noveboracensis*) utilize these habitats in high densities during the winter and young Sora and Virginia rails have been seen during late summer.

**Migratory and Resident Landbirds**

Many passerines (perching birds) that nest in temperate North America and winter in Central and South America migrate through the project area, crossing the Gulf of Mexico during spring and fall migrations. During spring migration coastal woodlots and other wooded habitats in the project area provide the first landfall for these trans-Gulf neotropical migrants. Migrant passerines that use McFaddin NWR include many species of warblers, vireos, tanagers, thrushes, and buntings, including many Avian Species of Conservation Concern. Songbird species nesting on McFaddin NWR include the orchard oriole (*Icterus spurius*), Eastern kingbird (*Tyrannus tyrannus*), and scissor-tailed flycatcher (*Tyrannus forficatus*).

Upland grassland habitats on McFaddin NWR provide wintering and/or migrational habitat for several grassland songbird species including LeConte's sparrow (*Ammodramus leconteii*), mottled ducks (*Anas fulvigula*), and seaside sparrows (*Ammodramus maritimus*). Upland grassland habitats also provide nesting habitat for species including dickcissel (*Spiza americana*), Eastern meadowlark (*Sturnella magna*) and mottled ducks.

Several species of raptors commonly observed within McFaddin NWR include red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), turkey vulture (*Cathartes aura*), American kestrel (*Falco sparverius*), white-tailed kite (*Elanus leucurus*), Northern harrier (*Circus cyaneus*), and short-eared owl (*Asio flammeus*). Many other raptor species are observed during spring and fall migrations.

**Fisheries Resources**

The region's coastal fishery is classified as a warm water fishery resource with moderate to high numbers of salt and brackish water species occurring in the Gulf of Mexico and large estuarine bay systems. Over 95% of the marine organisms found in the Gulf of Mexico depend on estuarine habitats (salt, brackish, and intermediate marshes) for their survival, and estuaries are often referred to as the food pantry for the ocean. This natural resource base is the cornerstone of a very important commercial and sport fishing industry based on the harvest and sale of seafood. Millions of tons of penaid shrimp, crabs, finfish, oysters, clams, and other marine life are dependent on the biological richness afforded by the estuaries. Segments of the estuarine habitats are important nursery habitats for a variety of living marine resources, especially in their early life stages.

Estuarine marshes and associated habitats have been identified by the Gulf of Mexico Fishery Management Council (GMFMC) as Essential Fish Habitat (EFH) for juvenile white shrimp (*Litopenaeus setiferus*) and brown shrimp (*Farfantepenaeus aztecus*), and juvenile red drum (*Sciaenops ocellatus*). EFH known to occur in the project area includes estuarine emergent wetlands, estuarine mud, sand and shell substrates, submerged aquatic vegetation, and estuarine water column. Detailed information on red drum, shrimp, and other Federally managed fisheries and their EFH is provided in the 1998 amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the GMFMC. The

1998 EFH amendment was prepared as required by the Magnuson-Stevens Fishery Conservation and Management Act.

**Mammals**

Some of the more common mammals within McFaddin NWR include raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), nine-banded armadillo (*Dasypus novemcinctus*), swamp cottontail rabbit (*Sylvilagus aquaticus*), Virginia opossum (*Didelphis virginiana*), muskrat (*Ondatra zibethicus*), nutria (*Myocaster coypus*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), and feral hog (*Sus scrofa*).

**Reptiles, Amphibians, and Invertebrates**

Common reptiles within McFaddin NWR include the American alligator (*Alligator mississippiensis*), western cottonmouth (*Agkistrodon piscivorus*), speckled kingsnake (*Lampropeltis getula*), red-eared slider (*Trachemys scripta*), and snapping turtle (*Chelydra serpentina*). Common amphibians include the pig frog (*Rana grylio*), southern leopard frog (*Rana sphenocephala*), Gulf Coast toad (*Bufo valliceps*), and bullfrog (*Rana catesbeiana*). The lesser siren (*Siren intermedia*) and three-toed amphiuma (*Amphiuma tridactylum*) are probably common though seldom-seen amphibians found in freshwater habitats.

Alligators currently occur in over 90% of their historic range with the largest concentrations in Texas occurring in the middle and upper coastal counties and suitable inland habitats. Preferred habitats include river valleys, streams, oxbow lakes, marshes, swamps, estuaries, bayous, and slow moving creeks where they will feed on various species of fish, turtles, snakes, and mammals such as nutria and muskrat. American alligator populations within McFaddin NWR have trended upward since surveys of this species were initiated in the mid-1980s (USFWS unpublished data). Alligators now can be found in all wetland habitats on McFaddin NWR.

Invertebrate populations are an essential food resource for migratory birds and estuarine fishery species. Various amphipods, midges, mysid shrimp, grass shrimp, crayfish, and numerous crabs are present within all marsh habitats in the project area. Some of these invertebrate populations occur in tremendous quantities. Mosquitoes, biting flies, chiggers, and imported fire ants (*Solenopsis invicta*) are other common invertebrates. Common butterfly species include monarch (*Danaus plexippus*), little yellow (*Pyrisitia lisa*) and Gulf fritillary (*Agraulis vanillae*) butterflies. Common dragonfly species include the common green darner (*Anax junius*) and seaside dragonlet (*Erythrodiplax berenice*).

Native rangia clams (*Rangia cuneata*) historically occurred across the entire McFaddin NWR and thrive in salinity ranges between 3 to 10 ppt (parts per thousand). However, populations have been decimated by salt water intrusion in the majority of the Salt Bayou marsh system. Periwinkle snails (*Littoraria irrorata*) are found in the salt marshes and in the brackish marsh with the higher salinity levels where smooth cordgrass (*Spartina alternaflora*) has become established. Fiddler crabs (*Uca sp.*) are found the high tide line in high marsh to the intertidal zone across portions of the project area.

### *Threatened and Endangered Species and Other Special Status Species*

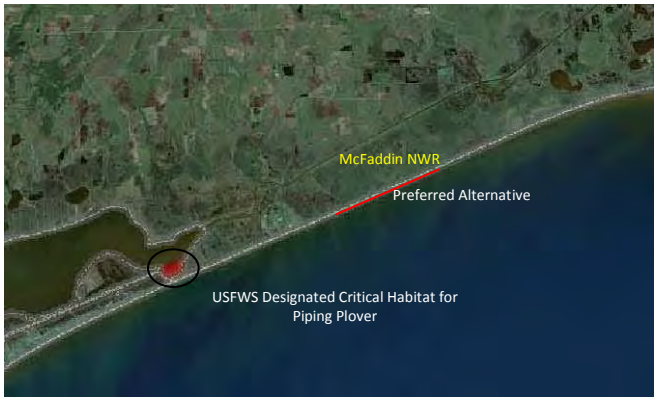
Several Federally-listed Threatened and Endangered (T&E) Species, listed under the ESA, occur within the project area. Several recent actions by the USFWS under the ESA have changed the status of T&E species occurring within the project area. In 1999, the USFWS de-listed and removed the Arctic peregrine falcon from the list of T&E species. The bald eagle was down-listed from Endangered and reclassified as Threatened in 1995.

The ESA requires the designation of "critical habitat" for listed species when "prudent and determinable." Critical habitat includes geographic areas that contain the physical or biological features that are essential to the conservation of the species and that may need special management or protection. Critical habitat designations affect only federal agency actions or federally funded or permitted activities. Federal agencies are required to avoid "destruction" or "adverse modification" of designated critical habitat.

There are no known Federally-listed T&E plant species present on McFaddin NWR.

Three species of sea turtles, the Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) are Federally-listed as endangered, and two species, the loggerhead (*Caretta caretta*) and green (*Chelonia mydas*), are Federally-listed as threatened. All five species occur in the region's nearshore Gulf waters, and the Kemp's ridley, loggerhead and green sea turtles can be found in shallow bays typical of East Galveston Bay adjacent to the neighboring Anahuac NWR. Strandings of dead and injured sea turtles occasionally occur along the Gulf shoreline within McFaddin NWR.

The Gulf Coast of Texas attracts a large population of wintering piping plovers (*Charadrius melodus*), a Federally-listed threatened species. Piping plovers are normally only observed in small numbers wintering on the beaches of McFaddin NWR, as well as during spring and fall migration. There have been no records to date of nesting piping plovers on the Refuge Complex. In 2001, the USFWS designated Critical Habitat for the wintering piping plovers in Texas. However, the nearest designated Critical Habitat for this species is located on Bolivar Peninsula, north of Rollover Pass.



The American alligator received protection under the ESA in 1974, when they were listed as Endangered. Following population increases, the listing status was changed to Threatened due to similarity of appearance with the Endangered American crocodile.

McFaddin NWR lies within the historic ranges of four Federally-listed T&E species: Attwater's Prairie Chicken (*Tympanuchus cupido attwateri*), red wolf (*Canis lupus rufu*), Eskimo Curlew (*Numenius borealis*), and West Indian Manatee (*Trichechus manatus*). These species have been extirpated within the region.

## 3.3 *Human Environment*

According to 2010 US Census, the population of Jefferson County was estimated to be 252,273. The largest population centers in Jefferson County are Beaumont and Port Arthur with populations of 118,296 and 53,818 respectively.

The major employment industries in the county include manufacturing, construction, services, trade, and government. The major employers in Port Arthur include the correctional facilities, school district, St. Mary Hospital, Tenet Mid-Jefferson/Park Place (medical service), and various petrochemical manufacturing and petroleum refining companies.

The 2010 estimated median household income for Jefferson County was $42,883.

### *Cultural Resources:*

A background review, conducted by Southeastern Archeological Research, Inc (SEARCH), identified one archaeological site within 1 mile of the project area (*Appendix E*). The McFaddin Beach Site is a Paleoindian site, submerged off the coast of the McFaddin NWR. Numerous Paleoindian artifacts and fossil remains of Pleistocene animals have been found along the beach in this area, though archeological interpretations indicate that the artifacts identified along the beach are in a secondary context, and the Paleoindian site is located below the current shoreline.

### *Socioeconomic Resources*

The project site is located approximately 13 miles from the city of Sabine Pass, Texas with a population of 2,214 in July 2007. Several other small towns are also within 30-90 miles away, and the Beaumont Metro Area is approximately 29 miles north and slightly east of McFaddin NWR. Predominate land uses in the vicinity of McFaddin NWR are grazing, residential areas, and some oil and gas development. The Port Arthur Chamber of Commerce lists McFaddin NWR as one of the area's main attractions. McFaddin NWR is open for hunting, fishing, wildlife observation and photography, and other wildlife dependent recreation. McFaddin NWR also plays a role in the local economy as refuge employees typically live in the surrounding communities, own property, and support local businesses through routine purchases.

### *Public Use and Recreation*

All six priority wildlife dependent recreational uses of the National Wildlife Refuge System are offered on the McFaddin NWR. These include hunting, fishing, wildlife observation, photography, environmental education and interpretation. McFaddin NWR typically sees over 80,000 visitors a year,

including an annual event, Marsh Madness, which accommodates over 250 visitors, and an annual field trip made by Hamshire-Fannett Elementary School, typically about 250 elementary school students. Hunting programs offered on McFaddin NWR are for waterfowl, and McFaddin NWR typically has about 4,500 individual hunter-visits per year. Fishing is also offered on McFaddin NWR, including surf fishing and fishing in other designated areas and fishing piers. Fishing typically accounts for about 27,750 of the 80,000 visits to the refuge. McFaddin NWR has about 15 miles of paved roadways for visitors to use when enjoying wildlife observation, along with an observation deck. There are approximately 100 wildlife observation visits during a single year. McFaddin NWR is also used as a destination for beach access and kayak participation. McFaddin NWR visitors contribute to local and regional economies through tourism-related purchases and expenditures, and nature tourism is an important and growing industry in the region and in Texas as a whole.

**Hunting**

Waterfowl hunting has been a tradition along the upper Texas coast for generations. Prior to the establishment of McFaddin NWR, the area was hunted through private ownership or lease. Currently, waterfowl hunting is offered on McFaddin NWR, ranging from free, first-come, first-serve programs to a more formal fee permit reservation system. Different hunt units are open on different days of the week to provide hunting opportunities throughout the week, as well as periods of rest for waterfowl. Approximately 40% of McFaddin NWR is typically open for waterfowl hunting, the maximum allowable on lands acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 715d.).

**Fishing**

Saltwater fishing opportunities are available on McFaddin NWR. Saltwater fishing opportunities are found along 19 miles of beach along the Gulf of Mexico, in 10 Mile Cut and 5 Mile Cut of Salt Bayou, in Star Lake, Clam Lake, Willow Lake, Barnett Lake, and on the GIWW. This is the largest user group of McFaddin NWR.

**Wildlife Observation and Photography**

Wildlife inhabiting the coastal marshes, prairies and woodlands on McFaddin NWR are abundant and diverse. Dozens of migratory bird species utilize habitat on the refuges to feed, rest, and nest. Over 27 species of waterfowl can be found throughout the winter months, and flocks of snow geese in excess of 100,000 can sometimes be seen. Spring and fall are prime time for migrating shorebirds and songbirds. Migrating shorebirds primarily utilize beach areas and mudflats on McFaddin NWR. Small and colorful neotropical songbirds can be found in the small woodlands or riparian corridors located primarily on Highway 87 of McFaddin NWR. Of special interest to the birding community are the secretive rails that occupy refuge marshes. All six species of North American rails can be found within McFaddin NWR at some time during the year. In addition, resident waterbirds are visible in wetland habitats throughout the year.

**Environmental Education and Interpretation**

McFaddin NWR staff provides interpretive tours and programs to interested schools and organizations upon request. Special events are held on McFaddin NWR throughout the year to promote awareness and understanding of the important natural resources found along the upper Texas coast.

# *4.0 ENVIRONMENTAL CONSEQUENCES*

This chapter analyzes and discusses the potential environmental effects or consequences that can reasonably be expected by the implementation of the *Preferred Alternative* described in Chapter 2.0 of this EA. An analysis of the effects of management actions has been conducted on the physical environment (air quality, soils and water quality); biological environment (vegetative habitats, wildlife habitats, and T&E species); and socioeconomic environment (cultural resources, socioeconomic background and public use and recreational uses).

The direct, indirect, and cumulative impacts of the *Preferred Alternative* is considered. Direct impacts are the impacts that would be caused by the alternative at the same time and place as the action. Indirect impacts are impacts that occur later in time or distance from the triggering action. Cumulative impacts are incremental impacts resulting from other past, present, and reasonably foreseeable future actions, including those taken by Federal and non-Federal agencies, as well as undertaken by private individuals. Cumulative impacts may result from singularly minor but collectively significant actions taking place over a period of time.

## 4.1 *Physical Environment*

### *Impacts on Air Quality*

**Alternative A-No Action Alternative**

Without the *Preferred Alternative*, the function of the wetlands in the McFaddin NWR system would be drastically diminished and therefore the total volume of carbon sequestration that occurs within the Salt Bayou system would be drastically diminished.

**Alternative B-Preferred Alternative**

The *Preferred Alternative* may result in some short-term negative impacts as a result of the use of heavy equipment and large trucks to dig and move earthen materials. Temporary impacts to air quality from dust and emissions produced by heavy equipment would be minimal and would be undetectable after project implementation. Additional $CO_2$ and other green house gases produced would be offset by the protection of the coastal marsh ecosystem that serves as a carbon reservoir by sequestration of carbon in the marsh grass root zone. By increasing the health and function of the wetlands within the McFaddin NWR, it is expected that the net volume of carbon sequestration that would occur within the wetlands would far offset the temporary impacts to air quality produced to create the project.

### *Impacts on Soils*

**Alternative A-No Action Alternative**

The *No Action Alternative* would ultimately result in impacts to soils. Soils within the McFaddin NWR would experience slow increases in soil salinities over time. Vegetative cover would disappear and surface organic soils would begin to erode away and flow into the Sabine Neches Waterway. Increased issues with soil redox potential would occur as the sulfates within the water react with organic soils. Redox potential involves releasing oxygen and gaining hydrogen, or gaining an electron. Redox potential is a diagnostic tool used for determining whether an area is functioning well as a wetland. This can be measured within the soil by determining the availability of hydrogen ions in the soil. The reaction with the soils causes the production of hydrogen sulfide which is harmful to plant life. The added stress leads to more rapid die off of the vegetative habitats. Once surface vegetation dies, the organic soils erode at a faster rate, leading to further conversion of vegetated marsh to open water.

**Alternative B-Preferred Alternative**

The *Preferred Alternative* would result in short term adverse impacts due to the covering of existing soils with approximately 63 acres of borrowed earthen material for the berm and by excavation of approximately 89 acres of material from the borrow areas. Erosion rates in the immediate construction area are likely to increase slightly due to the removal of vegetation in the short term. Best management practices (BMPs) would be utilized by contractors to minimize soil loss. Long term soil benefits would consist of lowering salinities as sea water intrusion is decreased and the reduction of redox levels within the organic soils. Issues with hydrogen sulfide production within the marsh would be minimized which would benefit vegetative habitats. Both of these impacts would have positive effects to the vegetative habitats within McFaddin NWR. As vegetative habitats recover, organic soils would be increased by the accumulation of above ground biomass as well as the production of subterranean biomass. Open water habitat would slowly be converted back to vegetated marsh by natural ecological processes.

### *Impacts on Water Quality and Wetlands*

**Alternative A-No Action Alternative**

No short-term impacts to the water quality or quantity are expected beyond what is already occurring. Impacts to water quality or quantity are expected from the *No Action Alternative* on a long term basis. The filtration ability of the McFaddin NWR system to absorb natural and agriculture based nutrient run off from the Gulf of Mexico and Sabine-Neches River System will be impacted as the wetlands ability to function decreases.

Water quality impacts would be due to increased salinities, decreased dissolved oxygen, increased nutrient loading, increased turbidity, increased sulfide levels, increased water temperatures, and increased water depths. Fluctuations in salinities can cause die-offs of entire communities of species, including: submerged vegetative plants, beneficial bacterial colonies, and invertebrate/vertebrate level organisms. These die-offs, which can cause oxygen depletions, directly impact water quality.

Increased salinity levels are stressful to species in the vegetative, bacterial, invertebrate, and vertebrate communities. Increased salinity levels from sea water bring in naturally occurring sulfates which are converted in wetlands with organic substrates to sulfides which are toxic to a host of different species. As currents move the water, the area of impact may increase in severe cases. Nearly half of the acreage on the western portion of McFaddin NWR has experienced this condition.

Nutrient loading will increase due to the additional death of plant communities as well as by the decreased viability of the plant species, reducing the nutrient uptake. This can cause eutrophication to occur, which can cause increases in algal blooms across the marsh which leads to less production of submerged aquatic vegetation allowing more nutrients into the Sabine Neches Waterway and the Gulf of Mexico.

**Alternative B-Preferred Alternative**

The *Preferred Alternative* may result in some short-term negative impacts due to the disturbance of soils and the subsequent potential for suspension of sediments in water during rainfall events. However, due to the existence of acres of heavily vegetated marsh surrounding the project area, suspended sediments will be filtered from the water before there is any chance that the sediments would reach any adjacent water body. Long-term positive impacts are expected due to reduced salinities within the protected marsh as well as within the entire watershed. The fluctuation of salinity levels would decrease and historical isohaline divisions would occur.

Additional positive impacts would occur by the reduction of naturally suspended sulfates within the sea water being introduced into ecosystem. Decreased salt water inflows would reduce the sulfates entering the marsh and decrease the capability of the marsh to produce harmful sulfides. With reduced fluctuations in salinity levels and sulfides, the water quality will improve and have fewer issues from decreased dissolved oxygen levels. Higher dissolved oxygen with less erratic swings would decrease the amount of situations where low dissolved oxygen kills invertebrates and vertebrates.

Nutrient loading would be decreased as the healthy marshes are better suited for removing nitrates, phosphates, and phosphorus from the water than unhealthy marshes. With lower nutrient loads, fewer issues with widespread algae growth would occur. Algae growth prevents McFaddin NWR from reaching management goals by depressing the production of plants on which waterfowl forage. With lower nutrient loads, the total volume of nutrients entering the Sabine Neches Waterway and the Gulf of Mexico would decrease.

## 4.2 *Biological Environment*

### *Impacts on Vegetative Habitats*

**Alternative A-No Action Alternative**

No increase of short term impacts to vegetative habitats would be expected with the *No Action Alternative*. However, this alternative would have long term negative impacts on biological resources of McFaddin NWR. As overwash occurs, salinities will increase with the continual inflow of salt water. As

salinities increase, issues with increased sulfides and redox potential will cause regular degradation of marsh vegetation. These increased salinities will cause emergent marsh vegetation to die and make soils more susceptible to erosion further degrading emergent marsh within the area. The increases redox potential will depress plant productivity which reduces vegetation above and below ground.

Fresh and intermediate wetlands will be rapidly converted to brackish wetland habitat with the corresponding loss of associated plant and animal species because of the lack of salinity tolerance. Emergent marsh will continue to be converted to open water with conversion rates accelerating as more time passes. This is primarily because vegetative species with high salt tolerance are not naturally present within the system, and the most salt tolerant species are currently reaching the highest survivability extremes. This lack of species to replace the more fresh tolerant species causes further issues with wave generated erosion. The end result is large expanses of shallow muddy open water that provides habitat for very few species, including estuarine dependent fishes.

Much of the salt prairie and high marsh is losing fresh to intermediate marsh species diversity and being replaced with plant communities associated with vegetated salt flats. The aquatic plant community, specifically the submerged aquatic vegetation and floating aquatic vegetation, will not be able to tolerate the higher salinities. Within a few short years, all floating aquatic vegetation will be lost due to salinity increases across the marsh, and diversity of submerged aquatic vegetation may be reduced to very few species. This loss is already apparent in eastern portions of McFaddin NWR.

**Alternative B-Preferred Alternative**

In the short term, the *Preferred Alternative* would result in impacts to approximately 152 acres of vegetation due to the impact of the proposed berm and the excavation of the borrowed earthen material for the proposed berm. In addition, erosion rates in the immediate construction area are likely to increase slightly due to the temporary removal of vegetation. Construction is estimated to take approximately six to eight months. BMPs would be utilized by construction contractors to minimize any loss of soils due to erosion issues.

The 152 acres consist of high marsh habitat that is gradually degrading. The *Preferred Alternative* would convert 89 acres to shallow open water and estuarine emergent wetlands to provide an enhanced aquatic resource for McFaddin NWR. There will be a reduction of salts and sulfides currently within the system as well as decreases in the redox potential. The decreases in salinities will invigorate the plant community as well as increase colonization of new emergent marsh vegetation. This will not only facilitate the production of new organic soils, but also the deposition of above ground biomass and cause increases in subterranean biomass from root production.

Species diversity with the emergent marsh community north of the berm will increase as the reappearance of many vegetative species with lower salinity tolerance will occur. This will create more of a mosaic of habitats available for all species within the McFaddin NWR. As species diversity increases, a corresponding increase in production of food availability will occur across the ecosystem, from the microbial community to the vertebrate community.

The invaluable characteristic of the wetland to filter nutrients will increase and the system's capacity to perform carbon sequestration and storage will return. Water temperatures will decrease, allowing suspended oxygen levels to remain high, and overall water quality will improve.

The aquatic plant community, specifically the submerged aquatic vegetation and floating aquatic vegetation, will greatly improve under this alternative. Within a few short years, the species of floating aquatic vegetation lost due to salinity increases across the marsh will naturally reestablish, and the diversity of submerged aquatic vegetation will return.

### *Impacts on Wildlife*

**Alternative A-No Action Alternative**

If the *No Action Alternative* was chosen, the existing habitat conditions would be maintained. There would be no change in diversity or abundance of wildlife that use the area in the short-term, however, long-term declines in diversity and abundance of wildlife would occur.

***Wintering and Resident Waterfowl***

If the *No Action Alternative* was chosen, wintering populations of dabbling ducks (*Anatidae sp.*) would experience a probable short-term increase in numbers as open water habitat increases. However, as plant diversity decreases, food availability will experience a corresponding decrease and dabbling duck numbers will eventually decline. Diving duck species would decline rapidly as primary forage plant species are lost due to salt water intrusion. The Snow geese (*Chen caerulescens*) numbers would decline as prime forage species disappear due to increased salinities. Other species of geese would disappear first among the waterfowl as these birds seek more suitable habitat. Non-migratory mottled duck numbers would quickly drop as productivity decreases due to the lack of survival among broods because of increased salinities.

***Shorebirds, Wading Birds, Marsh, and Waterbirds***

If the *No Action Alternative* was chosen, marshes on McFaddin NWR that provide shallow water feeding, breeding, and resting habitat for numerous shorebirds, wading birds, and other marsh and waterbirds would be converted to non-suitable habitat as organic soils erode from the system leaving water depths too deep for birds to utilize. Birds that utilize the beaches would not be greatly impacted.

Nesting wading, marsh, and waterbird species, including least bittern (*Ixobrychus exilis*), purple gallinule (*Porphyrula martinica*) common moorhen (*Gallinule Chloropus*), pied-billed grebe (*Podilymbus podiceps*), and American Bitterns (*Botaurus lentiginosus*), would all decrease as preferred salinity ranges for nesting and brood survival are surpassed. King rail's (*Rallus elegans*) nesting attempts would also drastically halt as salinity ranges increase.

***Migratory and Resident Landbirds***

If the *No Action Alternative* was chosen, many of passerines would experience minimal impacts due to the use of wooded areas that would not be impacted. Migrant passerines that use McFaddin NWR

include many species of warblers, vireos, tanagers, thrushes, and buntings. Some birds arriving on the northern migration against north winds are too tired to make wooded habitats to the north. These birds frequently utilize cane patches and other "fall out areas" for foraging and shelter as they rebuild strength from crossing the Gulf. Impacts to the overall population to any single species would be minimal. Songbird species nesting on McFaddin NWR would likely experience minimal impacts.

Raptor species utilizing McFaddin NWR would not experience overall population impacts across the species range, but barn owls would experience a loss of nesting habitat. Osprey would gain additional foraging habitat as the marsh is converted to open water, however, data indicates these habitats would produce and support much lower productivity of osprey's primary forage species.

***Fisheries Resources***

If the *No Action Alternative* was chosen, coastal fisheries would experience an increase in production as more areas are converted from emergent marsh to open water communities. However, this increase will suddenly decrease as the patchwork of grass clumps gives way to larger expanses of open water. Open water habitats have been shown to hold significantly less estuarine species than areas with islands of grass or other habitats that increase the ratio of shoreline per acre of habitat. Large expanses of shallow water habitat have been shown to contain the lowest densities of estuarine fisheries of any coastal habitat containing open water.

Fresh water fisheries species utilizing these coastal marshes would be lost within McFaddin NWR.

***Mammals***

Of the mammals on McFaddin NWR, only the river otter would experience any type of positive impact under this alternative. As open water habitat increases, the increase in forage areas and fisheries species would provide a possible short-term net benefit. However, as open water areas increase, this benefit would be lost and habitat for resting and escape would disappear. These impacts together would cause a long-term population decrease. All other mammals in the marsh such as raccoons, rice rats, and muskrats are currently being impacted by the salt water intrusion and will continue to be negatively impacted by the loss of vegetative cover, productivity, and forage base under this alternative.

***Reptiles, Amphibians, and Invertebrates***

If the *No Action Alternative* was chosen, as salinities levels increase all species of amphibians will disappear from McFaddin NWR. This has already occurred within parts of the system due to salinity increases. Under this alternative, all reptiles in the project area will experience long-term population decreases due to increased salinities.

The overall impact to invertebrate populations due to changes in salinity is largely unknown. Many species of invertebrates such as various amphipods, midges, mysid shrimp, grass shrimp, and crayfish, will experience population decreases. The overall impact to those large scale populations would be unknown, but locally, these species would likely disappear from McFaddin NWR. Numerous crabs are present within all marsh habitats in the project area and it is likely that most of these would experience

an increase in population. With blue crabs, the increase would be temporary and disappear as conversion of emergent marsh to open water continues. Impacts to the insect community are largely unknown, however impacts are likely to decrease terrestrial as well as wetland dependent species, due to a lack of desired habitats.

If the *No Action Alternative* was chosen, the native rangia clams would likely continue to experience population decreases as increases in salinities reduced reproduction potential. Common periwinkle populations would probably benefit in a positive manner as more available habitat became available. Native rangia clams (*Rangia cuneata*) historically occurred across the entire Salt Bayou system and thrive in salinity ranges between 3 to 10 ppt. Periwinkle snails (*Littoraria irrorata*) and Fiddler crabs (*Uca sp.*) would likely not experience drastic reductions in habitat. Periwinkle snails are typically found in salt marshes and in brackish marshes with the higher salinity levels where smooth cordgrass (*Spartina alternaflora*) has become established. Fiddler crabs are found near the high tide line across much of the project area.

**Alternative B-Preferred Alternative**

***Wintering and Resident Waterfowl***

The implementation of the *Preferred Alternative* would convert approximately 89 acres of emergent wetlands to shallow open water habitat. However, the *Preferred Alternative* would not significantly affect the current ratio of emergent marsh to open water throughout the entire Refuge. Slow increases in emergent marsh habitat are expected. Due to decreased salinities, overall productivity of marsh vegetation would increase, which will provide more forage for wintering waterfowl. With increases in species diversity a corresponding increase in diversity of the types of forage would occur as well. Dabbling ducks would have increased availability to plant tubers and seeds. Diving ducks would have increased availability to prime forage for diving waterfowl, such as sago pondweed (*Potamogeton pectinatus*), banana waterlily (*Nyphaea mexicana*), and perhaps water shield (*Brasenia*). Snow geese numbers would likely be maintained at or near current levels. Some increases in both white-fronted geese and white-cheeked geese would likely occur as suitable habitat increased.

The local population of mottled ducks would likely increase as more suitable habitat occur at low salinity levels. This will increase the probability of brood survival across McFaddin NWR rather than just portions of it, as is the current situation.

***Shorebirds, Wading Birds, Marsh, and Waterbirds***

The *Preferred Alternative* would cause little change for a majority of the species of shorebirds. The species that use the tidal flats and beaches would have no negative or positive impacts occurring from this alternative. The species utilizing the marshes on McFaddin NWR for shallow water feeding, breeding, and resting habitat would benefit by the long-term protection of these habitats. For several of the larger long billed species like willet, whimbrel, godwits, and long-billed curlews, this alternative would create highly preferred habitat for foraging on fiddler crabs. Wading and marsh birds would

benefit from the creation of shallow fresh water habitat providing increased foraging areas, with increases in nesting rails and bitterns very likely as well as pied-billed grebe and common moorhens.

***Migratory and Resident Landbirds***

If the *Preferred Alternative* was implemented, some passerines would benefit by the protection of patches of cane that provide shelter and foraging potential when the wooded areas to the north cannot be reached. Songbird species nesting on McFaddin NWR would not benefit either positively or negatively from this alternative.

If the *Preferred Alternative* was implemented, nesting birds would not be impacted in either positively or negatively by this alternative. Seaside sparrows might have some habitat currently being lost due to decreases in salinities and corresponding changes in the plant communities.

If the *Preferred Alternative* was implemented, raptors commonly observed on McFaddin NWR would benefit in a positive manner as the habitat conditions stabilize, and forage species would not disappear due to habitat loss. Northern Harriers would experience long term prey base increases as marsh rodent populations increase with the fresher marsh conditions.

***Fisheries Resources***

The implementation of the *Preferred Alternative* would not immediately affect estuarine fisheries but a gradual increase in habitat would be expected. Impacts from salinity fluctuations and other water quality issues would be reduced greatly and the system would experience fewer periods of low dissolved oxygen. The *Preferred Alternative* would reestablish the natural isohaline gradients that are present in estuarine ecosystem and benefit all species that utilize the coastal marsh as nurseries. This portion of McFaddin NWR would remain highly productive and continue to serve as the one of the last functioning estuarine nurseries for the Texas side of the Sabine Lake ecosystem.

Fresh water fisheries species utilizing these coastal marshes would have positive impacts due to this alternative. As salinity fluctuations are stabilized and salinity ranges decrease, these species would likely become reestablished across the entire western portion of Salt Bayou impacted by this alternative.

***Mammals***

If the *Preferred Alternative* were chosen, all species of mammals would benefit by the long term protection of the habitat and the increase in primary plant production that would occur.

***Reptiles, Amphibians, and Invertebrates***

If the *Preferred Alternative* were chosen, the diversity of plants and amphibians would have the greatest known benefits. As salinities decrease and water quality stabilizes, all amphibian populations should stabilize and expand across the areas of McFaddin NWR from which they currently have disappeared.

All known reptiles in the project area and on McFaddin NWR would benefit from this alternative as salinities decrease and water quality stabilizes.

Invertebrate populations would stabilize and become reestablished in areas where salinity and water quality have made survival currently unfeasible. Crayfish and fiddler crabs would both benefit in a positive manner. Crayfish would have increases in habitat available to recolonize and would benefit from the fresh water borrow areas. Fiddler crabs numbers would also increase dramatically with the creation of borrow areas.

Native rangia clams (*Rangia cuneata*) historically occurred in McFaddin NWR and thrive in salinity ranges between 3 to 10 ppt. However, populations have been decimated by salt water intrusion in most of the system east of Clam Lake as regular salinities increased well above the survival threshold of rangia clams. Periwinkle snails (Littoraria irrorata) are found in the salt marshes and in the brackish marsh with the higher salinity levels where smooth cordgrass (*Spartina alternaflora*) has become established. Fiddler crabs (*Uca sp*.) are found near the high tide line across much of the project area.

### *Impacts on Threatened and Endangered Species and Special Status Species*

**Alternative A-No Action Alternative**

If the *No Action Alternative* were chosen, the American alligator (*Alligator mississippiensis*) would be impacted. American alligator can only thrive in high salinities for a short time. As conversion of emergent marsh to open water continues, alligators would either move to more suitable habitat or die off.

**Alternative B-Preferred Alternative**

If the Preferred Alternative were chosen, the increase in suitable habitat due to decreases in salinity and increases in water quality would benefit the American alligator.

The nearest designated Critical Habitat for the piping plovers is located on Bolivar Peninsula, north of Rollover Pass. Piping plovers are normally only observed in small numbers wintering on the beaches of McFaddin NWR, as well as during spring and fall migration. There have been no records to date of nesting piping plovers on the Refuge Complex.

## 4.3 *Human Environment*

### *Impacts on Cultural Resources*

**Alternative A-No Action Alternative**

If the *No Action Alternative* were chosen, no impacts to cultural resources are expected. The single archeological site noted by SEARCH lies below the existing shoreline and seaward of the project area.

**Alternative B-Preferred Alternative**

If the *Preferred Alternative* were chosen, no impacts to cultural resources are expected. The single, historical archeological site noted by SEARCH lies below the existing shoreline and seaward of the project area (*Appendix E*). In addition, a pedestrian archeological survey of the project area identified no cultural resources, either on the surface or within any of the 312 shovel tests completed.

### *Impacts on Socioeconomics*

**Alternative A-No Action Alternative**

In the long-term, socioeconomic conditions would ultimately be affected under the *No Action Alternative* due to the loss of potential revenue from the surrounding community if duck hunting diminished due to loss of associated habitat. Losses due to impacts to the fisheries community would impact both the recreational and commercial fishing sectors of the environment. According to McFaddin NWR staff, the estimated revenue generated by the average hunter is approximately $1,984.00 annually and approximately $1,280.00 annually per fisherman. With an annual visitation rate of 4,500 hunters and over 27,000 fishermen, a large portion of McFaddin NWR revenue would be lost under this alternative.

Impacts due to the loss of cattle grazing within McFaddin NWR due to salinity increases and conversion of emergent marsh to open water habitat would occur as well.

**Alternative B-Preferred Alternative**

If the *Preferred Alternative* were chosen, the economic and social condition of the area would remain relatively the same; however there would be short-term positive benefits to the local economy during the construction phase of the project, since labor and materials would be utilized locally, as much as possible. The construction labor force would need temporary housing and meals in the nearby towns of Sabine Pass and Port Arthur.

### *Impacts on Public Use and Recreation*

**Alternative A-No Action Alternative**

Implementation of the *No Action Alternative* would cause long-term negative impacts to wildlife recreational programs on McFaddin NWR. The conversion of habitat and the affect on the wildlife species diversity would ultimately decrease the quality of the wildlife dependent recreation. Waterfowl hunting would ultimately decline as the coastal marsh fragments convert to open water habitat and submerged aquatic vegetation disappears.

Fishing on the refuge would likely experience short term positive impacts as additional habitat (open water) is created, but would collapse as open water habitat become more common. This open water habitat is the least used of any of the coastal fisheries habitat present on the Gulf Coast. Wildlife observation and photography would likely experience short term positive impacts as additional habitat (open water) is created adjacent to McFaddin NWR roads, however, long term impacts would be negative as habitat is converted to open water.

**Alternative B-Preferred Alternative**

If the *Preferred Alternative* was chosen, both fauna and flora within McFaddin NWR would benefit in a positive manner. Waterfowl hunting would experience long term positive impacts as the salinities decrease in the coastal marsh and submerged aquatic vegetation is reestablished. Fishing on the refuge

would experience positive impacts as salinity fluctuations stabilize and more historical isohaline lines are established across the coastal marsh. Wildlife observation and photography would likely experience slight positive impacts as salinities stabilize across the marsh and wildlife reestablishes itself across the coastal marsh.

## 4.4 *Environmental Justice*

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations; February 11, 1994) was designed to focus the attention of Federal Agencies on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The order directed Federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. The order is intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority and low income communities with access to public information and opportunities for participation in matters related to human health and the environment.

Neither of the alternatives described in this EA will disproportionately place any adverse environmental, economic, social, or health impacts on minority and low income populations. Implementation of the proposed action is anticipated to benefit the environment and people in the surrounding communities.

## 4.5 *Indian Trust Assets*

No Indian Trust Assets have been identified in McFaddin NWR. There are no reservations or ceded lands present. Therefore, no impacts are anticipated to result from implementation of either alternative described in the EA.

## 4.6 *Farmland Protection Act*

The Farmland Protection Policy Act (FPPA) of 1981, P.L. 97-98 and amendments 9 USC 4201(b), authorizes the National Resources Conservation Service (NRCS) to develop criteria for identifying the effects of Federal programs on the conversion of farmland to non-agricultural uses. Projects considered exempt under the FPPA include those that require no additional right of way (ROW) or require ROW that is developed, urbanized, or zoned for urban use.

No additional ROW is required for the *Preferred Alternative*; therefore it is exempt from the requirements of the FPPA and would not require coordination with the NRCS.

## 4.7 *Irreversible and Irretrievable Commitment of Resources*

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that this use could have on future generations. Irreversible effects primarily result from the use or destruction of specific resources that cannot be replaced within a reasonable time frame, such as energy or minerals. Irretrievable resource commitments involve the loss in value of an affected

resource that cannot be restored as a result of the action, such as extinction of a threatened or endangered species or the disturbance of a cultural resource.

Neither of the alternatives would result in a large commitment of nonrenewable resources. The *Preferred Alternative* would require the irretrievable commitment of fossil fuels (diesel and gasoline), oils, and lubricants used by heavy equipment and vehicles. The *Preferred Alternative* may result in unavoidable harm or harassment to some wildlife, however, the USFWS would implement BMPs to minimize potential impacts.

## 4.8 *Assessment of Cumulative Impacts*

A cumulative impact is defined as an impact on the environment that results from the incremental impact of the *Preferred Alternative* when added to other past, present, and reasonably foreseeable future action regardless of what agency (Federal or nonFederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

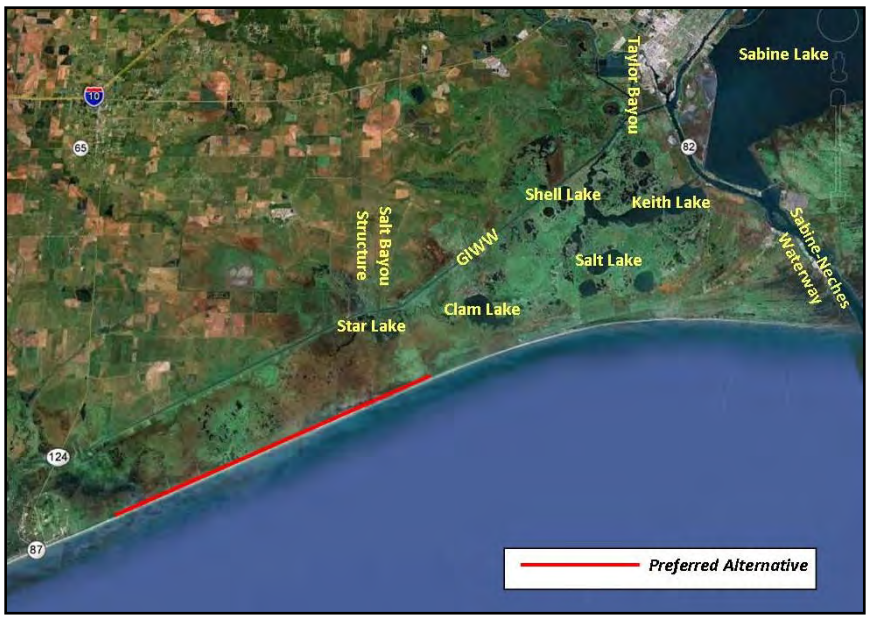
Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can accumulate spatially, when different actions affect different areas of the same resource. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially cancelling out each other's effects on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource.

The planned location lies within the East Galveston Bay and Sabine Lake Watersheds, which span USFWS, State of Texas, and private land ownerships. There are many various navigation, drainage, and restoration past and present actions that have altered hydrology within the impact area and the proposed hydrological action within the project area. Navigation, drainage, and restoration past and present actions, when combined with the proposed hydrological action, may have cumulative impacts on the human environment. Brief descriptions of these projects are presented below:

### *Past Changes in the Natural Drainage System*

Numerous hydrological based projects have been completed within this portion of the Salt Bayou System in an effort to restore former hydrological conditions by either restricting salt water intrusion or in an effort to mimic historical saline regimes. Hydrological alterations have occurred within the project area in the past, both before and after these lands were acquired for the McFaddin NWR.

The following is a list of known hydrological alterations (TPWD/USFWS 1990). The map below depicts some of the altered lakes and waterways that are described.




**Construction of the Railroad from Beaumont to Sabine Pass**

In 1863, a railroad was completed from Beaumont to Sabine Pass. The railroad was built across the marsh on an elevated dirt embankment. The rail line lay between Sabine Lake and Little Keith Lake and presently, portions of the elevated rail bed are still visible and show on aerial photography. According to testimony at a Federal Land Office hearing in Port Arthur, a major rainfall event caused severe flooding in the Sabine Lake Watershed. Complaints were aired that the railroad embankment was curtailing sheet flooding from the marsh into Sabine Lake, so the railroad company dug a ditch under the railroad into Sabine Lake. This railroad and subsequent ditch marked the first major human alteration of the historic drainage pattern.

**Construction of Sabine-Neches Waterway**

Shallow draft sailing vessels were able to enter Sabine Pass from the Gulf and negotiate the narrow channel up to a point just below the main body of Sabine Lake. Barges and smaller vessels were able to negotiate the 6 foot depths of Sabine Lake. In the late 1800's, a group of real estate speculators headed by entrepreneur, Arthur Stillwell, purchased land which comprises much of present day Port Arthur and began constructing a ship channel from the new town site of Port Arthur to Sabine Pass. The 50-foot wide by five foot deep channel was completed shortly before 1900. Further expansions occurred regularly from that time on until the current depth was reached in the 1960s. The present depth of the Sabine-Neches Waterway is 42 feet by 500 feet wide.

**Opening of Little Keith Lake into Ship Channel**

The ship channel was constructed immediately east of the railroad and, like the railroad, traversed between the west shoreline of Sabine Lake and Little Keith Lake. The newly dug channel allowed salt water to penetrate marshes between the Salt Bayou System and Sabine Lake and allowed salt water to

enter Little Keith Lake because the new channel crossed the ditch dug earlier by the railroad to reduce freshwater flooding potential west of the railroad.

**Construction of Gulf Intra-coastal Waterway**

The GIWW segment that passed through southeast Texas was completed in 1933 and utilized a portion of the existing Port Arthur Ship Channel. This reduced costs and provided additional navigation benefits for the Port of Port Arthur. The GIWW crossed and obliterated several miles of Salt Bayou immediately north of Shell Lake as well as severing Salt Bayou immediately north of Star Lake. Shortly thereafter, the lower portion of Taylor Bayou was re-routed to join the GIWW. The construction dimensions at the GIWW were 120 feet wide and 12 feet deep. The current dimensions are now 500 to 700 feet wide and it is dredged 12 to 14 feet deep to maintain target depth for a longer period.

During the original dredging of the GIWW, hydraulic dredge effluent pipes were placed on both sides of the canal and mounds of dredged material piled up. Heavier clay lumps settled near the end of the pipe and the lighter materials traveled farther before they settled in the marsh. The initial construction, and later maintenance dredging, resulted in a well defined embankment on both sides of the GIWW, which kept saline water in the canal from mixing with water in the adjacent marsh.

**Water Control Structures at Star Lake, Salt Bayou, and Little Keith Lake**

The GIWW Project included the construction of large concrete water control structures on both sides of the canal at Star Lake, at the outfall of Salt Bayou, and at the Little Keith Lake Cut. The control structures were built to allow private landowners to control water levels in the marsh.

**Deterioration of Structures**

The local sponsor of the GIWW segment that ran through Jefferson County was the Jefferson County Commissioners Court which handled the majority of county activities at that time. When time and the erosive action of salt water began to damage the water control structures, the Commissioner's court chose not to fund needed repair, and landowners could not handle the sizeable repair costs so the structures fell into a poor state of repair and eventually became completely inoperative. Without maintenance, erosion eventually swept around the ends. Errant barges also sideswiped the structures, damaging them beyond repair. Shoreline erosion has left the structures standing in the GIWW, well away from the current shoreline position.

**Closure of Little Keith Lake**

In 1962, two major hunt clubs controlled hunting and fishing access to the entire Salt Bayou drainage system and adjoining marshes south of the GIWW. A group of fisherman challenged the authority of the hunting clubs to exclude fisherman. Their contention was based on the premise that Salt Bayou waters were navigable and therefore property of the State and open to the general public. In 1966, the USACE built a levee around Little Keith Lake and filled the lake bed with dredge spoil from the adjacent ship channel. In addition to eliminating the passage of saline water from the ship channel into the Salt Bayou

drainage, it was commonly viewed that any potential for boat access into Keith Lake and the other lakes was forever sealed. The public use proponents eventually disbanded and the open conflict faded.

**Reopening of Little Keith Lake Cut**

In 1972, the Parks Division of the TPWD purchased a 16,000-acre tract of land from Planet Oil and Mineral Company that had earlier purchased the entire McFaddin Ranch. The tract included limited beach frontage. The majority of the land was marsh. Immediately after purchase, the marsh was opened to the public for hunting and fishing. Shortly thereafter, interest developed in opening a cut through the former Little Keith Lake Cut into the ship channel for improved water circulation into the Salt Bayou drainage system. Field level biological recommendations called for using a dragline to open a narrow, shallow and meandering cut from the ship channel into Keith Lake and then to let hydraulic pressures open the cut to the depth and width necessary to handle water movement. The end result was a hydraulically dredged 3,600-foot straight line channel, 155 feet wide and 5.5 feet deep. The project was completed in September 1977. Accelerated volumes of water began moving through the Salt Bayou drainage system from the adjacent 45-foot deep ship channel. Salinity levels reached a continuous, all-time high after the construction project and daily saltwater tides began to push deeper into the marsh. The tidal surge supplied by the adjacent Port Arthur Ship Channel has caused continuous scouring of the pass so that tidal influence continues to impact the marsh system. The current channel size is over 250 feet wide and more than 12 feet deep.

**Construction of Salt Bayou Structure**

In 1990, the USACE constructed a Water Control Structure on Salt Bayou and the GIWW. It was designed to release excess water after heavy rainfall or flooding events. The structural design also allows for the potential inflows of fresh water from the GIWW when river flows from the Sabine and Neches Rivers move water westward through the GIWW.

### *Summary of Cumulative Impacts*

**Water Quality**

Since 2005, three hurricanes have struck the refuge, including two hurricanes of significant size. Hurricane Rita was a category three hurricane when it struck on September 24, 2005, just 35 miles to the east of McFaddin NWR and pushed more than three feet of salt water over the proposed project area. Hurricane Humberto was a category one hurricane that struck on September 13, 2007, with the eye passing directly over McFaddin NWR and pushed more than two feet of water over the proposed project area. Hurricane Ike was a category two hurricane that also struck on September 13, 2008, about 33 miles west of the proposed project site and flooded the area with more than fifteen feet of storm surge. The area also was impacted by winds from Tropical Storm Gustav in 2008. These events pushed storm created waves against the shoreline which altered the beach shoreline along this portion of the Gulf of Mexico. The historical beach dune has been destroyed along more than 30 miles of the Texas Chenier Plain Refuge Complex and, due to changes in the natural waterways by dredging and jetties, there are no longer any sediments moving into the system. Erosion has washed away the back dune,

across the historical marsh ridge that was present, and into the high marsh to the north. Erosion rates now have a 3 year average of more than 15 to 45 feet yearly. As erosion has continued, the trends in similar areas to the east and west have experienced a rapid increase of erosion rates with average rates reaching more than 70 feet yearly. The current situation has left the marsh ridge with an elevation of between 3.6 to less than 6 feet MSL. Currently, at times when winds from the south reach 20 miles per hour (mph) or more along more than 15 miles of coast line, this low elevation allows significant water to wash across the ridge into the interior marsh. This regular inundation into the marsh has increased the salinity levels in the entire Salt Bayou System and removed the largest source of fresh water from the system. In addition to the potential of projected sea level rise, these issues would put 52,800 acres of McFaddin NWR south of the GIWW in jeopardy of not being able to meet even the most basic refuge management goals.

Currently there are USACE plans under development for the Sabine-Neches Waterway to be deepened from the current 42-foot depth to a 50 to 55-foot depth. The deeper channel is expected to exert an increase in tidal action which would increase salt water intrusion, even during years with normal or above average rainfall.

Cumulative impacts on water quality within the proposed project area have occurred and would continue to occur, because of changes in hydrology, creation of navigation channels, tropical storms, and natural processes. Water quality impacts have occurred within the project area in the past, both before and after these lands were acquired for McFaddin NWR. With past inoperable water control structures, salt water began to enter the marsh south of the GIWW at three locations; Star Lake, Salt Bayou, and the Little Keith Lake Cut (TPWD/USFWS 1990). Salinities within the system increased and marshes now are at or near brackish levels.

Beneficial cumulative effects to water quality are expected to result from the *Preferred Alternative* which would decrease salt water intrusion and minimize negative impacts on water quality. These restoration and enhancement activities would improve the quality of the wetlands and further increase water quality within the proposed project area as salinities are suspected to decline, erosion is expected to drop, and water clarity is expected to improve. The availability of fresh water south of the GIWW is directly tied to the amount of precipitation that falls during any given year. During years with extended droughts or above normal high tidal influences, there is no available water to flush salt water from the system or impede salt water intrusion. This increased salt water intrusion will have many long term impacts due to the lack of the dune presence on the beach.

**Vegetative Habitats**

Impacts on vegetation have occurred due to the effects of past and present management activities, climatic events, and salinity increases within the project area. With the rise of salinity, smooth cordgrass, hog cane and oyster grass have increased throughout the marsh, especially near the mouth of saltwater inlets (TPWD/USFWS 1990). Field ascertainment work in 1977, as related to the original land purchase for the McFaddin NWR, documented the absence of oyster grass throughout the land presently contained within McFaddin NWR (TPWD/USFWS 1990). Much of the salt prairie and high

marsh is losing fresh to intermediate marsh species diversity and being replaced with plant communities associated with vegetated salt flats. This slow conversion of the habitat between the gulf and low marsh will continue to be converted to a higher salinity tolerant plant community. It eventually will become a vegetated salt flat with the associated vegetative habitats.

Although emergent vegetation was slow to respond to rising salinities within the marsh, submerged and floating freshwater and intermediate marsh plants disappeared within a very short time when salinities increased (TPWD/USFWS 1990). Within a few short years, all floating aquatic vegetation will be lost due to salinity increases across the marsh, and diversity of submerged aquatic vegetation will eventually be reduced to a single species. This loss is already apparent across large eastern portions of the Salt Bayou system.

Beneficial cumulative effects to vegetation are expected to result from the *Preferred Alternative*, as the *Preferred Alternative* will decrease salt water intrusion, increase sediment and nutrient transport, and minimize negative impacts on vegetation. With the conversion of emergent marsh to open water, all species discussed within the wildlife impacts will lose the use of the emergent marsh habitat and will be forced elsewhere or die off.

**Wildlife Habitats**

As salinities rose within the system, freshwater fish and wildlife species were gradually replaced with marine species. Blue crabs and shrimp replaced the various invertebrates, sunfish species, crawfish, and anurans (TPWD/USFWS 1990). Furbearer and waterfowl populations remained high during early periods of saltwater intrusion, but with increased salt water intrusion, the carrying capacity for waterfowl began to diminish as salt intolerant species were eliminated. Currently, summer production of mottled ducks and winter usage by migrant waterfowl is well below population goals (TPWD/USFWS 1990). The *Preferred Alternative* would provide net ecological benefits for overall marsh health, waterfowl, shorebirds, alligators, and estuarine dependent fisheries within the region. Waterfowl and shorebirds would benefit from the reestablishment of a beach ridge. Anuran and crustacean species would increase, as well as species that forage on these organisms.

**Socioeconomics**

Cumulative impacts on socioeconomic functions have occurred due to the effects of past and present management actions within the project area. Beneficial cumulative effects to socioeconomic functions are expected to result from the *Preferred Alternative*, by resulting in higher quality visitor experiences. The *Preferred Alternative* will provide the mechanism (i.e., decreasing saltwater intrusion) needed for the marshes within McFaddin NWR to improve and revegetate.

Currently, this marsh is not in optimal condition to provide hurricane protection from high velocity storm surges to the City of Port Arthur or the industry supported there. The *Preferred Alternative* would provide the potential for improved protection from hurricane storm surges for approximately 150,000 citizens and billions of dollars per year in the shipping, refining, and petrochemical industries. Also, with marsh improvements made by this project, fisheries and waterfowl populations will likely increase and

remain at higher health levels. This will present more quality hunting and fishing opportunities within McFaddin NWR.

Summary of Environmental Impacts by Alternative

| **Environmental Resource** | **Alternative A:** ***No Action Alternative*** | **Alternative B:** ***Preferred Alternative*** |
|---|---|---|
| Impacts to Air Quality | No effect | Direct negative (short term) and long term positive impacts |
| Impacts to Geology and Soils | Long term impacts | Direct negative (short term) and long term positive impacts |
| Impacts to Water Resources | Long term impacts | Direct negative (short term) and long term positive impacts |
| Impacts on Vegetative Habitats | Direct and indirect negative impacts | Direct and indirect positive impacts |
| Impacts on Wildlife Habitats | Long term impacts | Positive direct and indirect impacts |
| Impacts to Threatened and Endangered Species | Direct negative impacts | No effect |
| Impacts on Cultural Resources | No effect | No effect |
| Impacts on Socioeconomic Resources | Direct and indirect negative impacts | Direct and indirect positive impacts |
| Impacts on Public Use and Recreation | Direct and indirect negative impacts | Positive direct and indirect impacts |

## *5.0 CONSULTATION, COORDINATION AND DOCUMENT PREPARATION*

Document prepared by LJA Engineering, Inc. and Refuge Staff, McFaddin National Wildlife Refuge, U.S. Fish and Wildlife Service, Sabine Pass, Texas.

### 5.1 *Agencies and individuals consulted in the preparation of this document include:*

- State Historic Preservation Office
- Tim Cooper, USFWS
- Jena Moon, USFWS
- Patrick Walther, USFWS
- Jim Sutherlin, TPWD
- Jerry Mambretti, TPWD
- Jamie Schubert, National Marine Fisheries Service
- Rusty Swafford, National Marine Fisheries Service
- Salt Bayou Working Group, Interagency Cooperative focused on the restoration of Salt Bayou

### 5.2 *References*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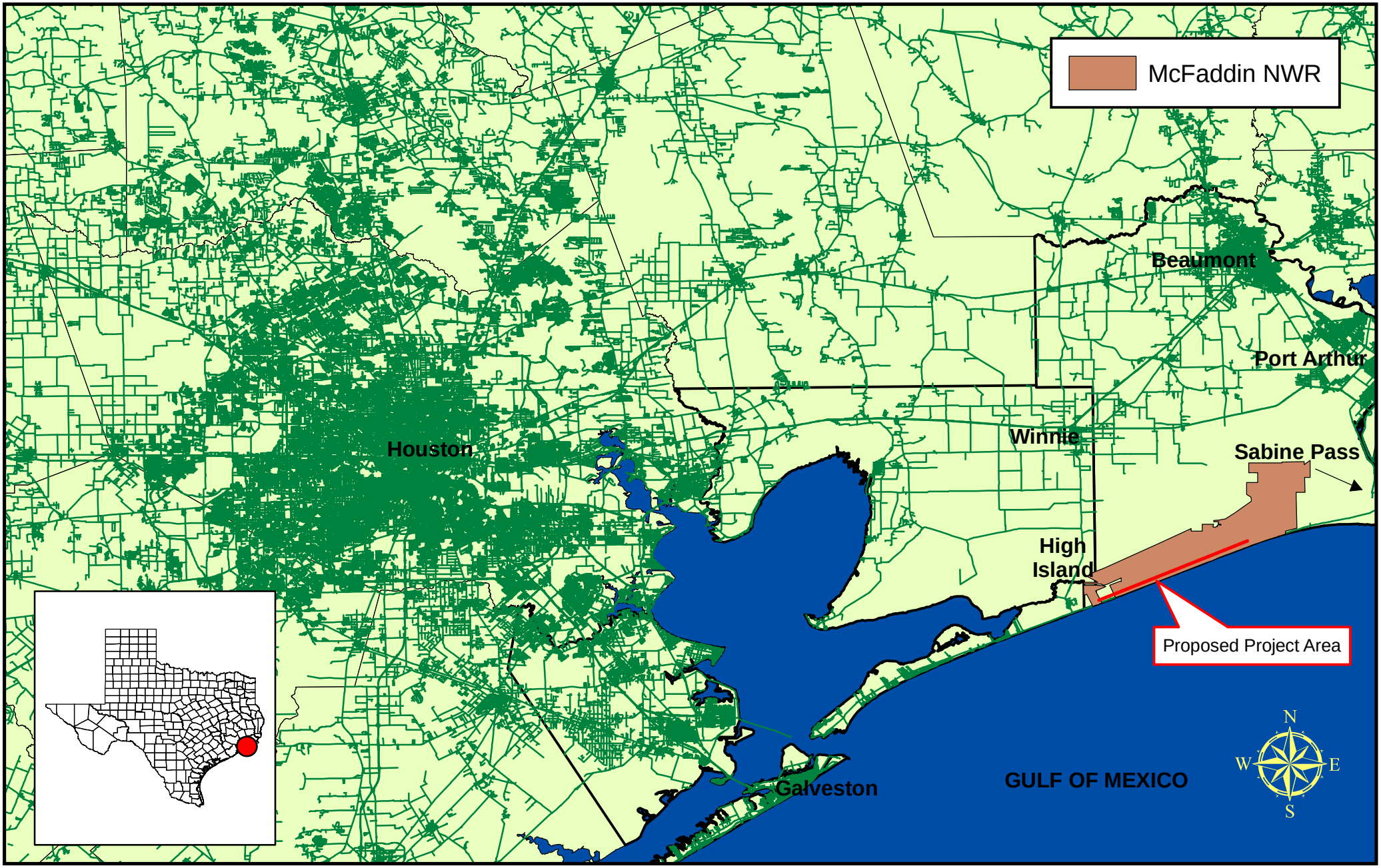
***Appendices***

# APPENDIX A




# Appendix A

## Vicinity Map

**U.S. Fish and Wildlife Service**
**McFaddin National Wildlife Refuge**
**Overwash Protection Berm**

October 2013 | LJA Project No. 395-1003

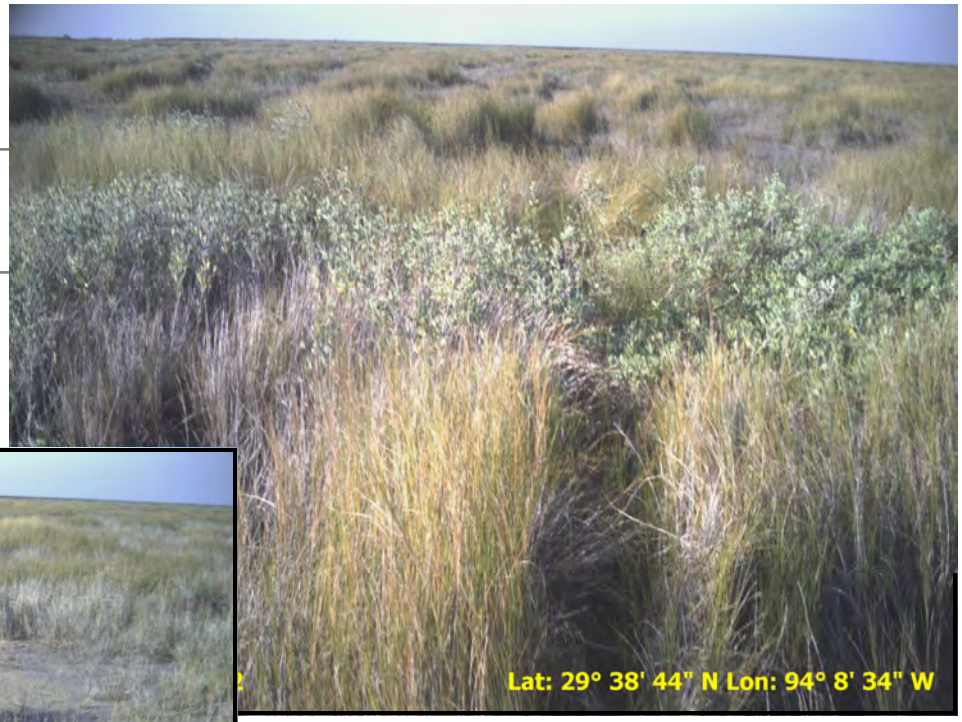
**LJA Engineering, Inc.**

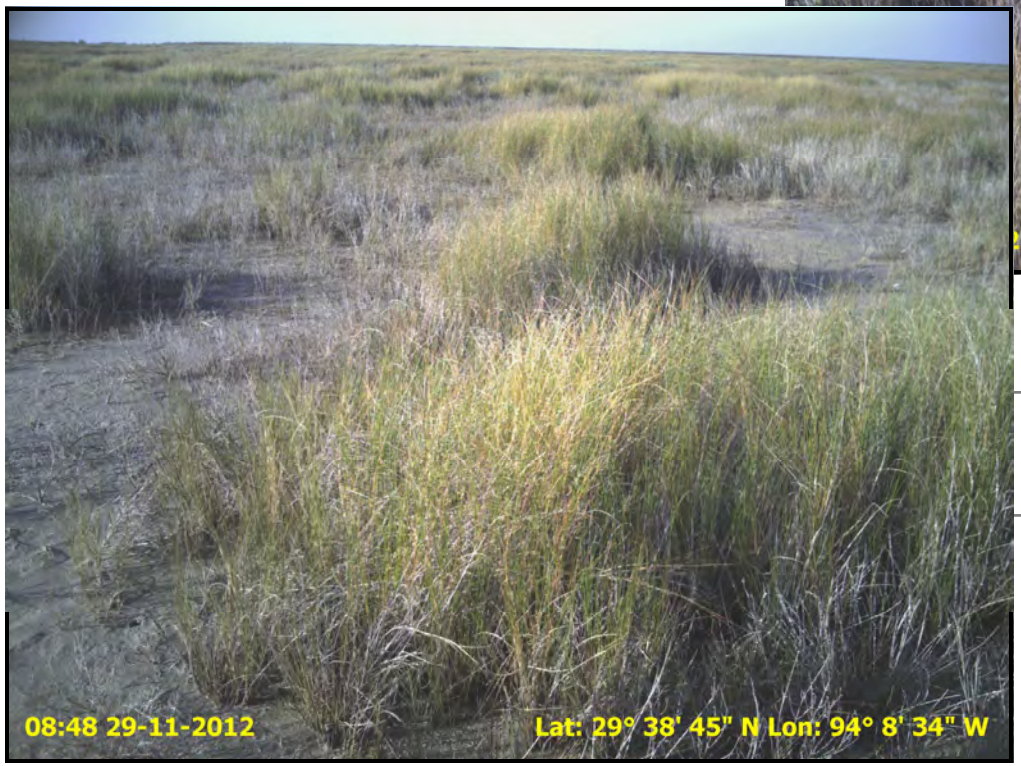
# APPENDIX B

**Proposed Berm Location**
Western End - Facing West

**Proposed Borrow Location**
Western End - Facing East

**Proposed Berm Location**
Eastern End - Facing West



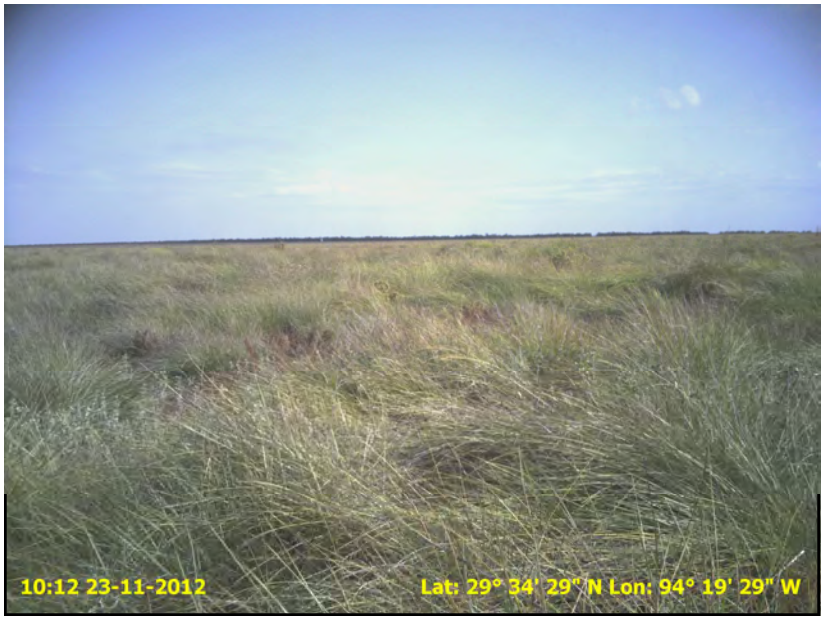

**Proposed Borrow Location**
Eastern End - Facing West

**Proposed Berm Location**
Facing West

**Proposed Borrow Location**
Facing West

**Proposed Berm Location**
Facing East

**Proposed Borrow Location**
Facing East




## Vegetation

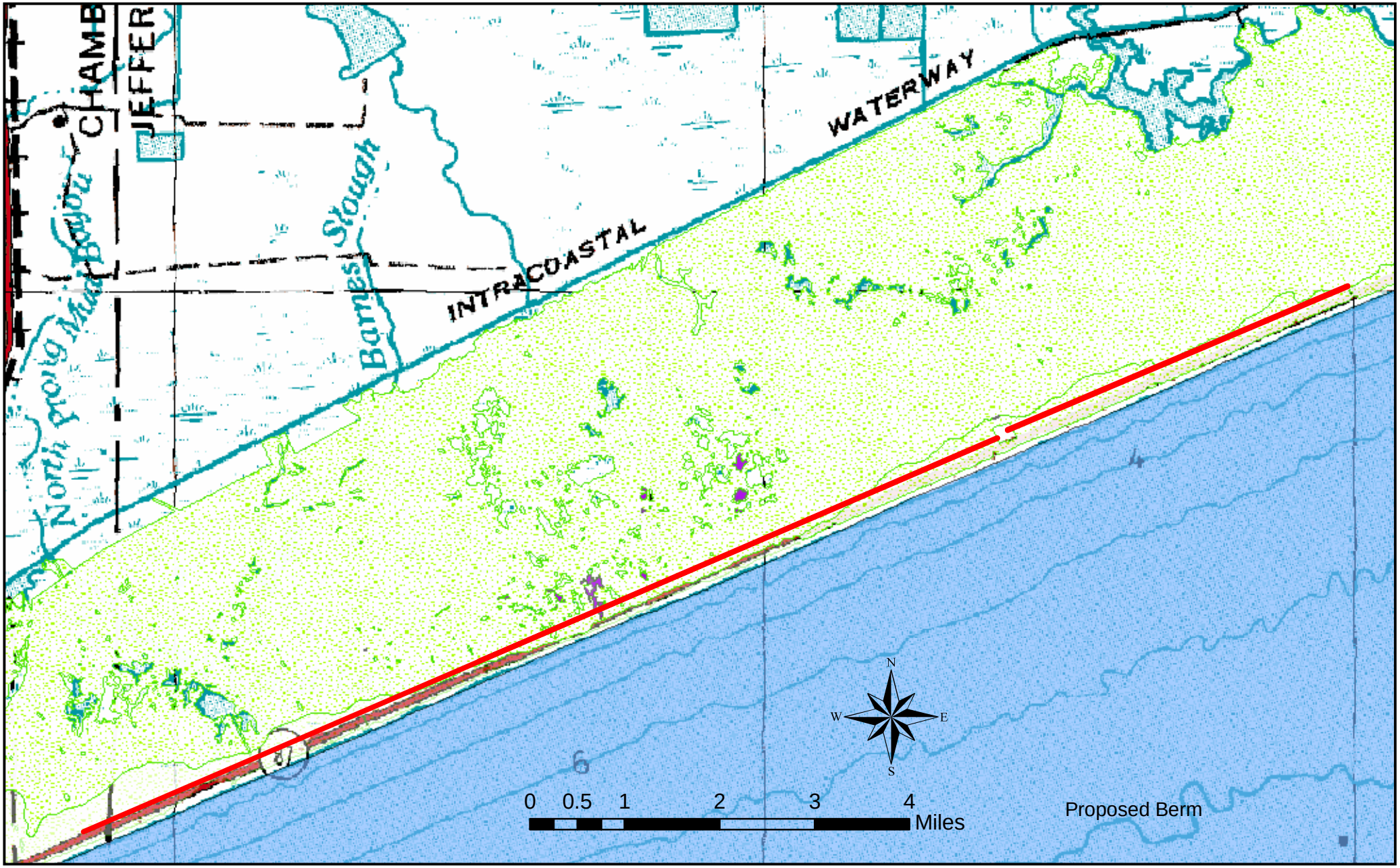
| | |
|---|---|
| *Ambrosia artemisiifolia* | Common Ragweed |
| *Batis maratima* | Turtleweed |
| *Borrichia frutescens* | Bushy seaside tansy |
| *Paspalum plicatulum* | Brownseed paspalum |
| *Rayjacksonia phyllocephala* | Camphor daisy |
| *Salicornia virginica* | American Glasswort, Pickleweed |
| *Spartina alterniflora* | Smooth Cordgrass |
| *Spartina patens* | Saltmeadow cordgrass |
| *Sporobolus virginicus* | Seashore dropseed |
| *Suaeda calceoliformis* | Pursh seepweed/horned sea-blite |
| *Symphytrichum tenuifolium* | Perennial saltmarsh aster |

**Current Beach Images**
December 2012
Facing West

Beach Images
December 2010

**Beach Images**
May 2008
Pre Hurricane Ike

# APPENDIX C




# Appendix C

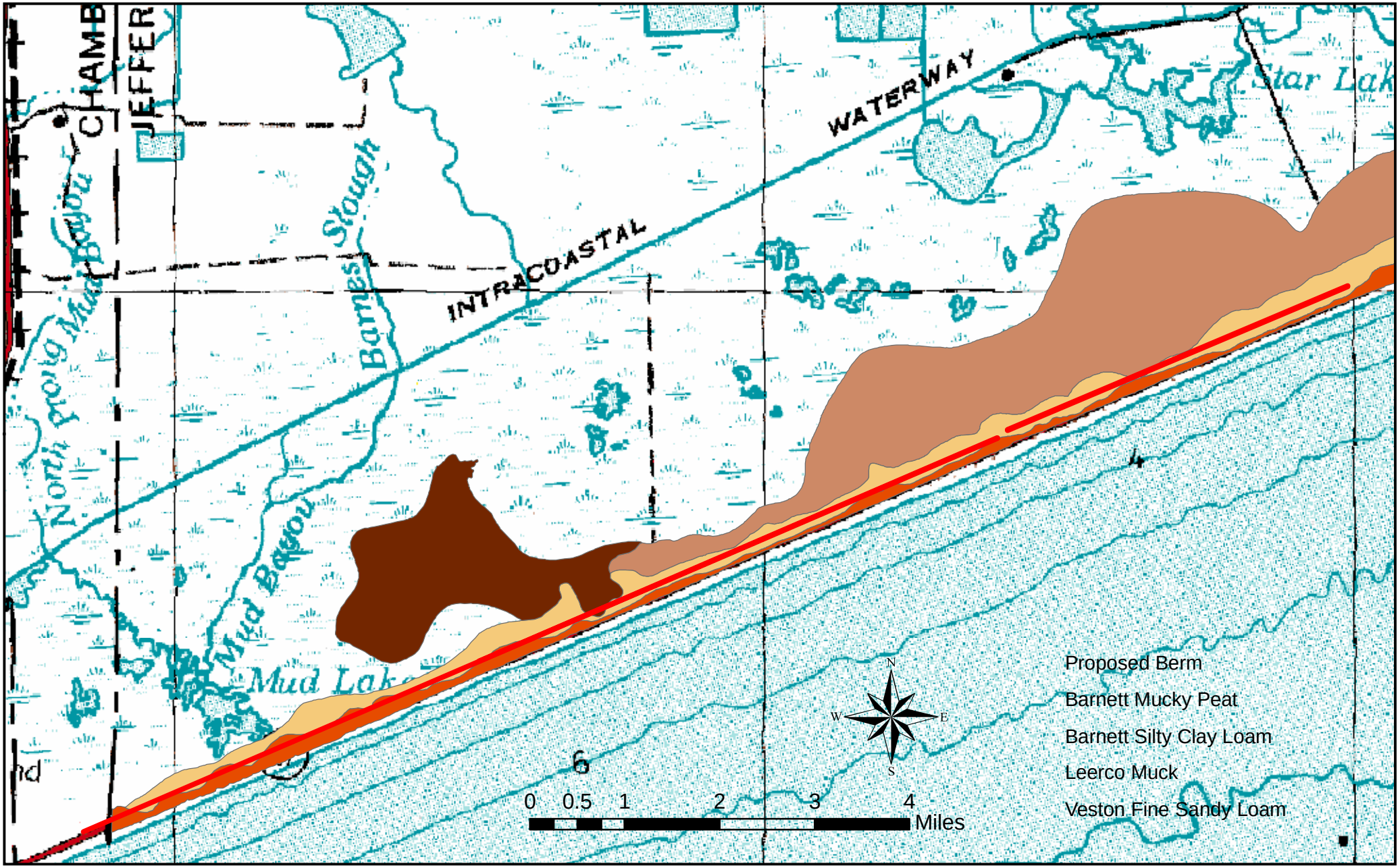
**Project Area with National Wetland Inventory**

**U.S. Fish and Wildlife Service**
**McFaddin National Wildlife Refuge**
**Environmental Assessment for**
**Overwash Protection Berm**

October 2013

LJA Project No. 395-1003

# APPENDIX D




# Appendix D

**Project Area with NRCS Soil Types**

**U.S. Fish and Wildlife Service**
**McFaddin National Wildlife Refuge**
**Environmental Assessment for**
**Overwash Protection Berm**

October 2013

LJA Project No. 395-1003

# APPENDIX E

# TECHNICAL MEMORANDUM
## ARCHAEOLOGICAL SURVEY OF MCFADDIN OVERWASH PROTECTION BERM PROJECT
## JEFFERSON COUNTY, TEXAS

**CONSULTANT:** Southeastern Archaeological Research, Inc.
428 E. Government Street, Pensacola, FL 32502
**PRINCIPAL INVESTIGATOR:** Jeff Enright, MA, RPA
**PROJECT ARCHAEOLOGIST** Andrew Roberts, MA, RPA
**LJA Job:** b079a-1006
**SEARCH Job:** 2853_12120P
**CLIENT:** LJA Engineering
**DATE:** January 2013

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In December 2012, Southeastern Archaeological Research, Inc. (SEARCH) conducted a Phase I archaeological investigation, including pedestrian survey and shovel testing, in support of the US Fish and Wildlife Service's construction of a protection berm in the McFaddin Wildlife Refuge, Jefferson County, Texas (**Figure 1**). The project consists of constructing an earthen berm inland from the current shoreline to create a protective barrier for the sensitive wetland habitat against coastal erosion and storm events. The project area is situated approximately 165 meters (541.34 feet) from the modern shoreline and extends 16.09 kilometers (10.4 miles) along the coast. The project entails excavating material from a borrow area and redepositing the soil approximately 30 meters (98.43 feet) seaward of the borrow area to create the protective berm.

SEARCH conducted the archaeological investigation on behalf of LJA Engineering in order to identify any cultural resources within the project area. The purpose of the survey was to locate, identify, and bound any archaeological resources, historic structures, and historic districts within the project area and assess their potential for listing in the National Register of Historic Places (NRHP). This investigation was conducted to comply with Section 106 of the National Historic Preservation Act (as amended) and its implementing regulation 36 CFR Part 800 (*Protection of Historic Properties*). All work complied with the Texas Historical Commission (THC) guidelines (Texas Administration Code, Title 13, Part 2, Chapter 26, Rule 26.20; Council of Texas Archeologists, Archeological Survey Standards for Texas).

Because the project area is located within a US Wildlife Refuge, a federal property, the effort falls under the jurisdiction of the Archaeological Resources Protection Act of 1979 (ARPA) and therefore required SEARCH to obtain an ARPA permit prior to any undertaking. After submitting the ARPA application, personal communications with the cultural director of the US Fish and Wildlife Service Region 2 resulted in the acquisition of a Special Use Permit to proceed with the work (Siegel, personal communications 2012). These permits replaced the need to acquire an Antiquities Permit from the THC (THC, personal communications 2012).

Jeffrey Enright MA, RPA, served as the Principal Investigator for this project. Andrew Roberts MA, RPA, prepared the technical report and directed the fieldwork. Survey was conducted by Kendra Crane, Spencer Prentice, Andrew Roberts MA, RPA, Jon Simon Suarez, MA, RPA, Emily Wicke, and Brian Worthington MA, RPA.

**Figure 1. Project location map**

## PROJECT ENVIRONMENT

The proposed McFaddin Overwash Protection Berm Project is located within the McFaddin National Wildlife Refuge in Jefferson County, Texas. The McFaddin Wildlife Refuge falls within the Texas-Louisiana Coastal Marshes region of the Western Gulf Coastal Plain. This region is characterized by relatively flat topography and mainly natural grassland vegetation (**Figure 2**). Surrounding areas have been utilized as cropland, with rice, grain sorghum, cotton, and soybeans as principal crops. The project area has not experienced any recent agricultural development (Environmental Protection Agency 2012).

**Figure 2. Project area overview.**

# METHODS

## Background Literature Review

Prior to fieldwork, SEARCH conducted a background literature review to identify any previously recorded cultural resources near or within the project area. SEARCH reviewed the Texas Archaeological Sites Atlas (Atlas), an online database containing data related to archaeological sites and historic properties.

## Archaeological Field Survey

SEARCH conducted a Phase I pedestrian survey of a corridor measuring approximately 16.09 kilometers (10.4 miles) long and 50 meters (164 feet) wide on McFaddin Beach to identify any archaeological sites that may be present in the project area. The survey included an intensive pedestrian survey with shovel testing in an effort to identify any surface or subsurface cultural resources. Survey was conducted along two transects spaced approximately 30 meters (98 feet) apart, with shovel tests pits (STPs) conducted every 100 meters (328.08 feet), or in areas with high potential for cultural resources, such as exposed artifact scatters. Upon the discovery of archaeological resources, SEARCH endeavored to determine both horizontal and vertical boundaries of the feature and/or larger site through delineation shovel tests at approximately 15-meter (49-foot) intervals.

STPs were excavated at a minimum of 30 x 30 centimeters (12 x 12 inches) and to a depth of 1 meter (3.3 feet) or until sterile soils, impenetrable surfaces, or the water table was encountered. STPs were excavated in levels not exceeding 20 centimeters (7.9 inches) in thickness, and were excavated below artifact-bearing levels/strata, when possible. Soils were excavated in arbitrary levels within observable natural strata; levels did not cross-cut natural strata. Excavated soil was sifted through a screen no greater than 6.4 millimeters (0.25 inch) in size.

# RESULTS

## Background Literature Review

The background review identified one archaeological site within 1 mile (1.6 kilometers) of the project area. The McFaddin Beach Site (41JF50) is a Paleoindian site, submerged off the coast of the McFaddin Wildlife Refuge. Numerous Paleoindian artifacts and fossil remains of Pleistocene animals have been found along the beach in this area. Archaeological interpretations of the area indicate that the artifacts identified along the beach are in a secondary context and the site is located below the current shoreline (Pearson and Weinstein 1983; Pearson et al. 1982, 1986; Texas Beyond History 2009).

## Archaeological Field Survey

SEARCH conducted the Phase I pedestrian survey of the project area between December 4 and December 11, 2012. Five archaeologists, under the supervision of an archaeological field director, conducted the survey. Shovel tests adhered to the proposed standards and were excavated every 100 meters (328.08 feet), where possible. A total of 312 shovel tests were excavated throughout the project area. All shovel tests encountered shallow basal clay at an average depth of 20 centimeters (7.9 inches) below surface (cmbs) (**Appendix A**). No cultural resources were identified in any of the shovel tests or on the surface of the project area.

Previous investigations in the area identified the Pleistocene Beaumont Formation less than 2 meters (6.6 feet) below ground surface. Radiocarbon and optically stimulated luminescence (OSL) dates taken from the Beaumont Formation range from 28,000 to 135,000 calendar years BP or more. These date ranges predate known human occupation dates in Texas by several thousand years (Pearson and Weinstein 1983; Pearson et al. 1982, 1986; Texas Beyond History 2009). Therefore, the Beaumont Formation is considered to be a culturally sterile soil and an acceptable terminus for shovel tests. The Beaumont Formation is clearly visible eroding out from the beachhead along McFaddin Beach (**Figure 3**). In-field analysis of the shovel test results determined that the overlying Holocene-era sand layer has been largely eroded away, exposing the Beaumont formation at a much shallower depth than previously recorded. Beaumont clay was encountered on average between 10 and 20 cmbs (3.9 to 7.9 inches). It was determined that there was no need for archaeological deep testing due to the extremely shallow depths of the intact deposits. This recommendation was communicated to David Siegel, Cultural Resource Manager for the Southwest Region of the US Fish and Wildlife Service, who subsequently supported the recommendation (Siegel, personal communication 2012).

**Figure 3. Exposed Pleistocene era Beaumont Formation clay on McFaddin Beach.**

## CONCLUSION AND RECOMMENDATIONS

This technical memorandum presents the results of a Phase I survey conducted in support of the proposed McFaddin Beach Overwash Protection Berm Project in the McFaddin Wildlife Refuge, Jefferson County, Texas. The project consists of constructing an earthen berm inland from the current shoreline to create a protective barrier for the sensitive wetland habitat against coastal erosion and storm events.

SEARCH archaeologists conducted an intensive pedestrian survey with shovel tests at 100-meter (328.08-foot) intervals along two transects within the project area. A total of 312 shovel tests were conducted throughout the project area (**Appendix A**). All work complied with THC guidelines (Texas Administration Code, Title 13, Part 2, Chapter 26, Rule 26.20; Council of Texas Archeologists, Archeological Survey Standards for Texas). All shovel tests identified shallow basal clay. No cultural resources were found in any shovel tests or on the ground surface. SEARCH recommends that no further investigation is necessary and that cultural resources clearance for the project area is warranted.

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2012 Ecoregions of Texas. Electronic document, http://www.epa.gov/wed/pages/ecoregions/tx_eco.htm, accessed January 2012.

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Pearson, Charles E., George J. Castille, and Richard A. Weinstein
1982 *Cultural Resources Survey of the Big Hill Storage Complex Pipeline, Nederland to the Gulf of Mexico, Jefferson County, Texas.* Coastal Environments, Inc., Baton Rouge.

Pearson, Charles E., David B. Kelley, Richard A. Weinstein, and Sherwood M. Gagliano
1986 *Archaeological Investigations on the Outer Continental Shelf: A Study within the Sabine River Valley, Offshore Louisiana and Texas.* Coastal Environments, Inc., Baton Rouge.

Texas Beyond History
2009 McFaddin Beach: This Site is All Washed Up! Electronic document, http://www.texasbeyondhistory.net/mcfaddin/index.html, accessed December 2012.

# Appendix A
# Shovel Test Data

# Shovel Test Log Transect A

| Transect | Shovel Test | Strata | Depth (cmbs) | Matrix Description | Artifacts | Cause of Termination |
|---|---|---|---|---|---|---|
| A | 1 | I | 0-12 | Loose Sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12-23 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 2 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 20-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 3 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 4 | I | 0-24 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 5 | I | 0-17 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 6 | I | 0-23 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 7 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 8 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 9 | I | 0-12 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 10 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 11 | I | 0-5 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 12 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| A | 13 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 14 | I | 0-3 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 15 | NA | Not excavated | Not excavated due to standing water | NA | Watertable |
| A | 16 | I | 0-4 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 4-12 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 17 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| A | 18 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| A | 19 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 20 | I | 0-17 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 21 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 22 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 20-25 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 23 | I | 0-10 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| A | 24 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 25 | I | 0-14 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 26 | I | 0-10 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| A | 27 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 28 | I | 0-15 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 29 | I | 0-12 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12-23 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 30 | I | 0-3 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 31 | I | 0-13 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| A | 32 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 20-30 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 33 | I | 0-3 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 3-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 34 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 35 | I | 0-13 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13-17 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 36 | I | 0-16 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 37 | I | 0-16 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 38 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-25 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 39 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-24 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 40 | I | 0-14 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 41 | I | 0-23 | Loose sand 10 YR 4/3 | NA | Watertable |
| A | 42 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 43 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 44 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 45 | I | 0-13 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 46 | I | 0-12 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12-16 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 47 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 48 | I | 0-5 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 49 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 50 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-25 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 51 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 52 | I | 0-12 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 53 | I | 0-9 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 54 | I | 0-5 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 55 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 56 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 57 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-23 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 58 | I | 0-3 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 3-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 59 | I | 0-9 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9-18 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 60 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 61 | I | 0-10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| A | 62 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14-16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 63 | I | 0-5 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 64 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 65 | I | 0-8 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 8+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 66 | I | 0-5 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 67 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 68 | I | 0-6 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 6-16 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 69 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 70 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 71 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 72 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 73 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 74 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-23 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 75 | I | 0-24 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 24+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 76 | I | 0-9 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 77 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 78 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 10-15 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 79 | I | 0-23 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 80 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 81 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 82 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 83 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 84 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 85 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 86 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 87 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 88 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 89 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 90 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-35 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 91 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 92 | I | 0-23 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23-28 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 93 | I | 0-17 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 94 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 95 | I | 0-22 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 22-30 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 96 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 97 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 98 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 99 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 100 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| A | 101 | I | 0-17 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 102 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 103 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 104 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 105 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 106 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 107 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 108 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 109 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 110 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 111 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 112 | I | 0-17 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 113 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 114 | I | 0-17 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 115 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 116 | I | 0-19 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 19-27+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 117 | I | 0-19 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 19+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 118 | I | 0-8 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 8+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 119 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 120 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 121 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-28+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 122 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 123 | I | 0-22 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 22-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 124 | I | 0-19 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 19+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 125 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 126 | I | 0-7 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 7+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 127 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 128 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 129 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 130 | I | 0-27 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 27+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 131 | I | 0-23 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 132 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 133 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 134 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 135 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 136 | NA | Not excavated | Not excavated due to standing water (pond). | NA | Water |
| A | 137 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 138 | I | 0-3 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 3-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 139 | NA | Not excavated | Basal clay at surface. | NA | Basal Clay |
| A | 140 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 141 | I | 0-19 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 19+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 142 | I | 0-7 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 7+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 143 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 144 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 145 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 146 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect A

| | | | | | | |
|---|---|---|---|---|---|---|
| A | 147 | I | 0-5 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 148 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 149 | I | 0-23 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 150 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 151 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 152 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| A | 153 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 154 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 155 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 156 | I | 0-25 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 25-35+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 157 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 158 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| A | 159 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect B

| Transect | Shovel Test | Strata | Depth (cmbs) | Matrix Description | Artifacts | Cause of Termination |
|---|---|---|---|---|---|---|
| B | 1 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 2 | I | 0-25 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 25-35+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 3 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| B | 4 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 5 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| B | 6 | I | 0-15 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 7 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 8 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 9 | I | 0-11 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 11-18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 10 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 11 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 12 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| B | 13 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 14 | I | 0-13 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 15 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 16 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 17 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 18 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 19 | I | 0-17 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 20 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| B | 21 | I | 0-20 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 22 | I | 0-15 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 23 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 24 | I | 0-14 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 25 | I | 0-11 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 11+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 26 | I | 0-16 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 27 | I | 0-5 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 28 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 29 | I | 0-22 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 22+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 30 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Watertable |
| B | 31 | I | 0-9 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 32 | I | 0-18 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18-36+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 33 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 34 | I | 0-10 | Wet loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 35 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 36 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 37 | I | 0-2+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| B | 38 | I | 0-2+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| B | 39 | NA | Not excavated | Not excavated due to standing water. | NA | Watertable |
| B | 40 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 41 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 42 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 43 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 44 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 45 | I | 0-9 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 46 | I | 0-22 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 22-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 47 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 48 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 49 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 50 | I | 0-17 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 51 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 52 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| B | 53 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 54 | I | 0-16 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 55 | I | 0-17 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 56 | I | 0-10 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| B | 57 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 58 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 59 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 60 | I | 0-8 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 8-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 61 | I | 0-14 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 62 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 63 | I | 0-16 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 64 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 65 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 66 | I | 0-23 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23-28+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 67 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 68 | I | 0-23 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 69 | I | 0-25 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 25-35+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 70 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-26+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 71 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 72 | I | 0-20 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 73 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-100 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 74 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 75 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| B | 76 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 77 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 78 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-21+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 79 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 80 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 81 | I | 0-11 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 11-18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 82 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 83 | I | 0-9 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 84 | I | 0-21 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 21+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 85 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 86 | I | 0-10 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 87 | I | 0-13 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 88 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 89 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 90 | I | 0-8 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 8-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 91 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 92 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 93 | I | 0-21 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 21+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 94 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 95 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 96 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 97 | I | 0-18 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 98 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 99 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 100 | I | 0-23 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 101 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 102 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 103 | I | 0-15 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 104 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 105 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 106 | I | 0-14 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 14+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 107 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 108 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 109 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 110 | I | 0-12 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 111 | I | 0-19 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 19-25+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 112 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 113 | I | 0-17 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 17-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 114 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 115 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 116 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 117 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 118 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 119 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 120 | I | 0-20 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 20-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| B | 121 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 122 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 123 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 124 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 125 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 126 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 127 | I | 0-10+ | Loose sand 10 YR 4/3 | NA | Watertable |
| B | 128 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 129 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 130 | I | 0-10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay/Watertable |
| B | 131 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 132 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 15-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 133 | I | 0-23 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 23-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 134 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 135 | I | 0-12 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 12-20 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 136 | I | 0-15 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 137 | I | 0-16 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 138 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-20+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 139 | I | 0-21 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 21+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 140 | I | 0-13 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 13+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 141 | I | 0-12 | Loose sand 10 YR 4/3 | NA | Basal Clay/Watertable |
| | | II | 12-18 | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 142 | I | 0-9 | Semi-compact sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 9+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 143 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 144 | I | 0-18 | Loose sand 10 YR 4/3 | NA | Basal Clay |

# Shovel Test Log Transect B

| | | | | | | |
|---|---|---|---|---|---|---|
| | | II | 18+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 145 | I | 0-25 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 25-30+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 146 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 147 | I | 0-10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | Basal Clay |
| B | 148 | I | 0-10+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| B | 149 | I | 0-29+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |
| B | 150 | I | 0-10 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 10-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 151 | I | 0-5 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 5-15+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 152 | I | 0-16 | Loose sand 10 YR 4/3 | NA | Basal Clay |
| | | II | 16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. | NA | |
| B | 153 | I | 0-16+ | Compact Clay 10 YR 4/3 with 10 YR 5/6 mottles. Basal clay at surface. | NA | Basal Clay |

**Shovel Test Locations**

| STP | EASTING NAD83 Stateplane Texas South Central | NORTHING NAD83 Stateplane Texas South Central |
|---|---|---|
| AST 1 | 3512312.69 | 13815131.83 |
| AST2 | 3511974.14 | 13814985.75 |
| AST3 | 3511717.95 | 13814825.40 |
| AST4 | 3511439.36 | 13814661.56 |
| AST6 | 3510924.90 | 13814457.72 |
| AST5 | 3511159.21 | 13814532.19 |
| AST 7 | 3510653.38 | 13814335.18 |
| AST 8 | 3510363.95 | 13814175.51 |
| AST 9 | 3510058.10 | 13814038.32 |
| AST 10 | 3509774.39 | 13813870.66 |
| AST 11 | 3509469.71 | 13813734.70 |
| AST 12 | 3509169.66 | 13813589.31 |
| AST 13 | 3508868.25 | 13813436.77 |
| AST 14 | 3508563.74 | 13813286.32 |
| AST 15 | 3508264.22 | 13813142.25 |
| AST 16 | 3507950.66 | 13813005.68 |
| AST 17 | 3507652.29 | 13812842.30 |
| AST 18 | 3507337.21 | 13812707.30 |
| AST 19 | 3507063.54 | 13812571.09 |
| AST 20 | 3506779.46 | 13812424.56 |
| AST 21 | 3506478.34 | 13812275.45 |
| AST 22 | 3506174.71 | 13812121.16 |
| AST 23 | 3505863.45 | 13811988.24 |
| AST 24 | 3505568.73 | 13811829.53 |
| AST 25 | 3505270.57 | 13811690.91 |
| AST 26 | 3504980.73 | 13811538.87 |
| AST 27 | 3504681.81 | 13811420.49 |
| AST 28 | 3504367.36 | 13811253.31 |
| AST 29 | 3504068.05 | 13811124.54 |

| STP | EASTING NAD83 Stateplane Texas South Central | NORTHING NAD83 Stateplane Texas South Central |
|---|---|---|
| BST1 | 3512211.23 | 13815215.41 |
| BST2 | 3511897.24 | 13815112.44 |
| BST3 | 3511646.97 | 13814899.31 |
| BST4 | 3511356.88 | 13814724.58 |
| BST5 | 3511057.95 | 13814621.97 |
| BST 6 | 3510836.11 | 13814498.04 |
| BST 7 | 3510452.16 | 13814325.67 |
| BST 8 | 3510173.69 | 13814166.30 |
| BST 9 | 3509875.73 | 13814032.37 |
| BST 10 | 3509613.40 | 13813911.85 |
| BST 11 | 3509303.82 | 13813763.00 |
| BST 12 | 3509010.05 | 13813609.92 |
| BST 13 | 3508695.87 | 13813487.68 |
| BST 14 | 3508397.91 | 13813342.25 |
| BST 15 | 3508096.90 | 13813188.77 |
| BST 16 | 3507787.13 | 13813062.82 |
| BST 17 | 3507505.18 | 13812869.16 |
| BST 18 | 3507191.28 | 13812741.06 |
| BST 19 | 3506874.88 | 13812594.17 |
| BST 20 | 3506494.12 | 13812411.48 |
| BST 21 | 3506238.55 | 13812297.97 |
| BST 22 | 3505945.87 | 13812136.37 |
| BST 23 | 3505662.25 | 13812013.94 |
| BST 24 | 3505360.58 | 13811872.55 |
| BST 25 | 3505048.59 | 13811738.63 |
| BST 26 | 3504746.34 | 13811562.92 |
| BST 27 | 3504454.17 | 13811426.80 |
| BST 28 | 3504143.71 | 13811272.22 |
| BST 29 | 3503830.40 | 13811107.85 |

**Shovel Test Locations**

| | | | | | |
|---|---|---|---|---|---|
| AST 30 | 3503759.13 | 13810963.39 | BST 30 | 3503528.14 | 13810987.45 |
| AST 31 | 3503466.01 | 13810822.88 | BST 31 | 3503254.37 | 13810837.50 |
| AST 32 | 3503155.53 | 13810669.92 | BST 32 | 3502951.81 | 13810680.49 |
| AST 33 | 3502848.42 | 13810510.38 | BST 33 | 3502704.30 | 13810576.15 |
| AST 34 | 3502547.55 | 13810364.76 | BST 34 | 3502410.47 | 13810423.20 |
| AST 35 | 3502248.49 | 13810232.54 | BST 35 | 3502087.42 | 13810243.54 |
| AST 36 | 3501950.62 | 13810093.05 | BST 36 | 3501766.00 | 13810121.57 |
| AST 37 | 3501646.40 | 13809931.65 | BST 37 | 3501149.56 | 13809792.06 |
| AST 38 | 3501327.33 | 13809782.20 | BST 38 | 3500852.97 | 13809646.69 |
| AST 39 | 3501025.59 | 13809657.47 | BST 39 | 3500540.06 | 13809533.96 |
| AST 40 | 3500746.61 | 13809484.42 | BST 40 | 3500246.23 | 13809368.11 |
| AST 41 | 3500434.79 | 13809337.41 | BST 41 | 3499936.06 | 13809213.38 |
| AST 42 | 3500130.55 | 13809196.53 | BST 42 | 3499619.43 | 13809079.05 |
| AST 43 | 3499832.70 | 13809050.30 | BST 43 | 3499304.65 | 13808907.02 |
| AST 44 | 3499531.92 | 13808910.54 | BST 44 | 3499081.26 | 13808816.39 |
| AST 45 | 3499244.14 | 13808758.49 | BST 45 | 3498777.17 | 13808662.69 |
| AST 46 | 3498949.00 | 13808611.92 | BST 46 | 3498477.39 | 13808513.39 |
| AST 47 | 3498648.86 | 13808488.64 | BST 47 | 3498158.18 | 13808377.56 |
| AST 48 | 3498350.92 | 13808334.75 | BST 48 | 3497844.80 | 13808215.62 |
| AST 49 | 3498064.23 | 13808179.27 | BST 49 | 3497551.80 | 13808077.93 |
| AST 50 | 3497747.66 | 13808044.35 | BST 50 | 3497256.70 | 13807921.85 |
| AST 51 | 3497449.10 | 13807893.95 | BST 51 | 3496932.60 | 13807778.67 |
| AST 52 | 3497154.21 | 13807743.22 | BST 52 | 3496625.17 | 13807638.39 |
| AST 53 | 3496854.33 | 13807610.67 | BST 53 | 3496314.28 | 13807481.82 |
| AST 54 | 3496563.12 | 13807464.58 | BST 54 | 3495970.29 | 13807327.33 |
| AST 55 | 3496266.00 | 13807317.66 | BST 55 | 3495676.87 | 13807167.28 |
| AST 56 | 3495964.95 | 13807159.28 | BST 56 | 3495368.34 | 13807012.53 |
| AST 57 | 3495664.78 | 13807019.13 | BST 57 | 3495102.52 | 13806896.95 |
| AST 58 | 3495368.40 | 13806873.56 | BST 58 | 3494867.31 | 13806773.09 |
| AST 59 | 3495077.55 | 13806737.12 | BST 59 | 3494583.08 | 13806622.14 |
| AST 60 | 3494774.05 | 13806614.24 | BST 60 | 3494264.68 | 13806468.46 |
| AST 61 | 3494482.72 | 13806452.19 | BST 61 | 3493958.56 | 13806338.26 |
| AST 62 | 3494181.68 | 13806305.72 | BST 62 | 3493116.71 | 13805722.91 |
| AST 63 | 3493885.62 | 13806158.02 | BST 63 | 3492819.45 | 13805559.41 |

**Shovel Test Locations**

| | | | | | |
|---|---|---|---|---|---|
| AST 64 | 3493312.38 | 13805698.27 | BST 64 | 3492511.19 | 13805421.30 |
| AST 65 | 3493027.05 | 13805519.18 | BST 65 | 3492226.70 | 13805290.92 |
| AST 66 | 3492729.62 | 13805403.37 | BST 66 | 3491934.21 | 13805138.46 |
| AST 67 | 3492422.80 | 13805281.21 | BST 67 | 3491643.96 | 13804994.54 |
| AST 68 | 3492137.83 | 13805111.42 | BST 68 | 3491325.42 | 13804842.99 |
| AST 69 | 3491835.34 | 13804978.15 | BST 69 | 3491024.27 | 13804688.12 |
| AST 70 | 3491551.74 | 13804816.46 | BST 70 | 3490711.93 | 13804529.03 |
| AST 71 | 3491252.74 | 13804665.52 | BST 71 | 3490441.00 | 13804409.70 |
| AST 72 | 3490928.78 | 13804544.90 | BST 72 | 3490154.00 | 13804260.30 |
| AST 73 | 3490632.98 | 13804386.53 | BST 73 | 3489828.44 | 13804096.77 |
| AST 74 | 3490347.22 | 13804230.18 | BST 74 | 3489531.89 | 13803963.02 |
| AST 75 | 3490044.16 | 13804083.07 | BST 75 | 3489253.33 | 13803824.53 |
| AST 76 | 3489747.09 | 13803952.71 | BST 76 | 3488937.41 | 13803651.96 |
| AST 77 | 3489457.80 | 13803773.06 | BST 77 | 3488627.84 | 13803518.83 |
| AST 78 | 3489154.87 | 13803625.06 | BST 78 | 3488346.02 | 13803382.21 |
| AST 79 | 3488842.02 | 13803483.90 | BST 79 | 3488060.77 | 13803235.48 |
| AST 80 | 3488539.89 | 13803332.22 | BST 80 | 3487750.85 | 13803100.75 |
| AST 81 | 3488231.45 | 13803177.03 | BST 81 | 3487476.64 | 13802941.16 |
| AST 82 | 3487926.13 | 13803030.43 | BST 82 | 3487186.00 | 13802776.69 |
| AST 83 | 3487623.49 | 13802885.08 | BST 83 | 3486883.01 | 13802658.83 |
| AST 84 | 3487330.76 | 13802713.52 | BST 84 | 3486566.10 | 13802493.55 |
| AST 85 | 3487041.83 | 13802595.59 | BST 85 | 3486300.88 | 13802373.33 |
| AST 86 | 3486722.01 | 13802466.84 | BST 86 | 3486010.85 | 13802239.23 |
| AST 87 | 3486438.91 | 13802284.89 | BST 87 | 3485711.57 | 13802057.25 |
| AST 88 | 3486125.17 | 13802139.85 | BST 88 | 3485408.23 | 13801908.41 |
| AST 89 | 3485832.50 | 13801986.44 | BST 89 | 3485115.02 | 13801759.49 |
| AST 90 | 3485536.10 | 13801840.86 | BST 90 | 3484790.56 | 13801629.16 |
| AST 91 | 3485225.78 | 13801718.84 | BST 91 | 3484481.26 | 13801479.57 |
| AST 92 | 3484923.60 | 13801557.95 | BST 92 | 3484175.41 | 13801325.14 |
| AST 93 | 3484627.28 | 13801400.85 | BST 93 | 3483877.69 | 13801164.87 |
| AST 94 | 3484309.59 | 13801249.02 | BST 94 | 3483575.39 | 13801019.52 |
| AST 95 | 3484008.72 | 13801112.50 | BST 95 | 3483218.59 | 13800850.04 |
| AST 96 | 3483701.71 | 13800956.30 | BST 96 | 3482925.44 | 13800687.05 |
| AST 97 | 3483408.67 | 13800793.67 | BST 97 | 3482617.29 | 13800529.94 |

**Shovel Test Locations**

| | | | | | |
|---|---|---|---|---|---|
| AST 98 | 3483108.75 | 13800653.38 | BST 98 | 3482367.95 | 13800426.13 |
| AST 99 | 3482801.97 | 13800508.03 | BST 99 | 3482086.33 | 13800275.98 |
| AST 100 | 3482516.24 | 13800331.43 | BST 100 | 3481788.04 | 13800143.68 |
| AST 101 | 3482198.57 | 13800215.50 | BST 101 | 3481483.33 | 13799985.95 |
| AST 102 | 3481905.06 | 13800066.15 | BST 102 | 3481157.27 | 13799820.96 |
| AST 103 | 3481615.50 | 13799920.67 | BST 103 | 3480849.21 | 13799670.93 |
| AST 104 | 3481323.45 | 13799781.37 | BST 104 | 3480549.89 | 13799507.20 |
| AST 105 | 3481036.06 | 13799640.45 | BST 105 | 3480260.42 | 13799384.10 |
| AST 106 | 3480720.23 | 13799480.20 | BST 106 | 3479955.07 | 13799223.92 |
| AST 107 | 3480434.48 | 13799336.00 | BST 107 | 3479654.81 | 13799077.24 |
| AST 108 | 3480137.14 | 13799192.81 | BST 108 | 3479400.31 | 13798951.63 |
| AST 109 | 3479824.58 | 13799033.11 | BST 109 | 3479092.91 | 13798793.56 |
| AST 110 | 3479510.28 | 13798880.29 | BST 110 | 3478783.64 | 13798656.80 |
| AST 111 | 3479216.44 | 13798731.54 | BST 111 | 3478480.26 | 13798499.59 |
| AST 112 | 3478925.37 | 13798581.90 | BST 112 | 3478160.46 | 13798346.17 |
| AST 113 | 3478634.25 | 13798436.50 | BST 113 | 3477850.36 | 13798185.02 |
| AST 114 | 3478333.94 | 13798327.66 | BST 114 | 3477539.53 | 13798024.64 |
| AST 115 | 3478050.81 | 13798153.35 | BST 115 | 3477243.03 | 13797879.95 |
| AST 116 | 3477747.62 | 13797996.50 | BST 116 | 3476952.61 | 13797738.58 |
| AST 117 | 3477431.68 | 13797864.05 | BST 117 | 3476634.92 | 13797588.76 |
| AST 118 | 3477147.83 | 13797702.74 | BST 118 | 3476301.76 | 13797419.02 |
| AST 119 | 3476848.65 | 13797567.09 | BST 119 | 3476011.38 | 13797278.73 |
| AST 120 | 3476554.83 | 13797433.30 | BST 120 | 3475752.86 | 13797139.91 |
| AST 121 | 3476253.85 | 13797275.24 | BST 121 | 3475457.76 | 13796995.79 |
| AST 122 | 3475980.89 | 13797122.59 | BST 122 | 3475153.10 | 13796852.78 |
| AST 123 | 3475663.02 | 13796989.56 | BST 123 | 3474836.76 | 13796699.61 |
| AST 124 | 3475348.52 | 13796815.17 | BST 124 | 3474538.53 | 13796548.27 |
| AST 125 | 3475056.32 | 13796702.14 | BST 125 | 3474148.18 | 13796355.24 |
| AST 126 | 3474767.53 | 13796536.76 | BST 126 | 3473881.33 | 13796220.74 |
| AST 127 | 3474457.81 | 13796384.39 | BST 127 | 3473638.47 | 13796080.89 |
| AST 128 | 3474151.04 | 13796237.98 | BST 128 | 3473341.02 | 13795938.13 |
| AST 129 | 3473852.81 | 13796093.62 | BST 129 | 3473007.01 | 13795807.61 |
| AST 130 | 3473550.80 | 13795953.10 | BST 130 | 3472635.10 | 13795599.42 |
| AST 131 | 3473255.63 | 13795818.36 | BST 131 | 3472344.76 | 13795459.08 |

**Shovel Test Locations**

| | | |
|---|---|---|
| AST 132 | 3472976.54 | 13795643.58 |
| AST 133 | 3472658.23 | 13795479.93 |
| AST 134 | 3472348.64 | 13795346.99 |
| AST 135 | 3472042.39 | 13795193.70 |
| AST 137 | 3471516.91 | 13794950.81 |
| AST 138 | 3465154.69 | 13791819.03 |
| AST 139 | 3465461.22 | 13791950.91 |
| AST 140 | 3465781.88 | 13792100.22 |
| AST 141 | 3466101.33 | 13792242.31 |
| AST 142 | 3466263.46 | 13792301.07 |
| AST 143 | 3466568.12 | 13792510.85 |
| AST 144 | 3466873.62 | 13792658.70 |
| AST 145 | 3467187.19 | 13792792.68 |
| AST 146 | 3467508.03 | 13792964.54 |
| AST 147 | 3467780.38 | 13793087.56 |
| AST 148 | 3468084.77 | 13793241.99 |
| AST 149 | 3468392.82 | 13793391.28 |
| AST 150 | 3468618.17 | 13793500.49 |
| AST 151 | 3468914.67 | 13793637.64 |
| AST 152 | 3469213.81 | 13793814.16 |
| AST 153 | 3469518.30 | 13793952.53 |
| AST 155 | 3470071.21 | 13794232.69 |
| AST 154 | 3469772.51 | 13794074.82 |
| AST 156 | 3470374.62 | 13794366.12 |
| AST 157 | 3470679.89 | 13794527.80 |
| AST 158 | 3470996.56 | 13794662.12 |
| AST 159 | 3471254.88 | 13794787.90 |

| | | |
|---|---|---|
| BST 132 | 3472111.57 | 13795362.92 |
| BST 133 | 3471320.35 | 13794951.73 |
| BST 134 | 3471027.04 | 13794798.58 |
| BST 135 | 3470619.54 | 13794618.27 |
| BST 136 | 3470323.18 | 13794472.04 |
| BST 137 | 3470020.87 | 13794332.84 |
| BST 138 | 3469621.18 | 13794099.90 |
| BST 139 | 3469320.03 | 13793973.78 |
| BST 140 | 3468976.98 | 13793800.82 |
| BST 141 | 3468677.28 | 13793668.32 |
| BST 142 | 3468369.81 | 13793518.12 |
| BST 143 | 3468126.94 | 13793385.25 |
| BST 144 | 3467833.07 | 13793242.59 |
| BST 145 | 3467530.38 | 13793091.36 |
| BST 146 | 3467203.58 | 13792941.53 |
| BST 147 | 3466901.10 | 13792782.80 |
| BST 148 | 3466602.42 | 13792644.78 |
| BST 149 | 3466302.33 | 13792481.95 |
| BST 150 | 3466007.53 | 13792340.42 |
| BST 151 | 3465698.92 | 13792188.47 |
| BST 152 | 3465386.23 | 13792017.92 |
| BST 153 | 3465145.07 | 13791920.27 |

SOUTHEASTERN ARCHAEOLOGICAL RESEARCH, INC.

April 30, 2013

Bill Worsham
Director of Coastal Engineering
LJA Engineering, Inc.
5316 Highway 290 West, Suite 150
Austin, TX 78735

**Re: Fieldwork Summary Report**
**Archaeological Survey of the McFaddin Overwash Protection Berm Project**
**Project Expansion**

**LJA Job: b079a-1006**
**SEARCH Job: 2853_12120P**

Dear Mr. Worsham,

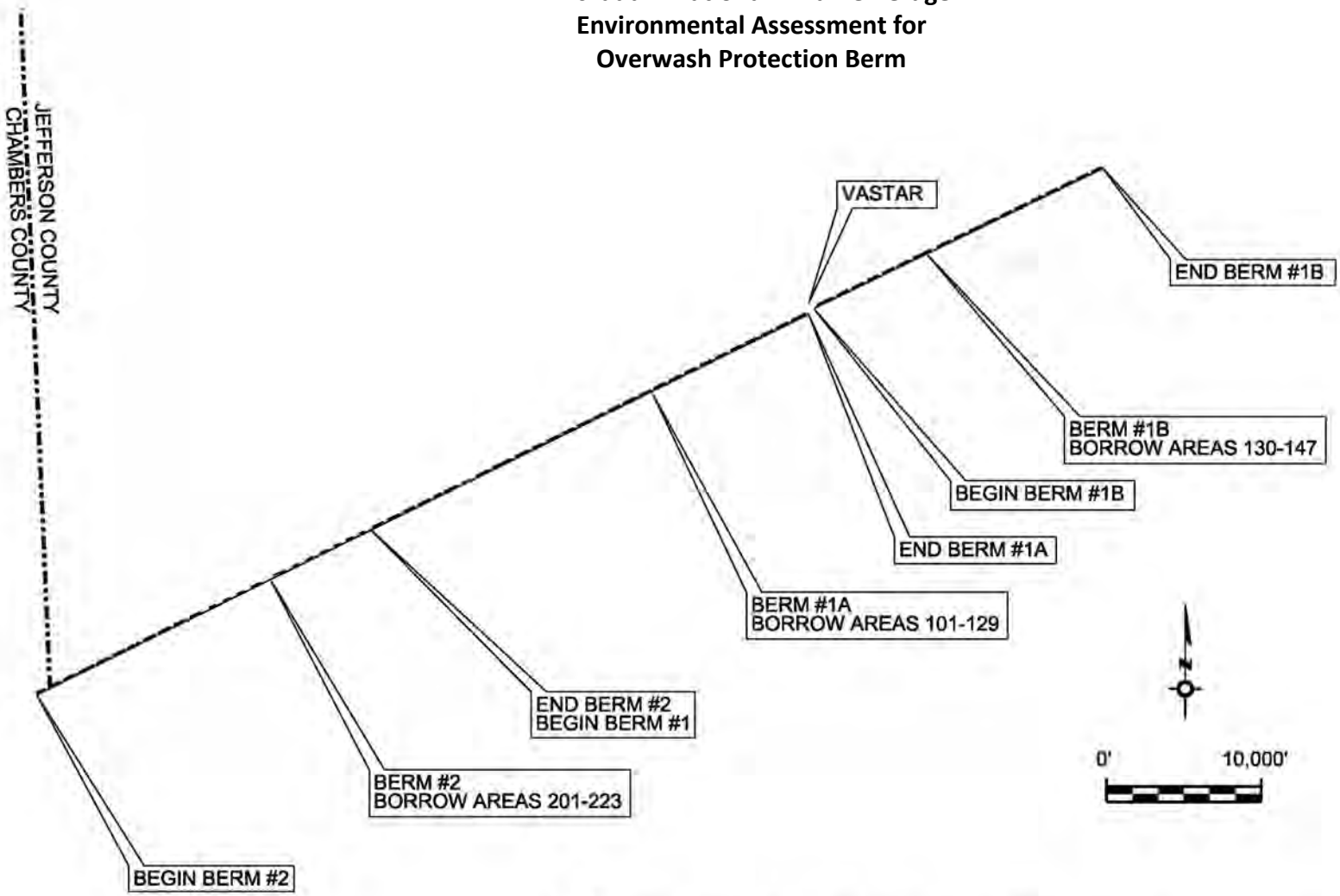
Southeastern Archaeological Research, Inc. (SEARCH) recently completed a pedestrian survey with shovel testing throughout the expanded project area proposed for the McFaddin Overwash Protection Berm Project. Shovel test survey was conducted April 8-11, 2013 and adhered to the Texas Historical Commission guidelines (Texas Administration Code, title 13, Part 2, Chapter 26, Rule 26.20; Council of Texas Archeologists, Archeological Survey Standards for Texas). A total of 132 shovel tests were excavated throughout the project area. All shovel tests encountered shallow basal clay (previously determined to be culturally sterile) at an average depth of 15 centimeters below surface. No cultural resources were identified in any of the shovel tests or on the surface of the project area. In-field analysis of the shovel test results determined that there was no need for archaeological deep testing due to the extreme shallow depths of the intact deposits. This recommendation was communicated following similar results during the December 2012 investigation to David Siegel, Cultural Resource Manager for the Southwest Region of the US Fish and Wildlife Service, who subsequently supported the recommendation. SEARCH recommends that cultural resources clearance for the project area is warranted. SEARCH will prepare a more in-depth draft report for your review and submittal to the US Fish and Wildlife Service.

Sincerely,

Jeff Enright
Project Manager

428 East Government Street • Pensacola, Florida 32502 • Phone 850-607-2846 • Fax 850-607-8439
www.searchinc.com

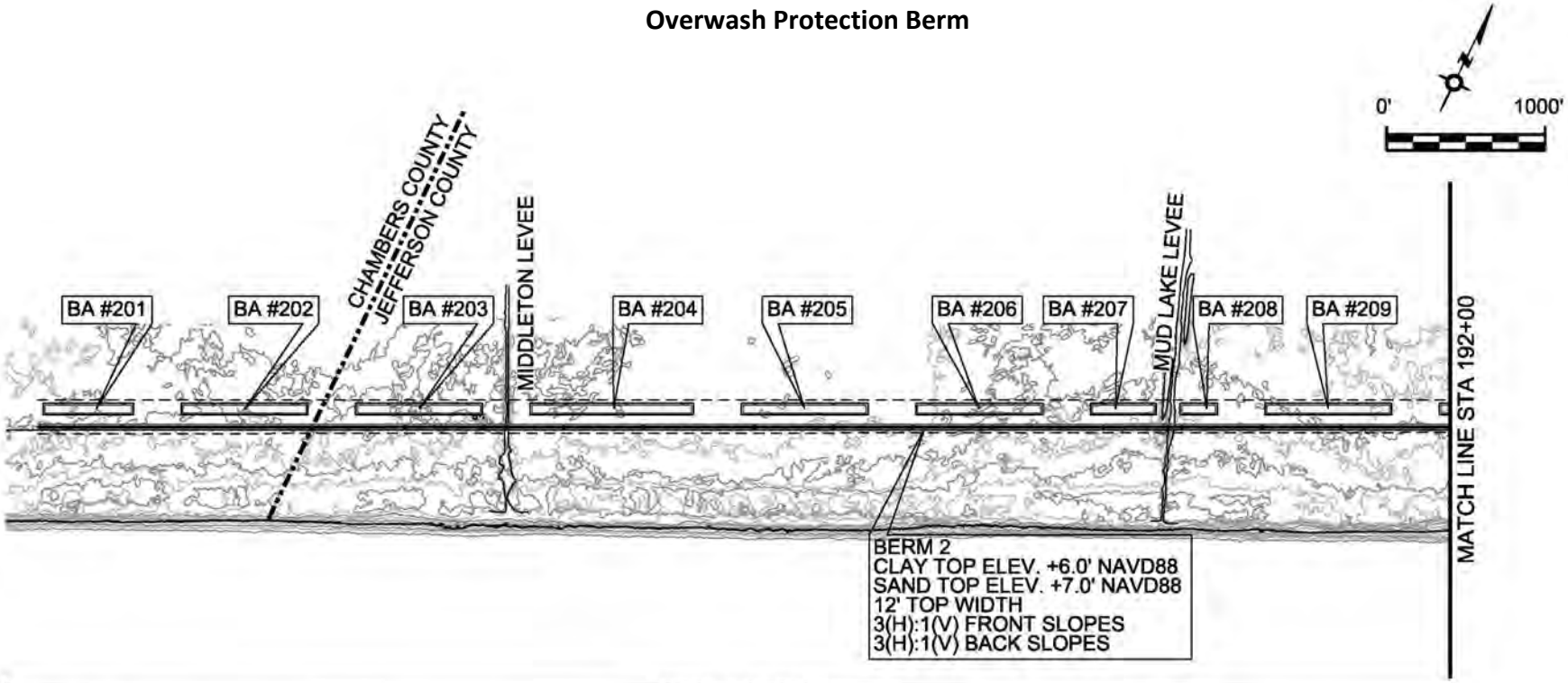
# APPENDIX F




NOTE:
USGS 7.5 MINUTE QUADRANGLE MAPS FOR MUD LAKE (1994), STAR LAKE (1994), SOUTH OF STAR LAKE (1994), AND WHITES RANCH (1993)

| BERMS | | | |
|---|---|---|---|
| NAME | EARTHWORK (C.Y.) | FOOTPRINT AREA (acres) | LENGTH (ft) |
| BERM 2 | 85,547 CY FILL | 19.88 | 24,060 |
| BERM 1a | 111,968 CY FILL | 26.03 | 31,491 |
| BERM 1b | 73,444 CY FILL | 17.07 | 20,656 |

**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

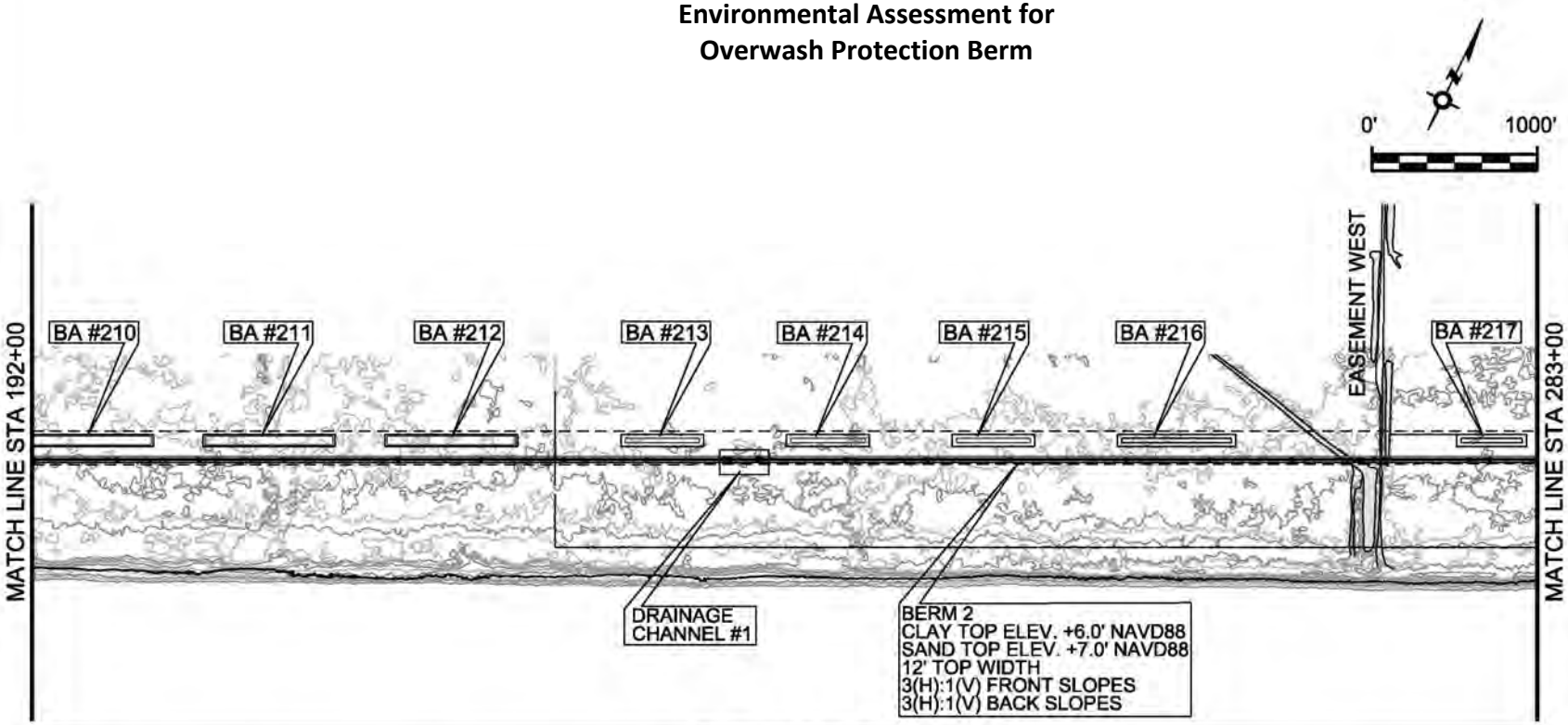



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#201 | 3,138 CUT | 0.98 | 13,781,253.25 | 3,443,507.35 | 13,781,505.62 | 3,444,018.44 | 13,781,438.37 | 3,444,051.65 | 13,781,186.00 | 3,443,540.56 |
| BA#202 | 4,449 CUT | 1.38 | 13,781,638.44 | 3,444,287.43 | 13,781,992.64 | 3,445,004.75 | 13,781,925.39 | 3,445,037.96 | 13,781,571.19 | 3,444,320.64 |
| BA#203 | 4,989 CUT | 1.38 | 13,782,125.46 | 3,445,273.75 | 13,782,479.66 | 3,445,991.06 | 13,782,412.41 | 3,446,024.27 | 13,782,058.22 | 3,445,306.95 |
| BA#204 | 6,540 CUT | 1.77 | 13,782,612.49 | 3,446,260.06 | 13,783,068.52 | 3,447,183.60 | 13,783,001.27 | 3,447,216.81 | 13,782,545.24 | 3,446,293.26 |
| BA#205 | 5,343 CUT | 1.38 | 13,783,201.34 | 3,447,452.60 | 13,783,555.54 | 3,448,169.91 | 13,783,488.29 | 3,448,203.12 | 13,783,134.09 | 3,447,485.80 |
| BA#206 | 6,496 CUT | 1.38 | 13,783,688.36 | 3,448,438.91 | 13,784,042.56 | 3,449,156.23 | 13,783,975.31 | 3,449,189.43 | 13,783,621.11 | 3,448,472.11 |
| BA#207 | 3,762 CUT | 0.72 | 13,784,175.38 | 3,449,425.22 | 13,784,359.57 | 3,449,798.22 | 13,784,292.32 | 3,449,831.43 | 13,784,108.13 | 3,449,458.43 |
| BA#208 | 2,277 CUT | 0.40 | 13,784,425.98 | 3,449,932.72 | 13,784,529.58 | 3,450,142.54 | 13,784,462.33 | 3,450,175.74 | 13,784,358.73 | 3,449,965.93 |
| BA#209 | 6,287 CUT | 1.38 | 13,784,662.40 | 3,450,411.53 | 13,785,016.60 | 3,451,128.85 | 13,784,949.35 | 3,451,162.05 | 13,784,595.16 | 3,450,444.74 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 2 | 24,060 FT | 19.88 | 85,547 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

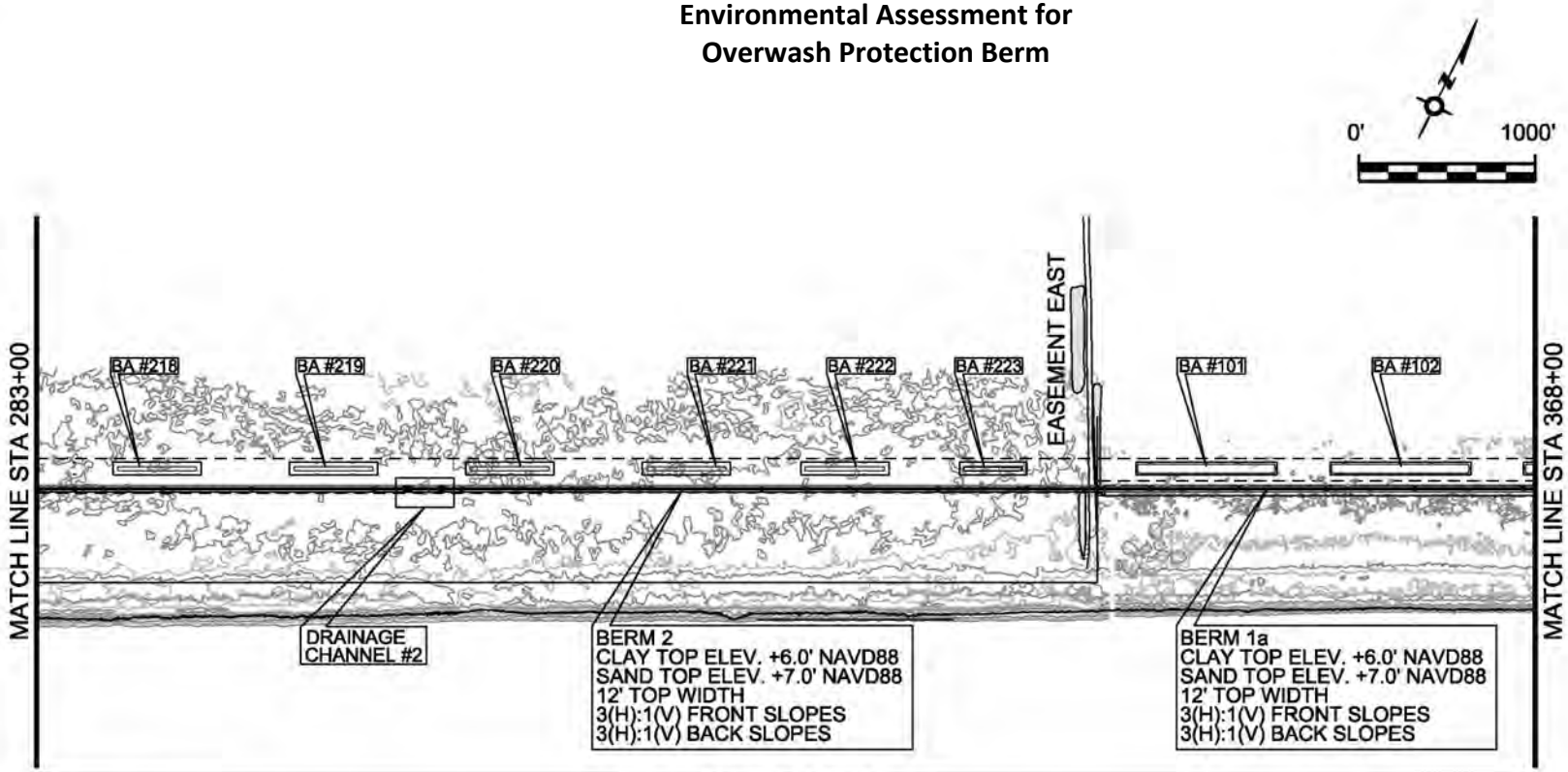



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#210 | 5,801 CUT | 1.38 | 13,785,149.43 | 3,451,397.84 | 13,785,503.62 | 3,452,115.16 | 13,785,436.38 | 3,452,148.36 | 13,785,082.18 | 3,451,431.05 |
| BA#211 | 5,783 CUT | 1.38 | 13,785,636.45 | 3,452,384.15 | 13,785,990.65 | 3,453,101.47 | 13,785,923.40 | 3,453,134.68 | 13,785,569.20 | 3,452,417.36 |
| BA#212 | 5,570 CUT | 1.38 | 13,786,123.47 | 3,453,370.46 | 13,786,477.67 | 3,454,087.78 | 13,786,410.42 | 3,454,120.99 | 13,786,056.22 | 3,453,403.67 |
| BA#213 | 8,829 CUT | 0.86 | 13,786,755.45 | 3,454,650.35 | 13,786,976.83 | 3,455,098.67 | 13,786,909.58 | 3,455,131.88 | 13,786,688.20 | 3,454,683.55 |
| BA#214 | 8,821 CUT | 0.86 | 13,787,198.20 | 3,455,546.99 | 13,787,419.57 | 3,455,995.32 | 13,787,352.32 | 3,456,028.52 | 13,787,130.95 | 3,455,580.20 |
| BA#215 | 8,810 CUT | 0.86 | 13,787,640.95 | 3,456,443.64 | 13,787,862.32 | 3,456,891.96 | 13,787,795.07 | 3,456,925.17 | 13,787,573.70 | 3,456,476.85 |
| BA#216 | 12,594 CUT | 1.23 | 13,788,083.69 | 3,457,340.29 | 13,788,400.26 | 3,457,981.39 | 13,788,333.01 | 3,458,014.60 | 13,788,016.44 | 3,457,373.49 |
| BA#217 | 7,436 CUT | 0.73 | 13,788,991.58 | 3,459,178.94 | 13,789,178.42 | 3,459,557.33 | 13,789,111.18 | 3,459,590.53 | 13,788,924.34 | 3,459,212.15 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 2 | 24,060 FT | 19.88 | 85,547 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

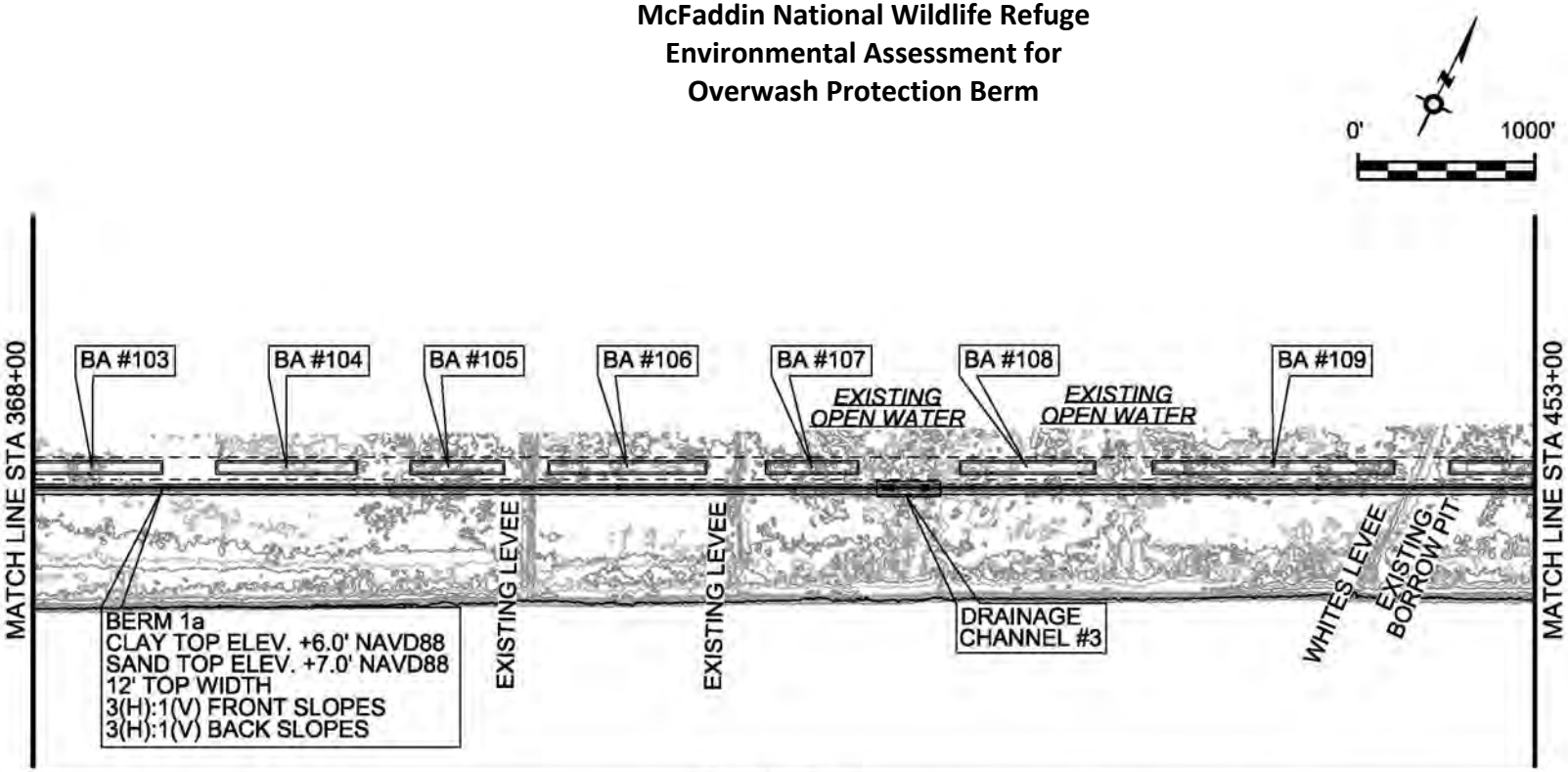



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#218 | 8,820 CUT | 0.86 | 13,789,399.80 | 3,460,005.65 | 13,789,621.17 | 3,460,453.97 | 13,789,553.92 | 3,460,487.18 | 13,789,332.55 | 3,460,038.85 |
| BA#219 | 8,820 CUT | 0.86 | 13,789,842.54 | 3,460,902.30 | 13,790,063.92 | 3,461,350.62 | 13,789,996.67 | 3,461,383.82 | 13,789,775.30 | 3,460,935.50 |
| BA#220 | 8,816 CUT | 0.86 | 13,790,285.29 | 3,461,798.94 | 13,790,506.66 | 3,462,247.27 | 13,790,439.42 | 3,462,280.47 | 13,790,218.04 | 3,461,832.15 |
| BA#221 | 8,813 CUT | 0.86 | 13,790,728.04 | 3,462,695.59 | 13,790,949.41 | 3,463,143.91 | 13,790,882.16 | 3,463,177.12 | 13,790,660.79 | 3,462,728.79 |
| BA#222 | 8,814 CUT | 0.86 | 13,791,126.51 | 3,463,502.57 | 13,791,347.88 | 3,463,950.89 | 13,791,280.64 | 3,463,984.10 | 13,791,059.26 | 3,463,535.78 |
| BA#223 | 6,723 CUT | 0.66 | 13,791,524.98 | 3,464,309.55 | 13,791,693.67 | 3,464,651.17 | 13,791,626.42 | 3,464,684.38 | 13,791,457.73 | 3,464,342.76 |
| BA#101 | 4,180 CUT | 1.38 | 13,791,967.73 | 3,465,206.20 | 13,792,321.93 | 3,465,923.52 | 13,792,254.68 | 3,465,956.72 | 13,791,900.48 | 3,465,239.40 |
| BA#102 | 4,156 CUT | 1.38 | 13,792,454.75 | 3,466,192.51 | 13,792,808.95 | 3,466,909.83 | 13,792,741.70 | 3,466,943.03 | 13,792,387.50 | 3,466,225.72 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 2 | 24,060 FT | 19.88 | 85,547 CY FILL |
| BERM 1a | 31,491 FT | 26.03 | 111,968 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

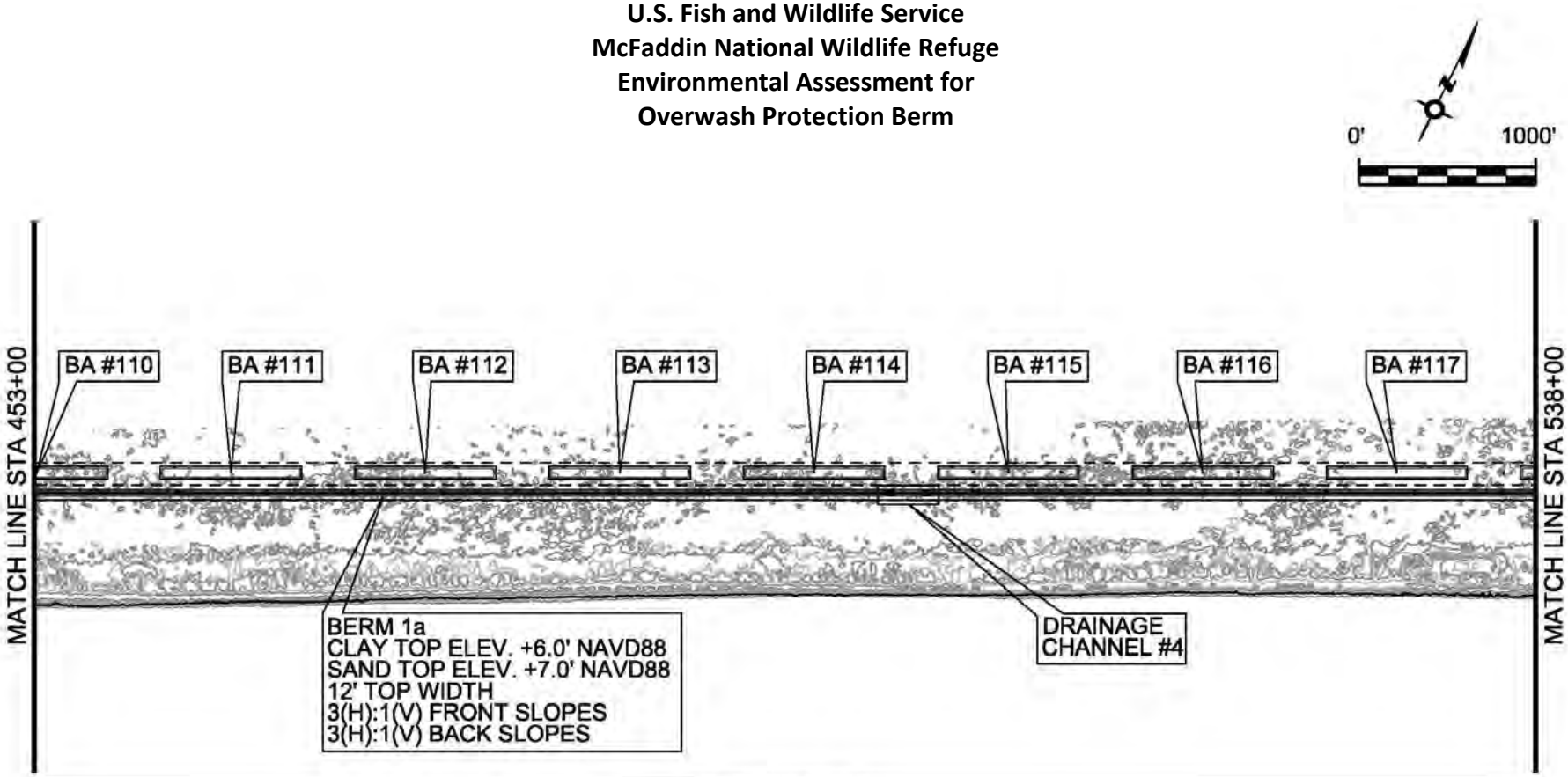



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#103 | 4,180 CUT | 1.38 | 13,792,941.77 | 3,467,178.82 | 13,793,295.97 | 3,467,896.14 | 13,793,228.72 | 3,467,929.34 | 13,792,874.52 | 3,467,212.03 |
| BA#104 | 4,156 CUT | 1.38 | 13,793,428.80 | 3,468,165.13 | 13,793,782.99 | 3,468,882.45 | 13,793,715.74 | 3,468,915.66 | 13,793,361.55 | 3,468,198.34 |
| BA#105 | 2,817 CUT | 0.92 | 13,793,915.82 | 3,469,151.44 | 13,794,152.46 | 3,469,630.70 | 13,794,085.22 | 3,469,663.91 | 13,793,848.57 | 3,469,184.65 |
| BA#106 | 4,491 CUT | 1.55 | 13,794,260.88 | 3,469,850.27 | 13,794,659.36 | 3,470,657.25 | 13,794,592.11 | 3,470,690.46 | 13,794,193.63 | 3,469,883.47 |
| BA#107 | 2,955 CUT | 0.91 | 13,794,806.23 | 3,470,954.71 | 13,795,040.23 | 3,471,428.59 | 13,794,972.98 | 3,471,461.80 | 13,794,738.99 | 3,470,987.91 |
| BA#108 | 3,751 CUT | 1.33 | 13,795,291.69 | 3,471,937.85 | 13,795,633.26 | 3,472,629.58 | 13,795,566.01 | 3,472,662.79 | 13,795,224.44 | 3,471,971.06 |
| BA#109 | 7,698 CUT | 2.36 | 13,795,774.99 | 3,472,916.61 | 13,796,383.04 | 3,474,148.03 | 13,796,315.79 | 3,474,181.24 | 13,795,707.74 | 3,472,949.82 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1a | 31,491 FT | 26.03 | 111,968 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

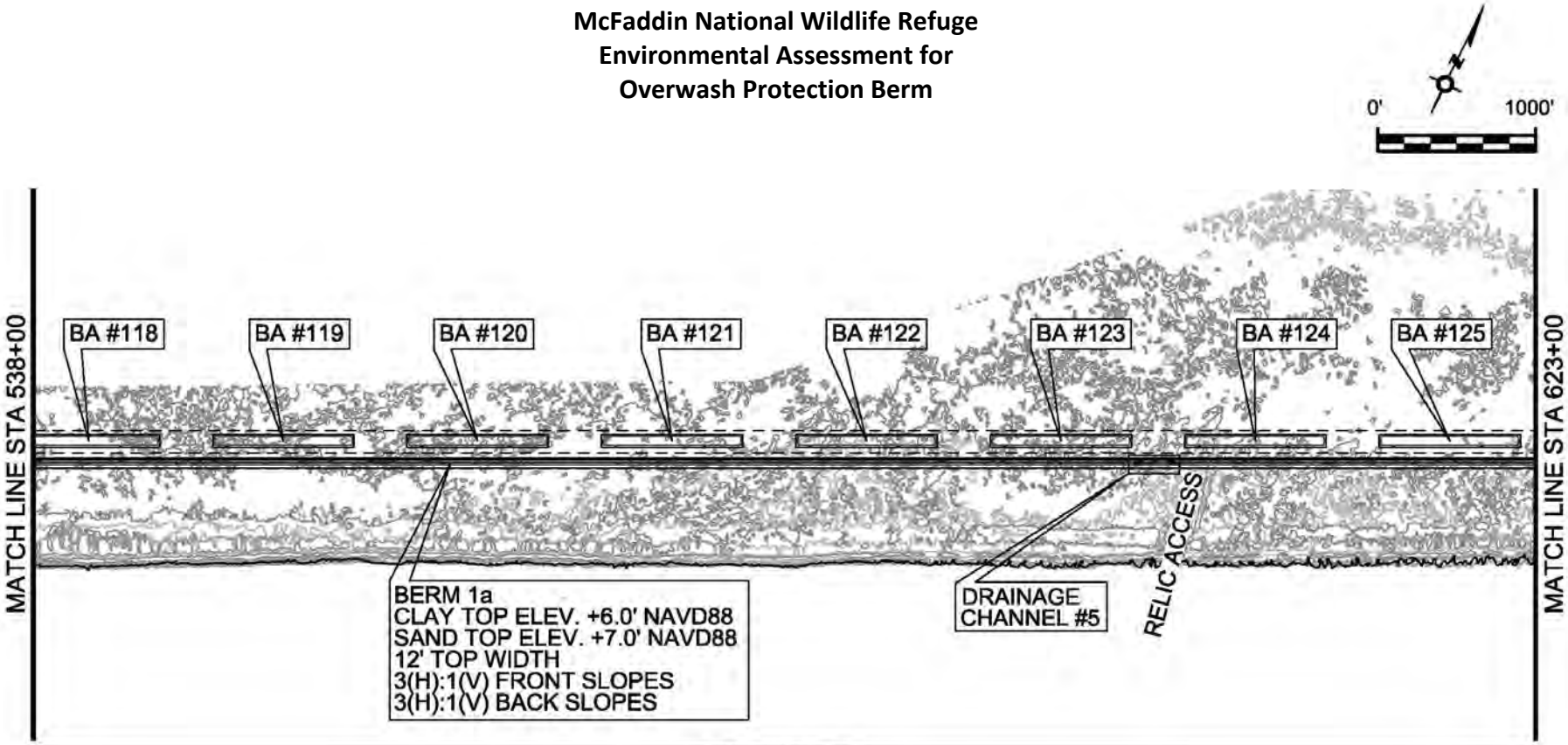



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#110 | 5,188 CUT | 1.55 | 13,796,519.31 | 3,474,424.01 | 13,796,917.78 | 3,475,231.00 | 13,796,850.54 | 3,475,264.20 | 13,796,452.06 | 3,474,457.22 |
| BA#111 | 4,846 CUT | 1.38 | 13,797,050.61 | 3,475,499.99 | 13,797,404.81 | 3,476,217.31 | 13,797,337.56 | 3,476,250.51 | 13,796,983.36 | 3,475,533.20 |
| BA#112 | 4,771 CUT | 1.38 | 13,797,537.63 | 3,476,486.30 | 13,797,891.83 | 3,477,203.62 | 13,797,824.58 | 3,477,236.82 | 13,797,470.38 | 3,476,519.51 |
| BA#113 | 4,799 CUT | 1.38 | 13,798,024.65 | 3,477,472.61 | 13,798,378.85 | 3,478,189.93 | 13,798,311.60 | 3,478,223.14 | 13,797,957.40 | 3,477,505.82 |
| BA#114 | 4,735 CUT | 1.38 | 13,798,511.67 | 3,478,458.92 | 13,798,865.87 | 3,479,176.24 | 13,798,798.62 | 3,479,209.45 | 13,798,444.42 | 3,478,492.13 |
| BA#115 | 4,747 CUT | 1.38 | 13,798,998.69 | 3,479,445.23 | 13,799,352.89 | 3,480,162.55 | 13,799,285.64 | 3,480,195.76 | 13,798,931.45 | 3,479,478.44 |
| BA#116 | 4,579 CUT | 1.38 | 13,799,485.72 | 3,480,431.55 | 13,799,839.91 | 3,481,148.86 | 13,799,772.67 | 3,481,182.07 | 13,799,418.47 | 3,480,464.75 |
| BA#117 | 4,225 CUT | 1.38 | 13,799,972.74 | 3,481,417.86 | 13,800,326.94 | 3,482,135.17 | 13,800,259.69 | 3,482,168.38 | 13,799,905.49 | 3,481,451.06 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1a | 31,491 FT | 26.03 | 111,968 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

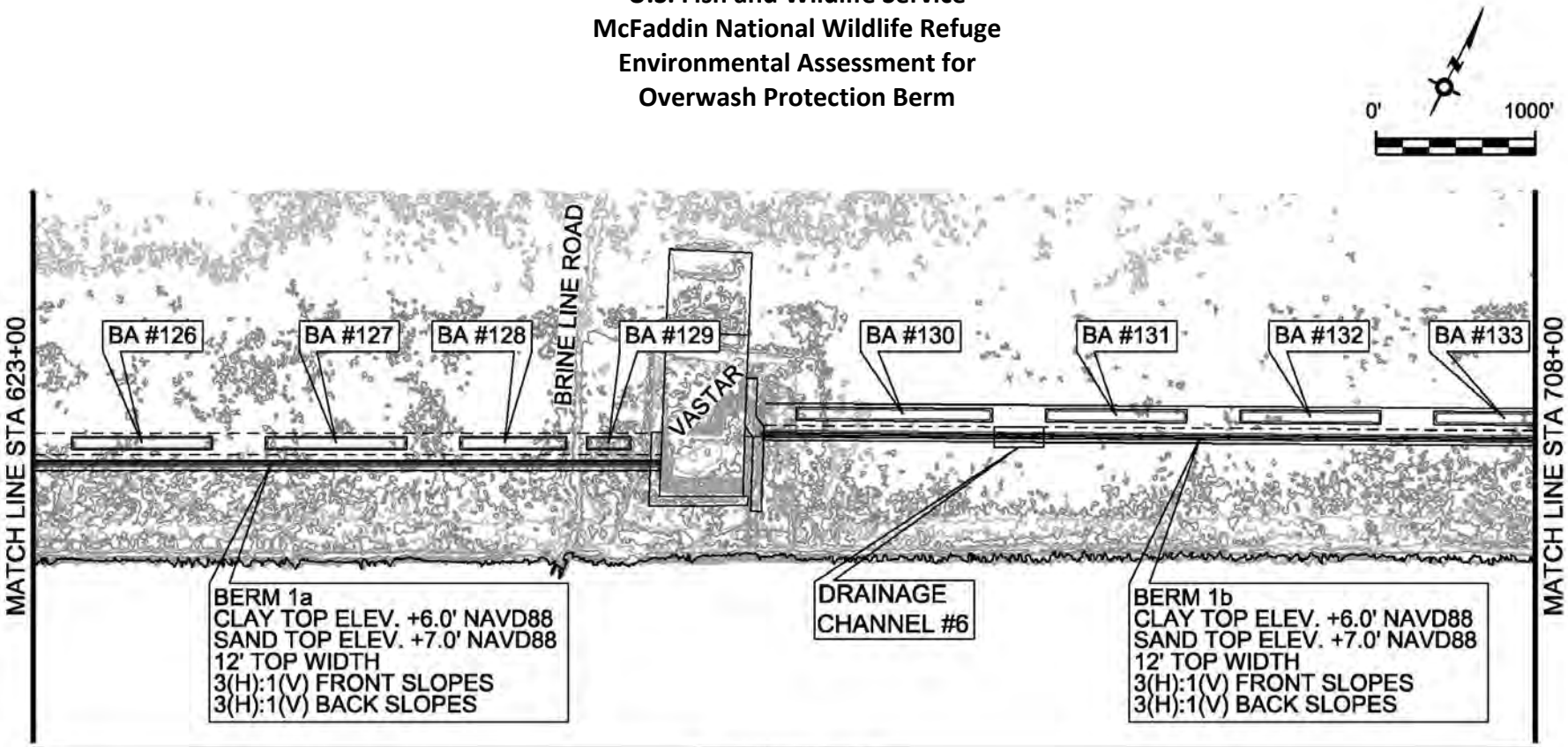



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#118 | 4,482 CUT | 1.38 | 13,800,459.76 | 3,482,404.17 | 13,800,813.96 | 3,483,121.49 | 13,800,746.71 | 3,483,154.69 | 13,800,392.51 | 3,482,437.37 |
| BA#119 | 4,705 CUT | 1.38 | 13,800,946.78 | 3,483,390.48 | 13,801,300.98 | 3,484,107.80 | 13,801,233.73 | 3,484,141.00 | 13,800,879.53 | 3,483,423.69 |
| BA#120 | 4,560 CUT | 1.38 | 13,801,433.80 | 3,484,376.79 | 13,801,788.00 | 3,485,094.11 | 13,801,720.75 | 3,485,127.31 | 13,801,366.55 | 3,484,410.00 |
| BA#121 | 4,468 CUT | 1.38 | 13,801,920.82 | 3,485,363.10 | 13,802,275.02 | 3,486,080.42 | 13,802,207.77 | 3,486,113.63 | 13,801,853.58 | 3,485,396.31 |
| BA#122 | 4,971 CUT | 1.38 | 13,802,407.85 | 3,486,349.41 | 13,802,762.04 | 3,487,066.73 | 13,802,694.80 | 3,487,099.94 | 13,802,340.60 | 3,486,382.62 |
| BA#123 | 4,601 CUT | 1.38 | 13,802,894.87 | 3,487,335.72 | 13,803,249.07 | 3,488,053.04 | 13,803,181.82 | 3,488,086.25 | 13,802,827.62 | 3,487,368.93 |
| BA#124 | 4,577 CUT | 1.38 | 13,803,381.89 | 3,488,322.04 | 13,803,736.09 | 3,489,039.35 | 13,803,668.84 | 3,489,072.56 | 13,803,314.64 | 3,488,355.24 |
| BA#125 | 4,227 CUT | 1.38 | 13,803,868.91 | 3,489,308.35 | 13,804,223.11 | 3,490,025.66 | 13,804,155.86 | 3,490,058.87 | 13,803,801.66 | 3,489,341.55 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1a | 31,491 FT | 26.03 | 111,968 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

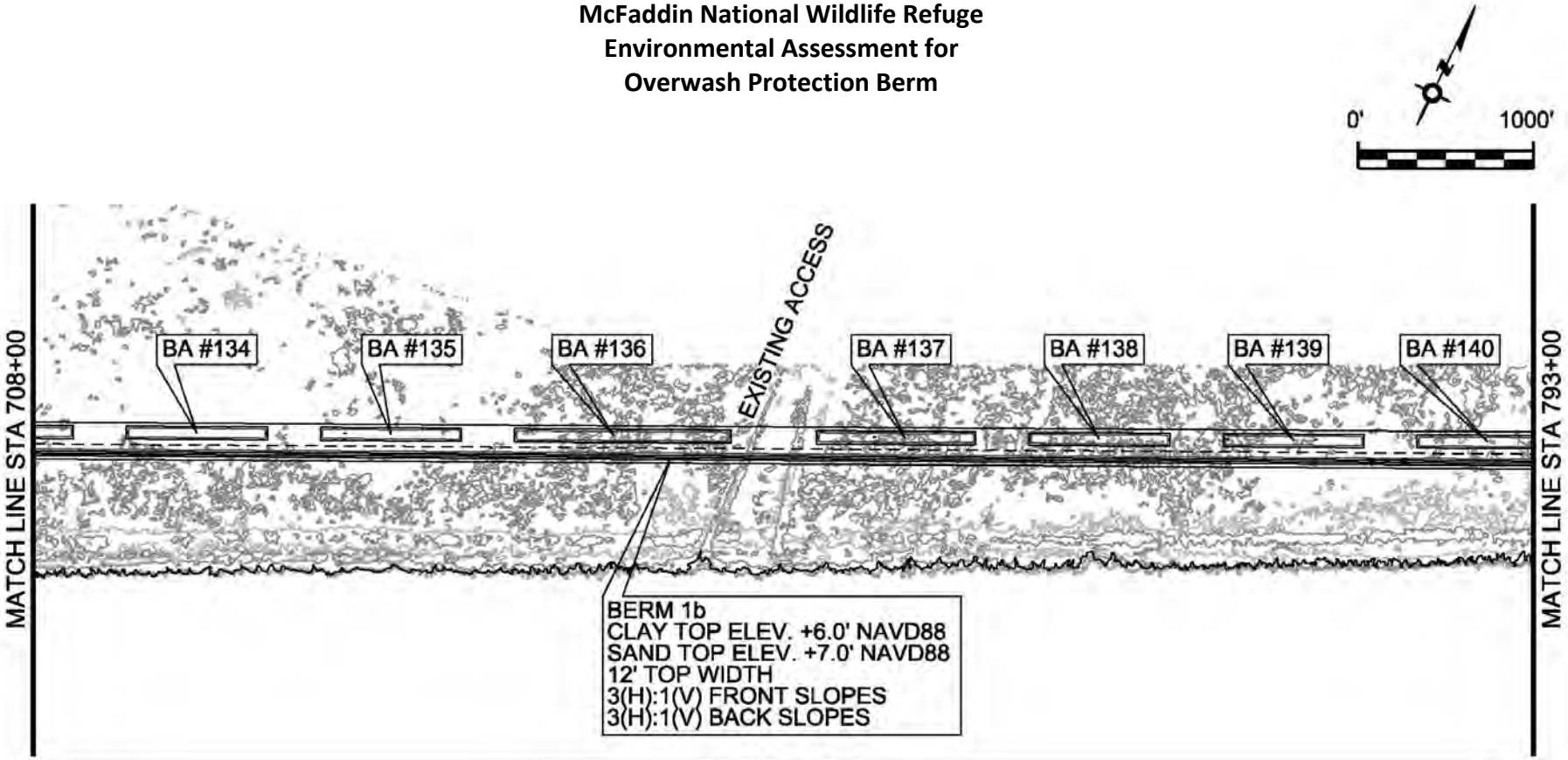



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#126 | 4,314 CUT | 1.38 | 13,804,355.93 | 3,490,294.66 | 13,804,710.13 | 3,491,011.98 | 13,804,642.88 | 3,491,045.18 | 13,804,288.68 | 3,490,327.86 |
| BA#127 | 4,376 CUT | 1.38 | 13,804,842.96 | 3,491,280.97 | 13,805,197.15 | 3,491,998.29 | 13,805,129.90 | 3,492,031.49 | 13,804,775.71 | 3,491,314.18 |
| BA#128 | 3,313 CUT | 1.04 | 13,805,329.98 | 3,492,267.28 | 13,805,597.78 | 3,492,809.64 | 13,805,530.53 | 3,492,842.84 | 13,805,262.73 | 3,492,300.49 |
| BA#129 | 1,456 CUT | 0.43 | 13,805,646.48 | 3,492,908.27 | 13,805,757.17 | 3,493,132.43 | 13,805,689.92 | 3,493,165.64 | 13,805,579.24 | 3,492,941.47 |
| BA#130 | 5,900 CUT | 1.91 | 13,806,321.83 | 3,493,898.76 | 13,806,807.17 | 3,494,898.76 | 13,806,739.70 | 3,494,931.51 | 13,806,254.35 | 3,493,931.51 |
| BA#131 | 4,314 CUT | 1.38 | 13,806,938.16 | 3,495,168.64 | 13,807,287.48 | 3,495,888.36 | 13,807,220.01 | 3,495,921.11 | 13,806,870.69 | 3,495,201.39 |
| BA#132 | 4,255 CUT | 1.38 | 13,807,418.47 | 3,496,158.24 | 13,807,767.78 | 3,496,877.96 | 13,807,700.31 | 3,496,910.71 | 13,807,350.99 | 3,496,190.99 |
| BA#133 | 4,306 CUT | 1.38 | 13,807,898.77 | 3,497,147.84 | 13,808,248.08 | 3,497,867.56 | 13,808,180.00 | 3,497,900.60 | 13,807,831.30 | 3,497,180.59 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1a | 31,491 FT | 26.03 | 111,968 CY FILL |
| BERM 1b | 20,656 FT | 17.07 | 73,444 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

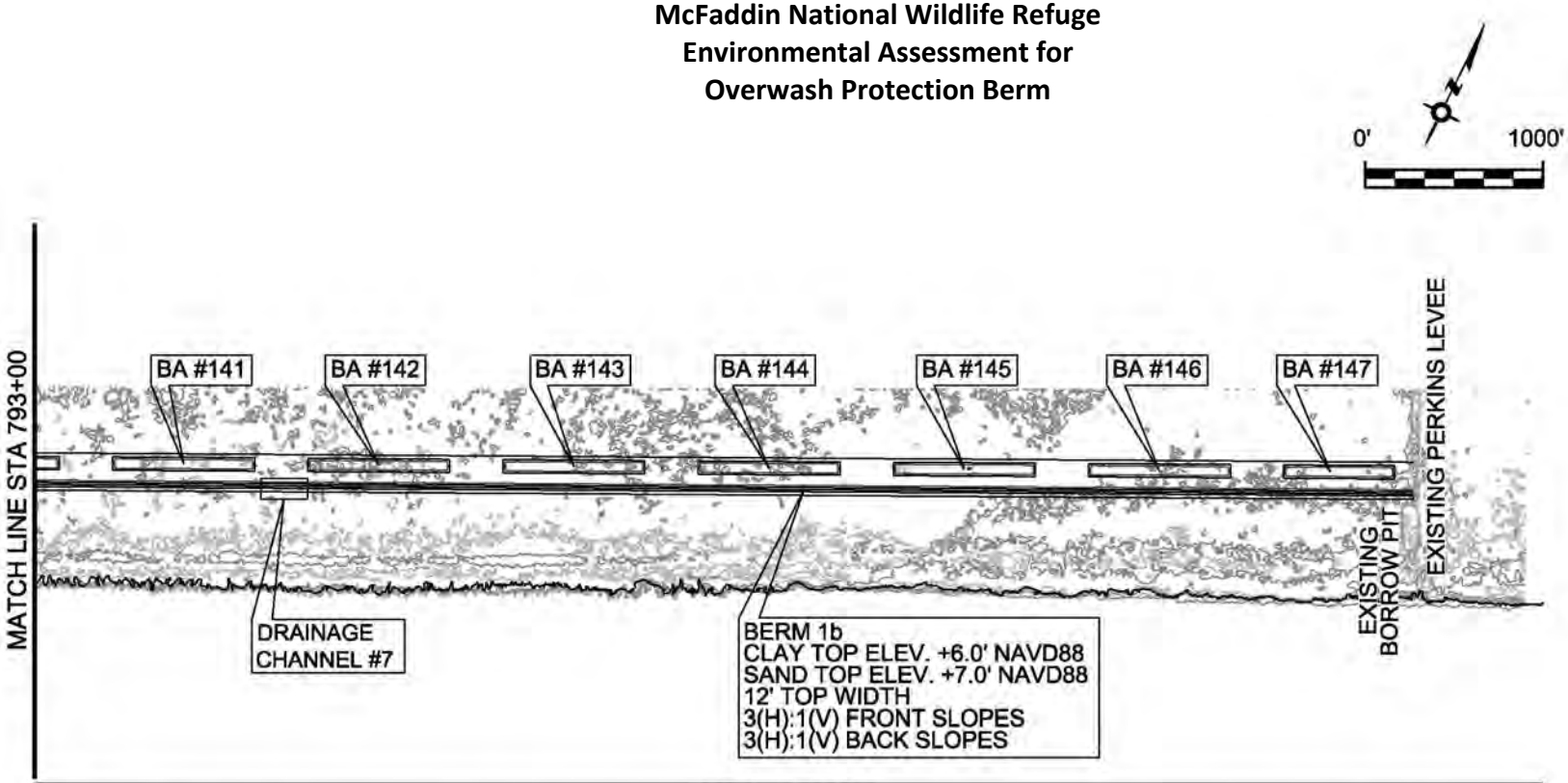



| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#134 | 4,293 CUT | 1.38 | 13,808,379.07 | 3,498,137.44 | 13,808,728.39 | 3,498,857.16 | 13,808,660.92 | 3,498,889.91 | 13,808,311.60 | 3,498,170.19 |
| BA#135 | 4,334 CUT | 1.38 | 13,808,859.38 | 3,499,127.04 | 13,809,208.69 | 3,499,846.76 | 13,809,141.22 | 3,499,879.51 | 13,808,791.91 | 3,499,159.79 |
| BA#136 | 7,082 CUT | 2.11 | 13,809,339.68 | 3,500,116.64 | 13,809,875.19 | 3,501,219.98 | 13,809,807.71 | 3,501,252.73 | 13,809,272.21 | 3,500,149.39 |
| BA#137 | 5,321 CUT | 1.55 | 13,810,087.41 | 3,501,657.24 | 13,810,480.39 | 3,502,466.92 | 13,810,412.92 | 3,502,499.67 | 13,810,019.94 | 3,501,689.99 |
| BA#138 | 4,523 CUT | 1.38 | 13,810,611.38 | 3,502,736.80 | 13,810,960.69 | 3,503,456.52 | 13,810,893.22 | 3,503,489.27 | 13,810,543.91 | 3,502,769.55 |
| BA#139 | 4,842 CUT | 1.38 | 13,811,091.68 | 3,503,726.40 | 13,811,441.00 | 3,504,446.12 | 13,811,373.52 | 3,504,478.87 | 13,811,024.21 | 3,503,759.15 |
| BA#140 | 5,021 CUT | 1.38 | 13,811,571.99 | 3,504,716.00 | 13,811,921.30 | 3,505,435.72 | 13,811,853.83 | 3,505,468.47 | 13,811,504.51 | 3,504,748.75 |

| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1b | 20,656 FT | 17.07 | 73,444 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**




| BORROW AREAS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | EARTHWORK | AREA | North Corner | | East Corner | | South Corner | | West Corner | |
| | (C.Y.) | (acres) | Northing | Easting | Northing | Easting | Northing | Easting | Northing | Easting |
| BA#141 | 5,218 CUT | 1.38 | 13,812,052.29 | 3,505,705.60 | 13,812,401.60 | 3,506,425.32 | 13,812,334.13 | 3,506,458.07 | 13,811,984.82 | 3,505,738.35 |
| BA#142 | 4,951 CUT | 1.38 | 13,812,532.59 | 3,506,695.20 | 13,812,881.91 | 3,507,414.92 | 13,812,814.43 | 3,507,447.67 | 13,812,465.12 | 3,506,727.95 |
| BA#143 | 4,951 CUT | 1.38 | 13,813,012.90 | 3,507,684.80 | 13,813,362.21 | 3,508,404.52 | 13,813,294.74 | 3,508,437.27 | 13,812,945.42 | 3,507,717.55 |
| BA#144 | 4,835 CUT | 1.38 | 13,813,493.20 | 3,508,674.40 | 13,813,842.51 | 3,509,394.12 | 13,813,775.04 | 3,509,426.87 | 13,813,425.73 | 3,508,707.15 |
| BA#145 | 5,032 CUT | 1.38 | 13,813,973.50 | 3,509,664.01 | 13,814,322.82 | 3,510,383.72 | 13,814,255.34 | 3,510,416.47 | 13,813,906.03 | 3,509,696.75 |
| BA#146 | 4,845 CUT | 1.38 | 13,814,453.81 | 3,510,653.61 | 13,814,803.12 | 3,511,373.32 | 13,814,735.65 | 3,511,406.07 | 13,814,386.33 | 3,510,686.35 |
| BA#147 | 3,763 CUT | 1.07 | 13,814,934.11 | 3,511,643.21 | 13,815,206.68 | 3,512,204.80 | 13,815,139.21 | 3,512,237.55 | 13,814,866.64 | 3,511,675.95 |

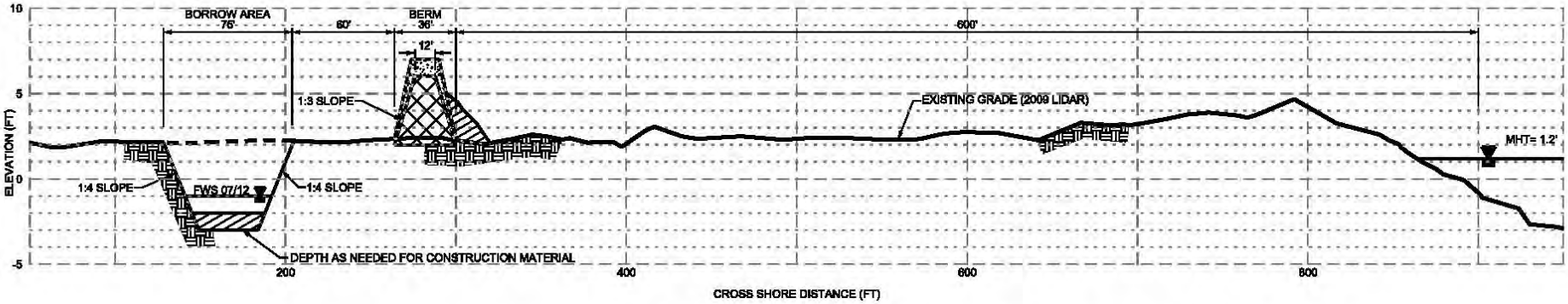
| BERMS | | | |
|---|---|---|---|
| NAME | LENGTH | FOOTPRINT AREA (acres) | EARTHWORK (C.Y.) |
| BERM 1b | 20,656 FT | 17.07 | 73,444 CY FILL |



**Appendix F**
**Plan View of**
**Berm Nos. 2, 1A , and 1B (west to east)**

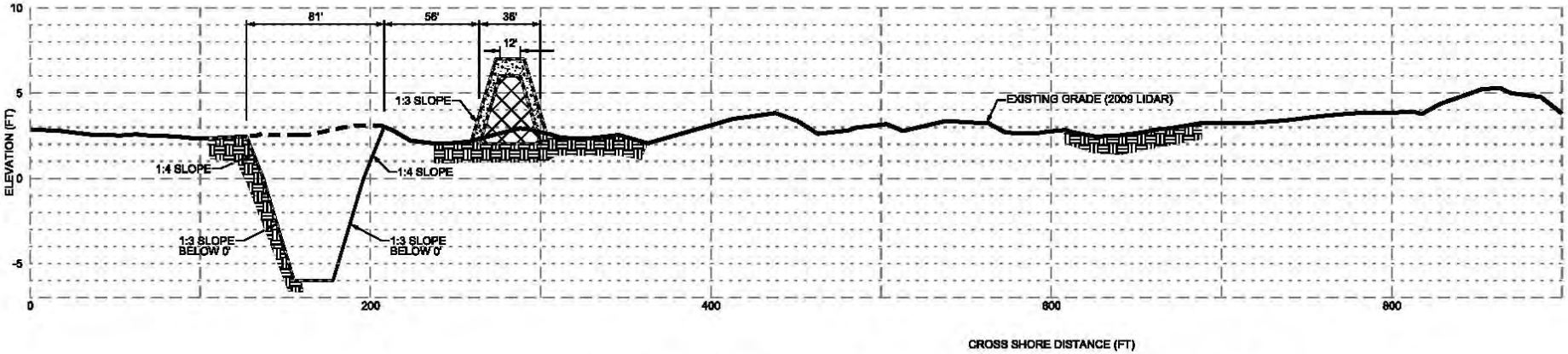
# APPENDIX G

# U.S. Fish and Wildlife Service
# McFaddin National Wildlife Refuge
# Environmental Assessment for
# Overwash Protection Berm




01 TYPICAL SECTION FOR BERM AND ASSOCIATED BORROW AREAS

SCALE: 1"=100' H, 1"=10' V




02 INCREASED DEPTH SECTION FOR BORROW AREAS #213-223

SCALE: 1"=100' H, 1"=10' V

KEY

- CLAY BERM
- REMOVED/REPLACED ORGANICS
- IMPORTED SAND, 1' THICK
- FWS 07/12 — APPROXIMATE FREE WATER SURFACE, OBSERVED DURING GEOTECHNICAL ENGINEERING STUDY BORINGS 07/2012

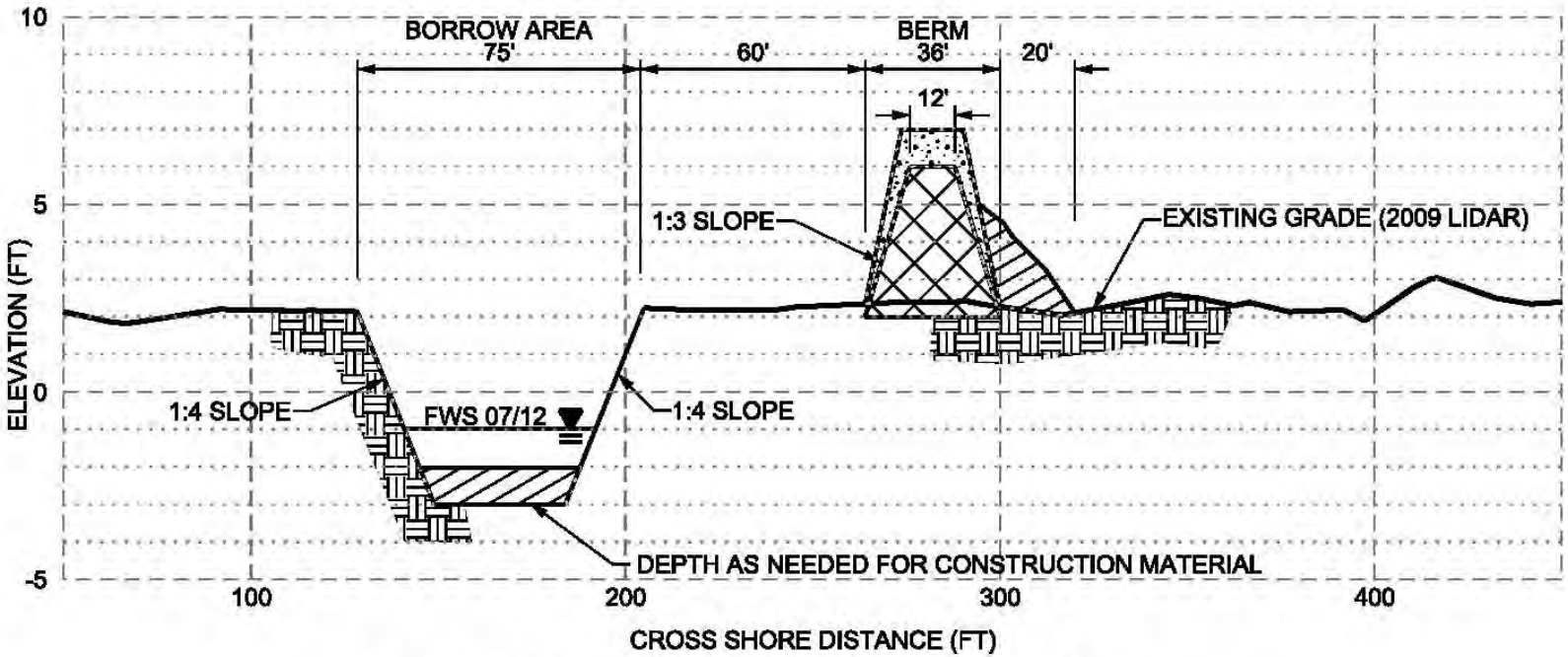
0' 100'

**NOTE: All elevations relate to NAVD 88**

**Appendix G**
**Berm Typical Section**

# APPENDIX H

**U.S. Fish and Wildlife Service**
**McFaddin National Wildlife Refuge**
**Environmental Assessment for**
**Overwash Protection Berm**




02 DETAIL FOR BERM AND ASSOCIATED BORROW AREAS
SCALE: 1"=60' H, 1"=6' V

KEY

REMOVED/REPLACED ORGANICS

CLAY BERM

IMPORTED SAND, 1' THICK

FWS 07/12 APPROXIMATE FREE WATER SURFACE, OBSERVED DURING GEOTECHNICAL ENGINEERING STUDY BORINGS 07/2012

0' 60'

NOTE: All elevations relate to NAVD 88

**Appendix H**
**Berm Details**

# APPENDIX I

# Compatibility Determination

**Use:** Construction of a clay and sand berm to restore hurricane damaged dune ridge and reduce frequency and extent of sea water inundation into interior marshes.

**Refuge Name:** McFaddin National Wildlife Refuge (NWR)

**Establishing and Acquisitions Authority (ies):**

The Migratory Bird Conservation Act of 1929.

**Refuge Purpose:**

"…for use as an inviolate sanctuary, or for any other management purpose for migratory birds." 16 USC § 715d (Migratory Bird Conservation Act)

**National Wildlife Refuge System Mission:**

"The mission of the National Wildlife Refuge System (NWRS) is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended) [16 USC 668dd-668ee]

**Description of Use:**

*a) What is the use? Is the use a priority public use?*

McFaddin NWR is proposing to construct a 14.5 mile clay and sand berm that would reduce the frequency and extent of sea water inundation in its interior marshes. The primary purpose of the berm is to prevent saltwater intrusion into McFaddin NWR along the shoreline due to tides and storm water levels, occurring more frequently than the 5 year return interval (20% chance of occurrence in a given year). Secondary goals include creating additional marsh habitat and increasing berm resiliency during storm events.

Considering the purpose of McFaddin NWR, compatibility with potential future restoration activities, and budget constraints, the creation of a gently-sloping earthen berm will aid in preventing sea water overwash into the refuge. McFaddin NWR consists of the largest remaining freshwater marsh on the Texas Coast, along with thousands of acres of intermediate to brackish marsh. Meeting the habitat needs of diverse wetland dependent resident and migratory birds requires maintaining a range of coastal marsh habitat types, as well as sequential stages of the plant community within these marsh types. Providing freshwater inflows and restricting saltwater intrusion are critical to maintaining the Chenier Plain's historic continuum of fresh, intermediate, and brackish saline marshes. Habitat values for waterfowl, shorebirds, and many wading bird species are greatly enhanced in intermediate marshes with early successional plant

communities containing several perennial and annual plant species (primarily grasses and sedges). The project will immediately reduce sea water inundation.

This use is not a priority public use. Stipulations to Ensure Compatibility are to be included in the Special Use Permit to help minimize environmental impacts and ensure compatibility with the purposes for which the refuge was established, as well as the mission of the NWRS.

*b) Where would this use be conducted?*

Established in 1980, McFaddin NWR covers more than 58,000-acres and is part of the Salt Bayou marsh system which comprises the area west of Sabine Lake and the Sabine-Neches Waterway, and south of the Gulf Intracoastal Waterway (GIWW). This system consists of a continuum of saline tidal to freshwater microtidal systems. McFaddin NWR is located along SH 87 in the southeastern portion of Texas, near the Louisiana border. The Refuge lies approximately 15 miles south of Port Arthur, 90 miles east of Houston, and 12 miles west of Sabine Pass. McFaddin NWR is bounded on the south by the Gulf of Mexico, on the east by Texas Parks and Wildlife Department (TPWD) Property and private land, on the west by private land near High Island, and both the GIWW and private property to the north. The proposed project will be located approximately 600-feet landward of the McFaddin NWR Gulf shoreline, parallel to the remaining alignment of State Highway (SH) 87 in Jefferson and Chambers Counties.

The proposed construction of a 14.5 mile berm on McFaddin NWR is important, given that the historical beach dune has been destroyed, due to changes in the natural waterways by dredging and jetties, and there are no longer any sediments moving into the system. Erosion has washed away the back dune, across the historical marsh ridge that was present, and into the high marsh to the north. Erosion rates now have a 3 year average of more than 15 to 45 feet yearly. As erosion has continued, the trends in similar areas to the east and west have experienced a rapid increase of erosion rates with average rates reaching more than 70 feet yearly. The current situation has left the marsh ridge with an elevation of between 3.6 to less than 6 feet MSL. Currently, at times when winds from the south reach 20 miles per hour (mph) or more along more than 15 miles of coast line, this low elevation allows significant water to wash across the ridge into the interior marsh. This regular inundation into the marsh has increased the salinity levels in the entire Salt Bayou System and removed the largest source of fresh water from the system. In addition to the potential of projected sea level rise, these issues would put 52,800 acres of McFaddin NWR south of the GIWW in jeopardy of not being able to meet even the most basic refuge management goals.

*c) When would this use be conducted?*

The construction of the project would occur between January 15, 2014 and August 31, 2014. The construction is not expected to take the entire 10 month period, but the coordination with the permitting authorities has created a large construction timeframe to allow for rain and delays before the final completion. Efforts to minimize impacts to the piping plover are to be incorporated in the construction. Impacts to wintering waterfowl will occur in the project area through construction. These short term impacts will provide increased habitat values for

affected species for many years. Funding deadlines and the size of the project will not allow us to avoid these impacts by a seasonal construction closure,

*d) How will this use be conducted?*

The proposed berm will consist of a trapezoidal berm configuration with +6 ft NAVD88 crest elevation, +2 ft NAVD88 foundation elevation, 1V:3H side slopes side slopes and a 12 ft crest width. The clay material will be excavated from borrow areas adjacent to and landward of the berm. Each foot of the clay berm will be covered with 1.5 CY of imported sand and approximately 1 CY of organics and sand stripped from the berm footprint. This sand covered, clay core berm will be kept vegetated by Refuge personnel, as necessary.

The creation of borrow areas were located on the landward side of the proposed berm alignment. Impacts to the marsh will be minimized by the ability to restrict construction activities to the corridor between the borrow areas and berm. This would also eliminate the traffic thoroughfare running to and from centrally located borrow areas. Where possible borrow areas will consist of smaller, shallower areas, thus reducing the overall impact to the marsh, creating shallow open water and estuarine intertidal emergent wetlands to provide an enhanced aquatic resource for McFaddin NWR. Some areas will be designed with deeper pits to designed reduce the overall loss of marshland between the borrow pits.

Design consideration was given to the need and ability to drain sea water back into the Gulf following major storm surge events. Different locations were determined as optimal locations because flows were already concentrated alongside existing levees and borrow areas. A total of six locations were determined for the length of the proposed berm. Each of the major drainage areas between the existing levees in McFaddin NWR has a discharge point. Using these points, the duration of the inundation can be reduced versus the impounding time should the entire Refuge be forced to drain across the interior marshes into the GIWW.

*e) Why is this use being proposed?*

The proposed berm project will stop the future conversion of tens of thousands of acres of refuge habitat into open sea water. At current rates, more than 200 acres of marsh habitat are lost annually. Historically, it has required an entire growing season for these marshes to recover following sea water inundation as subsequent rainfall helps flush the system and reduce salinities. Present conditions under which sea water continues to enter the marsh on a frequent basis will prevent such recovery, and accelerate the marsh die-off. Cascading effects include reduced biomass production and loss of organic soils, leading to rapid conversion to open salt water. In addition to the conversion of hundreds of acres per year to open water at the Gulf shoreline, the interior of the marsh will then open up and eventually connect to the Gulf of Mexico. Examples of this progression are evident only a few miles to the east in Southern Louisiana, where billions of dollars are now being spent to respond to similar circumstances after the fact. Without constructing a berm, the function of the wetlands in the McFaddin NWR system would be drastically diminished and, therefore, the total volume of carbon sequestration that occurs within the Salt Bayou system would be drastically diminished.

McFaddin NWR lies within a bio-geographical region known as the Chenier Plain (Gosselink et al. 1979). Geographically, the Chenier Plain region extends from Vermillion Bay in southwestern Louisiana to East Galveston Bay in southeastern Texas. A distinguishing feature of the region is the presence of cheniers, ridges representing the ancient Gulf shorelines which are generally aligned parallel to the Gulf or as fanshaped alluvial deposits at the mouths of rivers. The higher cheniers support woody vegetation, hence the name chenier, a French word which means "place of oaks". Cheniers are more prevalent in Louisiana than in Texas, perhaps because of the alignment of the Gulf shoreline and its proximity to the Mississippi River, the Chenier Plain region's primary sediment source. Given the region's significant annual rainfall, wetlands isolated from the Gulf by the cheniers and ridges developed into highly productive and diverse freshwater coastal marsh habitats. The existing beach ridge on McFaddin NWR was produced by those alluvial deposits and is responsible for the existence of the freshwater marshes within Salt Bayou.

The building the proposed berm will create the conversion of 118 acres of degraded wetlands to shallow open water and estuarine inter-tidal emergent wetlands, thus providing an enhanced aquatic resource for McFaddin NWR. Estuarine inter-tidal emergent wetlands are recognized as nationally-declining wetland types. There will be a reduction of salts and sulfides currently within the system, as well as decreases in the redox potential. Decreases in salinities will invigorate the plant community and increase colonization of new emergent marsh vegetation. This will not only facilitate the production of new organic soils, but also the deposition of above ground biomass and cause increases in subterranean biomass from root production. Species diversity with the emergent marsh community north of the berm will increase as the reappearance of many vegetative species with lower salinity tolerance will occur. This will create more of a mosaic of habitats available for all species within the McFaddin NWR. As species diversity increases, a corresponding increase in production of food availability will occur across the ecosystem, from the microbial community to the vertebrate community. The invaluable characteristic of the wetland to filter nutrients will increase and the system's capacity to perform carbon sequestration and storage will return. Water temperatures will decrease, allowing suspended oxygen levels to remain high, and overall water quality will improve. Aquatic plant communities, specifically the submerged aquatic vegetation and floating aquatic vegetation, will greatly improve with the construction of the berm. Within a few short years, the species of floating aquatic vegetation lost due to salinity should increase across the marsh reestablish naturally, and the diversity of submerged aquatic vegetation will return.

**Availability of Resources:**

The construction funding has been developed from a combination of funds from Federal, State and Jefferson County funding sources. There are limited resources needed to administer this proposed project beyond the proposed construction budget. Adequate refuge personnel and operational funds are available to manage the recurring proposed project costs such as small repairs, mowing and some law enforcement to deal with trespass issues.

**<u>Anticipated Impacts of the Use</u>:**

The following is a summary of the anticipated impacts, both from not building and building the berm. Please refer to the EA for a more complete review of the anticipated impacts of the project.

*Beneficial Impacts:*

The building of the berm would keep the current ratio of emergent marsh to open water the same, or would slowly change toward increasing emergent marsh habitat. Due to decreased salinities, overall productivity of marsh vegetation would increase, which will provide more forage for wintering waterfowl. With increases in species diversity, a corresponding increase in diversity of the types of forage would occur as well. Dabbling ducks would have increased availability to plant tubers and seeds. Diving ducks would have increased availability to prime forage, such as sago pondweed (*Potamogeton pectinatus*), banana waterlily (*Nyphaea mexicana*), and perhaps water shield (*Brasenia*). Snow geese numbers would likely be maintained at or near current levels. Some increases in both white-fronted geese and white-cheeked geese would likely occur as suitable habitat increased. Local population of mottled ducks would likely increase as more suitable habitat occurs at low salinity levels. This will increase the probability of brood survival across McFaddin NWR, rather than just portions of it, as is the current situation.

*<u>Waterbirds:</u>*
Waterbird species utilizing the marshes on McFaddin NWR for shallow water feeding, breeding, and resting habitat would benefit by long-term protection of these habitats. For several of the larger long-billed species like willet, whimbrel, godwits, and long-billed curlews, constructing the berm would create highly preferred habitat for foraging on fiddler crabs. Wading and marsh birds would benefit from the creation of shallow fresh water habitat by providing increased foraging areas. Increases in nesting rails and bitterns would be very likely, as well as in pied-billed grebe and common moorhens.

*<u>Raptors:</u>*
Raptors, commonly observed on McFaddin NWR, would benefit in a positive manner as the habitat conditions stabilize, and forage species would not disappear due to habitat loss. Northern Harriers should experience long term prey base increases, as marsh rodent populations increase with fresher marsh conditions.

*<u>Fisheries Resources:</u>*
Constructing the berm would reestablish the natural isohaline gradients that are present in estuarine ecosystem and benefit all species that utilize the coastal marsh as nurseries. This portion of McFaddin NWR would remain highly productive and continue to serve as the one of the last functioning estuarine nurseries for the Texas side of the Sabine Lake ecosystem. Fresh water fisheries species utilizing these coastal marshes would have positive impacts due to this alternative. As salinity fluctuations are stabilized and salinity ranges decrease, these species would likely become reestablished across the entire western portion of Salt Bayou.

*Mammals:*
All species of mammals would likely benefit by long-term protection of habitat and the increase in primary plant production that would result by berm construction.

*Alligators:*
Decreases in salinity and increases in water quality would benefit the American alligator by increasing suitable habitat.

*Negative Impacts:*

*Habitat Loss:*

Berm construction would result in a loss of habitat along the footprint of the berm, totaling 181 acres of wetland habitat over the 14.5 mile structure.

*Soils:*
Berm construction would result in short term adverse impacts due to the covering of existing soils with borrowed earthen material for the berm and by excavation of material from the borrow areas. Erosion rates in the immediate construction area are likely to increase slightly due to the removal of vegetation in the short term. Best management practices (BMPs) would be utilized by contractors to minimize soil loss.

*Water Quality and Wetlands:*
Berm construction may result in some short-term negative impacts due to the disturbance of soils and the subsequent potential for suspension of sediments in water during rainfall events. However, due to the existence of acres of heavily vegetated marsh surrounding the project area, suspended sediments will be filtered from the water before there is any chance that the sediments would reach any adjacent water body.

*Vegetation Impacts:*
In the short term, berm construction would result in some adverse impacts on high marsh habitat due to the excavation of the borrowed earthen material for the proposed berm. In addition, erosion rates in the immediate construction area are likely to increase slightly due to the temporary removal of vegetation. Best Management Practices would be utilized by construction contractors to minimize any loss of soils due to erosion issues.

**Public Review and Comment:**

A 30-day comment period will be established for this Compatibility Determination (CD), along with the notice to prepare an EA. The USFWS will provide copies of the CD and EA on their website and at field offices, as well as publish a news release, send out letters, and/or emails to potential interested parties announcing the public comment period for this CD and EA.

**Determination (check one below):**

_____Use is Not Compatible

__X___Use is Compatible with Following Stipulations

**Stipulations Necessary to Ensure Compatibility:**
Construction of a clay and sand berm to restore degraded dune ridge and reduce frequency and extent of sea water inundation into interior marshes provides the Refuge with a management tool to improve habitat quality for target organisms, while ensuring the long term viability of fragile marsh habitat. Environmental stipulations are to be included to help minimize environmental impacts and ensure compatibility with the purposes for which the refuge was established, as well as the mission of the NWRS. These stipulations include:

- Unauthorized public access along the berm and borrow areas will be prohibited to protect the berm from additional sources of erosion, wildlife species using the area, and available forage species important to wildlife. Public access will continue to be limited to the beach area.
- Beach traffic resulting from this project may be limited during between October and April because of the possible presence of the endangered piping plover.
- An ability to continue law enforcement in this area by routine patrols to protect the structure and reduce the impacts with trespass on adjacent areas.

**Justification:**

Not completing this project would have long term negative impacts on biological resources of McFaddin NWR, which is inconsistent with the mission of the NWRS. As overwash occurs, salinities will increase with the continual inflow of salt water. As salinities increase, issues with increased sulfides and redox potential will cause regular degradation of marsh vegetation. These increased salinities will cause emergent marsh vegetation to die and make soils more susceptible to erosion further degrading emergent marsh within the area. The increases redox potential will depress plant productivity which reduces vegetation above and below ground. Fresh and intermediate wetlands will be rapidly converted to brackish wetland habitat with the corresponding loss of associated plant and animal species because of the lack of salinity tolerance. Emergent marsh will continue to be converted to open water with conversion rates accelerating as more time passes. This is primarily because vegetative species with high salt tolerance are not naturally present within the system, and the most salt tolerant species are currently reaching the highest survivability extremes. This lack of species to replace the more fresh tolerant species causes further issues with wave generated erosion. The end result is large expanses of shallow muddy open water that provides habitat for very few species, including estuarine dependent fishes. Much of the salt prairie and high marsh is losing fresh to intermediate marsh species diversity and being replaced with plant communities associated with vegetated salt flats. The aquatic plant community, specifically the submerged aquatic vegetation and floating aquatic vegetation, will not be able to tolerate the higher salinities. Within a few short years, all floating aquatic vegetation will be lost due to salinity increases across the marsh, and diversity of submerged aquatic vegetation may be reduced to very few species. This loss is already apparent in eastern portions of McFaddin NWR.

Without building a berm, marshes on McFaddin NWR that provide shallow water feeding, breeding, and resting habitat for numerous shorebirds, wading birds, and other marsh and waterbirds would be converted to non-suitable habitat as organic soils erode from the system leaving water depths too deep for birds to utilize. Birds that utilize the beaches would not be greatly impacted. Nesting wading, marsh, and waterbird species, including least bittern (*Ixobrychus exilis*), purple gallinule (*Porphyrula martinica*) common moorhen (*Gallinule Chloropus*), pied-billed grebe (*Podilymbus podiceps*), and American Bitterns (*Botaurus lentiginosus*), would all decrease as preferred salinity ranges for nesting and brood survival are surpassed. King rail's (*Rallus elegans*) nesting attempts would also drastically halt as salinity ranges increase.

Coastal fisheries would experience an increase in production as more areas are converted from emergent marsh to open water communities. However, this increase will suddenly decrease as the patchwork of grass clumps gives way to larger expanses of open water. Open water habitats have been shown to hold significantly less estuarine species than areas with islands of grass or other habitats that increase the ratio of shoreline per acre of habitat. Large expanses of shallow water habitat have been shown to contain the lowest densities of estuarine fisheries of any coastal habitat containing open water. Fresh water fisheries species utilizing these coastal marshes would be lost within McFaddin NWR.

As salinities levels increase, all species of amphibians will eventually disappear from McFaddin NWR. This has already occurred within parts of the system due to salinity increases. Without constructing a berm to restrict saltwater intrusion, all reptiles in the project area will experience long-term population decreases due to increased salinities. The overall impact to invertebrate populations due to changes in salinity is largely unknown, however, many species such as various amphipods, midges, mysid shrimp, grass shrimp, and crayfish, will experience population decreases. The overall impact to those large scale populations would be unknown, but locally, these species would likely disappear from McFaddin NWR. Numerous crabs are present within all marsh habitats in the project area and likely most of these would experience an increase in population. With blue crabs, the increase would be temporary and then disappear as conversion of emergent marsh to open water continued. Also, native rangia clams would likely continue to experience population decreases as increases in salinities reduced reproduction potential.

**Signatures:** Project Leader: _____

Refuge Supervisor: _____

**Concurrence:** Regional Chief _____

Regional Director: _____

**Mandatory 10-yr Re-evaluation Date:** _____