Draft Environmental Assessment

Addicks and Barker Dam Safety Modification

US Army Corps of Engineers®
Galveston District

October 2012

DRAFT
STATEMENT OF FINDINGS
AND
FINDING OF NO SIGNIFICANT IMPACT
FOR
ADDICKS AND BARKER DAM SAFETY MODIFICATION STUDY, FORT BEND AND HARRIS COUNTIES, TEXAS

1. Purpose. This document addresses the proposed replacement of[in the PN notice, it is clearly documented that the existing outlet works will be replaced and then removed] the outlet works at Addicks and Barker Reservoirs in Fort Bend and Harris Counties, Texas. The need for the replacement was identified when the U.S. Army Corps of Engineers (USACE), Galveston District conducted a Dam Safety Action Classification (DSAC) inspection on both Addicks and Barker Reservoirs in 2010. This Environmental Assessment (EA) was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) and Council on Environmental Quality (CEQ) regulations to document findings concerning the environmental impacts of the proposed action.

2. Proposed Action. At both dams, the USACE proposes the construction of new outlet structures that include an intake tower, steel lined conduits, parabolic spillway, stilling basin, cutoff wall, and downstream filter, and abandoning the existing structures in place. The new outlet structures would be located within the existing dam embankments, about 400 feet from the existing structures. A cutoff wall would be constructed beneath the outlet works and tied into the existing slurry cutoffs to prevent seepage. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. A new outlet channel would be excavated to connect the new structure to existing outlet channel. To limit transference of risk, discharge curves for the new outlet structures would closely duplicate the existing structures. After the new structures are completed, the existing upstream intake tower, tower bridge, and the parabolic spillway would be removed, the existing conduits would be filled with grout, a cutoff wall would be constructed through the conduits, and a filter would be placed immediately downstream of the abandoned conduits. Portions of the existing outlet channels would also be filled in. An earthen cofferdam with cutoff wall beneath the foundation would be used during construction of the new structures and would be at the same elevation as the top of the existing dams. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

3. Alternatives. The Galveston District considered 14 alternatives to repair the outlet structures. Alternative NS1 was permanent implementation of the Interim Risk Reduction Measures. Alternative NS2 was a no action plan. Alternative S1 was removal of both Addicks and Barker Dams. Alternatives 1A and 1B was to replace the outlet structures and remove the existing outlet structures. Alternatives 2A and 2B replace the outlet

structures and abandon the existing outlet structures in place. Alternatives 3A and 3B would construct a cutoff through the existing structures and replace the spillway. Alternatives 4A and 4B would construct a cutoff through the existing structure, replace the spillway, and repair the joints. Alternatives 5A and 5B would construct a cutoff through the existing structure, replace the spillway and install a steel liner. Alternatives 6A and 6B would construct an upstream cutoff wall and replace the spillway. Alternatives 7A and 7B would construct an upstream cutoff wall, replace the spillway and repair the joints. Alternatives 8A and 8B would construct an upstream cutoff wall, replace the spillway, and install a steel liner. Alternatives 9A and 9B would install a jet grout cutoff and replace the spillway. Alternatives 10A and 10B would install a jet grout cutoff, replace the spillway and repair the joints. Alternatives 11A and 11B would install a jet grout cutoff, replace the spillway and install a steel liner.

Alternatives 2A and 2B were selected as the recommended plan.

4. Coordination. A Public Notice and Notice of Availability was issued to interested parties including Federal and state agencies on February 1, 2013, which described the proposed action and announced the availability of the Draft EA. Comments on the public notice and Draft EA and the District's responses will be included in Appendix A of the Final EA.

5. Environmental Effects. Galveston District has taken every reasonable measure to evaluate the environmental, social and economic impacts of the proposed project. Based on information provided in the EA and coordination with Federal, state, and local agencies, temporary and permanent effects resulting from the proposed project have been identified and can be found in Section 4 of the Draft EA. The following resources and the effects of the proposed project have been identified:

- Construction impacts of the Preferred Alternative will be temporary in duration and limited in spatial extent and are not anticipated to significantly impact the overall project area.
- The 2009 Master Plan will be adjusted to match the land use needed for the proposed project; therefore, no significant impacts to land use would occur as a result of the proposed project.
- Considering the temporary and transient nature of construction activities, as well as the air quality mitigation measures proposed to be implemented, it is anticipated that implementation of the Preferred Alternative would be below the *de minimus* threshold and would not have any significant impact on air quality in the project area.
- Noise levels from proposed construction activities would be consistent with current ambient noise levels in the project area, and NSRs would be buffered from noise by the existing earthen levees surrounding Addicks and Barker Reservoirs; therefore, no significant noise related impacts are anticipated.
- Temporary and localized impacts to water quality within the project study area are anticipated. Stormwater BMP’s would be implemented; therefore, impacts to

water quality are anticipated to be minimal and no significant impacts to the water quality of the project study area are anticipated to occur.

- There are no known Hazardous, Toxic or Radioactive Waste (HTRW) sites on the reservoirs. No impacts associated with the HTRW sites within the project study area are anticipated.
- There are no prime and unique farmlands located on the reservoirs.
- Minimal localized impacts to vegetation are anticipated due to implementation of the Preferred Alternative. Portions of the project area that are temporarily impacted during construction activities would be expected to naturally re-vegetate following completion of construction activities. Wetlands within the project area that are temporarily impacted during construction activities would be returned to original grade following construction activities and would be expected to naturally re-vegetate. Permanent impacts to wetlands will be mitigated by restoring habitat functionality to another portion of the reservoir as discussed in Chapter 5.0. [Identify acres of wetland impacts and proposed mitigation]
- Temporary and localized impacts to wildlife resources are anticipated in the project area. Affected habitats are not unique to the study area and suitable habitat for displaced wildlife would be readily available. Significant impacts to wildlife resources within the project study area are not anticipated.
- Implementation of the Preferred Alternative would not affect threatened and endangered species.
- There are no known cultural resource sites in the proposed project sites where work is anticipated to occur and no impacts are anticipated.
- Impacts to aesthetic resources within the project study area are not anticipated to occur as a result of implementation of the Preferred Alternative.
- Minor and localized temporary impacts to recreational resources are anticipated to occur during implementation of the Preferred Alternative. The George Bush hike and Bike trail located on the top of Barker Dam would be temporarily closed and re-routed during construction activities. Following completion of construction activities, recreational resources would be expected to return to pre-construction conditions.
- Implementation of the Preferred Alternative would not cause an increase in daily traffic counts in the vicinity of the dams and no road closures would occur. No impacts to general traffic and circulation in the reservoirs are anticipated.
- Implementation of the Preferred Alternative would not impact existing facilities or utility systems.
- Implementation of the Preferred Alternative would not have adverse or disproportionate impacts on minority or low-income populations. Impacts to socioeconomic resources and environmental justice within the project study area are not anticipated.

It is the District's conclusion that the proposed project will not have a significant impact on the environment or to the surrounding human population.

6. Determinations. The proposed replacement of the outlet works were determined to be compliant with the following Federal legislation: National Environmental Policy Act, Endangered Species Act, Clean Water Act, National Historic Preservation Act, Clean Air Act, Executive Order 11990 (Protection of Wetlands), Executive Order 11988 (Floodplain Management), Council on Environmental Quality (Memorandum; Prime or Unique Farmlands), Executive Order 12898 (Environmental Justice), Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, Executive Order 13112 (Invasive Species), Migratory Bird Treaty Act (MBTA), Memorandum of Agreement between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agricultural to Address Aircraft-Wildlife Strikes, Protection of Environment, Executive Order 11514, and Executive Order 13186 (Migratory Bird Habitat Protection)

7. Findings. Based on my analysis of the Draft EA and other information pertaining to the proposed project, I find that the proposed replacement of the outlet works at Addicks and Barker Reservoirs will not have a significant effect on the quality of the human environment. [TCMP does not apply to this project!] After consideration of the information presented in the Draft EA, I have determined that an Environmental Impact Statement is not required under the provisions of NEPA, Section 102, and other applicable regulations of the U.S. Army Corps of Engineers, and that the proposed project may be constructed.

_____ (date)

_____
Christopher Sallese
Colonel, U.S. Army Corps of Engineers,
District Engineer

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Abbreviations and Acronyms

ACSLS	adjusted cost per statistical life saved
ALL	Annualized life loss
APF	annual probability of failure
ASTM	American Society of Testing and Materials
BA	Biological Assessment
BBTP	Buffalo Bayou and Tributaries Project
cfs	cubic feet per second
CSLS	cost per statistical life saved
DSAC	Dam Safety Action Classification
EA	Environmental Assessment
EDR	Environmental Data Resources, Inc.
FPPA	Farmland Protection Policy Act
HGB	Houston-Galveston-Brazoria Intrastate Air Quality Control Region
HTRW	Hazardous, Toxic, Radioactive Wastes
IH	Interstate Highway
LPST	Leaking Petroleum Storage Tank
MRM	Multiple Resource Management
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NS	non-structural alternatives
NSRs	Noise Sensitive Receptors
NRCS	National Resource Conservation Service
OPS	Project Operations
PFMA	Potential Failure Mode Analysis
PFMs	Potential Failure Modes
SW3P	Storm Water Pollution Prevention Plan
TCEQ	Texas Commission on Environmental Quality
TMDLs	Total Maximum Daily Loads
TPWD	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
VSL	value of a statistical life

1.0 Introduction

The purpose of this Environmental Assessment (EA) is to document proposed repairs to the Buffalo Bayou and Tributaries Project (BBTP) and the potential environmental effects of those repairs. The project would serve to repair existing flood control infrastructure by replacing the outlet works infrastructure at both Addicks and Barker Dams using the most cost effective and environmentally acceptable approaches practicable. The project would ensure that Addicks and Barker Reservoirs continue to provide downstream flood protection to the City of Houston, Texas, and surrounding metropolitan areas.

This EA presents potential environmental effects associated with construction and operation of repairs to the flood control outlet works infrastructure by the U.S. Army Corps of Engineers (USACE), Galveston District (the District). It describes the proposed project and presents the project purpose and need, alternatives, the affected environment, and predicted consequences to the natural and human environment. The public will have the opportunity to provide comments on the proposed project during the public noticing period. The final EA will contain the public comments received during the public notice period along with the District's responses to these comments.

This document is consistent with the National Environmental Policy Act (NEPA) of 1969 (42 USC § 4321) by describing the systematic, interdisciplinary evaluation of potential effects to the natural and human environment for issues of concern. This EA is consistent with the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Parts 1500-1508), USACE Engineer Regulation (ER) 200-2-2 (*Environmental Quality: Procedures for Implementing NEPA,* 33 CFR 230), and ER 1105-2-100 (*Planning Guidance Notebook*).

1.1 Project Description

Addicks and Barker Reservoirs are located in southeast Texas in the San Jacinto River basin approximately 17 miles west of downtown Houston. The reservoirs are strategically located above the confluence of Buffalo Bayou and South Mayde Creek. Downstream of this confluence, Buffalo Bayou continues east through downtown Houston, where it joins White Oak Bayou, and eventually becomes the Houston Ship Channel, which flows into San Jacinto Bay. The majority of both Addicks and Barker Reservoirs fall within Harris County; however, a small portion of Barker Reservoir crosses into Fort Bend County. Addicks Reservoir is situated on the north side of Interstate Highway (IH) 10 with State Highway (SH) 6 bisecting the reservoir north to south. Barker Reservoir is situated on the south side of IH 10, west of SH 6.

Addicks and Barker Reservoirs were constructed in the mid-1940's as an integral part of the BBTP. The BBTP, sponsored by the USACE, reduces potential flood damages downstream along Buffalo Bayou through a combination of reservoirs, channel improvements, and detention basins. Following completion of both the Addicks and Barker Dams in the mid-1940's, the project is estimated to have prevented potential flood damages totaling $4,643,104,000 through September 2008.

Both Addicks and Barker Reservoirs consist of earthen levees, concrete outlet works, and uncontrolled spillways. The earthen levee is 61,166 feet long at Addicks Reservoir and 71,900 feet long at Barker Reservoir. The earthen levee has a crest that is 12 feet wide and 49.6 feet above the original streambed at Addicks Reservoir and 38.7 feet above the original streambed at Barker Reservoir. The ends of both dams are armored with roller-compacted concrete that serves as uncontrolled spillways. Addicks and Barker Reservoirs each currently have five gated conduits serving as the outlet works. The original design concept for both dams provided for four of the five outlet conduits to be uncontrolled, permitting a combined uncontrolled discharge of approximately 15,700 cubic feet per second (cfs) into Buffalo Bayou. In 1948, two of the four uncontrolled conduits were gated at each dam resulting in a reduced combined uncontrolled discharge of approximately 7,900 cfs, which was considered to be the channel capacity at that time.

The threat of flooding in the areas below the dams continued to rise with the increase in urban development in the areas surrounding the reservoirs throughout the 1940s and 1950s. In 1960, a study was prepared to consider the feasibility of gating the remaining uncontrolled conduits. As a result of that study, the remaining uncontrolled conduits on both reservoirs were gated by 1963. Normal operating procedures specify that releases from the two reservoirs, in addition to the uncontrolled runoff downstream, should not exceed 2,000 cfs as measured at the Piney Point Road gauging station, located 10.7 channel miles below Barker Reservoir. Addicks Dam has a maximum discharge capacity of 7,852 cfs and Barker Dam 8,734 cfs.

Addicks and Barker Reservoirs are designed and located to collect large amounts of precipitation during storm events and then release accumulated rainfall into Buffalo Bayou at a controlled rate. The reservoirs are normally “dry”, impounding water only during storm or flood events. Under normal conditions, two of the five gates at each dam are set to allow passage of normal water flows. During storm events, the all gates are closed until it is safe to release stormwater downstream. The “dry” condition of the reservoirs has presented the USACE with several management opportunities, including the management of environmental and cultural resources. The reservoirs also provide the public with quality outdoor recreational experiences including opportunities for hiking, biking, playing ball, picnicking and various other opportunities.

1.2 Identification of the Project Study Area

For the purpose of this EA, the project study area encompasses the entirety of Addicks and Barker Reservoirs in addition to all areas within a 10-mile radius around both Reservoirs having a center-point at the intersection of IH 10 and SH 6. Although work associated with the proposed project would be concentrated in the vicinity of both existing outlet structures, the project study area allows for a complete evaluation of potential environmental, social, and economic effects associated with both direct and indirect impacts of the proposed project. Exhibit 1 presents a vicinity map of the project study area for this EA.

1.3 Purpose and Need for the Project

The USACE operates 610 dams throughout the United States. As part of the responsibility for managing these dams, the USACE has a comprehensive Dam Safety Program that features public safety as its primary objective. The USACE Dam Safety Program is critical to addressing the nation's aging infrastructure, reducing the risks of flood and storm damage and ensuring owned and operated dams are safe and present minimal risk to the public. The USACE routinely inspects and evaluates its dams to ensure compliance with the Federal Guidelines for Dam Safety issued in 1979.

In 2005, the USACE initiated the Dam Safety Action Classification (DSAC) System to provide consistent and systematic guidelines for addressing dam safety issues and deficiencies, and to allow prioritization of work at the national level. The DSAC provides a standard strategy for the continued safety and security of USACE projects and the public. This risk management approach includes two components: probability of dam failure and consequences should failure occur.

Both Addicks and Barker Reservoirs are currently categorized as DSAC I. Dams in this classification have been determined to be critically near failure or at extremely high risk under normal operations. Characteristics of this classification of dams include:

- The confirmation of progression toward failure meaning that they are almost certain to fail under normal operations at any time within a few years without intervention; or,
- The dams have extremely high risk due to a combination of life or economic consequences with an extremely high probability of failure.

The current DSAC was determined during an initial screening level assessment during the Fiscal Year 2008 Screening for Portfolio Risk Analysis. Subsequent to the completion of this analysis, a Potential Failure Mode Analysis (PFMA) was initiated in August 2009 and finalized in May 2010. The PFMA is a method of analysis where particular flaws and initiating conditions are postulated, and the full range of effects of the flaw or the initiating condition on the system are revealed. The methods of failure are indentified, described, and evaluated with respect to their credibility and significance. Potential Failure Modes (PFMs) are ways that failure can occur and are described as the means by which element or component failures must occur to cause loss of the outlet works sub-system or system function.

PFMs identified during the PFMA for Addicks Dam include:

- PFM 1 – Seepage flow along or beneath outlet works structure due to voids or low stress areas leads to headcut erosion beneath outlet works structure.
- PFM 6 – Foundation seepage and piping beneath conduit or within the window with no cutoff wall between cutoff wall and conduit leads to backward piping and erosion.

PFMs identified during the PFMA for Barker Dam include:

- PFM 1 – Seepage flow along or beneath outlet works structure due to voids or low stress areas leads to headcut erosion beneath outlet works structure.

- PFM 7 – Seepage and piping in foundation at old Buffalo Bayou channel exiting at the end of the stilling basin – beneath the cutoff wall.
- PFM 8 – Seepage and piping in foundation at end of cutoff trench downstation of Noble Road into the Clodine ditch (Sta 491+50) and other locations with pervious zones in the foundation above the flowline of the ditch.

A high concentration of industrial, commercial, and residential development is located throughout the Buffalo Bayou corridor, downstream of the Addicks and Barker Reservoirs, as well as significant infrastructure inventory including highways, roads and utilities, and water and sewage treatment facilities. The City of Houston, located downstream of the Addicks and Barker Reservoirs, is currently the fourth largest city in the United States. Over four million people live, work in and transit through the Buffalo Bayou watershed. The Addicks and Barker Reservoirs are crucial components to preventing major flood damage to property and loss of life within the Buffalo Bayou and surrounding watersheds.

The purpose of this project is to repair aging and failing outlet structures at both Addicks and Barker Dams by implementation of a long-term solution that would protect property and life downstream of the reservoirs. If existing deficiencies with the outlet works structures at both dams are not corrected, failure at one or both of the dams could lead to catastrophic consequences to life and property within the watershed.

1.4 Study Authority

Addicks and Barker Reservoirs are part of the BBTP authorized by the Rivers and Harbors Act approved June 30, 1938, and modified by the Flood Control Act of August 11, 1939, and September 3, 1954. All lands within the reservoirs were acquired for flood risk management purposes. Although flood risk management remains the sole authorized purpose of the reservoirs, Section 209 of the Flood Control Act of 1954 allows for the development and use of reservoir areas for recreational and related purposes. This EA was prepared pursuant to NEPA policies to address potential impacts of improvements to the outlet structures at both Addicks and Barker Dams. The lead agency for this project is the USACE, Galveston District. NEPA coordination was not initially conducted for the BBTP or the construction of Addicks and Barker Reservoirs as their authorization and construction occurred prior to 1969 and the implementation of NEPA. Actions within the reservoirs subsequent to the implementation of NEPA have been coordinated as appropriate.

2.0 Alternatives

The Galveston District formulated 25 alternative plans (two non-structural and one structural plan required by regulation, and 11 plans for Addicks and 11 plans for Barker). These alternative plans consist of a system of structural and/or nonstructural measures, strategies, or programs formulated to meet (fully or partially) the identified Dam Safety Modification (DSM) study risk reduction objectives. The alternative plans were formulated, screened and refined throughout the study process.

2.1 Alternative NS1: Permanent Implementation of the IRRMs

The first plan, designated as Plan NS1, meets the requirement of providing an alternative that would make the Interim Risk Reduction Measures (IRRMs) permanent. The critical IRRM relative to the failure mode at Addicks and Barker Dams is filling the voids beneath the outlet works conduits and spillway aprons with grout. Other measures include:

- coordinating an emergency action plan with local sponsors
- installing a reservoir regulator alarm system for stage and rainfall reporting
- installing an outlet conduit monitoring instrumentation and enhanced lighting
- conducting risk communication meetings with the public
- creating an interim reservoir control action plan
- updating the emergency action plan
- replacing the outlet structure gate
- installing a granular filter to control any seepage along the conduit
- installing inspection plugs along the conduit bottom and spillway

Filling the voids beneath the outlet works conduits would return Addicks and Barker Dams to their post-construction condition. However, this alternative does not provide for an adequate seepage barrier and filter to prevent a recurrence of erosion beneath the outlet works conduits. Also, this alternative does not address problems at the conduit joints.

2.2 Alternative NS2: No Action

The No Action Alternative would maintain the current condition of failure progressing, which essentially is the definition of a DSAC I classification dam. For Addicks and Barker Dams, the progressing failure mode is seepage and erosion beneath the outlet works conduits. The no action alternative corresponds to the existing conditions of the dams.

2.3 Alternative S1: Remove Addicks and Barker Dams

The removal of Addicks and Barker Dams would be to the extent necessary to ensure run-of-the-bayou conditions at all times. A significant portion of the embankment would be removed and stable slopes created on what remained of the embankment. The excavated fill would be placed in upland disposal areas and re-vegetation would be performed. This alternative would eliminate Addicks and Barker Reservoirs as a part of the flood control system on Buffalo Bayou through the city of Houston. This alternative meets the Corps of Engineers policy requirement to study the removal of the structures.

2.4 Alternatives 1A and 1B: Replace Structure and Remove Existing Structure

At both dams, these alternatives consist of construction of a new outlet structure that includes an intake tower, steel lined conduits, parabolic spillway, stilling basin, cutoff wall, downstream filter, and removal of the existing outlet structure (Figure 1). The new outlet structure would be located within the existing dam embankment, about 400 feet west of the existing structure. A cutoff wall would be constructed beneath the outlet works and tied into the existing slurry cutoffs

to prevent seepage. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. An outlet channel would be excavated to connect the new structure to existing outlet channel. This channel would be located in the existing project footprint. To limit transference of risk, discharge curves for the new outlet structure would closely duplicate the existing structure. After the new structure is completed, the existing structure would be completely removed. The embankment would be reconstructed to include a cutoff wall. The existing outlet channel would also be filled in. Earthen cofferdams with cutoff wall beneath the foundations would be used for both the construction of the new structure and removal of the existing structure. These cofferdams would be constructed to the same elevation as the top of the existing dam. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

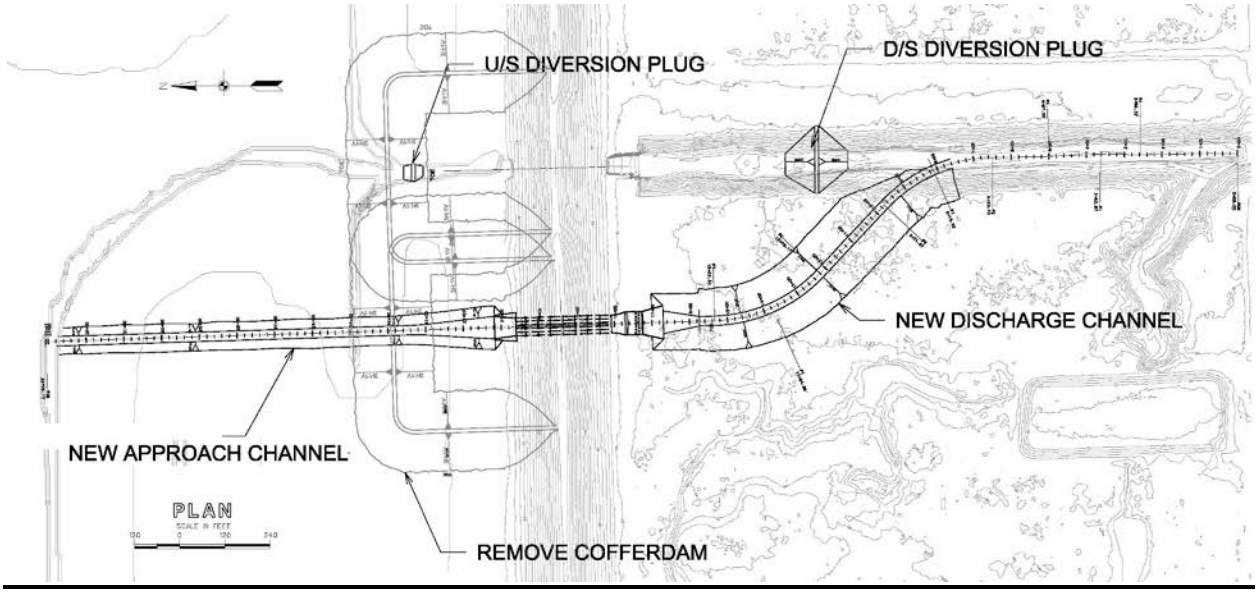

Figure 1. Addicks Reservoir Alternative 1A Plan Map

2.5 Alternatives 2A and 2B: Replace Structure and Abandon Existing Structure

At both dams, these alternatives consist of construction of a new outlet structure that includes an intake tower, steel lined conduits, parabolic spillway, stilling basin, cutoff wall, downstream filter, and abandoning the existing structure in place (Figures 2 and 3). The new outlet structure would be located within the existing dam embankment, about 400 feet west of the existing structure. A cutoff wall would be constructed beneath the outlet works and tied into the existing slurry cutoffs to prevent seepage. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. A new outlet channel would be excavated to connect the new structure to existing outlet channel. To limit transference of risk, discharge curves for the new outlet structure would closely duplicate the existing structure. After the new structure is completed, the existing upstream intake tower, tower bridge, and the parabolic spillway would be removed, the existing conduits would be filled with grout, a cutoff wall would be constructed

through the conduits and a filter would be placed immediately downstream of the abandoned conduits. The existing outlet channel would also be filled in. An earthen cofferdam with cutoff wall beneath the foundation would be used during construction of the new structure and would be at the same elevation as the top of the existing dam. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

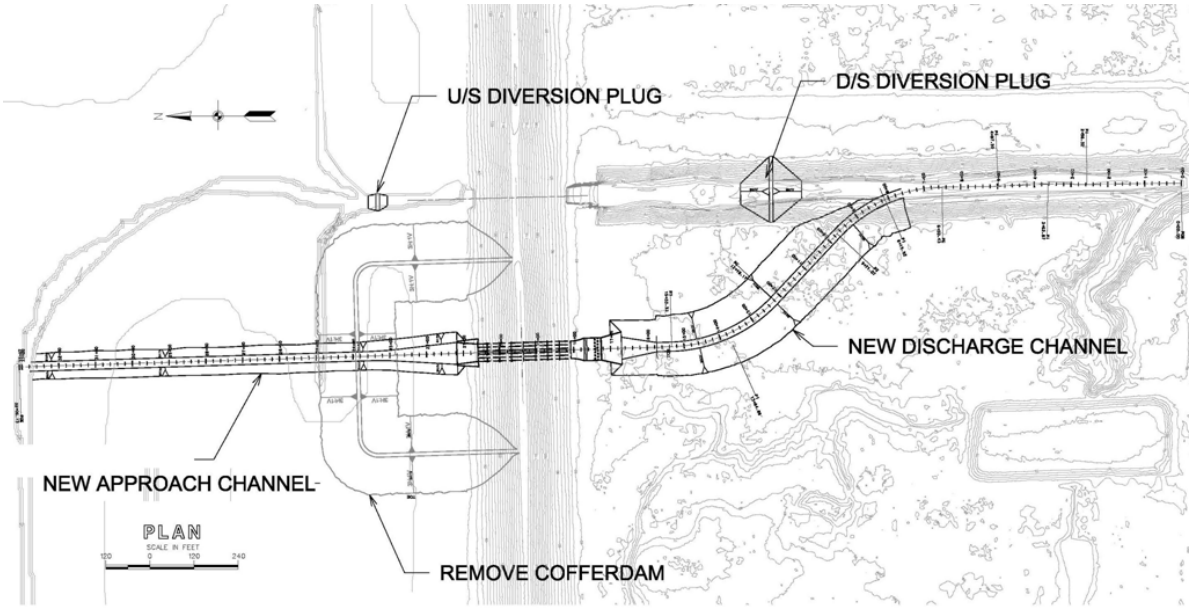

Figure 2. Addicks Reservoir Alternative 2A Plan Map

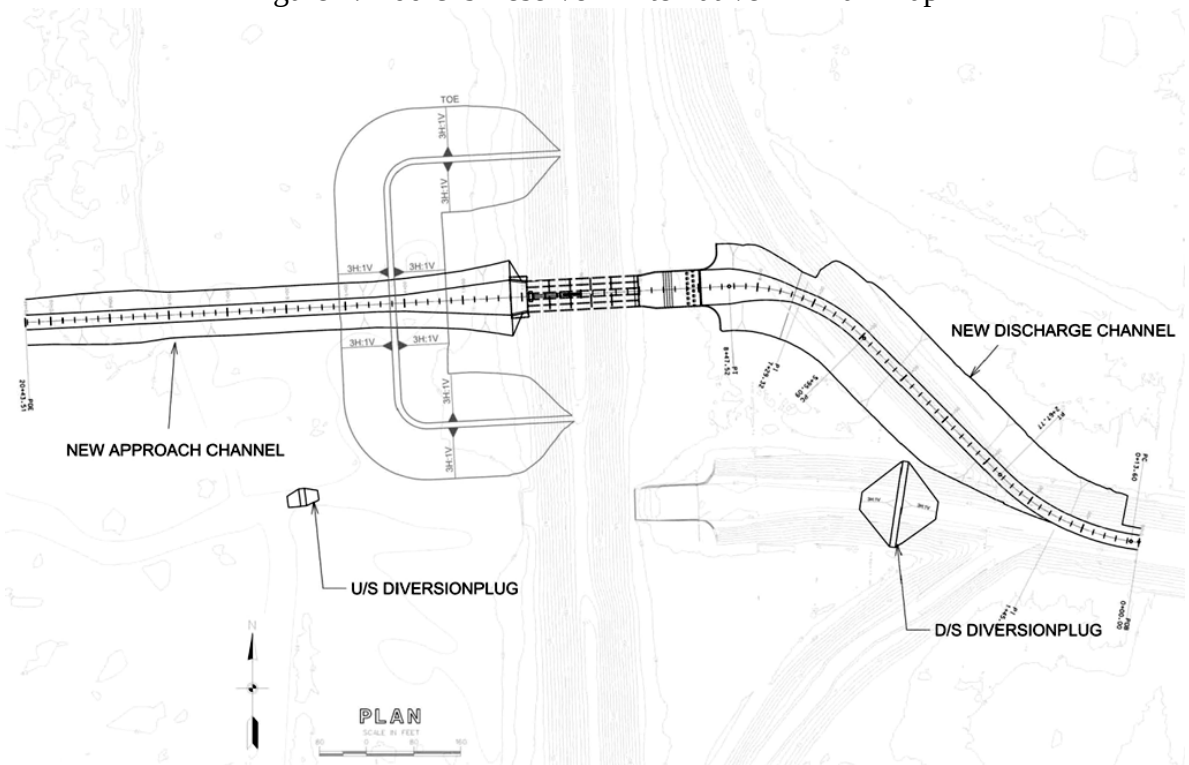

Figure 3. Barker Reservoir Alternative 2B Plan Map

2.6 Alternatives 3A and 3B: Cutoff through Existing Structure and Replace Spillway

At both dams, these alternatives include construction of a cutoff wall through the conduit and replacement of the parabolic spillway and stilling basin (Figure 4). A seepage cutoff would be constructed through the existing outlet works structure to block seepage paths along the structure. This cutoff would tie into the existing cutoff wall and generally be aligned through an offset upstream of the centerline of the dam embankment. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. These alternatives include diversion of water, construction of the cutoff through an operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

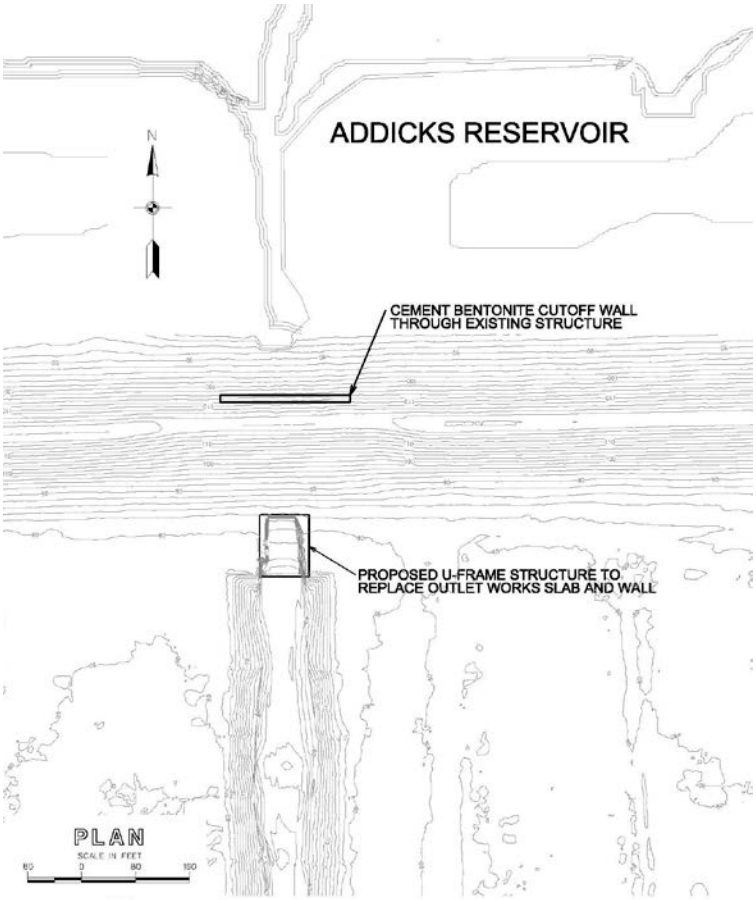

Figure 4. Addicks Reservoir Alternative 3A Plan Map

2.7 Alternatives 4A and 4B – Cutoff through Existing Structure, Replace Spillway and Joint Repair

At both dams, these alternatives include construction of a cutoff wall through the conduit, replacement of the parabolic spillway and stilling basin, and construction of joint repairs along the conduits (Figure 5). A seepage cutoff would be constructed through existing outlet works structure to cutoff seepage paths along the structure. This cutoff would tie in to the existing cutoff wall and generally be aligned through and offset upstream of the centerline of the dam embankment. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. The joints between the conduit monoliths would be locally repaired with some combination of waterstops, steel plates, and/or concrete inset and flush with existing conduit. This is to prevent issues that are associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

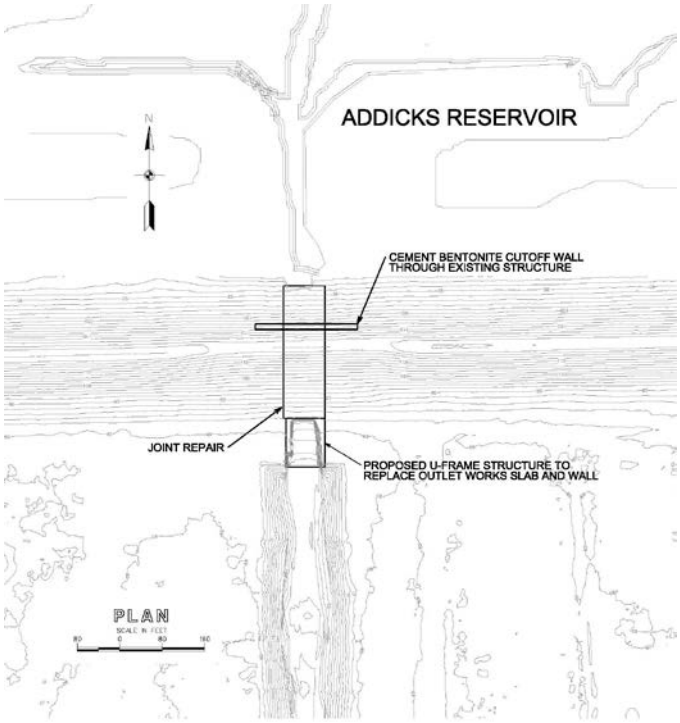

Figure 5. Addicks Reservoir Alternative 4A Plan Map

2.8 Alternatives 5A and 5B – Cutoff through Existing Structure, Replace Spillway and Steel Liner

At both dams, these alternatives include construction of a cutoff wall through the conduit, replacement of the parabolic spillway and stilling basin, and construction of joint repairs along the conduits (Figures 6 and 7). A seepage cutoff would be constructed through existing outlet works structure to block seepage paths along the structure. This cutoff would tie in to the existing cutoff wall and generally be aligned through and offset upstream of the centerline of the dam embankment. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. A round steel liner insert would be grouted into each of the existing conduits to provide an effective joint repair. This would be done to prevent issues associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. This steel liner would result in significant deviations from the existing discharge capability curve because the conduits are currently rectangle and the round pipe would result in more than 30 percent discharge capability loss. This change to the discharge capability curve would effectively transfer risk from the downstream to the upstream since limiting discharges would result in water rising onto private property upstream of the reservoir. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

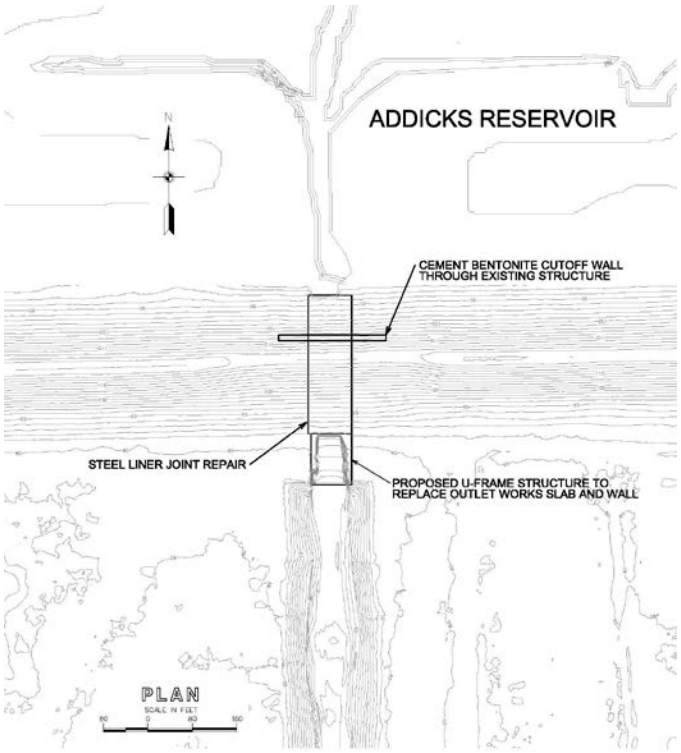

Figure 6. Addicks Reservoir Alternative 5A Plan Map

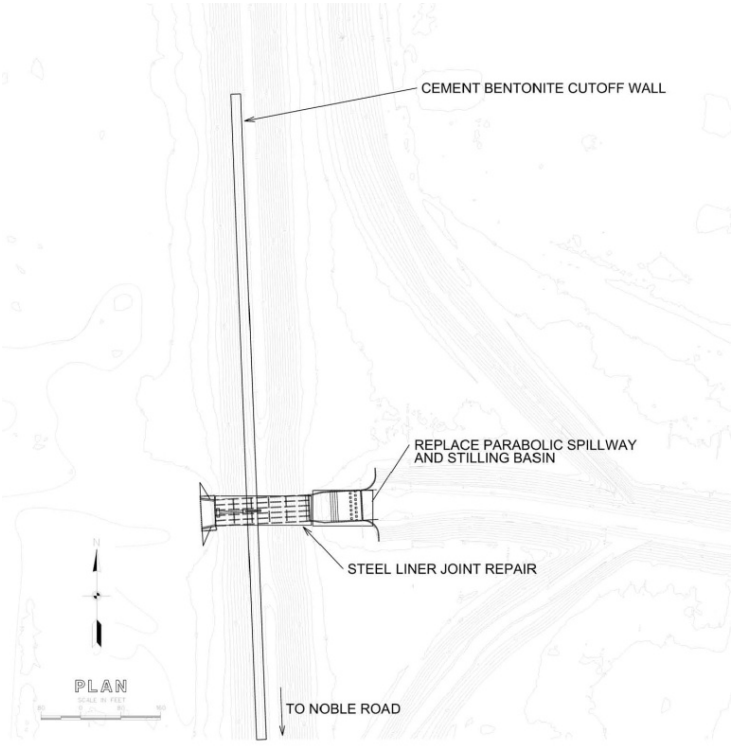

Figure 7. Barker Reservoir Alternative 5B Plan Map

2.9 Alternatives 6A and 6B – Upstream Cutoff Wall and Replace Spillway

At both dams, these alternatives include construction of a cutoff wall that would tie into the existing cutoff wall, and then go around the upstream end of the intake structure (Figure 8). There would be a clay blanket on top of the upstream embankment to complete the cutoff wall. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

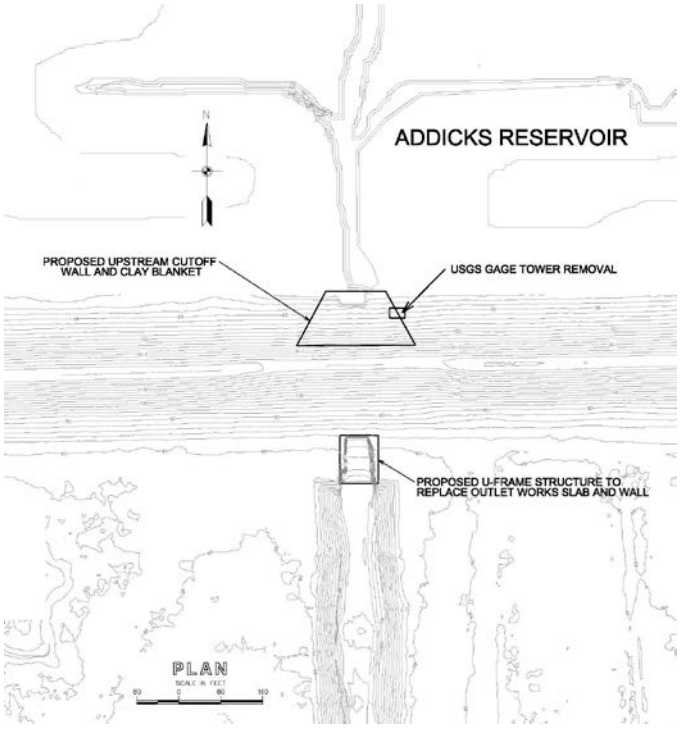

Figure 8. Addicks Reservoir Alternative 6A Plan Map

2.10 Alternatives 7A and 7B – Upstream Cutoff Wall, Replace Spillway, and Joint Repair

These alternatives include construction of a cutoff wall that would tie into the existing cutoff wall, and then go around the upstream of the intake structure (Figure 9). There would be a clay blanket on top of the upstream embankment to complete the cutoff. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. The joints between the

conduit monoliths would be locally repaired with some combination of waterstops, steel plates, and/or concrete inset and flush with existing conduit. This is to prevent issues that are associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. During the expert elicitation for this set of alternatives, assumptions were made that an effective joint repair could be constructed. Because of the location of the dams and issues associated with desiccation cracking of clay materials, this alternative did not meet the tolerable risk guidelines. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

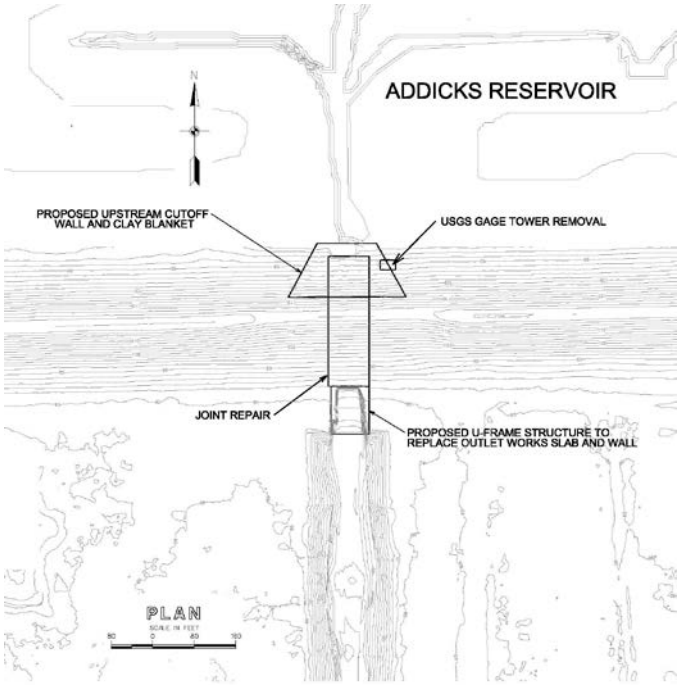

Figure 9. Addicks Reservoir Alternative 7A Plan Map

2.11 Alternatives 8A and 8B – Upstream Cutoff Wall, Replace Spillway, and Steel Liner

These alternatives include construction of a cutoff wall that would tie into the existing cutoff wall, and then go around the upstream of the intake structure (Figure 10). There would be a clay blanket on top of the upstream embankment to complete the cutoff. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. A round steel liner insert would be grouted into each of the existing conduits to provide an effective joint repair. This is to prevent issues that are associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. This steel liner would result in significant deviations from the existing discharge

capability curve because the conduits are currently rectangle and the round pipe would result in more than 30 percent loss in discharge capabilities. This change to the discharge capability curve would effectively transfer risk from the downstream to the upstream as limiting discharges would result in water rising onto private owned property upstream of the reservoir more frequently. Because of the location of the dams and issues associated with desiccation cracking of clay materials, this alternative did not meet the tolerable risk guidelines. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

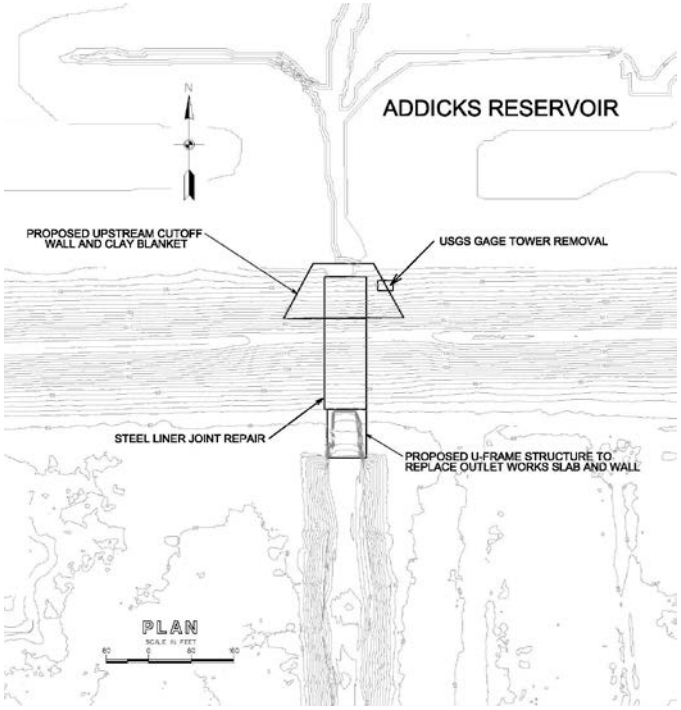

Figure 10. Addicks Reservoir Alternative 8A Plan Map

2.12 Alternatives 9A and 9B – Jet Grout Cutoff and Replace Spillway

These alternatives include construction of a jet grout cutoff wall beneath the existing conduits and replacement of the parabolic spillway and stilling basin (Figure 11). The benefit of using jet grout is that it can be constructed without completely cutting through the conduits. The down side of jet grout is the limited confidence in the final constructed project and the potential for continuous flaws to exist through the wall. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall

would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

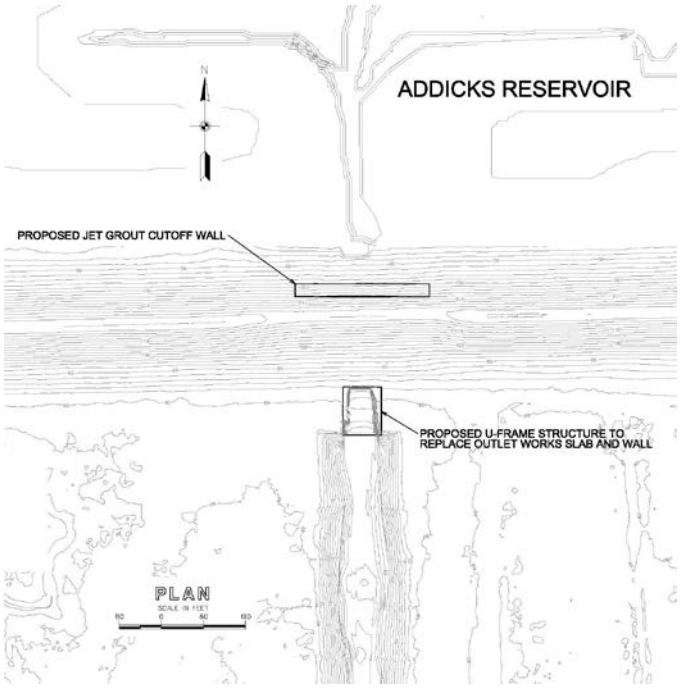

Figure 11. Addicks Reservoir Alternative 9A Plan Map

2.13 Alternatives 10A and 10B – Jet Grout Cutoff, Replace Spillway, and Joint Repair

These alternatives include construction of a jet grout cutoff wall beneath the existing conduits and replacement of the parabolic spillway and stilling basin (Figure 12). The benefit of using jet grout is that it can be constructed without completely cutting through the conduits. The down side of jet grout is the limited confidence in the final constructed project and the potential for continuous flaws to exist through the wall. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. The joints between the conduit monoliths would be locally repaired with some combination of waterstops, steel plates, and/or concrete inset and flush with existing conduit. This is to prevent issues that are associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. During the expert elicitation for this alternative, assumptions were made that an effective joint repair could be constructed. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

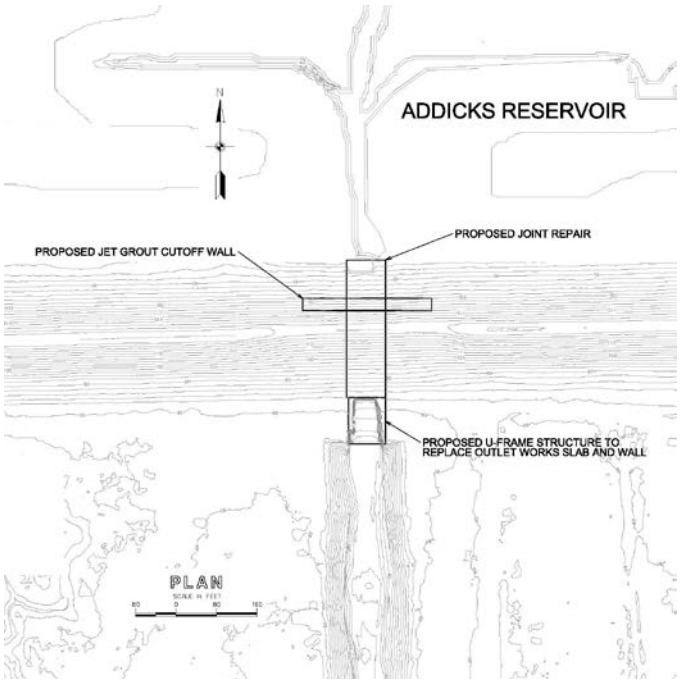

Figure 12. Addicks Reservoir Alternative 10A Plan Map

2.14 Alternatives 11A and 11B – Jet Grout Cutoff, Replace Spillway, and Steel Liner

These alternatives include construction of a jet grout cutoff wall beneath the existing conduits and replacement of the parabolic spillway and stilling basin (Figure 13). The benefit of using jet grout is that it can be constructed without completely cutting through the conduits. The down side of jet grout is the limited confidence in the final constructed project and the potential for continuous flaws to exist through the wall. The replacement of the parabolic spillway and stilling basin would include removal of the existing spillway and stilling basin slabs and walls, installation of a filter, and construction of a new stilling basin. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. A round steel liner insert would be grouted into each of the existing conduits to provide an effective joint repair. This is to prevent issues that are associated with water flowing from the conduits into the very fine-grain sand foundation as well as water flowing from the very fine-grain sand foundation into the conduits. This steel liner would result in significant deviations from the existing discharge capability curve because the conduits are currently rectangle and the round pipe would result in more than 30 percent loss in discharge capabilities. This change to the discharge capability curve would effectively transfer risk from the downstream to the upstream as limiting discharges would result in water rising onto private owned property upstream of the reservoir more frequently. These alternatives include diversion of water, construction of the cutoff through and operating conduit, and split construction for replacement of the parabolic spillway and stilling basin. Additionally, at Barker Reservoir, a cutoff wall would be constructed at Noble Road, to effectively cutoff seepage through the fine-grain sand foundation from the borrow site to Clodine Ditch.

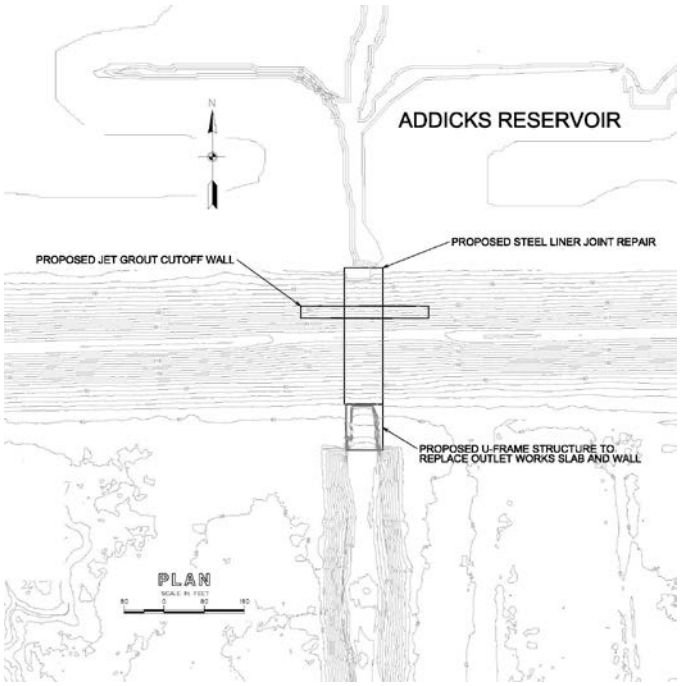

Figure 13. Addicks Reservoir Alternative 11A Plan Map

2.15 Staging Areas

The staging area for Addicks Reservoir for Alternatives 1A to 11A would be located on USACE property south of the outlet works on the east side of the existing channel (Exhibit 2). The staging area for Barker Reservoir for Alternatives 1B to 11B would be located on USACE property in two locations. The first would be located east of the outlet works and south of the existing channel and the second would be located east of the dam, south of the Addicks Field Office and north of Nobel Road (Exhibit 3).

2.16 Borrow Areas

Five borrow areas have been proposed for use for Alternatives 1A, 2A, 1B, and 2B. Three borrow areas are located in Addicks Reservoir (Exhibit 2) and two are located in Barker Reservoir (Exhibit 3).

2.17 Evaluation Criteria and Alternatives Screening

In January 2012, the USACE met with the Risk Management Center (RMC) to brief them on the project alternatives. During this meeting, the USACE and the RMC determined that two measures being proposed and investigated would not provide sufficient protections from the PFM.

These two measures were:

- the Upstream Cement-Bentonite Cutoff with Clay Blanket, and
- the Jet Grout Cut-off through Conduit.

The Upstream Cement-Bentonite Cutoff with Clay Blanket was a key measure for Alternatives 6A, 7A, 8A, 6B, 7B, and 8B. The Jet Grout Cut-off through Conduit was a key measure for Alternatives 9A, 10A, 11A, 9B, 10B, and 11B. Accordingly, these alternatives were eliminated from further consideration.

Remaining alternative plans were evaluated and screened iteratively, first using the primary criteria to determine technically acceptable plans that meet tolerable risk guidelines and loss of life guidelines pursuant to ER 1110-2-1156, Safety of Dams – Policy and Procedures, Chapter 5. Tolerable Risk Guidelines. These requirements are:

(1) The total annual probability of failure (APF) must not be greater than 0.0001,
(2) The loss of life risk (product of annual probability of failure and population at risk) must be less than 0.001, and
(3) The total risk to the person most at risk is less than 0.0001.

The policy for the estimated annual probability of failure (APF) under the USACE tolerable risk guidelines is as follows.

- Total APF less than 0.0001/year is considered tolerable provided the other tolerable risk guidelines are met.
- Total APF greater than 0.0001/year is considered unacceptable except in exceptional circumstances.
- Although only the total APF is to be evaluated against this guideline, it is important that contributions to the total APF from the individual failure modes, loading types, loading ranges, exposure scenarios, etc., are analyzed. The analysis and evaluation of the individual failure modes can lead to an improved understanding of failure modes that affect the total annual probability of failure. It can also provide insights leading to the identification of both structural and non-structural risk reduction measures, including interim measures.

Annualized life loss (ALL) guideline is the expected value (average annual) of incremental potential life loss resulting from dam failure. The policy for the estimated ALL under the USACE tolerable risk guidelines is as follows.

- ALL > 0.01 lives/year: ALL risk in this range is unacceptable except in exceptional circumstances and is reason for urgent actions to reduce risk.

- ALL between 0.01 and 0.001 lives/year: ALL risk in this range is unacceptable except in exceptional circumstances and is reason for actions taken to reduce risk.

- ALL < 0.001 lives/year: ALL risk in this range may be considered tolerable provided the other tolerable risk guidelines are met.

As with APF, it is the total life safety risk that is to be evaluated against the life safety guidelines.

Plans were also screened to determine the degree to which they satisfy study objectives. The life-safety metrics above reflect the primary study objective to reduce safety risks caused by potential dam failure. Other study objectives are to return the dams to a condition that allows them to satisfy their authorized purposes. Addicks and Barker dams and reservoirs were authorized as flood damage reduction projects. The reservoirs are dry reservoirs, and as such, do not have other authorized purposes found at most USACE reservoirs; i.e. water supply, hydropower, camping, boating, etc. Therefore, the primary study objective is to effectively reduce flood risks in the study area.

Each of the plans was evaluated for environmental impacts. A qualitative description of the environmental consequences for each of the plans was developed. These impacts are presented in Chapter 4: Environmental Consequences.

Based on this iteration of the screening process, Alternatives NS1 and NS2 were eliminated from further consideration because they failed to meet the probability of failure guidelines and the life risk guidelines. Alternative S1 was eliminated because it failed to meet the probability of failure guidelines and the life risk guidelines, and it had significant environmental impacts. Alternative S2 was also eliminated because it had significant environmental impacts (Table 1).

The remaining alternatives that meet the APF and ALL requirements satisfied the study objectives, and did not have significant environmental impacts. Alternatives 1A - 5A and 1B - 5B were further screened based on economic information and USACE guidelines. In the third iteration of screening, cost estimates for construction of the alternate plans was developed. Each plan was then screened based on:

- Disproportionality Ratio, and
- Compliance with USACE essential guidelines (Completeness, Effectiveness, Efficiency Ranking, Acceptability and Robustness, Resiliency, and Redundancy).

The cost per statistical life saved (CSLS) is calculated by dividing the plan cost by the estimated reduction in fatalities with the plan in place. The cost of the plan is converted to an average annual cost and is divided by the incremental reduction in the annualized life loss. USACE has adopted the criteria used by the Department of Transportation, which estimates the value of a statistical life (VSL) to be $5.8 million. Plans with a CSLS below $5.8 million are deemed be a cost effective means to reduce safety risks.

USACE regulations describe two approaches to calculating the cost per statistical life saved. The unadjusted CSLS, or UCSLS, is calculated as described in the preceding paragraph. The adjusted CSLS or, ACSLS, is calculated after the annual plan costs have been adjusted to account for other benefits achieved by the plan. The annual economic benefits are subtracted from the annual plan costs to determine the adjusted annual costs. This adjusted cost is then divided by the incremental reduction in ALL to calculate the adjusted cost per statistical life saved, ACSLS. When the annual economic benefits exceed the annual costs (this is indicated by a benefit cost ratio greater than 1.0), the ACSLS equals zero.

The disproportionality ratio is another means to evaluate the cost effectiveness of risk reduction plans. Disproportionality is used as a test of justification to reduce risks below the tolerable risk limit, or further, based on the concept of ALARP (as low as reasonably practicable). Disproportionality measures the ratio of sacrifice (cost, time, effort, trouble) in implementing a risk reduction plan versus the incremental risk reduction achieved by the plan. USACE guidelines state that plans with a disproportionality ratio between zero and one have a "Very Strong" justification for implementation. When comparing plans that have similar disproportionality values, the lowest cost alternative would ordinarily be selected.

Alternative plans were also screened considering the four criteria described in Principles and Guidelines (P&G): completeness, effectiveness, efficiency, and acceptability.

- Completeness refers to the extent to which the plan provides and accounts for all necessary investments or other actions to ensure the realization of risk reduction objectives, including actions by other federal and non-federal entities.
- Effectiveness refers to the extent to which the plan contributes to achieving the objectives.
- Efficiency refers to the extent to which the plan is the most cost effective means of achieving the objectives.
- Acceptability refers to the extent to which a plan is acceptable in terms of applicable laws, regulations and public policies.

Robustness, Resiliency, and Redundancy, in terms of dam safety, are also considered in the criterion.

- Redundancy is the use of multiple lines of defense that are linked to potential failure modes. The most vulnerable failure modes need the greatest redundancy.
- Resilience is the use of enhancements to improve the ability of the system to sustain loads greater than the design load to achieve gradual failure modes over some duration rather than sudden failure modes.
- Robustness is the use of more conservative assumptions to increase capacity to compensate for greater degrees of uncertainty and risk.

Table 1. Comparison of Alternatives

Screening Criteria	Alternatives												
	NS1	NS2	S1	1A	2A	3A	4A	5A	1B	2B	3B	4B	5B
Cost	N/A	N/A	TBD	$64.7M	$51.4M	$11.7M	$12.1M	$18.7M	$54.2M	$43.3M	$27.0M	$27.5M	$34.1M
Meet Probability of Failure Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Meet Life Risk Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ACSLS	N/A	N/A	TBD	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Disproportionality Ratio (ACSLS/WTP)	N/A	N/A	TBD	0	0	0	0	0	0	0	0	0	0
Completeness	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acceptability	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Effectiveness	None	None	None	Full	Full	Partial	Partial	Full	Full	Full	Partial	Partial	Full
Efficiency Ranking	6	8	9	1	3	5	4	2	1	3	5	4	2
Robustness	No	No	No	Yes	Yes	No	No	No	Yes	Yes	No	No	No
Redundancy	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Resiliency	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes
Implementation (PED & Construction)	N/A	N/A	Study ~3yrs PED ~2 yrs Const ~2yrs	PED ~1.5 yrs Const ~2.5 yrs	PED ~1.5 yrs Const ~3 yrs	PED ~1.5 yrs Const ~1 yr	PED ~1.5 yrs Const ~1 yr	PED ~1.5 yrs Const ~1 yr	PED ~1.5 yrs Const ~3.3 yrs	PED ~1.5 yrs Const ~2.5 yrs	PED ~1.5 yrs Const ~1 yr	PED ~1.5 yrs Const ~1 yr	PED ~1.5 yrs Const ~1 yr
Environmental Impacts	No Impacts	No Impacts	Significant Impacts	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary	Minor and Temporary

Shaded column is the Preferred Alternative

In the third iteration of the screening process, Alternatives 3A, 4A, 3B, and 4B were eliminated from further consideration because they had the lowest efficiency rankings, were considered only partially effective, and were not considered either robust or resilient. Alternatives 1A and 1B were eliminated from further consideration because they were the most expensive plans and, based on the other screening criteria, they rated very similar to Alternatives 2A, 5A, 2B, and 5B.

For the fourth iteration of the screening process, an on-site Constructability Review (CR) was conducted on 16-20 April 2012 at Addicks and Barker Dams by an independent 5 person team (in accordance with Chapter 22 of ER 1110-2-1156). The Constructability Review Team (CRT) deliberated on the various aspects of Alternatives 2A, 5A, 2B, and 5B with respect to their constructability. Overall, the consensus of the CRT was:

1. All alternatives evaluated (2A, 5A, 2B, and 5B) are considered constructible and meet all Phase 1 dam safety risk reduction requirements.
2. All alternatives are considered equal as long-term solutions to the identified Phase 1 dam safety issues.
3. Alternatives 5A and 5B provide the least cost dam safety modifications. However, they have the following drawbacks:
    a. Alternatives 5A and 5B reduce operational outlet capability by 40 to 50%.
    b. Alternatives 5A and 5B have significantly reduced outlet capacity during construction.
    c. Alternatives 5A and 5B would require changes to the Water Control Plan (WCP). The time (process) to change the WCP would increase the dam safety risk exposure of both structures.
    d. Greater construction risks exist for alternatives 5A and 5B
        - Requires diversion of water
        - Requires cutoff through operating conduit
        - Requires split construction in stilling basin
        - Complicated construction sequence
4. Considering all factors that have been evaluated, Alternatives 2A and 2B provide the highest certainty of success in the implementation of the dam safety modifications.

2.18 Recommended Plan

Based on these final analyses by the CRT, the USACE Galveston District recommends Alternatives 2A and 2B as the preferred plan. The construction sequence for the preferred plan would be as follows (see Figures 2 and 3):

- Construct cofferdams around the locations of the new outlet structures. The material for construction of the cofferdams would come from the borrow areas identified within the Reservoirs.
- Prepare the site and construct the new outlet structures. This would include clearing all vegetation south of Addicks Dam to IH-10 along a corridor approximately 560 feet west of the existing discharge channel. This corridor would not be in an environmentally sensitive area. New inlet and outlet channels would be excavated. A slurry cutoff in

Barker Dam would be constructed from approximately 300 feet north of Noble Road to approximately 1,100 feet south of Noble Road.

- Divert flow through newly constructed outlet works.
- Abandon original outlet works in place by removing intake structures, spillways, and stilling basins. Place earthfill caps over the upstream and downstream ends of the abandoned conduits using material from the cofferdams. Fill original discharge channels to existing ground using cofferdam material.
- Tear down the coffer dam and compact the material along the base of the dam to help prevent additional seepage issues. Part of the seepage control would consist of a small berm in Addicks Reservoir constructed at the base of the dam south of Clay Road for approximately 2,400 meters.

3.0 AFFECTED ENVIRONMENT

3.1 Project Area

The proposed project would be constructed within Addicks and Barker Reservoirs, located in the San Jacinto River Basin, approximately 17 miles west of downtown Houston. Work proposed for the Barker Dam outlet structure would be constructed on a 28.89-acre tract of land at the existing outlet structure location. Earthen materials for construction of the Preferred Alternative at Barker Dam would be borrowed from either one of two borrow areas located within the Barker Reservoir (Exhibit 3).

Work proposed for the Addicks Dam outlet structure would be constructed on a 50.42-acre tract of land at the existing outlet structure location. Earthen materials for the construction of the Preferred Alternative at Addicks Dam would be borrowed from any one of three borrow areas located within the Addicks Reservoir (Exhibit 2).

The project area is located in a region known as the Gulf Coast Prairies and Marshes Ecoregion (Gould, 1975). This region is a narrow band about 60 miles wide along the Texas coast bordering the Gulf of Mexico and stretching from the Sabine River to the Rio Grande. The region is generally flat and gradually slopes coastward from an elevation of approximately 245 feet (Diamond and Smeins, 1984). It is comprised of shallow bays, estuaries, salt marshes, dunes, and tidal flats, as well as tallgrass coastal prairie, riparian forests, mottes and coastal woodlots, and dense brush habitats.

The climate in the project area is classified as humid subtropical (Pidwirny, 2006). Spring thunderstorms occasionally bring tornadoes to the area. Prevailing winds are from the south and southwest during most of the year, bringing heat across the continent from the deserts of Mexico and moisture from the Gulf of Mexico. During the summer months, it is common for the temperature to reach over 90°F (32°C), with an average of 99 days per year above 90°F (32°C). Winters in the project area are fairly temperate. The average high in January, the coldest month, is 63°F (17°C), while the average low is 45°F (7°C). Harris County, which includes the majority of the project area, receives an average of 47.8 inches of precipitation each year as measured at Bush International Airport. Normal monthly rainfall in the project area varies from about three

inches to over five inches, with the heaviest rainfall occurring during May and June (NOAA, 2011).

3.2 Land Use

When the Reservoirs were first constructed in the 1940s, they were surrounded by a rural landscape. It wasn't until the mid to late 1970s before development from the City of Houston reached the southeast corners of both of the Reservoirs and isolated housing developments appeared on the north east corners. By the mid to late 1980s, the area surrounding the Reservoirs had been completely urbanized and by the mid 1990s, development had occurred far past the reservoirs.

According to the 2009 Master Plan for Addicks and Barker Reservoirs, the proposed work areas, borrow area 2, and the staging areas are all located on lands allocated to Project Operations while borrow areas 1, 3, 4, and 5 are all located on lands allocated to Multiple Resource Management.

Project Operations (OPS) include lands required for the structure, operations center, office, maintenance compound, borrow areas, dams, gage houses, outlet structures, lands required for administrative and maintenance needs, and other areas that are used solely for project operations. The purpose of this land use classification is to provide adequate land for the safe and efficient operation and maintenance of the reservoirs for their authorized purpose of flood risk management.

Multiple Resource Management (MRM) areas are lands that are managed for specific activities, provided the activities do not interfere with the authorized purpose of the reservoirs (flood damage reduction). Four management activities have been identified for Addicks and Barker Reservoirs are: low impact recreation, wildlife management, vegetative management, and future recreation. Currently, all lands classified as MRM on both Addicks and Barker Reservoirs are being managed for low impact recreation, vegetative management, and wildlife management.

3.3 Air Quality

The project area is located in an area designated as the Houston-Galveston-Brazoria Intrastate Air Quality Control Region (HGB) by the EPA. The HGB is in attainment or unclassified with the NAAQS for all criteria pollutants except ozone and was classified as having marginal nonattainment with the 8-hour NAAQS for ozone as of 20 July, 2012.

3.4 Noise

The project area is surrounded by urban development, primarily residential neighborhoods, commercial retail shops, and business offices. The noise levels in these areas range from faint to loud. There are noise sources in the study area that generate substantially greater levels of noise than typically encountered in the surrounding neighborhoods. These noise sources are Interstate Highway (IH) 10, other main roadways, West Houston Airport, and firing ranges in the reservoirs. Standard decibel ranges for the existing noise levels in the project study area can be found in Table 2.

Table 2: Existing Noise Levels in the Project Study Area		
Land Use Category	**Decibel Range**	**Subjective Evaluation**
Residential Neighborhoods	30-70	Faint to Loud
Retail Shops	40-70	Moderate to Loud
Business Offices	50-70	Moderate to Loud
Residential Streets	65-80	Loud to Very Loud
Busy Urban Streets	70-105	Loud to Very Loud
IH 10	80-105	Very Loud
West Houston Airport	90-120	Very Loud to Deafening

Noise Sensitive Receptors (NSRs) are facilities or areas where excessive noise may disrupt normal activity or cause annoyance or loss of business. Land uses such as residential, religious, educational, recreational, and medical facilities are more sensitive to increased noise levels than are commercial and industrial land uses. Table 3 gives an overview of the NSRs that are located in the vicinity and their distance to the proposed project.

Table 3: NSRs in the Project Study Area and Their Distance from the Proposed Project Sites		
Type of NSR	**Approximate Distance from Proposed Project Sites (Miles)**	
	Addicks Project Site	**Barker Project Site**
Residential Neighborhood	0.10	0.21
Schools	0.96	0.66
Hospital	3.36	2.94
Churches	0.50	0.59
Cemeteries	0.62	1.90
Parks	0.43	0.00

3.5 Water Quality

There are three creeks or bayous that flow within the project area: Langham Creek, South Mayde Creek, and Buffalo Bayou. The non-tidal portion of Buffalo Bayou (TCEQ Segment 1014) has been identified by the Texas Commission on Environmental Quality (TCEQ) for contact recreation use and as having limited capacity to support aquatic life. Langham Creek and South Mayde Creek have been identified as having limited capacity to support aquatic life (TCEQ, 1997). In order to determine if a water body can be used for its intended uses, the TCEQ has established safe levels for seven indicators of water quality including chloride, sulfate, total dissolved solids, dissolved oxygen, pH, fecal coliform and temperature. Two of these indicators (total dissolved solids and temperature) are not monitored for contact recreation use or low quality aquatic habitat use.

All of the creeks in the reservoirs exhibit impairments, primarily due to bacteria levels. In 2008 the non-tidal portion of the Buffalo Bayou watershed (Segment 1014) was identified by the TCEQ as significantly impaired for bacteria, and listed on the Texas 303(d) List (TCEQ, 2008). In 2009, Segment 1014 was removed from the list due to the development and approval of Total Maximum Daily Loads (TMDLs) in this segment of the bayou. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality

standards, and an allocation of that load among the various sources of that pollutant. According to the Clean Water Act, each state must develop TMDLs for all the waters on the 303(d) list. On April 8, 2009, the TCEQ adopted TMDLs for Buffalo Bayou. The EPA approved the TMDLs on June 11, 2009, at which time the TMDLs became part of the state's Water Quality Management Plan. As stated in the 2010 Texas Integrated Report - Water Bodies and Parameters Removed from the 303(d) List, the non-tidal portion of Buffalo Bayou has been classified as category 4a (TCEQ, 2010).

3.6 Hazardous, Toxic, and Radioactive Wastes

On May 18, 2012, Environmental Data Resources, Inc. (EDR) conducted a search of environmental databases according to American Society of Testing and Materials (ASTM) E1527-05 standard specifications. A three-mile search radius was used from an estimated center point of the proposed project area to investigate surrounding environmental conditions. All proposed project activities are located within the three-mile search radius.

A total of 17 Leaking Petroleum Storage Tank (LPST) sites were recorded within three miles of the center point of the search radius. Sixteen of these LPST sites have been issued "Final Concurrence" by the TCEQ and would not represent an environmental risk. One site located at 1042 S. Highway 6 is owned by the USACE. This site is listed as "Final Concurrence Pending." There is no evidence to indicate that this LPST site pending closure represents an environmental risk to the proposed project area.

Four solid waste disposal sites are listed in the database search as occurring within three miles of the center point of the search radius. Three properties within the radius are listed as "Voluntary Cleanup Properties." Two historical dry cleaning locations occur within the radius. None of these properties are known to present an environmental risk to the proposed project area.

Databases of federal and state inventory listings that would pose a low risk of environmental contamination to the environment within the proposed project area were examined and were not considered in further detail. These listings include but are not limited to: Emergency Release Reports (SPILLS), RCRA-Non Generator, Industrial Hazardous Waste, Facility Index System (FINDS), RCRA Conditionally Exempt Small Quantity Generator (CESQG), RCRA Administrative Action Tracking System (RAATS), Aboveground Storage Tank (AST), Aerometric Information Retrieval System (AIRS), RCRA Small Quantity Generator (RCRA-SQG), and the Underground Storage Tank (UST) databases.

3.7 Prime and Unique Farmlands

In 2008, the National Resource Conservation Service (NRCS) confirmed that the lands within Addicks and Barker Dams were exempt from the Farmland Protection Policy Act (FPPA) since the land within Addicks and Barker Reservoirs was converted to be a water storage and flood risk management project over 60 years ago and continues to be used for that purpose. The NRCS determined that the lands within the reservoirs are not considered prime or unique farmlands. Correspondence with NRCS is attached in Appendix A.

3.8 Vegetation and Wetlands

The existing vegetative cover within the project study area consists of herbaceous uplands, forested uplands, emergent wetlands, forested wetlands, and perennial tributaries. Table 4 details the vegetative communities within each proposed project construction measure or feature (site). Figures 21 through 27 depict the boundaries of each vegetative communitiy that would be affected by construction of the proposed project.

Table 4: Vegetative Communities Potentially Affected by Project Measure/Feature (Site)

Project Area	Herbaceous Uplands (acres)	Forested Uplands (acres)	Emergent Wetlands (acres)	Perennial and Seasonal Tributaries (acres)
Addicks Dam Outlet Structure Site	23.65	18.59*	5.42	2.70
Barker Dam Outlet Structure Site	18.80	4.67	3.28	2.14
Borrow Area 1	17.46	1.28	-	-
Borrow Area 2	6.67	-	0.60	-
Borrow Area 3	-	45.36	75.28	-
Borrow Area 4	-	-	56.11	-
Borrow Area 5	-	49.13	3.10	-

*Ephemeral Tributaries (0.15 acres) was included in the total for Forested Uplands

Herbaceous uplands include areas that were historically coastal prairie but now consist mostly of mixed prairie, old field habitat (mix of native and non-native plants), and maintained and mowed areas. Although several locations within various proposed construction sites contain vegetation commonly found in a healthy coastal prairie ecosystem, many of these vegetative communities have been altered by invasion of native and exotic woody and herbaceous species.

Dominant species identified within herbaceous uplands consist of broomsedge bluestem (*Andropogon virginicus*), bushy bluestem (*Andropogon glomeratus*), purple poppymallow (*Callirhoe involucrata*), annual marsh elder (*Iva annua*), Jesuit's bark (*Iva frutescens*), hirsute sedge (*Carex complanata*), yellow thistle (*Cirsium horridulum*), needleleaf rosette grass (*Dichanthelium aciculare*), velvet panicum (*Dichanthelium scoparium*), hairy fimbry (*Fimbristylis puberula*), hairawn muhly (*Muhlenbergia capillaris*), Bermudagrass (*Cynodon dactylon*), bahiagrass (*Paspalum notatum*), yellow foxtail (*Setaria pumila*), woodrush flatsedge (*Cyperus entrerianus*), powderpuff (*Mimosa strigillosa*), great ragweed (*Ambrosia trifida*), Cuman ragweed (*Ambrosia psilostachya*), yellowdicks (*Helenium amarum*), brownseed paspalum (*Paspalum plicatulum*), Nuttall's prairie parsley (*Polytaenia nuttallii*), anglestem beaksedge (*Rhynchospora caduca*), globe beaksedge (*Rhynchospora globularis*), Macartney rose (*Rosa bracteata*), blackeyed Susan (*Rudbeckia hirta*), little bluestem (*Schizachyrium scoparium*), fewflower nutrush (*Scleria pauciflora*), Canada goldenrod (*Solidago altissima*), slender rosinweed (*Silphium gracile*), Brazilian vervain (*Verbena brasiliensis*), tuberous vervain (*Verbena rigida*), hogwort (*Croton capitatus*), common plantain (*Plantago major*), and southern blackberry (*Rubus trivialis*). Individual trees and shrubs are interspersed throughout the herbaceous uplands and include poisonbean (*Sesbania drummondii*), common persimmon (*Diospyros virginiana*), black willow (*Salix nigra*), buttonbush (*Cephalanthus occidentalis*), and

Chinese tallow (*Triadica sebifera*). These trees range from three to 14 inches in diameter at breast height (dbh) and 15 to 30 feet in height. Stem densities are estimated to be below 15 stems per acre.

Forested upland communities consist of riparian forests, upland pine areas, and open canopy areas dominated by a variety of woody species including oaks, pines, elms, and ashes. Invasive species were observed throughout these communities. These vegetative communities are located in the southern portion of the Addicks Dam Site, the western portion of the Barker Dam Site, and proposed Borrow Areas 1, 3, and 5. One ephemeral tributary flows through the southern portion of the Addicks Dam Site within the forested upland community. Individual trees within this community ranged from three to 24 inches dbh and 15 to 45 feet in height. Stem densities for woody species are estimated to be between 30 and 300 stems per acre.

Dominant species found in forested uplands include water oak (*Quercus nigra*), willow oak (*Quercus phellos*), loblolly pine (*Pinus taeda*), live oak (*Quercus virginiana*), pecan (*Carya illinoinensis*), water hickory (*Carya aquatica*), common persimmon, green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), winged elm (*Ulmus alata*), cedar elm (*Ulmus crassifolia*), hackberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), American sycamore (*Platanus occidentalis*), slippery elm (*Ulmus rubra*), white ash (*Fraxinus americana*), red mulberry (*Morus rubra*), yaupon (*Ilex vomitoria*), Chinese privet (*Ligustrum sinense*), possumhaw (*Ilex decidua*), boxelder (*Acer negundo*), cockspur hawthorn (*Crataegus crus-galli*), green hawthorn (*Crataegus viridis*), dwarf palmetto (*Sabal minor*), western soapberry (*Sapindus saponaria*) and in wetter areas black willow and buttonbush. Herbaceous and vine layers constitute a minor portion of this vegetative community and include slender woodoats (*Chasmanthium laxum*), southern arrowwood (*Viburnum dentatum*), poisonbean, eastern baccharis (*Baccharis halimifolia*), American beautyberry (*Callicarpa americana*), Alabama supplejack (*Berchemia scandens*), muscadine (*Vitis rotundifolia*), saw greenbrier (*Smilax bona-nox*), roundleaf greenbrier (*Smilax rotundifolia*), field blackberry, honeysuckle (*Lonicera japonica*), peppervine (*Ampelopsis arborea*), and Macartney rose.

Emergent wetlands are located in the Addicks Dam Site, Barker Dam Site, and proposed Borrow Areas 2, 3, and 4. These areas are either depressional in nature or abutting flowing tributaries and other open waters. The emergent wetlands were dominated by anglestem beaksedge, maidencane (*Panicum hemitomon*), swamp smartweed (*Polygonum hydropiperoides*), spotted ladysthumb (*Polygonum persicaria*), Pennsylvania smartweed (*Polygonum pensylvanicum*), common rush (*Juncus effusus*), common threesquare (*Schoenoplectus pungens*), marsh seedbox (*Ludwigia palustris*), floating primrose-willow (*Ludwigia peploides*), mountain spikerush (*Eleocharis montana*), sand spikerush (*Eleocharis montevidensis*), common mallow (*Malva neglecta*), smutgrass (*Sporobolus indicus*), green flatsedge (*Cyperus virens*), hogwort, saltgrass (*Distichlis spictatum*), curlydock (*Rumex crispus*), white heath aster (*Symphyotrichum ericoides*), and broadleaf arrowhead (*Sagittaria latifolia*). Individual trees and shrubs were interspersed throughout the herbaceous wetlands and included poisonbean, common persimmon, black willow, buttonbush, and Chinese tallow. Observed trees ranged from three to 12 inches dbh and 15 to 30 feet in height. Stem densities for woody species are estimated to be below 15 stems per acre.

Forested wetlands are located in proposed Borrow Areas 3, 4, and 5. The forested wetlands are dominated by Chinese tallow, poisonbean, common persimmon, black willow, green ash, and buttonbush. Individual trees within this community ranged from three to 18 inches dbh and 15 to 28 feet in height. Stem densities are estimated to be between 30 and 300 stems per acre. Herbaceous species in this vegetative community include swamp smartweed, marsh seedbox, sand spikerush, anglestem beaksedge, annual marsh elder, maidencane, common threesquare, and white heath aster.

Perennial and seasonal tributary habitat is located within and below the ordinary high water marks (OHWM) of Langham Creek at the Addicks Dam Site, and Buffalo Bayou and its associated tributaries at the Barker Dam Site. Due to the flow regimes of these tributaries, no vegetation was observed within their boundaries. These communities are abutted by herbaceous uplands, forested uplands, and emergent wetlands. Typical substrates within these habitats consist of either silty and sandy loams, mucks, several rock riprap-lined runs, or pools constructed as erosion and flow control measures downstream of both dams.

3.9 Invasive Species

Invasive species are both native and non-native species of plants or animals that heavily colonize a particular habitat resulting in adverse effects to that habitat. Invasive species are able to invade and begin to alter an ecosystem within a few decades because they have few natural pests or diseases in an ecosystem. Growth rates and specialized reproductive characteristics enable invasive species to outcompete other plants or animals in the ecosystem. The most common invasive plant species in the reservoirs include Chinese tallow (*Triadica sebifera*), woodrush flatsedge (*Cyperus entrerianus*), salt cedar (*Tamarix* sp.), narrow leaf cattail (*Typha angustifolia*), alligator weed (*Alternanthera philoxeroides*), common reed (*Phragmites australis*), Macartney rose (*Rosa bracteata*), and honey mesquite (*Prosopis glandulosa*).

The primary invasive animal in both reservoirs is feral domestic hogs (*Sus scrofa*). Additionally, the channeled apple snail (*Pomacea canaliculata*) is known to occur within both reservoirs.

3.10 Wildlife

Bottomland hardwood forests in the reservoirs provide important stopover habitat for migrating neo-tropical songbirds of the Central Flyway (Barrow et al., 2005), as well as songbirds, wintering birds, and year-round residents. During spring and fall migration, neo-tropical migrants such as American redstarts (*Setophaga ruticilla*), Baltimore orioles (*Icterus galbula*), and black-throated green warblers (*Dendroica virens*) are likely to use the reservoirs. During winter, typical migrant species include ruby-crowned kinglet (*Regulus calendula*), yellow-rumped warbler (*Dendroica coronata*), white-throated sparrow (*Zonotrichia albicollis*), and yellow-bellied sapsucker (*Sphyrapicus varius*). Typical wintering waterfowl include wood duck (*Aix sponsa*) and mallard (*Anas platyrhynchos*) (Guilfoyle 2001). Year round residents of bottomland hardwood forest within the reservoirs include the tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), Carolina chickadee (*Poecile carolinensis*), downy woodpecker (*Picoides pubescens*), northern cardinal (*Cardinalis cardinalis*), and red-bellied woodpecker (*Melanerpes carolinus*) (Guilfoyle, 2001). Wading birds, such as the great

egret (*Ardea alba*), great blue heron (*Ardea herodias*), and little blue heron (*Egretta caerula*), also use the bottomland hardwood forests within the reservoirs (Guilfoyle, 2001).

Wetlands within the reservoirs provide habitat for waterfowl such as black-bellied whistling-duck (*Dendrocygna autumnalis*), northern shoveler (*Anas clypeata*), mallard, northern pintail (*Anas acuta*), blue-winged teal (*Anas discors*), gadwall (*Anas strepera*), American wigeon (*Anas americana*), and mottled duck (*Anas fulvigula*) and roseate spoonbill (*Platalea ajaja*).

The reservoirs provide habitat for numerous small to medium-sized mammals including raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), eastern fox squirrel (*Sciurus niger*), eastern gray squirrel (*Sciurus carolinensis*), cottontail rabbit (*Sylvilagus* spp.), striped skunk (*Mephitis mephitis*), nine-banded armadillo (*Dasypus nobemcinctus*), and rodents, including hispid cotton rat (*Sigmodon hispidus*), white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus* spp.), and house mouse (*Mus musculus*). Typical large mammals found within the reservoirs include white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), North American beaver (*Castor canadensis*), feral hog (*Sus scrofa*), feral dogs (*Canis lupus familiaris*), feral cats (*Felis catus*), and North American river otter (*Lontra canadensis*).

Amphibians found in the reservoirs include green tree frogs (*Hyla cinerea*), southern leopard frogs (*Rana sphenocephala*), bullfrogs (*Lithobates catesbeianus*), and Gulf Coast toad (*Bufo valliceps*). Typical reptiles include common snapping turtle (*Chelydra serpentina*), red-eared slider (*Trachemys scripta*), three-toed box turtle (*Terrapene carolina*), ornate box turtle (*Terrapene ornata*), green anole (*Anolis carolinensis*), five-lined skink (*Eumeces fasciatus*), and slender glass lizard (*Ophisaurus attenuatus*). The reservoirs also support a number of snake species such as prairie king snake (*Lampropeltis calligaster*), copperhead (*Agkistrodon contortrix*), cottonmouth (*Agkistrodon piscivorus*), and various other species of water snakes (University of Texas, 2000).

3.11 Threatened and Endangered Species

Texas Parks and Wildlife Department (TPWD) was contacted on May 18, 2012, regarding their knowledge of recorded data about the documented presence or potential presence of state listed species on or adjacent to the proposed project areas. TPWD responded on May 21, 2012, with a search of the NDD and stated that the following species were documented within a ten mile radius of the project areas:

- Houston toad (*Anaxyrus houstonensis*)
- Texas windmill grass (*Chloris texensis*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Texas prairie dawn (*Hymenoxys texana*)
- Coastal gay-feather (*Liatris bracteata*)
- Houston daisy (*Rayjacksonia aurea*)
- Plains spotted skunk (*Spilogale putorius interrupta*)
- Threeflower Broomweed (*Thurovia triflora*)

No state listed threatened or endangered species or their habitats were documented by the NDD search within one mile of proposed construction sites (dam outlet reconstruction areas and borrow locations).

The USACE maintains a database of known occurrences of Texas prairie dawn populations for both Addicks and Barker Reservoirs. While populations of this species are documented within Addicks and Barker Reservoirs, no known occurrences of Texas prairie dawn populations are documented within 0.40-miles of proposed project sites.

Table 5: Federal Threatened and Endangered Species in Harris and Fort Bend Counties

Common Name	Scientific Name	Federal Status
BIRDS		
Bald Eagle	*Haliaeetus leucocephalus*	Delisted, being Monitored for the first five years
Whooping Crane	*Grus americana*	Endangered
VASCULAR PLANTS		
Texas Prairie Dawn	*Hymenoxys texana*	Endangered

Only federally listed threatened and endangered species listed as occurring in either Harris or Fort Bend Counties, Texas were considered in further detail in the attached Biological Assessment (BA) in Appendix E and include the whooping crane, bald eagle, and Texas prairie dawn. Field surveys for listed species and their habitats were conducted in May 2012. No listed species or their associated habitats were observed in or near project construction sites.

3.12 Historic Properties

The project area within Addicks Reservoir has been subjected to five cultural resource investigations (see Table 6). These investigations have resulted in the identification of four cultural resources (see Table 7). The project area in Barker Reservoir has been inventoried once before. No cultural resources were identified. Garcia-Herreros (2005) found that the area south of the Addicks Dam was heavily impacted and severely disturbed during construction of the dams.

Table 6: Previous Cultural Resource Investigations at Addicks Reservoir

Year	Author	Title
1953	Wheat, Joe Ben	An Archeological Survey of the Addicks Dam Basin, Southeast Texas
1983	Fields, R. C., Freeman, M. D., and Kotter, S. M.	Inventory and Assessment of Cultural Resources at Addicks Reservoir, Harris County, Texas
1986	Fields, R. C., Godwin, M., Freeman, M., Lisk, S.	Inventory and Assessment of Cultural Resources at Barker Reservoir, Fort Bend and Harris Counties, Texas
1972	Dillehay and Mallouf	An Archeological Reconnaissance of Areas to Be Affected by the Proposed Nuclear Power Plant, AU Co, TX, and Associated Power Transmission Lines in AU, WL, FB, and HR Co's, TX
2005	Garcia-Herreros, Jorge	Phase I Cultural Resources Survey on United States Corps of Engineers

Table 6: Previous Cultural Resource Investigations at Addicks Reservoir		
Year	**Author**	**Title**
		Property for the Proposed Park Row Road Expansion, Harris County, Texas
2009	Soltysiak, Kristi	Archeological Assessment for the Proposed Terry Hershey Park Hike and Bike Trail Project in Harris County, Texas

Table 7: Archaeological Sites found near the project area in Addicks Reservoir				
Site Number	**Component**	**Artifacts**	**NR Status**	**References**
41HR184	Prehistoric	Lithic Debitage	Unevaluated	Dillehay and Mallouf, 1972
41HR187	Prehistoric	Lithic Debitage	Unevaluated	Dillehay and Mallouf, 1972
41HR208	Prehistoric	Lithic Debitage	Unevaluated	Dillehay and Mallouf, 1972
41HR211	Prehistoric	Lithic Debitage	Unevaluated	Dillehay and Mallouf, 1972

3.13 Aesthetic Resources

Natural and cultural features that give the project area landscape its character include topographic features, existing structures, and vegetation. While aesthetics are most often thought of as a visual resource, the aesthetic integrity of an area is heavily influenced by both audible and olfactory impacts.

The proposed project measures and features are located at the outlet works on both Addicks and Barker Dam and at several proposed borrow areas within Addicks and Barker Reservoirs. Even though the outlet works structures are considered "green areas," due to the grass cover on the dam, the aesthetic value of these areas are considered industrial in nature due to the presence of the outlet works. The proposed borrow areas are located in the interior of the reservoirs and are currently vegetated with herbaceous and forested cover. The existing condition of the proposed borrow areas contribute to the aesthetics of the reservoirs as "green areas" that are utilized by day users for wildlife observation, hiking, biking, and various other recreational uses.

3.14 Recreational Resources

Although numerous recreational facilities are available in the reservoirs, the only recreational resource within the project area is the George Bush hike and bike trail. This trail is located on Barker Dam. This 11.36-mile asphalt trail runs from Highland Knolls at Fry Road through George Bush Park to Highway 6, east of the Barker Reservoir, where it connects to the hike and bike trail in Terry Hershey Park.

3.15 Traffic and Circulation

There are six major roadways that transect Addicks Reservoir and two major roadways that transect Barker Reservoir. All of these roads include adjacent rights-of-way set aside for maintenance and repair. The three major north-south roads in Addicks Reservoir are SH 6, Barker-Cypress Road and North Eldridge Parkway. The three major east-west roadways in Addicks Reservoir include Clay Road, which crosses the northern portion of Addicks Reservoir; Groeschke Road, which runs from the west edge of Addicks Reservoir to SH 6; and Patterson Road, which runs from SH 6 to North Eldridge Parkway. There are several smaller roads that run

through Bear Creek Pioneers Park. Major public roadways surrounding Addicks Reservoir include IH 10 to the south, Barker Cypress Road to the west and Brittmoore Road and Beltway 8 to the east.

In Barker Reservoir, Westheimer Parkway runs east-west and South Barker Cypress runs north-south from north of Westheimer Parkway to FM 1093, south of Barker Reservoir. Major public roadways surrounding Barker Reservoir include Westpark Tollway to the south, Fry Road to the west, IH 10 to the north and SH 6 to the east.

The West Houston Airport is located along the western edge of Addicks Reservoir. This airport is located east of Barker Cypress Road, south of Clay Road, west of SH6 and north of Groeschke Road. It is a general aviation airport that contains one asphalt runway that is approximately 4,000 feet long.

3.16 Socioeconomics

According to the 2010 Census, there were approximately 1.5 million people living within a 10-mile radius of the Addicks and Barker Reservoirs. No individuals live on the Addicks and Barker Reservoirs; therefore, a socioeconomic profile of the population in a 10-mile radius of the reservoirs was used for comparison. The 10-mile radius was chosen as the maximum reasonable extent for socioeconomic impacts. The data presented below was obtained from the 2010 Census, unless otherwise noted.

Table 8. Comparison of Socioeconomic Factors Within 10 Miles of the Addicks and Barker Reservoirs

	10-mile Radius of Project Site	Harris County, TX	Fort Bend County, TX	Texas
Total Persons	1,511,651	4,092,459	585,375	25,145,561
Total Households	590,609	1,598,698	197,030	9,977,436
Percent Minority	65.4%	63.8%	67.0%	54.7%
Median Household Income*	$66,861	$51,444	$79,845	$49,646
Race and Ethnicity				
White	33.5%	33.0%	36.2%	45.3%
Black or African-American	15.5%	18.4%	21.1%	11.5%
American Indian or Alaska Native	0.2%	0.2%	0.2%	0.3%
Asian	11.5%	6.1%	16.9%	3.8%
Native Hawaiian or Other Pacific Islander	0.04%	0.1%	0.0%	0.1%
Other Race	0.2%	0.2%	0.2%	0.1%
Two or More Races	1.5%	1.2%	1.7%	1.3%
Hispanic	37.5%	40.8%	23.7%	37.6%
Age				
Under 10 Years	16.2%	16.0%	15.9%	15.3%
10 to 19 Years	15.0%	14.8%	16.4%	15.0%
20 to 69 Years	64.1%	63.9%	63.2%	62.7%
Over 69	4.7%	5.3%	4.5%	7.0%
Educational Attainment*				

Table 8. Comparison of Socioeconomic Factors Within 10 Miles of the Addicks and Barker Reservoirs				
	10-mile Radius of Project Site	**Harris County, TX**	**Fort Bend County, TX**	**Texas**
High School Diploma	82.1%	77.6%	88.6%	80.0%
B.S./B.A. or higher	34.7%	27.7%	40.4%	25.8%
Median Household Income Level*				
Less than $15,000	9.3%	12.1%	6.0%	13.4%
$15,000 - $25,000	9.9%	11.3%	5.9%	11.4%
$25,000 - $50,000	24.0%	25.3%	18.2%	25.5%
$50,000 - $75,000	17.4%	17.6%	17.1%	18.1%
Greater than $75,000	39.4%	33.7%	52.8%	31.6%

**Information obtained from U.S. Census Bureau, 2006-2010 American Community Survey (ACS). ACS data are estimates; they are not exact counts.*

The areas in the vicinity of the Addicks and Barker Reservoirs are either highly commercialized or consist of fairly affluent subdivisions. These areas are not considered socially or economically disadvantaged based upon the socioeconomic data provided in Table 8.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Environmental Consequences of the Non-Preferred Alternatives

An analysis of the alternatives was conducted to assess the environmental consequences that would result from implementation of the plans. Table 9 displays the resources that would likely be affected by construction of the Non-Preferred Alternatives, the Preferred Alternative, and Dam Failure. Section 4.2 provides further details of the environmental consequences that would result from implementation of the Preferred Alternative. The Preferred Alternative would result in only negligible (minor and/or temporary) impacts to the environment. The non-structural alternatives (NS1 and NS2) would most likely result in failure of the dams, leading to catastrophic flooding and significant impacts to multiple resources. Structural alternatives 1A to 11A and 1B to 11B would have temporary minor impacts to several resources (similar to the preferred alternative). Alternative S1, removal of the dams, would result in a loss of the flood protection provided by the dams. This would result in increased flooding along Buffalo Bayou and significant impacts to numerous resources.

Table 9. Comparison of Environmental Consequences for Construction of the Non-Preferred Alternatives to the Preferred Alternative and Dam Failure															
Resource Affected	Alternatives														
	NS1	NS2	S1	1A 1B	2A 2B	3A 3B	4A 4B	5A 5B	6A 6B	7A 7B	8A 8B	9A 9B	10A 10B	11A 11B	DF
Project Area	X	X	X												X
Soils, Topography and Geology	X	X	X	+	+	+	+	+	+	+	+	+	+	+	X
Land Use	X	X	X	+	+										X
Air Quality			X	+	+	+	+	+	+	+	+	+	+	+	
Noise				+	+	+	+	+	+	+	+	+	+	+	

Table 9. Comparison of Environmental Consequences for Construction of the Non-Preferred Alternatives to the Preferred Alternative and Dam Failure

Resource Affected	Alternatives														
	NS1	NS2	S1	1A 1B	2A 2B	3A 3B	4A 4B	5A 5B	6A 6B	7A 7B	8A 8B	9A 9B	10A 10B	11A 11B	DF
Water Quality	X	X	X	+	+	+	+	+	+	+	+	+	+	+	X
Hazardous, Toxic and Radioactive wastes			X												X
Prime and Unique Farmland			X												X
Vegetation			X	+	+	+	+	+	+	+	+	+	+	+	X
Invasive Species			X												X
Wildlife			X	+	+	+	+	+	+	+	+	+	+	+	X
Threatened and Endangered Species			X												X
Cultural Resources			X												X
Aesthetic Resources			X	+	+	+	+	+	+	+	+	+	+	+	X
Recreational Resources			X	+	+	+	+	+	+	+	+	+	+	+	X
Traffic and Circulation			X												X
Socioeconomic Resources and Environmental Justice			X												X

X = Significant Impact
+ = Negligible Impacts (Minor and/or Temporary)
Shaded column is the Preferred Alternative

4.2 Alternative Plan NS1 – Permanent Implementation of the IRRMs

Implementation of Alternative Plan NS1 would provide a rapid although temporary solution to the existing deficiencies that the outlet works at both Addicks and Barker Dams are currently experiencing. This Alternative does not provide for an adequate seepage barrier and granular filter to control any seepage along the conduit. Hydrological forces imposed during storm events at the outlet structures following implementation of Alternative Plan NS1 would continue to direct the structures towards progressive failure and ultimately result in failure of the dams. Failure of the dams would result in significant adverse impacts to environmental resources in the project area. Potentially catastrophic effects to public infrastructure and public safety to locations downstream of the dams may result from failure of the dams during a storm event located upstream of the outlet structures. In addition, there would be significant impacts to soils and topography, water quality, vegetation profiles, wildlife and wildlife habitats, cultural resources, aesthetic resources, recreational resources, and socioeconomic resources in flooded areas. A catastrophic flood event would also result in the spread of invasive species and potential spread of HTRW contaminants.

4.3 Alternative Plan NS2 – No Action

Implementation of Alternative Plan NS2 would not result in impacts to resources. However, the seepage and erosion beneath the outlet works at both Addicks and Barker Dams would continue until hydrological forces imposed during storm events at the outlet structures ultimately result in

failure of the dams. Failure of the dams would result in significant adverse impacts to environmental resources in the project area. Potentially catastrophic effects to public infrastructure and public safety to locations downstream of the dams may result from failure of the dams during a storm event located upstream of the outlet structures. In addition, there would be significant impacts to soils and topography, water quality, vegetation profiles, wildlife and wildlife habitats, cultural resources, aesthetic resources, recreational resources, and socioeconomic resources in flooded areas. A catastrophic flood event would also result in the spread of invasive species and potential spread of HTRW contaminants.

4.4 Alternative Plan S1 – Removal of Addicks and Barker Dams

Implementation of Alternative Plan S3 would remove Addicks and Barker Dams to the extent necessary to ensure run-of-the-bayou conditions at all times. This alternative would eliminate flood control to downstream areas including the City of Houston. Flooding may result in significant impacts to environmental resources in the project area including natural soils and topography, vegetation profiles, an increase in the spread of invasive species, wildlife habitat, cultural resources (including Historic Properties, Historic Districts, and Cemeteries), aesthetics along the bayou, recreational resources along the bayou, existing land use patterns, the socioeconomic profile of the communities along the bayou, and to traffic along and across the bayou. There would likely be a permanent decrease in water quality in Buffalo Bayou and a high potential to uncover HTRW contaminants along the bayou and spread them downstream. During removal of the dams, there would also be temporary impacts to air quality and impacts from noise.

4.5 Alternatives 1A to 11A and 1B to 11B

Implementation of Alternatives 1A to 11A and 1B to 11B would result in either the replacement of or repair to the outlet works at both Addicks and Barker Reservoirs. From an Environmental perspective, these alternatives are very similar. They have almost identical footprints, similar construction durations, similar access routes, staging areas, borrow areas, and construction equipment. Accordingly, the impacts associated with these alternatives are presented together. The impacts associated these alternatives would be temporary in duration and limited in spatial extent and are not anticipated to significantly impact the overall project area. However, the following impacts to environmental resources would be expected.

4.6 Impacts to the Project Area

Implementation of any of these Alternatives is limited in spatial extent, temporary in duration and would not substantially affect the overall project area. Most project activities would be confined to areas previously disturbed during construction of the dams in the 1940s and areas subsequently disturbed during repair of the structures. However, the proposed borrow areas needed for Alternatives 1A, 2A, 1B, and 2B are located outside the areas previously disturbed by construction and maintenance activities. Impacts in the project area would be negligible (minor and/or temporary). Impacts to the individual resources are presented in the following subsections.

4.7 Impacts to Land Use

Construction activities resulting from implementation of these alternatives would occur in areas that are currently designated by the 2009 Master Plan under the Operations (OPS) and Multiple Resource Management (MRM) land use classifications. Based upon the 2009 Master Plan, the land use activities permissible within lands classified as OPS include construction of reservoir related structures and use of soils for borrow areas. Land management strategies appropriate for the MRM classification include Low Impact Recreation, Wildlife Management, Vegetation Management, and Future Recreation. The proposed land use at the proposed construction areas (adjacent to the outlet works at both Addicks and Barker Reservoirs) is consistent with the existing land use as designated by the 2009 Master Plan. However, two of the proposed borrow areas in Addicks Reservoir and both the proposed borrow areas in Barker are within the MRM land use classification. While borrow areas would not normally be allowed within a MRM classification, the safe and effective operation of the reservoirs takes precedence over all other uses (Section 1.1, 2009 Master Plan). The Master Plan will be updated to change land use classification for the borrow areas from MRM to OPS.

4.8 Impacts to Air Quality

Project related air quality impacts were evaluated by calculating the worst case emissions for the various pieces of equipment that will be used to construct the proposed project (Appendix D). The Harris/Galveston/Brazoria Attainment Area is currently classified as marginal nonattainment for NO_X and SO2.

Table 10. Air Quality Emissions for the proposed project

	2015	2016	2017	2018	*de minimus* Threshold (tons/year)
NO_X	15.10	29.95	29.95	14.85	100
SO2	2.33	4.43	4.43	2.10	100

The estimated air quality pollutants associated with these alternatives are considered temporary since the impacts would not continue after the project was completed. The pollution sources would consist of land-based mobile source air toxins (MSATs) that would be used during the construction activities including off-road machinery (bulldozers, backhoe loaders, excavators) and on-road vehicles (employee vehicles). Construction related air pollution would include particulate matter (fugitive dust) from site preparation and construction.

Air contaminant emissions associated with on and off road machinery and vehicles would be primarily combustion products from fuel burned in these types of equipment. Off-road machinery emission sources would primarily be created by diesel-powered engines. On-road equipment would primarily be created by gasoline-powered engines.

Air contaminant emissions from the Proposed Alternative would result in *de minimus* emissions compared to those from existing sources in the HGB region. Due to the anticipated short-term duration of the construction activities, there would be no long-term impacts. Emissions from these activities would not adversely impact the long-term air quality in the area.

4.9 Impacts from Noise

The existing ambient noise in the project area is elevated by nearby major highways (SH 6) and Interstates (IH 10). Heavy machinery is anticipated to be the major source of noise during construction of these alternatives. Construction is proposed to occur during daylight hours when occasional loud noises are tolerable to surrounding NSRs. None of the NSRs are expected to be exposed to construction noise for a long duration; therefore, any extended disruption of normal activities is not expected. The existing earthen dams along both Addicks and Barker Dams would provide a buffer to NSRs from construction related noise. Provisions would be included in the plans and specifications that require the contractor to make every reasonable effort to minimize construction noise through abatement measures such as work-hour controls and proper maintenance of muffler systems. Because noise levels from proposed construction activities would be consistent with current ambient noise levels in the project area, and NSRs would be buffered from noise by the existing earthen dams surrounding Addicks and Barker Reservoirs, no noise related impacts are anticipated to result from these alternatives.

4.10 Impacts to Water Quality

Potential impacts to water quality associated with the construction of these alternatives include the potential for erosion and sedimentation during construction activities. During this period, stormwater runoff could carry sediment offsite into receiving water and possibly result in temporary increases in Total Suspended Solids (TSS). The impacts to receiving waterways downstream of this proposed project would be temporary and minimal. The USACE would prepare a Storm Water Pollution Prevention Plan (SW3P) and implement erosion and sedimentation control Best Management Practices (BMPs) to minimize any detrimental effects to water quality during construction.

The proposed project would disturb more than one acre of land, therefore the USACE would require the construction contractor to obtain a Texas Pollutant Discharge Elimination System (TPDES) storm water permit from TCEQ before the start of construction and to comply with all permit conditions. Any effects to water quality associated with the construction of the new facility would be short term and minimized by the use of BMPs. The proposed project is not expected to exacerbate bacterial levels to areas downstream of the project site. No long-term effects to water quality are expected as a result of the proposed project.

4.11 Impacts to Hazardous, Toxic and Radioactive Wastes

It is not anticipated that implementation of these alternatives would have the potential of intercepting contaminated soils and/or groundwater, disturbing any hazardous materials or creating any potential hazard to human health. During construction activities, unusable equipment, debris, and material shall be disposed of in an approved manner and location. The contractor would take appropriate precautions to prevent, minimize and control the spill of fuels, lubricants, and/or other hazardous materials in the construction areas. In the event that hazardous materials are discovered during implementation of the proposed project, the USACE would

handle, manage, and dispose of petroleum products, hazardous materials and other toxic waste in accordance with the requirements of local, state and federal agencies.

4.12 Impacts to Prime and Unique Farmlands

There are no prime or unique farmlands located within Addicks and Barker Reservoirs.

4.13 Impacts to Vegetation and Wetlands

Both temporary and permanent impacts to vegetative communities would result from construction activities associated with the implementation of these alternatives. It is anticipated that the replacement of the existing outlet works structures at both Addicks and Barker Dams with new outlet works structures, construction of a cutoff wall at the Barker Dam Site, excavation within the borrow area sites, and construction of a temporary cofferdam around both Langham Creek and Buffalo Bayou would impact the majority of vegetative communities surrounding the existing outlet structures. These impacts are anticipated to be temporary in nature. Suitable habitat, including herbaceous uplands, forested uplands, scrub/shrub uplands, emergent wetlands, herbaceous lowlands, forested lowlands, and perennial tributaries for displaced species and potential re-colonization exists adjacent to proposed construction and borrow site areas. The USACE anticipates that these adjacent, un-impacted areas would provide suitable refuges for wildlife during construction and potential seedbanks for re-establishment of existing vegetative communities once construction activities are complete. The USACE also anticipates that a portion of the un-vegetated perennial tributaries would be permanently impacted, primarily within the footprint of the existing outlet works structures at both the Addicks Dam Site and Barker Dam Site.

The proposed project may affect wetlands, depending on which borrow area(s) are used. The USACE anticipates excavating one of three borrow areas in Addicks Reservoir and one of two borrow areas in Barker Reservoir. There are no wetlands or waters located in Borrow Area 1. Borrow Area 2 has 0.60 acres of emergent wetland, Borrow Area 3 has 72.58 acres of emergent wetland, Borrow Area 4 has 56.11 acres of emergent wetland, and Borrow Area 5 has 3.10 acres of forested wetland. All impacts to wetlands would be mitigated pursuant to the Mitigation Plan described in further detail in Section 5.0.

Impacts to waters and wetlands at the site of the Addicks and Barker outlet works structures are shown in Figures 35 and 36. Temporary impacts to 5.44 acres of wetlands resulting from construction of the Preferred Alternative at these locations would result from construction of temporary coffer dams. No permanent wetland impacts at Addicks and Barker Dam sites would be anticipated. Wetlands at these locations have been previously degraded from historical land use activities associated with the construction of the original outlet works structures and levees. Following removal of temporary coffer dams, wetlands would be returned to pre-construction grades and would be expected to revegetate naturally. No mitigation would be required for temporary wetland impacts.

Permanent impacts would occur to 0.63 acres (539 linear feet) of Langham Creek at the Addicks Dam site. Impacts to Langham Creek would result from demolition of the original outlet works

structure at Addicks Dam and subsequent backfill for levee reconstruction. Permanent impacts would occur to 0.16 acres (681 linear feet) of an unnamed perennial RPW and 0.75 acres (675 linear feet) of Buffalo Bayou at the Barker Dam site. Permanent impacts at the Barker Dam site would result from construction of the new approach and discharge channels as well as the demolition of the original outlet works structure and subsequent backfill for levee reconstruction. No mitigation is proposed for impacts to waters. The newly constructed approach and discharge channels would provide similar values and functions to those waters that are permanently impacted by the proposed project.

Temporary impacts would occur to 0.68 acres (1,532 linear feet) of Langham Creek at the Addicks Dam site. Temporary impacts would occur to 0.65 acres (539 linear feet) of Buffalo Bayou and 0.04 acres (164 linear feet) of an unnamed seasonal RPW at the Barker Dam site. Temporary impacts at both Addicks and Barker Dam site would result from construction of the new discharge channel, construction of the temporary coffer dam, and demolition of the original outlet works structure. Following construction activities, waters would be returned to pre-construction grades. No mitigation would be required for temporary impacts to waters.

4.14 Impacts to Invasive Species

Invasive species play a dominant role in the vegetative structure and composition of the project area. While animal species are mainly transient to the site, manipulation of existing vegetative communities during construction of the preferred alternative would be required and could potentially increase colonization of invasive species into adjacent areas.

The USACE would implement an Invasive Species Management Plan in accordance with the *2009 Final Environmental Assessment for the 2009 Master Plan – Addicks and Barker Reservoirs.* Potential techniques include avoiding and minimizing the spread of invasive vegetation by burying excavated soil for several weeks under subsoil prior to installation to suffocate, decay, and eliminate the existing seed bank, cutting and grubbing the borrow areas prior to excavation to eliminate live seed and rhizome sources, utilizing soil from non-invasive dominated areas, and monitoring and mowing the project areas following project completion. Adherence to the Invasive Species Management Plan would assist the USACE in controlling, reducing, and potentially eradicating invasive species within the reservoirs.

4.15 Impacts to Wildlife

Implementation of these alternatives is anticipated to have a minimal and localized effect to wildlife populations in the vicinity of the project. Noise from construction of these alternatives would adversely affect small mammals and birds in the project area. Depending on the species affected, construction of these alternatives may result in their displacement to surrounding areas. Similar habitat is located in the surrounding area where displaced wildlife could find suitable habitat. Noise from construction of these alternatives is anticipated to temporarily disturb feeding behavior of wading birds and other aquatic and semi-aquatic bird species inhabiting the project area; however, suitable feeding habitat is present within the surrounding area.

Multiple trees would be impacted during construction, resulting in a net loss of avifauna roosts and other nesting locations. To minimize impacts to migratory and non-migratory birds, removal of trees would be conducted primarily between October and March, outside of the nesting season of migratory birds. If tree clearing work is proposed to be conducted within the nesting season of migratory birds, the project area would be surveyed for active nests to ensure preservation of nests prior to construction.

Implementation of these alternatives may result in the displacement of terrestrial vertebrate species such as small mammals, amphibians, and reptiles to surrounding areas. Adjacent natural areas would provide suitable refuges for terrestrial vertebrates during construction activities. Following construction activities, the impacted areas would be allowed to re-vegetate naturally and would continue to provide foraging and nesting habitat for terrestrial vertebrate communities. No permanent adverse impacts to wildlife populations are anticipated as a result of the proposed project.

4.16 Impacts to Threatened and Endangered Species

An assessment of the construction of the Preferred Alternative's (2A and 2B) potential to affect federally listed threatened and endangered species and their habitat was conducted in a BA (Appendix B). Species specific surveys of the proposed project area for the Preferred Alternative did not result in the identification of threatened or endangered species or their habitat. No critical habitat has been designated in the reservoirs. Only federally listed threatened and endangered species documented as occurring in Harris and Fort Bend Counties by the Clear Lake Office of the USFWS were considered in further detail in the BA, and consist of whooping crane, bald eagle, and Texas prairie dawn. The BA concludes that the proposed project would not affect any federally listed threatened or endangered species or their habitats.

While the remaining alternatives (1A, 3A-11A, 1B, and 3B-11B) were not assessed in the BA, these alternatives are so similar to the preferred alternatives (2A and 2B) that they would likely result in the same conclusion.

4.17 Impacts to Historic Properties

All cultural resources would be avoided during construction of the recommended plan using a 100-foot margin. Should it be determined during the design phase of the proposed project that cultural resources cannot be avoided using this 100-foot margin, then all cultural resources present, if any, shall be evaluated for inclusion in the National Register of Historic Places, assessed for effects from the proposed project, and mitigated pursuant to the Memorandum of Agreement (Appendix A) between the USACE, the Texas State Historic Preservation Officer, and the Advisory Council on Historic Preservation dated 1982.

4.18 Impacts to Aesthetic Resources

Construction of the proposed project would result in the aesthetic resources of the project area remaining unchanged over the long-term. Temporary impacts to aesthetic resources would result from implementation of these alternatives. Construction activities related to replacing the outlet work structures at both Addicks and Barker Dams, as well as excavation within borrow areas,

would be visible to adjacent residences, businesses and recreational bikers and pedestrians in the vicinity of the proposed project sites. Construction equipment, disturbed earth and temporary construction stockpile areas would be visible during construction. Following construction activities, the aesthetics of the project site would be returned to pre-construction conditions. The proposed project is not anticipated to result in long-term adverse affects to aesthetic resources.

4.19 Impacts to Recreational Resources

Implementation of these alternatives would temporarily impact a portion of the George Bush hike and bike trail on Barker Dam. The hike and bike trail would be temporarily closed and re-routed during construction. It would be reopened after construction is complete. No significant impact to recreational resources would result from implementation of these alternatives.

4.20 Impacts to Traffic and Circulation

Implementation of the Preferred Alternative would not result in impacts to the traffic and circulation near the proposed construction areas. Contractors and project related construction vehicles would access the Addicks Reservoir site via Addicks Dam Road. Addicks Dam Road can be accessed from North Eldridge Parkway or SH 6. Construction equipment and dump trucks responsible for moving dirt from the borrow areas to the construction area at Addicks Dam would conduct all work within Addicks Reservoir and would not impact traffic or circulation on public roadways.

The Barker Reservoir site would be accessed via SH 6 and other internal access driveways within Barker Reservoir. Construction equipment and dump trucks responsible for moving dirt from the borrow areas to the construction area at Barker Dam would conduct all work within Barker Reservoir and would not impact traffic or circulation on public roadways.

No road closures would result from implementation of the Preferred Alternative.

The features constructed during implementation of the Preferred Alternative would not become an attractant to wildlife or migratory bird populations that are deemed hazardous to aircraft per the Memorandum of Agreement between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the EPA, the USFWS, and the U.S. Department of Agricultural to address aircraft-wildlife strikes.

4.21 Impacts to Socioeconomic Resources

The proposed project is not expected to have adverse or disproportionate impacts on minority or low-income populations. The benefits of the proposed project are expected to be proportional for all residents in the area and the proposed project is of such limited nature and extent that it does not have the potential to alter the demographics or the economy at a local or regional scale. The project study area does not contain a higher percentage of minority or low-income families than Fort Bend or Harris Counties. No impacts to socioeconomics and Environmental Justice resulting from implementation of these alternatives are anticipated.

5.0 MITIGATION

Public law and USACE policy require that potential adverse impacts of a project on fish and wildlife resources be estimated during project planning and mitigated during project implementation. Mitigation planning under existing USACE policy requires the ability to measure fish and wildlife resources, to estimate the impacts of a proposed project on those resources, and to use an incremental analysis technique to develop a mitigation plan which is cost-effective.

All practicable means to avoid or minimize environmental impacts due to construction of the Proposed Alternative have been considered per 40 CFR §1505.2(c). The proposed project has been designed with the smallest practicable footprint to still meet the requirements of the proposed project. In addition, 40 CFR §1505.2(c) states that a monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation.

Construction of the Preferred Alternative would permanently impact wetlands located in the proposed borrow areas. The quantification of the size of wetlands observed in each borrow area is detailed in Section 3.8. The USACE plans to excavate one borrow area out of three alternative borrow areas in Addicks Reservoir and one borrow area out of two alternative borrow areas in Barker Reservoir. A decision as to which borrow areas are to be excavated out of the five that have been identified has not been made at this time. It is assumed that all wetlands excavated within the borrow areas would be permanently impacted. In order to compensate for the loss of habitat related to construction of the Preferred Alternative, the subsequent mitigation plan would be implemented.

Compensatory mitigation would replace the ecological functions and services provided by wetlands that would be impacted by the proposed project. Two compensatory mitigation action alternatives are proposed. Both alternatives include preservation of wetlands in conjunction with invasive vegetation management in Addicks and Barker Reservoirs. Invasive vegetation is known to exist within wetlands in both Addicks and Barker Reservoirs. The most common invasive plant species in the reservoirs include Chinese tallow (*Triadica sebifera*), woodrush flatsedge (*Cyperus entrerianus*), salt cedar (*Tamarix* sp.), narrow leaf cattail (*Typha angustifolia*), alligator weed (*Alternanthera philoxeroides*), common reed (*Phragmites australis*), Macartney rose (*Rosa bracteata*), and honey mesquite (*Prosopis glandulosa*).

Invasive species have the ability to outcompete native species, altering ecosystems and leading to decreased native biodiversity. Once invasive species become established, they require control through eradication, containment, or other management strategies to minimize the ecological impacts that they may cause. Various control strategies are available and have been proven to be effective including physical, chemical, and biological techniques. Management strategies are species-specific and require knowledge of the biology and ecology of each plant. Integrated Pest Management, or combining two or more control techniques, is an ideal management strategy that would likely be used to for dealing with many invasive species.

Suitable sites for compensatory mitigation were identified in Addicks and Barker Reservoirs through remote sensing tools, including the United States Fish and Wildlife Service (USFWS)

National Wetland Inventory (NWI). Two sites were selected as potential compensatory mitigation sites.

Compensatory Mitigation Alternative Site One includes an approximately 215-acre tract located in the southwestern portion of Addicks Reservoir, immediately west of State Highway (SH) 6. Figure 37 depicts an aerial photograph of Compensatory Mitigation Alternative Site One, which is a contiguous tract of palustrine forested wetlands according to the USFWS NWI data. During limited field surveys of the palustrine forested wetlands at Compensatory Mitigation Site One, several invasive species were observed, including woodrush flatsedge (*Cyperus entrerarianus*), bermudagrass (*Cynodon dactylon*), St. Augustine grass (*Stenotaphrum secundatum*), nutgrass (*C. rotundus*), Japanese honeysuckle (*Lonicera japonica*), Macartney rose (*Rosa bracteata*), Chinaberry (*Melia azedarach*), and Chinese tallow (*Triadica sebifera*). Invasive vegetative species at this site comprised approximately 15 percent areal coverage. Compensatory mitigation activities under this alternative include preservation of the 215-acre tract of contiguous wetlands along with invasive species management. The goal of invasive species management under this alternative is to reduce the areal coverage of invasive species within wetlands to less than five percent areal coverage within five years.

Compensatory Mitigation Site Two includes an approximately 841 acre tract located in the northeastern portion of Addicks Reservoir, north of Clay Road and east of North Eldridge Parkway. Figure 38 depicts an aerial photograph of Compensatory Mitigation Alternative Site Two, which contains remnant prairie pothole wetlands including approximately 93 acres of palustrine forested wetlands and approximately 92 acres of palustrine emergent wetlands according to the USFWS NWI data. During limited field surveys of the palustrine forested wetlands at Compensatory Mitigation Site Two, several invasive species were observed, including woodrush flatsedge, bermudagrass, St. Augustine grass, nutgrass, Japanese honeysuckle, Macartney rose, Chinaberry, and Chinese tallow. Invasive vegetative species in the palustrine forested wetlands comprised approximately 15 percent areal coverage. During limited field surveys of the palustrine emergent wetlands at Compensatory Mitigation Site Two, several invasive species were observed, including woodrush flatsedge, bermudagrass, St. Augustine grass, nutgrass, Japanese honeysuckle, Macartney rose, Chinaberry, and Chinese tallow. Invasive vegetative species in the palustrine emergent wetlands comprised approximately 15 percent areal coverage. Compensatory mitigation activities under this alternative include preservation of a total of approximately 185 acres of wetlands along with invasive species management. The goal of invasive species management under this alternative is to reduce the areal coverage of invasive species within wetlands to less than five percent areal coverage within five years.

The mitigation site would be determined to be successful if all the performance standards are met. The performance standards of the proposed mitigation include:

- The percent cover of invasive plants within the preserved wetlands must be less than five percent within five years of initial treatment
- The percent cover of invasive plants must be maintained at less than five percent for a period of 50 years following the initial treatment

If performance standards are not met, corrective actions would be conducted in order to correct any deficiencies with the mitigation success. Annual monitoring reports would be compiled and presented to appropriate agencies. These reports would specify the results of monitoring activities in regards to the performance standards and recommend specific corrective actions that would support in the mitigation area in meeting performance standards.

5.1 Habitat Evaluation Procedure Analysis

Habitat Evaluation Procedure (HEP) is a habitat-based evaluation methodology developed by USFWS in 1974 for use as an analytical tool in impact assessments and project planning. HEP is a species-habitat analysis of the ecological value of a study area. Its approach is to quantify the value of habitat available to a selected set of wildlife species within a specified geographic area of interest. The method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time, or of the same area at different points in time. Because HEP provides a quantitative method for such comparisons, it may be used in planning applications such as the assessment of current and future wildlife habitat or compensation analyses.

A HEP analysis was performed on the proposed wetland impact areas, including Borrow Areas 1, 2, 3, 4, and 5, to determine the appropriate amount of wetland mitigation that would be required to replace the values and functions of wetland habitat lost due to construction of the Preferred Alternative. Results of the HEP analysis conclude that both mitigation alternatives proposed would fully mitigate for impacts resulting from the construction of the Preferred Alternative. Further details can be found in the HEP analysis report in Appendix F.

5.2 Cost Effectiveness and Incremental Cost Analysis

For environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, two analytical methods are used to assist USACE planners in the mitigation decision process. Cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. Subsequent incremental cost analysis of the cost effective solutions is conducted to reveal changes in costs for increasing levels of environmental outputs. In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making. Cost effectiveness and incremental cost analysis for compensatory mitigation options associated with the proposed project is included in Appendix G.

6.0 CUMULATIVE IMPACTS

A cumulative effect is defined as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) 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 Part 1508.7). The following analysis abides by the CEQ's Considering Cumulative Effects under the National Environmental Policy Act (CEQ, 1997), and

Memorandum and Guidance on the Consideration of Past Actions in Cumulative Effects Analysis (CEQ, 2005).

Past major projects in the proposed project area consist of the Buffalo Bayou and Tributaries Project (BBTP) which included construction of Addicks and Barker Reservoirs, a system of canals to convey releases from the reservoirs to Galveston Bay, and a levee along Cypress Creek to prevent overflows into Addicks Reservoir. Other previous flood control projects constructed in association with the BBTP include channel improvements to various segments of Buffalo, Brays, and White Oak Bayous. Past major transportation projects within Addicks and Barker Reservoirs include the construction of SH 6, North Eldridge Parkway, and Clay Road through Addicks Reservoir, and the construction of Westheimer Parkway through Barker Reservoir.

Past major recreational developments within Addicks and Barker Reservoirs include the construction of Terry Hershey Park, Bear Creek Pioneers Park, George Bush Park and Bill Archer Dog Park. Terry Hershey Park comprises approximately 500 acres and consists of approximately 12.5 miles of hike and bike trails along Buffalo Bayou between Barker Reservoir and Sam Houston Tollway. Bear Creek Pioneers Park, located within Addicks Reservoir, is 2,168 acres in size and features paved roads and parking for visitors, walking and equestrian trails, a small zoo, playgrounds, ball fields, tennis courts, restrooms, picnic tables, and grills. George Bush Park, located within Barker Reservoir, is 7,800 acres in size and features jogging trails, ball fields, a shooting range, picnic pavilions, playgrounds, and ponds. Bill Archer Dog Park, located in Addicks Reservoir, is 17 acres in size and features paved roads and parking, walking paths, ponds, and shade trees.

Prior to construction of the reservoirs, including the recreational facilities and public thoroughfares found within them, land use in the area primarily consisted of ranching, rice farming (Barker), and dairying (Addicks), which resulted in the alteration of native prairie and woodland habitats. Woody vegetation became established with the decline of agricultural and ranching practices, and continued suppression of a natural fire regime. Adverse impacts resulting from the land-use conversion include the recruitment of exotic invasive species including Chinese tallow (*Triadica sebifera*), and more recently, deep-rooted sedge (*Cyperus enrerianus*) (USACE, 2009).

Outside the reservoirs, urban development in the surrounding area and region has increased with the decline of rice farming and the resulting conversion of extensive open space into urban land use, marking westward expansion of the City of Houston (Katy Prairie Conservancy, 2011). Minimal grazing (under grazing leases) still takes place within the reservoirs, and farming has stopped altogether since acquisition of the reservoir lands by the USACE. Despite the extensive impacts, native vegetation assemblages are identifiable within Addicks and Barker Reservoirs (Fields et al 1983; Fields et al 1986).

Current and reasonably foreseeable projects in the project area include the maintenance and improvement of the existing infrastructure (e.g. roads, utilities, and railways). Foreseeable flood control projects include additional channel modifications and detention basins along Buffalo, White Oak and Brays Bayous. The Brays Bayou Project includes approximately 21 miles of channel improvements between SH 6 and the Houston Ship Channel, modifications to

approximately 30 bridges, and the creation of four stormwater detention projects totaling approximately 900 acres (HCFCD, 2011a). Construction activity for the White Oak Bayou Project is currently occurring in the upper portion of the White Oak Bayou watershed. Construction of bypass channels has begun, while significant channel modifications on White Oak Bayou between Beltway 8 and North Houston Rosslyn will begin in the near future. Several stormwater detention basins along White Oak Bayou, between North Houston Rosslyn Road and Jones Road, are currently being excavated, and additional basins are planned in the near future (HCFCD, 2011b). Ecosystem restoration components are being studied as part of these projects and may be undertaken where feasible.

Foreseeable major road and highway construction in the immediate vicinity of Addicks and Barker Reservoirs include the extension of Memorial Drive (from SH 6 to Barker Cypress Road), the extension of Barker Cypress Road (from Kingsland Boulevard to South Barker Cypress Road), the extension of Highland Knolls Drive (from South Fry Road to Greenwind Chase Drive), the extension of Park Row (from Houston Chronicle Boulevard to Broadfield Boulevard and from SH 6 to North Eldridge Parkway), the extension of Morton Road (from Barker Cypress Road to Clay Road), and the completion of the Grand Parkway (SH 99) segments E (US 290 to IH 10) and F-1 (SH 249 to US 290) (H-GAC, 2011). Conversion of agricultural lands and green space to urban land use would result from increases in population and additional infrastructure. Foreseeable major recreational developments in the area include plans by Harris County Precinct #3, the City of Houston, Fort Bend County, and West Houston Trail Planning. Harris County Precinct #3, the City of Houston, and Fort Bend County currently hold park and recreation leases in Addicks and Barker Reservoirs. The West Houston Trail Planning is an ongoing project attempting to establish connectivity between various trails in West Houston. Many of those trails surround Addicks and Barker Reservoirs.

Reasonably foreseeable actions, combined with effects of the proposed project, would result in habitat loss, including wetland losses. Wetland losses require compensatory mitigation, both for the proposed project and all other actions within the project area.

When large storms approach the Houston-Galveston Area, it is difficult or impossible to predict where large rainfall totals may occur. Rainfall in the region is often very concentrated, with very large rainfall totals potentially accumulating in one specific area. Repetitive events causing the accumulation of stormwater runoff within the Addicks and Barker Reservoirs over a period of weeks or even months could be followed by a catastrophic rainfall event concentrated over the project study area at any time. Such a scenario would result in significant and lasting flooding in areas upstream of the study area. The proposed project does not affect upstream flood damage and safety risk.

Addicks and Barker Dams and Reservoirs were originally constructed to protect the City of Houston from flooding downstream of Buffalo Bayou. Significant residential and commercial development upstream was not an anticipated consequence in the mid-1940s when the original project was constructed. Construction of the dams and reservoirs represented implementation of a partial component of a larger flood damage reduction plan that included an extensive bypass channel directing flood waters away from the City of Houston toward the Galveston Bay system. The bypass channel was never completed.

Today, very extensive additional development exists downstream of the dams along Buffalo Bayou, all the way to downtown Houston. Upstream development exists in all directions surrounding the federal property comprising Addicks and Barker Reservoirs. A potential cumulative effect of restoring and continuing the level of downstream protection provided by the dams and reservoirs is enhanced economic growth and development. Providing a reliable dam and reservoir system does not entirely eliminate downstream safety and flood damage risk. A potential adverse cumulative effect of the proposed project is the perceived absence or reduction of flood risk on the part of the general public, both upstream and downstream, once the proposed project is completed. The proposed project does not affect potential upstream flood damage and safety risk and does not change the flood risk downstream.

The perceived absence or reduction of flood risk may spur additional economic growth and development, with its attendant negative cumulative effects (such as habitat loss and potential economic increases in flood damages) within downstream areas of Buffalo Bayou. The probability of flooding after the proposed project is completed remains the same. The H-GAC (2011) reports that there were 26 flood events between 2000 and 2010 in the Houston-Galveston region, representing an average of 2.36 flood events per year. H-GAC reports that with the area's flooding history, the presence of numerous bayous, rivers and streams, flat topography and clayey soils, the overall region has a 100 percent likelihood of flooding and could experience one or more flood events per year. The intensity of any flood within a specific location in the study area, including at Addicks and Barker Reservoirs, is unpredictable. The potentially negative cumulative effect of the project leading to a sense that flooding upstream or downstream is unlikely may be mitigated by a continuous Dam Safety Awareness education program. Such a program has been previously implemented by the USACE Galveston District for Addicks and Barker dams.

The anticipated adverse impacts of construction of the proposed project to the surrounding environment are minimal and would not significantly contribute to the cumulative effects of past, present, and future projects in areas surrounding Addicks and Barker Reservoirs. The proposed project would result in the construction of new outlet structures within both Addicks and Barker Dams. These structures would have a significant positive effect on public safety.

7.0 COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

The planning of the proposed project is in accordance with the "USACE Campaign Plan" goals. Potential direct and indirect effects inside and outside the project areas have been considered. Risk and uncertainty have been considered in evaluating alternatives, which are discussed in this document. The Recommended Alternative has been selected based on interdisciplinary coordination that utilizes the best professional and technical expertise available during the planning process.

Further, this EA has been prepared to satisfy the requirements of all applicable environmental laws and regulations. Preparation was in accordance with the CEQ's implementing regulations for NEPA, 40 CFR Parts 1500 – 1508, and the USACE Engineer Regulation (ER) 200-2-2,

Environmental Quality: Procedures for Implementing NEPA. The planning and implementation of the proposed project is consistent with the USACE Environmental Operating Principles.

The following list of applicable environmental laws and regulations were considered in the planning of this project, and their status of compliance to each.

National Environmental Policy Act: This environmental assessment has been prepared in accordance with CEQ's implementing regulations for NEPA. The environmental and social consequences of the Proposed Action have been analyzed in accordance with NEPA and presented in the assessment.

Endangered Species Act**:** A BA has been prepared to support the USACE coordination of the draft EA's Proposed Action with the USFWS regarding threatened, endangered or proposed species and their critical habitats in the project area. The USACE requested information on listed species that may occur in the project area from the USFWS by letters dated March 29, 2010. The USFWS provided the requested responses on April 08, 2010. The BA concluded that the Proposed Action would not result in any significant adverse impacts on Federally listed threatened or endangered species (Section 4.16). The BA and correspondence with the USFWS and NMFS regarding the BA are provided in Appendix A.

Clean Water Act: The Proposed Action was analyzed pursuant to Section 404(b)(1) of the Clean Water Act and this analysis is included in Appendix C. Coordination with the TCEQ will be pursued. The TCEC is responsible for the issuance of the state water quality certification pursuant to Section 401 of the Clean Water Act. A copy of the state water quality certification will be included in Appendix C of the final EA.

National Historic Preservation Act: Compliance with the NHPA requires identification of all properties in the project area listed on, or eligible for listing on, the NRHP. For any adversely affected properties, mitigation measures must be developed in coordination with the SHPO and the Advisory Council on Historic Preservation. No listed properties or properties eligible for listing have been identified within the vicinity of the project area. Coordination with the SHPO has been initiated, seeking concurrence with a determination of no effect to Historic Properties by the Proposed Alternative activities. A copy of the SHPO letter will be included in Appendix A of the final EA.

Clean Air Act: NAAQS have been established by the EPA to protect public health and welfare. The State of Texas has adopted these standards as the air quality criteria for the state. The Proposed Action is located in Harris County which is a non-attainment area for ozone. Emissions from the construction of the Recommended Alternative is not considered regionally significant (Section 4.8; Appendix D).

Executive Order 11990 (Protection of Wetlands): The Proposed Alternative has been analyzed for compliance with Executive Order 11990. All wetland impacts resulting from implementation of the Preferred Alternative would be temporary. Wetlands proposed to be temporarily impacted are located within previously disturbed lands designated under the OPS land use classification

per the 2009 Master Plan for Addicks and Barker Dams. No mitigation would be required for temporary impacts to previously disturbed lands.

Executive Order 11988 (Floodplain Management): Federal agencies are directed to evaluate the potential effects of proposed actions in floodplains. Construction activities would occur within floodplains as the result of implementation of the Preferred Alternative. No practicable alternative exist for avoiding impact to floodplains that would serve the purpose and need of the proposed project. The local floodplain administrator would be consulted to ensure that the project complies with local floodplain regulations and guideline.

Council on Environmental Quality (Memorandum; Prime or Unique Farmlands): A Form AD-1006 was submitted to NRCS for their evaluation (Appendix A). NRCS determined that since Addicks and Barker Reservoirs were already part of an authorized flood risk management project, the reservoir project lands are not considered prime or unique farmlands.

Executive Order 12898 (Environmental Justice): Federal agencies are required to identify and address (as appropriate) disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. As such, Federal agencies are directed to achieve environmental justice to the greatest extent practicable and permitted by law. Implementation of the Preferred Alternative would have no disproportionately high or adverse impacts on minority and low-income populations in the communities surrounding the reservoirs.

Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984: The Hazardous, Toxic, and Radioactive Waste (HTRW) assessment performed as part of the proposed project complies with the requirements of RCRA and HSWA. The hazardous waste assessment can be found in Section 3.7 of this document.

Executive Order 13112 (Invasive Species): This EO directs federal agencies to, within administration budgetary limits, prevent the introduction of invasive species, detect and respond rapidly to and control populations of such species in a cost-effective manner, monitor invasive species populations accurately and reliably, provide for restoration of native species and habitat condition in ecosystems that have been invaded, conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species, and promote public education on invasive species and the means to address them. Several invasive plant species (primarily *Triadica sebifera*, *Rosa bracteata*, *Cyperus entrerianus*, *Ligustrum sinense*, and *Lonicera japonica*) are prevalent at Addicks and Barker Reservoirs. The USACE would implement an Invasive Species Management Plan in accordance with the 2009 Final Environmental Assessment for the 2009 Master Plan for Addicks and Barker Reservoirs to aid in controlling the spread of invasive species.

Migratory Bird Treaty Act (MBTA): The MBTA of 1918 extends Federal protection to migratory bird species. The nonregulated "take" of migratory birds is prohibited under this act in a manner similar to the prohibition of "take" of threatened and endangered species under the Endangered Species Act. EO 13186 "Responsibility of Federal Agencies to Protect Migratory Birds" requires Federal agencies to assess potential effects of their actions on migratory birds.

The timing of construction and resource management activities would be coordinated to avoid impacts to migratory and nesting birds.

Memorandum of Agreement between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agricultural to Address Aircraft-Wildlife Strikes: This Memorandum of Agreement (MOA) was developed with the intention to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources. Pursuant to this MOA, Agencies should not construct projects within a specified distance of airports that may become an attractant to wildlife deemed hazardous to aircraft. The features constructed during implementation of the Preferred Alternative would not become an attractant to wildlife or migratory bird populations.

Protection of Environment, Executive Order 11514: This EO directs federal agencies to "initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals." The proposed project complies with EO 11514.

Executive Order 13186 (Migratory Bird Habitat Protection): Section 3a and 3e of EO 13186 directs federal agencies to evaluate the effects of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative effects to migratory birds. Implementation of the Preferred Alternative is not anticipated to have a measurable negative effect on migratory bird populations.

8.0 CONCLUSIONS

As presented in Section 4.0 – Environmental Consequences of Preferred Alternative, construction of the Preferred Alternative would result in minor and/or temporary impacts to environmental resources within the project study area. The following conclusions summarize the findings of this EA:

- Implementation of the Preferred Alternative is temporary in duration and limited in spatial extent and is not anticipated to significantly impact the overall project area.
- The 2009 Master Plan will be adjusted to match the land use needed for the proposed project; therefore, no significant impacts to land use would occur as a result of the proposed project.
- Considering the temporary and transient nature of construction activities, as well as the air quality mitigation measures proposed to be implemented, it is anticipated that implementation of the Preferred Alternative would be below the *de minimus* threshold and would not have any significant impact on air quality in the project area.
- Noise levels from proposed construction activities would be consistent with current ambient noise levels in the project area, and NSRs would be buffered from noise by the existing earthen levees surrounding Addicks and Barker Reservoirs; therefore, no significant noise related impacts are anticipated.
- Temporary and localized adverse impacts to water quality within the project study area are anticipated. Stormwater BMP's would be implemented; therefore, impacts to

water quality are anticipated to be minimal and no significant impacts to the water quality of the project study area are anticipated to occur.

- There are no known Hazardous, Toxic or Radioactive Waste sites on the reservoirs. No impacts associated with the HTRW sites within the project study area are anticipated.
- There are no prime and unique farmlands located on the reservoirs.
- Minimal localized impacts to vegetation are anticipated due to implementation of the Preferred Alternative. Portions of the project area that are temporarily impacted during construction activities would be expected to naturally re-vegetate following completion of construction activities. Wetlands within the project area that are temporarily impacted during construction activities would be returned to original grade following construction activities and would be expected to naturally re-vegetate. Permanent impacts to wetlands will be mitigated by restoring habitat functionality to another portion of the reservoir as discussed in Chapter 5.0.
- Implementation of the Preferred Alternative would beneficially support the control and/or eradication of invasive species within the project area. An Invasive Species Management Plan, in accordance with the 2009 Master Plan would be implemented to assist with the control and eradication of invasive species within the project area.
- Temporary and localized impacts to wildlife resources are anticipated in the project area. Affected habitats are not unique to the study area and suitable habitat for displaced wildlife would be readily available. Significant impacts to wildlife resources within the project study area are not anticipated.
- Implementation of the Preferred Alternative would not affect threatened and endangered species.
- There are no known cultural resource sites in the proposed project sites where work is anticipated to occur and no impacts are anticipated.
- Impacts to aesthetic resources within the project study area are not anticipated to occur as a result of implementation of the Preferred Alternative.
- Minor and localized temporary impacts to recreational resources are anticipated to occur during implementation of the Preferred Alternative. The George Bush hike and Bike trail located on the top of Barker Dam would be temporarily closed and re-routed during construction activities. Following completion of construction activities, recreational resources would be expected to return to pre-construction conditions.
- Implementation of the Preferred Alternative would a negligible increase in daily traffic counts in the vicinity of the dams and no road closures would result. No impacts to traffic and circulation are anticipated.
- Implementation of the Preferred Alternative would not cause significant impacts to existing facilities or utility systems.
- Implementation of the Preferred Alternative is not expected to have adverse or disproportionate impacts on minority or low-income populations. Significant impacts to socioeconomic resources and environmental justice within the project study area are not anticipated.

In summary, implementation of the Preferred Alternative is anticipated to result in minimal localized and temporary adverse affects to the surrounding environment. No significant impacts

to environmental resources within the project study area are anticipated. Therefore, the preparation of an Environmental Impact Statement is not required.

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Appendix A

Agency Correspondence and Memorandum of Agreements

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 5/8/08
Name Of Project Master Plan Revision, Addicks and Barker Reserv	Federal Agency Involved USACE Galveston
Proposed Land Use High Density Recreation	County And State Harris and Fort Bend Counties, Texas
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 5/8/08

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply – do not complete additional parts of this form).*	Yes ☐	No ☒	Acres Irrigated / Average Farm Size
Major Crop(s)	Farmable Land In Govt. Jurisdiction Acres: %		Amount Of Farmland As Defined in FPPA Acres: %
Name Of Land Evaluation System Used	Name Of Local Site Assessment System		Date Land Evaluation Returned By NRCS 6/12/08

PART III *(To be completed by Federal Agency)*	Alternative Site Rating			
	Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	136.5	201.0	106.0	
B. Total Acres To Be Converted Indirectly				
C. Total Acres In Site	136.5	201.0	106.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland				
B. Total Acres Statewide And Local Important Farmland				
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted				
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value				
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*	0	0	0	0

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use					
2. Perimeter In Nonurban Use					
3. Percent Of Site Being Farmed					
4. Protection Provided By State And Local Government					
5. Distance From Urban Builtup Area					
6. Distance To Urban Support Services					
7. Size Of Present Farm Unit Compared To Average					
8. Creation Of Nonfarmable Farmland					
9. Availability Of Farm Support Services					
10. On-Farm Investments					
11. Effects Of Conversion On Farm Support Services					
12. Compatibility With Existing Agricultural Use					
TOTAL SITE ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	0	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

(See Instructions on reverse side)

Form AD-1006 (10-83)

This form was electronically produced by National Production Services Staff

Mr. Jones,
Attached is the completed Farmland Conversion Impact Rating Form you sent for the Master Plan Revision of the Addicks and Barker Reservoir in Harris and Fort Bend Counties, Texas. After reviewing the materials you provided we determined that the Farmland Protection Policy Act does not apply in this case. The project area was converted to a water storage or flood risk management project over 60 years ago and is still being used primarily for that purpose. Farmlands will not be converted when you revise your land classifications. The attached form indicates the exemption from the FPPA. Thank you for the materials you sent to evaluate the project.
Laurie Kiniry

Laurie N. Kiniry
Soil Scientist, USDA-NRCS Temple, TX
254-742-9861

For information about your soils...
http://websoilsurvey.nrcs.usda.gov/app/
For published soil surveys
http://soils.usda.gov/survey/printed_surveys

From: Jones, Seth W SWG [mailto:Seth.W.Jones@SWG02.usace.army.mil]
Sent: Thursday, May 08, 2008 6:10 PM
To: Kiniry, Laurie - Temple, TX
Subject: Determination of Prime and Unique Farmland - Addicks and Barker Reservoirs, Harris and Fort Bend Counties, Texas

Ms. Kiniry,

Per our phone conversation I'm sending you a project description and maps for the USACE Galveston District's project (Master Plan Revision for Addicks and Barker Reservoirs) and the form AD-1006. We are preparing NEPA documentation for the Master Plan Revision and are requesting an evaluation/determination for Prime and Unique Farmland under the FPPA reservoir project lands proposed to be reclassified as High Impact Recreation (Sites A, B, and C on the attached Map Figure 1 and Table 1).

The Addicks and Barker Reservoirs project lands are part of the Federal Buffalo Bayou flood risk management project authorized in 1938. The reservoirs were constructed in the mid to late 1940's. Thank you so much for your attention and guidance.

Please contact me at your convenience for any additional information you may need.

Sincerely,
Seth Jones
USACE Galveston
409-766-3068

MEMORANDUM OF AGREEMENT

WHEREAS, the Corps of Engineers (COE), Galveston District, has determined that the operation and maintenance of Addicks and Barker Reservoirs, Harris and Fort Bend Counties, Texas, will have an effect upon properties included in or eligible for inclusion in the National Register of Historic Places (National Register) and has requested the comments of the Advisory Council on Historic Places (Council) pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. 470) and its implementing regulations, "Protection of Historic and Cultural Properties" (36 CFR 800);

NOW, THEREFORE, the COE , the Texas State Historic Preservation Officer (Texas SHPO), and the Council agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the affect of the undertaking on historic properties.

STIPULATIONS

I. Prior to any land disturbing activities or the sale or transfer of any lands by the COE or its licensees, lessees, or permittees, the COE will conduct or cause to be conducted a cultural resource survey designed in accordance with guidelines established in consultation with the Texas SHPO to identify historic and cultural properties included in or eligible for the National Register that may be affected by the undertaking. The "Proposed Guidelines for Recovery of Scientific, Prehistoric, Historic, and Archeological Data: Methods, Standards, and Reporting Requirements," Federal Register 5374-5383, 28 January 1977 (36 CFR Part 66), and Sections I and II of Part III of "Treatment of Archeological Properties: A Handbook" (Advisory Council 1980) (Handbook), will be considered in developing the guidance. The COE will provide the Council with a copy of the guidelines established.

A. Cultural resource surveys and assessments conducted by the COE will be administered by the COE staff archeologist. Surveys and assessments conducted by other parties will be closely coordinated with the COE staff archeologist, who will review scopes of work, proposals, field work in progress, and resulting technical reports.

B. Copies of survey reports will be provided to the Texas SHPO for review and comment.

C. All identified historic and cultural properties will be evaluated in consultation with the Texas SHPO to identify those properties that appear to meet National Register criteria for evaluation. For those properties that appear to meet the criteria the COE will seek determinations of eligibility or nominations from the Secretary of the Interior in accordance with National Register procedures (36 CFR 63.3 and 36 CFR 60.9).

D. For those properties included in or eligible for the National Register, the COE will evaluate, in consultation with the Texas SHPO, the proposed undertaking to determine effect pursuant to 36 CFR 800.4(b). If it is determined that the undertaking will not diminish those characteristics of the property that qualify it for inclusion in the National Register (that is, will have "no effect") the undertaking may proceed.

II. When it is not prudent and feasible to avoid an adverse effect to a National Register or eligible property the COE will consult with the Texas SHPO and:

A. If the affected property is included in or eligible for the National Register primarily because it may be likely to yield information important in prehistory or history, and it and the proposed undertaking meet the criteria of Section X of Part II of the Handbook, the COE will implement a data recovery program in consultation with the Texas SHPO which considers the guidance of Part III of the Handbook, and the proposed 36 CFR 66.

B. If the affected property is eligible for or included in the National Register primarily for criteria other than the important information it may be likely to yield, the COE will develop and implement measures acceptable to the SHPO to mitigate the adverse effect.

C. If the COE and Texas SHPO cannot agree on a satisfactory data recovery program under (a) above or cannot agree on appropriate mitigation measures under (b) above, the COE will request the recommendations of the Council and provide the Council with a copy of the plan, the COE's opinions about the plan, and the Texas SHPO's opinions about the plan. The Council will be afforded 30 days in which to provide recommendations about the plan to the COE which will take them into account in reaching a final decision about the extent of data recovery or other mitigation measures to be required.

III. During activities covered by this Agreement and after the cultural resource surveys required by Stipulation I have been completed, should previously unknown historic or cultural properties be discovered, the COE will cause potentially damaging activities to be delayed until it has had an opportunity to consult with the Texas SHPO and has complied with Section 800.7 of the Council's regulations (36 CFR 800).

IV. Within 5 years from the date of ratification of this Agreement the COE will determine in consultation with the Texas SHPO the efficacy of developing a long-range management plan for historic and cultural properties contained within project lands or portions of such lands on an incremental basis. The plan will take into account the information obtained by completed surveys and will establish procedures and priorities for orienting future investigations to identify, assess, and manage historic and cultural properties. The plan will demonstrate consideration of the guidance contained in the Handbook or other guidance more current at that time, as well as preservation management techniques and methods generally expected by the historic preservation profession and pertinent to the area. If the COE determines preparation of

the plan is not appropriate at that time the available information will be evaluated at intervals no longer than 3 years and a determination made in consultation with the Texas SHPO about the appropriateness of such a plan, and its preparation. The plan will be incorporated into COE Master Plans and other planning documents.

V. Failure to carry out the terms of this Agreement requires that the COE again request the Council's comments in accordance with 36 CFR 800. If the COE cannot carry out the terms of the Agreement, it shall not take or sanction any action or make any irreversible commitment that would foreclose the Council's consideration of modifications or alternatives to the proposed action that could avoid or mitigate the adverse effect until the commenting process has been completed.

VI. If any of the signatories to this Agreement in consultation with other parties in interest, determine that the terms of the Agreement cannot be met or believes a change is necessary, that signatory shall immediately request the consulting parties to consider an amendment or addendum to the Agreement. Such an amendment or addendum shall be executed in the same manner as the original Agreement.

30 Aug 82
DISTRICT ENGINEER (DATE)
U.S. ARMY ENGINEER DISTRICT, GALVESTON

3 Sept. 1982
TEXAS STATE HISTORIC PRESERVATION (DATE)
OFFICER

Oct 4, 1982
EXECUTIVE DIRECTOR (DATE)
ADVISORY COUNCIL ON HISTORIC PRESERVATION

10/20/82
CHAIRMAN (DATE)
ADVISORY COUNCIL ON HISTORIC PRESERVATION

Memorandum of Agreement Between
the Federal Aviation Administration,
the U.S. Air Force,
the U.S. Army,
the U.S. Environmental Protection Agency,
the U.S. Fish and Wildlife Service, and
the U.S. Department of Agriculture
to Address Aircraft-Wildlife Strikes

PURPOSE

The signatory agencies know the risks that aircraft-wildlife strikes pose to safe aviation.

This Memorandum of Agreement (MOA) acknowledges each signatory agency's respective missions. Through this MOA, the agencies establish procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources.

BACKGROUND

Aircraft-wildlife strikes are the second leading causes of aviation-related fatalities. Globally, these strikes have killed over 400 people and destroyed more than 420 aircraft. While these extreme events are rare when compared to the millions of annual aircraft operations, the potential for catastrophic loss of human life resulting from one incident is substantial. The most recent accident demonstrating the grievous nature of these strikes occurred in September 1995, when a U.S. Air Force reconnaissance jet struck a flock of Canada geese during takeoff, killing all 24 people aboard.

The Federal Aviation Administration (FAA) and the United States Air Force (USAF) databases contain information on more than 54,000 United States civilian and military aircraft-wildlife strikes reported to them between 1990 and 1999[1]. During that decade, the FAA received reports indicating that aircraft-wildlife strikes, damaged 4,500 civilian U.S. aircraft (1,500 substantially), destroyed 19 aircraft, injured 91 people, and killed 6 people. Additionally, there were 216 incidents where birds struck two or more engines on civilian aircraft, with damage occurring to 26 percent of the 449 engines involved in these incidents. The FAA estimates that during the same decade, civilian U.S. aircraft sustained $4 billion worth of damages and associated losses and 4.7 million hours of aircraft downtime due to aircraft-wildlife strikes. For the same period,

[1] FAA estimates that the 28,150 aircraft-wildlife strike reports it received represent less than 20% of the actual number of strikes that occurred during the decade.

USAF planes colliding with wildlife resulted in 10 Class A Mishaps[2], 26 airmen deaths, and over $217 million in damages.

Approximately 97 percent of the reported civilian aircraft-wildlife strikes involved common, large-bodied birds or large flocks of small birds. Almost 70 percent of these events involved gulls, waterfowl, and raptors (Table 1).

About 90 percent of aircraft-wildlife strikes occur on or near airports, when aircraft are below altitudes of 2,000 feet. Aircraft-wildlife strikes at these elevations are especially dangerous because aircraft are moving at high speeds and are close to or on the ground. Aircrews are intently focused on complex take-off or landing procedures and monitoring the movements of other aircraft in the airport vicinity. Aircrew attention to these activities while at low altitudes often compromises their ability to successfully recover from unexpected collisions with wildlife and to deal with rapidly changing flight procedures. As a result, crews have minimal time and space to recover from aircraft-wildlife strikes.

Increasing bird and wildlife populations in urban and suburban areas near airports contribute to escalating aircraft-wildlife strike rates. FAA, USAF, and Wildlife Services (WS) experts expect the risks, frequencies, and potential severities of aircraft-wildlife strikes to increase during the next decade as the numbers of civilian and military aircraft operations grow to meet expanding transportation and military demands.

SECTION I.

SCOPE OF COOPERATION AND COORDINATION

Based on the preceding information and to achieve this MOA's purpose, the signatory agencies:

A. Agree to strongly encourage their respective regional and local offices, as appropriate, to develop interagency coordination procedures necessary to effectively and efficiently implement this MOA. Local procedures should clarify time frames and other general coordination guidelines.

B. Agree that the term "airport" applies only to those facilities as defined in the attached glossary.

C. Agree that the three major activities of most concern include, but are not limited to:

1. airport siting and expansion;

[2] See glossary for the definition of a Class A Mishap and similar terms.

2. development of conservation/mitigation habitats or other land uses that could attract hazardous wildlife to airports or nearby areas; and

3. responses to known wildlife hazards or aircraft-wildlife strikes.

D. Agree that "hazardous wildlife" are those animals, identified to species and listed in FAA and USAF databases, that are most often involved in aircraft-wildlife strikes. Many of the species frequently inhabit areas on or near airports, cause structural damage to airport facilities, or attract other wildlife that pose an aircraft-wildlife strike hazard. Table 1 lists many of these species. It is included solely to provide information on identified wildlife species that have been involved in aircraft-wildlife strikes. It is not intended to represent the universe of species concerning the signatory agencies, since more than 50 percent of the aircraft-wildlife strikes reported to FAA or the USAF did not identify the species involved.

E. Agree to focus on habitats attractive to the species noted in Table 1, but the signatory agencies realize that it is imperative to recognize that wildlife hazard determinations discussed in Paragraph L of this section may involve other animals.

F. Agree that not all habitat types attract hazardous wildlife. The signatory agencies, during their consultative or decisionmaking activities, will inform regional and local land use authorities of this MOA's purpose. The signatory agencies will consider regional, local, and site-specific factors (e.g., geographic setting and/or ecological concerns) when conducting these activities and will work cooperatively with the authorities as they develop and implement local land use programs under their respective jurisdictions. The signatory agencies will encourage these stakeholders to develop land uses within the siting criteria noted in Section 1-3 of FAA Advisory Circular (AC) 150.5200-33 (Attachment A) that do not attract hazardous wildlife. Conversely, the agencies will promote the establishment of land uses attractive to hazardous wildlife outside those siting criteria. Exceptions to the above siting criteria, as described in Section 2.4.b of the AC, will be considered because they typically involve habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge).

G. Agree that wetlands provide many important ecological functions and values, including fish and wildlife habitats; flood protection; shoreline erosion control; water quality improvement; and recreational, educational, and research opportunities. To protect jurisdictional wetlands, Section 404 of the Clean Water Act (CWA) establishes a program to regulate dredge and/or fill activities in these wetlands and navigable waters. In recognizing Section 404 requirements and the Clean Water Action Plan's goal to annually increase the Nation's net wetland acreage by 100,000 acres through 2005, the signatory agencies agree to resolve aircraft-wildlife conflicts. They will do so by

avoiding and minimizing wetland impacts to the maximum extent practicable, and will work to compensate for all associated unavoidable wetland impacts. The agencies agree to work with landowners and communities to encourage and support wetland restoration or enhancement efforts that do not increase aircraft-wildlife strike potentials.

H. Agree that the: U.S. Army Corps of Engineers (ACOE) has expertise in protecting and managing jurisdictional wetlands and their associated wildlife; U.S. Environmental Protection Agency (EPA) has expertise in protecting environmental resources; and the U.S. Fish and Wildlife Service (USFWS) has expertise in protecting and managing wildlife and their habitats, including migratory birds and wetlands. Appropriate signatory agencies will cooperatively review proposals to develop or expand wetland mitigation sites, or wildlife refuges that may attract hazardous wildlife. When planning these sites or refuges, the signatory agencies will diligently consider the siting criteria and land use practice recommendations stated in FAA AC 150/5200-33. The agencies will make every effort to undertake actions that are consistent with those criteria and recommendations, but recognize that exceptions to the siting criteria may be appropriate (see Paragraph F of this section).

I. Agree to consult with airport proponents during initial airport planning efforts. As appropriate, the FAA or USAF will initiate signatory agency participation in these efforts. When evaluating proposals to build new civilian or military aviation facilities or to expand existing ones, the FAA or the USAF, will work with appropriate signatory agencies to diligently evaluate alternatives that may avoid adverse effects on wetlands, other aquatic resources, and Federal wildlife refuges. If these or other habitats support hazardous wildlife, and there is no practicable alternative location for the proposed aviation project, the appropriate signatory agencies, consistent with applicable laws, regulations, and policies, will develop mutually acceptable measures, to protect aviation safety and mitigate any unavoidable wildlife impacts.

J. Agree that a variety of other land uses (e.g., storm water management facilities, wastewater treatment systems, landfills, golf courses, parks, agricultural or aquacultural facilities, and landscapes) attract hazardous wildlife and are, therefore, normally incompatible with airports. Accordingly, new, federally-funded airport construction or airport expansion projects near habitats or other land uses that may attract hazardous wildlife must conform to the siting criteria established in the FAA Advisory Circular (AC) 150/5200-33, Section 1-3.

K. Agree to encourage and advise owners and/or operators of non-airport facilities that are known hazardous wildlife attractants (See Paragraph J) to follow the siting criteria in Section 1-3 of AC 150/5200-33. As appropriate, each signatory agency will inform proponents of these or other land uses about the land use's potential to attract hazardous species to airport areas.

The signatory agencies will urge facility owners and/or operators about the critical need to consider the land uses' effects on aviation safety.

L. Agree that FAA, USAF, and WS personnel have the expertise necessary to determine the aircraft-wildlife strike potentials of various land uses. When there is disagreement among signatory agencies about a particular land use and its potential to attract hazardous wildlife, the FAA, USAF, or WS will prepare a wildlife hazard assessment. Then, the appropriate signatory agencies will meet at the local level to review the assessment. At a minimum, that assessment will:

1. identify each species causing the aviation hazard, its seasonal and daily populations, and the population's local movements;

2. discuss locations and features on and near the airport or land use attractive to hazardous wildlife; and

3. evaluate the extent of the wildlife hazard to aviation.

M. Agree to cooperate with the airport operator to develop a specific, wildlife hazard management plan for a given location, when a potential wildlife hazard is identified. The plan will meet applicable FAA, USAF, and other relevant requirements. In developing the plan, the appropriate agencies will use their expertise and attempt to integrate their respective programmatic responsibilities, while complying with existing laws, regulations, and policies. The plan should avoid adverse impacts to wildlife populations, wetlands, or other sensitive habitats to the maximum extent practical. Unavoidable impacts resulting from implementing the plan will be fully compensated pursuant to all applicable Federal laws, regulations, and policies.

N. Agree that whenever a significant aircraft-wildlife strike occurs or a potential for one is identified, any signatory agency may initiate actions with other appropriate signatory agencies to evaluate the situation and develop mutually acceptable solutions to reduce the identified strike probability. The agencies will work cooperatively, preferably at the local level, to determine the causes of the strike and what can and should be done at the airport or in its vicinity to reduce potential strikes involving that species.

O. Agree that information and analyses relating to mitigation that could cause or contribute to aircraft-wildlife strikes should, whenever possible, be included in documents prepared to satisfy the National Environmental Policy Act (NEPA). This should be done in coordination with appropriate signatory agencies to inform the public and Federal decision makers about important ecological factors that may affect aviation. This concurrent review of environmental issues will promote the streamlining of the NEPA review process.

P. Agree to cooperatively develop mutually acceptable and consistent guidance, manuals, or procedures addressing the management of habitats attractive to

hazardous wildlife, when those habitats are or will be within the siting criteria noted in Section 1-3 of FAA AC 5200-33. As appropriate, the signatory agencies will also consult each other when they propose revisions to any regulations or guidance relevant to the purpose of this MOA, and agree to modify this MOA accordingly.

SECTION II.
GENERAL RULES AND INFORMATION

A. Development of this MOA fulfills the National Transportation Safety Board's recommendation of November 19, 1999, to form an inter-departmental task force to address aircraft-wildlife strike issues.

B. This MOA does not nullify any obligations of the signatory agencies to enter into separate MOAs with the USFWS addressing the conservation of migratory birds, as outlined in Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, dated January 10, 2001 (66 *Federal Register*, No. 11, pg. 3853).

C. This MOA in no way restricts a signatory agency's participation in similar activities or arrangements with other public or private agencies, organizations, or individuals.

D. This MOA does not alter or modify compliance with any Federal law, regulation or guidance (e.g., Clean Water Act; Endangered Species Act; Migratory Bird Treaty Act; National Environmental Policy Act; North American Wetlands Conservation Act; Safe Drinking Water Act; or the "no-net loss" policy for wetland protection). The signatory agencies will employ this MOA in concert with the Federal guidance addressing wetland mitigation banking dated March 6, 1995 (60 *Federal Register*, No. 43, pg. 12286).

E. The statutory provisions and regulations mentioned above contain legally binding requirements. However, this MOA does not substitute for those provisions or regulations, nor is it a regulation itself. This MOA does not impose legally binding requirements on the signatory agencies or any other party, and may not apply to a particular situation in certain circumstances. The signatory agencies retain the discretion to adopt approaches on a case-by-case basis that differ from this MOA when they determine it is appropriate to do so. Such decisions will be based on the facts of a particular case and applicable legal requirements. Therefore, interested parties are free to raise questions and objections about the substance of this MOA and the appropriateness of its application to a particular situation.

F. This MOA is based on evolving information and may be revised periodically without public notice. The signatory agencies welcome public comments on this MOA at any time and will consider those comments in any future revision of this MOA.

G. This MOA is intended to improve the internal management of the Executive Branch to address conflicts between aviation safety and wildlife. This MOA does not create any right, benefit, or trust responsibility, either substantively or procedurally. No party, by law or equity, may enforce this MOA against the United States, its agencies, its officers, or any person.

H. This MOA does not obligate any signatory agency to allocate or spend appropriations or enter into any contract or other obligations.

I. This MOA does not reduce or affect the authority of Federal, State, or local agencies regarding land uses under their respective purviews. When requested, the signatory agencies will provide technical expertise to agencies making decisions regarding land uses within the siting criteria in Section 1-3 of FAA AC 150/5200-33 to minimize or prevent attracting hazardous wildlife to airport areas.

J. Any signatory agency may request changes to this MOA by submitting a written request to any other signatory agency and subsequently obtaining the written concurrence of all signatory agencies.

K. Any signatory agency may terminate its participation in this MOA within 60 days of providing written notice to the other agencies. This MOA will remain in effect until all signatory agencies terminate their participation in it.

SECTION III. PRINCIPAL SIGNATORY AGENCY CONTACTS

The following list identifies contact offices for each signatory agency.

Federal Aviation Administration
Office Airport Safety and Standards
Airport Safety and
Compliance Branch (AAS-310)
800 Independence Ave., S.W.
Washington, D.C. 20591
V: 202-267-1799
F: 202-267-7546

U.S. Air Force
HQ AFSC/SEFW
9700 Ave., G. SE, Bldg. 24499
Kirtland AFB, NM 87117
V: 505-846-5679
F: 505-846-0684

U.S. Army
Directorate of Civil Works
Regulatory Branch (CECW-OR)
441 G St., N.W.
Washington, D.C. 20314
V: 202-761-4750
F: 202-761-4150

U.S. Environmental Protection Agy.
Office of Water
Wetlands Division
Ariel Rios Building, MC 4502F
1200 Pennsylvania Ave., SW
Washington, D.C. 20460
V: 202-260-1799
F: 202-260-7546

U.S. Fish and Wildlife Service
Division of Migratory Bird Management
4401 North Fairfax Drive, Room 634
Arlington, VA 22203
V: 703-358-1714
F: 703-358-2272

U.S. Department of Agriculture
Animal and Plant Inspection Service
Wildlife Services
Operational Support Staff
4700 River Road, Unit 87
Riverdale, MD 20737
V: 301-734-7921
F: 301-734-5157

Signature Page

Original Signed by:
Woodie Woodward **12/17/2002**

_____ _____
Associate Administrator for Airports, Date
Federal Aviation Administration

Original Signed by:
Kenneth W. Hess **27 May 2003**

_____ _____
Chief of Safety, Date
U. S. Air Force

Original Signed by:
R.L. Brownlee **December 9, 2002**

_____ _____
Assistant Secretary of the Army (Civil Works), Date
U.S. Army

Original Signed by:
G. Tracy Mehan, III **1/17/03**

_____ _____
Assistant Administrator, Office of Water, Date
U.S. Environmental Protection Agency

Original Signed by:
Paul R. Schmidt **7/29/03**

_____ _____
Assistant Director, Migratory Birds Date
and State Programs,
U.S. Fish and Wildlife Service

Original Signed by:
Richard D Curnow **9 January 2003**

_____ _____
Acting Deputy Administrator, Wildlife Services Date
U.S. Department of Agriculture

GLOSSARY

This glossary defines terms used in this MOA.

Airport. All USAF airfields or all public use airports in the FAA's National Plan of Integrated Airport Systems (NPIAS). Note: There are over 18,000 civil-use airports in the U.S., but only 3,344 of them are in the NPIAS and, therefore, under FAA's jurisdiction.

Aircraft-wildlife strike. An aircraft-wildlife strike is deemed to have occurred when:

1. a pilot reports that an aircraft struck 1 or more birds or other wildlife;
2. aircraft maintenance personnel identify aircraft damage as having been caused by an aircraft-wildlife strike;
3. personnel on the ground report seeing an aircraft strike 1 or more birds or other wildlife;
4. bird or other wildlife remains, whether in whole or in part, are found within 200 feet of a runway centerline, unless another reason for the animal's death is identified; or
5. the animal's presence on the airport had a significant, negative effect on a flight (i.e., aborted takeoff, aborted landing, high-speed emergency stop, aircraft left pavement area to avoid collision with animal)

(Source: *Wildlife Control Procedures Manual*, Technical Publication 11500E, 1994).

Aircraft-wildlife strike hazard. A potential for a damaging aircraft collision with wildlife on or near an airport (14 CFR 139.3).

Bird Sizes. Title 40, Code of Federal Regulations, Part 33.76 classifies birds according to weight:

small birds weigh less than 3 ounces (oz).
medium birds weigh more than 3 oz and less than 2.5 lbs.
large birds weigh greater than 2.5 lbs.

Civil aircraft damage classifications. The following damage descriptions are based on the *Manual on the International Civil Aviation Organization Bird Strike Information System*:

Minor: The aircraft is deemed airworthy upon completing simple repairs or replacing minor parts and an extensive inspection is not necessary.

Substantial: Damage or structural failure adversely affects an aircraft's structural integrity, performance, or flight characteristics. The damage normally requires major repairs or the replacement of the entire affected component. Bent fairings or cowlings; small dents; skin punctures; damage to wing tips, antenna, tires or brakes, or engine blade damage not requiring blade replacement are specifically excluded.

Destroyed: The damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Significant Aircraft-Wildlife Strikes. A significant aircraft-wildlife strike is deemed to have occurred when any of the following applies:

1. a civilian, U.S. air carrier aircraft experiences a multiple aircraft-bird strike or engine ingestion;
2. a civilian, U.S. air carrier aircraft experiences a damaging collision with wildlife other than birds; or
3. a USAF aircraft experiences a Class A, B, or C mishap as described below:

    A. **Class A Mishap:** Occurs when at least one of the following applies:
        1. total mishap cost is $1,000,000 or more;
        2. a fatality or permanent total disability occurs; and/or
        3. an Air Force aircraft is destroyed.
    B. **Class B Mishap:** Occurs when at least one of the following applies:
        1. total mishap cost is $200,000 or more and less than $1,000,000; and/or
        2. a permanent partial disability occurs and/or 3 or more people are hospitalized;
    C. **Class C Mishap:** Occurs when at least one of the following applies:
        1. cost of reported damage is between $20,000 and $200,000;
        2. an injury causes a lost workday (i.e., duration of absence is at least 8 hours beyond the day or shift during which mishap occurred); and/or
        3. an occupational illness causing absence from work at any time.

Wetlands. An ecosystem requiring constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or

near the surface and the presence of physical, chemical, and biological features indicating recurrent, sustained inundation, or saturation. Common diagnostic wetland features are hydric soils and hydrophytic vegetation. These features will be present, except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development.

(Source the 1987 Delineation Manual; 40 CFR 230.3(t)).

Wildlife. Any wild animal, including without limitation any wild mammal, bird, reptile, fish, amphibian, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, including any part, product, egg, or offspring there of (50 CFR 10.12, *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants*). As used in this MOA, "wildlife" includes feral animals and domestic animals while out of their owner's control (14 CFR 139.3, *Certification and Operations: Land Airports Serving CAB-Certificated Scheduled Air Carriers Operating Large Aircraft (Other Than Helicopters)*)

Table 1. Identified wildlife species, or groups, that were involved in two or more aircraft-wildlife strikes, that caused damage to one or more aircraft components, or that had an adverse effect on an aircraft's flight. Data are for 1990-1999 and involve only civilian, U.S. aircraft.

Birds	No. reported strikes
Gulls (all spp.)	874
Geese (primarily, Canada geese)	458
Hawks (primarily, Red-tailed hawks)	182
Ducks (primarily Mallards.)	166
Vultures (primarily, Turkey vulture)	142
Rock doves	122
Doves (primarily, mourning doves)	109
Blackbirds	81
European starlings	55
Sparrows	52
Egrets	41
Shore birds (primarily, Killdeer & Sandpipers)	40
Crows	31
Owls	24
Sandhill cranes	22
American kestrels	15
Great blue herons	15
Pelicans	14
Swallows	14
Eagles (Bald and Golden)	14
Ospreys	13
Ring-necked pheasants	11
Herons	11
Barn-owls	9
American robins	8
Meadowlarks	8
Buntings (snow)	7
Cormorants	6
Snow buntings	6
Brants	5
Terns (all spp.)	5
Great horned owls	5
Horned larks	4
Turkeys	4
Swans	3
Mockingbirds	3
Quails	3
Homing pigeons	3
Snowy owls	3
Anhingas	2

Birds	No. reported strikes
Ravens	2
Kites	2
Falcons	2
Peregrine falcons	2
Merlins	2
Grouse	2
Hungarian partridges	2
Spotted doves	2
Thrushes	2
Mynas	2
Finches	2
Total known birds	2,612

Mammals	No. reported strikes
Deer (primarily, White-tailed deer)	285
Coyotes	16
Dogs	10
Elk	6
Cattle	5
Bats	4
Horses	3
Pronghorn antelopes	3
Foxes	2
Raccoons	2
Rabbits	2
Moose	2
Total known mammals	340

Ring-billed gulls were the most commonly struck gulls. The U.S. ring-billed gull population increased steadily at about 6% annually from 1966-1988. Canada geese were involved in about 90% of the aircraft-goose strikes involving civilian, U.S. aircraft from 1990-1998. Resident (non-migratory) Canada goose populations increased annually at 13% from 1966-1998. Red-tailed hawks accounted for 90% of the identified aircraft-hawk strikes for the 10-year period. Red-tailed hawk populations increased annually at 3% from 1966 to 1998. Turkey vultures were involved in 93% of he identified aircraft-vulture strikes. The U.S. Turkey vulture populations increased at annually at 1% between 1966 and 1998. Deer, primarily white-tailed deer, have also adapted to urban and airport areas and their populations have increased dramatically. In the early 1900's, there were about 100,000 white-tailed deer in the U.S. Current estimates are that the U.S. population is about 24 million.

Appendix B

Biological Assessment

Draft Biological Assessment
Addicks and Barker Dam Safety Modification
Harris County, Texas

US Army Corps
of Engineers ®
Galveston District

United States Army Corps of Engineers
Galveston District
PO Box 1229
Galveston, Texas 77550

October 2012

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1.0 INTRODUCTION

1.1 Purpose of the Biological Assessment

This Biological Assessment (BA) is being prepared for the purpose of fulfilling the U.S. Army Corps of Engineers (USACE) requirements as outlined under Section 7(c) of the Endangered Species Act (ESA) of 1973, as amended. The proposed federal action is the replacement of the existing outlet works structures at both Addicks and Barker Dams, and the abandonment of the existing outlet works. This BA is being prepared to assist the U.S. Fish and Wildlife Service (USFWS) in fulfilling their obligations under the ESA.

This BA evaluates the potential impacts that the proposed modification of the Addicks and Barker Dams may have on federally listed threatened and endangered species identified by the USFWS as occurring within the proposed action area as described in section 1.2.1 of this document. Table 1 identifies federally listed threatened and endangered species for Harris and Fort Bend Counties, Texas. This species list was partially obtained from databases managed by the USFWS (USFWS, 2012a). Additional federally protected species found in Table 1 are listed within the Texas Parks and Wildlife Department (TPWD) database as potentially occurring in Harris and Fort Bend Counties (TPWD, 2012a and 2012b). The species listed in the TPWD database are not covered in further detail in this BA as they have not been recognized as occurring in Harris and Fort Bend Counties, Texas, by the Clear Lake field office of the USFWS.

Table 1: Federally Listed Threatened and Endangered Species in Harris and Fort Bend Counties, Texas

Common Name	Scientific Name	USFWS Listing
Amphibians		
Houston Toad	*Anaxyrus houstonensis*	E†
Birds		
American Peregrine Falcon	*Falco peregrinus anatum*	DL†
Arctic Peregrine Falcon	*Falcon peregrinus tundrius*	DL†
Attwater's Greater Prairie Chicken	*Tympanuchus cupido attwateri*	E†
Bald Eagle	***Haliaeetus leucocephalus***	**DM***
Brown Pelican	*Pelecanus occidentalis*	DM†
Interior Least Tern	*Sterna antillarum athalassos*	E†
Red-cockaded Woodpecker	*Picoides borealis*	E†
Sprague's Pipit	*Anthus spragueii*	C†
Whooping Crane	***Grus americana***	**E***
Wood Stork	*Mycteria americana*	E†
Fishes		
American Eel	*Anguilla rostrata*	UR†
Sharpnose Shiner	*Notropis oxyrhynchus*	C†
Smalltooth Sawfish	*Pristis pectinata*	E†

Mammals		
Louisiana Black Bear	*Ursus americanus luteolus*	T†
Red Wolf	*Canis rufus*	E†
Mollusks		
Smooth pimpleback	*Quadrula houstonensis*	C†
Texas fawnsfoot	*Truncilla macrodon*	C†
Reptiles		
Alligator Snapping Turtle	*Macrochelys temmincki*	UR†
Green Sea Turtle	*Chelonia mydas*	T†
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E†
Leatherback Sea Turtle	*Dermochelys coriacea*	E†
Loggerhead Sea Turtle	*Caretta caretta*	T†
Plants		
Texas Prairie Dawn	***Hymenoxys texana***	**E***

† Species is listed by the U.S. Fish and Wildlife Service, but is not listed to occur within either Harris or Fort Bend Counties by the Clear Lake office of the U.S. Fish and Wildlife Service (May 2012).
* Species listed in **bold** are described in further detail in this BA.
E = Endangered T = Threatened
DL = Delisted Taxon DM = Delisted Taxon, re covered, being monitored first five years
UR = Under Review C = Candidate Species for Listing

1.2 Description of the Proposed Project and Existing Habitats

1.2.1 Identification of the Proposed Action Area

The proposed action is lo cated on federal lands within A ddicks and Barker Reservoirs. The reservoirs are located west of the City of Houston in Harris and Fort Bend Counties, Texas. The Addicks and Barker dam s were authorized an d constructed in the m id-to-late 1940s for the purpose of flood risk management within Harris County, Texas.

For the purpose of this BA, the proposed ac tion area encom passes Addicks and Barker Reservoirs in addition to all areas within a 10-mile radius around bot h reservoirs, having a center-point at the inter section of Interstate Highway (IH) 10 and State Highway (SH) 6. This action area allows for a complete evaluation of potential direct and indirect environmental effects that would result from the proposed action. F igure 1 presents a vicinity m ap of t he proposed action area for this BA.

1.2.2 Proposed Project Description

The preferred altern ative for the p roposed project involves replacement of the ex isting outlet works structures at both Addicks and Barker Dams. At Addicks Reservoir, the preferred alternative includes construction of a new outlet structure to includ e an intake tower, steel lined conduits, parabolic spillway, stilling basin, cuto ff wall, downstream filter, and aban doning the existing structure in place. The new outlet works st ructure would be located within the existing dam embankment, about 400’ from the existing st ructure. A cutoff wall would be constructed beneath the outle t works structure and tied into the existing slurry cutoffs to provide positive

cutoff of seepage. An engineered filter and drainage system would provide controlled discharge of seepage and retain soil particles to limit migration from the dam embankment or foundation. An outlet channel would be excavated to connect the new structure to the existing outlet channel. This channel would be located in the existing project footprint.

To limit transference of risk, discharge curves for the new outlet structure would closely duplicate the existing structure. After the new structure is completed, the existing upstream intake tower and tower bridge, as well as the parabolic spillway, would be removed. Existing conduits would be filled with grout, a cutoff wall would be constructed through the conduits, and a filter would be placed immediately downstream of the abandoned conduits. The existing outlet channel would also be filled. At Addicks Reservoir, an earthen cofferdam with cutoff wall beneath the foundation would be used for construction of the new structure and would be at the same elevation as the top of the existing dam.

At Barker Reservoir, an earthen cofferdam would be used for construction of the new structure and would be at the same elevation as the top of the existing dam. A cutoff wall would be constructed at Noble Road to effectively cut off seepage through the fine grain sand foundation from an upstream borrow site to Clodine Ditch, just downstream of the embankment.

Direct impacts to existing habitats resulting from the proposed action would occur at the proposed construction sites including Addicks and Barker Dam Sites. Direct impacts to existing habitat resulting from excavation of borrow areas would occur in any one of two potential borrow areas located in the Barker Reservoir (Borrow Areas 4 or 5) and in any one of three borrow areas located in the Addicks Reservoir (Borrow Areas 1, 2, or 3). Potential direct impacts would also occur at Borrow Areas 1, 2, 3, 4, and/or 5. Figures 2 and 3 depict the locations of the proposed construction sites, including borrow areas.

1.2.3 Existing Habitat

The proposed action area is located in the Gulf Coast Prairies and Marshes natural region of Texas, which includes approximately 20,312 square miles of land (Gould, 1960). Gulf Coast Prairies are nearly level with slow surface drainage and elevations ranging from sea level to approximately 250 feet above mean sea level (MSL). In addition to wildlife habitat, the prairies are used for crops, livestock grazing, and urban and industrial centers. It is estimated that as much as 99 percent of the coastal prairies in Texas have been converted to agricultural land (Gould, 1960; McMahan et al, 1984).

Qualified biologists with surveying experience for listed species typically found in the gulf coastal plain of Texas performed site investigations for listed species and their associated habitats in May 2012. Based on field surveys and site reconnaissance, the existing vegetative cover within the proposed construction sites consists of herbaceous uplands, forested uplands, emergent wetlands, forested wetlands, and perennial and seasonal tributaries. These field surveys were restricted to areas deemed to be construction sites for the measures and features associated with the proposed project (dam outlet reconstruction and borrow areas).

Herbaceous uplands (66.58 acres) include areas that were historically coastal prairie but now consist mostly of mixed prairie, old field habitat (mix of native and non-native plants), and maintained and mowed areas. Although several locations in the proposed construction sites contain vegetation commonly found in a healthy coastal prairie ecosystem, many of these vegetative communities have been altered by invasion of native and exotic woody and herbaceous species. Herbaceous uplands are located in the Addicks Dam Site, Barker Dam Site, and Borrow Areas 1 and 2.

Dominant species identified within the herbaceous uplands consist of broomsedge bluestem (*Andropogon virginicus*), bushy bluestem (*Andropogon glomeratus*), purple poppymallow (*Callirhoe involucrata*), annual marsh elder (*Iva annua*), Jesuit's bark (*Iva frutescens*), hirsute sedge (*Carex complanata*), yellow thistle (*Cirsium horridulum*), needleleaf rosette grass (*Dichanthelium aciculare*), velvet panicum (*Dichanthelium scoparium*), hairy fimbry (*Fimbristylis puberula*), hairawn muhly (*Muhlenbergia capillaris*), Bermudagrass (*Cynodon dactylon*), bahiagrass (*Paspalum notatum*), yellow foxtail (*Setaria pumila*), woodrush flatsedge (*Cyperus entrerianus*), powderpuff (*Mimosa strigillosa*), great ragweed (*Ambrosia trifida*), Cuman ragweed (*Ambrosia psilostachya*), yellowdicks (*Helenium amarum*), brownseed paspalum (*Paspalum plicatulum*), Nuttall's prairie parsley (*Polytaenia nuttallii*), anglestem beaksedge (*Rhynchospora caduca*), globe beaksedge (*Rhynchospora globularis*), Macartney rose (*Rosa bracteata*), blackeyed Susan (*Rudbeckia hirta*), little bluestem (*Schizachyrium scoparium*), fewflower nutrush (*Scleria pauciflora*), Canada goldenrod (*Solidago altissima*), slender rosinweed (*Silphium gracile*), Brazilian vervain (*Verbena brasiliensis*), tuberous vervain (*Verbena rigida*), hogwort (*Croton capitatus*), common plantain (*Plantago major*), and southern blackberry (*Rubus trivialis*). Individual trees and shrubs are interspersed throughout the herbaceous uplands and include poisonbean (*Sesbania drummondii*), common persimmon (*Diospyros virginiana*), black willow (*Salix nigra*), buttonbush (*Cephalanthus occidentalis*), and Chinese tallow (*Triadica sebifera*). These trees range from three to 14 inches in diameter at breast height (dbh) and 15 to 30 feet in height. Stem densities are estimated to be below 15 stems per acre.

Forested upland communities (119.03 acres) consist of riparian forests, upland pine areas, and open canopy areas dominated by a variety of woody species including oaks, pines, elms, and ashes. Invasive species were observed throughout these communities. These vegetative communities are located in the southern portion of the Addicks Dam Site, the western portion of the Barker Dam Site, and Borrow Areas 1, 3, and 5. One ephemeral tributary flows through the southern portion of the Addicks Dam Site within the forested upland community. Individual trees within this community ranged from three to 24 inches dbh and 15 to 45 feet in height. Stem densities for woody species are estimated to be between 30 and 300 stems per acre.

Dominant species found in the forested uplands include water oak (*Quercus nigra*), willow oak (*Quercus phellos*), loblolly pine (*Pinus taeda*), live oak (*Quercus virginiana*), pecan (*Carya illinoinensis*), water hickory (*Carya aquatica*), common persimmon, green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), winged elm (*Ulmus alata*), cedar elm (*Ulmus crassifolia*), hackberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), American sycamore (*Platanus occidentalis*), slippery elm (*Ulmus rubra*), white ash (*Fraxinus americana*), red mulberry (*Morus rubra*), yaupon (*Ilex vomitoria*), Chinese privet (*Ligustrum sinense*),

possumhaw (*Ilex decidua*), boxelder (*Acer negundo*), cockspur hawthorn (*Crataegus crus-galli*), green hawthorn (*Crataegus viridis*), dwarf palmetto (*Sabal minor*), western soapberry (*Sapindus saponaria*) and in wetter areas water tupelo (*Nyssa aquatica*), black willow, and buttonbush. Herbaceous and vine layers constitute a minor portion of this vegetative community and include slender woodoats (*Chasmanthium laxum*), southern arrowwood (*Viburnum dentatum*), poisonbean, eastern baccharis (*Baccharis halimifolia*), American beautyberry (*Callicarpa americana*), Alabama supplejack (*Berchemia scandens*), muscadine (*Vitis rotundifolia*), saw greenbrier (*Smilax bona-nox*), roundleaf greenbrier (*Smilax rotundifolia*), field blackberry, honeysuckle (*Lonicera japonica*), peppervine (*Ampelopsis arborea*), and Macartney rose.

Emergent wetlands (32.21 acres) are located in the Addicks Dam Site, Barker Dam Site, and Borrow Areas 2, 3, and 4. These areas are either depressional in nature or abutting flowing tributaries and other open waters. The emergent wetlands were dominated by angleste m beaksedge, maidencane (*Panicum hemitomon*), swamp smartweed (*Polygonum hydropiperoides*), spotted ladysthum b (*Polygonum persicaria*), Pennsylvania smartweed (*Polygonum pensylvanicum*), common rush (*Juncus effusus*), common threesquare (*Schoenoplectus pungens*), marsh seedbox (*Ludwigia palustris*), floating primrose-willow (*Ludwigia peploides*), mountain spikerush (*Eleocharis montana*), sand spikerush (*Eleocharis montevidensis*), common mallow (*Malva neglecta*), smutgrass (*Sporobolus indicus*), green flatsedge (*Cyperus virens*), hogwort, saltgrass (*Distichlis spictatum*), curlydock (*Rumex crispus*), white heath aster (*Symphyotrichum ericoides*), and broadleaf arrowhead (*Sagittaria latifolia*). Individual trees and shrubs were interspersed throughout the herbaceous wetlands and included poisonbean, common persimmon, black willow, buttonbush, and Chinese tallow. Observed trees ranged from three to 12 inches dbh and 15 to 30 feet in height. Stem densities for woody species are estimated to be below 15 stems per acre.

Forested wetlands (111.59 acres) are located in Borrow Areas 3, 4, and 5. The forested wetlands are dominated by Chinese tallow, poisonbean, common persimmon, black willow, green ash, and buttonbush. Individual trees within this community ranged from three to 18 inches dbh and 15 to 28 feet in height. Stem densities are estimated to be between 30 and 300 stems per acre. Herbaceous species in this vegetative community include swamp smartweed, marsh seedbox, sand spikerush, anglestem beaksedge, annual marsh elder, maidencane, common threesquare, and white heath aster.

Perennial and seasonal tributary habitat (4.84 acres) is located within the ordinary high water marks (OHWM) of Langham Creek at the Addicks Dam Site, and Buffalo Bayou and its associated tributaries at the Barker Dam Site. Due to the flow regimes of these tributaries, no vegetation was observed within their boundaries. These communities are abutted by herbaceous uplands, forested uplands, and emergent wetlands. Typical substrates within these habitats consist of either silty and sandy loams, mucks, several rock riprap-lined runs, or pools constructed as erosion and flow control measures downstream of both dams.

2.0 STATUS OF THE LISTED SPECIES KNOWN TO OCCUR IN THE PROPOSED ACTION AREA

Of the species listed in Table 1, the whooping crane (*Grus americana*), bald eagle (*Haliaeetus leucocephalus*), and Texas prairie dawn (*Hymenoxys texana*) are listed by the Clear Lake field office of the USFWS as occurring in Harris and Fort Bend Counties, Texas. There is no designated critical habitat for any of these listed species within the proposed action area. Detailed descriptions of the three species follow.

2.1 Whooping Crane

The whooping crane is North America's tallest bird, with males approaching approximately five feet tall. This species has a long, sinuous neck, long legs, a white body with feathers accented by jet-black wingtips, and a red and black head with a long, pointed beak. The wings of the whooping crane measure approximately seven feet across. It is named for its call, which has been described as a shrill, bugle-like trumpeting.

2.1.1 Reasons for Status

Habitat loss and degradation as well as hunting caused declining numbers of these birds until 1939. At that time, only 18 whooping cranes survived. The whooping crane was federally listed as endangered on March 11, 1967 (32 FR 4001). The whooping crane only occurs in North America and currently exists in three wild populations in 12 captive sites. In Texas, the Aransas National Wildlife Refuge and surrounding portions of Aransas, Calhoun, and Refugio Counties are designated as critical habitat (43 FR 36588). Subsequent to its initial listing, the species has slowly recovered, and as of July 2010, the total wild population had increased to approximately 383 individuals. The combined captive and wild populations as of July 2010 equaled 535 individual whooping cranes (USFWS 2012b).

2.1.2 Habitat

The whooping crane breeds, migrates, winters, and forages in a variety of wetland and other habitats, including coastal marshes and estuaries, inland marshes, lakes, ponds, wet meadows, rivers, and agricultural fields. Whooping cranes breed and nest in wetland habitat in Wood-Buffalo National Park, Canada. Bulrush (*Scirpus* spp.) is the dominant vegetation type in the potholes used for nesting, although cattail, sedge, muskgrass, and other aquatic plants are common. Nest sites are primarily located in shallow ponds that contain bulrush.

During migration, whooping cranes use a variety of habitats; however, wetland mosaics appear to be the most suitable. For feeding, whooping cranes primarily use shallow, seasonally and semi-permanently flooded palustrine wetlands. For roosting, they use various cropland and emergent wetlands. In Nebraska, whooping cranes also use riverine habitats (USFWS, 2012b).

On the Texas coast, common habitat includes saltmarsh, intertidal fringe, freshwater marshes, and wetland mosaics on both the mainland and barrier islands.

2.1.3 Range

The whooping crane is a bi-annual migrant, traveling between its summer habitat in central Canada and its wintering grounds on the Texas coast, across the Great Plains of the U.S. in the spring and fall of each year. The migratory corridor runs in an early straight line from the Canadian Prairie Provinces of Alberta and Saskatchewan through the Great Plains states of eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Their migration corridor is approximately 2,400 miles (3,862 km) long by 220 miles (354 km) wide. Approximately 95% of known sightings of whooping cranes have been observed inside of this corridor.

Autumn migration normally begins in mid-September, with most birds arriving on the Texas wintering grounds between late October and mid-November. Whooping cranes migrate south as individuals, pairs, in family groups, or as small flocks of three to five birds. They are diurnal migrants and stop daily to feed and rest. Local weather conditions influence distance and direction of travel, but whooping cranes generally are capable of reaching the autumn staging grounds in the north central portion of the Saskatchewan agricultural area on the second day of migration, where they remain for two to four weeks. Migration from Saskatchewan to the wintering grounds is usually rapid and may be completed in a week. Although close association with other whooping cranes is tolerated at times on the wintering grounds, pairs and family groups typically occupy and defend relatively discrete territories. As spring approaches, "dancing" behavior (running, leaping and bowing, unison calling, and flying) increases in frequency, and is indicative of pre-migratory restlessness. Spring migration departure dates are normally between March 25 and April 15, with the last birds usually leaving by May 1 (USFWS, 2012b).

2.1.4 Distribution in Texas

Whooping cranes migrate through the central portion of the state of Texas, from the eastern panhandle to the Dallas-Fort Worth area and south through the Austin area to the central coast. This migration occurs during October-November and again in March-April. Whooping cranes occupy wintering habitat in the Aransas National Wildlife Refuge in Aransas and Refugio Counties, Texas. Whooping cranes have also been documented in freshwater marshes and other semi-aquatic habitat along the Texas coast during the wintering season.

2.1.5 Presence in Proposed Action Area

Although foraging whooping cranes are found along the Texas Coast during winter months, they are not expected to occur in the proposed action area due to the significant amount of urban development surrounding the reservoirs and the lack of documented nesting and/or foraging sites in the proposed action area. No occurrences of Whooping cranes were documented by the TPWD Natural Diversity Database (NDD) within ten miles of the proposed action area.

2.2 Bald Eagle

A large raptor, the bald eagle has a wingspan of approximately seven feet. Adults have a dark brown body and wings, white head and tail, and a yellow beak. Juveniles are mostly brown with

white mottling on the body, tail, and undersides of wings. Adult plumage is usually obtained by the sixth year. In flight, the bald eagle often soars or glides with the wings held at a right angle to the body.

2.2.1 Reasons for Status

The bald eagle adapts poorly to radical changes in its environment, and has a relatively low reproductive rate with deferred maturity and a small clutch size. The bald eagle uses a large area for hunting and is sensitive to chemical contaminants in the food chain.

Habitat alterations and human encroachment resulted in a slow bald eagle population decline for many decades. Increased human populations have resulted in accelerated habitat destruction, one of the primary factors attributed to bald eagle population decline. Other factors include hunting and environmental contaminants, including DDT and its metabolites. It should be noted that a significant amount of new habitat has been created over the course of the past few decades in the form of man-made reservoirs. Reservoirs now primarily provide wintering and non-nesting habitat, but are gradually receiving more use by nesting bald eagles. Although reservoirs have a mitigating effect on the negative effects of habitat alteration, continually declining population levels resulted in the bald eagle's original listing on the Federal list of Threatened and Endangered species in 1978.

On July 12, 1995, the USFWS published notice to reclassify the bald eagle from endangered to threatened in the 43 States where it had been listed as endangered, and retain the threatened status for the other 5 States. On July 6, 1999, the USFWS published a proposed rule to delist the bald eagle throughout the lower 48 States due to recovery of the population (64 FR 36454). The bald eagle was officially delisted from the Federal List of Endangered and Threatened species on August 8, 2007.

The bald eagle is currently being monitored by the USFWS in Texas in accordance with the June 4, 2009, Post-Delisting Monitoring Plan. The Post-Delisting Monitoring Plan will monitor the status of the bald eagle by collecting data on occupied nests over a 20-year period with sampling events held every five years. The Post-Delisting Monitoring Plan was designed to monitor and verify that the recovered, delisted population remains secure from the risk of extinction once the protections of the ESA are removed. The USFWS can relist the bald eagle if future monitoring or other information shows listing is necessary to prevent a significant risk to the bald eagle.

Despite its delisting, the bald eagle remains protected under the 1918 Migratory Bird Treaty Act and 1940 Bald Eagle Protection Act.

2.2.2 Habitat

In Texas, the bald eagle is found along quiet rivers, coastal areas, lakeshores, and reservoirs with an abundance of fish and large, tall trees. It breeds in the eastern third of the state and winters wherever open water occurs. Breeding bald eagles build large stick nests lined with leaves, grass and Spanish moss and use them for several years.

They prefer to nest, perch, and roost primarily in old-growth and mature stands of conifers or hardwoods. Eagles usually select the oldest and tallest trees that have good visibility, an open canopy structure, and are near a source of food. Nests can weigh several hundred pounds and can be as many as six feet in diameter. Wintering and nesting activity occurs mainly near large freshwater impoundments with standing timber located in or around the water. The nesting period usually extends from October 1 to May 15. Breeding pairs, which generally bond for life, return to their same territory year after year. Nests are often situated on ecotonal boundaries of forest, marsh, and open water, typically in trees higher than 40 feet. Eagles typically choose sites more than 0.75 miles (1.2 km) from low-density human disturbance and more than 1.2 miles (1.8 km) from medium to high-density human disturbance (USFWS, 2012c).

2.2.3 Range

The bald eagle breeds from central Alaska across Canada to Labrador and Newfoundland, and south to southern mainland Alaska and the Aleutian Islands. It also breeds in Baja California, central Arizona, southwestern and central New Mexico, and along the Gulf Coast from Texas to Florida. Locally the bald eagle occurs throughout much of the Great Basin and Great Plains. Bald eagles winter in most of their breeding range, from southern Alaska and Canada southward. Resident populations are found along the Atlantic, Pacific, and Gulf coasts.

2.2.4 Distribution in Texas

The bald eagle breeds primarily in the eastern third of Texas, and winters wherever open water occurs. The bald eagle population of Texas is divided into two populations: breeding birds and non-breeding birds or wintering birds. Breeding populations occur primarily in the eastern third of the state and along coastal counties from Rockport to Houston. Non-breeding or wintering populations are located primarily in the panhandle, central, and east Texas, and in other areas of suitable habitat throughout the state (TPWD, 2012d).

2.2.5 Presence in Proposed Action Area

Although two large perennial tributaries (Langham Creek and Buffalo Bayou) exist within the proposed action area, no large water bodies fitting the habitat description of the bald eagle exist. The proposed action area exists within the highly urbanized western portions of Houston, Texas. Bald eagles may pass through the proposed action area as transient migrants. Known occurrences of bald eagles have been documented within the proposed action area by the TPWD NDD. Figure 4 depicts the locations of known occurrences within the vicinity of the proposed action area.

2.3 Texas Prairie Dawn

Texas prairie dawn is a delicate annual one to six inches tall. Despite being one of the state's smallest sunflowers, Texas prairie dawn is not easily overlooked. Its yellow flower heads, less than a 1/2 inch in diameter, stand out brightly in the patches of dull gray barren sand in which the

species is normally found. It flowers from mid-March to early April and generally disappears by mid-summer.

2.3.1 Reasons for Status

Suitable habitat for this species is limited to a small geographic area. The Texas prairie dawn was not encountered by botanists for approximately 100 years after its original discovery in 1889 near Hockley, Harris County, Texas, and was thought to be extinct (TPWD, 2012c). Three small populations were found in 1981 near Cypress, Harris County, Texas, and the species was placed on the Federal Endangered Species List on March 13, 1986 by the USFWS (Husain, 2011).

The Texas prairie dawn is currently known to exist in Fort Bend and Harris Counties, Texas. A large population of this species is protected by the USACE within Addicks and Barker Reservoirs. It has been documented on approximately 118 locations within Addicks and Barker Reservoirs. The majority of the documented occurrences within Addicks Reservoir are primarily located in the northern and western portions of the reservoir. The majority of documented occurrences within Barker Reservoir are primarily located in the northwest portions of the reservoir. Figure 5 depicts the locations of the documented occurrences within both reservoirs.

A population of Texas prairie dawn was recently discovered in the early 2000s on several acres of land owned by the Katie Prairie Conservancy (KPC) in northwest Harris County, Texas. The KPC is working with the USFWS and TPWD in evaluating a management plan to ensure that this species will survive and increase its population around the state of Texas.

The human population within the geographical area where this species is located is currently undergoing tremendous and rapid growth. Many areas of its natural habitat are rapidly disappearing. Current threats to the species include highway development, urban expansion, herbicide use, conversion to improved pasture, and invasion of brush and other woody species.

2.3.2 Habitat

Texas prairie dawn is associated with poorly drained, sparsely vegetated areas known as "slick spots" at the bases of mima mounds in open grassland or in almost barren areas. Soils are generally slightly saline, sticky when wet, and powdery when dry. The plant is sometimes associated with other Texas Coastal Prairies and Marshes endemics such as Texas windmill-grass (*Chloris texensis*) and Houston camphor daisy (*Machaeranthera aurea*).

2.3.3 Range and Distribution in Texas

The known range of Texas prairie dawn occurs only in Harris and Fort Bend Counties, Texas.

2.3.4 Presence in Proposed Action Area

Figure 5 displays the known locations of Texas prairie dawn within Addicks and Barker Reservoirs. No known populations of Texas Prairie dawn occur within the footprint of the proposed construction sites, including Addicks Dam Site, Barker Dam Site, and Borrow Areas 1

through 5. The proposed construction sites where direct impacts will occur from the proposed action are dominated by a diverse mix of habitat, including upland forests, perennial and seasonal tributaries, herbaceous uplands, and emergent wetlands. No mima mounds, depressions or other microtopographical features exist within these areas. Soils are classified as either fine sandy loams or firm, very hard clay, neither of which are conducive to Texas prairie dawn establishment.

3.0 EFFECTS ANALYSIS AND AVOIDANCE, MINIMIZATION, AND CONSERVATION MEASURES

The following sections provide the findings of the Galveston District and species-specific avoidance, minimization, and conservation measures that support the effect determination. Effect determinations are presented using the language of the ESA.

- *No Effect* – The proposed action will not affect a federally listed species or critical habitat.

- *May Affect, but not likely to adversely affect* – The project may affect listed species and/or critical habitat; however, the effects are expected to be discountable, insignificant, or completely beneficial.

- *Likely to adversely affect* – Adverse effects to listed species and/or critical habitat may occur as a direct result of the proposed action or its interrelated or independent actions and the effect is not discountable, insignificant, or completely beneficial. Under this determination, an additional determination is made whether the action is likely to jeopardize the continued survival and eventual recovery of the species.

3.1 Whooping Crane

No nesting or foraging sites were observed within the proposed construction sites. The proposed action area is located in a highly urbanized area of Harris County and is not adjacent to any coastal or estuarine systems. No occurrences of whooping cranes were documented by the TPWD NDD within the proposed action area. Proposed construction activities would not affect this species.

Effect Determination: *No Effect.*

3.2 Bald Eagle

No designated critical habitat is located within the proposed action area. The closest known occurrence according to TPWD NDD to the proposed construction sites is located approximately 7.4 miles south-southwest of Borrow Area 5, north of the intersection of Grand Parkway (SH 99) and U.S. Highway 90 in the town of Sugarland, Texas (see attached Figure 4). No bald eagle nesting or foraging sites were observed within the proposed construction sites. Proposed construction activities would not affect this species.

Effect Determination: *No Effect.*

3.3 Texas Prairie Dawn

Figure 5 displays the known locations of Texas prairie dawn within Addicks and Barker Reservoirs. No known populations of Texas Prairie dawn occur within the footprint of the proposed construction sites are proposed. No designated critical habitat exists within the proposed action area. Although several occurrences of Texas prairie dawn have been documented within the proposed action area, it is unlikely that the Texas prairie dawn would be affected by the proposed project.

Effect Determination: *No Effect.*

4.0 SUMMARY

Of the three species referenced in this BA, only the Texas prairie dawn and bald eagle are known to occur within the proposed action area. The locations of all known Texas prairie dawn populations in Addicks and Barker Reservoirs are included in Figure 5. The proposed construction sites are located outside of all documented Texas prairie dawn locations. The proposed federal action would have no effect on Texas prairie dawn. If Texas prairie dawn is observed inside the construction sites before, during, or following construction activities, appropriate avoidance, minimization, and conservation measures should be taken to ensure this species is not adversely affected.

The locations of all NDD recorded bald eagle occurrences in the vicinity of Addicks and Barker Reservoirs are included in Figure 4. The proposed construction sites are located outside of all documented bald eagle locations. The proposed federal action would have no effect on bald eagles. If bald eagles are observed on the construction sites before, during, or following construction activities, appropriate avoidance, minimization, and conservation measures should be taken to ensure this species is not adversely affected.

The project would have no effect on any other federally-listed threatened or endangered species indentified in this BA. If any of the listed species referenced in this BA are encountered during construction activities, the USACE would cease work and coordinate with the USFWS.

5.0 LITERATURE CITED

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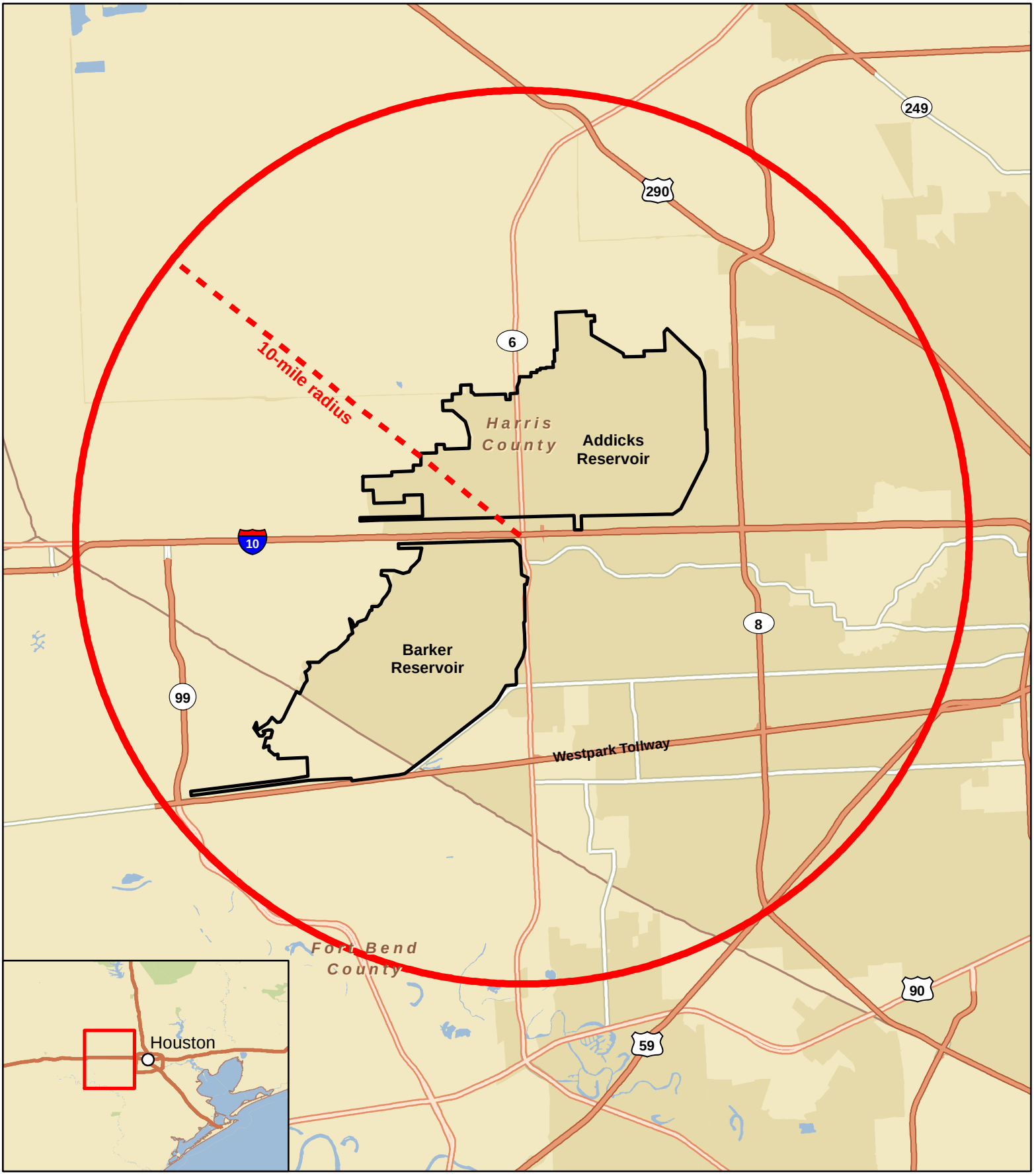
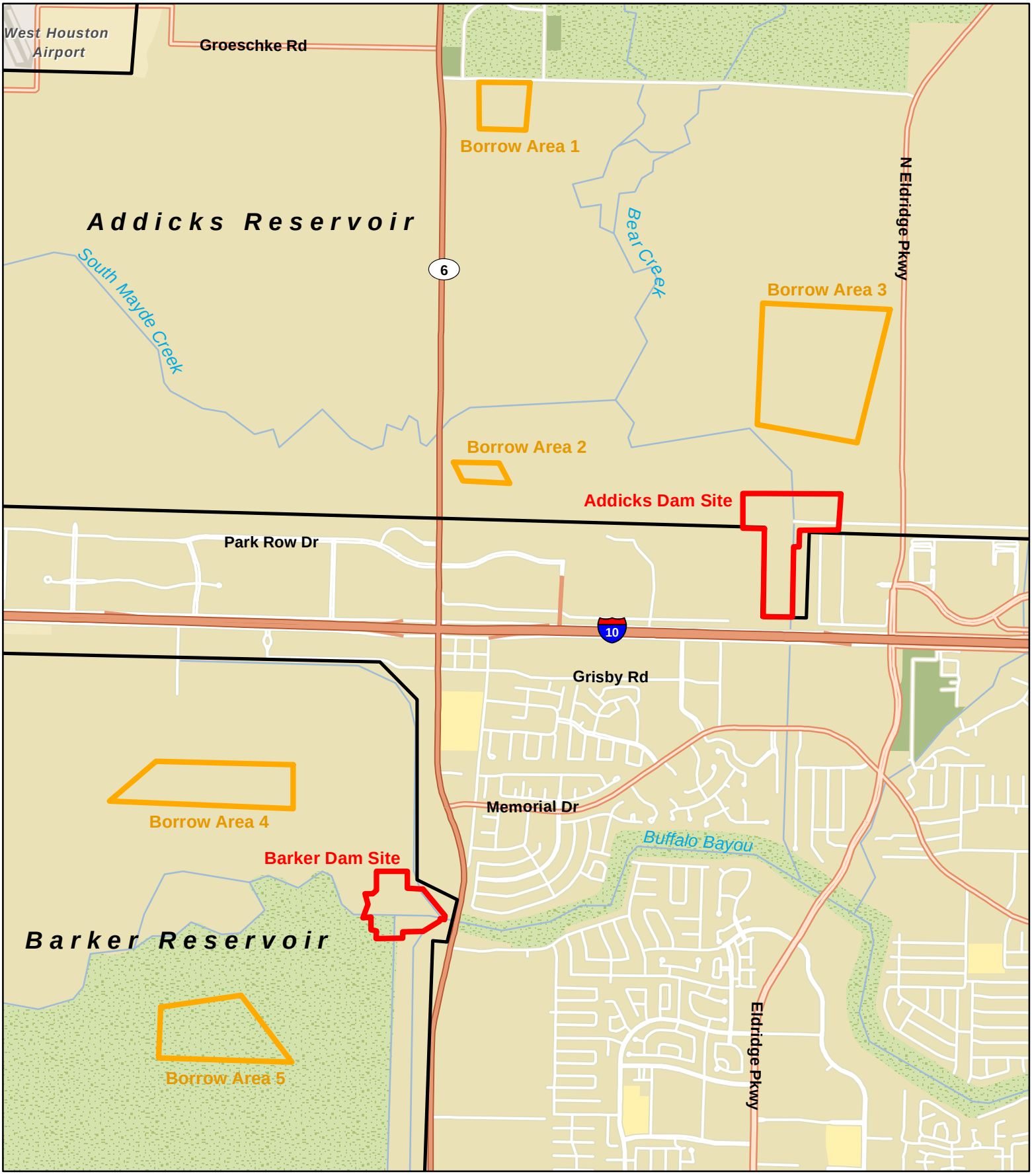
2012c. Bald Eagle. http://www.fws.gov/migratorybirds/NewReportsPublications/FactSheets/bald_eagle_fact_sheet%5B1%5D.pdf Accessed May 21, 2012.

FIGURES



Addicks and Barker Dam Safety Modification
FIGURE 1
PROJECT STUDY AREA VICINITY MAP

Harris and Fort Bend Counties, Texas



0 1,200 2,400
Feet

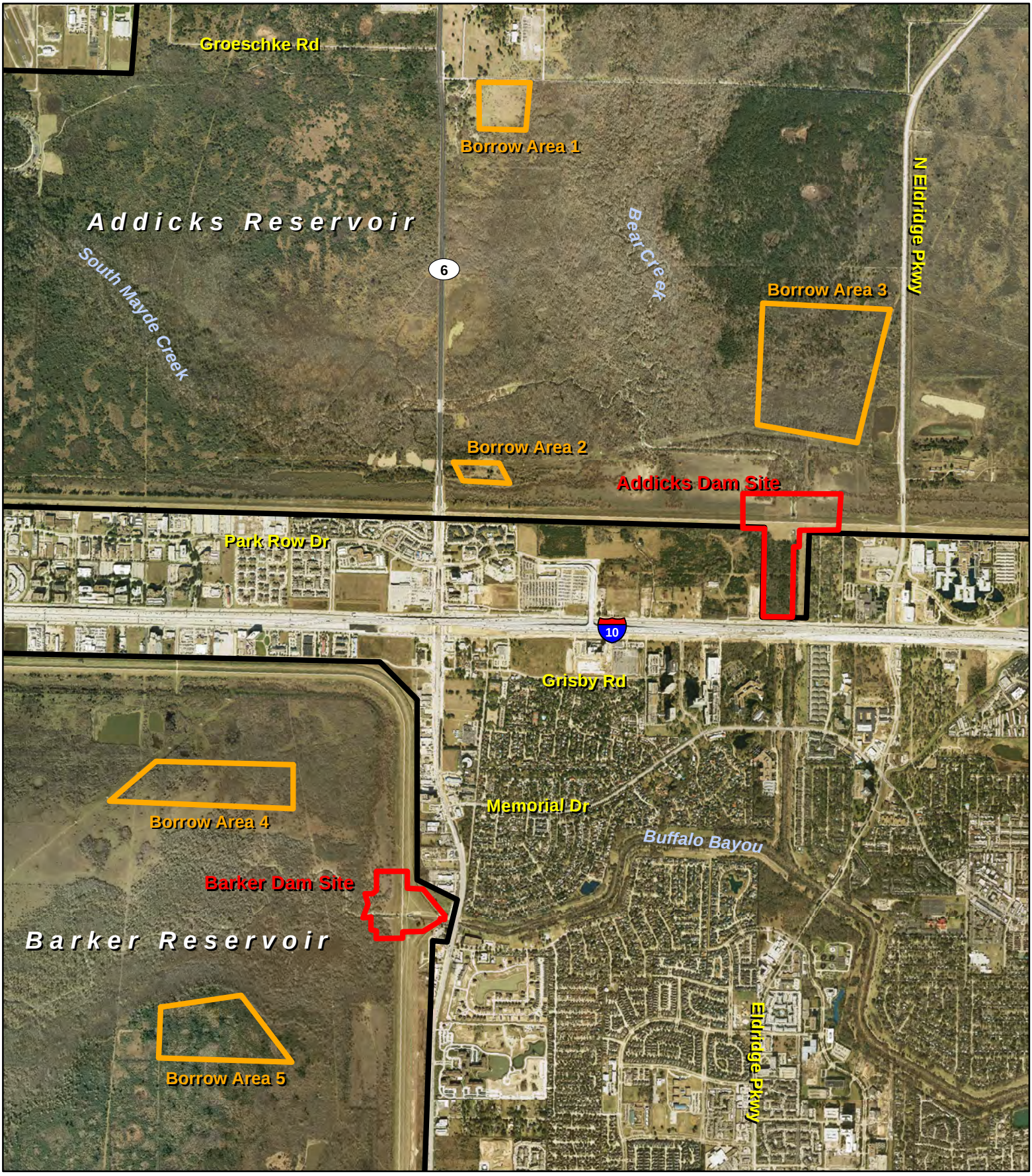
N

Addicks and Barker Dam Project Boundary
Potential Borrow Areas
Addicks and Barker Reservoir Boundary

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 2

ADDICKS AND BARKER RESERVOIRS
VICINITY MAP - PROPOSED CONSTRUCTION SITES
Harris County, Texas



0 1,200 2,400
Feet

N

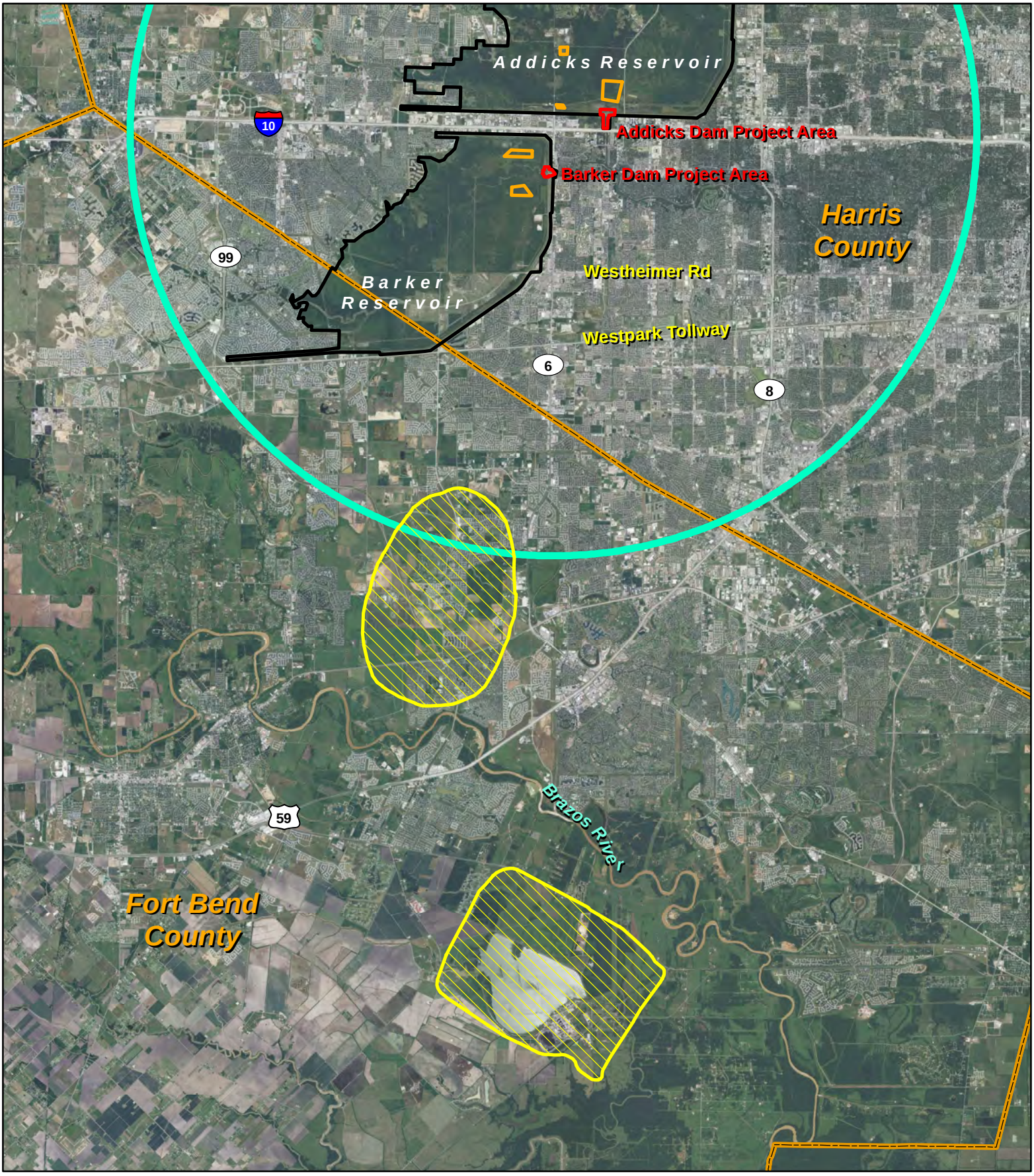
- Addicks and Barker Dam Project Boundary
- Potential Borrow Areas
- Addicks and Barker Reservoir Boundary

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 3

ADDICKS AND BARKER RESERVOIRS
2008 AERIAL PHOTOGRAPH WITH
PROPOSED CONSTRUCTION SITES

Harris County, Texas



Addicks and Barker Dam Project Boundary
Potential Borrow Areas
Addicks and Barker Reservoir Boundary
Bald Eagles Locations
Proposed Action Area

N

0 1.5 3 Miles

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 4
ADDICKS AND BARKER RESERVOIRS
2010 AERIAL PHOTOGRAPH WITH
PROPOSED CONSTRUCTION SITES AND
DOCUMENTED BALD EAGLE LOCATIONS

Harris and Fort Bend Counties, Texas

Addicks and Barker Dam Project Boundary
Potential Borrow Areas
Addicks and Barker Reservoir Boundary
County Line
Documented Texas Prairie Dawn Locations

N

0 3,500 7,000
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 5
ADDICKS AND BARKER RESERVOIRS
2008 AERIAL PHOTOGRAPH WITH PROPOSED CONSTRUCTION SITES AND DOCUMENTED TEXAS PRAIRIE DAWN LOCATIONS
Harris and Fort Bend Counties, Texas

EVALUATION OF SECTION 404(b)(1) GUIDELINES (SHORT FORM)

PROPOSED PROJECT: Addicks and Barker Dam Safety Modification Study.

	Yes	No*
1. Review of Compliance (230.10(a)-(d))		
A review of the proposed project indicates that:		
a. The placement represents the least environmentally damaging practicable alternative and, if in a special aquatic site, the activity associated with the placement must have direct access or proximity to, or be located in the aquatic ecosystem, to fulfill its basic purpose (if no, see section 2 and information gathered for EA alternative).	**X**	
b. The activity does not appear to:		
1) Violate applicable state water quality standards or effluent standards prohibited under Section 307 of the Clean Water Act;	**X**	
2) Jeopardize the existence of Federally-listed endangered or threatened species or their habitat; and	**X**	
3) Violate requirements of any Federally-designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies).	**X**	
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, an economic values (if no, see values, Section 2)	**X**	
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see Section 5)	**X**	

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
1) Substrate impacts		**X**	
2) Suspended particulates/turbidity impacts		**X**	
3) Water column impacts		**X**	
4) Alteration of current patterns and water circulation		**X**	
5) Alteration of normal water fluctuation/hydroperiod	**X**		
6) Alteration of salinity gradients	**X**		
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
1) Effect on threatened/endangered species and their habitat		**X**	
2) Effect on the aquatic food web		**X**	
3) Effect on other wildlife (mammals, birds, reptiles and amphibians)		**X**	

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
c. Special Aquatic Sites (Subpart E)			
1) Sanctuaries and refuges	**X**		
2) Wetlands		**X**	
3) Mud flats	**X**		
4) Vegetated shallows	**X**		
5) Coral reefs	**X**		
6) Riffle and pool complexes	**X**		
d. Human Use Characteristics (Subpart F)			
1) Effects on municipal and private water supplies	**X**		
2) Recreational and Commercial fisheries impacts	**X**		
3) Effects on water-related recreation	**X**		
4) Aesthetic impacts	**X**		
5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves	**X**		

	Yes
3. Evaluation of Dredged or Fill Material (Subpart G)	
a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material (check only those appropriate)	
1) Physical characteristics	
2) Hydrography in relation to known or anticipated sources of contaminants	
3) Results from previous testing of the material or similar material in the vicinity of the project	
4) Known, significant sources of persistent pesticides from land runoff or percolation	
5) Spill records for petroleum products or designated (Section 311 of Clean Water Act) hazardous substances	
6) Otherpublic records of significant introduction of contaminants from industries, municipalities or other sources	
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities	

List appropriate references:

1)

	Yes	No
b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredged or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and placement sites and not likely to degrade the placement sites, or the material meets the testing exclusion criteria.	**X**	

	Yes
4. Placement Site Delineation (230.11(f))	
a. The following factors as appropriate, have been considered in evaluating the placement site:	**N/A**
1) Depth of water at placement site	
2) Current velocity, direction, and variability at placement site	
3) Degree of turbulence	
4) Water column stratification	
5) Discharge vessel speed and direction	
6) Rate of discharge	
7) Fill material characteristics (constituents, amount, and type of material, settling velocities)	
8) Number of discharges per unit of time	
9) Other factors affecting rates and patterns of mixing (specify)	

List appropriate references:

	Yes	No
b. An evaluation of the appropriate factors in 4a above indicates that the placement site and/or size of mixing zone are acceptable.	**N/A**	

	Yes	No
5. Actions to Minimize Adverse Effects (Subpart H)		
All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77 to ensure minimal adverse effects of the proposed discharge.	**X**	

List actions taken:

1)

	Yes	No*
6. Factual Determination (230.11)		
A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:		

a. Physical substrate at the placement site (review Sections 2a. 3, 4, and 5 above)	**X**	
b. Water circulation, fluctuation and salinity (review Sections 2a. 3, 4, and 5)	**X**	
c. Suspended particulates/turbidity (review Sections 2a. 3, 4, and 5)	**X**	
d. Contaminant availability (review Sections 2a. 3, and 4)	**X**	
e. Aquatic ecosystem structure and function (review Sections 2b and c, 3, and 5)	**X**	
f. Placement site (review Sections 2, 4, and 5)	**X**	
g. Cumulative impacts on the aquatic ecosystem	**X**	
h. Secondary impacts on the aquatic ecosystem	**X**	

7. Evaluation Responsibility

a. This evaluation was prepared by: **Jerry L. Androy**
Position: **Environmental Lead/Archeologist**

8. Findings	**Yes**
a. The proposed placement site for discharge of or fill material complies with the Section 404(b)(1) Guidelines.	**X**
b. The proposed placement site for discharge of dredged or fill material complies with the Section 404(b)(1) Guidelines with the inclusion of the following conditions:	

List of conditions:

c. The proposed placement site for discharge of dredged or fill material does not comply with the Section 404(b)(1) Guidelines for the following reason(s):	
1) There is a less damaging practicable alternative	
2) The proposed discharge will result in significant degradation of the aquatic ecosystem	
3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem	

_____ Date	_____ CAROLYN MURPHY Chief, Environmental Section

NOTES:

* A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

Negative responses to three or more of the compliance criteria at the preliminary stage indicate

that the proposed projects may not be evaluated using this "short form" procedure. Care should be used in assessing pertinent portions of the technical information of items 2a-e before completing the final review of compliance.

Negative response to one of the compliance criteria at the final stage indicates that the proposed project does not comply with the Guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form" evaluation process is inappropriate.

Appendix D

Air Quality Analysis

	Equipment				Emission Rate	
		Hours	HP	Load Factor	NOX	VOC
Addicks Reservoir	**Agricultural Tractor**	107	350	59%	5.1855796	0.6284272
	Air Compressor	4540	230	43%	2.9597069	0.228783
	Bucket	175	350	43%	4.0891554	0.2871882
	Chipper	1474	125	43%	5.5854924	0.5494683
	Concrete/Industrial Saw	3,911	6	78%	0.9099999	62.807919
	Crane	2119	350	43%	4.2905919	0.3223134
	Crawler	21,180	160	59%	3.7592743	0.3060689
	Dumper/Tender	3,676	400	21%	3.3473836	0.1862279
	Excavator	14119	150	59%	3.5462134	0.2925814
	Generator	10,167	11	68%	2.7739994	8.085377
	Grader	1,651	165	59%	3.7275103	0.3038857
	Highway Truck	19099	230	59%	2.9597069	0.228783
	Off-Highway Truck	16,054	330	59%	3.3473836	0.1862279
	Off-Highway, Water Truck	1169	330	59%	3.3473836	0.1862279
	Other Construction Equipment	9227	175	59%	4.6888012	0.3662925
	Other General Industrial Equipment	1001	75	43%	3.7650431	2.4212818
	Pump	6,086	21	43%	4.6668262	0.535964
	Tractor/Loader/Backhoe	2318	200	21%	6.0061466	0.9490323
	Vibrator	10,005	5	48%	0.9099999	62.807919
Barker Reservoir	**Air Compressor**	3988	230	43%	2.9597069	0.228783
	Bucket	474	350	43%	4.0891554	0.2871882
	Chipper	1082	125	43%	5.5854924	0.5494683
	Concrete/Industrial Saw	3,243	6	78%	0.9099999	62.807919
	Crane	1731	350	43%	4.2905919	0.3223134
	Crawler	17,155	160	59%	3.7592743	0.3060689
	Dumper/Tender	4,555	400	21%	3.3473836	0.1862279
	Excavator	18457	150	59%	3.5462134	0.2925814
	Generator	7,890	11	68%	2.7739994	8.085377
	Grader	1,236	165	59%	3.7275103	0.3038857
	Highway Truck	17735	230	59%	2.9597069	0.228783
	Off-Highway Truck	11,063	330	59%	3.3473836	0.1862279
	Off-Highway, Water Truck	917	330	59%	3.3473836	0.1862279
	Other Construction Equipment	13415	175	59%	4.6888012	0.3662925
	Other General Industrial Equipment	737	75	43%	3.7650431	2.4212818
	Pump	52,133	21	43%	4.6668262	0.535964
	Tractor/Loader/Backhoe	1578	200	21%	6.0061466	0.9490323
	Vibrator	7,821	5	48%	0.9099999	62.807919

	Equipment	Estimated Equipment Hours by Calendar Year			
		2015	2016	2017	2018
Addicks Reservoir	Agricultural Tractor	35.3	35.3	35.3	
	Air Compressor	1498.2	1498.2	1498.2	
	Bucket	57.8	57.8	57.8	
	Chipper	486.4	486.4	486.4	
	Concrete/Industrial Saw	1290.6	1290.6	1290.6	
	Crane	699.3	699.3	699.3	
	Crawler	6989.4	6989.4	6989.4	
	Dumper/Tender	1213.1	1213.1	1213.1	
	Excavator	4659.3	4659.3	4659.3	
	Generator	3355.1	3355.1	3355.1	
	Grader	544.8	544.8	544.8	
	Highway Truck	6302.7	6302.7	6302.7	
	Off-Highway Truck	5297.8	5297.8	5297.8	
	Off-Highway, Water Truck	385.8	385.8	385.8	
	Other Construction Equipment	3044.9	3044.9	3044.9	
	Other General Industrial Equipment	330.3	330.3	330.3	
	Pump	2008.4	2008.4	2008.4	
	Tractor/Loader/Backhoe	764.9	764.9	764.9	
	Vibrator	3301.7	3301.7	3301.7	
Barker Reservoir	Air Compressor		1316.0	1316.0	1316.0
	Bucket		156.4	156.4	156.4
	Chipper		357.1	357.1	357.1
	Concrete/Industrial Saw		1070.2	1070.2	1070.2
	Crane		571.2	571.2	571.2
	Crawler		5661.2	5661.2	5661.2
	Dumper/Tender		1503.2	1503.2	1503.2
	Excavator		6090.8	6090.8	6090.8
	Generator		2603.7	2603.7	2603.7
	Grader		407.9	407.9	407.9
	Highway Truck		5852.6	5852.6	5852.6
	Off-Highway Truck		3650.8	3650.8	3650.8
	Off-Highway, Water Truck		302.6	302.6	302.6
	Other Construction Equipment		4427.0	4427.0	4427.0
	Other General Industrial Equipment		243.2	243.2	243.2
	Pump		17203.9	17203.9	17203.9
	Tractor/Loader/Backhoe		520.7	520.7	520.7
	Vibrator		2580.9	2580.9	2580.9

	Equipment	NOX Emissions by Calendar Year				VOC Emissions by Calendar Year			
		2015	2016	2017	2018	2015	2016	2017	2018
Addicks Reservoir	Agricultural Tractor	0.0417	0.0417	0.0417		0.0051	0.0051	0.0051	
	Air Compressor	0.4834	0.4834	0.4834		0.0374	0.0374	0.0374	
	Bucket	0.0392	0.0392	0.0392		0.0028	0.0028	0.0028	
	Chipper	0.1610	0.1610	0.1610		0.0158	0.0158	0.0158	
	Concrete/Industrial Saw	0.0061	0.0061	0.0061		0.4182	0.4182	0.4182	
	Crane	0.4977	0.4977	0.4977		0.0374	0.0374	0.0374	
	Crawler	2.7342	2.7342	2.7342		0.2226	0.2226	0.2226	
	Dumper/Tender	0.3760	0.3760	0.3760		0.0209	0.0209	0.0209	
	Excavator	1.6119	1.6119	1.6119		0.1330	0.1330	0.1330	
	Generator	0.0767	0.0767	0.0767		0.2237	0.2237	0.2237	
	Grader	0.2179	0.2179	0.2179		0.0178	0.0178	0.0178	
	Highway Truck	2.7904	2.7904	2.7904		0.2157	0.2157	0.2157	
	Off-Highway Truck	3.8061	3.8061	3.8061		0.2117	0.2117	0.2117	
	Off-Highway, Water Truck	0.2771	0.2771	0.2771		0.0154	0.0154	0.0154	
	Other Construction Equipment	1.6249	1.6249	1.6249		0.1269	0.1269	0.1269	
	Other General Industrial Equipment	0.0442	0.0442	0.0442		0.0284	0.0284	0.0284	
	Pump	0.0933	0.0933	0.0933		0.0107	0.0107	0.0107	
	Tractor/Loader/Backhoe	0.2127	0.2127	0.2127		0.0336	0.0336	0.0336	
	Vibrator	0.0079	0.0079	0.0079		0.5486	0.5486	0.5486	
Barker Reservoir	Air Compressor		0.4246	0.4246	0.4246		0.0328	0.0328	0.0328
	Bucket		0.1061	0.1061	0.1061		0.0075	0.0075	0.0075
	Chipper		0.1182	0.1182	0.1182		0.0116	0.0116	0.0116
	Concrete/Industrial Saw		0.0050	0.0050	0.0050		0.3468	0.3468	0.3468
	Crane		0.4066	0.4066	0.4066		0.0305	0.0305	0.0305
	Crawler		2.2146	2.2146	2.2146		0.1803	0.1803	0.1803
	Dumper/Tender		0.4659	0.4659	0.4659		0.0259	0.0259	0.0259
	Excavator		2.1071	2.1071	2.1071		0.1738	0.1738	0.1738
	Generator		0.0596	0.0596	0.0596		0.1736	0.1736	0.1736
	Grader		0.1632	0.1632	0.1632		0.0133	0.0133	0.0133
	Highway Truck		2.5911	2.5911	2.5911		0.2003	0.2003	0.2003
	Off-Highway Truck		2.6228	2.6228	2.6228		0.1459	0.1459	0.1459
	Off-Highway, Water Truck		0.2174	0.2174	0.2174		0.0121	0.0121	0.0121
	Other Construction Equipment		2.3625	2.3625	2.3625		0.1846	0.1846	0.1846
	Other General Industrial Equipment		0.0326	0.0326	0.0326		0.0209	0.0209	0.0209
	Pump		0.7992	0.7992	0.7992		0.0918	0.0918	0.0918
	Tractor/Loader/Backhoe		0.1448	0.1448	0.1448		0.0229	0.0229	0.0229
	Vibrator		0.0062	0.0062	0.0062		0.4289	0.4289	0.4289
	Estimated Tons per Calendar Year	15.10	29.95	29.95	14.85	2.33	4.43	4.43	2.10

Draft Habitat Evaluation Procedure
Addicks and Barker Dam Safety Modification
Harris County, Texas

United States Army Corps of Engineers
Galveston District
PO Box 1229
Galveston, Texas 77550

September 2012

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Appendices

1.0 Background Information

Addicks and Barker Reservoirs are located in southeast Texas in the San Jacinto River basin approximately 17 miles west of downtown Houston. Both reservoirs were constructed in the mid-1940s as an integral part of the Buffalo Bayou and Tributaries Project (BBTP). The BBTP, sponsored by the United States Army Corps of Engineers (USACE), reduces potential flood damages downstream along Buffalo Bayou through a combination of reservoirs, channel improvements, and detention basins. In 2005, the USACE initiated the Dam Safety Action Classification (DSAC) System to provide consistent and systematic guidelines for addressing dam safety issues and deficiencies, and to allow prioritization of work at the national level. The DSAC provides a standard strategy for the continued safety and security of USACE projects and the public. This risk management approach includes two components: probability of dam failure and consequences if failure occurs.

Both Addicks and Barker Reservoirs are currently categorized as DSAC I. Dams in this classification have been determined to be critically near failure or at extremely high risk under normal operations. The purpose of the Addicks and Barker Dam Safety Modification (DSM) project is to improve aging and failing outlet structures at both Addicks and Barker Dams through the implementation of a long-term solution that will protect property and life downstream of the reservoirs. If existing deficiencies with the outlet works structures at both dams are not corrected, failure at one or both of the dams could lead to catastrophic consequences to life and property within the watershed.

The proposed project will be constructed in Addicks and Barker Reservoirs. Proposed work associated with the Barker Dam outlet structure will take place on a 28.89-acre tract of land at the current location of the existing Barker Dam outlet structure. Earthen materials for the construction at Barker Dam will be borrowed from one of two proposed borrow areas located in the Barker Reservoir. Proposed work associated with construction of the Addicks Dam outlet structure would take place on a 50.42-acre tract of land at the current location of the existing Addicks Dam outlet structure. Earthen materials for the construction at Addicks Dam will be borrowed from one of three proposed borrow areas located in the Addicks Reservoir.

The project would serve to improve existing flood control infrastructure by replacing the outlet works infrastructure at both Addicks and Barker Dams using the most cost effective and environmentally sensitive approaches practicable. The project will ensure that Addicks and Barker Reservoirs continue to provide flood protection to the City of Houston, Texas, and surrounding metropolitan areas downstream.

The USACE is committed to developing an environmentally compatible project that will minimize impacts to ecologically sensitive areas. Based on assessments of the potential environmental impacts, both individual and cumulative, the USACE is preparing an Environmental Assessment (EA) in compliance with the National Environmental Policy Act (NEPA). The USACE will render a final decision on the Clean Water Act 404 permit application associated with the anticipated discharge of dredged or fill materials into waters of the United States, including wetlands. The Draft EA is anticipated to be complete in 2012. To ensure adequate compensation for impacts to wetlands and waters of the U.S., the USACE is conducting a wildlife habitat impact assessment on the proposed project site as well as a comparative assessment of the wildlife habitat proposed for preservation on a proposed compensatory mitigation site. The USACE determined that the Habitat Evaluation Procedure (HEP) developed by the USFWS is the most applicable tool available to quantify wildlife habitat effects of the proposed project.

1.1 Habitat Evaluation Procedure Overview

The HEP is a habitat-based evaluation methodology developed by USFWS in 1974 for use as an analytical tool in impact assessments and project planning. HEP is a species-habitat analysis of the ecological value of a study

area. The approach quantifies the value of habitat available to a selected set of wildlife species in a specified geographic area of interest. The method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time. Because HEP provides a quantitative method for such comparisons, it may be used in planning applications such as the assessment of current and future wildlife habitat or compensation analyses.

HEP appraises a study area by quantifying its habitat value, calculated as the product of habitat quantity and habitat quality. This value is expressed in Habitat Units (HU). Habitat quantity is simply the total area of habitat available within the study area, usually expressed in number of acres. Available habitat in the study area may be subdivided into cover types, or distinct areas with similar ecological characteristics that are adequately homogeneous. If the study area is subdivided into cover types, habitat quantities used in evaluation may be subsets of the study area. Habitat quality is expressed in terms of a Habitat Suitability Index (HSI), which is determined by comparing the ecological characteristics of the study area to the habitat characteristics that are optimum for the evaluation species. Evaluation species are representative wildlife species with known habitat requirements selected to provide the basis for assessment of habitat suitability.

HSI values are based on two components, including the habitat characteristics that provide ideal conditions for an evaluation species and the habitat characteristics existing in the study area. These characteristics are described by a set of measurable habitat variables, such as the height and percent cover of various vegetation types, the distance to water or food, the availability of perching or nesting sites, or the frequency of flooding. The set of habitat variables needed to determine HSI values are obtained from documented habitat suitability models for each evaluation species. These models describe the life requisites for each species, the relationship between the values of habitat variables, the suitability of the area to meet its life requisites, and the method to integrate these suitability relationships into an HSI value. HSI values range from 0.0 to 1.0, with 0.0 representing unsuitable conditions and 1.0 being optimal conditions.

Habitat values may be calculated for each evaluation species within its available habitat or for each cover type within the study area. Calculations based on existing ecological conditions can be used to describe baseline conditions and serve as a reference point for comparison to predicted future habitat values with or without proposed actions or mitigation measures. HEP provides a consistent means of assessing project impacts by demonstrating, in HUs gained or lost, the beneficial or adverse impacts anticipated as a result of various courses of action. HEP aids mitigation analysis by identifying which factors negatively impact habitat values in various scenarios, thus suggesting means for improving habitat or selecting mitigation lands.

The generalized process for conducting a HEP study involves the following components (USFWS 1980):

- Determine the applicability of HEP and define the study area
- Delineate habitat or vegetation cover types
- Select the relevant evaluation species
- Determine each species' life requisites
- Measure habitat variables for suitability
- Determine baseline and future habitat units
- Develop compensation/mitigation plans for the proposed project

1.2 Project Description

Wildlife habitat on the borrow areas and the mitigation sites were assessed using HEP. Descriptions of the borrow areas and the mitigation sites are provided below.

1.2.1 Borrow Areas

The Preferred Alternative involves replacement of the existing outlet works structures at both Addicks and Barker Dams with new outlet works structures, as well as the construction of an upstream impervious blanket and slurry cutoff extension at Barker Dam.

Proposed work associated with the Preferred Alternative for the Addicks and Barker Dam structures would involve the construction of temporary earthen cofferdams around both the proposed and existing outlet works structures during proposed construction activities to ensure there is one operational structure at each dam at all times. Five potential borrow areas are proposed to obtain the soils required for construction of the earthen cofferdams. Two borrow areas, one from each reservoir, will be excavated to provide earthen material for construction. In Addicks Reservoir (Borrow Areas 1, 2, and 3), soil would be excavated from a 35-acre section of the selected borrow area. The selected Barker Reservoir borrow area (Borrow Area 4 or 5) would have soil excavated from an approximately 30-acre area.

Removal of soils at selected borrow area sites would involve complete removal of vegetation from the excavated area. Earthen material would be removed, converting the excavated area from current conditions to an earthen pit with no habitat value. Figures 1 and 2 depict the locations of the proposed borrow areas.

1.2.2 Mitigation Alternatives

Compensatory mitigation is required by the USACE to replace the ecological functions and services provided by wetlands that are proposed to be impacted by the project. Two compensatory mitigation action alternatives are proposed for examination in this HEP analysis. Both alternatives include enhancement and preservation of wetlands in conjunction with invasive vegetation species management. Invasive vegetation is known to exist within wetlands in both Addicks and Barker Reservoirs. The most common invasive plant species in the reservoirs include Chinese tallow (*Triadica sebifera*), woodrush flatsedge (*Cyperus entrerianus*), salt cedar (*Tamarix sp.*), narrow leaf cattail (*Typha angustifolia*), alligator weed (*Alternanthera philoxeroides*), common reed (*Phragmites australis*), Macartney rose (*Rosa bracteata*), and honey mesquite (*Prosopis glandulosa*).

Invasive species have the ability to outcompete native species, altering ecosystems and leading to decreased native biodiversity. Once invasive species become established, they require control through eradication, containment, or other management strategies to minimize the ecological impacts that they may cause. Various control strategies are available and have been proven to be effective including physical, chemical, and biological techniques. Management strategies are species-specific and require knowledge of the biology and ecology of each plant. Integrated Pest Management, or combining two or more control techniques, is an ideal management strategy that would likely be used to for dealing with multiple invasive species.

In addition to invasive species removal, enhancement of mitigation areas will include the planting and maintenance of native wetland shrub and herbaceous vegetation. The goal of wetland enhancement is to improve the habitat value for species that utilize scrub-shrub wetlands. Potential native wetland shrub species include hawthorn (*Crataegus* spp.), dogwood (*Cornus* spp.) buttonbush (*Cephalanthus occidentalis*), rattlebush (*Sesbania drummondii*), and wax myrtle (*Morella cerifera*). Planting options for native wetland herbaceous species include switchgrass (*Panicum virgatum*), annual marsh elder (*Iva annua*), maidencane (*Panicum hemitomon*) and Indian woodoats (*Chasmanthium latifolium*).

Determination of the appropriate size of wetland to be used for compensatory mitigation is established by two factors. Firstly, the size of the wetland used for mitigation must be at least as great as the area of the impacted wetlands. Secondly, the increase in the habitat value of wetlands, as determined by the HEP analysis, resulting from mitigation efforts, must be at least as great as the habitat value of the wetland area lost to mitigation. If the

net increase in the habitat value of a mitigation area is less than the habitat value of equivalent acreages lost to impacts, then the size of the mitigation area must be increased until equivalent habitat value is obtained. This HEP analysis will determine the habitat value for all borrow areas and mitigation alternatives for the proposed project.

Mitigation for all wetland impacts to Addicks and Barker borrow areas will occur on either Borrow Area 4 or Borrow Area 5 in Barker Reservoir. Determination of the borrow area chosen for mitigation will be dependent on which Barker Reservoir borrow area is chosen for excavation. Thirty acres of the selected Barker Reservoir borrow area will be excavated for earthen material, and the remaining wetland areas on the selected borrow area will be utilized for compensatory mitigation. If the remaining area within the selected borrow area does not have a sufficient area of wetlands to meet compensatory mitigation requirements, then additional wetland habitat will be utilized adjacent to the selected borrow area. Table 1 details the six options available for borrow area and mitigation alternative selection.

For the purpose of analysis, Borrow Areas 4 and 5 have each been divided into two sections: a proposed project area and a mitigation alternative area. Both borrow areas are relatively homogeneous; therefore, locations of the proposed project area and mitigation area may be altered within each borrow area. Assumptions associated with future habitat conditions on each borrow area and mitigation alternative are not expected to differ in the event of project realignment, nor will proposed project and mitigation acreages change. Therefore, project area and mitigation alternative habitat values will not differ in the event of project area realignment in these borrow areas.

Table 1. Borrow Area and Mitigation Alternative Selection Options

	Excavated Area					Mitigation Alternative	
	Borrow Area 1	Borrow Area 2	Borrow Area 3	Borrow Area 4	Borrow Area 5	Mitigation Alternative 1	Mitigation Alternative 2
Option 1	X			X		X	
Option 2		X		X		X	
Option 3			X	X		X	
Option 4	X				X		X
Option 5		X			X		X
Option 6			X		X		X

2.0 Baseline Assessment

The baseline assessment involved the assessment of multiple factors, including cover type determination, selection of evaluation species, determination of baseline suitability indices, and the determination of baseline habitat units. The methodologies for these determinations are discussed in more detail below.

2.1 Cover Type Determination

The project area is located in the Gulf Coast Prairies and Marshes natural region of Texas, which includes approximately 20,312 square miles (Gould et al. 1960). Gulf Coast prairies are nearly level with slow surface drainage and elevations ranging from sea level to approximately 250 feet above mean sea level (MSL). In addition to wildlife habitat, the prairies are used for crops, livestock grazing, and urban and industrial centers. It is estimated that as much as 99% of the coastal prairies in Texas have been converted to agricultural land (Gould 1960, McMahan et al. 1984).

The existing vegetative cover on the borrow areas consists of herbaceous uplands, forested uplands, emergent wetlands, scrub-shrub wetlands, and perennial tributaries. Table 2 details the vegetative communities by borrow area. Based on field surveys, a review of historical aerial photographs, and site reconnaissance, the project area is historically prairie, with wetlands dominated by emergent vegetation. Invasion of non-native Chinese tallow in the 1980's altered wetland species assemblages, converting the areas to low-quality scrub-shrub wetlands. Removal of Chinese tallow from these areas and the planting of native shrub and herbaceous wetland species would increase habitat value and return wetlands to a high-quality state.

Table 2. Borrow Area Vegetative Communities

Project Area	Herbaceous Uplands (acres)	Forested Uplands (acres)	Emergent Wetlands (acres)	Scrub-Shrub Wetlands (acres)
Borrow Area 1	17.46	1.28	--	--
Borrow Area 2	6.67	--	0.60	--
Borrow Area 3	--	45.36	--	75.28
Borrow Area 4	--	--	--	56.11
Borrow Area 5	--	49.13	--	3.10
Total Acreage	24.13	95.77	0.60	135.09

2.2 Evaluation Species Selection

Four evaluation species were selected by the HEP team based on their ecological significance in the emergent or scrub-shrub wetland cover types and the availability of applicable HSI models. The evaluation species includes three bird species (Marsh Wren (*Cistothorus palustris)*, Yellow Warbler (*Setophaga petechia*), and Veery (*Catharus fuscescens*)) and one reptile species (slider turtle (*Trachemys scripta*)). These species were selected for the HEP analysis due to the presence of their primary feeding and nesting guilds in the emergent or scrub-shrub wetland cover types found on the borrow areas and the mitigation alternatives. These species were utilized to assess the ecological value of each borrow area and the mitigation alternatives for this HEP analysis.

2.2.1 Marsh Wren

The Marsh Wren is a locally abundant breeding bird in fresh and saltwater marshes across the United States. They often winter on the Gulf Coast and can be year-round residents in sub-tropical climates where marshes do not freeze over. Marsh Wrens feed on insects and spiders caught in the marsh vegetation and floor. They use the marsh environment as protection for their nests, commonly located in marsh vegetation, and as support for their arthropod food source (Gutzwiller and Anderson 1987).

2.2.2 Slider Turtle

The slider turtle, also commonly referred to as the red-eared slider, is a predominantly aquatic turtle with a habitat range from Virginia to New Mexico and throughout Central and South America. They are found in all types of water bodies but prefer still water with depths between 1 and 2 meters. Other habitat preferences include water with a soft benthos, abundant vegetation, and suitable basking sites. Because slider turtles are habitat and diet generalists, their range is quite large. As juveniles, their diet is primarily carnivorous (and sometimes detritivorous), but as they mature they become predominantly herbivorous. The highest densities of slider turtles occur where algal blooms and aquatic macrophytes are abundant enough to provide cover from predators while supporting high densities of aquatic invertebrates and small vertebrates.

Mating occurs in the water, but suitable terrestrial environments (sandy loose soil located above the water table) are required for egg-laying. Nesting occurs between April and July with egg laying females often laying two clutches during this time. There is considerable migration among this species, both to search for more suitable habitat and for mate selection. Older males are more likely to migrate than other slider turtles (Morreale and Gibbons 1986).

2.2.3 Yellow Warbler

The Yellow Warbler is a small songbird that is common over a wide range of North America. The breeding and foraging habitat of yellow warblers is typically riparian or otherwise moist land with a dense, woody growth of small trees. Yellow Warblers build their nests in the vertical fork of a bush or small tree such as willow (*Salix* spp.), hawthorn (*Crataegus* spp.), raspberry (*Rubus* spp.), dogwood (*Cornus* spp.), or honeysuckle (*Lonicera* spp.). The nest is typically within about 10 feet of the ground but occasionally up to 40 feet. The Yellow Warbler spends the breeding season in thickets and disturbed habitats, particularly along streams and wetlands. Yellow Warblers primarily feed on insects and forage along the slender branches of shrubs and small trees (Schroeder 1982).

2.2.4 Veery

The Veery is a small thrush species. This bird inhabits damp, deciduous forest and riparian habitats; generally younger stands and second-growth areas with an open canopy and dense understory. Veeries forage primarily on the forest floor, by flipping over dead leaves with their bills, but have also known to feed by flycatching and gleaning insects from foliage. This species is an open cup nester, generally building nests on the ground or low shrubs. Therefore, areas that are inundated during the breeding season make poor Veery breeding habitat (Sousa 1982).

2.3 Habitat Variable Measurements and Cover Type Descriptions

Field sampling was conducted by the HEP team members in May of 2012. Proposed mitigation will only compensate for impacts to wetlands and rare or unique habitats, including native prairie or old growth forest. No rare or unique habitat was observed on the borrow areas. Therefore, the HEP analysis was performed only for the emergent and scrub-shrub wetland cover types. A total of seven sample sites were assessed during the field

surveys. Five sample sites were assessed in the Addicks and Barker Reservoirs borrow areas. Two sample sites were assessed in mitigation site alternatives located on Borrow Areas 4 and 5. Photographs taken to document typical habitats encountered during the field assessments are presented in Appendix A. Field datasheets documenting results of field measurements for species habitat variables are provided in Appendix B.

The location of sampling sites in the borrow areas and the mitigation alternatives are depicted on aerial photographs in Figures 2-7 in the Exhibits. Because only upland habitats were observed on Borrow Area 1, no HEP observation points are located on this site. Table 3 reports the total emergent and scrub-shrub wetland acreages in the borrow areas and the mitigation alternatives. The following descriptions of historical and present conditions of each borrow area are based on field observations and a review of historical aerial photographs.

Table 3. Total Wetland Acreages in Borrow Areas and Mitigation Sites

Project Area	Emergent Wetland (Acres)	Scrub-Shrub Wetland (Acres)
Borrow Area 1	--	--
Borrow Area 2	0.60	--
Borrow Area 3	--	75.28
Borrow Area 4 (proposed project area)	--	30.00
Borrow Area 5 (proposed project area)	--	0.13
Mitigation Alternative 1	--	26.11
Mitigation Alternative 2	--	2.97
Total	0.60	535.95

2.3.1 Historical Conditions of Borrow Areas and Existing Cover Type Descriptions

The lands within Addicks and Barker Reservoirs have a long history of human disturbance. German settlers began arriving in the area in the mid-1800's. Prior to the establishment of German settlers, much of the lands within the reservoirs were comprised of native prairies, prairie potholes, and riparian habitat abutting major surface water features. Following settlement by the Germans, and prior to construction of the reservoirs in the mid-1940's, land use was primarily ranching and rice farming in Barker Reservoir and dairying and row cropping in Addicks Reservoir. The introduction of agricultural practices such as leveling and levee construction for rice farming and disking for row cropping leveled many of the microtopographic features historically present in both reservoirs. Agricultural activities resulted in the alteration of the native prairie and woodland habitats. Woody vegetation became established with the decline of agricultural and ranching practices and with the continued suppression of a natural fire regime. Returning vegetation often includes the exotic invasive species Chinese tallow (*Triadica sebifera*). Chinese tallow trees have created dense stands of vegetation, crowding out and outcompeting native prairie vegetation over large portions of both reservoirs. Subsequent to construction of the levees and outlet structures in the mid-1940's, the hydrological conditions of surface and ground waters within the reservoir have been altered as a result of impounded water during and following storm events.

For the proposed project, Borrow Areas 1, 2, and 3 are located inside of Addicks Reservoir. Borrow Areas 4 and 5 are located inside Barker Reservoir. The historical conditions and existing cover type descriptions along with a list of vegetation of each borrow area and mitigation alternative are discussed in further detail below.

Individual vegetative species identified during field investigations have been assigned an indicator status by the 2012 National Wetland Plant List. The indicator status illustrates a species' propensity toward upland (UPL) or wetland (OBL) environments. Species not specifically recorded on the 2012 Plants List were assigned an

indicator status of UPL unless otherwise noted. Indicator status of all species identified during field surveys are included below.

2.3.2 Borrow Area 1

Borrow Area 1 is an 18.74-acre tract located southeast of the intersection of State Highway (SH) 6 and Patterson Road in Addicks Reservoir. Based upon a review of historical aerial photographs using Google Earth imagery, the habitat on Borrow Area 1 appears to have been upland herbaceous habitat as far back as 1944. The 1944 aerial photograph depicts several structures indicative of agricultural practices to the immediate west of Borrow Area 1 and the lands within Borrow Area 1 were likely utilized for agricultural practices in this era. Review of aerial photographs from the 1970's through current day combined with a field assessment of the site, revealed that a majority of the site is currently utilized for grazing activities of domestic livestock. A stock pond was excavated between 2004 and 2005. Forested habitat started encroaching on the southeastern portion of the site in the 1980's. Currently, the southeastern portion of the site consists of an upland forest dominated by Chinese tallow.

Field observations of Borrow Area 1 identified two cover types: herbaceous uplands and forested uplands. Herbaceous uplands comprise 17.46 acres of the site. Typical herbaceous vegetative species observed within the herbaceous upland cover type included common carpetgrass (*Axonopus fissifolius,* FACW), Bermudagrass (*Cynodon dactylon,* FACU), bushy bluestem (*Andropogon glomeratus,* FACW), wild oat (*Avena fatua,* UPL), Cherokee sedge (*Carex cherokeensis,* FACW), woodrush flatsedge (*Cyperus entrerianus,* FACW), annual marsh elder (*Iva annua,* FAC), common sunflower (*Helianthus annuus,* FAC), hogwort (*Croton capitatus,* UPL), foxtail millet (*Setaria italic,* FACU), and Jesuit's bark (*Iva frutescens,* FACW). Several species of trees were observed scattered throughout the herbaceous uplands. Table 4 describes species of trees observed and their relative abundance within this cover type.

Forested uplands comprise 1.28 acres of the site. Typical species observed within the forested upland cover type included Chinese tallow (FAC), green ash (*Fraxinus pennsylvanica,* FACW), sawtooth blackberry (*Rubus argutus,* FAC), saw greenbriar (*Smilax bona-nox,* FAC), wild oat, and Cherokee sedge. Table 4 describes the relative abundance or tree species observed within this cover type.

If Borrow Area 1 is chosen for excavation, the entire borrow area will be excavated for earthen material. No wetland habitat would be impacted.

2.3.3 Borrow Area 2

Borrow Area 2 is a 7.27-acre tract located east of SH 6 and north of the earthen levee in Addicks Reservoir. Based upon a review of historical aerial photographs using Google Earth imagery, the habitat on Borrow Area 2 appears to have been upland herbaceous habitat as far back as 1944. The 1944 aerial photograph depicts several structures indicative of agricultural practices to the west and south of Borrow Area 2, and the lands within Borrow Area 1 were likely utilized for agricultural practices in this era. Review of aerial photographs from 1978 depicts several areas of ground disturbance within this tract. Portions of this tract may have been utilized as a staging area and/or borrow area for the construction of the Addicks Reservoir levee. Historical aerial photographs from the 1990's through today depict the site as comprised of primarily herbaceous vegetation with sporadic trees throughout. A power line easement traverses the northern portion of the site.

Field observations of Borrow Area 2 identified two cover types: herbaceous uplands and emergent wetlands. Herbaceous uplands comprise 6.67 acres of the site. Typical herbaceous vegetative species observed within the herbaceous upland cover type included Vasey's grass (*Paspalum urvillei,* FAC), bahiagrass (*Paspalum notatum,* FACU), Canada goldenrod (*Solidago altissima,* FACU), dogfennel (*Eupatorium capillifolium,* FACU), Mediterranean lovegrass (*Eragrostis barrelieri,* UPL), shortbristle horned beaksedge (*Rhynchospora corniculata,* OBL), cumin ragweed (*Ambrosia psilostachya,* FAC), green flatsedge (*Cyperus virens,* FACW), foxtail millet,

peppervine (*Ampelopsis arborea,* FAC), southern dewberry (*Rubus trivialis,* FACU), common carpetgrass, slender woodoats (*Chasmanthium laxum,* FACW), Bermudagrass, woodrush flatsedge, annual marsh elder, saw greenbriar, powderpuff (*Mimosa strigillosa,* FAC), common sunflower, poison ivy (*Toxicodendron radicans,* FAC), and Jesuit's bark. Several species of trees were observed scattered throughout the herbaceous uplands. Table 4 describes species of trees observed and their relative abundance within this cover type.

Typical species observed within the 0.60 acres of emergent wetland cover type included woodrush flatsedge, swamp smartweed (*Polygonum hydropiperoides,* OBL), mountain spikerush (*Eleocharis Montana,* OBL), and spring spiderlilly (*Hymenocallis liriosme,* OBL). No tree species were observed within this cover type.

If Borrow Area 2 is chosen for excavation, the entire site will be excavated for earthen material, impacting 0.6 acres of herbaceous wetland habitat.

2.3.4 Borrow Area 3

Borrow Area 3 is a 120.64-acre tract located west of North Eldridge Parkway and north of the earthen levee in Addicks Reservoir. Based upon a review of historical aerial photographs using Google Earth imagery, Borrow Area 3 appears to have been utilized for agricultural operations in 1944. The 1944 aerial photograph depicts several structures indicative of agricultural practices located within Borrow Area 3, as well as several plowed fields and stock ponds. Several isolated aerial signatures on the 1944 aerial photograph indicative of prairie potholes are located primarily in the northeastern section of Borrow Area 3. All structures and evidence of agricultural activities were removed from the site prior to 1978, and the tract appears to be dominated by prairie vegetation with isolated stands of trees throughout. In the 1989 historical aerial photograph, approximately 65% of the site is depicted as being covered by scrub and trees, likely the result of Chinese tallow invasion. Coverage of scrub and trees increased through the 2000's and currently covers approximately 95% of the site.

Field observations of Borrow Area 3 identified two cover types: forested uplands and scrub-shrub wetlands. Forested uplands comprise 45.36 acres of the site. Typical species observed within the forested upland cover type included loblolly pine (*Pinus taeda,* FAC), Ashe's juniper (*Juniperus ashei,* UPL), Chinese tallow, water oak (*Quercus nigra,* FAC), green hawthorn (*Crataegus viridis,* FACW), American elm (*Ulmus Americana,* FAC), willow oak (*Quercus phellos,* FACW), foxtail millet, poison ivy, yaupon (*Ilex vomitoria,* FAC), common persimmon (*Diospyros virginiana,* FAC), Bermudagrass, Johnsongrass (*Sorghum halepense,* FACU), trumpet creeper (*Campsis radicans,* FAC), Cherokee sedge, switchgrass (*Panicum virgatum,* FAC), saw greenbriar, and peppervine. Table 4 describes the relative abundance of tree species observed within this cover type.

Scrub-shrub wetlands comprise 75.28 acres of the site. Typical herbaceous species observed within the scrub-shrub wetland cover type included switchgrass, annual marsh elder, common rush (*Juncus effuses,* OBL), anglestem beaksedge (*Rhynchospora caduca,* OBL*),* sawtooth blackberry, Cherokee sedge, buttonbush (*Cephalanthus occidentalis,* OBL), inkberry (*Ilex glabra,* FACW), common threesquare (*Schoenoplectus pungens,* OBL), green flatsedge, saw greenbriar, and peppervine. As previously mentioned, the site was historically comprised of a predominantly herbaceous habitat. Scrub and tree species have invaded and become predominant on the site in within the past three decades. Typical tree species observed within the scrub-shrub wetland cover type included Chinese tallow, green ash, green hawthorn, and water oak. Table 4 describes the relative abundance of tree species observed within this cover type.

If Borrow Area 3 is chosen for excavation, 35 acres of the site will be excavated for earthen material, impacting 1.4 acres of scrub-shrub wetland habitat. The remaining 73.88 acres of scrub-shrub wetland located on Borrow Area 3 will remain unimpacted.

2.3.5 Borrow Area 4/Mitigation Alternative 1

Borrow Area 4, also the site for Mitigation Alternative 1, is a 56.11 acre tract located in the northeastern portion of Barker Reservoir. Based upon a review of historical aerial photographs using Google Earth imagery, Borrow Area 4 appears to have consisted of herbaceous prairie and/or pasturelands in 1944. The 1944 aerial photograph depicts structures to the north of the tract and fencelines throughout the tract that are indicative of agricultural practices. In the 1989 historical aerial photograph, approximately 25% of the site is depicted as being covered by scrub and trees, likely the result of Chinese tallow invasion. Coverage of scrub and trees increased through the 2000's and currently covers approximately 75% of the site. Buffalo Bayou is located less than one quarter of a mile south of Borrow Area 4. When the gates of the outlet structures of Barker Dam are closed during and immediately following storm events, water within the Buffalo Bayou tributary backs up onto the adjacent floodplain and floods Borrow Area 4.

Field observations of Borrow Area 4 identified one cover type: scrub-shrub wetlands. Typical herbaceous species observed within the scrub-shrub wetland cover type included Pennsylvania smartweed (*Polygonum pensylvanicum,* FACW), mustang grape (*Vitis mustangensis,* UPL), switchgrass, Bermudagrass, Jesuit's bark, Mediterranean lovegrass, common rush, anglestem beaksedge, shortbristle horned beaksedge, Cherokee sedge, and green flatsedge. As previously mentioned, the site was historically comprised of a predominantly herbaceous habitat. Scrub and tree species have invaded and become predominant on the site in within the past three decades. Typical tree species observed within the scrub-shrub wetland cover type included Chinese tallow, green ash, American elm, and green hawthorn. Table 4 describes the relative abundance of tree species observed within this cover type.

If Borrow Area 4 is chosen for the proposed project, 30 acres of scrub-shrub wetland habitat will be excavated and the remaining 26.11 acres of wetland habitat will be used for Mitigation Alternative 1.

2.3.6 Borrow Area 5/Mitigation Alternative 2

Borrow Area 5, also the site for Mitigation Alternative 2, is a 52.23-acre tract located in the northeastern portion of Barker Reservoir approximately 0.75 miles south of Borrow Area 4. Based upon a review of historical aerial photographs using Google Earth imagery, Borrow Area 5 appears to have consisted of herbaceous prairie and/or pasturelands in 1944. The 1944 aerial photograph depicts several fencelines throughout the tract that are indicative of agricultural practices. Several prairie potholes are also visible throughout the site in the 1944 aerial photograph. In the 1989 historical aerial photograph, approximately 10% of the site is depicted as being covered by scrub and trees, likely the result of Chinese tallow invasion. Coverage of scrub and trees increased through the 2000's and currently covers approximately 95% of the site. Based upon a review of elevation data on Google Earth, Borrow Area 5 is located on a bluff which is approximately five feet higher that the floodplain of Buffalo Bayou, which is immediately north of the tract.

Field observations of Borrow Area 5 identified two cover types: forested uplands and scrub-shrub wetlands. Forested uplands comprise 49.13 acres of the site. Typical species observed within the forested upland cover type included loblolly pine, Chinese tallow, sugarberry (*Celtis laevigata,* FACW), American elm, willow oak, Texas vervain (*Verbena halei,* UPL), Canada goldenrod, Mediterranean lovegrass, common rush, anglestem beaksedge, whitetinge sedge (*Carex albicans,* FAC), foxtail millet, yaupon, slender woodoats, blackeyed Susan (*Rudbeckia hirta,* FACU), velvet panicum (*Dichanthelium scoparium,* FACW), common carpetgrass, hogwort, Macartney rose (*Rosa bracteata,* UPL), saw greenbriar, Cherokee sedge, switchgrass. Table 4 describes the relative abundance of tree species observed within this cover type.

Scrub-shrub wetlands comprise 3.10 acres of the site. Typical herbaceous species observed within the scrub-shrub wetland cover type included swamp smartweed, common spikerush (*Eleocharis palustris,* OBL), mountain spikerush, common rush, spotted ladysthumb (*Polygonum persicaria,* FACW), anglestem beaksedge, marsh

seedbox *(Ludwigia palustris,* OBL*),* maidencane (*Panicum hemitomon,* OBL), perennial ryegrass (*Lolium perenne,* FACU), Cherokee sedge, buttonbush, common duckweed (*Lemna minor,* OBL), common threesquare, green flatsedge, and Canada goldenrod. As previously mentioned, the site was historically comprised of a predominantly herbaceous habitat. Scrub and tree species have invaded and become predominant on the site in within the past three decades. Typical tree species observed within the scrub-shrub wetland cover type included Chinese tallow, green ash, and black willow (*Salix nigra,* OBL). Table 4 describes the abundance of tree species observed within this cover type.

If Borrow Area 5 is chosen for the proposed project, 30 acres of the site will be excavated, impacting 0.13 acres of wetland habitat. The remaining 2.97 acres of wetland habitat on Borrow Area 5 will be utilized for Mitigation Alternative 2.

Table 4. Percent Abundance of Tree Species on Each Borrow Area

Common Name	Scientific Name	Approximate % Abundance
Borrow Area 1		
Upland Herbaceous Cover Type		
Chinese tallow	*Triadica sebifera*	8
American elm	*Ulmus americana*	6
Green hawthorn	*Crataegus viridis*	3
Forested Upland Cover Type		
Chinese tallow	*Triadica sebifera*	80
Green ash	*Fraxinus pennsylvanica*	10
Borrow Area 2		
Upland Herbaceous Cover Type		
Green ash	*Fraxinus pennsylvanica*	8
Chinese tallow	*Triadica sebifera*	6
Emergent Wetland Cover Type		
No Trees Observed		
Borrow Area 3		
Forested Upland Cover Type		
Loblolly pine	*Pinus taeda*	35
Chinese tallow	*Triadica sebifera*	35
Water oak	*Quercus nigra*	10
Willow oak	*Quercus phellos*	7
American elm	*Ulmus americana*	4
Green hawthorn	*Crataegus viridis*	4
Ashe's juniper	*Juniperus ashei*	2
Scrub-shrub Wetland Cover Type		
Chinese tallow	*Triadica sebifera*	60
Water oak	*Quercus nigra*	10
Green hawthorn	*Crataegus viridis*	5
Green ash	*Fraxinus pennsylvanica*	5
Borrow Area 4		
Scrub-shrub Wetland Cover Type		
Chinese tallow	*Triadica sebifera*	60
American elm	*Ulmus americana*	10
Green hawthorn	*Crataegus viridis*	6
Green ash	*Fraxinus pennsylvanica*	4
Borrow Area 5		
Forested Upland Cover Type		
Chinese tallow	*Triadica sebifera*	35

Table 4. Percent Abundance of Tree Species on Each Borrow Area

Common Name	Scientific Name	Approximate % Abundance
Loblolly pine	*Pinus taeda*	15
Willow oak	*Quercus phellos*	15
Sugarberry	*Celtis laevigata*	10
American elm	*Ulmus americana*	10

Table 4. Percent Abundance of Tree Species on Each Borrow Area

Common Name	Scientific Name	Approximate % Abundance
Scrub-shrub Wetland Cover Type		
Chinese tallow	*Triadica sebifera*	35
Green ash	*Fraxinus pennsylvanica*	5
Black willow	*Salix nigra*	5

2.4 Baseline Habitat Suitability Indices

Calculation of HSI values were performed for wetland habitats on the borrow areas and the mitigation alternatives according to standard models developed for each evaluation species. Habitat variables assessed for each species model are included in Appendix B and the specific HSI calculations for each species evaluated are included in Appendix C.1. To compute the HSIs for an individual species, values obtained in the field for each variable were converted to Sustainability Indices (SIs) utilizing species specific models. Species SI values were input into life requisite equations established in the models to obtain an individual species HSI. Table 5 displays HSI values for each species on borrow areas and the mitigation sites. Average HSI values for each area were calculated as the arithmetic mean of all the individual species' HSI values. No wetlands are located on Borrow Area 1, therefore, no HSI values were calculated for this borrow area.

Table 5. Baseline Habitat Suitability Indices for Each Species

	Slider	Marsh Wren	Yellow Warbler	Veery	Average HSI Value
Borrow Area 1	Not Applicable*				
Borrow Area 2	0.13	0.79	--	--	0.46
Borrow Area 3	--	--	0.97	1.00	0.99
Borrow Area 4 (Proposed Project Area)	--	--	0.99	0.70	0.85
Borrow Area 5 (Proposed Project Area)	--	--	0.95	1.00	0.98
Mitigation Alternative 1 (BA4)	--	--	0.99	0.88	0.94
Mitigation Alternative 2 (BA5)	--	--	0.76	0.88	0.82

*No wetlands were present in Borrow Area 1.

2.5 Baseline Habitat Units

Baseline Habitat Units (HUs) were calculated for each borrow area and mitigation alternative by multiplying the average HSI value for each site by the total wetland acreage on each site. Table 6 displays the HUs for the borrow areas and the mitigation alternatives.

Table 6. Baseline Habitat Units for
Borrow Areas and Mitigation Alternatives

Project Area	Average HSI Values	Area (acres)	Total Habitat Units
Borrow Area 1	Not Applicable*		
Borrow Area 2	0.46	0.60	0.28
Borrow Area 3	0.99	75.28	74.53
Borrow Area 4 (Proposed Project Area)	0.85	30.00	25.50
Borrow Area 5 (Proposed Project Area)	0.98	0.13	0.13
Mitigation Alternative 1 (BA4)	0.94	26.11	24.54
Mitigation Alternative 2 (BA5)	0.82	2.97	2.43

*No wetlands were present in Borrow Area 1.

3.0 Habitat Evaluation Procedure Results

To determine the long term habitat value for the borrow areas and the mitigation sites, HUs available to each species were projected for several project milestones, or target years, over a period of analysis beginning the year that baseline data was collected (target year 0; Y0) and concluding 50 years after construction commencement. Datasheets calculating the projected HSI for each species are included in Appendix C.2. Estimates of future HUs were calculated for "no action" and "with-project" alternatives. Habitat availability for each species under each alternative for the period of analysis was determined by dividing by the life of the project by the total HUs, to calculate Average Annual Habitat Units (AAHUs). AAHU values create a common metric to allow impacts and compensation to be quantified and compared.

Project schedules for Addicks and Barker Dam are offset by a period of one year, with work associated with Addicks Dam scheduled to begin in 2015 and Barker Dam project work scheduled to begin in 2016. Therefore, target years associated with Addicks Reservoir borrow areas differ from those associated with Barker Reservoir borrow areas and mitigation alternatives. Target years associated with Addicks borrow areas, Barker borrow areas, and mitigation alternatives are described in Sections 3.1, 3.2, and 3.3 respectively.

Assumptions associated with predicting future habitat values for the no action and with-project scenarios for the borrow areas and the mitigation sites are outlined in Sections 3.1.1 - 3.3.2. Datasheets calculating AAHUs for each are located in Appendix C.3.

3.1 Addicks Reservoir Sites (Borrow Areas 2 and 3)

Several target years have been identified for analysis of the Addicks Reservoir borrow areas. Baseline data was collected in 2012 (target year 0; Y0). Proposed construction is scheduled to begin in 2015 (Y1) and conclude in 2018 (Y2). The 50-year life of the project will end in 2068 (Y3), yielding a 56-year period of analysis.

Explicit descriptions of the assumptions associated with the no action and with-project scenarios for each Addicks Reservoir borrow area are outlined below.

3.1.1 Borrow Area 2

Current Conditions

Borrow Area 2 is currently dominated by herbaceous uplands and emergent wetland habitat. Emergent vegetation in the wetland habitat currently provides approximately 80% cover, and is dominated by grasses and sedges. Standing water within the wetland is approximately one foot deep, with zero flow.

No Action Scenario

The emergent wetland habitat in Borrow Area 2 is located on a power line easement, and will be maintained throughout the period of analysis. No shrub layer will be allowed to form in the wetlands. Habitat units for all target years are projected to be equivalent to baseline HUs.

With-Project Scenario

If Borrow Area 2 is chosen for excavation, 0.60 acres of wetland habitat will be impacted and have a habitat value of zero for the entire period of analysis. All mitigation for impacts to wetlands located on Borrow Area 2 would

occur on either Borrow Area 4 or 5. Mitigation details are described in the with-project scenarios for Mitigation Alternatives 1 and 2. All mitigation will begin in Y1 (2015), concurrent with site impacts.

In Y1 (2015), excavation of Borrow Area 2 would occur. Impacts to the 0.60 acres of wetland habitat located on the project site would have a habitat value of zero. It is assumed that there will be no standing water, emergent vegetation, or woody vegetation on the project site.

In Y2 (2018), it is assumed that habitat value will continue to be zero, with no standing water, emergent vegetation, or woody vegetation on the project site.

In Y3 (2068) it is assumed that habitat value will continue to be zero, with no standing water, emergent vegetation, or woody vegetation on the project site.

3.1.2 Borrow Area 3

Current Conditions

The shrub layer on Borrow Area 3 is dominated by approximately 4.5 m tall Chinese tallow, providing approximately 58% crown cover. The herbaceous layer is approximately 73 cm tall and provides approximately 91% cover. Borrow Area 3 is generally dry, with no standing water present. However, Borrow Area 3 is subject to occasional, short-term flooding, which is contingent on precipitation and Addicks Dam water release rates.

No Action Scenario

Under the no action scenario, Chinese tallow in Borrow Area 3 is expected to continue to dominate the shrub layer, and shrub crown cover is expected to increase as the Chinese tallow trees mature. Cover values for herbaceous vegetation are projected to decrease due to light limitation from the shrub layer. The flood regime is not expected to change for Borrow Area 3; therefore the percent of the cover type flooded is expected to remain constant during the period of analysis.

By Y1 (2015), shrub crown cover is projected to reach approximately 60%, with an average shrub height of approximately 4.65 m. The herbaceous canopy cover is projected to decrease to approximately 85%. The average height of the herbaceous canopy is expected to remain approximately 73 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2018), shrub crown cover is projected to reach approximately 70%, with an average shrub height of approximately 4.75 m. The herbaceous canopy cover is projected to decrease to approximately 80%. The average height of the herbaceous canopy is expected to remain approximately 73 cm.

By Y3 (2068), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The herbaceous canopy cover is projected to decrease to approximately 45%. The average height of the herbaceous canopy is expected to remain approximately 73 cm.

With-Project Scenario

If Borrow Area 3 is chosen, approximately 35 acres of the borrow area will be excavated and converted to bare ground. The area excavated will be predominantly uplands; however, 1.40 acres of scrub-shrub wetlands will be impacted during excavation and have zero habitat value throughout the life of the project. All mitigation for impacts to wetlands located on Borrow Area 3 would occur on either Borrow Area 4 or 5. Mitigation details are described in the with-project scenarios for Mitigation Alternatives 1 and 2. All mitigation will begin in Y1 (2015), concurrent with site impacts.

In Y1 (2015), construction will begin on Borrow Area 3. Excavation will impact 1.4 acres of wetland habitat and reduce wetland habitat to 73.88 acres. The remaining wetlands are projected to be consistent with the no action scenario parameters. Shrub crown cover is projected to reach approximately 60%, with an average shrub height of approximately 4.65 m. The herbaceous canopy cover is projected to decrease to approximately 85%. The average height of the herbaceous canopy is expected to remain approximately 73 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2018), shrub crown cover is projected to reach approximately 70%, with an average shrub height of approximately 4.75 m. The herbaceous canopy cover is projected to decrease to approximately 80%. The average height of the herbaceous canopy is expected to remain approximately 73 cm.

By Y3 (2068), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The herbaceous canopy cover is projected to decrease to approximately 45%. The average height of the herbaceous canopy is expected to remain approximately 73 cm.

3.2 Barker Reservoir Sites (Borrow Areas 4 and 5)

Several target years have been identified for analysis of the Barker Dam borrow areas. Baseline data was collected in 2012 (target year 0; Y0). Mitigation associated with impacts to Addicks Dam borrow areas will begin in 2015 (Y1), concurrent with construction in Addicks Reservoir. Proposed excavation of the selected Barker Dam borrow area is scheduled to begin in 2016 (Y2) and conclude in 2019 (Y3). Compensatory mitigation for impacts to Barker Dam borrow areas will begin in Y2, concurrent with excavation. The 50-year life of the project will end in 2069 (Y4), yielding a 57-year period of analysis.

Explicit descriptions of the assumptions associated with the no action and with-project scenarios for each Barker Dam borrow area are outlined below.

3.2.1 Borrow Area 4

Proposed Project Area Current Conditions

The shrub layer on the proposed project area in Borrow Area 4 is dominated by approximately 5 m tall Chinese tallow, providing approximately 60% crown cover. The herbaceous layer is approximately 25 cm tall. The average herbaceous canopy cover in the proposed project area in Borrow Area 4 is 40%. The proposed project area in Borrow Area 4 is generally dry, with no standing water present. However, Borrow Area 4 is subject to occasional, short-term flooding, which is contingent on precipitation and Barker Dam water release rates.

Proposed Project Area No Action Scenario

Under the no action scenario, Chinese tallow in Borrow Area 4 is expected to continue to dominate the shrub layer, and shrub crown cover is expected to increase during the period of analysis, as the Chinese tallow trees mature. Baseline crown cover values for herbaceous vegetation are low enough that light limitation due to shading is not likely to occur. Therefore, herbaceous cover values are projected to remain similar to baseline conditions throughout the period of analysis. The flooding regime is not expected to change for Borrow Area 4, therefore the percent of the cover type flooded is expected to hold constant during the period of analysis.

By Y1 (2015), shrub crown cover is projected to reach approximately 64%, with an average shrub height of approximately 5.15 m. The average herbaceous canopy cover in the proposed project area in Borrow Area 4 is projected to be approximately 40%. The average height of the herbaceous canopy is expected to remain approximately 25 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2016), shrub crown cover is projected to reach approximately 65%, with an average shrub height of approximately 5.2 m. The average herbaceous canopy cover in Borrow Area 4 is projected to be approximately 40%. The average height of the herbaceous canopy is expected to remain approximately 25 cm.

By Y3 (2019), shrub crown cover is projected to reach approximately 70%, with an average shrub height of approximately 5.4 m. The average herbaceous canopy cover in Borrow Area 4 is projected to remain 40%. The average height of the herbaceous canopy is expected to remain approximately 25 cm.

By Y4 (2069), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The average herbaceous canopy cover in Borrow Area 4 is projected to be approximately 40%. The average height of the herbaceous canopy is expected to remain approximately 25 cm.

Proposed Project Area With-Project Scenario

If Borrow Area 4 is selected for excavation, 30 acres of wetland habitat on the proposed project site will be impacted and have zero habitat value. Excavation would begin in Y2 (2016) and be complete in Y3 (2019).

Target year Y1 (2015) is the year in which mitigation for impacts to the selected Addicks Dam site will begin on the mitigation site. At this time however, there will be no impacts to the proposed project area on Borrow Area 4. Cover values are assumed to be consistent with the no action scenario. Shrub crown cover is projected to reach approximately 64%, with an average shrub height of approximately 5.15 m. The average herbaceous canopy cover in the proposed project area in Borrow Area 4 is projected to be approximately 40%. The average height of the herbaceous canopy is expected to remain approximately 25 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

In Y2 (2016), excavation would begin on the proposed project site. Thirty acres of wetland habitat on the proposed project site will be impacted and have zero habitat value. The entire project area is assumed to be bare ground, with zero shrub cover and zero herbaceous vegetation.

In Y3 (2019), it is assumed that the proposed project site will continue to be bare ground with zero shrub cover, zero herbaceous vegetation, and zero habitat value.

By Y4 (2069) it is assumed that the proposed project site will continue to be bare ground with zero shrub cover, zero herbaceous vegetation, and zero habitat value.

3.2.2 Borrow Area 5

Proposed Project Area Current Conditions:

The shrub layer on the proposed project area wetlands on Borrow Area 5 is dominated by approximately 4 m tall Chinese tallow, providing approximately 55% crown cover. The herbaceous layer is approximately 55 cm tall providing approximately 95% cover. Borrow Area 5 is generally dry, with no standing water present. However, the proposed project area in Borrow Area 5 is subject to occasional, short-term flooding, which is contingent on precipitation and Barker Dam water release rates.

Proposed Project Area No Action Scenario

Under the no action scenario, Chinese tallow in the proposed project area wetlands on Borrow Area 5 is expected to continue to dominate the shrub layer, and shrub crown cover is expected to increase during the period of analysis, as the Chinese tallow trees mature. Cover values for herbaceous vegetation are projected to decrease due to light limitation from the shrub layer. The flood regime is not expected to change for the proposed project

area on Borrow Area 5, therefore the percent of the cover type flooded is expected to hold constant during the period of analysis.

By Y1 (2015), shrub crown cover is projected to reach approximately 59%, with an average shrub height of approximately 4.15 m. The herbaceous canopy cover is projected to decrease to approximately 82%. The average height of the herbaceous canopy is expected to remain approximately 55 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2016), shrub crown cover is projected to reach approximately 60%, with an average shrub height of approximately 4.2 m. The herbaceous canopy cover is projected to decrease to approximately 80%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

By Y3 (2019), shrub crown cover is projected to reach approximately 60%, with an average shrub height of approximately 4.7 m. The herbaceous canopy cover is projected to decrease to approximately 70%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

By Y4 (2069), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The herbaceous canopy cover is projected to decrease to approximately 55%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

Proposed Project Area With-Project Scenario

If Borrow Area 5 is selected for excavation, 30 acres of the proposed project site will be excavated, impacting 0.13 acres of wetland habitat. Excavation would begin in Y2 (2016) and be complete in Y3 (2019). Excavated wetlands are projected to have zero habitat value for the life of the project.

Target year Y1 (2015) is the year in which mitigation for impacts to the selected Addicks Dam site will begin on the mitigation site. At this time however, there will be no impacts to the proposed project area on Borrow Area 5. Cover values for this target year are assumed to be consistent with the no action scenario. Shrub crown cover is projected to be approximately 59%, with an average shrub height of approximately 4.15 m. The average herbaceous canopy cover is projected to be approximately 82%. The average height of the herbaceous canopy is expected to remain approximately 55 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

In Y2 (2016), excavation would begin on the project site. Impacts to the 1.4 acres of wetlands within the 30-acre project site will have zero habitat value. The entire project area is assumed to be bare ground, with zero shrub cover and zero herbaceous vegetation.

In Y3 (2019), excavation would be complete on the project site. Impacted wetlands will continue to have zero habitat value. The entire project area is assumed to be bare ground, with zero shrub cover and zero herbaceous vegetation.

By Y4 (2069) it is assumed that the project site will continue to be bare ground with zero shrub cover, zero herbaceous vegetation, and zero habitat value.

3.3 Mitigation Alternatives

3.3.1 Mitigation Alternative 1 (Borrow Area 4)

Mitigation Alternative 1 (Borrow Area 4) Current Conditions

The shrub layer on Mitigation Alternative 1 is dominated by approximately 5 m tall Chinese tallow, providing approximately 75% crown cover. The herbaceous layer is approximately 30 cm tall. The average herbaceous canopy cover on Mitigation Alternative 1 is 55%. Borrow Area 4 is generally dry, with no standing water present. However, Borrow Area 4 is subject to occasional, short-term flooding, which is contingent on precipitation and Barker Dam water release rates.

Mitigation Alternative 1 (Borrow Area 4) No Action Scenario

Under the no action scenario, Chinese tallow on Mitigation Alternative 1 is expected to continue to dominate the shrub layer, and shrub crown cover is expected to increase during the period of analysis, as the Chinese tallow trees mature. Cover values of herbaceous vegetation are projected to decrease due to light limitation from the shrub layer in some areas. The flooding regime is not expected to change for Borrow Area 4, therefore the percent of the cover type flooded is expected to hold constant during the period of analysis.

By Y1 (2015), shrub crown cover is projected to reach approximately 78%, with an average shrub height of approximately 5.15 m. The average herbaceous canopy cover on Mitigation Alternative 1 is projected to be approximately 52%. The average height of the herbaceous canopy is expected to remain approximately 30 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2016), shrub crown cover is projected to reach approximately 80%, with an average shrub height of approximately 5.2 m. The average herbaceous canopy cover is projected to be approximately 50%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

By Y3 (2019), shrub crown cover is projected to reach approximately 80%, with an average shrub height of approximately 5.4 m. The average herbaceous canopy cover is projected to be approximately 45%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

By Y4 (2069), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The average herbaceous canopy cover is projected to be approximately 35%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

Mitigation Alternative 1 (Borrow Area 4) With-Project Scenario

If Borrow Area 4 is chosen for excavation, then all mitigation compensation for impacts to Addicks and Barker borrow areas will occur on Mitigation Alternative 1 (on Borrow Area 4) and on sufficient adjacent wetlands to fulfill mitigation area and habitat unit requirements. Mitigation areas must be at least as large as the area of wetland lost to impacts. The net gain in habitat units resulting from improvements to the mitigation area must be greater than or equal to the total HUs lost to impacts to wetlands. Mitigation for impacts to the excavated Addicks Reservoir Borrow Area would begin in Y1 (2015), and mitigation for impacts to Borrow Area 4 would begin in Y2 (2016).

Mitigation will involve improvements to existing shrub-scrub wetland habitats. Invasive Chinese tallow will be removed and replaced with native wetland shrubs approximately 2.5 m in height. The shrub canopy will be maintained at approximately 70% crown cover and herbaceous cover will be maintained at approximately 90% cover.

In Y1 (2015), mitigation for impacts to either Borrow Area 2 or Borrow Area 3 will begin. Shrub crown cover is projected to be 74% with an average shrub height of approximately 4.75 m. The average herbaceous canopy cover in Mitigation Alternative 1 is projected to be approximately 60%.The average height of the herbaceous canopy is expected to remain approximately 30 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

In Y2 (2016), mitigation for impacts to Borrow Area 4 will begin. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 90%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

In Y3 (2019), Mitigation Alternative 1 will have reached target vegetative cover values. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 90%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

In Y4 (2069), Mitigation Alternative 1 will continue to be maintained at target vegetative cover values. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 90%. The average height of the herbaceous canopy is expected to remain approximately 30 cm.

3.3.2 Mitigation Alternative 2 (Borrow Area 5)

Mitigation Alternative 2 (Borrow Area 5) Current Conditions

The shrub layer on Mitigation Alternative 2, located on Borrow Area 5, is dominated by approximately 4 m tall Chinese tallow, providing approximately 35% crown cover. The herbaceous layer is approximately 55 cm tall, providing an average of 97% cover. Borrow Area 5 is generally dry, with no standing water present. However, Borrow Area 5 is subject to occasional, short-term flooding, which is contingent on precipitation and Barker Dam water release rates.

Mitigation Alternative 2 (Borrow Area 5) No Action Scenario

Under the no action scenario, Chinese tallow in the proposed project area in Mitigation Alternative 2 is expected to continue to dominate the shrub layer, and shrub crown cover is expected to increase during the period of analysis, as the Chinese tallow trees mature. Cover values for herbaceous vegetation are projected to decrease due to light limitation from the shrub layer. The flooding regime is not expected to change for Mitigation Area 2, therefore the percent of the cover type flooded is expected to hold constant during the period of analysis.

By Y1 (2015), shrub crown cover is projected to reach approximately 45%, with an average shrub height of approximately 4.15 m. The herbaceous canopy cover is projected to decrease to approximately 92%. The average height of the herbaceous canopy is expected to remain approximately 55 cm as the herbaceous species composition is not expected to significantly differ from the baseline year.

By Y2 (2016), shrub crown cover is projected to reach approximately 47%, with an average shrub height of approximately 4.2 m. The herbaceous canopy cover is projected to decrease to approximately 87%. The average height of the herbaceous canopy is expected to remain approximately 55.

By Y3 (2019), shrub crown cover is projected to reach approximately 55%, with an average shrub height of approximately 4.7 m. The herbaceous canopy cover is projected to decrease to approximately 83%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

By Y4 (2069), shrub crown cover is projected to reach approximately 100%, with an average shrub height of approximately 6 m. The herbaceous canopy cover is projected to decrease to approximately 55%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

Mitigation Area 2 (Borrow Area 5) With-Project Scenario

If Borrow Area 5 is chosen for excavation, then all mitigation compensation for impacts to Addicks and Barker borrow areas will occur on Mitigation Alternative 2 in Borrow Area 5 and on a sufficient area of adjacent wetlands to fulfill mitigation area and habitat unit requirements. Mitigation areas must be at least as large as the area of wetland lost to impacts. The net gain in habitat units resulting from improvements to the mitigation area must be greater than or equal to the total HUs lost to impacts to wetlands. Mitigation for impacts to the excavated Addicks Reservoir Borrow Area would begin in Y1 (2015), and mitigation for impacts to Borrow Area 5 would begin in Y2 (2016).

Mitigation will involve improvements to existing habitats. Invasive Chinese tallow will be removed and replaced with native wetland shrubs of approximately 2.5 m in height. The shrub canopy will be maintained at approximately 70% crown cover and herbaceous cover will be maintained at approximately 90% cover.

In Y1 (2015), mitigation for impacts to either Borrow Area 2 or Borrow Area 3 would begin. Shrub crown cover is projected to be 65% with an average shrub height of approximately 3.25 m. The average herbaceous canopy cover in Mitigation Alternative 2 is projected to be approximately 97%. The average height of the herbaceous canopy is expected to remain approximately 55 cm, as the herbaceous species composition is not expected to significantly differ from the baseline year.

In Y2 (2016), mitigation for impacts to Borrow Area 5 would begin. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 97%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

In Y3 (2019), Mitigation Alternative 2 will be maintained at target vegetative cover values. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 97%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

In Y4 (2069), Mitigation Alternative 2 will continue to be maintained at target vegetative cover values. Shrub crown cover is projected to be 70% with an average shrub height of approximately 2.5 m. The average herbaceous canopy cover is projected to be approximately 97%. The average height of the herbaceous canopy is expected to remain approximately 55 cm.

3.4 Results

Average Annual Habitat Units were calculated for wetland cover types on each borrow area and mitigation alternative. Borrow Area 1 had no wetland cover types. Therefore, Borrow Area 1 AAHUs for the no action and the with-project alternatives are zero. Excavation of Borrow Areas 2, 3, 4, and 5 will result in a loss of AAHUs. The largest loss of AAHUs would result from the excavation of Borrow Area 4. Table 7 details the difference in AAHUs between the no action and with-project scenarios for each borrow area. Calculations of borrow area AAHUs are located in Appendix C.3.

Mitigation Alternative 1 AAHUs were calculated to be 22.41 for the no action alternative and 48.30 for the with-project scenario, yielding a gain of 25.89 AAHUs resulting from wetland enhancement. To achieve the gain in AAHUs for Mitigation Area 1, an additional 22.89 acres of wetland habitat will be added to the original 26.11 mitigation acres to be preserved and enhanced. Mitigation Alternative 2 AAHUs were calculated to be 2.73 for the

no action alternative and 4.44 for the with-project scenario, yielding a gain of 1.71 AAHUs resulting from wetland enhancement. To achieve the gain in AAHUs for Mitigation Area 2, an additional 1.53 acres of scrub-shrub wetland habitat will be added to the original 2.97 mitigation acres to be preserved and enhanced. Table 7 reports the difference in AAHUs between the no action and with-project scenarios for each mitigation alternative. Calculations of mitigation alternative AAHUs are located in Appendix C.3. Table 8 details the additional wetland area needed by each mitigation alternative to fulfill mitigation requirements. Figures 8 and 9 depict the areas and locations of additional areas to be used for Mitigation Alternatives 1 and 2.

Table 7. Net Difference in AAHU Values for Each Borrow Area and Mitigation Alternative

	No Action AAHU's	With-Project AAHU's	Net Difference
Borrow Area 1	0.00	0.00	0.00
Borrow Area 2	0.28	0.00	-0.28
Borrow Area 3	69.17	67.92	-1.25
Borrow Area 4	25.11	1.58	-23.53
Borrow Area 5	0.12	0.01	-0.11
Mitigation Alternative 1 (BA4)	22.41	48.30	25.89
Mitigation Alternative 2 (BA5)	2.73	4.44	1.71

Table 8. Additional Mitigation Area Needed to Meet Mitigation Requirements

	Current Area (Acres)	Additional Area Needed for Mitigation (Acres)	Total Area (Acres)
Mitigation Alternative 1 (BA4)	26.11	22.89	49.00
Mitigation Alternative 2 (BA5)	2.97	1.53	4.50

3.5 Net Habitat Benefits of the Overall Project

Over the period of analysis, the no action scenarios for the borrow areas range from 0 AAHUs for Borrow Area 1 to 69.17 AAHUs for Borrow Area 3. The greatest net loss in AAHUs resulting from the with-project scenarios would be due to the excavation of Borrow Area 4, which would result in the loss of 23.53 AAHUs (94%). Excavation of 1.4 wetland acres on Borrow Area 3's 35-acre proposed project site would result in a net loss of 1.25 AAHUs (2%). Excavation of Borrow Area 2 would result in a net loss of 0.28 AAHUs (100%), and excavation of Borrow Area 5 would yield a net loss of 0.11 AAHUs (92%). Excavation of each of these sites would result in the total loss of wetland habitat, and the conversion of excavated areas within the selected borrow areas to exposed earth, with zero habitat value.

Over the period of analysis, the no action scenarios for the mitigation alternatives yield a total of 22.41 AAHUs for Mitigation Alternative 1 and 2.97 AAHUs for Mitigation Alternative 2. The with-project scenarios for the mitigation alternatives would yield 48.30 AAHUs for Mitigation Alternative 1 and 4.44 AAHUs for Mitigation Alternative 2. Wetland enhancement would increase AAHUs for Mitigation Alternative 1 by 25.89 AAHUs (116%). Likewise, the with-project alternative for Mitigation Alternative 2 would result in an increase of 1.71 AAHUs (63%). Increases in AAHUs would result from the preservation of additional wetland areas outside of the current mitigation area boundaries and the enhancement of wetland habitat. Mitigation Alternative 1 would require an increase of 22.89 acres, for a total of 49 mitigation acres. Mitigation Alternative 2 would require an increase of 1.53 acres, for a total of 4.5 mitigation acres. Wetland habitat enhancement will involve a reduction in invasive species abundance to five percent areal coverage, as well as the planting of native wetland scrub and herbaceous species. Following

wetland enhancement efforts, habitat in the selected mitigation alternative will be preserved and maintained in perpetuity.

One borrow area from each reservoir will be excavated for earthen material for the construction of temporary earthen cofferdams during proposed work on Addicks and Barker Reservoirs. A comprehensive comparison of the net benefits of all possible borrow area and mitigation alternatives is located in Table 9. For example, Option 2, the excavation of Borrow Areas 2 and 4, and the enhancement of Mitigation Alternative 1, would provide a gain of 2.08 AAHUs. Excavation of Borrow Areas 2 and 4 would impact 0.60 areas of emergent wetlands from Borrow Area 2 and 30.00 acres of scrub-shrub wetlands from Borrow Area 4. All options yield a net gain in AAHUs. Therefore, any of the listed Options 1-6 are viable mitigation alternatives.

Table 9. AAHU Net Gain Analysis for Borrow Areas and Mitigation Site Alternative Combinations

Borrow Areas		Net Loss (AAHUs)	Mitigation Alternative	Net Gain (AAHUs)	Total Offset (AAHUs)
Option 1					
Borrow Area 1	Borrow Area 4	23.53	Mitigation Alternative 1 (BA4)	25.89	2.36
Option 2					
Borrow Area 2	Borrow Area 4	23.81	Mitigation Alternative 1 (BA4)	25.89	2.08
Option 3					
Borrow Area 3	Borrow Area 4	24.78	Mitigation Alternative 1 (BA4)	25.89	1.11
Option 4					
Borrow Area 1	Borrow Area 5	0.11	Mitigation Alternative 2 (BA5)	1.71	1.60
Option 5					
Borrow Area 2	Borrow Area 5	0.39	Mitigation Alternative 2 (BA5)	1.71	1.32
Option 6					
Borrow Area 3	Borrow Area 5	1.36	Mitigation Alternative 2 (BA5)	1.71	0.35

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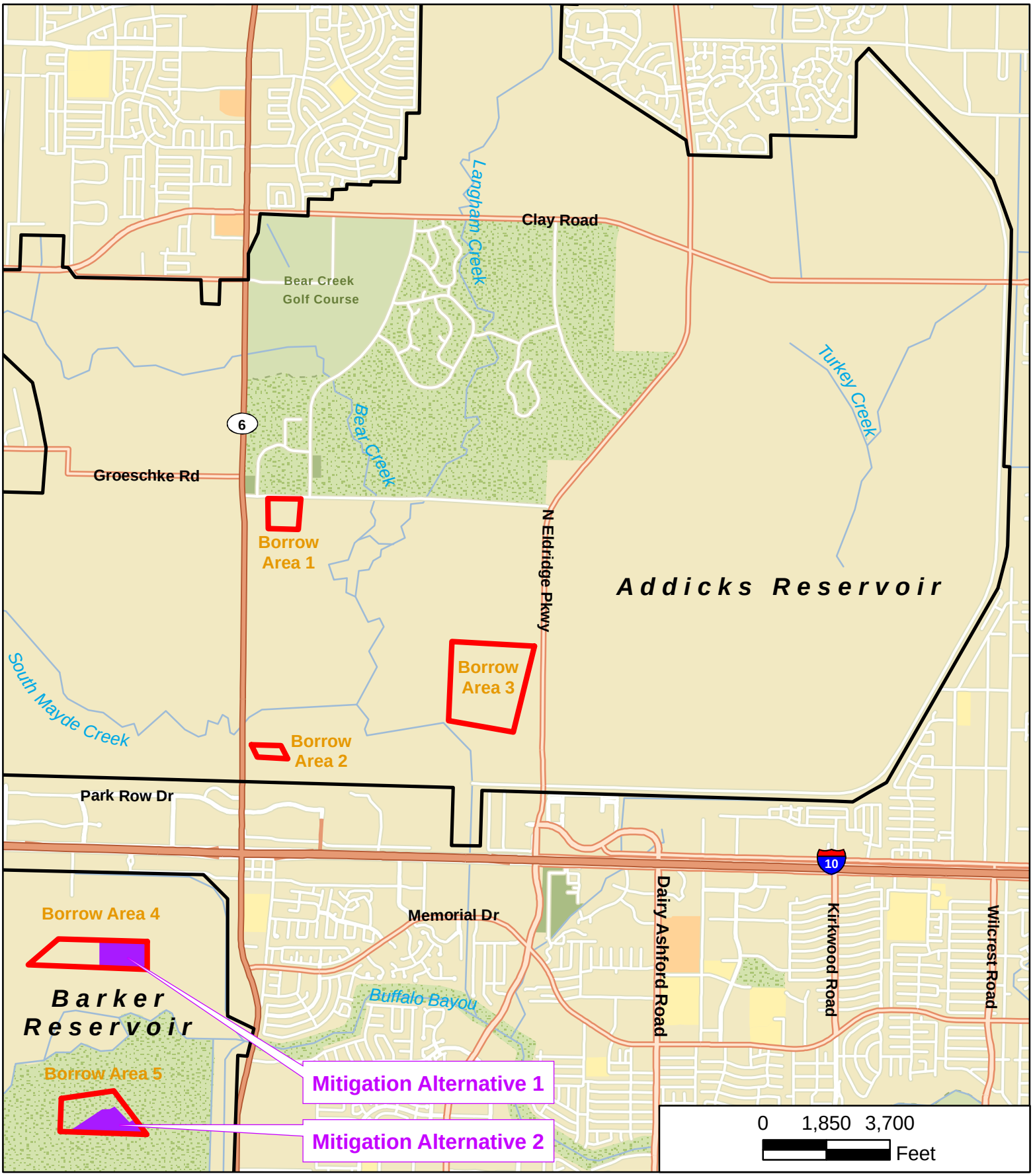
Exhibits



US Army Corps of Engineers ®
Galveston District

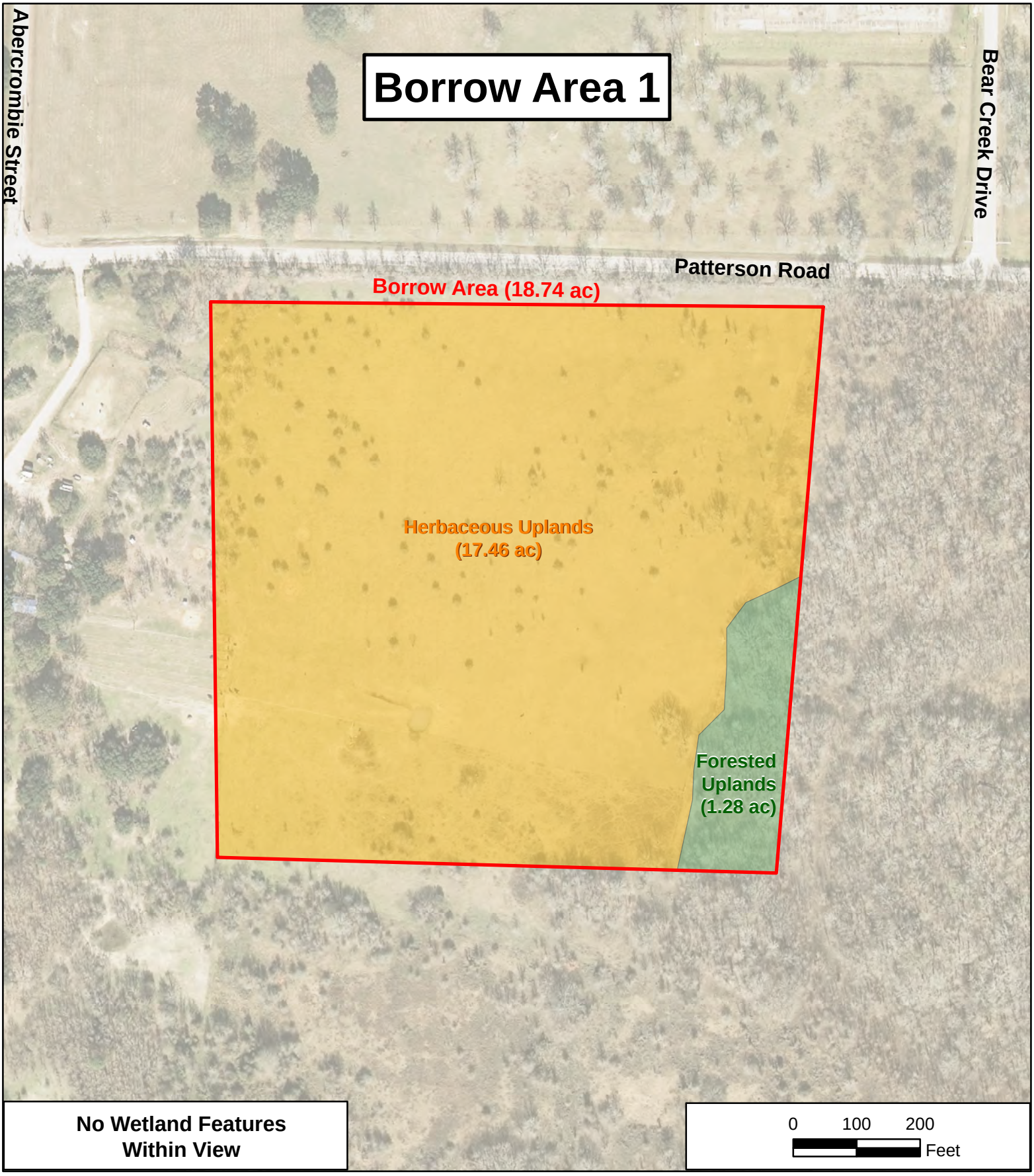
- Borrow Areas
- Addicks and Barker Reservoir Boundary
- Mitigation Alternatives

N

Addicks and Barker Dam
Safety Modification
FIGURE 1

VICINITY MAP

Harris County, Texas



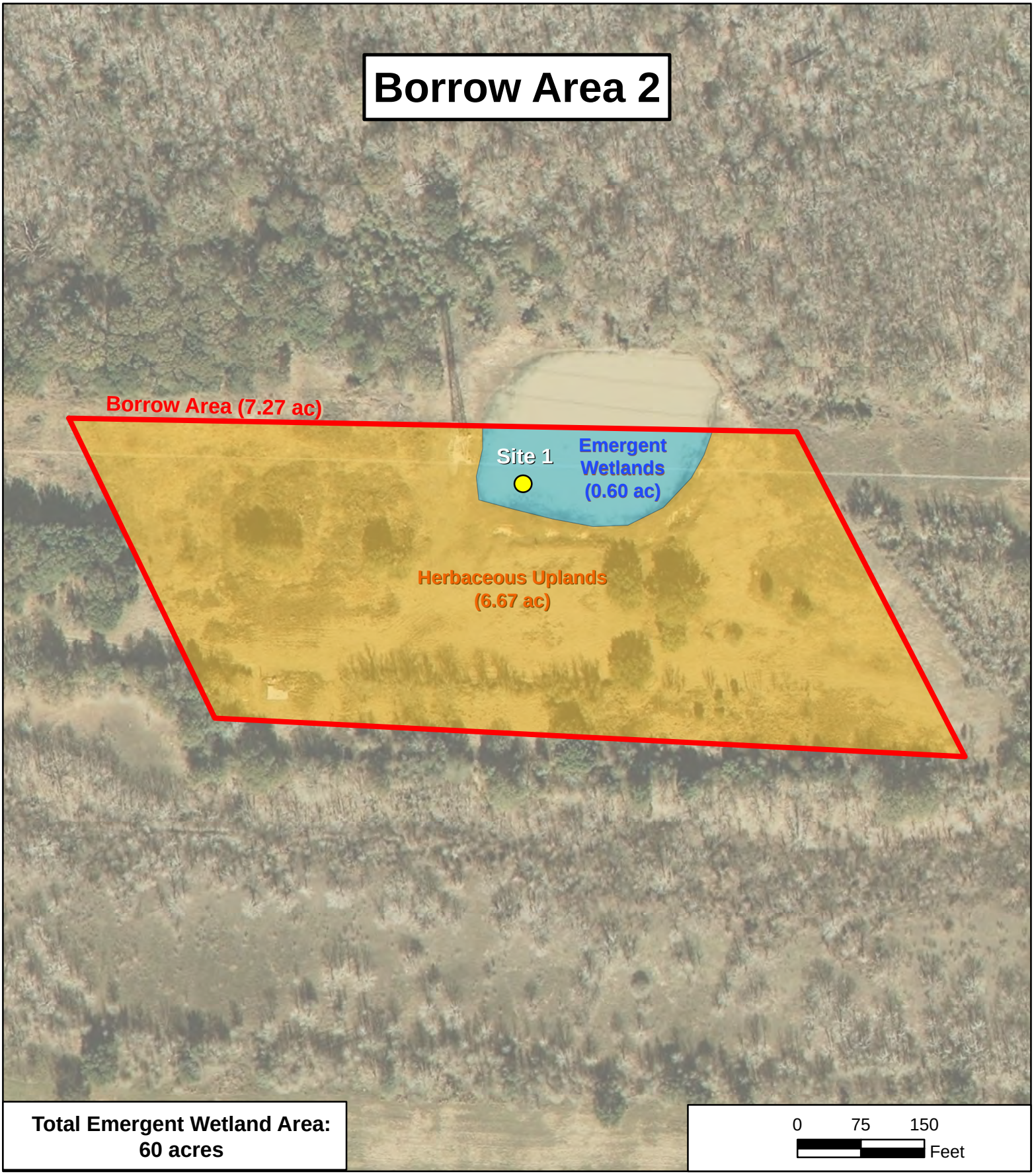
US Army Corps of Engineers ®
Galveston District

- Borrow Area 1 (18.74 acres)
- Herbaceous Uplands (17.46 acres)
- Forested Uplands (1.28 acres)

N

Addicks and Barker
Dam Safety Modification
FIGURE 3
2008 AERIAL PHOTO OF BORROW AREA 1 WITH EXISTING VEGETATIVE COVER TYPES

Harris County, Texas



Total Emergent Wetland Area: 60 acres

0 75 150 Feet

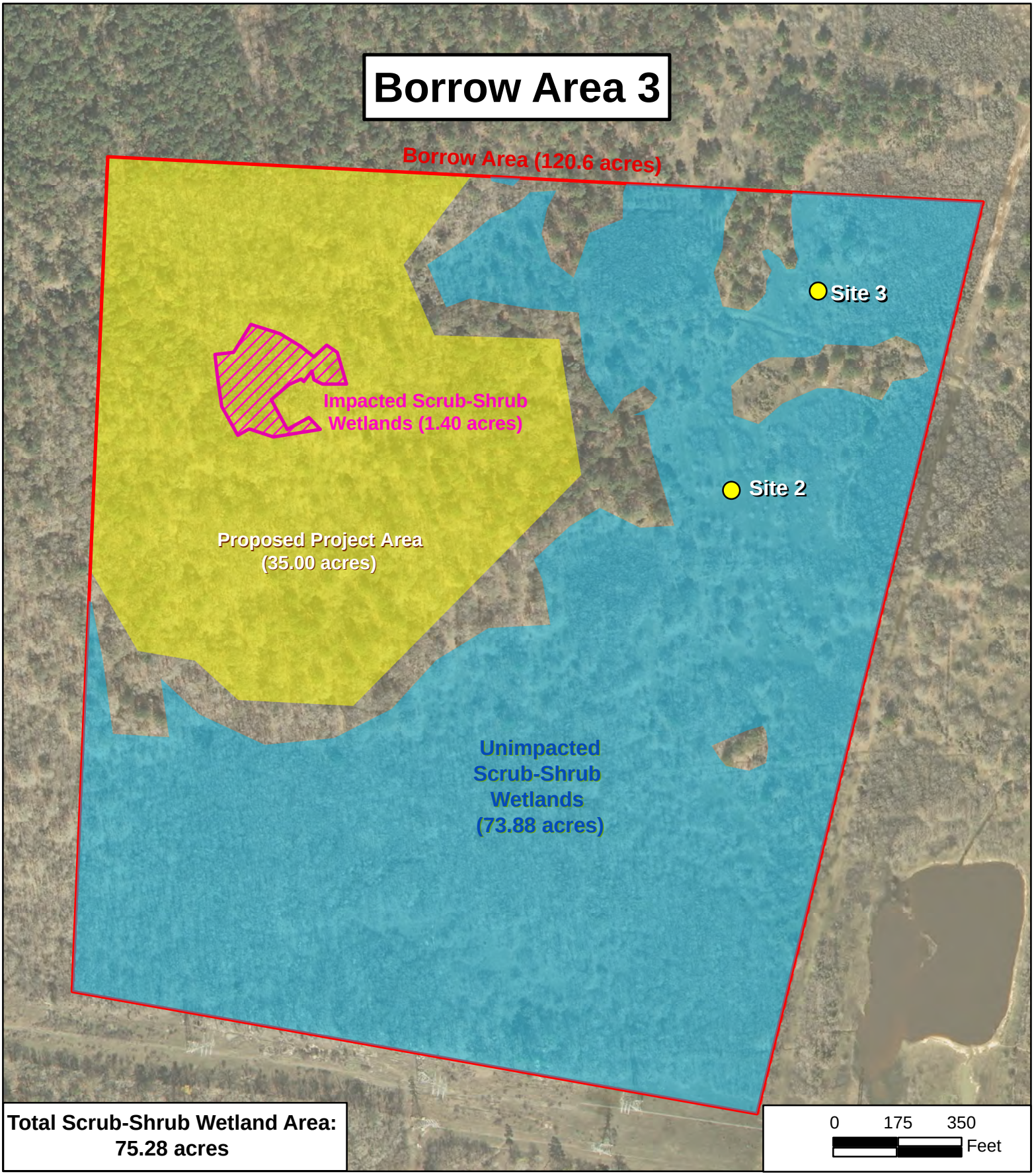
US Army Corps of Engineers ®
Galveston District

Borrow Area 2 (7.27 acres)
Emergent Wetland (0.60 acres)
Herbaceous Uplands (6.67 acres)

N

Addicks and Barker
Dam Safety Modification
FIGURE 4
2008 AERIAL PHOTOGRAPH OF BORROW AREA 2 WITH EXISTING VEGETATIVE COVER TYPES

Harris County, Texas



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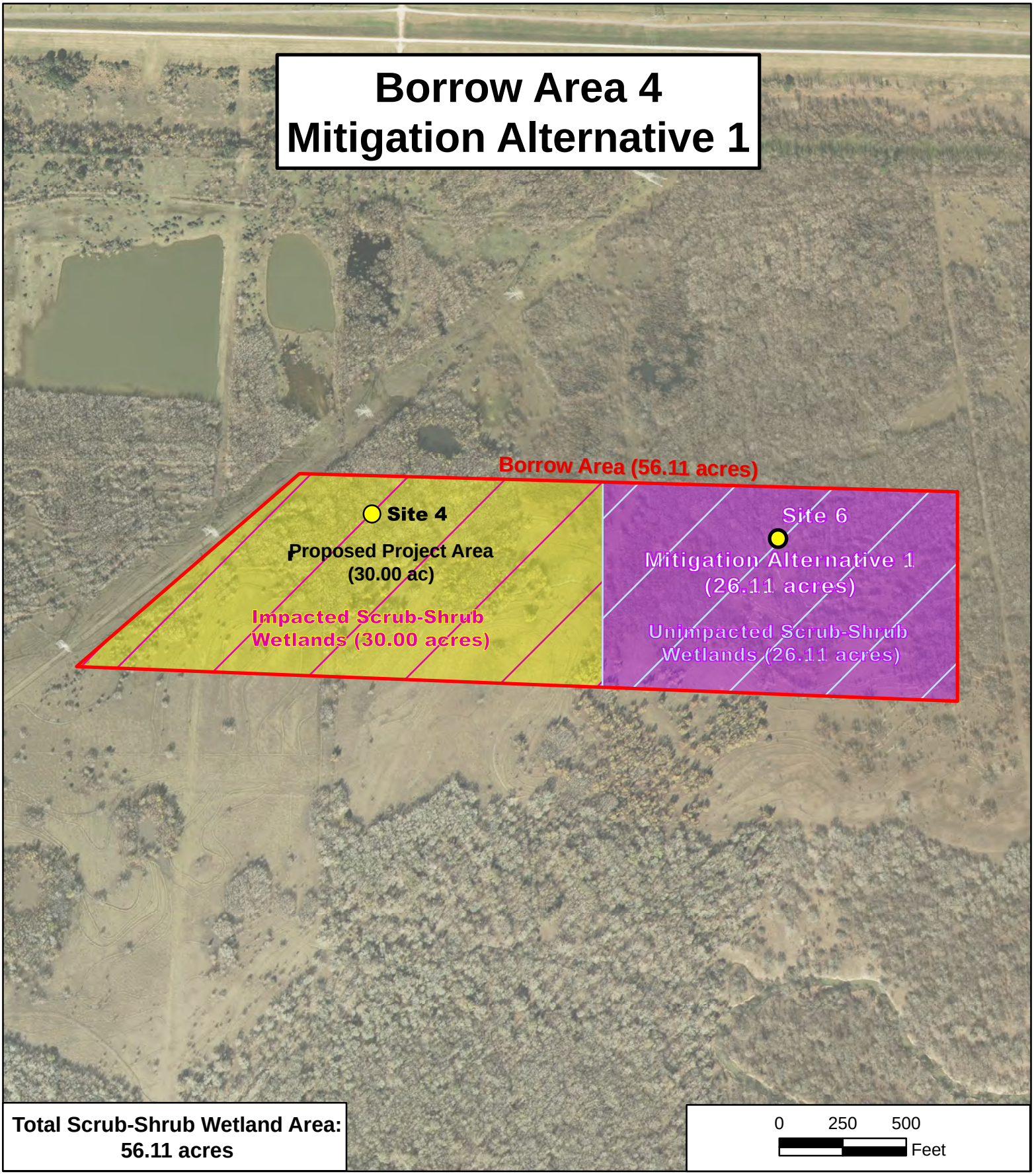
- Borrow Area (120.64 acres)
- Impacted Scrub-Shrub Wetlands (1.40 acres)
- Proposed Project Area (35.00 acres)
- Unimpacted Scrub-Shrub Wetland (73.88 acres)

N

Addicks and Barker
Dam Safety Modification
FIGURE 5
2008 AERIAL PHOTO OF BORROW AREA 3 WITH WETLANDS AND PROPOSED PROJECT AREA

Harris County, Texas

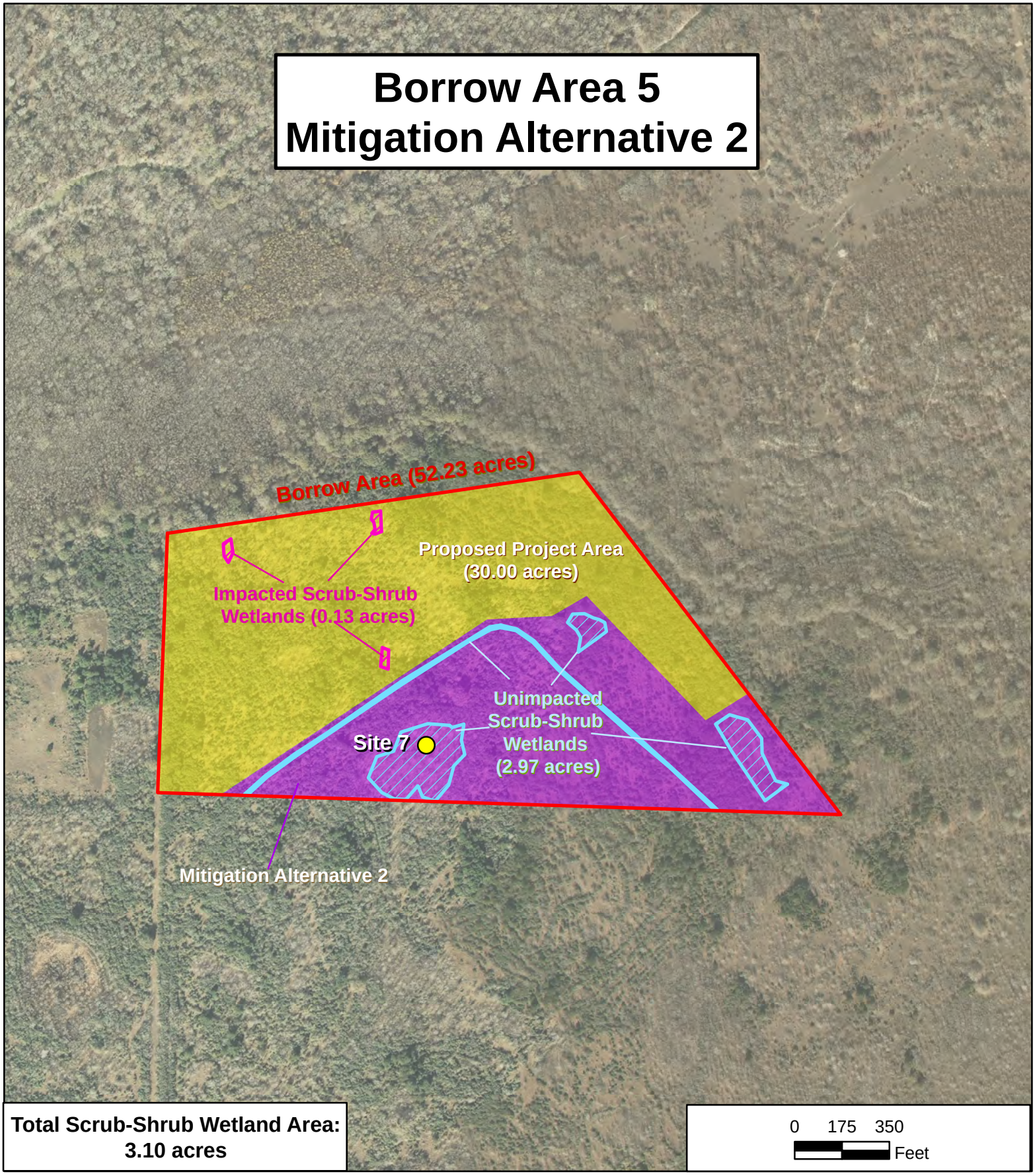


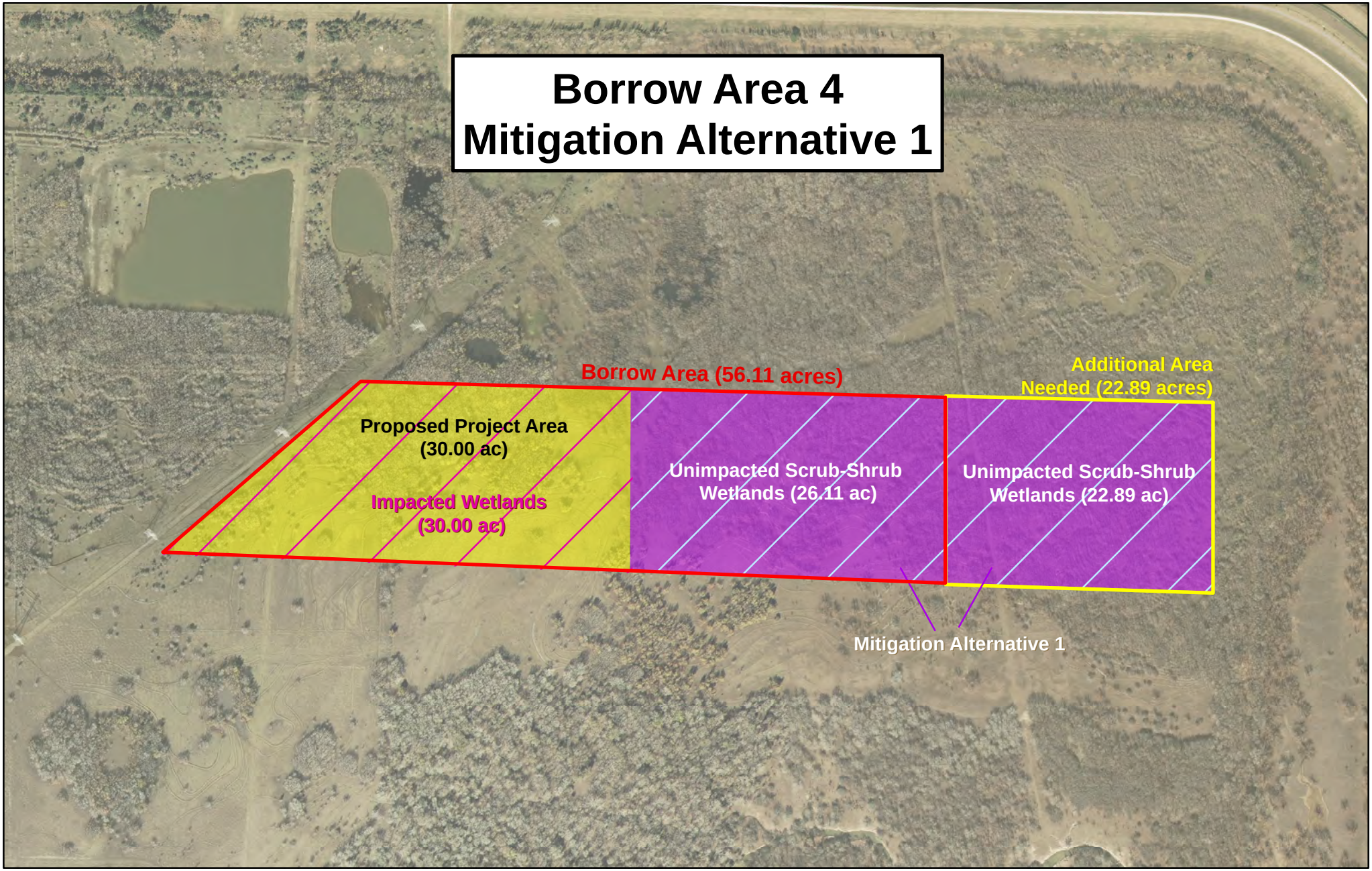
US Army Corps of Engineers ®
Galveston District

- Borrow Area 4 (56.11 acres)
- Unimpacted Scrub-Shrub Wetlands (26.11 acres)
- Impacted Scrub-Shrub Wetlands (30.00 acres)
- Proposed Project Area (30.00 acres)
- Mitigation Alternative 1 (26.11 acres)

N

Addicks and Barker
Dam Safety Modification
FIGURE 6
2008 AERIAL PHOTOGRAPH OF
BORROW AREA 4 WITH PROPOSED ,
PROJECT AREA, MITIGATION ALTERNATIVE 1,
AND EXISTING VEGETATIVE COVER TYPES
Harris County, Texas


Borrow Area 5
Mitigation Alternative 2
Borrow Area (52.23 acres)
Proposed Project Area
(30.00 acres)
Impacted Scrub-Shrub
Wetlands (0.13 acres)
Unimpacted
Scrub-Shrub
Wetlands
(2.97 acres)
Site 7
Mitigation Alternative 2
Total Scrub-Shrub Wetland Area:
3.10 acres
0 175 350
Feet
US Army Corps
of Engineers ®
Galveston District
Borrow Area (52.23 acres)
Impacted Scrub-Shrub Wetlands (0.13 acres)
Proposed Project Area (30.00 acres)
Unimpacted Scrub-Shrub Wetlands (2.97 acres)
Mitigation Alternative 2
N
Addicks and Barker
Dam Safety Modification
FIGURE 7
2008 AERIAL PHOTOGRAPH OF
BORROW AREA 5 WITH PROPOSED
PROJECT AREA, MITIGATION ALTERNATIVE 2,
AND EXISTING VEGETATIVE COVER
Harris County, Texas



US Army Corps of Engineers ®
Galveston District

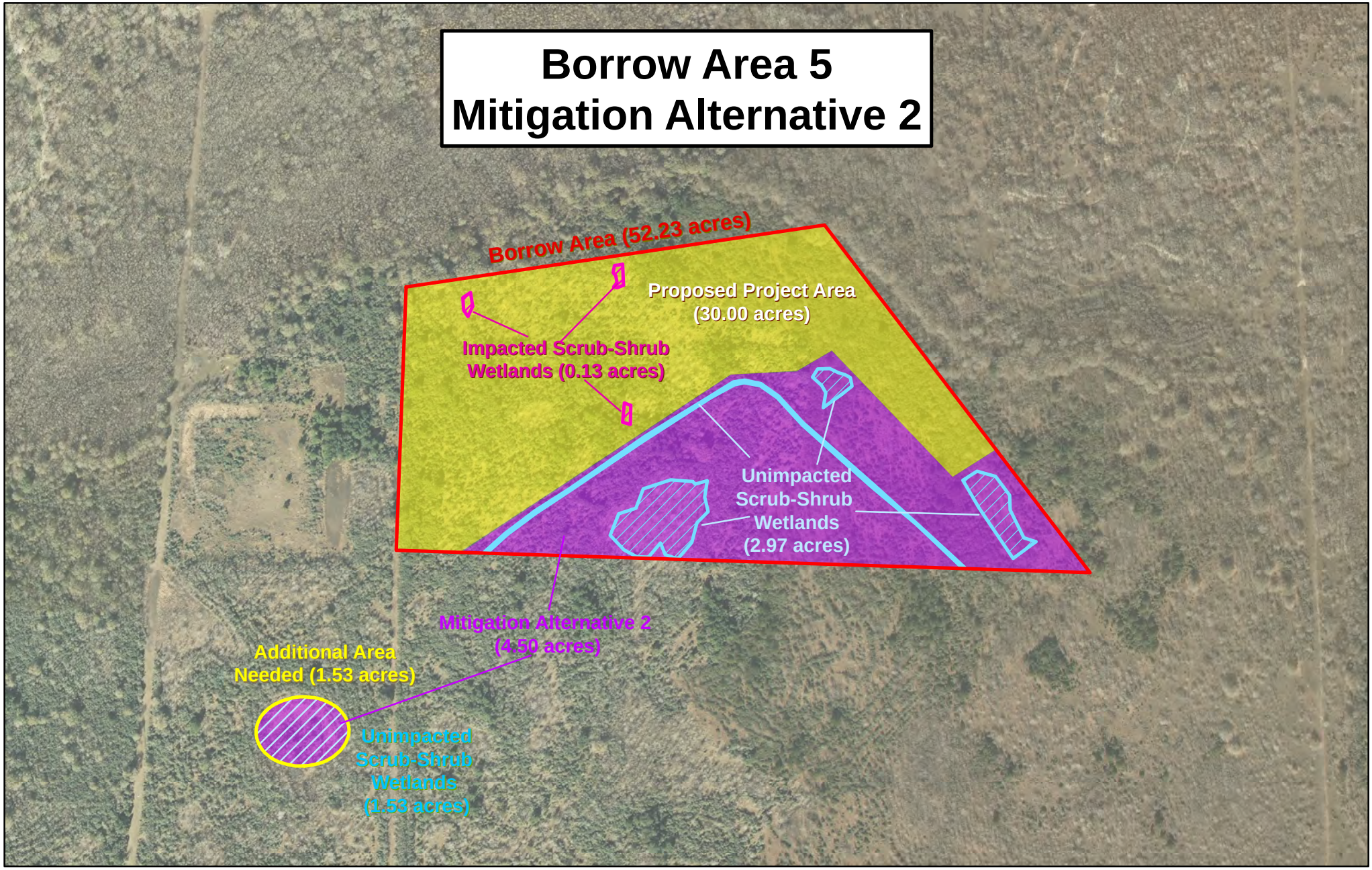
- Proposed Project (30.00 acres)
- Borrow Area 4 (56.11 acres)
- Impacted Scrub-Shrub Wetlands (30.00 acres)
- Unimpacted Scrub-Shrub Wetlands (26.11 acres)
- Mitigation Alternative 1 (49.00 acres)
- Additional Acreage Needed (22.89 acres)

N

0 250 500
Feet

Addicks and Barker
Dam Safety Modification
FIGURE 8
2008 AERIAL PHOTOGRAPH OF
MITIGATION ALTERNATIVE 1 WITH
ADDITIONAL AREA REQUIREMENTS

Harris County, Texas



US Army Corps of Engineers ®
Galveston District

- Borrow Area (52.23 acres)
- Impacted Scrub-Shrub Wetlands (0.13 acres)
- Proposed Project Area (30.00 acres)
- Unimpacted Scrub-Shrub Wetlands (2.97 acres)
- Mitigation Alternative 2 (4.50 acres)
- Additional Acreage Needed (1.53 acres)

N

0 175 350
Feet

Addicks and Barker
Dam Safety Modification
FIGURE 9
2008 AERIAL PHOTOGRAPH OF
MITIGATION ALTERNATIVE 2 WITH
ADDITIONAL AREA REQUIREMENTS

Harris County, Texas

Appendix B

Field Datasheets

Borrow Area 2/Site 1
Field Datasheets

Cover Type: Emergent Wetlands Species: Slider, Marsh Wren			
Variable		**Optimal Conditions**	**Borrow Area / Site Number** **Borrow Area 2/ Site 1**
Slider			
Variable Name	#	Value	Value
Percent cover of emergent vegetation	V1	**>80%**	80
Water velocity (ft/sec)	V2	**0**	0
Water depth (ft)	V3	**3.2-6.6**	1
Water regime: a) Permanently flooded, b) Intermittently exposed, c) semipermanently flooded, d) seasonally flooded, e) temporarily flooded, f) saturated, g) Intermittently flooded	V4	**A**	E
Water temperature: a) <15°C, b) 15-20°C, c) 20-25°C, d) 25-30°C, e) 30-35°C, f) 35-40°C, g) > 40°C	V5	**D**	D
Marsh Wren			
Variable Name	#	Value	Value
Growth form of emergent hydrophytes: a) cattails, cordgrasses, bulrushes; b) bluejoint reedgrass, reed canary-grass, sedges; c) buttonbush and mangrove; d) other growth forms not listed.	V1	**A**	B
Percent canopy cover of emergent herbaceous vegetation	V2	**80**	80
Mean water depth (cm)	V3	**>15**	30
Percent canopy cover of woody vegetation	V4	**0**	0

Borrow Areas 3 - 5 and Mitigation Alternatives 1 and 2
Field Datasheets

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery								
			Borrow Area/Site number					
Variable		**Optimal Conditions**	**Borrow Area 3 /Site 2**	**Borrow Area 3 /Site 3**	**Borrow Area 4 /Site 4**	**Borrow Area 5 /Site 5**	**Mitigation Alternative 1/Site 6**	**Mitigation Alternative 2/Site 7**
Yellow Warbler								
Variable Name	#	Value	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	60	60	55	75	35
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.5	5	4	5	4
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98	98
Veery								
Variable Name	#	Value	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	15	10	15	10
Percent deciduous shrub crown cover	V3	**>70%**	55	60	60	55	75	35
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.5	5	4	5	4
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	92	90	40	95	55	97
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	75	70	25	55	30	55

Appendix C

Determination of HSI Values for HEP Analysis

Borrow Area 2/Site 1
HSI Worksheets

Cover Type: Emergent Wetlands Species: Slider, Marsh Wren			
Variable		**Optimal Conditions**	**Borrow Area / Site Number** **Borrow Area 2/ Site 1**
Slider			
Variable Name	#	Value	Value
Percent cover of emergent vegetation	V1	**>80%**	80
Water velocity (ft/sec)	V2	**0**	0
Water depth (ft)	V3	**3.2-6.6**	1
Water regime: a) Permanently flooded, b) Intermittently exposed, c) semipermanently flooded, d) seasonally flooded, e) temporarily flooded, f) saturated, g) Intermittently flooded	V4	**A**	E
Water temperature: a) <15°C, b) 15-20°C, c) 20-25°C, d) 25-30°C, e) 30-35°C, f) 35-40°C, g) > 40°C	V5	**D**	D
Emergent Wetlands Model		SI	SI
	SI1	**1.00**	0.91
	SI2	**1.00**	1.00
	SI3	**1.00**	0.13
	SI4	**1.00**	0.20
	SI5	**1.00**	1.00
Suitability of food/cover *= SI1*	SIFC	**1.00**	0.91
Suitability of water *= min(SI1, SI2, SI3)*	SIW	**1.00**	0.13
Suitability of temperature *=SI5*	SIT	**1.00**	1.00
HSI *= min(FSIFC, SIW, SIT)*		**1.00**	0.13
Marsh Wren			
Variable Name	#	Value	Value
Growth form of emergent hydrophytes: a) cattails, cordgrasses, bulrushes; b) bluejoint reedgrass, reed canary-grass, sedges; c) buttonbush and mangrove; d) other growth forms not listed.	V1	**A**	B
Percent canopy cover of emergent herbaceous vegetation	V2	**80**	80
Mean water depth (cm)	V3	**>15**	30
Percent canopy cover of woody vegetation	V4	**0**	0
Emergent Wetlands Model		SI	SI
	SI1	**1.00**	0.50
	SI2	**1.00**	1.00
	SI3	**1.00**	1.00
	SI4	**1.00**	1.00
HSI *=(SI1 x SI2 x SI3)$^{1/3}$ x SI4*		**1.00**	0.79

Borrow Areas 3 - 5 and Mitigation Alternatives 1 and 2
HSI Worksheets

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery								
			Borrow Area/Site number					
Variable		**Optimal Conditions**	**Borrow Area 3 /Site 2**	**Borrow Area 3 /Site 3**	**Borrow Area 4 /Site 4**	**Borrow Area 5 /Site 5**	**Mitigation Alternative 1 /Site 6**	**Mitigation Alternative 2 /Site 7**
Yellow Warbler								
Variable Name	#	Value	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	60	60	55	75	35
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.5	5	4	5	4
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.92	1.00	1.00	0.92	1.00	0.58
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.95	0.99	0.99	0.95	0.99	0.76
HSI *= Reproduction*		**1.00**	**0.95**	**0.99**	**0.99**	**0.95**	**0.99**	**0.76**
Veery								
Variable Name	#	Value	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	15	10	15	10
Percent deciduous shrub crown cover	V3	**>70%**	55	60	60	55	75	35
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.5	5	4	5	4
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	92	90	40	95	55	97
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	75	70	25	55	30	55
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.85	0.90	0.85	0.90
	SI3	**1.00**	0.70	0.80	0.80	0.70	1.00	0.30
	SI4	**1.00**	0.63	0.63	0.50	0.75	0.50	0.75
	SI5	**1.00**	1.00	1.00	0.17	1.00	0.42	1.00
	SI6	**1.00**	1.00	1.00	0.83	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	1.05	1.09	0.70	1.10	0.88	0.88
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**0.70**	**1.00**	**0.88**	**0.88**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Appendix C.2

Projected HSI Value Worksheets

Borrow Area 2/Site 1 Target Year Projections
No Action Scenario

Cover Type: Emergent Wetlands Species: Slider, Marsh Wren						
			Borrow Area / Site Number			
Variable		**Optimal Conditions**	**Borrow Area 2/Site 1 Y0**	**Borrow Area 2/Site 1 Y1**	**Borrow Area 2/Site 1 Y2**	**Borrow Area 2/Site 1 Y3**
Slider						
Variable Name	#	Value	Value	Value	Value	Value
Percent cover of emergent vegetation	V1	**>80%**	80	80	80	80
Water velocity (ft/sec)	V2	**0**	0	0	0	0
Water depth (ft)	V3	**3.2-6.6**	1	1	1	1
Water regime: a) Permanently flooded, b) Intermittently exposed, c) semipermanently flooded, d) seasonally flooded, e) temporarily flooded, f) saturated, g) Intermittently flooded	V4	**A**	E	E	E	E
Water temperature: a) <15°C, b) 15-20°C, c) 20-25°C, d) 25-30°C, e) 30-35°C, f) 35-40°C, g) > 40°C	V5	**D**	D	D	D	D
Emergent Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.91	0.91	0.91	0.91
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.13	0.13	0.13	0.13
	SI4	**1.00**	0.20	0.20	0.20	0.20
	SI5	**1.00**	1.00	1.00	1.00	1.00
Suitability of food/cover *= SI1*	SIFC	**1.00**	0.91	0.91	0.91	0.91
Suitability of water *= min(SI1, SI2, SI3)*	SIW	**1.00**	0.13	0.13	0.13	0.13
Suitability of temperature *=SI5*	SIT	**1.00**	1.00	1.00	1.00	1.00
HSI *= min(FSIFC, SIW, SIT)*		**1.00**	0.13	0.13	0.13	0.13
Marsh Wren						
Variable Name	#	Value	Value	Value	Value	Value
Growth form of emergent hydrophytes: a) cattails, cordgrasses, bulrushes; b) bluejoint reedgrass, reed canary-grass, sedges; c) buttonbush and mangrove; d) other growth forms not listed.	V1	**A**	B	B	B	B
Percent canopy cover of emergent herbaceous vegetation	V2	**80**	80	80	80	80
Mean water depth (cm)	V3	**>15**	30	30	30	30
Percent canopy cover of woody vegetation	V4	**0**	0	0	0	0
Emergent Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.50	0.50	0.50	0.50
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	1.00	1.00	1.00	1.00
	SI4	**1.00**	1.00	1.00	1.00	1.00
HSI $=(SI1 \times SI2 \times SI3)^{1/3} \times SI4$		**1.00**	0.79	0.79	0.79	0.79

Borrow Area 3/Site 2 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery						
			Borrow Area/Site number			
Variable		**Optimal Conditions**	**Borrow Area 3/Site 2 Y0**	**Borrow Area 3/Site 2 Y1**	**Borrow Area 3/Site 2 Y2**	**Borrow Area 3/Site 2 Y3**
Yellow Warbler						
Variable Name	#	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	58	68	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.65	4.75	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.92	0.97	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.95	0.98	0.99	0.77
HSI = *Reproduction*		**1.00**	**0.95**	**0.98**	**0.99**	**0.77**
Veery						
Variable Name	#	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	55	58	68	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.65	4.75	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	92	82	68	42
Average height of herbaceous canopy (cm)(late spring/early summer conditions)	V6	**>30 cm**	75	75	75	75
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.70	0.76	0.96	1.00
	SI4	**1.00**	0.63	0.59	0.56	0.50
	SI5	**1.00**	1.00	0.87	0.64	0.20
	SI6	**1.00**	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	1.05	1.02	1.02	0.84
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**1.00**	**0.84**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 3/Site 3 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery						
			Borrow Area/Site number			
Variable		**Optimal Conditions**	**Borrow Area 3/Site 3 Y0**	**Borrow Area 3/Site 3 Y1**	**Borrow Area 3/Site 3 Y2**	**Borrow Area 3/Site 3 Y3**
Yellow Warbler						
Variable Name	#	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	60	62	72	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.65	4.75	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98
Reproduction *= (V1 x V2 x V3)* $^{1/2}$		**1.00**	0.99	0.99	0.99	0.77
HSI *= Reproduction*		**1.00**	**0.99**	**0.99**	**0.99**	**0.77**
Veery						
Variable Name	#	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	60	62	72	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.65	4.75	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**> 90%**	90	87	72	47
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	70	70	70	70
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.80	0.84	1.00	1.00
	SI4	**1.00**	0.63	0.59	0.56	0.50
	SI5	**1.00**	1.00	0.95	0.70	0.28
	SI6	**1.00**	1.00	1.00	1.00	1.00
HSI *= SI1 x [(SI3 x SV4)* $^{1/2}$ *+ 0.5 x (SI5 x SI6)* $^{1/2}$ *]*		**1.50**	1.09	1.07	1.05	0.88
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**1.00**	**0.88**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 4/Site 4 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Borrow Area 4/Site 4 Y0**	**Borrow Area 4/Site 4 Y1**	**Borrow Area 4/Site 4 Y2**	**Borrow Area 4/Site 4 Y3**	**Borrow Area 4/Site 4 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	60	64	65	70	100
Average height of deciduous shrub canopy (m)	V2	**>2**	5	5.15	5.2	5.4	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	1.00	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.99	0.99	0.99	0.99	0.77
HSI = *Reproduction*		**1.00**	**0.99**	**0.99**	**0.99**	**0.99**	**0.77**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	15	15	15	15	15
Percent deciduous shrub crown cover	V3	**>70%**	60	64	65	70	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	5	5.15	5.2	5.4	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**> 90%**	40	40	40	40	40
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	25	25	25	25	25
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.85	0.85	0.85	0.85	0.85
	SI3	**1.00**	0.80	0.88	0.90	1.00	1.00
	SI4	**1.00**	0.50	0.50	0.50	0.50	0.50
	SI5	**1.00**	0.17	0.17	0.17	0.17	0.17
	SI6	**1.00**	0.83	0.83	0.83	0.83	0.83
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.70	0.72	0.73	0.76	0.76
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.70**	**0.72**	**0.73**	**0.76**	**0.76**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 5/Site 5 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Borrow Area 5/Site 5 Y0**	**Borrow Area 5/Site 5 Y1**	**Borrow Area 5/Site 5 Y2**	**Borrow Area 5/Site 5 Y3**	**Borrow Area 5/Site 5 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	59	60	70	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4	4.15	4.2	4.7	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.92	0.99	1.00	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.95	0.98	0.99	0.99	0.77
HSI $=$ *Reproduction*		**1.00**	**0.95**	**0.98**	**0.99**	**0.99**	**0.77**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	55	59	60	70	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4	4.15	4.2	4.7	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	95	82	80	70	55
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	55	55	55	55	55
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.70	0.78	0.80	1.00	1.00
	SI4	**1.00**	0.75	0.71	0.70	0.58	0.50
	SI5	**1.00**	1.00	0.87	0.84	0.67	0.42
	SI6	**1.00**	1.00	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	1.10	1.09	1.08	1.05	0.93
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**0.93**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Mitigation Alternative 1/Site 6 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Mitigation Alternative 1 /Site 6 Y0**	**Mitigation Alternative 1 /Site 6 Y1**	**Mitigation Alternative 1 /Site 6 Y2**	**Mitigation Alternative 1 /Site 6 Y3**	**Mitigation Alternative 1 /Site 6 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	75	78	80	85	100
Average height of deciduous shrub canopy (m)	V2	**>2**	5	5.15	5.2	5.4	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	1.00	0.90	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.99	0.99	0.99	0.94	0.77
HSI *= Reproduction*		**1.00**	**0.99**	**0.99**	**0.99**	**0.94**	**0.77**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	15	15	15	15	15
Percent deciduous shrub crown cover	V3	**>70%**	75	78	80	85	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	5	5.15	5.2	5.4	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**> 90%**	55	52	50	45	35
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	30	30	30	30	30
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.85	0.85	0.85	0.85	0.85
	SI3	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI4	**1.00**	0.50	0.50	0.50	0.50	0.50
	SI5	**1.00**	0.42	0.37	0.34	0.25	0.08
	SI6	**1.00**	1.00	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.88	0.86	0.85	0.81	0.72
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.88**	**0.86**	**0.85**	**0.81**	**0.72**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Mitigation Alternative 2/Site 7 Target Year Projections
No Action Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Mitigation Alternative 2 /Site 7 Y0**	**Mitigation Alternative 2 /Site 7 Y1**	**Mitigation Alternative 2 /Site 7 Y2**	**Mitigation Alternative 2 /Site 7 Y3**	**Mitigation Alternative 2 /Site 7 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	35	45	47	55	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4	4.15	4.2	4.7	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.58	0.75	0.78	0.92	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.76	0.86	0.88	0.95	0.77
HSI *= Reproduction*		**1.00**	**0.76**	**0.86**	**0.88**	**0.95**	**0.77**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	35	45	47	55	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4	4.15	4.2	4.7	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	97	92	87	83	55
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	55	55	55	55	55
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.30	0.50	0.54	0.70	1.00
	SI4	**1.00**	0.75	0.71	0.70	0.58	0.50
	SI5	**1.00**	1.00	1.00	0.95	0.89	0.42
	SI6	**1.00**	1.00	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.88	0.99	0.99	0.99	0.93
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.88**	**0.99**	**0.99**	**0.99**	**0.93**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 2/Site 1 Target Year Projections
With-Project Scenario

Cover Type: Emergent Wetlands Species: Slider, Marsh Wren						
			Borrow Area / Site Number			
Variable		**Optimal Conditions**	**Borrow Area 2 Y0**	**Borrow Area 2 Y1**	**Borrow Area 2 Y2**	**Borrow Area 2 Y3**
Slider						
Variable Name	#	Value	Value	Value	Value	Value
Percent cover of emergent vegetation	V1	**>80%**	80	0	0	0
Water velocity (ft/sec)	V2	**0**	0	0	0	0
Water depth (ft)	V3	**3.2-6.6**	1	0	0	0
Water regime: a) Permanently flooded, b) Intermittently exposed, c) semipermanently flooded, d) seasonally flooded, e) temporarily flooded, f) saturated, g) Intermittently flooded	V4	**A**	E	0	0	0
Water temperature: a) <15°C, b) 15-20°C, c) 20-25°C, d) 25-30°C, e) 30-35°C, f) 35-40°C, g) > 40°C	V5	**D**	D	0	0	0
Emergent Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.91	0.20	0.20	0.20
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.13	0.00	0.00	0.00
	SI4	**1.00**	0.20	0.00	0.00	0.00
	SI5	**1.00**	1.00	0.00	0.00	0.00
Suitability of food/cover *= SI1*	SIFC	**1.00**	0.91	0.20	0.20	0.20
Suitability of water *= min(SI1, SI2, SI3)*	SIW	**1.00**	0.13	0.00	0.00	0.00
Suitability of temperature *=SI5*	SIT	**1.00**	1.00	0.00	0.00	0.00
HSI *= min(FSIFC, SIW, SIT)*		**1.00**	0.13	0.00	0.00	0.00
Marsh Wren						
Variable Name	#	Value	Value	Value	Value	Value
Growth form of emergent hydrophytes: a) cattails, cordgrasses, bulrushes; b) bluejoint reedgrass, reed canary-grass, sedges; c) buttonbush and mangrove; d) other growth forms not listed.	V1	**A**	B	0	0	0
Percent canopy cover of emergent herbaceous vegetation	V2	**80**	80	0	0	0
Mean water depth (cm)	V3	**>15**	30	0	0	0
Percent canopy cover of woody vegetation	V4	**0**	0	0	0	0
Emergent Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.50	0.00	0.00	0.00
	SI2	**1.00**	1.00	0	0	0
	SI3	**1.00**	1.00	0	0	0
	SI4	**1.00**	1.00	1.00	1.00	1.00
HSI *=(SI1 x SI2 x SI3)$^{1/3}$ x SI4*		**1.00**	0.79	0.00	0.00	0.00

Borrow Area 3/Site 2 Target Year Projections
With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery						
			Borrow Area/Site number			
Variable		**Optimal Conditions**	**Borrow Area 3/Site 2 Y0**	**Borrow Area 3/Site 2 Y1**	**Borrow Area 3/Site 2 Y2**	**Borrow Area 3/Site 2 Y3**
Yellow Warbler						
Variable Name	#	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	58	68	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.65	4.75	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.92	0.97	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98
Reproduction *= (V1 x V2 x V3)$^{1/2}$*		**1.00**	0.95	0.98	0.99	0.77
HSI *= Reproduction*		**1.00**	**0.95**	**0.98**	**0.99**	**0.77**
Veery						
Variable Name	#	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	55	58	68	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.65	4.75	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	92	82	68	42
Average height of herbaceous canopy (cm)(late spring/early summer conditions)	V6	**>30 cm**	75	75	75	75
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.70	0.76	0.96	1.00
	SI4	**1.00**	0.63	0.59	0.56	0.50
	SI5	**1.00**	1.00	0.87	0.64	0.20
	SI6	**1.00**	1.00	1.00	1.00	1.00
HSI *= SI1 x [(SI3 x SV4)$^{1/2}$ + 0.5 x (SI5 x SI6)$^{1/2}$]*		**1.50**	1.05	1.02	1.02	0.84
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**1.00**	**0.84**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 3/Site 3 Target Year Projections
With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery						
			Borrow Area/Site number			
Variable		**Optimal Conditions**	**Borrow Area 3/Site 3 Y0**	**Borrow Area 3/Site 3 Y1**	**Borrow Area 3/Site 3 Y2**	**Borrow Area 3/Site 3 Y3**
Yellow Warbler						
Variable Name	#	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	60	62	72	100
Average height of deciduous shrub canopy (m)	V2	**>2**	4.5	4.65	4.75	6
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	1.00	0.60
	SI2	**1.00**	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.99	0.99	0.99	0.77
HSI *= Reproduction*		**1.00**	**0.99**	**0.99**	**0.99**	**0.77**
Veery						
Variable Name	#	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	60	62	72	100
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4.5	4.65	4.75	6
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	90	87	72	47
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	70	70	70	70
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.80	0.84	1.00	1.00
	SI4	**1.00**	0.63	0.59	0.56	0.50
	SI5	**1.00**	1.00	0.95	0.70	0.28
	SI6	**1.00**	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	1.09	1.07	1.05	0.88
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**1.00**	**0.88**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 4/Site 4 Target Year Projections
With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Borrow Area 4/Site 4 Y0**	**Borrow Area 4/Site 4 Y1**	**Borrow Area 4/Site 4 Y2**	**Borrow Area 4/Site 4 Y3**	**Borrow Area 4/Site 4 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	60	64	0	0	0
Average height of deciduous shrub canopy (m)	V2	**>2**	5	5.15	0	0	0
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	0	0	0
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	0.00	0.00	0.00
	SI2	**1.00**	1.00	1.00	0.00	0.00	0.00
	SI3	**1.00**	0.98	0.98	0.10	0.10	0.10
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.99	0.99	0.00	0.00	0.00
HSI *= Reproduction*		**1.00**	**0.99**	**0.99**	**0.00**	**0.00**	**0.00**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	15	15	15	15	15
Percent deciduous shrub crown cover	V3	**>70%**	60	64	0	0	0
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	5	5.15	0	0	0
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	40	40	0	0	0
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	25	25	0	0	0
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.85	0.85	0.85	0.85	0.85
	SI3	**1.00**	0.80	0.88	0.00	0.00	0.00
	SI4	**1.00**	0.50	0.50	0.00	0.00	0.00
	SI5	**1.00**	0.17	0.17	0.00	0.00	0.00
	SI6	**1.00**	0.83	0.83	0.00	0.00	0.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.70	0.72	0.00	0.00	0.00
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.70**	**0.72**	**0.00**	**0.00**	**0.00**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Borrow Area 5/Site 5 Target Year Projections
With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Borrow Area 5/Site 5 Y0**	**Borrow Area 5/Site 5 Y1**	**Borrow Area 5/Site 5 Y2**	**Borrow Area 5/Site 5 Y3**	**Borrow Area 5/Site 5 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	55	59	0	0	0
Average height of deciduous shrub canopy (m)	V2	**>2**	4	4.15	0	0	0
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	0	0	0
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.92	0.99	0.00	0.00	0.00
	SI2	**1.00**	1.00	1.00	0.00	0.00	0.00
	SI3	**1.00**	0.98	0.98	0.10	0.10	0.10
Reproduction *= (V1 x V2 x V3)* $^{1/2}$		**1.00**	0.95	0.98	0.00	0.00	0.00
HSI *= Reproduction*		**1.00**	**0.95**	**0.98**	**0.00**	**0.00**	**0.00**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	55	59	0	0	0
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4	4.15	0	0	0
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	95	82	0	0	0
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	55	55	0	0	0
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.70	0.78	0.00	0.00	0.00
	SI4	**1.00**	0.75	0.71	0.00	0.00	0.00
	SI5	**1.00**	1.00	0.87	0.00	0.00	0.00
	SI6	**1.00**	1.00	1.00	0.00	0.00	0.00
HSI *= SI1 x [(SI3 x SV4)* $^{1/2}$ *+ 0.5 x (SI5 x SI6)* $^{1/2}$ *]*		**1.50**	1.10	1.09	0.00	0.00	0.00
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**1.00**	**1.00**	**0.00**	**0.00**	**0.00**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Mitigation Alternative 1/Site 6 Target Year Projections With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Mitigation Alternative 1 /Site 6 Y0**	**Mitigation Alternative 1 /Site 6 Y1**	**Mitigation Alternative 1 /Site 6 Y2**	**Mitigation Alternative 1 /Site 6 Y3**	**Mitigation Alternative 1 /Site 6 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	75	74	70	70	70
Average height of deciduous shrub canopy (m)	V2	**>2**	5	4.75	2.5	2.5	2.5
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.99	0.99	0.99	0.99	0.99
HSI *= Reproduction*		**1.00**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	15	15	15	15	15
Percent deciduous shrub crown cover	V3	**>70%**	75	74	70	70	70
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	5	4.75	2.5	2.5	2.5
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	55	60	90	90	90
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	30	30	30	30	30
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.85	0.85	0.85	0.85	0.85
	SI3	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI4	**1.00**	0.50	0.56	1.00	1.00	1.00
	SI5	**1.00**	0.42	0.50	1.00	1.00	1.00
	SI6	**1.00**	1.00	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.88	0.94	1.28	1.28	1.28
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.88**	**0.94**	**1.00**	**1.00**	**1.00**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Mitigation Alternative 2/Site 7 Target Year Projections With-Project Scenario

Cover Type: Scrub-Shrub Wetlands Species: Yellow Warbler, Veery							
			Borrow Area/Site number				
Variable		**Optimal Conditions**	**Mitigation Alternative 2 /Site 7 Y0**	**Mitigation Alternative 2 /Site 7 Y1**	**Mitigation Alternative 2 /Site 7 Y2**	**Mitigation Alternative 2 /Site 7 Y3**	**Mitigation Alternative 2 /Site 7 Y4**
Yellow Warbler							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent deciduous shrub crown cover	V1	**60-80%**	35	65	70	70	70
Average height of deciduous shrub canopy (m)	V2	**>2**	4	3.25	2.5	2.5	2.5
Percent of deciduous shrub canopy comprised by hydrophytic shrubs	V3	**100**	98	98	98	98	98
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.58	1.00	1.00	1.00	1.00
	SI2	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI3	**1.00**	0.98	0.98	0.98	0.98	0.98
Reproduction $= (V1 \times V2 \times V3)^{1/2}$		**1.00**	0.76	0.99	0.99	0.99	0.99
HSI *= Reproduction*		**1.00**	**0.76**	**0.99**	**0.99**	**0.99**	**0.99**
Veery							
Variable Name	#	Value	Value	Value	Value	Value	Value
Percent of the cover type flooded (average spring/early summer conditions)	V1	**0**	10	10	10	10	10
Percent deciduous shrub crown cover	V3	**>70%**	35	65	70	70	70
Average height of deciduous shrubs (m)	V4	**1.5-3.0 m**	4	3.25	2.5	2.5	2.5
Percent herbaceous canopy cover (late spring/early summer conditions)	V5	**>90%**	97	97	97	97	97
Average height of herbaceous canopy (cm) (late spring/early summer conditions)	V6	**>30 cm**	55	55	55	55	55
Scrub-Shrub Wetlands Model		SI	SI	SI	SI	SI	SI
	SI1	**1.00**	0.90	0.90	0.90	0.90	0.90
	SI3	**1.00**	0.30	0.90	1.00	1.00	1.00
	SI4	**1.00**	0.75	0.94	1.00	1.00	1.00
	SI5	**1.00**	1.00	1.00	1.00	1.00	1.00
	SI6	**1.00**	1.00	1.00	1.00	1.00	1.00
HSI $= SI1 \times [(SI3 \times SV4)^{1/2} + 0.5 \times (SI5 \times SI6)^{1/2}]$		**1.50**	0.88	1.28	1.35	1.35	1.35
Adjusted HSI *When calculated HSI is greater than 1, assign an HSI value = 1*		**1.00**	**0.88**	**1.00**	**1.00**	**1.00**	**1.00**

*** Variable V2 is not assessed in the wetlands model. Therefore, V2 has been excluded.**

Appendix C.3

AAHU Value Calculations

Borrow Area 2
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Cumulative HU's	AAHU's
Year Interval	0	3	3	50		
HSI	0.46	0.46	0.46	0.46		
Acres	0.60	0.60	0.60	0.60		
Target Year HU's	0.28	0.28	0.28	0.28		
Interval HU's	0.00	0.83	0.83	13.80	15.46	0.28

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Cumulative HU's	AAHU's
Year Interval	0	3	3	50		
HSI	0.46	0.00	0.00	0.00		
Acres	0.60	0.00	0.00	0.00		
Target Year HU's	0.28	0.00	0.00	0.00		
Interval HU's	0.00	0.21	0.00	0.00	0.21	0.00*

*0.0037

Borrow Area 3
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Cumulative HU's	AAHU's
Year Interval	0	3	3	50		
HSI	0.99	0.99	1.00	0.82		
Acres	75.28	75.28	75.28	75.28		
Target Year HU's	74.53	74.53	75.28	61.73		
Interval HU's	0.00	223.58	224.71	3425.24	3873.53	69.17

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Cumulative HU's	AAHU's
Year Interval	0	3	3	50		
HSI	0.99	0.99	1.00	0.82		
Acres	75.28	73.88	73.88	73.88		
Target Year HU's	74.53	73.14	73.88	60.58		
Interval HU's	0.00	221.50	220.53	3361.54	3803.57	67.92

Borrow Area 4
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.85	0.86	0.86	0.88	0.76		
Acres	30.00	30.00	30.00	30.00	30.00		
Target Year HU's	25.50	25.80	25.80	26.40	22.80		
Interval HU's	0.00	76.95	25.80	78.30	1250.00	1431.05	25.11

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.85	0.86	0.00	0.00	0.00		
Acres	30.00	30.00	30.00	30.00	30.00		
Target Year HU's	25.50	25.80	0.00	0.00	0.00		
Interval HU's	0.00	76.95	12.90	0.00	0.00	89.85	1.58

Borrow Area 5
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.98	0.99	1.00	1.00	0.85		
Acres	0.13	0.13	0.13	0.13	0.13		
Target Year HU's	0.13	0.13	0.13	0.13	0.11		
Interval HU's	0.00	0.38	0.13	0.39	6.18	7.08	0.12

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.98	0.99	0.00	0.00	0.00		
Acres	0.13	0.13	0.13	0.13	0.13		
Target Year HU's	0.13	0.13	0.00	0.00	0.00		
Interval HU's	0.00	0.38	0.06	0.00	0.00	0.45	0.01

Mitigation Alternative 1 (Borrow Area 4)
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.94	0.93	0.92	0.88	0.75		
Acres	26.11	26.11	26.11	26.11	26.11		
Target Year HU's	24.54	24.28	24.02	22.98	19.58		
Interval HU's	0.00	73.24	24.15	70.50	1109.68	1277.56	22.41

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.94	0.97	1.00	1.00	1.00		
Acres	26.11	49.00	49.00	49.00	49.00		
Target Year HU's	24.54	47.53	49.00	49.00	49.00		
Interval HU's	0.00	107.60	48.27	147.00	2450.00	2752.86	48.30

Mitigation Alternative 2 (Borrow Area 5)
AAHU Calculations

No Action AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.82	0.93	0.94	0.97	0.85		
Acres	2.97	2.97	2.97	2.97	2.97		
Target Year HU's	2.44	2.76	2.79	2.88	2.52		
Interval HU's	0.00	7.80	2.78	8.51	136.62	155.70	2.73

With-Project AAHU Values

	Y0	Y1	Y2	Y3	Y4	Cumulative HU's	AAHU's
Year Interval	0	3	1	3	50		
HSI	0.82	1.00	1.00	1.00	1.00		
Acres	2.97	4.50	4.50	4.50	4.50		
Target Year HU's	2.44	4.50	4.50	4.50	4.50		
Interval HU's	0.00	10.20	4.50	13.50	225.00	253.20	4.44

Cost-Effectiveness/Incremental Cost Analysis

For

Addicks and Barker Dam Safety Modification
Harris County, Texas

17 October 2012

Introduction

Addicks and Barker Reservoirs are located in southeast Texas in the San Jacinto River basin approximately 17 miles west of downtown Houston. Both reservoirs, which are owned and operated by the U.S. Army Corps of Engineers, were constructed in the mid-1940's as an integral part of the Buffalo Bayou and Tributaries Project (BBTP). The proposed project for Addicks Reservoir will borrow earthen material from one of three proposed borrow areas (Borrow Areas 1, 2, and 3) located within the Addicks Reservoir. Similarly, the proposed project for Barker Reservoir will borrow earthen material from one of two proposed borrow areas (Borrow Areas 4 and 5) located within the Barker Reservoir. Proposed use of these borrow areas would convert scrub-shrub wetland habitat to exposed earth thereby reducing the areas' habitat value.

Two mitigation alternatives are proposed as potential compensatory mitigation for the lost habitat. Both alternatives include preservation and enhancement of wetlands in conjunction with invasive vegetation species management. Borrow Area 4 is a 56.11-acre tract of scrub-shrub wetlands located in the northeastern portion of Barker Reservoir. If Borrow Area 4 is selected for use, 30 acres will be excavated and the remaining 26.11 acres of scrub-shrub wetland habitat together with an additional 22.89 acres of wetlands adjacent to Borrow Area 4 will be used for Mitigation Alternative 1. Borrow Area 5 includes approximately 49.13-acres of forested uplands and approximately 3.10-acres of scrub-shrub wetlands for a total of 52.23 acres located approximately 0.75 miles south of Mitigation Alternative 1. If Borrow Area 5 is selected for use, 30 acres will be excavated impacting 0.13 acres of scrub-shrub wetland habitat. The remaining 2.97 acres of wetland habitat together with an additional 1.53 acres of wetlands adjacent to Borrow Area 5 will be utilized for Mitigation Alternative 2.

A Habitat Analysis has been conducted to determine the average annual habitat units (AAHU) of the potential borrow areas and the alternative mitigation sites for both the "without project" and "with project" conditions. The results of the Habitat Analysis for the mitigation sites are summarized in Table 1.

Table 1. Total AAHUs for Each Mitigation Alternative

Site	Total without project AAHUs	Total with project AAHUs	Net difference
Mitigation Alternative 1	22.41	48.30	25.89
Mitigation Alternative 2	2.73	4.44	1.71

Cost-Effectiveness/Incremental Cost Analysis

Traditional benefit-cost analyses are not applicable to environmental planning because costs and benefits are expressed in different units; however, cost-effectiveness/incremental cost analysis (CE/ICA) offers plan evaluation approaches that are consistent with the evaluation framework described in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council 1983), referred to as the P&G,. The Institute for Water Resources (IWR) Planning Suite software, formerly called IWR Plan, was used to assist in performing the CE/ICA. Alternative mitigation plans for Addicks and Barker Reservoirs have been evaluated and compared in terms of cost (e.g. maintenance and monitoring) and environmental outputs (habitat units). IWR Planning Suite helps determine if the environmental benefits generated for a project are a best buy, or cost effective, when compared to other alternatives. The Corps' policies for cost effectiveness and incremental cost analysis, Engineer Regulation (ER) 1105-2-100, Appendix E, paragraph E-36, states:

> *Cost effectiveness and incremental cost analysis are two distinct analyses that must be conducted to evaluate the effects of alternative plans. First, it must be shown through cost effectiveness analysis that an alternative restoration plan's output cannot be produced more cost effectively by another alternative. "Cost effective" means that, for a given level of nonmonetary output, no other plan costs less and no other plan yields more output for less money. Subsequently, through incremental cost analysis, a variety of implementable alternatives and various-sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsor's and the Corps capabilities. The subset of cost effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. The most efficient plans are called "Best Buys." They provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output.*

CE/ICA techniques have been used to assist in determining the most cost effective mitigation alternatives and to help determine whether obtaining additional environmental benefits are worth the additional costs. Proposed mitigation alternatives were evaluated in terms of incremental average annual cost per average annual habitat unit using a 50-year period of analysis and the fiscal year (FY) 2012 interest rate of 4.00 percent.

The environmental benefits of plan alternatives (AAHU, Table 1) were input into the IWR Planning Suite along with the average annual costs of each alternative. Since the mitigation sites are on USACE property, there are no first costs for acquisition. The costs associated with the mitigation sites consist of maintenance treatment costs to control invasive species and monitoring costs. It should be noted that treatment would be limited to only the wetland habitat acreage. Treatment costs are $3,200 per acre or $156,800 ($3,200 x 49.00 acres) for mitigation alternative 1 and $14,400 ($3,200 x 4.50 acres) for mitigation alternative 2. Treatment is expected to occur annually for the first 5 years, every other year during the next five years, and once every three years during the remainder of the 50-year period of analysis. Monitoring costs are estimated to

be $5,500 annually. Average annual costs were calculated for the two mitigation alternatives using the FY 2012 Federal interest rate of 4.00 percent and are shown in Table 2.

Table 2. Average Annual Costs

	Average Annual Treatment Costs	Average Annual Monitoring Costs	Total Average Annual Costs
Mitigation Alternative 1	$77,700	$5,500	$83,200
Mitigation Alternative 2	$7,100	$5,500	$12,600

IWR Planning Suite classifies a plan as cost effective if no other plan provides the same level of output for less cost and if no other plan provides more output for the same or less cost. Saying the same thing in terms of IWR Planning Suite's cost and output parameters, a plan is cost effective if no other plan provides the same value of the output parameter variable with a lower value of the cost parameter variable and if no other plan provides a larger value of the output parameter variable for the same value, or less value, of the cost parameter variable.

IWR Planning Suite also identifies the subset of cost effective plans that are superior financial investments, called "best buys", through incremental cost analysis. Best buys are the most efficient plans at producing the output variable—they provide the greatest increase in the value of the output parameter variable for the least increase in the value of the cost parameter variable. The first best buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the first best-buy, the second best buy is the most efficient plan for producing additional output, and so on.

As shown in Table 3 and Figure 2 Mitigation Alternative 1 is the “best buy” plan.

Table 3. IWR results

Alternative	Cost* (Average Annual $)	Output (Average Annual HU relative to No Action)	Incremental cost	Incremental output	Inc cost per HU	Cost effective?
No Action	$0	0.00	N/A	N/A	N/A	Yes (Best Buy)
Alternative 2	$12,600	1.71	$12,600	1.71	$7,368	No
Alternative 1	$83,100	25.89	$70,500	24.18	$2,916	Yes (Best Buy)

Figure 1 shows the total average annual costs and output for the two mitigation alternatives and Figure 2 depicts the output and the incremental cost per unit for the best buy plan alternatives.

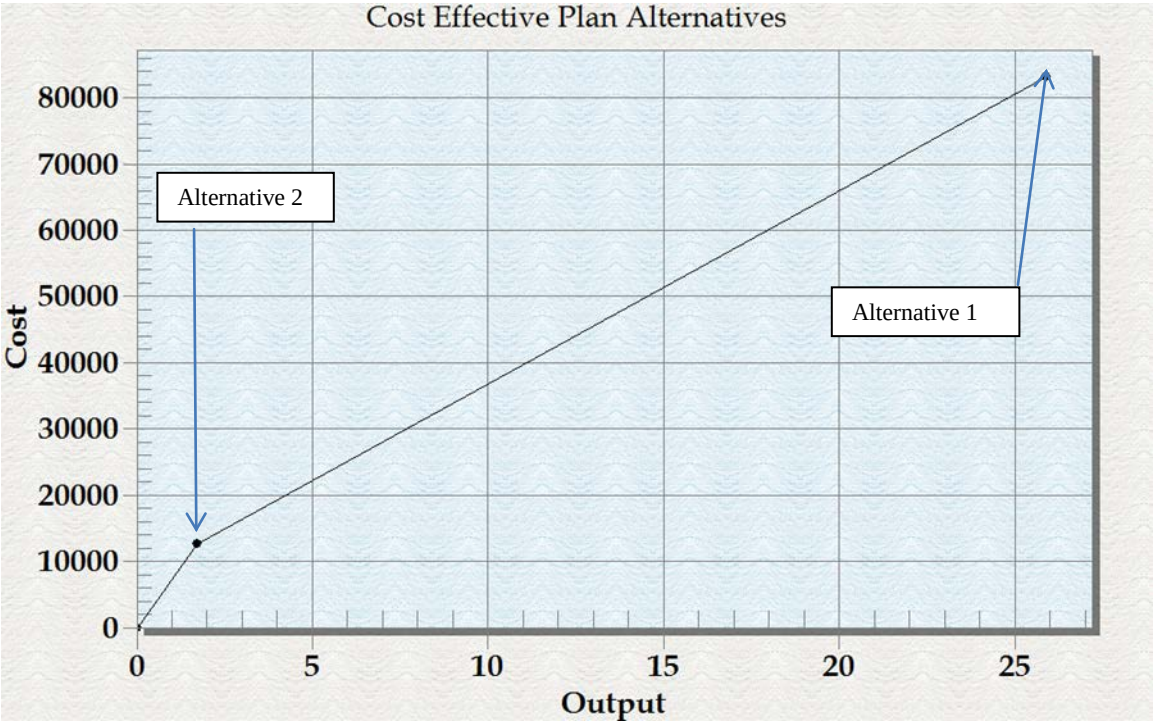


Figure 1. Output versus total average annual costs for best buy alternatives

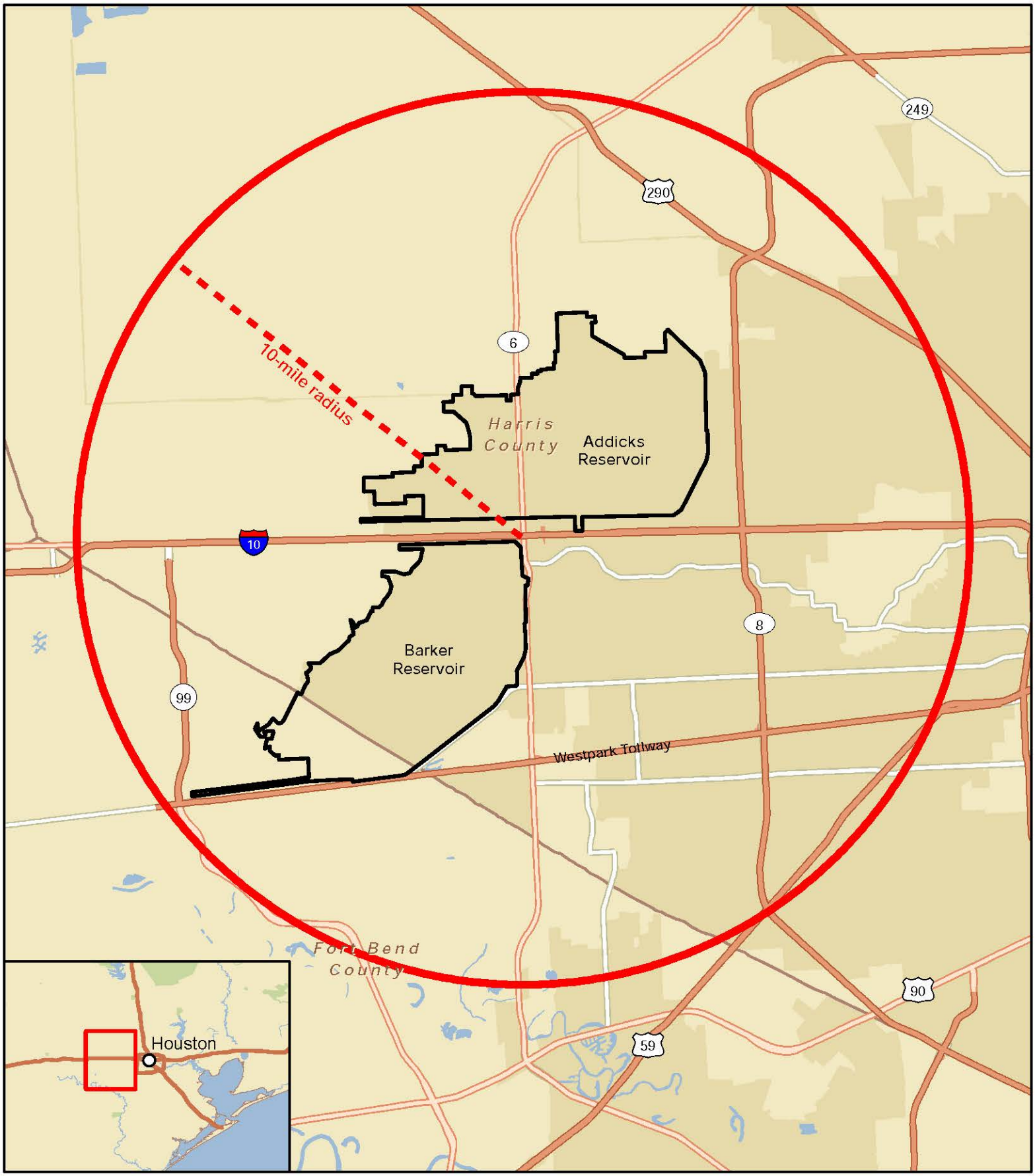
Figure 2. Output versus incremental cost per unit for best buy alternatives

Even though the CE/ICA analysis shows that Mitigation Alternative 2 is the "best buy" alternative, Mitigation Alternative 1 is the least cost plan.

Appendix G

Exhibits

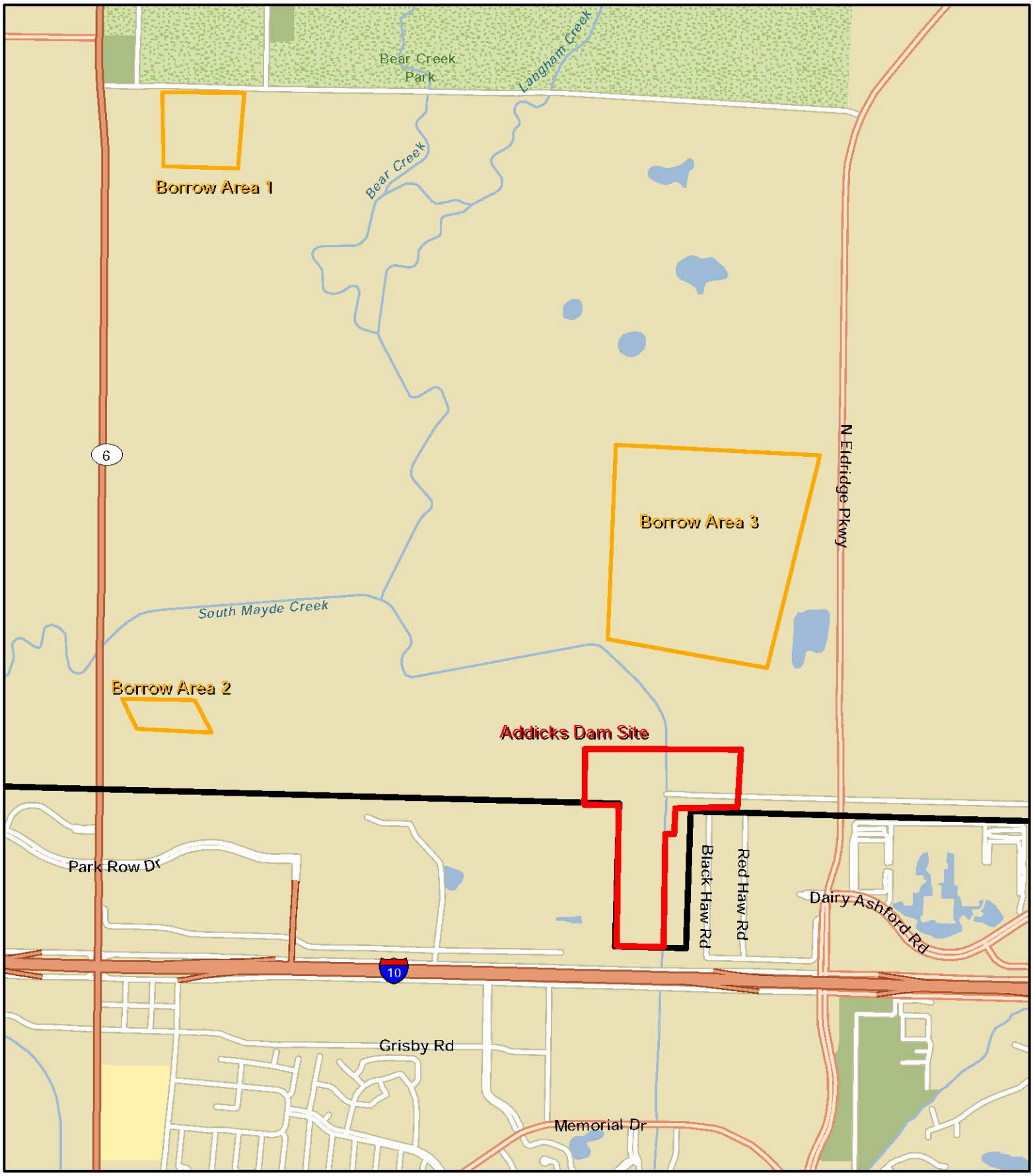
LIST OF EXHIBITS



Addicks and Barker Dam Safety Modification
FIGURE 1

PROJECT STUDY AREA VICINITY MAP

Harris and Fort Bend Counties, Texas



N

0 750 1,500

Feet

Addicks Dam Project Boundary

Potential Borrow Areas

Addicks Reservoir Boundary

US Army Corps of Engineers ®

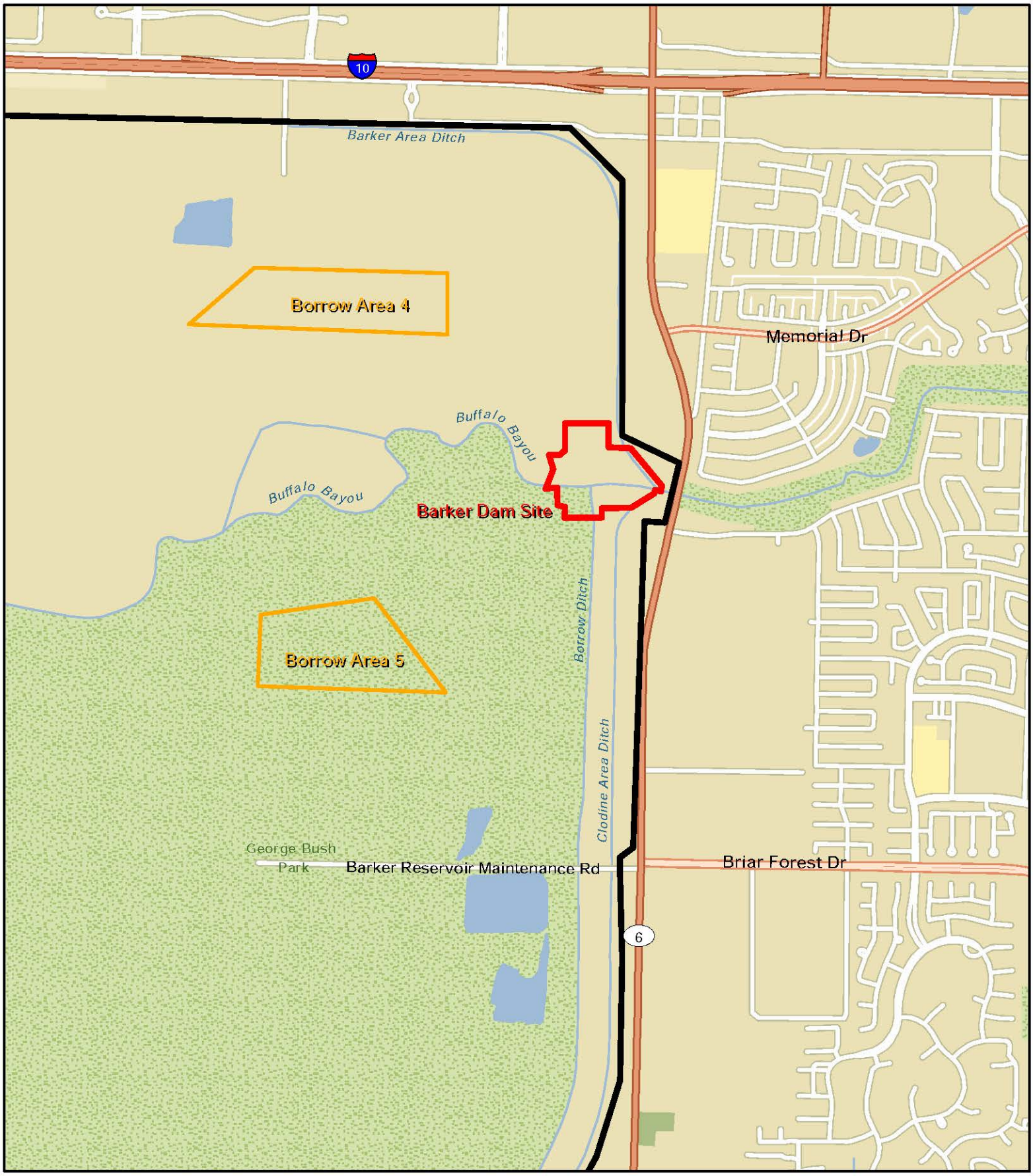
Galveston District

Addicks and Barker Dam Safety Modification

FIGURE 2

ADDICKS RESERVOIR PROPOSED CONSTRUCTION SITES VICINITY MAP

Harris County, Texas



N

0 850 1,700

Feet

Barker Dam Project Area

Potential Borrow Areas

Barker Reservoir Boundary

US Army Corps of Engineers ®

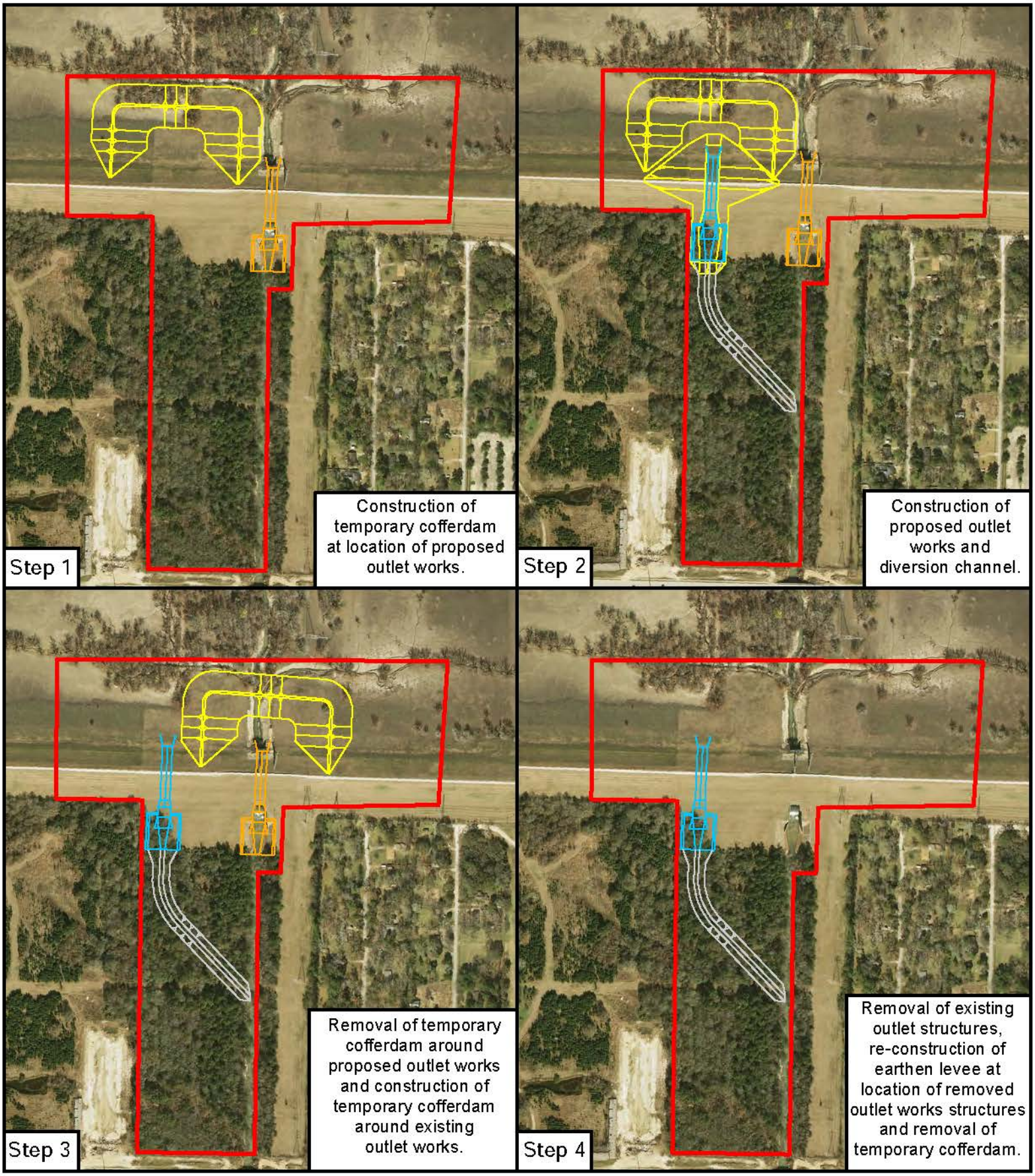
Galveston District

Addicks and Barker Dam Safety Modification

FIGURE 3

BARKER RESERVOIR PROPOSED CONSTRUCTION SITES VICINITY MAP

Harris County, Texas



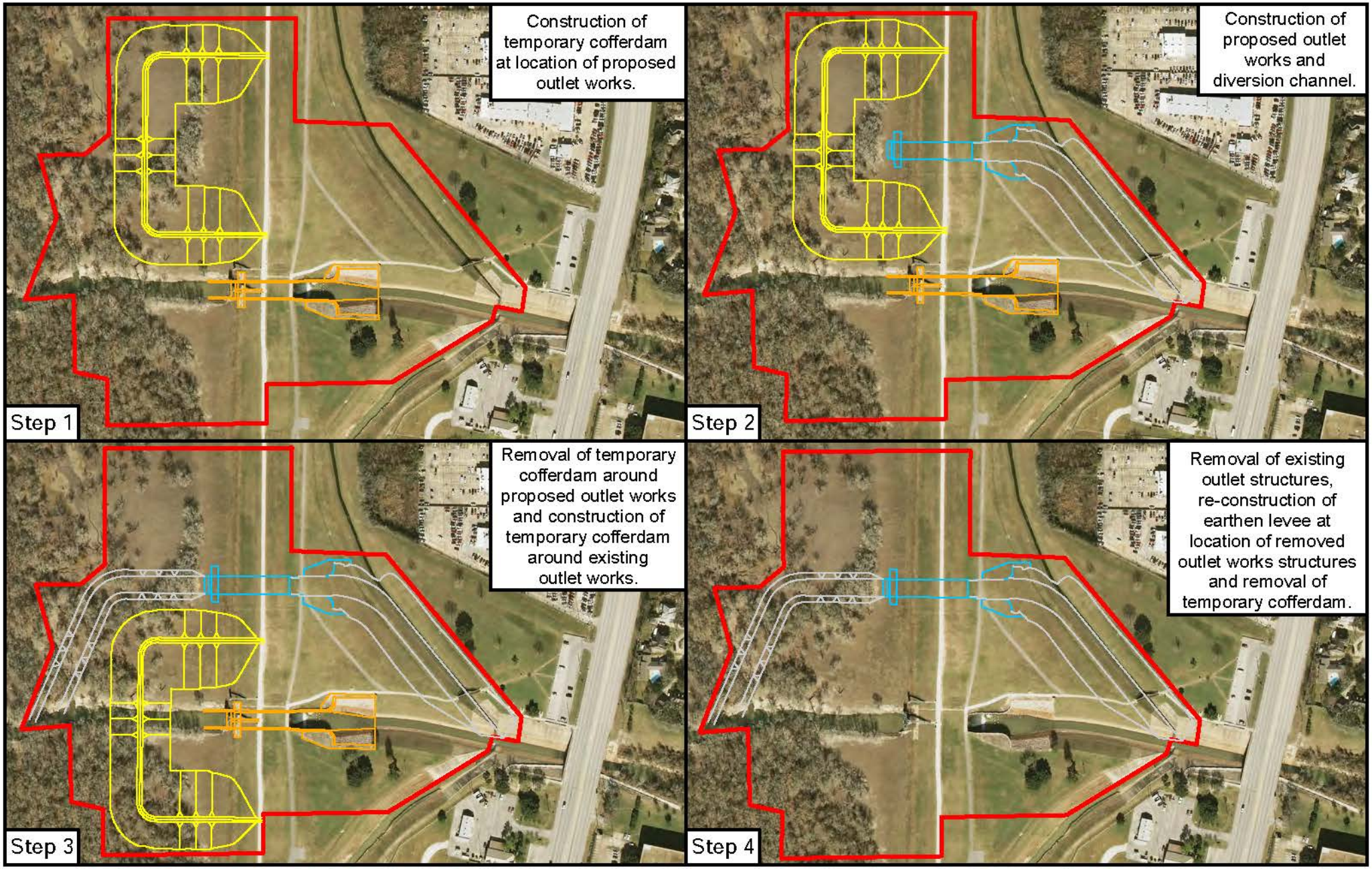
Project Area (50.42 acres)
Existing Outlet Works
Proposed Outlet Works
Diversion Channel
Temporary Cofferdam

N

0 300 600
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 4
2008 AERIAL PHOTOGRAPH WITH PROPOSED CONSTRUCTION SEQUENCE FOR THE PREFERRED ALTERNATIVE AT ADDICKS DAM
Harris County, Texas



Project Area (28.89 acres)
Existing Outlet Works
Proposed Outlet Works
Diversion Channel
Temporary Cofferdam

N

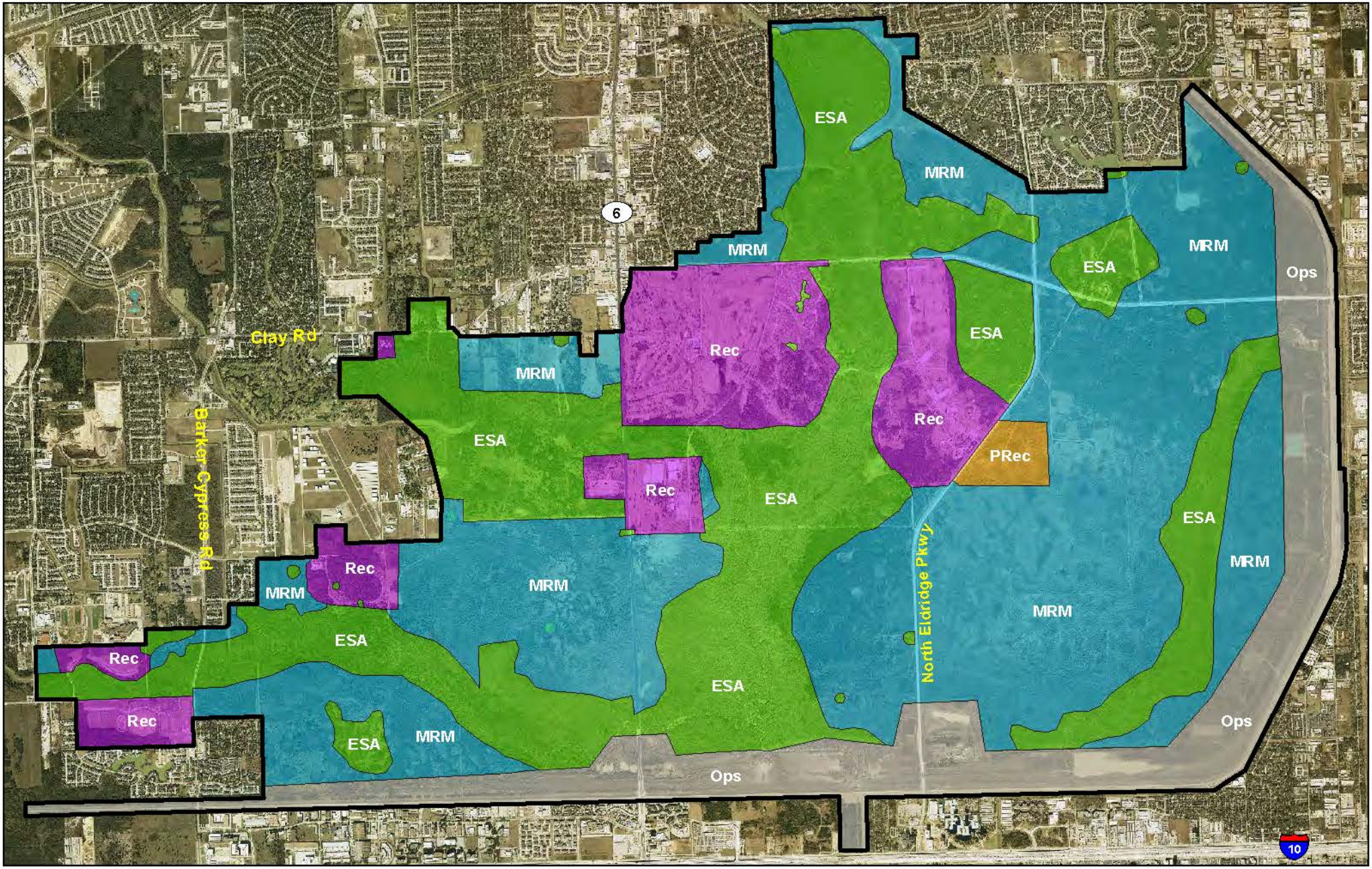
0 200 400
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 5

2008 AERIAL PHOTOGRAPH WITH PROPOSED CONSTRUCTION SEQUENCE FOR THE PREFERRED ALTERNATIVE AT BARKER DAM

Harris County, Texas



Addicks Reservoir
Recreation (Rec)
Proposed Recreation (PRec)
Project Operations (Ops)
Multiple Resource Management (MRM)
Environmentally Sensitive Area (ESA)

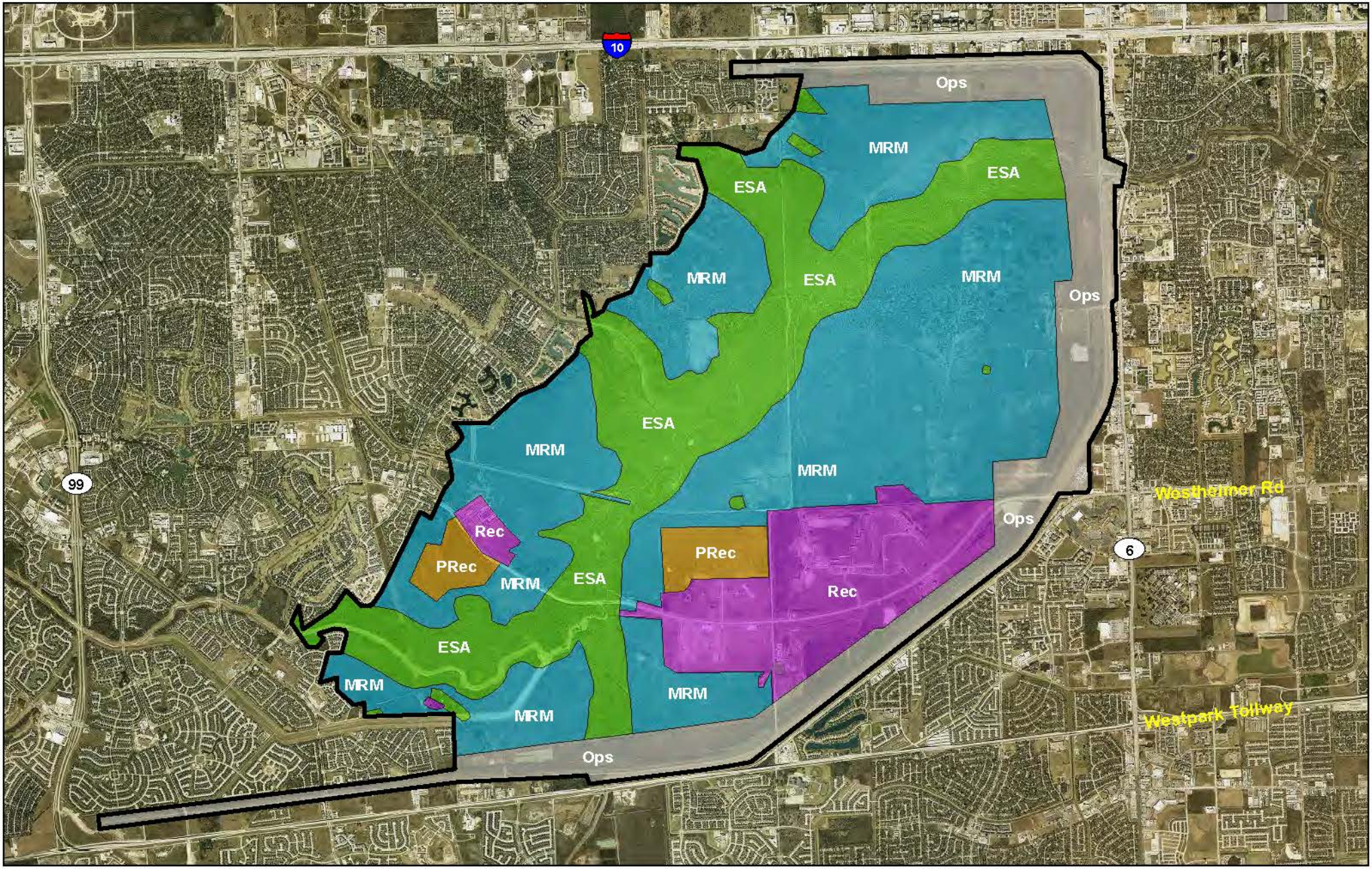
N

0 2,000 4,000
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 6
2008 AERIAL PHOTOGRAPH WITH 2009 MASTER PLAN LAND USE CLASSIFICATIONS FOR ADDICKS RESERVOIR

Harris County, Texas



Barker Reservoir
Recreation (Rec)
Proposed Recreation (PRec)
Project Operations (Ops)
Multiple Resource Management (MRM)
Environmentally Sensitive Area (ESA)

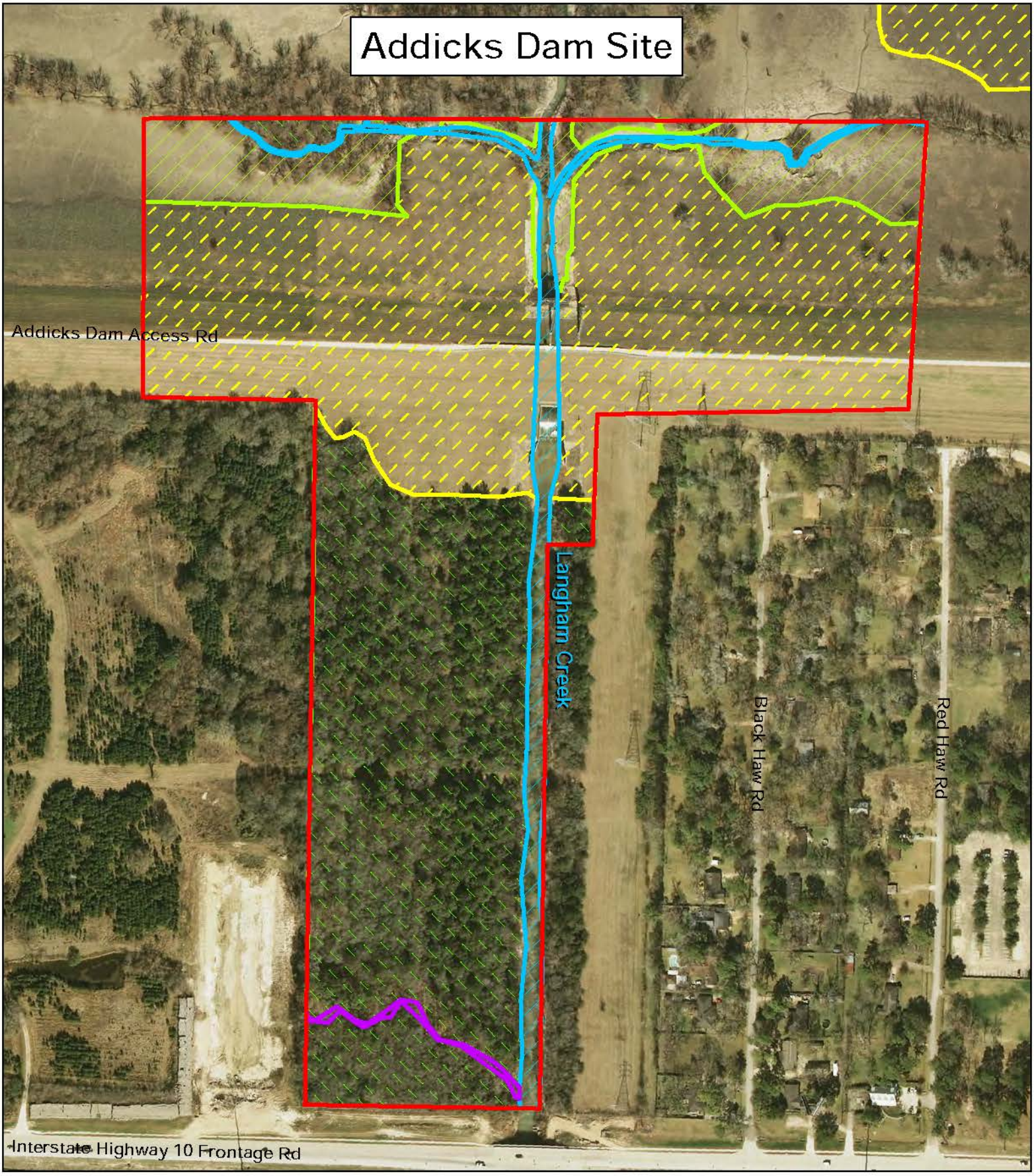
N

0 2,500 5,000
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 7
2008 AERIAL PHOTOGRAPH WITH 2009 MASTER PLAN LAND USE CLASSIFICATIONS FOR BARKER RESERVOIR

Harris County, Texas



Project Area (50.42 acres)
Emergent Wetlands (5.42 acres)
Ephemeral Tributaries (0.15 acres)
Perennial Tributaries (2.70 acres)
Herbaceous Upland (23.65 acres)
Forested Upland (18.44 acres)

N

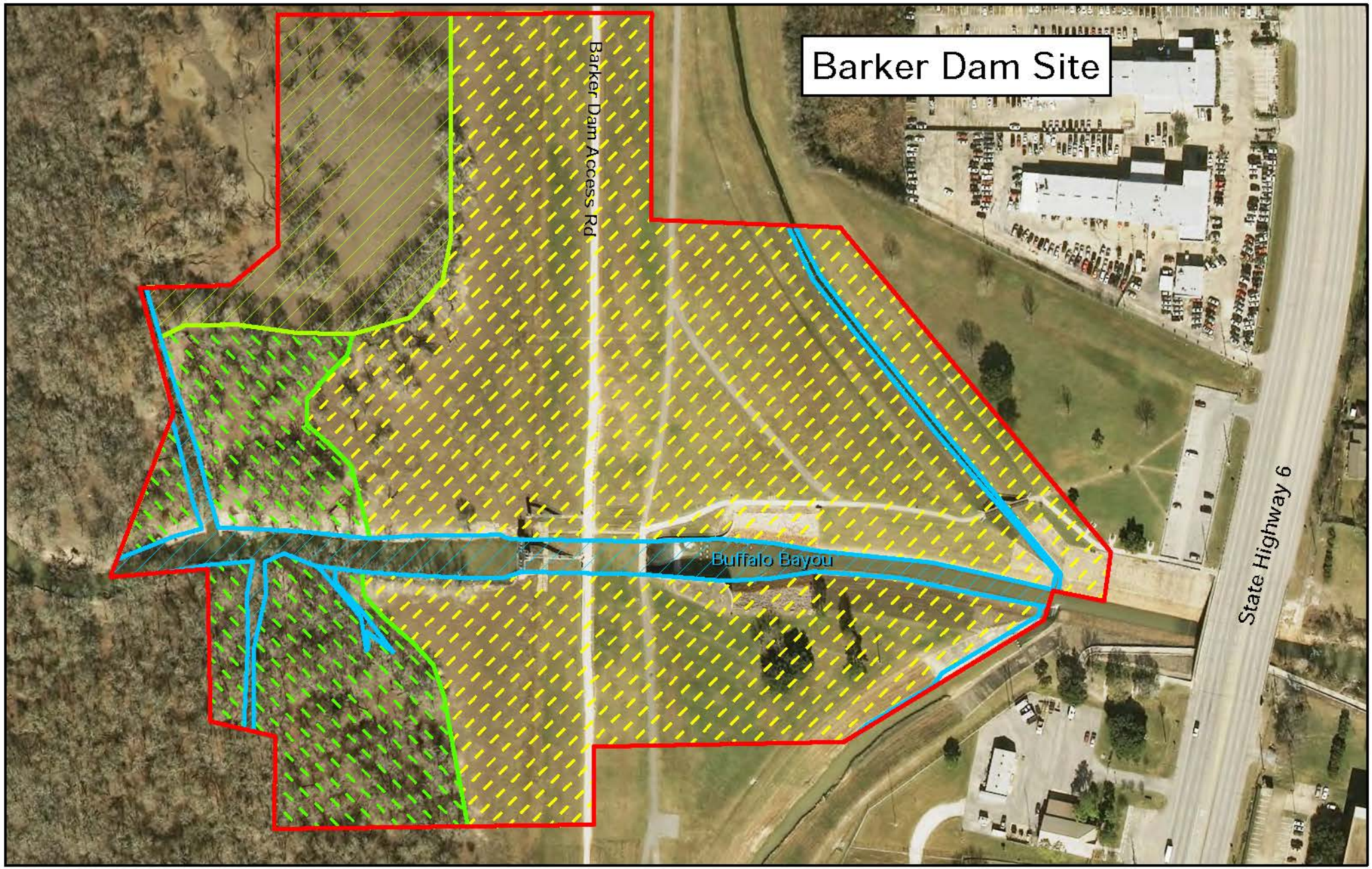
0 150 300
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 8

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Project Area (28.89 acres)
Emergent Wetlands (3.28 acres)
Perennial Tributaries (2.14 acres)
Forested Upland (4.67 acres)
Herbaceous Upland (18.80 acres)

N

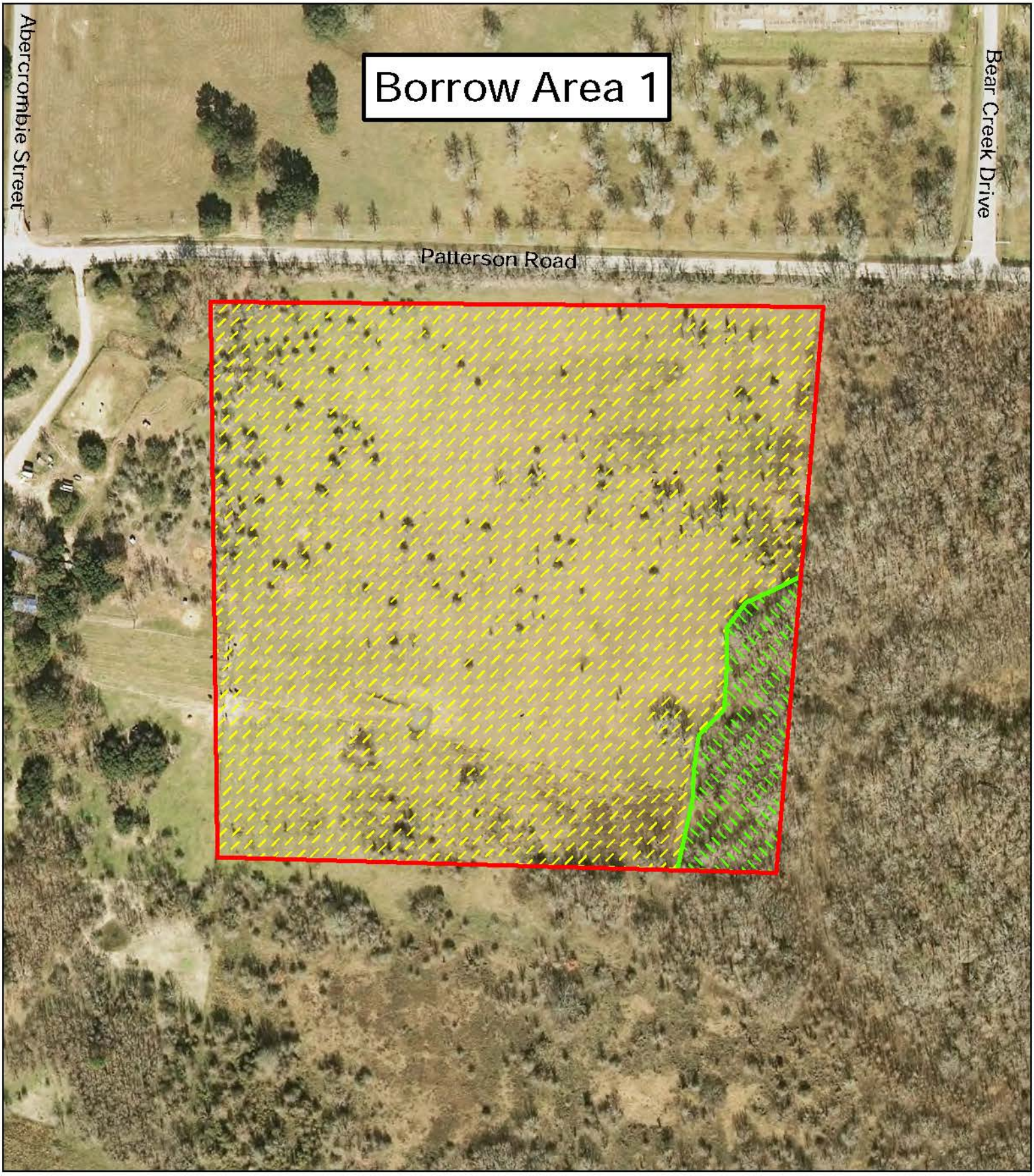
0 100 200
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 9

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Borrow Area 1 (18.74 acres)
Herbaceous Uplands (17.46 acres)
Forested Uplands (1.28 acres)

N

0 100 200 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 10

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas

Borrow Area 2 (7.27 acres)
Herbaceous Uplands (6.67 acres)
Emergent Wetlands (0.60 acres)

N

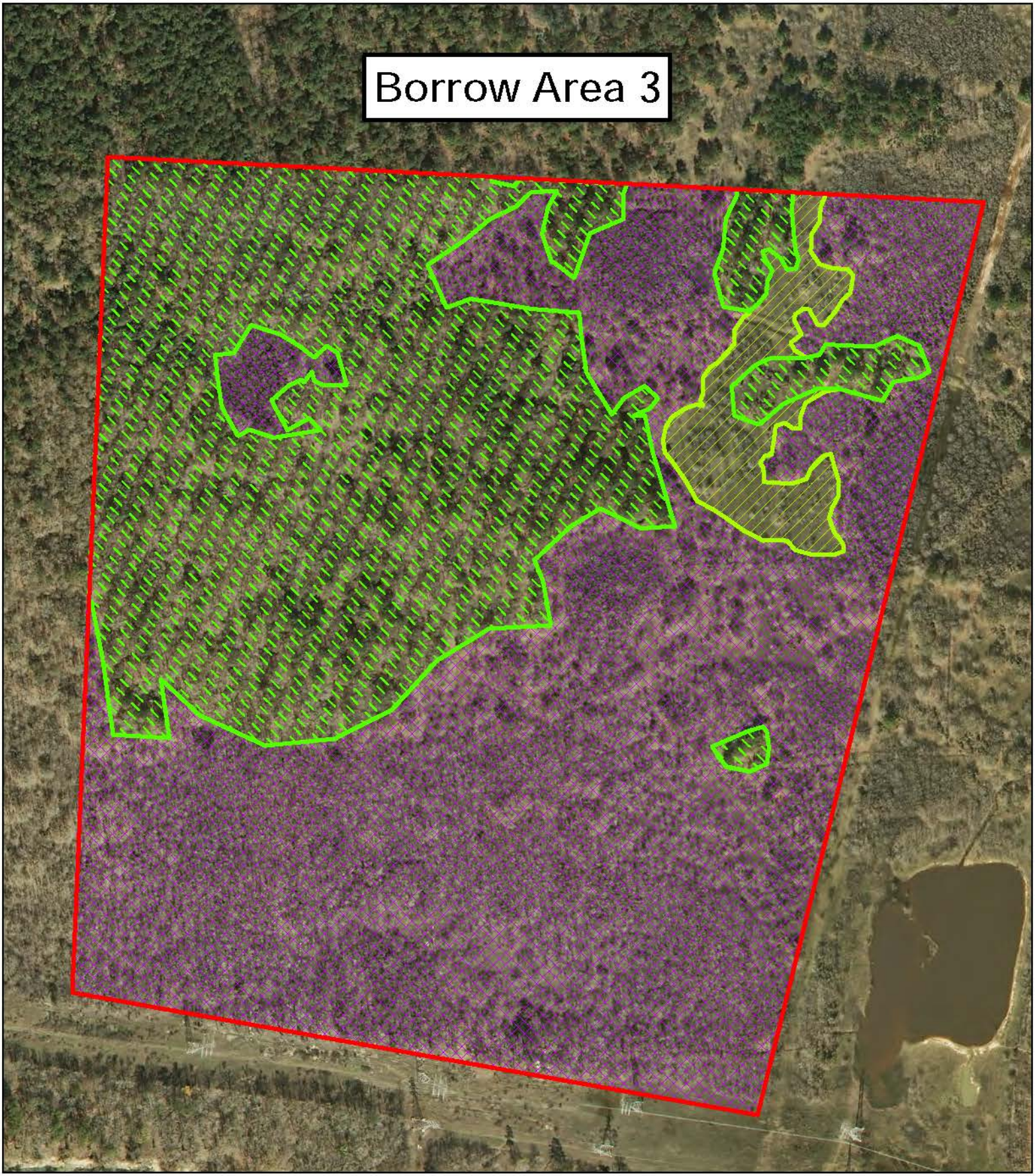
0 75 150 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 11

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Borrow Area 3 (120.64 acres)
Emergent Wetlands (4.56 acres)
Forested Wetlands (70.72 acres)
Forested Uplands (45.36 acres)

N

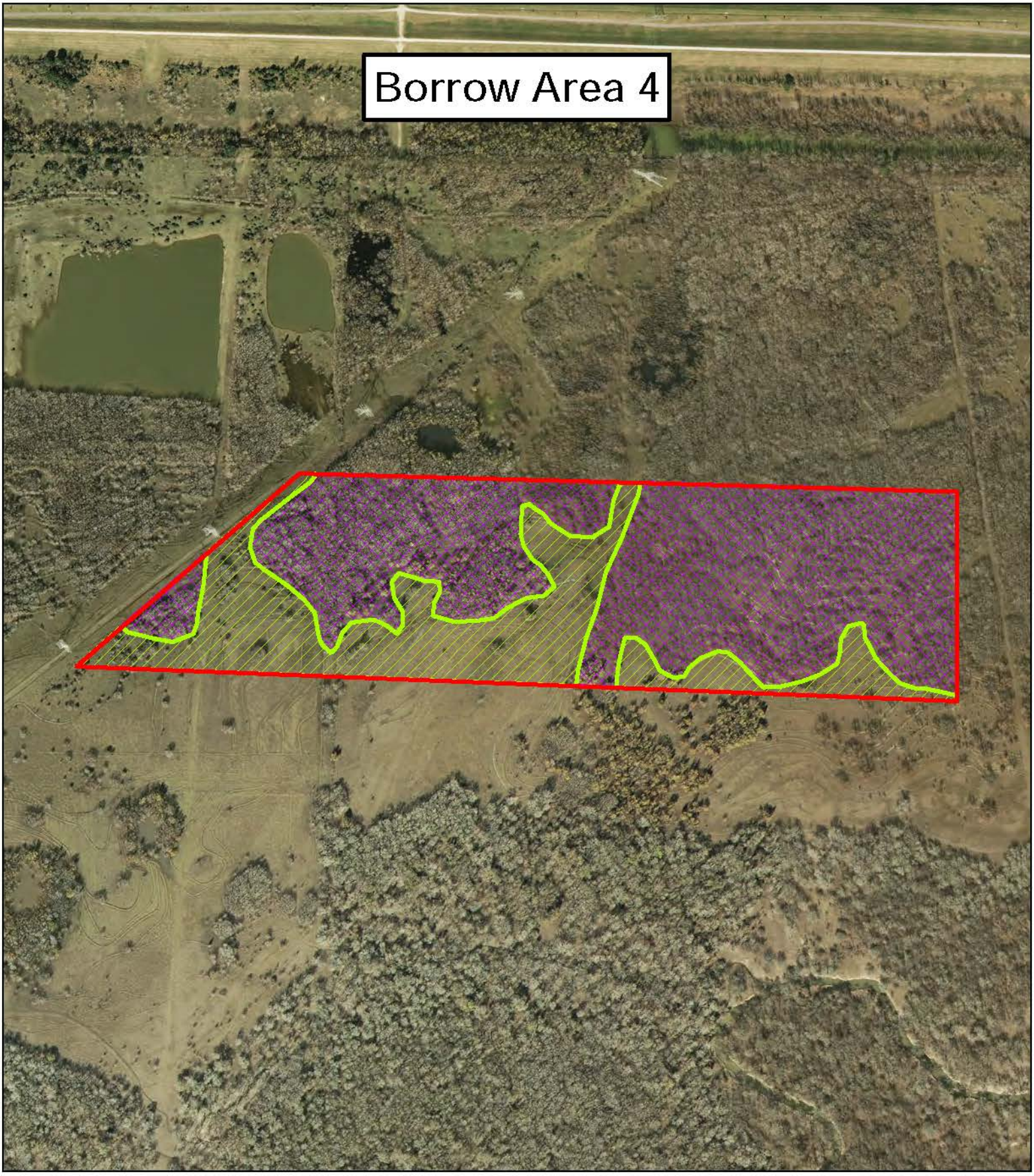
0 175 350
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 12

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Borrow Area 4 (56.11 acres)
Emergent Wetlands (18.34 acres)
Forested Wetlands (37.77 acres)

N

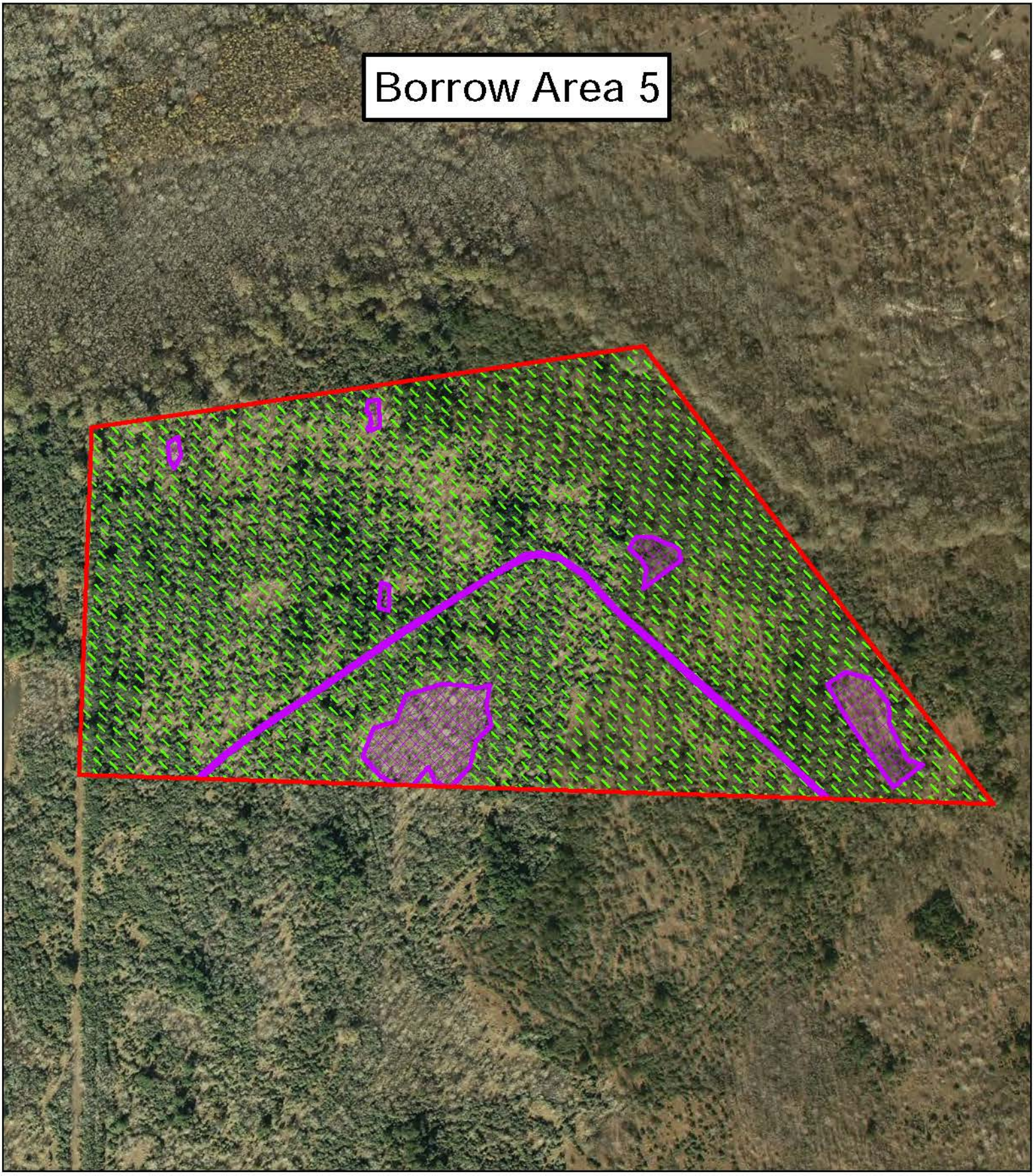
0 175 350
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 13

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Project Area (52.23 acres)
Forested Uplands (49.13 acres)
Forested Wetlands (3.10 acres)

N

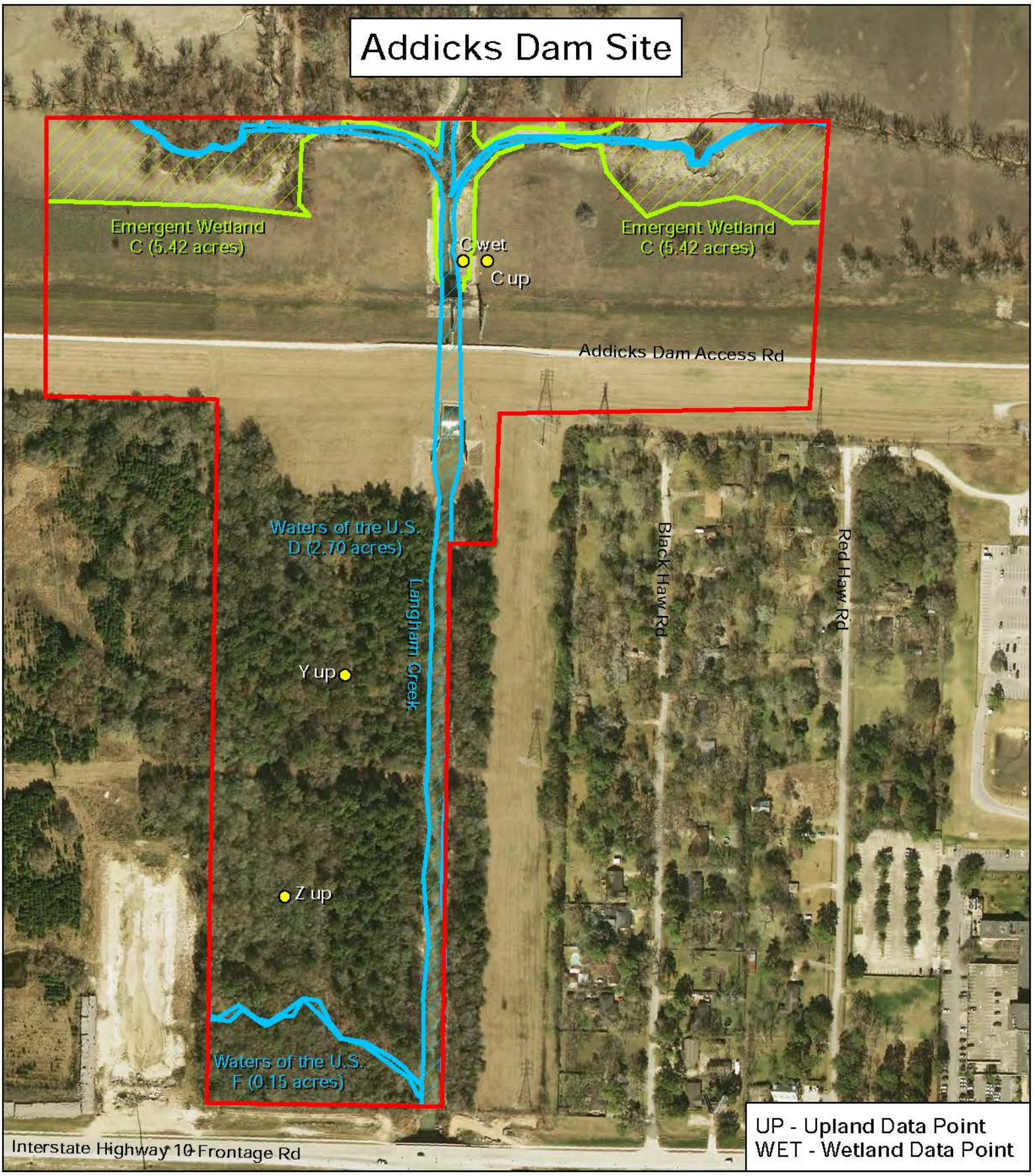
0 175 350
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 14

2008 AERIAL PHOTOGRAPH WITH EXISTING VEGETATION COMMUNITIES

Harris County, Texas



Data Point
Project Area (50.42 acres)
Emergent Wetlands (5.42 acres)
Waters of the U.S. (2.85 acres)

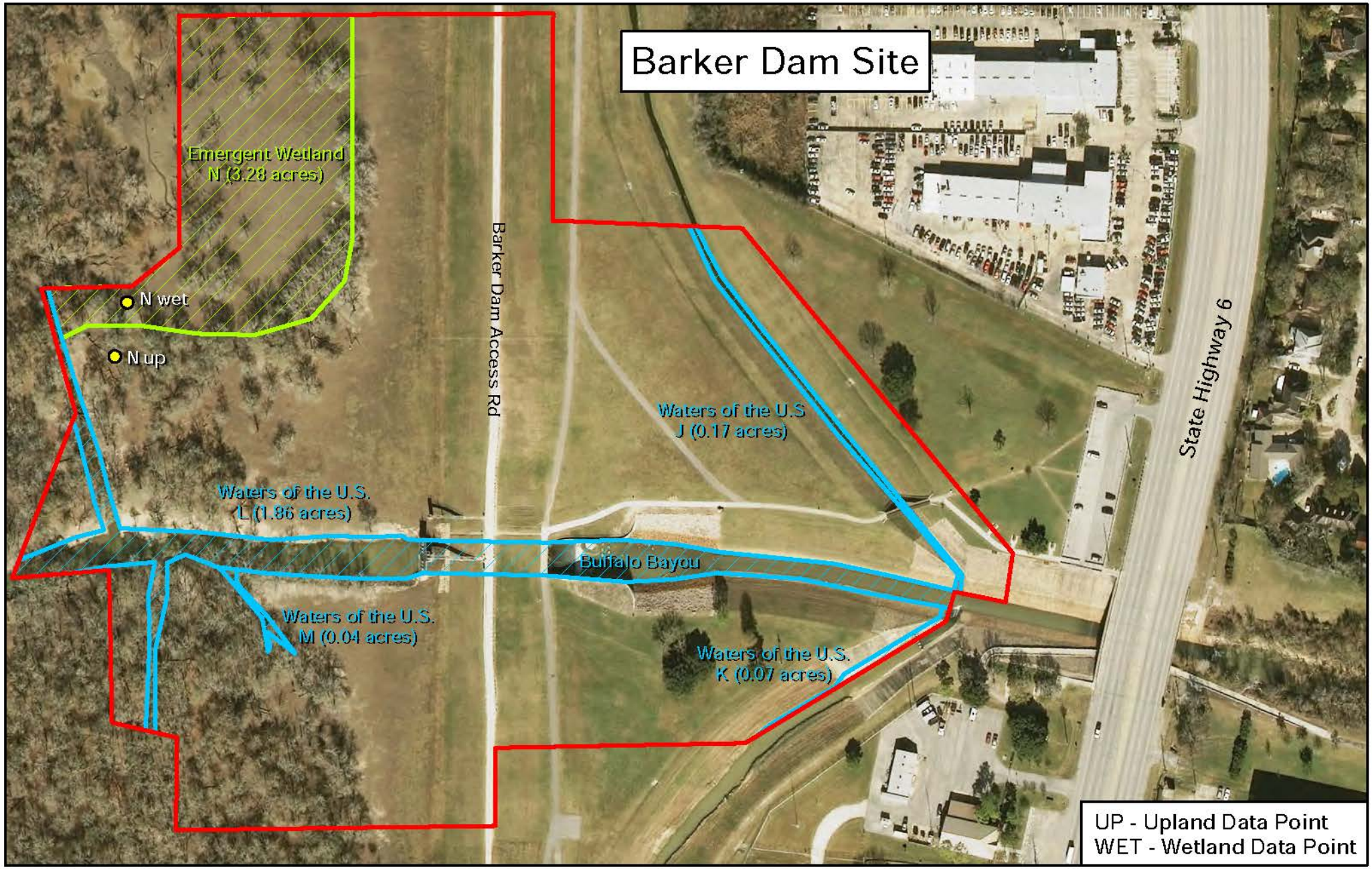
N

0 150 300
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 15
2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S. AND WETLAND FEATURE OVERLAYS

Harris County, Texas



Data Points
Project Area (28.89 acres)
Emergent Wetlands (3.28 acres)
Waters of the U.S. (2.14 acres)

N

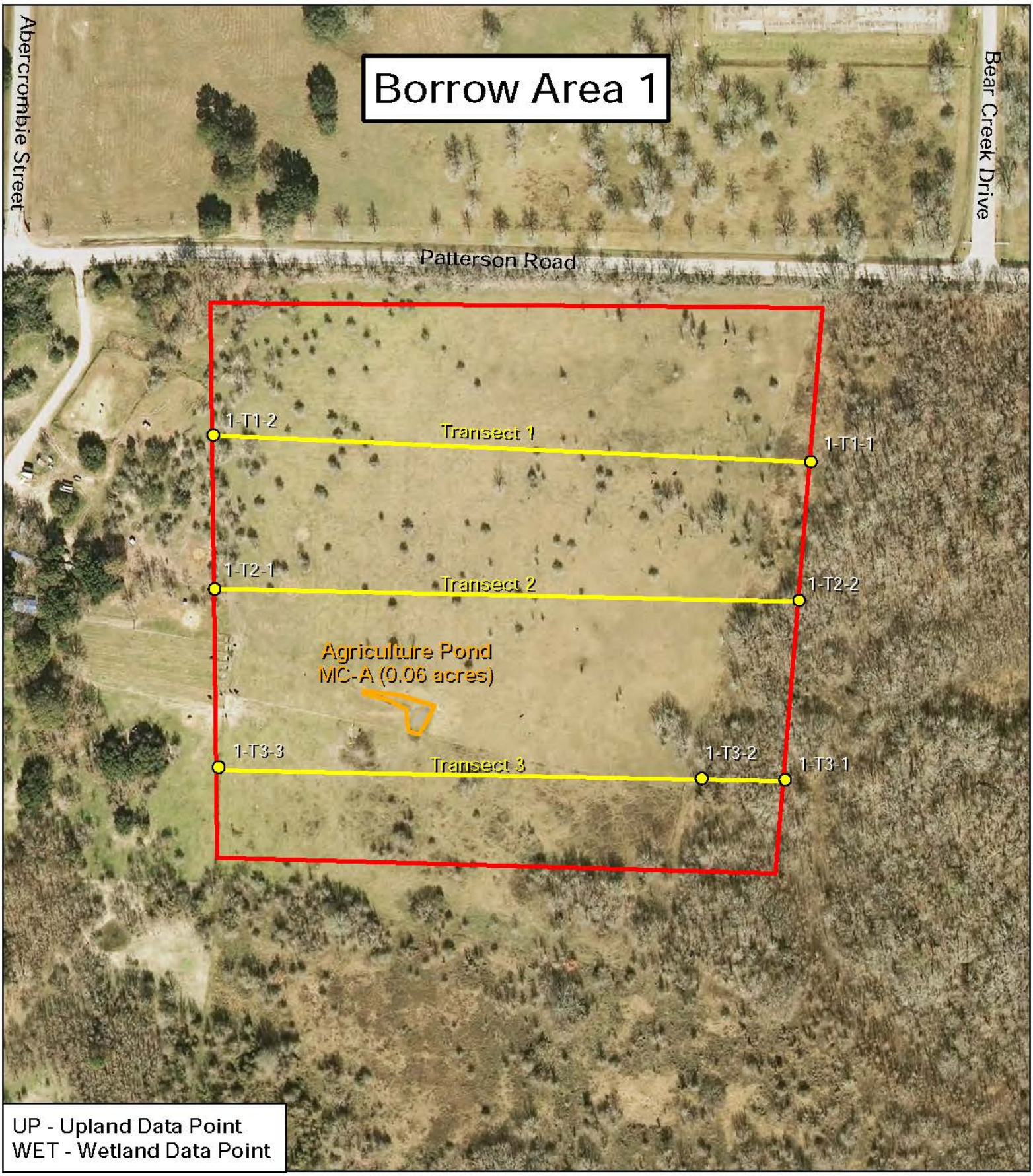
0 100 200
Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 16

2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S. AND WETLAND FEATURE OVERLAYS

Harris County, Texas



Data Point
Borrow Area 1 (18.74 acres)
Agriculture Pond (0.06 acres)
Transect Line

N

0 100 200 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 17
2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S. AND WETLAND FEATURE OVERLAYS

Harris County, Texas

Data Point
Borrow Area 2 (7.27 acres)
Emergent Wetland (0.60 acres)
Transect Line

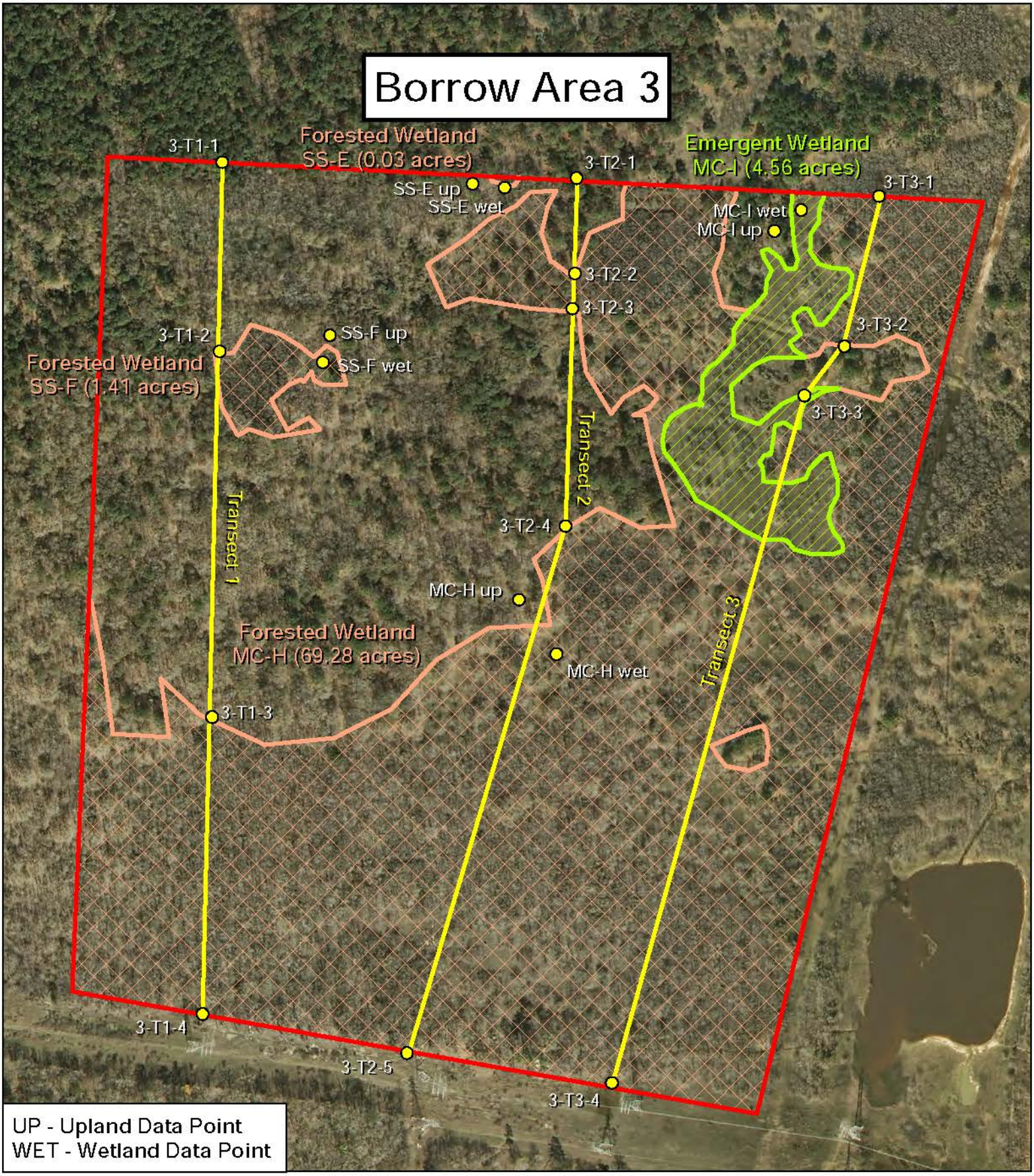
N

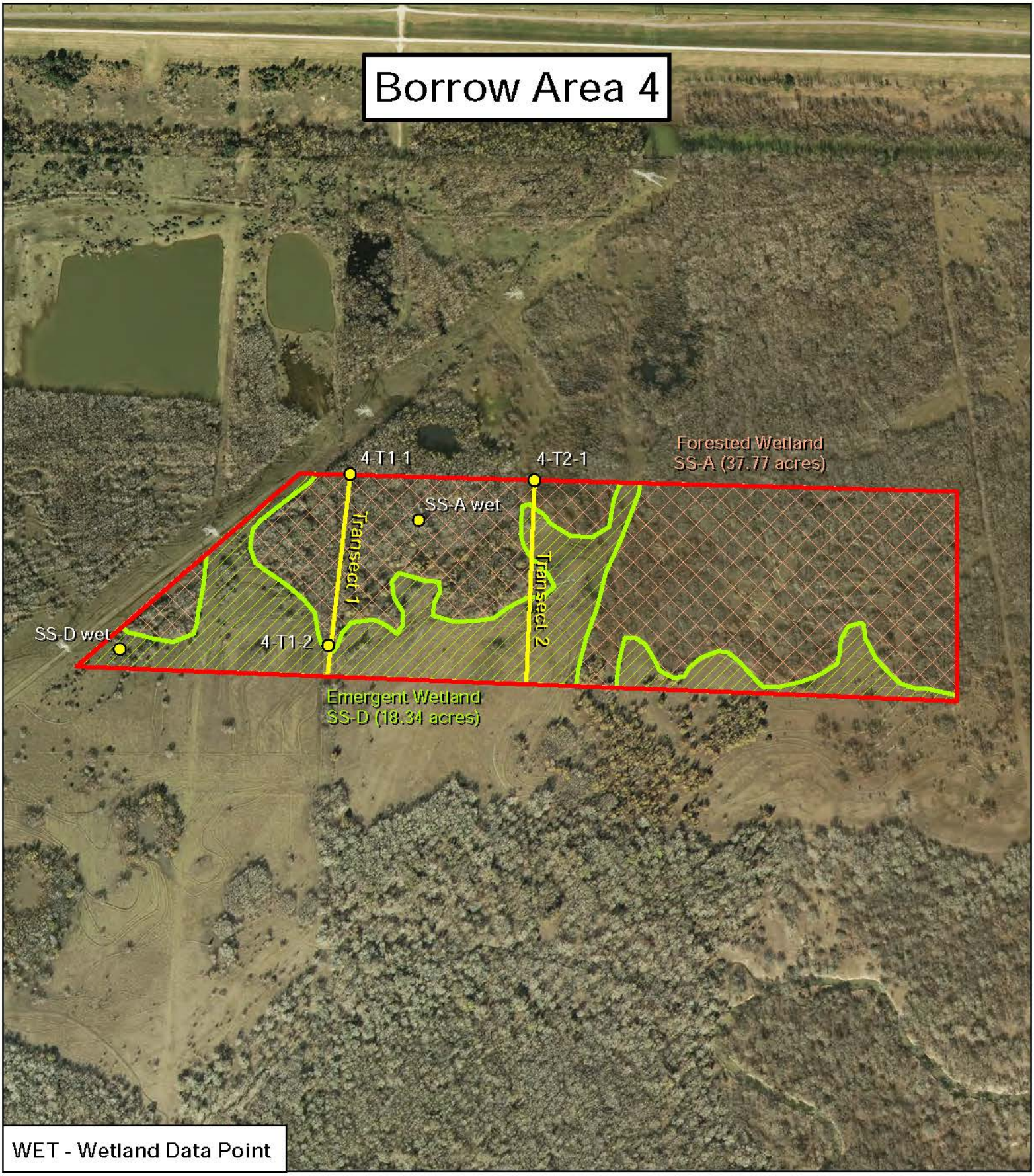
0 75 150 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 18
2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S. AND WETLAND FEATURE OVERLAYS

Harris County, Texas


Borrow Area 3
3-T1-1
Forested Wetland
SS-E (0.03 acres)
3-T2-1
Emergent Wetland
MC-I (4.56 acres)
3-T3-1
SS-E up
SS-E wet
MC-I wet
MC-I up
3-T2-2
3-T2-3
3-T1-2
SS-F up
SS-F wet
Forested Wetland
SS-F (1.41 acres)
3-T3-2
3-T3-3
Transect 2
Transect 1
3-T2-4
MC-H up
Forested Wetland
MC-H (69.28 acres)
MC-H wet
Transect 3
3-T1-3
3-T1-4
3-T2-5
3-T3-4
UP - Upland Data Point
WET - Wetland Data Point
Data Point
Project Area (120.64 acres)
Emergent Wetland (4.56 acres)
Forested Wetland (70.72 acres)
Transect Line
N
0
175
350
Feet
US Army Corps
of Engineers ®
Galveston District
Addicks and Barker
Dam Safety Modification
FIGURE 19
2008 AERIAL PHOTOGRAPH WITH
WATERS OF THE U.S. AND WETLAND
FEATURE OVERLAYS
Harris County, Texas



WET - Wetland Data Point

Data Point
Borrow Area 4 (56.11 acres)
Emergent Wetlands (18.34 acres)
Forested Wetlands (37.77 acres)
Transect Line

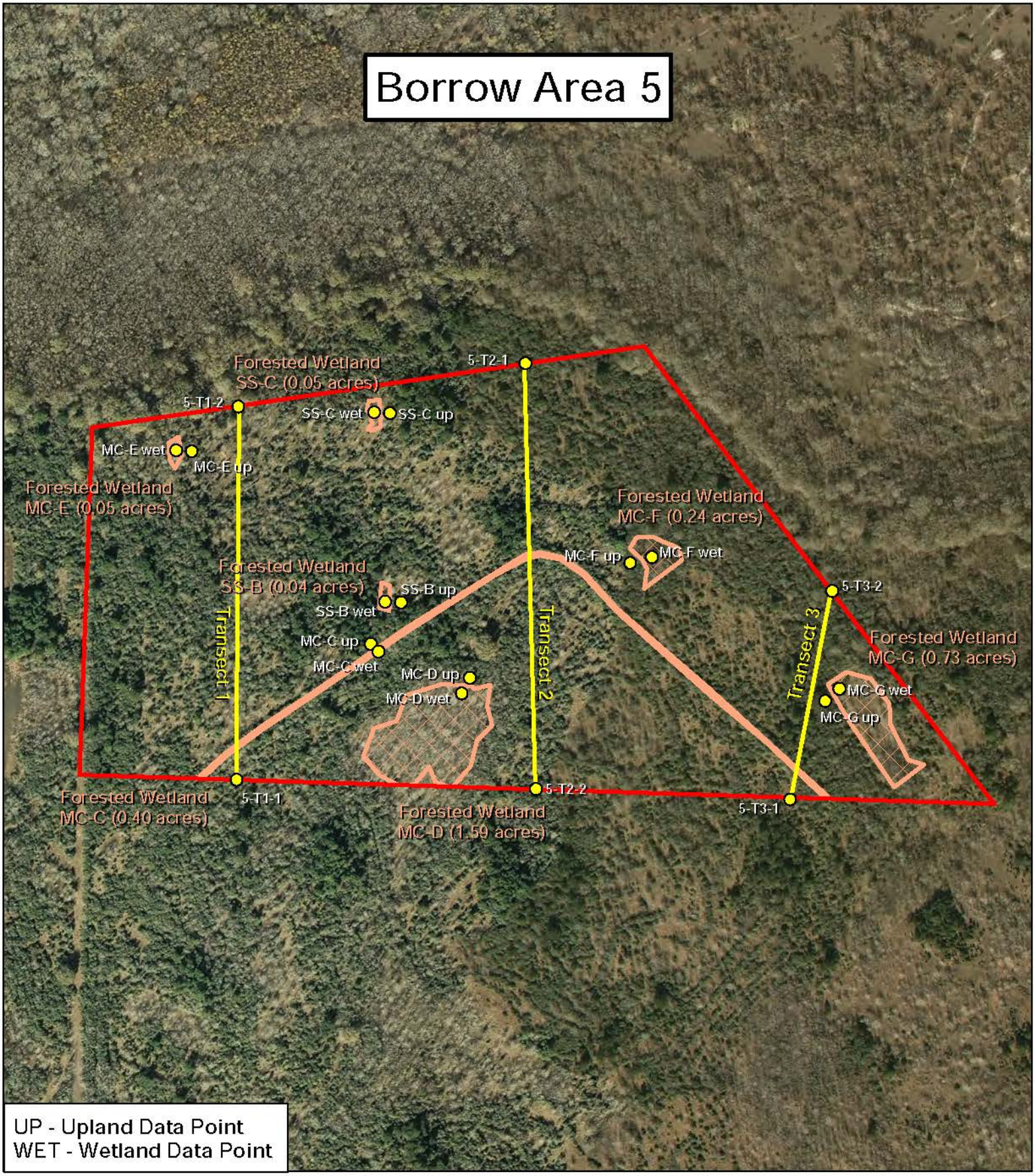
N

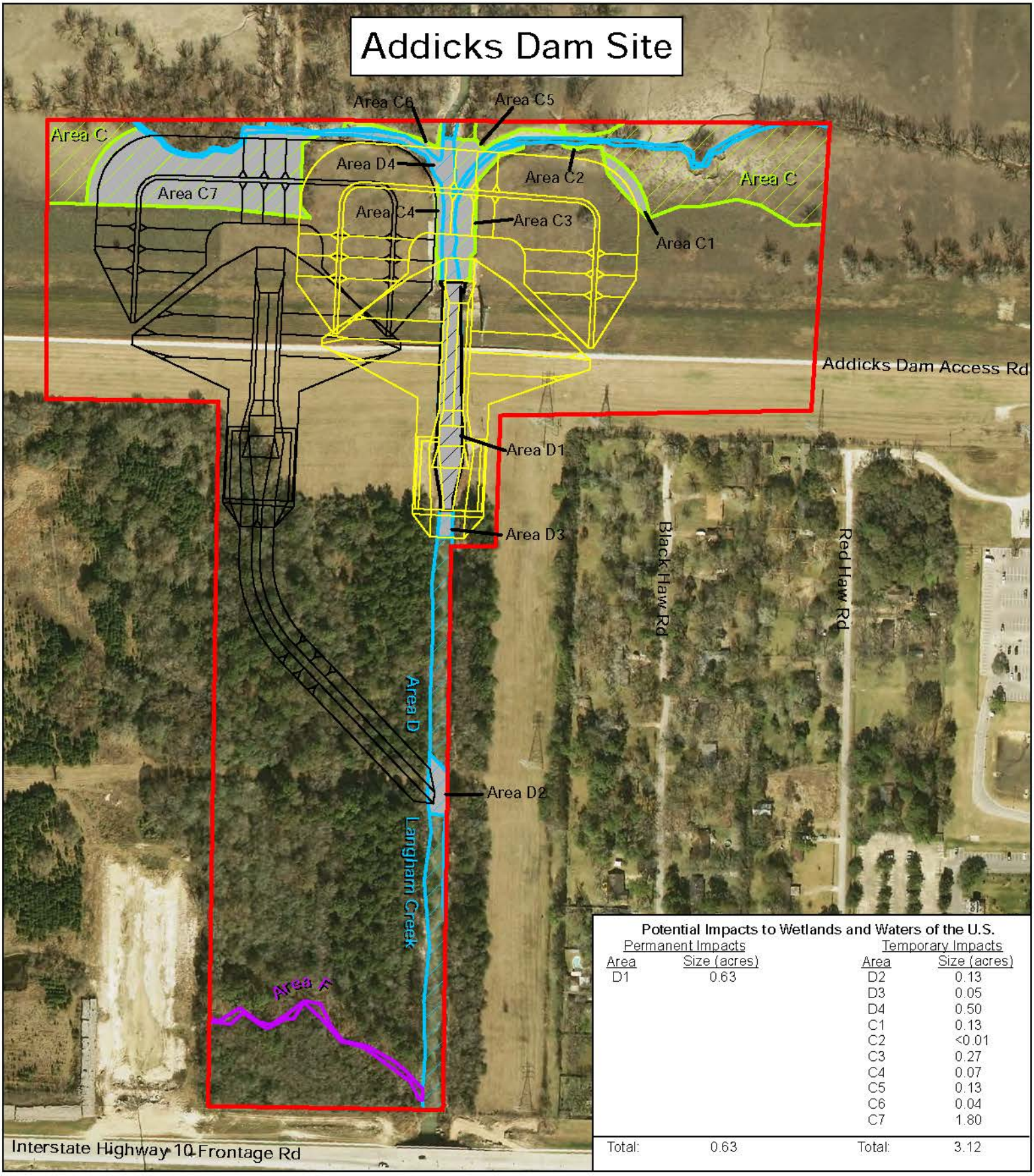
0 250 500 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 20
2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S. AND WETLAND FEATURE OVERLAYS

Harris County, Texas


Borrow Area 5
Forested Wetland
SS-C (0.05 acres)
5-T2-1
5-T1-2
SS-C wet
SS-C up
MC-E wet
MC-E up
Forested Wetland
MC-E (0.05 acres)
Forested Wetland
MC-F (0.24 acres)
MC-F up
MC-F wet
Forested Wetland
SS-B (0.04 acres)
SS-B up
SS-B wet
5-T3-2
Transect 1
Transect 2
Transect 3
MC-C up
MC-C wet
MC-D up
MC-D wet
Forested Wetland
MC-G (0.73 acres)
MC-G wet
MC-G up
Forested Wetland
MC-C (0.40 acres)
5-T1-1
5-T2-2
5-T3-1
Forested Wetland
MC-D (1.59 acres)
UP - Upland Data Point
WET - Wetland Data Point
Data Point
Project Area (52.23 acres)
Forested Wetlands (3.10 acres)
Transect Line
N
0
175
350
Feet
US Army Corps
of Engineers ®
Galveston District
Addicks and Barker
Dam Safety Modification
FIGURE 21
2008 AERIAL PHOTOGRAPH WITH
WATERS OF THE U.S. AND WETLAND
FEATURE OVERLAYS
Harris County, Texas



Potential Impacts to Wetlands and Waters of the U.S.

Permanent Impacts		Temporary Impacts	
Area	Size (acres)	Area	Size (acres)
D1	0.63	D2	0.13
		D3	0.05
		D4	0.50
		C1	0.13
		C2	<0.01
		C3	0.27
		C4	0.07
		C5	0.13
		C6	0.04
		C7	1.80
Total:	0.63	Total:	3.12

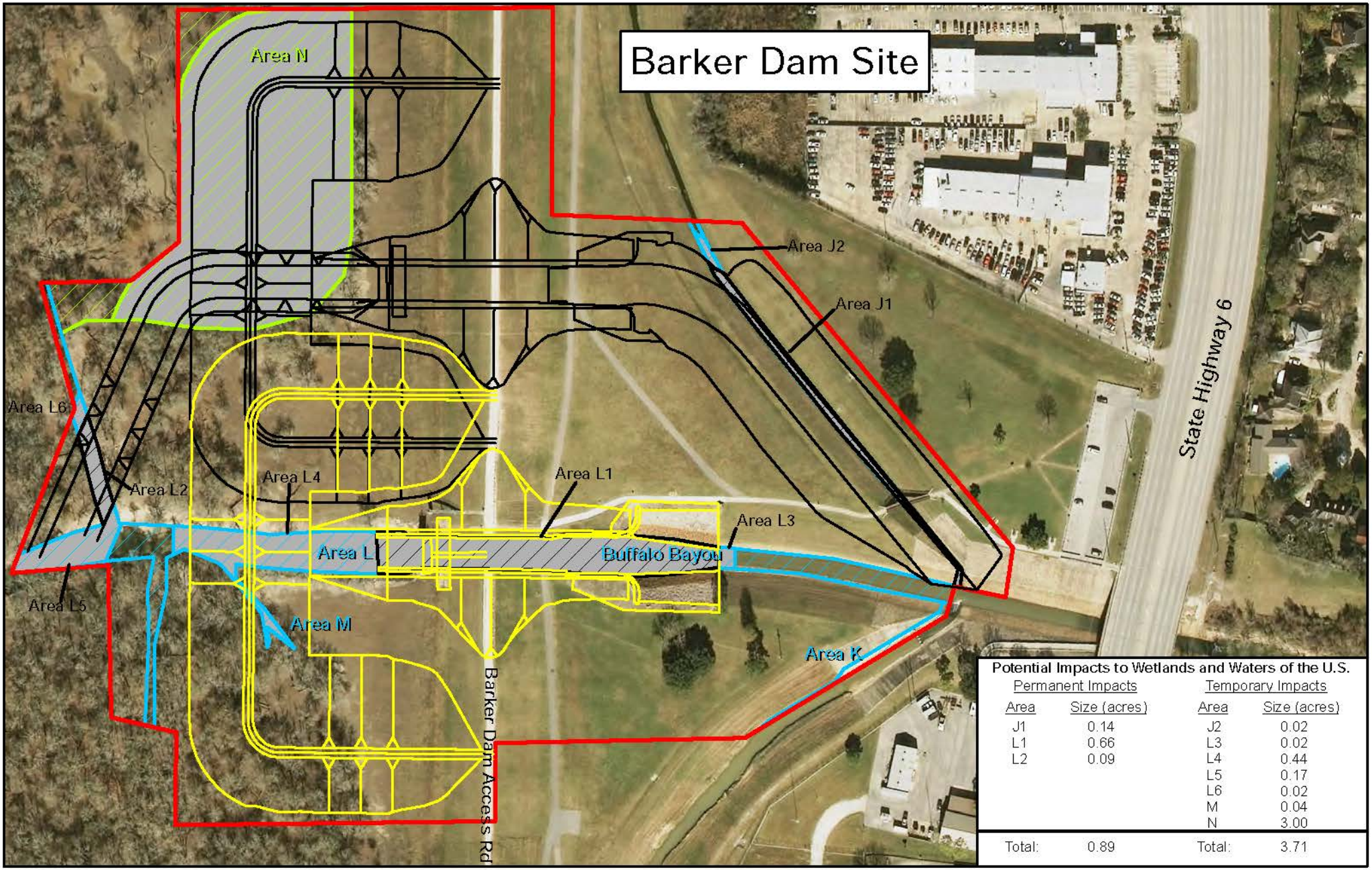
- Project Area (50.42 acres)
- Emergent Wetlands (PEM)
- Temporary Wetlands Impacts
- Waters of the U.S. - Perennial
- Waters of the U.S. - Ephemeral
- Temporary Waters of the U.S. Impacts
- Permanent Waters of the U.S. Impacts
- Existing Outlet Works/Proposed Cofferdam
- Proposed Outlet Works/Proposed Cofferdam/Proposed Diversion Channel

N

0 150 300 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker
Dam Safety Modification
FIGURE 22
2008 AERIAL PHOTOGRAPH WITH WATERS OF THE U.S., INCLUDING WETLANDS, AND PROPOSED IMPACTS DATA OVERLAYS
Harris County, Texas



Potential Impacts to Wetlands and Waters of the U.S.

Permanent Impacts		Temporary Impacts	
Area	Size (acres)	Area	Size (acres)
J1	0.14	J2	0.02
L1	0.66	L3	0.02
L2	0.09	L4	0.44
		L5	0.17
		L6	0.02
		M	0.04
		N	3.00
Total:	0.89	Total:	3.71

- Project Area (28.89 acres)
- Emergent Wetlands (PEM)
- Temporary Wetlands Impacts
- Waters of the U.S. - Perennial
- Temporary Waters of the U.S. Impacts
- Permanent Waters of the U.S. Impacts
- Existing Outlet Works/Proposed Cofferdam
- Proposed Outlet Works/Proposed Cofferdam/Proposed Diversion Channel

N

0 100 200 Feet

US Army Corps of Engineers ®
Galveston District

Addicks and Barker Dam Safety Modification
FIGURE 23

2008 AERIAL PHOTOGRAPH WITHWATERS OF THE U.S., INCLUDING WETLANDS, AND PROPOSED IMPACTS DATA OVERLAYS

Harris County, Texas