Attachment D-8
Mitigation Plan

MITIGATION PLAN

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO RIVER LOCKS SYSTEMS FEASIBILITY STUDY

US Army Corps of Engineers ®

Texas Department of Transportation ®

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1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), in cooperation with the Texas Department of Transportation (TxDOT) Maritime Division, is conducting a feasibility study to investigate improvements to the Gulf Intracoastal Waterway (GIWW), Brazos River Floodgates (BRFG) and Colorado River Locks (CRL) facilities that would reduce navigational difficulties, delays, and accidents occurring as tow operators transit the BRFG and CRL structures and across the Brazos and Colorado Rivers. As part of the Feasibility Study, the USACE has prepared an integrated Feasibility Report and Environmental Impact Statement (FR-EIS) in compliance with the National Environmental Policy Act (NEPA), USACE regulation ER-200-2, 33 Code of Federal Regulations (CFR) 230, the Flood Control Act of 1970 – Section 216, and other Federal, state, and local environmental policies and procedures.

This mitigation plan outlines the USACE's plan for mitigating habitat impacts caused by the Recommended Plan at the BRFG and CRL, namely wetland impacts. Section 2.0 describes the habitats present in the BRFG and CRL study areas, identifies anticipated impacts to those habitats, and evaluates the habitats to determine whether mitigation is warranted. The remainder of this report describes the proposed mitigation plan that has been developed to offset wetland impacts.

2.0 HABITAT IDENTIFICATION AND EVALUATIONS

2.1 Vegetation/Wildlife Habitats within the Study Areas

The BRFG and CRL study areas are in the Mid-Coast Barrier Islands and Coastal Marshes portion of the Western Gulf Coastal Plain ecoregion, which stretches from Galveston Bay in the north to Corpus Christi Bay in the south (Griffith et al. 2007). This ecoregion is characterized as having salt marsh on the back side of barrier islands, with fresh or brackish marshes near river deltas. The region contains a matrix of wetland and upland habitats that support a variety of wildlife species.

Vegetation communities/habitat types present in the BRFG and CRL study areas were mapped using aerial photography review and field reconnaissance. Six general vegetation communities/habitat types were observed in the study areas (**Figures 1 and 2**). **Table 1** lists the habitat types and the approximate percentage of each study area that contains the habitat. Descriptions of the habitat types follow the table.

Table 1 Estimated Habitat Types in the BRFG and CRL Study Areas

Habitat Type	% of BRFG Study Area	% of CRL Study Area
Open Water	36	35
Intertidal Marsh	2	1
High Marsh	21	8
Tidal Flat	0.5	0
Upland Shrub/Woods	30	43
Developed	11	13

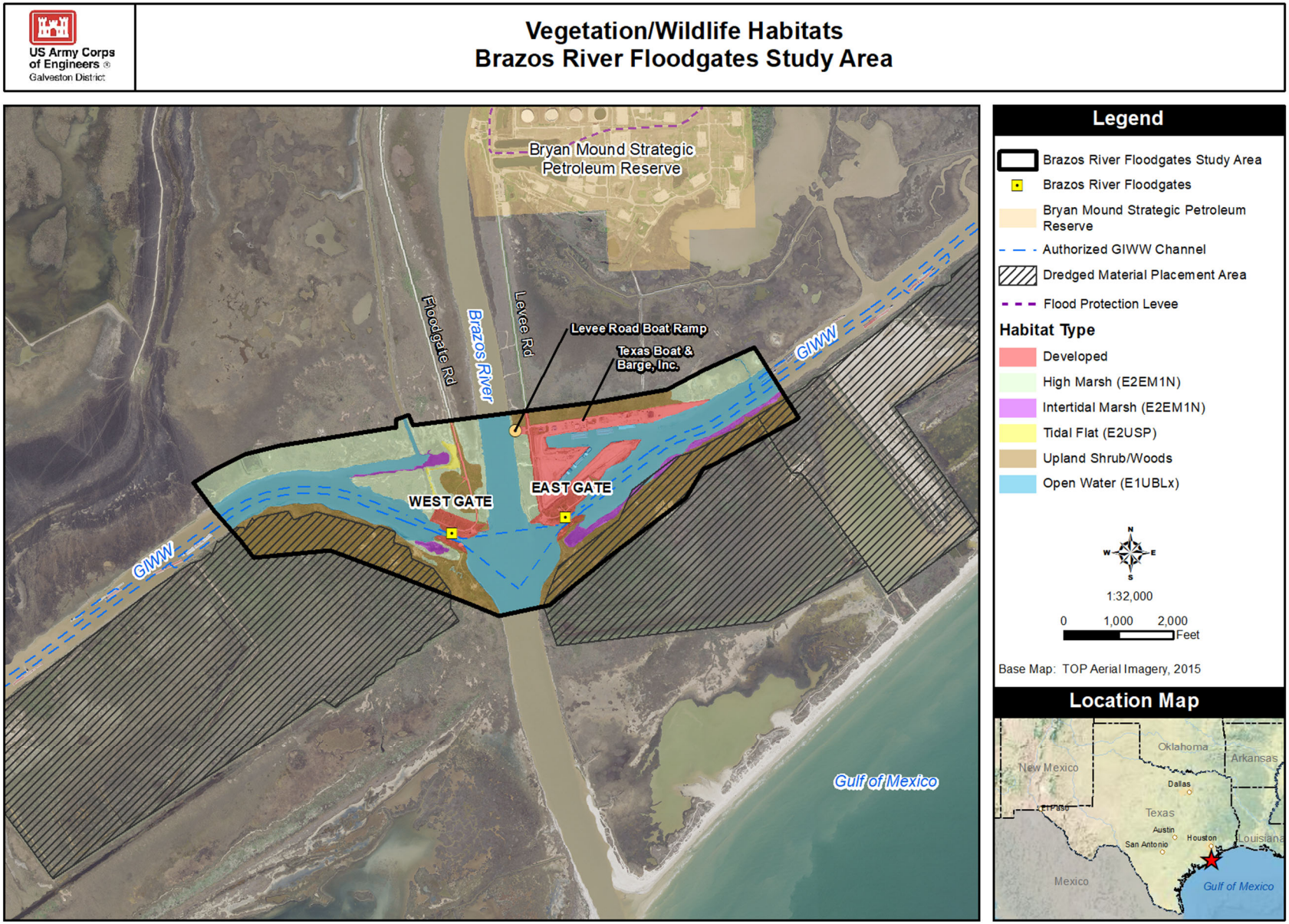

Figure 1 Vegetation/Wildlife Habitats in the BRFG Study Area

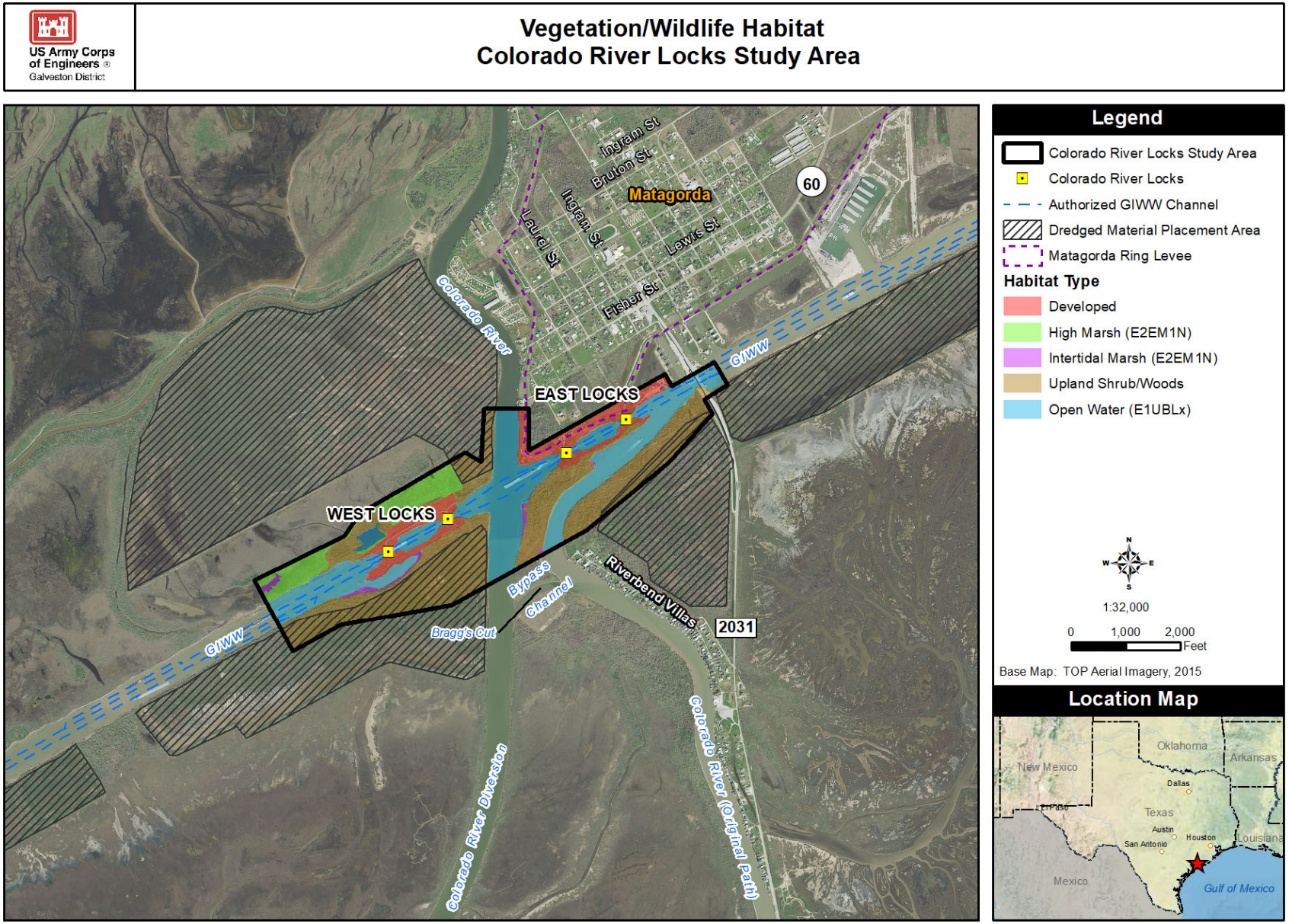

Figure 2 Vegetation/Wildlife Habitats in the CRL Study Area

Open Water

Open water is a major habitat type in both study areas and is present in the GIWW and Brazos and Colorado Rivers. The open water areas provide habitat for fish, shrimp, crabs, bottlenose dolphins (*Tursiops truncatus*), and other estuarine species. Most of the open water habitat experiences regular disturbances by barge tows and other vessels traveling through the GIWW, as well as periodic maintenance dredging.

High/Intertidal Marshes

High marsh habitat is the dominant wetland habitat in the study areas, occurring at low elevations but only infrequently inundated by very high tides. Common plant species observed in this habitat include turtleweed (*Batis maritima*), saltgrass (*Distichlis spicata*), saltworts (*Salicornia* spp.), Gulf cordgrass (*Spartina spartinae*), marshhay cordgrass (*S. patens*), sea-oxeye daisy (*Borrichia frutescens*), seepweed (*Suaeda linearis*), and marsh-elder (*Iva frutescens*). Scattered threesquare (*Schoenoplectus pungens*), wolfberry (*Lycium carolinianum*), saltcedar (*Tamarix ramosissima*), smooth cordgrass (*Spartina alterniflora*), and common reed (*Phragmites australis*) were also observed. In the BRFG study area, two small patches of high marsh located south of the GIWW and west of the Brazos River collect some fresh water from overland flow and groundwater seepage from an adjacent DMPA, but they are also influenced by high tides, washover from the GIWW, and/or tidally influenced water table. These wetland patches contain typical high marsh plant species, as well as scattered black willow (*Salix nigra*), rattlebush (*Sesbania drummondii*), sand spikerush (*Eleocharis montevidensis*), and common rush (*Juncus effusus*).

Intertidal marsh, which are wetland areas that occur at elevations between the low and high tides (intertidal zone), also occurs in both study areas and are dominated by smooth cordgrass (*Spartina alterniflora*), with species common to the high marsh habitat present along the edges. At the BRFG, intertidal marsh lines the south GIWW bank through much of the study area. At the CRL, intertidal marsh occurs as relatively small patches along the south GIWW bank, Bragg's Cut, and interior tidal ponds in the study area.

Tidal Flat

One small area of unvegetated tidal flat is in the BRFG study area. This habitat is adjacent to an intertidal marsh and contained less than 5 percent plant cover (turtleweed, smooth cordgrass, saltwort, and saltgrass). Algal mats covered an estimated 50 percent of the flat during a February 2017 field investigation. The area also showed evidence of disturbance from cattle.

Upland Shrub/Woods

Higher elevations in the study areas, such as portions of the river banks and in DMPAs, support upland shrub/woods vegetation. This habitat incudes relatively young (<50 years) riparian vegetation consisting of a mix of common native and non-native plant species. Common plant species observed in this habitat include American elm (*Ulmus americana*), sugar hackberry (*Celtis laevigata*), Chinaberry (*Melia azedarach*), Chinese tallow, honey mesquite (*Prosopis glandulosa*), Hercules'-club (*Zanthoxylum clava-herculis*), osage orange (*Maclura pomifera*), roughleaf dogwood (*Cornus drummondii*), retama (*Parkinsonia aculeata*), elbowbush (*Forestiera angustifolia*), eastern baccharis, saltcedar, Louisiana vetch (*Vicia ludoviciana*), rosettegrass (*Dichanthelium* sp.), catchweed (*Galium* sp.), crow-poison (*Nothoscordum bivalve*), hairyfruit chervil (*Chaerophyllum tainturieri*), giant ragweed (*Ambrosia trifida*),

mustang grape (*Vitis mustangensis*), poison ivy (*Toxicodendron radicans*), southern dewberry, Virginia creeper (*Parthenocissus quinquefolia*), and peppervine (*Ampelopsis arborea*).

2.2 Habitat Impacts Resulting from the Recommended Plan

Table 2 summarizes the acreages of vegetation/wildlife habitats impacted by the Recommended Plan. At the BRFG, the Recommended Plan would impact an estimated 125 acres, most of which would consist of temporary impacts to open water habitat during construction (e.g., barge access, pile-driving, dredging, turbidity). Approximately 13.8 acres of wetlands and 14.0 acres of upland shrub/woods habitat would be removed at the BRFG, most of which would be converted to open water. Approximately 6.7 acres of open water habitat would be filled and converted to the new floodgate structure.

Table 2 Impacts to Vegetation/Wildlife Habitats by the Recommended Plan (acres)[1]

Alternative	Developed	High Marsh	Intertidal Marsh	Tidal Flat	Upland Shrub/Woods	Open Water[2,3]	Total
BRFG (Alt. 3a.1)	3.1	2.4	11.4	0	14.0	94.4[2,3]	**125.3**
CRL (Alt. 4b.1)	12.7	0	0.7	0	11.4	61.0[2,3]	**85.8**

[1] Most impacted areas identified in this table would be converted to open water to realign the GIWW, construct the open channel west of the Brazos River, and remove portions of the existing floodgate structures. Therefore, the project would result in a net increase in open water habitat.
[2] Most reported impacts to open water are temporary construction impacts (e.g., barge access, pile-driving, turbidity, dredging) and include the entire area of open water present in the study area between the beginning and end of the new GIWW alignment.
[3] Approximately 6.7 acres of open water at BRFG and 2.8 acres of open water at CRL would be filled to construct the new floodgates and levee access.

At the CRL, the Recommended Plan would impact an estimated 86 acres, most of which would consist of temporary impacts to open water habitat during construction. Approximately 0.7 acre of wetlands and 11.4 acres of upland shrub/woods would be removed at the CRL, most of which would be converted to open water. Approximately 2.8 acres of open water habitat would be filled at the CRL to construct the new floodgate structures.

2.3 Habitat Evaluations

None of the vegetation communities/wildlife habitats impacted by the Recommended Plan are considered regionally rare, unique, or imperiled; however, the habitats were evaluated to determine their significance based on institutional, public, and technical recognition. Engineer Regulation (ER) 1105-2-100, Planning Guidance Notebook and the Water Resources Council Principles and Guidelines (P&G) describe the procedures for determining the significance of resources. The Institute for Water Resources' (IWR) Report 97-R-4, *Resource Significance Protocol For Environmental Project Planning*, provides more specific guidance for determining significance. Based on these guidance documents, the wetland habitats in the study areas (high/intertidal marshes and tidal flats) have institutional significance at a national level due to various laws and statutes that protect wetland resources (e.g., Clean Water Act Section 404(b)(1), Executive Order 11990). Wetland habitats also have technical significance due to their importance to water quality, biodiversity, and ecological productivity. Therefore, detailed habitat evaluations were conducted for wetland habitats in the study areas, and the USACE is proposing mitigation for wetland impacts.

Most of the open water resources in the study areas are within and immediately adjacent to the GIWW and Brazos and Colorado Rivers and have significance for navigation and/or as major freshwater, sediment, and nutrient sources to the local estuaries and Gulf of Mexico. In addition, the GIWW and Brazos and Colorado Rivers are considered essential fish habitat (EFH) in the study areas, and they provide habitat for bottlenose dolphins, which are protected under the Marine Mammal Protection Act (MMPA). Although the open water resources in the study areas are significant, they are not limiting in the project region. Furthermore, the proposed project is intended to improve navigation, and the Recommended Plan will result in a nete increase in open water habitat. Therefore, no mitigation is proposed for open water habitats.

The upland shrub/woods habitats that would be impacted by the Recommended Plan consist of relatively young (<50 years) woody growth, do not constitute bottomland hardwoods or other significant woodland habitat, and contain both common and non-native shrub and tree species. Although these habitats provide foraging, roosting, and nesting habitat for migratory birds protected under the Migratory Bird Treaty Act (MBTA), they are not unique in this respect (virtually all vegetated habitats support migratory birds), and similar habitats are common in the region. As a result, the upland shrub/woods habitats would not be expected to be considered significant ecological resources following the procedures in ER 1105-2-100, the P&G, and IWR Report 97-R-4, and the USACE is not proposing mitigation for upland shrub/woods habitat.

3.0 WETLAND MITIGATION PLAN

The Council on Environmental Quality (CEQ) and NEPA guidelines state that damages to fish and wildlife resources should be prevented to the extent practicable through planning, design, and incorporating mitigation measures. For USACE projects, mitigation plans should be the most efficient and least costly measures appropriate to reduce fish and wildlife resource losses. The intent is to maintain the integrity and viability of significant natural resources and their contributions to local or regional ecosystems by applying sound ecosystem management techniques.

The USACE evaluated wetland mitigation options to develop a mitigation plan to offset the projected wetland habitat losses resulting from the Recommended Plan. To ensure that the mitigation plan would adequately compensate for wetland losses, the USACE work with pertinent resource agencies to determine Habitat Units (HUs) using Habitat Evaluation Procedures (HEP) methodology and comparing average annual benefits of the mitigation project, in terms of Average Annual Habitat Units (AAHU) determined through the IWR Planning Suite annualizer, to the AAHUs under the Future Without Project (FWOP) Condition. The AAHUs provided by the mitigation project were calculated and compared to the FWOP Condition in the following stepwise process:

1. Using HEP methodology, baseline Habitat Suitability Indices (HSIs) for the existing wetland habitats in the study areas were calculated through on-site surveys conducted by an interagency biological team in February and March 2017. Average HSIs for each habitat type were calculated by averaging the HSIs across wildlife indicator species and representative data-collection points. HUs provided by each habitat type were then calculated by multiplying the average HSI for the habitat type by the number of acres of the habitat type that are present in the study area.

2. For the FWOP Condition (No Action Alternative), HUs were calculated over a 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs.

3. Similarly, AAHUs under the Future With Project Condition (Recommended Plan) were calculated, considering the areas of wetland habitats removed by the Recommended Plan.

4. To predict future habitat values *with* the implementation of mitigation, the interagency team met to predict future habitat values for each wildlife indicator species and habitat. From this effort, future HSIs were calculated for each habitat type, and HUs were calculated over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs for the mitigation scenarios.

The following discusses the analyses conducted in each step and the results.

3.1 Step 1: Baseline HSIs for Existing Wetland Habitats

An interagency biological team, including USACE, TxDOT, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and Texas Parks and Wildlife Department (TPWD) personnel, conducted field visits to evaluate the habitats in the BRFG and CRL study areas using HEP methodology. HEP is a habitat-based assessment methodology developed by the USFWS to estimate habitat values for use in project planning and impact assessment (USFWS 1980). HEP requires the use of HSI models developed for wildlife indicator species that use the habitats. The HSI models evaluate structural habitat composition variables that are contained in optimum habitat, and these variables are measured in the field.

Modeled habitat conditions are expressed as a numeric function (HSI value) ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. HSI values ranging from 0.01 to 0.24 are considered "poor" habitat, 0.25 to 0.49 are considered "below average" habitat, 0.50 to 0.69 are "average" habitat, 0.70 to 0.89 are "good" habitat, and 0.90 to 1.00 are considered "excellent" habitat. HUs are calculated by multiplying the HSI value for each habitat by the number of acres of that specific habitat type present in the study area.

The interagency team met in February and March 2017 to select wildlife indicator species that use each habitat in the BRFG and CRL study areas and then collect field data at representative locations within each habitat. Since the tidal wetlands (high marsh, intertidal marsh, and tidal flat) in the study areas are the only habitats for which mitigation is proposed, only the results of the tidal wetland habitat evaluations are provided here. The interagency team selected seven wildlife indicator species for the tidal wetland habitats. As shown in **Table 3**, the red drum, brown and white shrimp, and clapper rail were selected as indicator species for intertidal marsh; clapper rail, marsh wren, and mottled duck were selected for high marsh; and least tern for tidal flats. During the field visits, access to private properties in the study areas was limited, so data collection occurred on USACE property, in areas along the GIWW and Brazos and Colorado Rivers, and private properties where access was granted. Data were collected at six locations in tidal wetland habitats in the BRFG study area and four locations in tidal wetland habitats in the CRL study area. Of the high marsh habitats sampled, the interagency team determined that only one site had the potential to be used by the marsh wren and mottled duck.

Table 3 Tidal Wetland Habitats, Indicator Species, and HEP Data Sites

Habitat Type	Indicator Species					
	Red Drum	Brown/White Shrimp	Clapper Rail	Marsh Wren*	Mottled Duck	Least Tern
BRFG						
High Marsh			x			
Intertidal Marsh	x	x	x			
Tidal Flat						x
CRL						
High Marsh			x	x*	x*	
Intertidal Marsh	x	x	x			

* Marsh wren and mottled duck were evaluated only at one high marsh site in the CRL study area. During field investigations, the interagency team determined that the other high marsh habitats at BRFG and CRL were not suitable for these species.

Average HSI values and HUs for each habitat and indicator species are provided in **Table 4**. **Table 5** summarizes the existing wetland habitats in terms of acres and HUs. The habitats scored "average" to "excellent" except for the high marsh habitat at CRL, which scored "poor". The limiting factor causing high marsh habitats in the CRL study area to score "poor" was the lack of tidal waters adjacent to the habitats. As shown earlier in **Figure 2**, the high marsh habitats in the CRL study area are mostly separated from the GIWW and Colorado River by upland habitats.

Table 4 Average HSI Values and Habitat Units for Tidal Wetland Habitats

Habitat Type	**Acreage**	**Indicator Species**							**HSI Average**	**Habitat Units**
		Red Drum	Brown Shrimp	White Shrimp	Clapper Rail	Least Tern	Marsh Wren*	Mottled Duck*		
BRFG										
High Marsh	123.5				1.00				1.00	123.50
Intertidal Marsh	15.8	0.37	0.92	0.90	1.00				0.80	12.64
Tidal Flat	3.0					0.80			0.80	2.40
CRL										
High Marsh	32.0				0.15		0.85*	0.00*	0.25	8.00
Intertidal Marsh	4.6	0.45	0.97	0.91	0.98				0.83	3.82

* Marsh wren and mottled duck were evaluated only at one high marsh site in the CRL study area. During field investigations, the interagency team determined that the other high marsh habitats at BRFG and CRL were not suitable for these species.

Table 5 Average HSI Values and Habitat Units for Wetland Habitats in Study Areas

Habitat Type	**Acreage**	**HSI Average**	**Habitat Units**
BRFG Study Area			
High Marsh	123.5	1.00	123.50
Intertidal Marsh	15.8	0.80	12.64
Tidal Flat	3.0	0.80	2.40
CRL Study Area			
High Marsh	32.0	0.25	8.00
Intertidal Marsh	4.6	0.83	3.82

3.2 Step 2: FWOP Condition AAHUs

Through Step 2 above, AAHUs were calculated for each wetland habitat type under the FWOP Condition, or "No Action" Alternative. Under the FWOP Condition, no improvements would be made to the BRFG or CRL facilities, although the USACE will continue to perform normal O&M activities and natural ecological processes will continue to occur in the study areas. For the FWOP analysis, existing wetland habitats were assumed to maintain, and not degrade, over the 50-year analysis period. Although climate change, sea level rises, and periodic major storm events may affect wetland habitats over the analysis period, these effects are expected to be similar under the FWOP Condition and the Future With Project Condition. Based on this assumption, the HUs were calculated for the FWOP Condition over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs. The following summarizes the results for each habitat in the BRFG study area and CRL study area, respectively.

BRFG – Wetland Habitat Calculations under the FWOP Condition

Wetland habitats within the BRFG study area include 123.5 acres of high marsh (21 percent of the study area), 15.8 acres of intertidal marsh (2 percent of the study area), and 3.0 acres of tidal flats (0.5 percent of the study area). **Tables 6 through 8** provide, for each of these wetland habitat types, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year without-project conditions.

Table 6 BRFG FWOP Condition: *High Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
High Marsh	HSI	1.00	1.00	1.00	1.00	1.00	1.00		
	Acres	123.5	123.5	123.5	123.5	123.5	123.5		
	Target Year HU	123.50	123.50	123.50	123.50	123.50	123.50		
	Interval HU		123.50	494.00	617.50	1852.50	3087.50	6175.00	123.50

Table 7 BRFG FWOP Condition: *Intertidal Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Intertidal Marsh	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	15.8	15.8	15.8	15.8	15.8	15.8		
	Target Year HU	12.64	12.64	12.64	12.64	12.64	12.64		
	Interval HU		12.64	50.56	63.20	189.60	316.00	632.00	12.64

Table 8 BRFG FWOP Condition: *Tidal Flat* Habitat Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Tidal Flat	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	3.0	3.0	3.0	3.0	3.0	3.0		
	Target Year HU	2.40	2.40	2.40	2.40	2.40	2.40		
	Interval HU		2.40	9.60	12.00	36.00	60.00	120.00	2.40

CRL – Wetland Habitat Calculations under the FWOP Condition

Wetland habitats within the CRL study area include 32.0 acres of high marsh (8 percent of the study area) and 4.5 acres of intertidal marsh (1 percent of the study area). **Tables 9 and 10** provide, for each wetland habitat type, the AAHUs over the 50-year period of analysis, as well as calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year without-project conditions.

Table 9 CRL FWOP Condition: *High Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
High Marsh	HSI	0.25	0.25	0.25	0.25	0.25	0.25		
	Acres	32.0	32.0	32.0	32.0	32.0	32.0		
	Target Year HU	8.00	8.00	8.00	8.00	8.00	8.00		
	Interval HU		8.00	32.00	40.00	120.00	200.00	400.00	8.00

Table 10 CRL FWOP Condition: *Intertidal Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
Intertidal Marsh	HSI	0.83	0.83	0.83	0.83	0.83	0.83		
	Acres	4.6	4.6	4.6	4.6	4.6	4.6		
	Target Year HU	3.82	3.82	3.82	3.82	3.82	3.82		
	Interval HU		3.82	15.28	19.10	57.30	95.50	191.00	3.82

Summary of Habitat Calculations under the FWOP Condition

Based on the above FWOP analysis, **Table 11** summarizes the anticipated acres of wetland habitat types and associated AAHUs in the BRFG and CRL study areas under the FWOP Condition.

Table 11 Summary of Acres and AAHUs under the FWOP Condition

Habitat Type	Existing Acres	Existing AAHUs
BRFG		
High Marsh	123.5	123.50
Intertidal Marsh	15.8	12.64
Tidal Flat	3.0	2.40
CRL		
High Marsh	32.0	8.00
Intertidal Marsh	4.6	3.82

3.3 Step 3: Future With Project AAHUs

Through Step 3, AAHUs were calculated for each wetland habitat type under the Future With Project Condition (e.g., implementing the Recommended Plan). After refinements based on public input and further discussions with the navigation industry, the Recommended Plan at the BRFG (Alternative 3a.1) includes removing the existing 75-foot-wide east and west floodgates, shifting the GIWW centerline 300 feet south of the existing centerline, constructing new 125-foot-wide floodgates on the east side of the Brazos River, and constructing an open channel (no floodgates) west of the river. At the CRL, the refined plan (Alternative 4b.1) involves removing all four sets of existing 75-foot-wide gates, shifting the GIWW centerline 260 feet south of the existing centerline, and constructing two new 125-foot-wide gates. Detailed descriptions of the refined Recommended Plans at the BRFG and CRL are provided in Chapters 3 and 4 of the IFR-EIS.

Table 12 summarizes the anticipated wetland habitat changes in the study areas under the refined Recommended Plan. Overall, approximately 13.8 acres of wetland habitat would be lost at the BRFG and 0.7 acre of wetland habitat would be lost at the CRL. For each study area, HUs were calculated for the Future With Project Condition over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs. The following summarizes the results.

Table 12 Summary of Wetland Habitat Changes Under Recommended Plan

Habitat Type	Existing Area (acres)	Future With Project Conditions under the Recommended Plan (acres)	Change in Habitat under Recommended Plan (acres)
BRFG			
High Marsh	123.5	121.1	-2.4
Intertidal Marsh	15.8	4.4	-11.4
Tidal Flat	3.0	3.0	0
CRL			
High Marsh	32.0	32.0	0
Intertidal Marsh	4.6	3.9	-0.7

BRFG – Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

The Recommended Plan would remove 2.4 acres of high marsh and 11.4 acres of intertidal marsh at the BRFG; no impacts to tidal flats would occur. **Tables 13 through 15** provide, for each wetland type in the study area, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year with project conditions.

Table 13 BRFG Future With Project Condition: *High Marsh* Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
High Marsh	HSI	1.00	1.00	1.00	1.00	1.00	1.00		
	Acres	121.1	121.1	121.1	121.1	121.1	121.1		
	Target Year HU	121.10	121.10	121.10	121.10	121.10	121.10		
	Interval HU		121.10	484.40	605.50	1816.50	3027.50	6055.00	121.10

Table 14 BRFG Future With Project Condition: *Intertidal Marsh* Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Intertidal Marsh	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	4.4	4.4	4.4	4.4	4.4	4.4		
	Target Year HU	3.52	3.52	3.52	3.52	3.52	3.52		
	Interval HU		3.52	14.08	17.60	52.80	88.00	176.00	3.52

Table 15 BRFG Future With Project Condition: *Tidal Flat* Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Tidal Flat	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	3.0	3.0	3.0	3.0	3.0	3.0		
	Target Year HU	2.40	2.40	2.40	2.40	2.40	2.40		
	Interval HU		2.40	9.60	12.00	36.00	60.00	120.00	2.40

CRL – Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

The Recommended Plan would result in the loss of 0.7 acre of intertidal marsh at the CRL; no impacts to high marsh would occur. **Tables 16 and 17** provide, for each wetland habitat type in the study area, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year with project conditions.

Table 16 CRL Future With Project Conditions: *High Marsh* Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
High Marsh	HSI	0.25	0.25	0.25	0.25	0.25	0.25		
	Acres	32.0	32.0	32.0	32.0	32.0	32.0		
	Target Year HU	8.00	8.00	8.00	8.00	8.00	8.00		
	Interval HU		8.00	32.00	40.00	120.00	200.00	400.00	8.00

Table 17 CRL Future With Project Conditions: *Intertidal Marsh* Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Intertidal Marsh	HSI	0.83	0.83	0.83	0.83	0.83	0.83		
	Acres	3.9	3.9	3.9	3.9	3.9	3.9		
	Target Year HU	3.24	3.24	3.24	3.24	3.24	3.24		
	Interval HU		3.24	12.96	16.20	48.60	81.00	162.00	3.24

Summary of Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

In summary, the Recommended Plan will remove about 13.8 acres of wetland habitats at the BRFG site and 0.7 acre at the CRL site. As a result, the project will reduce AAHUs in the study areas compared to existing and FWOP conditions. **Table 18** summarizes the anticipated habitat changes within each study area.

Table 18 Comparison of Acres and AAHUs under FWOP Condition and Future With Project Condition (50-year period of analysis)

Habitat Type	**Existing/FWOP Acres**	**Existing/FWOP AAHUs**	**Future with Project Acres**	**Future with Project AAHUs**	**Net Acres**	**Net AAHUs**
BRFG						
High Marsh	123.5	123.50	121.1	121.10	-2.4	-2.40
Intertidal Marsh	15.8	12.64	4.4	3.52	-11.4	-9.12
Tidal Flat	3.0	2.40	3.0	2.40	0	0
CRL						
High Marsh	32.0	8.00	32.0	8.00	0	0
Intertidal Marsh	4.6	3.82	3.9	3.24	-0.7	-0.58

3.4 Step 4: Future AAHUs with Mitigation

In Step 4, future habitat values with the implementation of mitigation were projected to ensure that a mitigation plan would adequately compensate for wetland losses. To predict future habitat values of a potential mitigation site, the interagency team met to discuss the anticipated progression of a created wetland in terms of the habitat variables in the HSI models for the wildlife indicator species for each of the

wetland habitats that would be impacted by the Recommended Plan and thus created by a mitigation plan: high marsh and intertidal marsh. These data were input into the HSI models and future HSIs were calculated for each created habitat type at each project site (BRFG and CRL). The HSIs were annualized over the 50-year analysis period using the annualizer in the IWR Planning Suite.

BRFG – Habitat Calculations for Created High Marsh

High marsh habitat created in the BRFG study area is expected to result in an average annual HSI (AAHSI) of 0.98 over the 50-year period of analysis. Based on this AAHSI value, 2.45 acres of created high marsh would be needed to provide sufficient HUs to compensate for the 2.4 acres of high marsh loss due to the Recommended Plan. **Table 19** shows the anticipated HSI values at a BRFG high marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 19 BRFG On-site Mitigation: Projected Conditions for High Marsh Creation

Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HSI**	**AAHSI**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
HSI	0.00	0.79	1.00	1.00	1.00	1.00		
Interval HSI		0.40	3.58	5.00	15.00	25.00	48.98	0.98
Mitigation Needs:	AAHU = 2.40							
	AAHSI = 0.98							
	Acres Needed for Mitigation = AAHU / AAHSI = 2.40/0.98 = **2.45 acres**							

BRFG – Habitat Calculations for Created Intertidal Marsh

Intertidal marsh habitat created in the BRFG study area is expected to result in an AAHSI of 0.78 over the 50-year period of analysis. Based on this AAHSI value, 11.69 acres of created intertidal marsh would be needed to provide sufficient HUs to compensate for the 11.4 acres of intertidal marsh loss due to the Recommended Plan. **Table 20** shows the anticipated HSI values at a BRFG intertidal marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 20 BRFG On-site Mitigation: Projected Conditions for Intertidal Marsh Creation

Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HSI**	**AAHSI**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
HSI	0.05	0.63	0.80	0.80	0.80	0.80		
Interval HSI		0.34	2.86	4.00	12.00	20.00	39.20	0.78
Mitigation Needs:	AAHU = 9.12							
	AAHSI = 0.78							
	Acres Needed for Mitigation = AAHU / AAHSI = 9.12/0.78 = **11.69 acres**							

CRL – Habitat Calculations for Intertidal Marsh Creation

Intertidal marsh habitat created in the CRL study area is expected to result in an AAHSI of 0.76 over the 50-year period of analysis. Based on this AAHSI value, 0.76 acre of created intertidal marsh would be needed to provide sufficient HUs to compensate for the 0.7 acre of intertidal marsh loss due to the Recommended Plan. **Table 21** shows the anticipated HSI values at a CRL intertidal marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 21 CRL Mitigation Site: Projected Conditions for Intertidal Marsh Mitigation

Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HSI**	**AAHSI**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
HSI	0.05	0.46	0.70	0.75	0.80	0.80		
Interval HSI		0.26	2.32	3.63	11.63	20.00	37.84	0.76
Mitigation Needs:	AAHU = 0.58							
	AAHSI = 0.76							
	Acres Needed for Mitigation = AAHU / AAHSI = 0.58/0.76 = **0.76 acre**							

Summary of Habitat Calculations for Created Wetland Habitats and Resulting Mitigation Needs

Based on predicted habitat values of created high marsh and intertidal marsh in the study areas, 14.9 acres of marsh creation is needed to sufficiently offset the 14.5 acres of marsh habitats that would be impacted by the Recommended Plan. The 14.9 acres of created marsh would provide an estimated 12.10 AAHUs, which would replace the AAHUs that would be lost as a result of the project (**Table 22**).

Table 22 Wetland Habitats Impacted by the Recommended Plan and Mitigation Needs

Habitat Type	**Average Baseline HSI (Annualized)**	**Acres Lost**	**AAHUs Lost**	**Projected Mitigation HSI (Annualized)**	**AAHU Needed**	**Acres Needed**
BRFG						
High Marsh	1.00	2.4	2.40	0.98	2.40	**2.45**
Intertidal Marsh	0.80	11.4	9.12	0.78	9.12	**11.69**
CRL						
Intertidal Marsh	0.83	0.7	0.58	0.76	0.58	**0.76**
Total for Both Project Sites	***--***	***14.5***	***12.10***	***--***	***12.10***	***14.90***

3.5 Mitigation Alternatives Screening

The USACE considered three alternatives for meeting the identified mitigation needs, two of which had three different planting options/scales. The mitigation alternatives considered included:

1. Purchase mitigation bank credits
2. Establish wetlands off-site with the following planting scales:
    - Plugs purchased
    - Plugs collected on site
    - Seeded pots of marsh vegetation
3. Establish wetlands on-site with the following planting scales
    - Plugs purchased
    - Plugs collected on site
    - Seeded pots of marsh vegetation

The mitigation alternatives were screened based on high-level constraints and comparisons. Purchasing mitigation bank credits was screened out because, based on the USACE's Regulatory In-lieu Fee and Bank Information Tracking Information System (RIBITS) website (USACE 2017c), the BRFG and CRL project sites are not within the service area of any active or pending mitigation bank or in lieu fee program that has

tidal marsh credits. Both project sites are within the service area of two active mitigation banks: TxDOT's Coastal Bottomlands Mitigation Bank and the Danza del Rio Mitigation Bank. Each of these mitigation banks has freshwater/riverine wetland credits available, but neither has tidal wetland credits. Therefore, at this time, the anticipated tidal wetland impacts resulting from the project cannot be mitigated through mitigation bank or in lieu fee program credits.

Establishing wetlands off-site was also screened out because the projected benefits would be the same as establishing wetlands on site, but the off-site mitigation alternative would result in the addition of real estate costs, as well as contingencies such as finding a suitable off-site mitigation site and developing a cost-effective mitigation plan for the site. The PDT screened several locations for using dredged material from the project to convert open water to emergent wetland, including areas where emergent wetlands historically existed. However, the sites would require pumping dredged material longer distances than using adjacent DMPAs and would require construction of levees to contain the material, which not only adds costs to the mitigation plan but could also result in additional wetland impacts that need to be mitigated. After reviewing the refined Recommended Plans, the PDT determined that the plans at both facilities will provide areas along the existing and proposed GIWW where high marsh and intertidal marsh could be created on-site to mitigate anticipated impacts.

Based on the initial screening, one mitigation alternative was evaluated in further detail: establish wetlands on-site with three planting scales. As noted above, the three planting scales include (1) plugs purchased, (2) plugs collected on site, and (3) seeded pots of marsh vegetation. Leaving the created wetlands to vegetate on their own was not considered because interagency coordination indicated that, if left unplanted, the mitigation areas would establish vegetation very slowly, with a projected 10 percent coverage in 5 years compared to an expected 75 to 100 percent coverage if planted. The analysis of the on-site mitigation alternative assumes that the three planting scales would produce the same habitat benefits (AAHUs); however, the planting scales would affect mitigation cost. As a result, the on-site mitigation options were evaluated using cost effective/incremental cost analysis using the IWR Planning Suite (version 1.0.11). **Table 23** provides the preliminary cost estimates for each planting scale.

Table 23 Preliminary Cost Estimates for On-site Planting at Three Scales

Planting Scale	Cost per Plug	# Plugs/ Acre[1]	Plug Cost/ Acre	Planting Cost/ Acre	Constr. Cost/ Acre[2]	OMRRR Cost/ Acre[3]	Real Estate Cost/ Acre	Total Cost/ Acre[4]	Total Mitigation Cost[5]	Average Annual Cost/ Acre
Plugs purchased	$3.00	12,575	$37,725	$20,000	$30,000	$2,500	$3,400	$93,625	$1,395,013	$3,822
Plugs on-site	$1.00	12,575	$12,575	$20,000	$30,000	$2,500	$3,400	$68,475	$1,020,278	$2,813
Seeded nursery	$10.00	12,575	$125,750	$20,000	$30,000	$2,500	$3,400	$181,650	$2,706,585	$7,352

[1] # plugs/acre is based on planting on 2-foot centers on a triangular grid.
[2] Estimated costs for construction of rock breakwaters and/or placement and contouring of dredged material.
[3] OMRR&R = Operations, Maintenance, Repair, Replacement, and Rehabilitation. Because the mitigation sites should be self-sustaining after the success criteria are met, OMRR&R costs should be minimal.
[4] Note that these costs assume that site prep would be done through the dredged material placement.
[5] Total mitigation cost is based on a total mitigation acreage of 14.9 acres.

Collecting plugs on-site was identified as the Best Buy mitigation plan, as it incurs the lowest average annual cost per acre. An uncaptured ancillary benefit of the on-site plug option is that it promotes the establishment of other native marsh species in addition to the target species because other species or their seeds may be included in the collected plugs.

3.6 Mitigation Site Location and Implementation

As determined through the above analyses, the Recommended Plan would require a total 14.9 acres of wetland habitat creation, in the form of high marsh and intertidal marsh, between the BRFG and CRL sites. This includes 14.14 acres at the BRFG site and 0.76 acre at the CRL site. Establishing 14.9 acres of wetland habitats at these locations, as described above, would produce 12.10 AAHUs to offset the 12.10 AAHUs that would be lost as a result of the Recommended Plan.

Considering multiple mitigation alternatives, the USACE determined that creating wetland habitats on the project sites would be the most cost-effective mitigation solution. The PDT determined that the Recommended Plan at both facilities will provide areas along the existing and proposed GIWW where high marsh and intertidal marsh could be created to meet the mitigation requirements. Of the planting options evaluated for on-site wetland creation, collecting plugs on-site to plant within the mitigation areas was determined to be the Best Buy mitigation plan.

Based on the mitigation analysis, the USACE proposes to create 14.14 acres of wetland habitat at the BRFG site (2.45 acres of high marsh and 11.69 acres of intertidal marsh) and 0.76 acre of wetland habitat (intertidal marsh) at the CRL site. **Figures 3 and 4** show potential locations for the mitigation wetlands at each facility in relation to the Recommended Plan and study areas. During the pre-construction, engineering, and design (PED) phase of the project, the final design for dredging and placement at each facility would incorporate areas of sufficient size and with appropriate elevations to establish the mitigation wetlands along the existing and proposed GIWW.

Within the mitigation areas, the area will be filled and/or contoured to target elevations, which will be determined based on the existing elevations of impacted and/or nearby marshes. The elevations will take into account anticipated settling of fill material. In addition, the mitigation areas will be designed to minimize the potential for erosion from vessel wakes, currents in the GIWW, and flooding from the rivers. After the fill material has settled to the target elevation, areas where intertidal marsh will be established will be planted with smooth cordgrass at a minimum of 3-foot centers. Areas where high marsh will be established will be planted at a minimum of 3-foot centers, with herbaceous species found in nearby high marsh habitats, such as turtleweed, saltgrass, saltworts, Gulf cordgrass, marshhay cordgrass, sea-oxeye daisy, and seepweed. A nearby source marsh or marshes will be identified from which to collect the vegetation plugs. The use of collected plugs would facilitate the transplanting of various native plants or seeds that may be present in the plugs. The USACE will coordinate with TPWD and other agencies as needed to establish transplant methodology and obtain transplant permits.

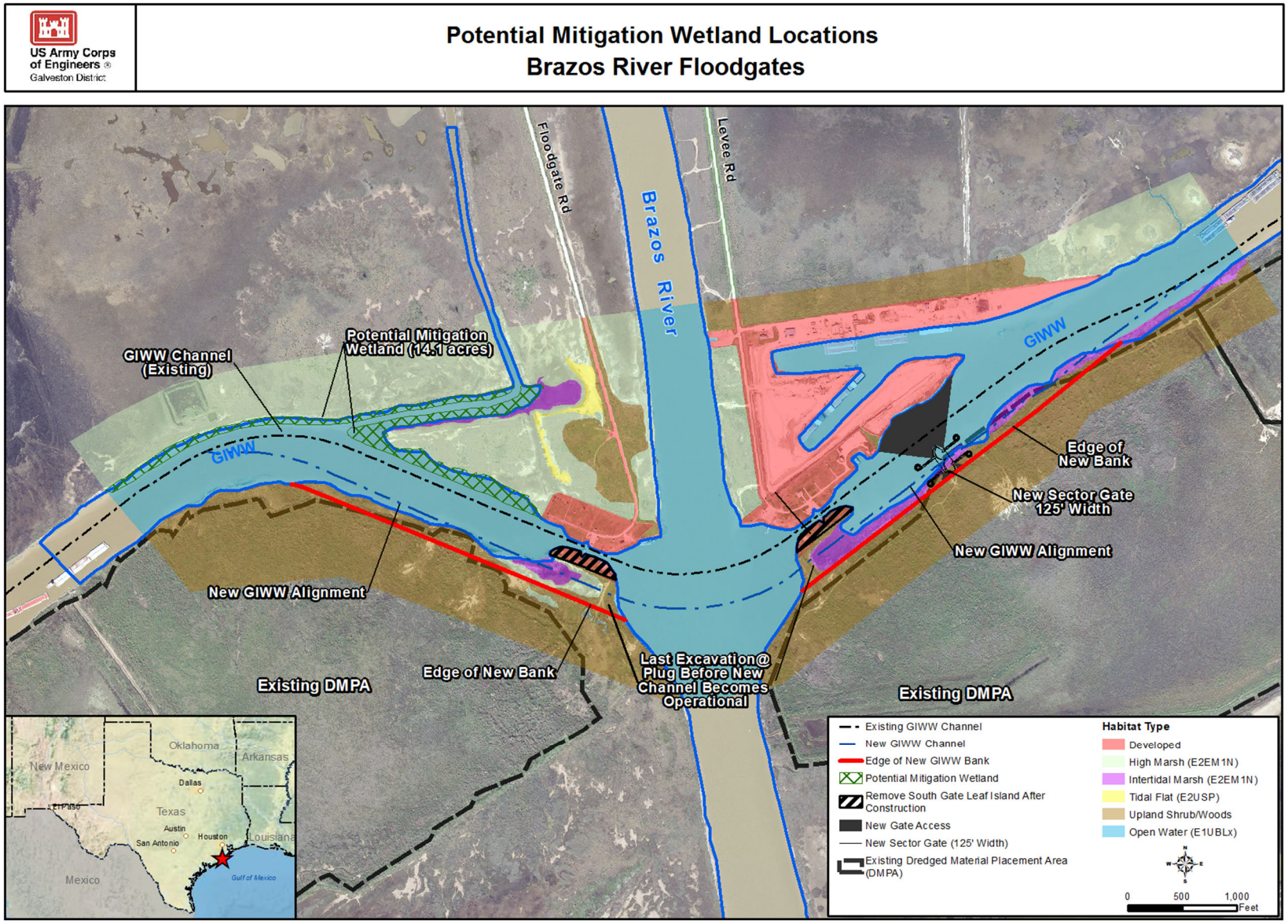

Figure 3 Potential Mitigation Wetland Location at BRFG

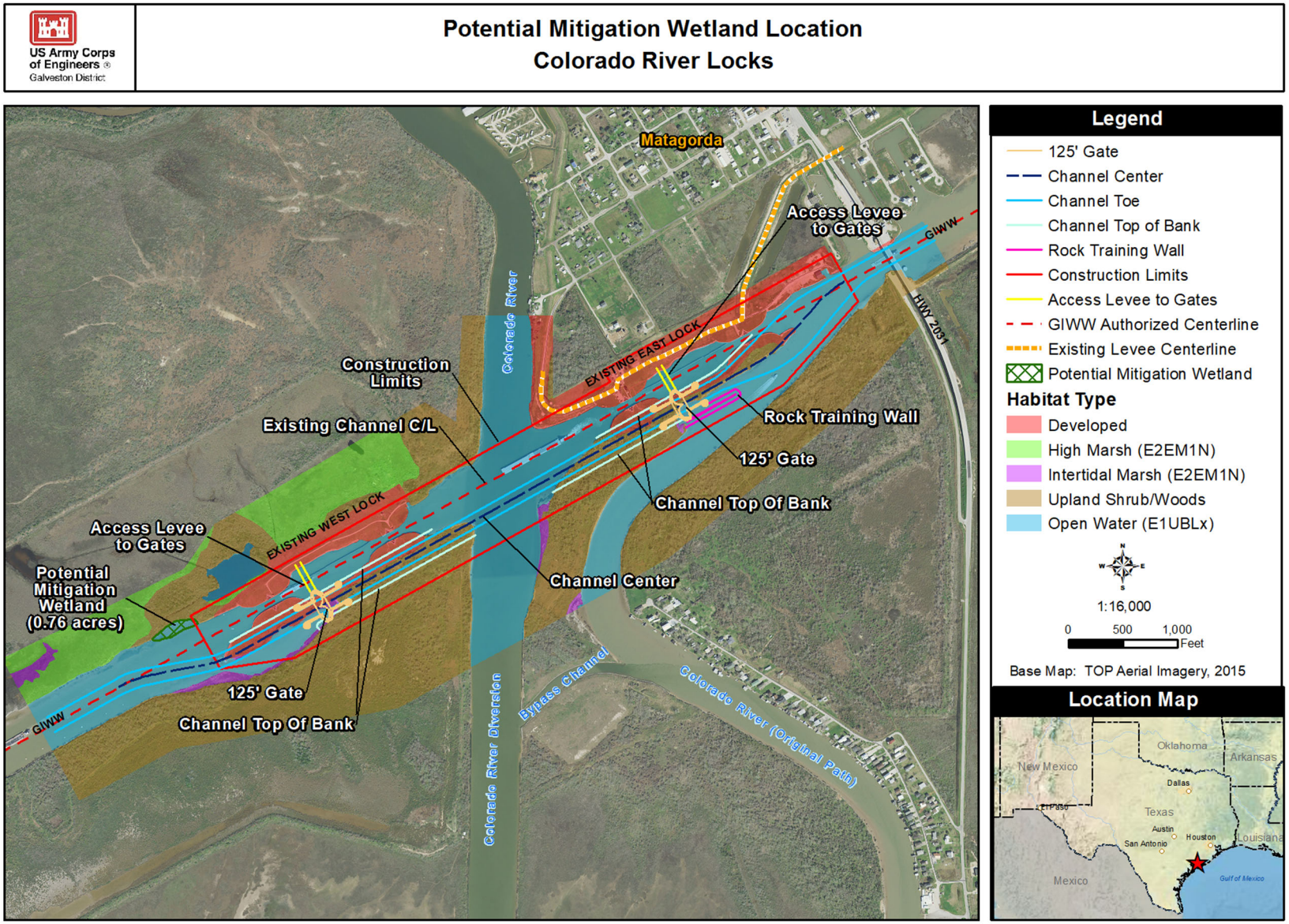

Figure 4 Potential Mitigation Wetland Location at CRL

The total estimated cost for the proposed 14.9 acres of marsh creation is $1,020,278 (**Table 24**). In addition to construction costs, the preliminary mitigation cost includes estimated real estate acquisition costs and Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs that may be needed for the success of the mitigation efforts. Because the mitigation sites should be self-sustaining after the success criteria are met, OMRR&R costs should be minimal, and a preliminary cost of $2,500 per year over the 50-year analysis period was estimated. The proposed mitigation plan would provide sufficient habitat units to meet mitigation requirements and compensate for the anticipated habitat loss due to the Recommended Plan at the BRFG and CRL facilities. Further development of the Recommended Plan and mitigation plan will determine final costs associated with wetland mitigation efforts.

Table 24 Preliminary Cost Estimates for Wetland Mitigation

Habitat Type	Acres Created	AAHUs Gained	Cost per acre	Total Cost
BRFG				
High Marsh	2.45	2.40	$68,475	$167,764
Intertidal Marsh	11.69	9.12	$68,475	$800,473
CRL				
Intertidal Marsh	0.76	0.58	$68,475	$52,041
TOTALS	**14.90**	**12.10**	**$68,475**	**$1,020,278**

3.7 Monitoring and Adaptive Management

The WRDA of 2007, Section 2036 requires that a mitigation plan include a plan for monitoring the implementation and ecological success of the proposed mitigation, and states that the monitoring should continue until the ecological success criteria have been met. This section discusses the feasibility-level monitoring and adaptive management strategies for the anticipated wetland mitigation efforts at the BRFG and CRL facilities. The primary intent of this preliminary Monitoring and Adaptive Management Plan (MAMP) is to identify monitoring and adaptive management actions appropriate for the project's mitigation goals and objectives. The MAMP, including costs, is based on currently available data and information developed during plan formulation of the mitigation plan. Uncertainties remain regarding the project design and construction details, extents of the mitigation areas and associated features, monitoring elements, and adaptive management opportunities. During the PED phase of the project, the PDT will develop a more detailed MAMP that will address uncertainties, provide a detailed cost breakdown, and further assess the establishment and success of the mitigation features proposed in the mitigation plan.

Authority and Purpose

Mitigation plans must include a strategy for monitoring the success of the mitigation [Section 2039, WRDA 2007]: "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits." Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecological mitigation projects.

Implementation

Pre-construction, during construction, and post-construction monitoring shall be conducted by utilizing a MAMP Team consisting of representatives of the USACE, TxDOT, and contracted personnel. Monitoring will focus on evaluating mitigation success and guiding adaptive management actions by determining if the

project has met Performance Standards. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives are summarized in **Table 25** and discussed below.

Table 25 Monitoring Criteria, Performance Standards, and Adaptive Management Strategies

Measurement	Performance Standard	Adaptive Management Measures
Herbaceous Plant Cover	70 percent cover by target marsh species	Replanting and/or re-contouring as needed Changing species composition Collecting plugs from different locations
Non-native Vegetation	< 10 percent cover by non-native or invasive species	Mechanical removal Local herbicide application Replanting as needed
Water Depth	Target water depth for specific habitat	Re-contouring as needed
Erosion Control	Minimal erosion observed	Install breakwaters or other controls Re-contouring as needed

The mitigation areas will be assessed prior to construction, then monitored initially at 6 months after construction and initial planting are completed. Afterward, the mitigation areas will be monitored annually for up to 3 years or until the mitigation success criteria are achieved. The mitigation areas will be considered successful when:

1) herbaceous cover of target plant species is at least 70 percent;
2) cover of non-native or invasive plant species is less than 10 percent; and
3) target water depths are present.

After any monitoring period, if it is determined that the mitigation areas are not progressing as planned, adaptive management actions outlined in **Table 25** will be implemented as appropriate.

Reporting

After each monitoring period, a report will be prepared and submitted to the USFWS, NMFS, TPWD, and other interested parties. Permanent locations for photographic documentation will be established to provide a visual record of habitat development over time. The photograph locations will be identified in the pre-construction monitoring report. Photographs taken at each location will be included in monitoring reports.

Monitoring and Adaptive Management Costs

Costs to be incurred during PED and construction phases include drafting of the detailed MAMP. Cost calculations for post-construction monitoring are displayed as a 3-year (maximum) total. If ecological success is determined earlier (prior to 3 years post-construction), then the monitoring program will cease and costs will decrease accordingly.

It is intended that monitoring conducted for the wetland mitigation will utilize centralized data management, data analysis, and reporting functions associated at the USACE Fort Worth District office. All data collection activities will follow consistent and standardized processes established in the detailed MAMP. Cost estimates include monitoring equipment, photograph point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements (**Table 26**). The current total estimate for developing the MAMP and conducting monitoring is $147,000.

Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs. With the addition of these MAMP costs to the anticipated constriction and OMRR&R costs, the total cost to construct, maintain, and monitor the proposed mitigation is $1,167,278.

Table 26 Preliminary Cost Estimates for Monitoring and Adaptive Management Plan Development

Category	Activities and Assumptions	PED Set-up & Data Acquisition	1-year Post-construction	2-year Post-construction	3-year Post-construction	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures	$16,000	$3,000	$3,000	$3,000	$25,000
	Cost Assumptions Workgroup/Performance Measures: assumes 2 staff x 24 hr/staff x $125/hr = $6,000 Draft Monitoring Plan: assumes 1 staff x 40 hr x $125/hr = $5,000 Coordinate/Finalize Monitoring Plan: assumes 1 staff x 40 hr x $125/hr = $5,000 Annual Updates (3 years): assumes 24 hr/year x $125/hr = $3,000					
Monitoring: Data Collection	Vegetation	$12,000	$12,000	$12,000	$12,000	$48,000
	Cost Assumptions Assumes up to 2 site visits per year x 2 staff x 24 hr/staff/visit x $125/hr = $12,000 Assumes base/construction year and 3 years post-construction = 4 years total Assumes most mitigation marsh is intertidal and dominated by *Spartina alterniflora*					
Data Analysis and Report	Assess monitoring data and performance standards and prepare reports	$10,000	$10,000	$10,000	$10,000	$40,000
	Cost Assumptions Assumes up to 2 site visits/reports per year x 40 hr/report x $125/hr = $10,000 Assumes base/construction year and 3 years post-construction = 4 years total Assumes most mitigation marsh is intertidal and dominated by *Spartina alterniflora*					
Database Management	Database development, management, maintenance	$3,000	$2,000	$2,000	$2,000	$9,000
	Cost Assumptions Database Setup (Year 1): assumes 24 hr/year x $125/hour = $3,000 Database Management (Years 2-4): assumes 16 hr/year x $125/hr = $2,000/year					
Adaptive Management Program	Detailed Adaptive Management Plan and Program Establishment	$10,000	--	--	--	$25,000
	Management of Adaptive Management Program	--	$5,000	$5,000	$5,000	
	Cost Assumptions AM Plan Establishment (Year 1): assumes 2 staff x 40 hours/staff x $125/hour = $10,000 AM Plan Management (Years 2-4): assumes 1 staff x 40 hr/year x $125/hr = $5,000/yr Assumes most mitigation marsh is intertidal and dominated by *Spartina alterniflora*					
	Total MAMP Costs	**$51,000**	**$32,000**	**$32,000**	**$32,000**	**$147,000**
	Total Construction and OMRRR Cost					**$1,020,278**
	TOTAL MITIGATION COST					***$1,167,278***

If implementation of adaptive management measures outlined in **Table 25** above becomes necessary, the implementation would require additional costs, as estimated in **Table 27** below. The costs for implementing adaptive management measures were estimated based on potential frequency of implementation and estimated level of effort anticipated for each measure. The preliminary total estimate for implementing the adaptive management plan is $50,000.

Table 27 Preliminary Cost Estimates for Implementation of Adaptive Management Measures

Adaptive Management Measure	Assumptions	Preliminary Cost
Replanting	Assume 10% of area (1.5 acres) may require one replanting Assume $10,000/acre for preparation, mobilization, plug collection, and planting	$15,000
Re-contouring	Assume minor re-contouring one time at $25,000	$25,000
Invasive and/or Nuisance Plant Control	None anticipated – mitigation will be mostly intertidal marsh where few species can survive.	$0
Erosion Control	Assume some erosion control will be needed at $10,000	$10,000
	TOTAL	**$50,000**