Attachment D-2
Biological Assessment

REVISED DRAFT

BIOLOGICAL ASSESSMENT

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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Acronyms and Abbreviations

Acronym or Abbreviation	Definition or Meaning
BA	Biological Assessment
BMP	best management practice
BO	Biological Opinion
BRFG	Brazos River Floodgates
CFR	Code of Federal Regulations
CRL	Colorado River Locks
CWS	Canadian Wildlife Service
dB	decibels
DCH	designated critical habitat
DMPA	Dredged Material Placement Area
ESA	Endangered Species Act
FR/EIS	Feasibility Report and Environmental Impact Statement
GARFO	Gulf Atlantic Regional Fisheries Office
H&H	hydrology and hydraulics
GIWW	Gulf Intracoastal Waterway
LF	linear feet
µPaRMS	micro-Pascal root-mean square
NAVD88	North American Vertical Datum of 1988

Acronym or Abbreviation	Definition or Meaning
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
ODMDS	ocean dredged material disposal sites
PCE	primary constituent element
SONAR	Sound Navigation and Ranging
TXNDD	Texas Natural Diversity Database
TxDOT	Texas Department of Transportation
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
WBNP	Wood Buffalo National Park
WMA	Wildlife Management Area

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), in cooperation with the Texas Department of Transportation (TxDOT) Maritime Division, is conducting the *Gulf Intracoastal Waterway (GIWW), Brazos River Floodgates and Colorado River Locks Systems Feasibility Study* to determine the feasibility of modifying the Brazos River Floodgates (BRFG) and Colorado River Locks (CRL) to reduce navigation impacts and costly waterborne traffic delays that are a result of aging infrastructure and inadequate channel dimensions. 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 Biological Assessment (BA) was prepared to fulfill the USACE's requirements under Section 7(c) of the Endangered Species Act (ESA) of 1973, as amended, and to provide information to assist the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) in reviewing the project's effects on federally listed threatened and endangered species, species proposed or candidates for listing, and designated critical habitat. The project is not expected to adversely affect any listed species; therefore, consultation with the USFWS and NMFS is expected to be informal, and no Biological Opinion (BO) is expected to be required for the project.

1.1 Background Information

The GIWW is a 1,300-mile-long, shallow-draft, man-made protected waterway that connects ports along the Gulf of Mexico from St. Marks, Florida, to Brownsville, Texas. The authorized channel dimensions are 125 feet wide and 12 feet deep. The GIWW is an essential component of the transportation network of Texas and the nation, reducing congestion on highway and rail systems, thereby decreasing maintenance costs and extending the life of these transportation systems. Compared to truck or rail transport, the use of barges to transport goods produces fewer air emissions, is more fuel-efficient, and provides a safer mode of transportation. The GIWW is also used by the commercial fishing industry and for recreational activities such as fishing, skiing, sightseeing, and traveling long distances in the protected waterway (TxDOT 2016).

The BRFG and CRL are two lock-type structures on the GIWW located about 40 miles apart on the upper to mid-Texas coast, in Brazoria and Matagorda Counties, respectively (**Figure 1**). They were initially installed in the early 1940s to prevent heavy sediment loads in the Brazos and Colorado Rivers from entering the GIWW. The structures are over 60 years old and were installed at a time when most tug boats pulled barges behind them, rather than using the modern pushing method. At each facility, the gate openings are 75 feet wide, which is narrower than the 125-foot-wide GIWW navigation channel. Although regulations restrict the width of tows to 55 feet, oversize tow permits are routinely granted for tows as wide as 108 feet, particularly along the upper Texas coast (TxDOT 2016). To move these wider tows through the BRFG and CRL, vessel operators must park the tows, break the barges apart, move them through the locks in smaller sets or individually, and reconnect the tows on the other side. This process, known as "tripping," is inefficient and causes delays that result in substantial costs to the towing industry each year (TxDOT 2013). In addition to the narrow gates, high flows in the Brazos and Colorado Rivers make

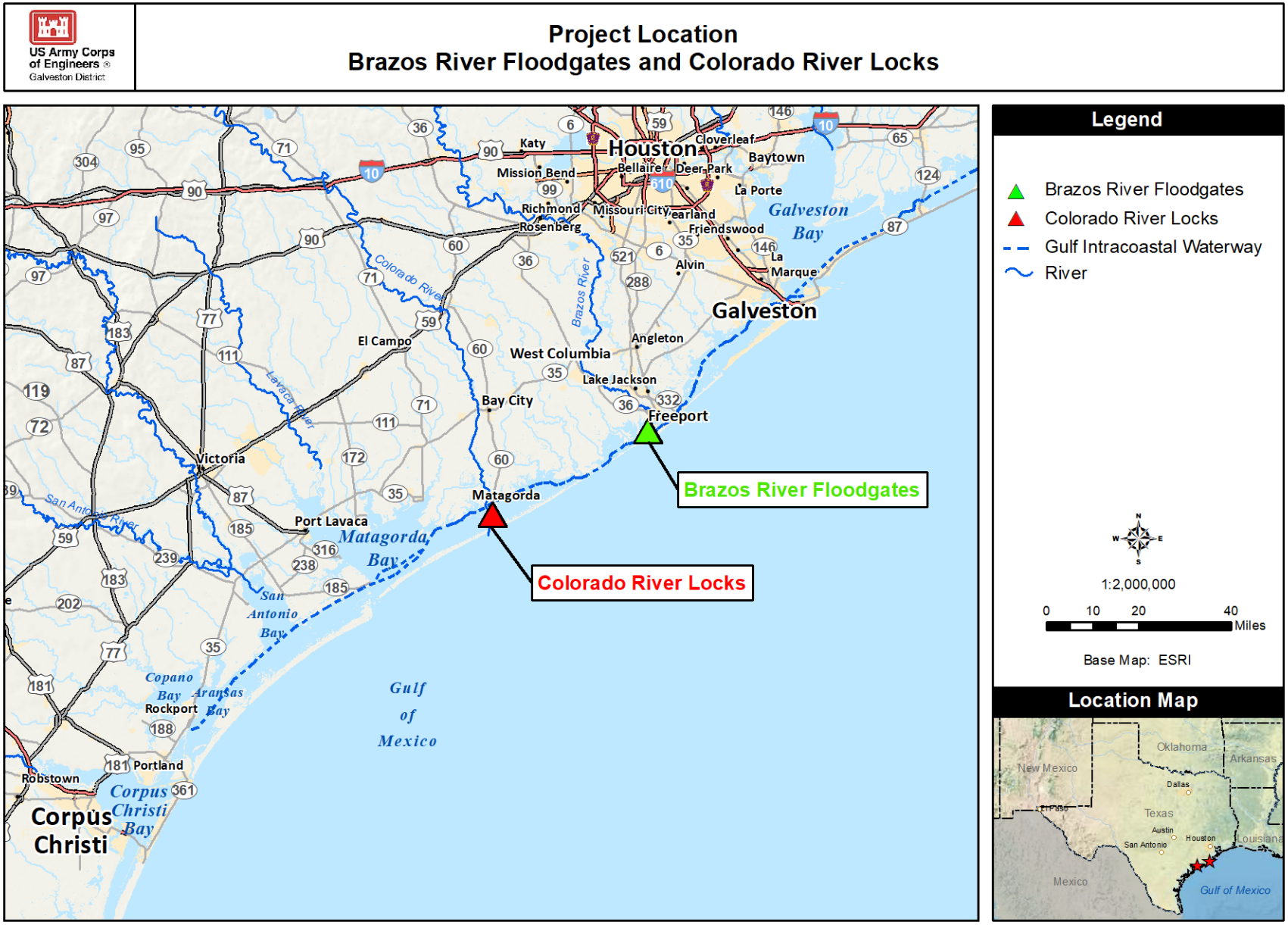

Figure 1 Project Location

navigation through the BRFG and CRL structures more difficult and result in temporary navigation restrictions and/or closures imposed by the USACE and United States (U.S.) Coast Guard. These restrictions and closures result in additional delays and economic impact to the towing industry.

1.2 Structure of this BA

Section 2.0 of this BA provides a description of existing conditions in the study areas. Section 3.0 summarizes the alternatives considered and the Recommended Plan. Threatened and endangered species of potential occurrence in Brazoria and Matagorda Counties, as well as designated critical habitat (DCH), are described in Section 4.0. Finally, Section 5.0 discusses the potential effects of the Recommended Plan on threatened and endangered species and provides the USACE's determinations of effect.

2.0 ENVIRONMENTAL BASELINE

2.1 Location

As described above, the BRFG and CRL are located about 40 miles apart on the upper to mid-Texas coast, in Brazoria and Matagorda Counties, respectively (**Figure 1**). For each facility, existing environmental conditions were evaluated within a study area that encompasses the maximum disturbance area for the reasonable alternatives. The BRFG study area encompasses roughly 600 acres and extends 1 mile east and west of the Brazos River crossing and up to 0.5 mile north and south of the river crossing (**Figure 2**). The CRL study area encompasses roughly 400 acres and extends 1 mile east and west of the Colorado River crossing and up to 0.25 mile north and south of the river crossing (**Figure 3**). Under the reasonable alternatives, all construction activities and associated direct impacts would occur within these study areas. In addition, nearby resources were identified and evaluated on a case-by-case basis depending on their potential to be indirectly affected by modifications to the BRFG and/or CRL facilities (e.g., effects of salinity and sedimentation changes on habitats, particularly piping plover DCH).

2.2 Land Use/Land Cover

Based on aerial photograph review and field reconnaissance, the BRFG and CRL study areas are largely undeveloped, with open water, emergent marsh, and upland shrub/woods being the major land cover types (**Figures 2 and 3**). Some livestock grazing occurs within these areas. Commercial navigation is a major land use in both study areas, represented by the GIWW, BRFG and CRL facilities and access roads, and existing dredged material placement areas (DMPAs) along the GIWW. Developed areas in the BRFG study area include Texas Boat and Barge, Inc., which is a barge storage, cleaning, maintenance, and repair facility located adjacent to the east floodgate. Nearby, the U.S. Department of Energy's Bryan Mound Strategic Petroleum Reserve, which is one of two Federal strategic petroleum reserve sites in Texas, is located about 1 mile north of the east floodgate (**Figure 2**). At the CRL facility, residential areas lie just outside the study area to the northeast in the town of Matagorda and to the south along the east bank of the original Colorado River channel (**Figure 3**). The area surrounding the study areas is also relatively undeveloped, although the City of Freeport lies northeast of the BRFG facility, and the town of Matagorda lies northeast of the CRL facility. Much of the surrounding undeveloped areas contain coastal bays and marshes, with upland coastal prairie and some cropland occurring further inland.

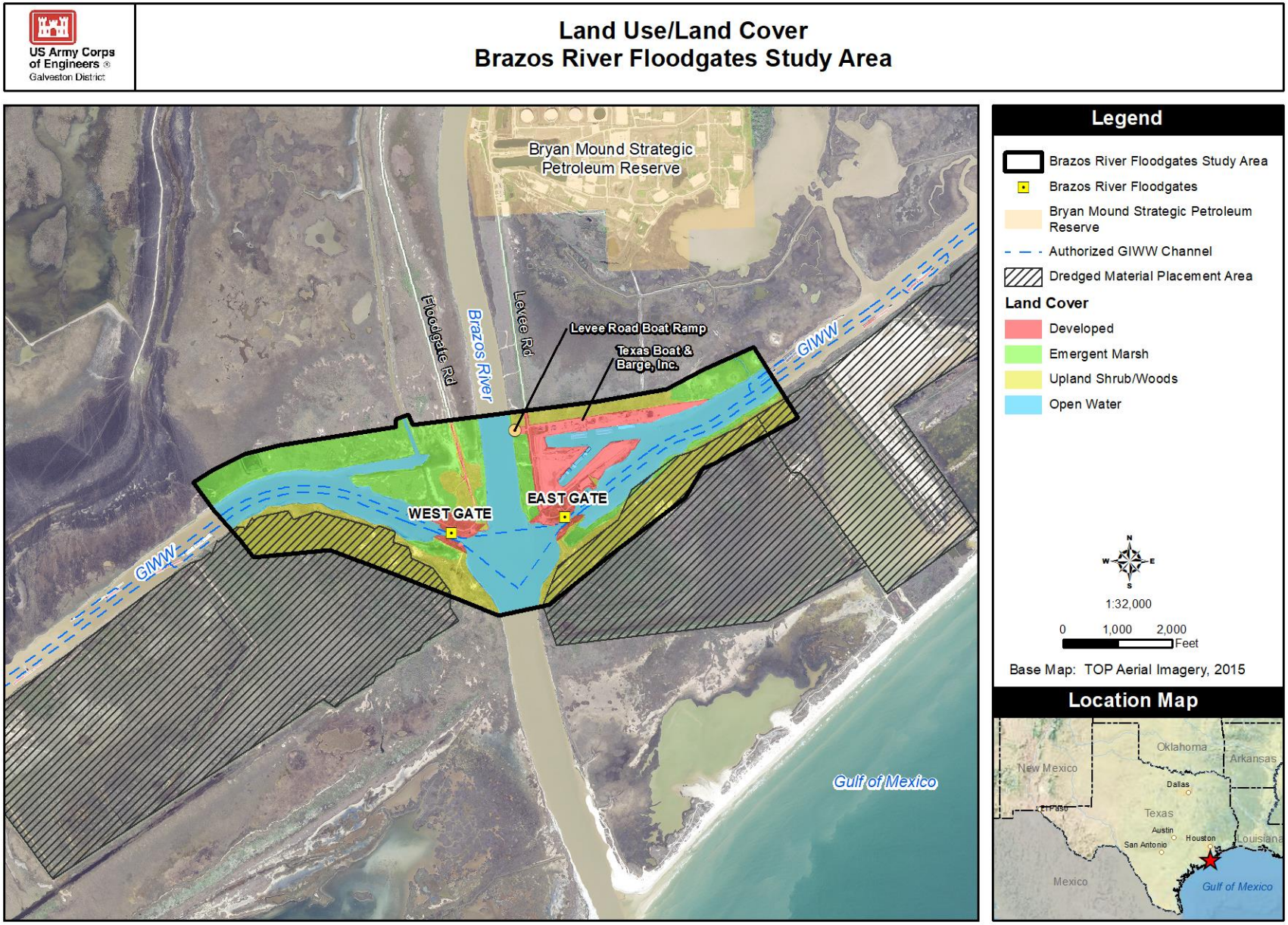

Figure 2 BRFG Study Area and Land Use/Land Cover

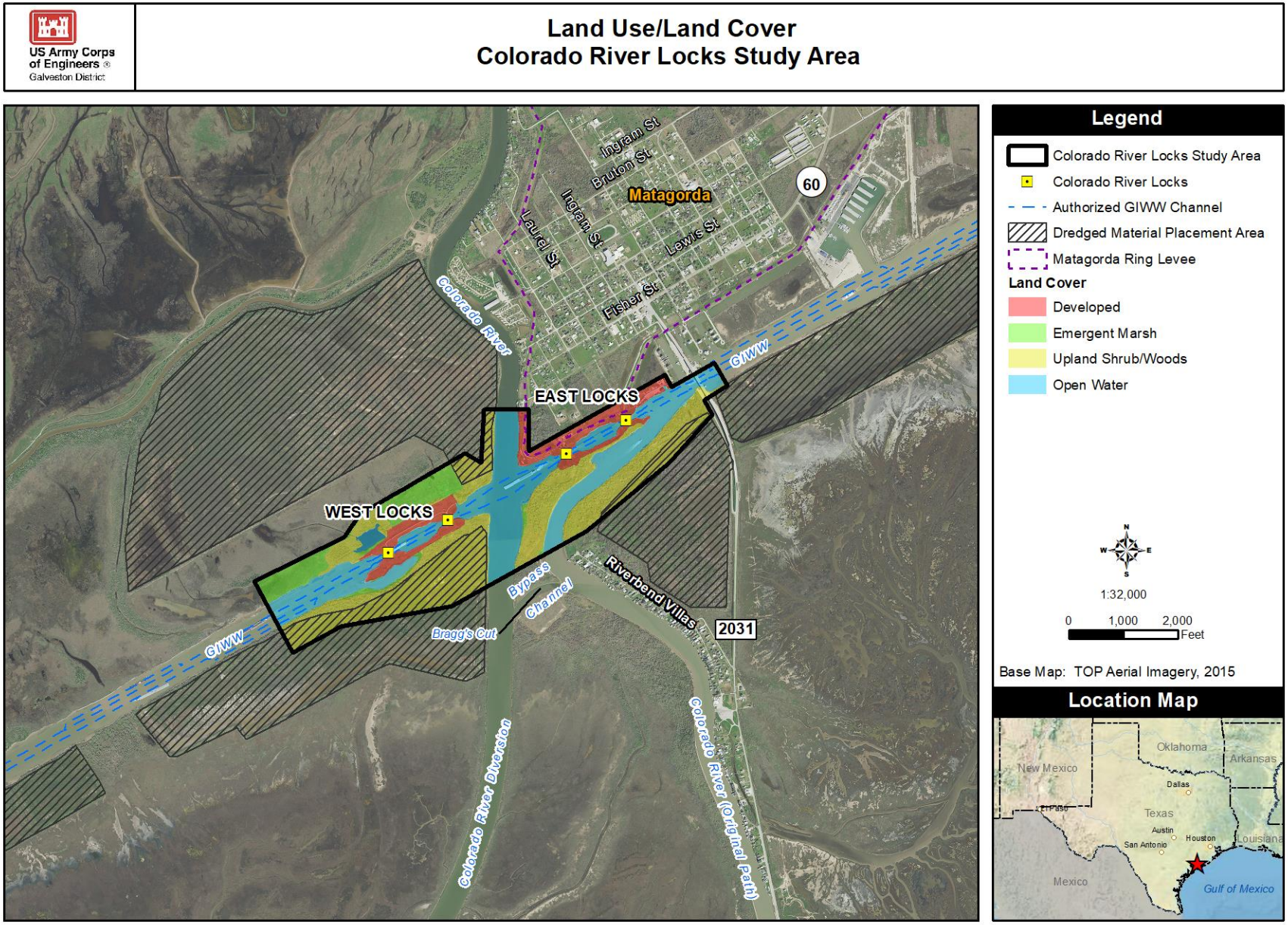

Figure 3 CRL Study Area and Land Use/Land Cover

2.3 Nearby Wildlife Refuges and Management Areas

National wildlife refuges (NWR) and state wildlife management areas (WMA) occur in the vicinity of the study areas. Near the BRFG, Justin Hurst WMA is located less than 1 mile north and San Bernard NWR is located approximately 3 miles west of the BRFG study area (**Figure 4**). Near the CRL is Mad Island WMA, which is located about 1.5 miles west of the CRL study area (**Figure 5**).

2.4 Vegetation and Wildlife Habitats

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 in the study areas were mapped using aerial photography review and field reconnaissance. Seven general vegetation communities/habitat types were observed within the BRFG and CRL study areas (**Figures 6 and 7**). **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	Percentage of BRFG Study Area	Percentage of CRL Study Area
Open Water	36	35
Intertidal Marsh	2	1
High Marsh	21	8
Tidal Flat	0.5	0
Freshwater Wetlands	< 0.1	0
Upland Shrub/Woods	30	43
Developed	11	13

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 Marsh

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.

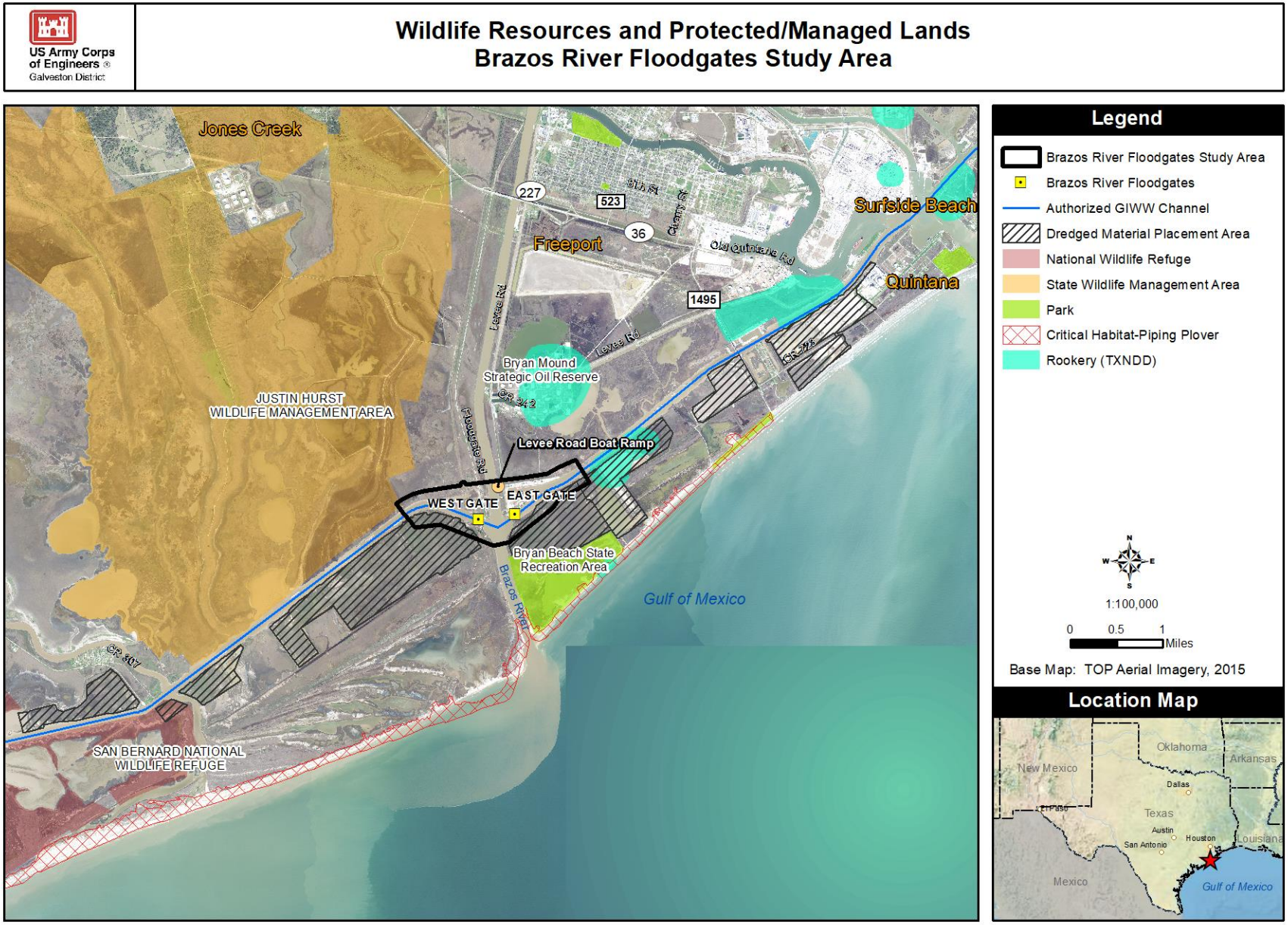

Figure 4 Wildlife Refuges and Management Areas Near the BRFG Study Area

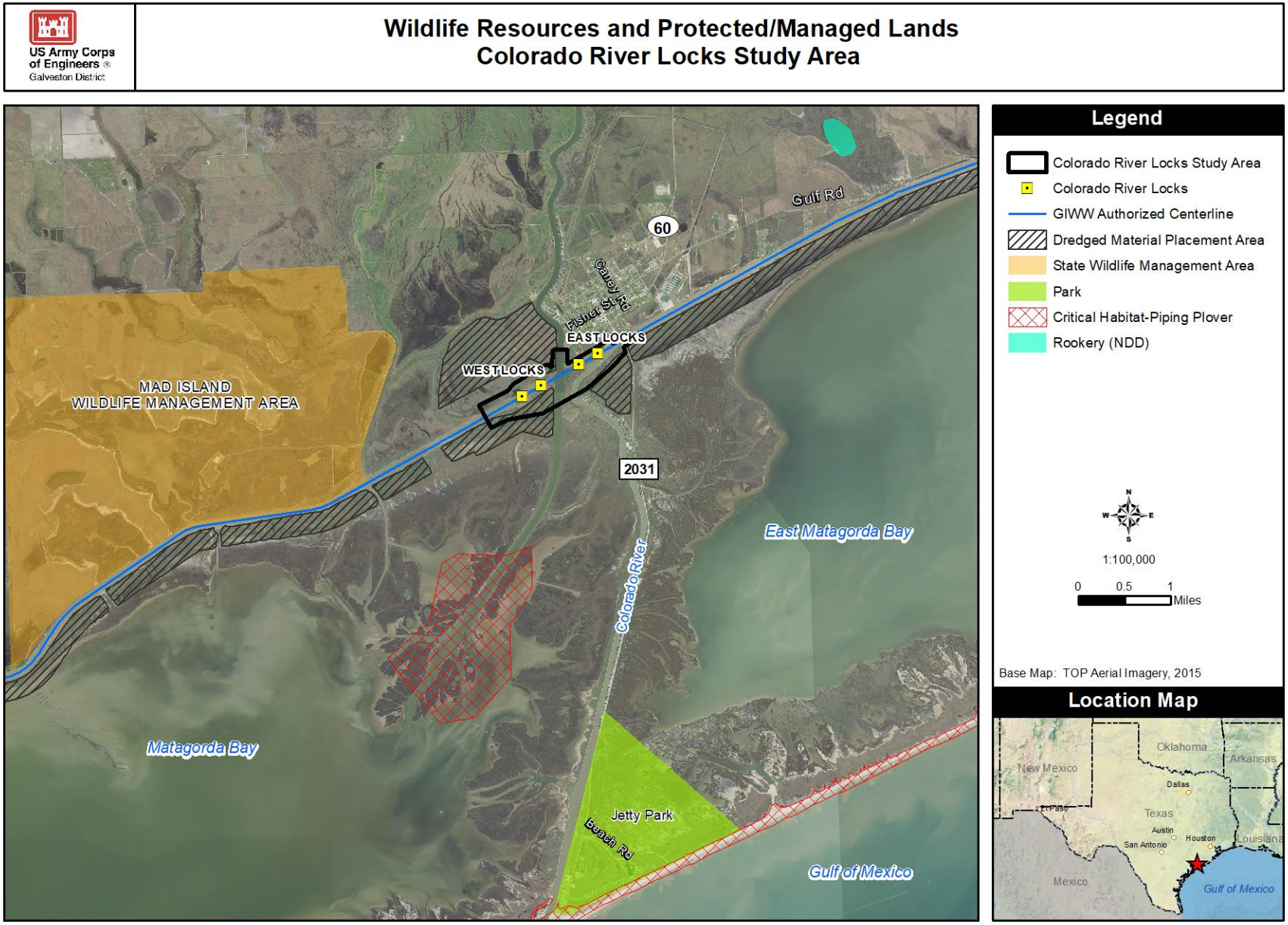

Figure 5 Wildlife Refuges and Management Areas Near the CRL Study Area

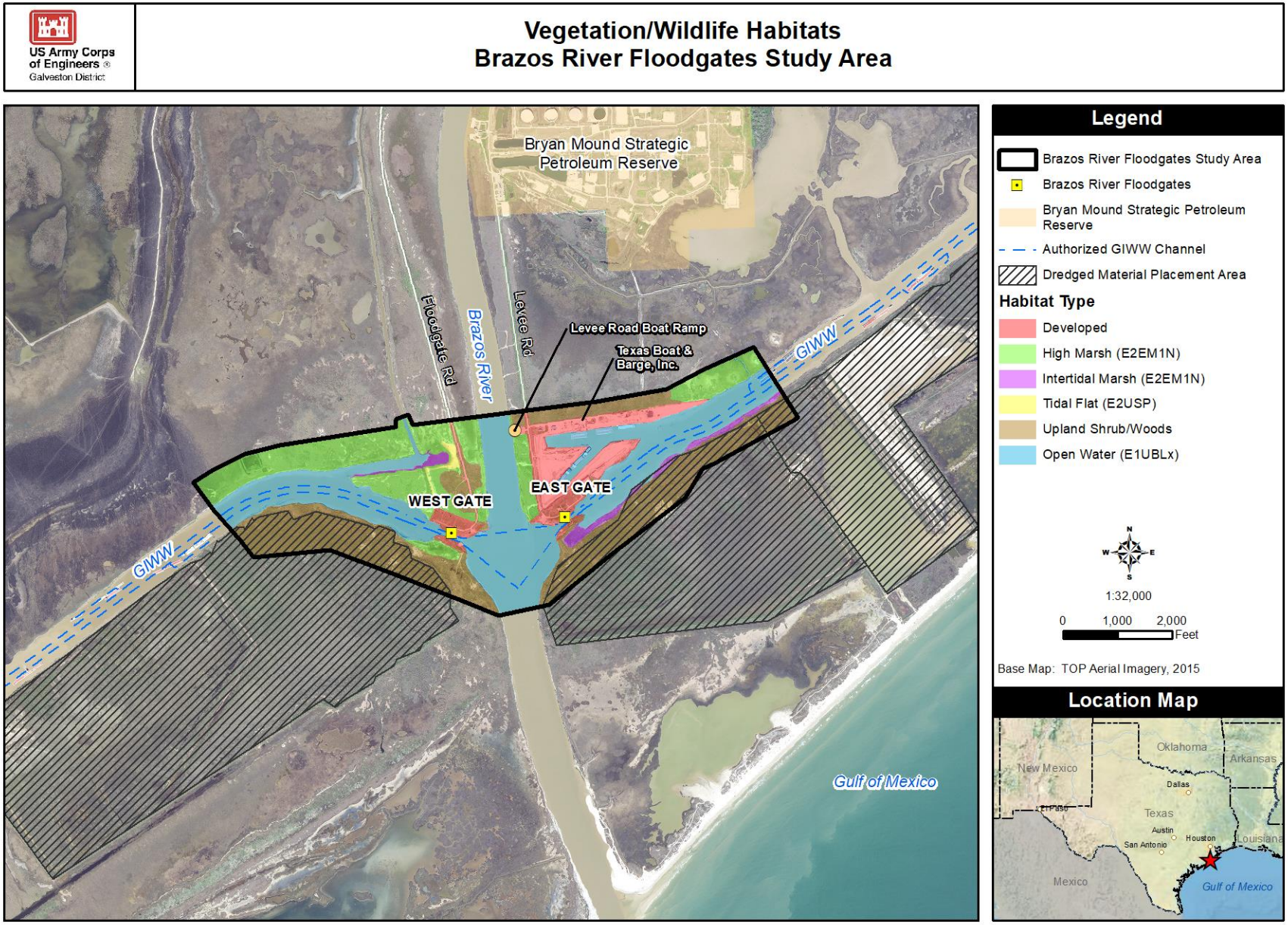

Figure 6 Vegetation/Wildlife Habitats in BRFG Study Area

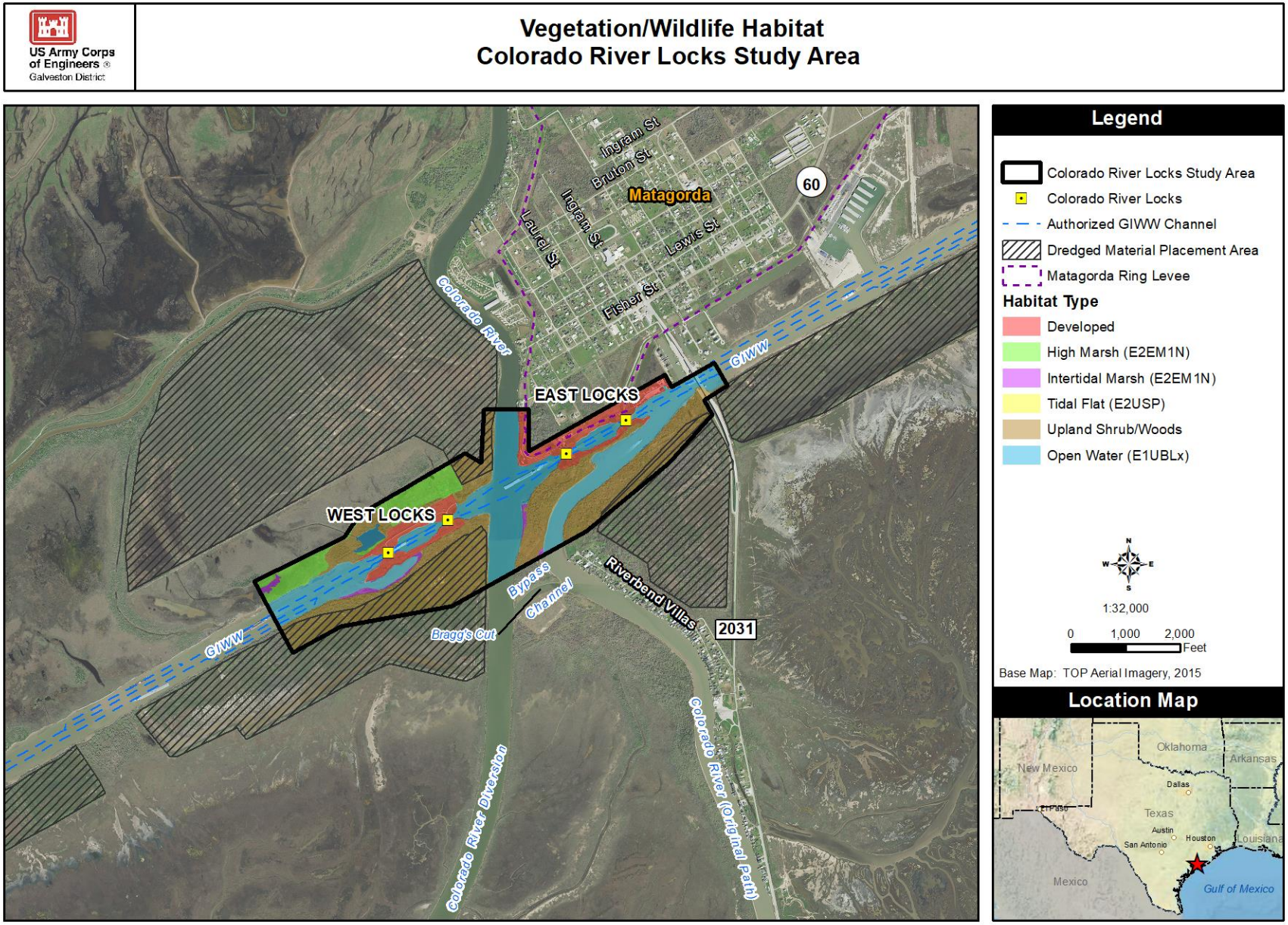

Figure 7 Vegetation/Wildlife Habitats in CRL Study Area

Intertidal Marsh

Along the GIWW in both study areas are patches of intertidal marsh, which are wetland areas that occur at elevations between the low and high tides (intertidal zone). These areas are dominated by smooth cordgrass (*Spartina alterniflora*), with species common to the high marsh habitat present along the edges.

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.

Freshwater Wetlands

Most of the wetlands in the study areas appear to be influenced by tides or tidal flooding; however, in the BRFG study area, two wetland areas with freshwater influence were observed south of the GIWW and west of the Brazos River. One area consists of two small excavated features that have steep banks ranging from approximately 3 to 6 feet high. When viewing the areas in the field, they appear to be within a DMPA, but review of DMPA boundaries show they are just outside the DMPA. The excavated areas contained standing water and little to no vegetation. The banks are vegetated with sea-oxeye daisy, Gulf cordgrass, black willow (*Salix nigra*), rattlebush (*Sesbania drummondii*), eastern baccharis (*Baccharis halimifolia*), Chinese tallow (*Triadica sebifera*), wolfberry, annual marsh-elder (*Iva annua*), southern dewberry (*Rubus trivialis*), goldenrod (*Solidago* sp.), and marshhay cordgrass.

The second wetland area with some freshwater influence is an emergent wetland that appears to be supported partially by a groundwater seep from the adjacent DMPA levee (possibly due to a clay pan created by dredged material disposal in the adjacent DMPA), as well as periodic overwash from the GIWW during high tides. The wetland is dominated by saltgrass, sand spikerush (*Eleocharis motevidensis*), common rush (*Juncus effusus*), and sea-oxeye daisy.

Upland Shrub/Woods

Higher elevations in the study areas, such as portions of the river banks and in DMPAs, support upland shrub/woods vegetation. 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*). The upland shrub/woods habitats in the study areas consist of relatively young (<50 years) woody growth and do not constitute bottomland hardwoods or other significant woodland habitat.

Developed

Developed areas in the study areas include the floodgate and lock facilities and Texas Boat & Barge, Inc. (BRFG study area).

3.0 SUMMARY OF ALTERNATIVES CONSIDERED AND RECOMMENDED PLAN

3.1 Summary of Alternatives Considered and Recommended Plan Identification

Early on in alternatives development, the USACE and TxDOT identified a number of alternatives that involved various measures to improve navigation through the BRFG and CRL facilities. Through multiple screening efforts, the USACE and TxDOT narrowed the reasonable alternatives to the No Action Alternative and five Action Alternatives at the BRFG facility, and the No Action Alternative and three Action Alternatives at the CRL facility. In an effort to minimize environmental impacts, the disturbance areas associated with the reasonable alternatives are located in and adjacent to the existing GIWW, BRFG, and CRL facilities. The USACE and TxDOT further evaluated these alternatives through hydrology and hydraulics (H&H) modeling, economic analysis, and environmental analysis to identify a Recommended Plan at each facility. **Table 2** lists the alternatives, provides a general overview of each alternative, and provides an estimated area that would be affected by the alternative.

Table 2 Summary of BRFG and CRL Alternatives Considered

Alternative	Alternative Overview	Preliminary Estimate of Acreage Affected	Recommended Plan?[2]
BRFG Alternatives			
No Action	No improvements would be made to the BRFG facility. Normal maintenance activities would continue.	0	No
2a	Rehab Existing Facilities – Rehabilitate existing floodgates, guide walls, and other infrastructure; no major changes to overall footprint, orientation, operations, or bathymetry; H&H and salinity modeling and analysis assume conditions would be the same as existing.	0[1]	No
3a	Gate Relocation on Existing Alignment – Move floodgates farther from Brazos River along existing GIWW alignment; widen chamber wall opening from 75 feet to 125 feet wide.	83	No
3a.1	**Open Channel West/East Gate Relocation – Similar to Alternative 3a but only includes a new east floodgate; removes west floodgate, leaving an open channel on the west side of the river.**	**79**	**Yes[2]**
9a	Open Channel – Remove floodgates and excavate an open channel north of the existing GIWW alignment to straighten this section of the GIWW.	75	No
9b/c	New Alignment/Gates with Control Structures – Excavate new channel north of existing GIWW alignment and construct 125-foot-wide floodgates on the new channel. Alt. 9c includes a flow control structure at existing west gate location, while Alt. 9b does not.	87	No

Table 2 Summary of BRFG and CRL Alternatives Considered

Alternative	Alternative Overview	Preliminary Estimate of Acreage Affected	Recommended Plan?[2]
CRL Alternatives			
No Action	No improvements would be made to the BRFG facility. Normal maintenance activities would continue.	0	No
2a	Rehab Existing Facilities – Rehabilitate existing locks, guide walls, and other infrastructure as needed; no major changes to overall footprint, guide wall orientation, gate operations, or bathymetry; H&H and salinity modeling/analysis assume conditions would be the same as existing.	0[1]	No
3b	Open Channel – Remove existing locks, creating an open channel through the intersection at the GIWW.	71	No
4b.1	**Removal of Riverside Gates – Remove riverside gates, converting the locks to floodgates.**	**71**	**Yes[2]**

[1] BRFG Alternative 2a and CRL Alternative 2a would rehabilitate the existing facilities within the existing footprints.
[2] The Recommended Plan presented in the DIFR-EIS is BRFG Alternative 3a.1 and CRL Alternative 4b.1.

The Recommended Plan that was presented to the public for review in the February 2018 DIFR-EIS included implementing Alternative 3a.1 (Open Channel West/East Gate Relocation) at the BRFG facility and Alternative 4b.1 (Removal of Riverside Gates) at the CRL facility. At the BRFG facility, the Recommended Plan consisted of constructing new 125-foot-wide floodgates along the existing alignment, set back approximately 1,000 feet from the river on the east side, and a minimum 125-foot-wide open channel on the west side of the river crossing. At the CRL facility, the Recommended Plan consisted of the removal of the existing river side sector gate structures and rehabilitation of the existing GIWW side sector gate structures.

3.2 Refinement of the Recommended Plan

In consideration of public comments and further discussions with the navigation industry, the USACE and TxDOT refined the Recommended Plan at each facility. First, the GIWW alignment at both facilities was shifted to the south of the existing alignment in order to maintain operation of the existing structures during construction. This refinement was made in response to concerns that the originally proposed temporary bypass channel, which would have remained open during the entire 1 to 2 years of anticipated construction, would result in excessive sedimentation and maintenance dredging costs in the GIWW and Freeport Channel during that period. Second, at the CRL facility, the Recommended Plan was refined to remove all four existing gate structures and construction a new 125-foot-wide gate on each side of the river. The following sections describe the refined plans at each facility.

3.2.1 Refined Plan at the BRFG

At the BRFG, the main features of the Recommended Plan are the removal of the existing gates on both sides of the river crossing, the construction of a 125-foot-wide open channel (no gate structure) on the west

side of the river, and construction of a new 125-foot-wide sector gate structure on the east side of the river. The centerline of the GIWW through the BRFG area would be shifted 300 feet south of the existing centerline, allowing the existing floodgates to remain in operation until the new channel and west floodgate are completed. The open channel on the west side of the river will have a bottom width of 125 feet and bottom depth of -12 feet NAVD88. The new 125-foot-wide sector gate on the east side of the river will be set back approximately 1,300 feet from the existing gate structure, providing increased safety and efficient vessel operation through the crossing. Construction of the open channel and new sector gate at the BRFG will take approximately two years to complete, if adequate funding is provided. Assuming one contract, the general construction sequence will include the following:

- Dredge the new channel alignment on the west and east sides of the river, leaving a plug at the existing floodgates to maintain separation between the new channel and the river.
- Construct the new gate structure, guidewalls, and end cells on the east side of the river.
- Excavate the plugs at the river, and complete dredging of the new channel.
- Transfer navigation traffic to the new GIWW channel and gate structure.
- Decommission existing floodgates, demolish the southern gate leaf on both sides of the river, and build levee access to the new gate structure.
- Complete final site work, including grading, parking, and support buildings.

Anticipated pile-driving activities associated with the proposed BRFG plan are outlined in **Table 3**.

Table 3 Anticipated Pile-Driving for the BRFG Recommended Plan

Project Component	Pile Size	Pile Type	Number of Piles	Hammer Type	Water Depth (meters)
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
Needle Girder Storage	24”	Concrete	60	Impact	0 (on land)
Reservation Buildings	13”	Timber Piles	272	Impact	0 (on land)

3.2.2 Refined Plan at the CRL

At the CRL, the main features of the Recommended Plan are the decommisioning of all four existing gate structures and the construction of a new 125-foot-wide sector gate structure on the east and west sides of the river. The centerline of the GIWW through the CRL area would be shifted 260 feet south of the existing centerline, allowing the existing lock structures to remain in operation until the new channel and gates are completed. The new channel will have a bottom width of 125 feet and bottom depth of -12 feet NAVD88.

Construction of the new CRL facility will take approximately two years to complete, if adequate funding is provided. Assuming one contract, the general construction sequence will include the following:

- Dredge the new channel alignment on the west and east sides of the river, leaving a plug to maintain separation between the new channel and the river.
- Construct the new gate structures, guidewalls, and end cells on each side of the river.
- Excavate the plugs at the river, and complete dredging of the new channel.
- Transfer navigation traffic to the new GIWW channel and gate structures.
- Decommission the existing lock facilities, demolish the southern gate leaf at each gate, and build levee access to the new gate structures.
- Complete final site work, including grading, parking, and support buildings.

The new CRL gate structures will be the same general dimensions as the new BRFG gate structure, so pile-driving activities associated with the proposed CRL plan are expected to be double the anticipated pile-driving at the BRFG (**Table 4**).

Table 4 Anticipated Pile-Driving for the CRL Recommended Plan

Project Component	Pile Size	Pile Type	Number of Piles	Hammer Type	Water Depth (meters)
West Gate Structure					
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
East Gate Structure					
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
Reservation Buildings	13”	Timber Piles	272	Impact	0 (on land)
Flow Separator	22”	PZ-22 Sheet Pile	500	Vibratory	< 5

3.3 Potential Effects of the Recommended Plan

This section summarizes the general impacts that may occur as a result of the Recommended Plan. Discussions of the impacts relative to each listed threatened or endangered species are provided in Section 5.0.

Habitat Loss

The anticipated impact areas associated with the Recommended Plan at each facility are shown in relation to vegetation/wildlife habitats on **Figures 8 and 9**, and the acreages of vegetation/wildlife habitats that are present within the anticipated impact areas are provided in **Table 5**. At the BRFG, the Recommended Plan would impact an estimated 125 acres, most of which would consist of temporary impacts to open water habitat. Approximately 13.8 acres of wetlands and 14.0 acres of upland shrub/woods habitat would be removed during construction. The USACE would provide mitigation for impacted wetland habitats.

Table 5 Impacts to Vegetation and Wildlife Habitats (acres)

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

[1] Most impacts to open water are temporary construction impacts. Although some open water would be filled to construct the proposed new gate structures and levee access, the project will result in a net increase in open water at both facilities due to excavation of the new GIWW alignment and removal of existing gate structures.

At the CRL, the Recommended Plan would impact an estimated 86 acres, most of which would consist of temporary impacts to open water habitat. Approximately 0.7 acre of wetlands and 11.4 acres of upland shrub/woods would be removed during construction. The USACE would provide mitigation for the impacted wetlands at CRL as well.

Noise and Vibration

The proposed construction at each facility will result in temporary increases in noise levels in the study areas. Primarily, underwater noise from pile-driving activities has the potential to affect sea turtles if they are in the study area during construction. No blasting or Sound Navigation and Ranging (SONAR) is anticipated during construction.

Dredging

The project includes dredging of new channels south of the existing channels, as well as removal of existing structures. It is anticipated that dredging would be completed using mechanical dredges and cutterhead suction dredges, neither of which are known to affect sea turtles (NMFS 2003). Dredged material would be placed in existing approved DMPAs and existing approved ocean dredged material disposal sites (ODMDS).

Turbidity

The proposed dredging, pile-driving, demolition, and other in-water construction activities would temporarily increase turbidity and suspended sediment in the GIWW, Brazos River, and Colorado River. In addition, land-based construction activities adjacent to the GIWW could result in increased sediment loads from stormwater runoff. The increase in turbidity is temporary, and local water quality is expected to

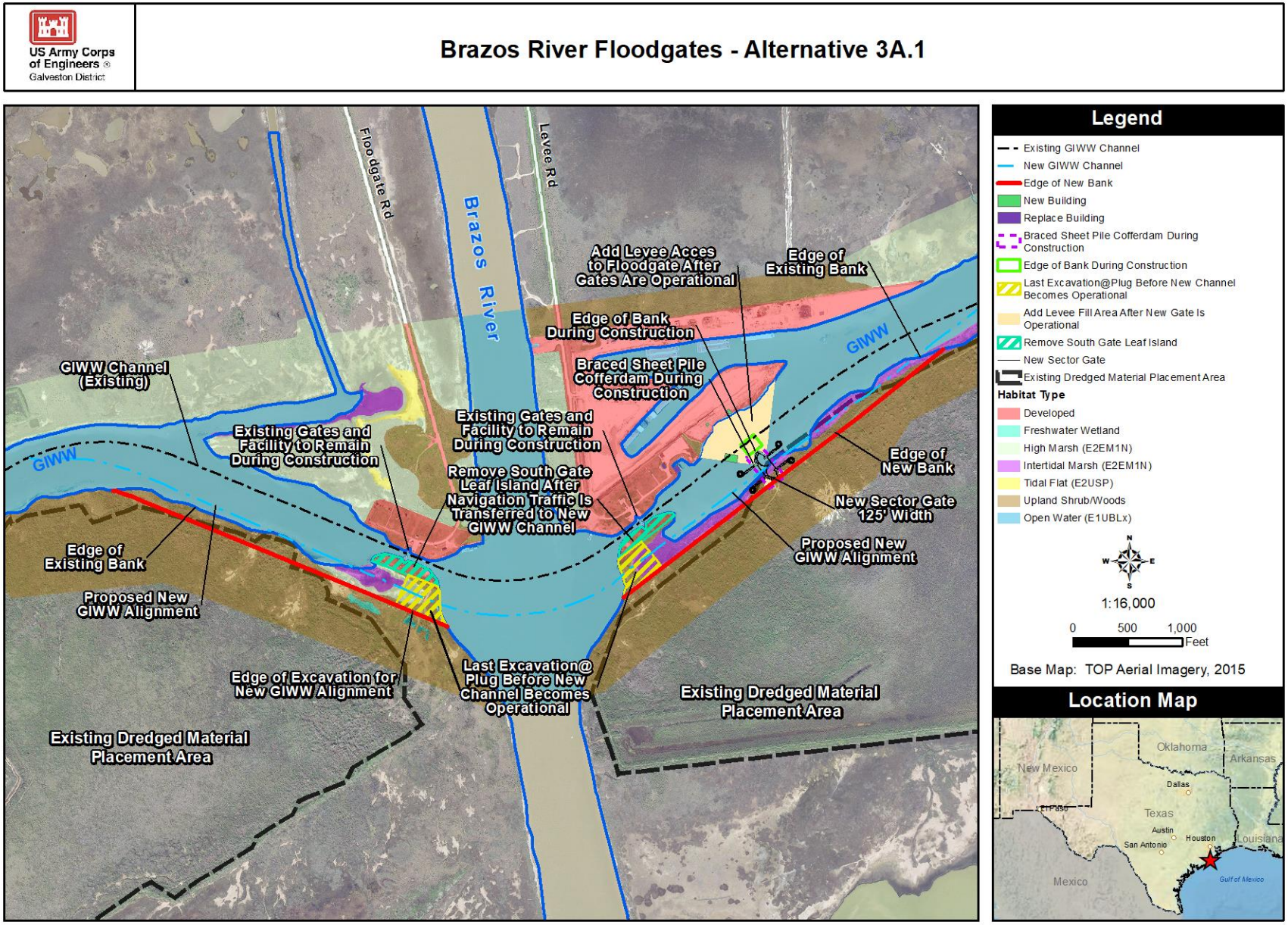

Figure 8 Vegetation/Wildlife Habitats Affected by BRFG Alternative 3a.1 (Recommended Plan)

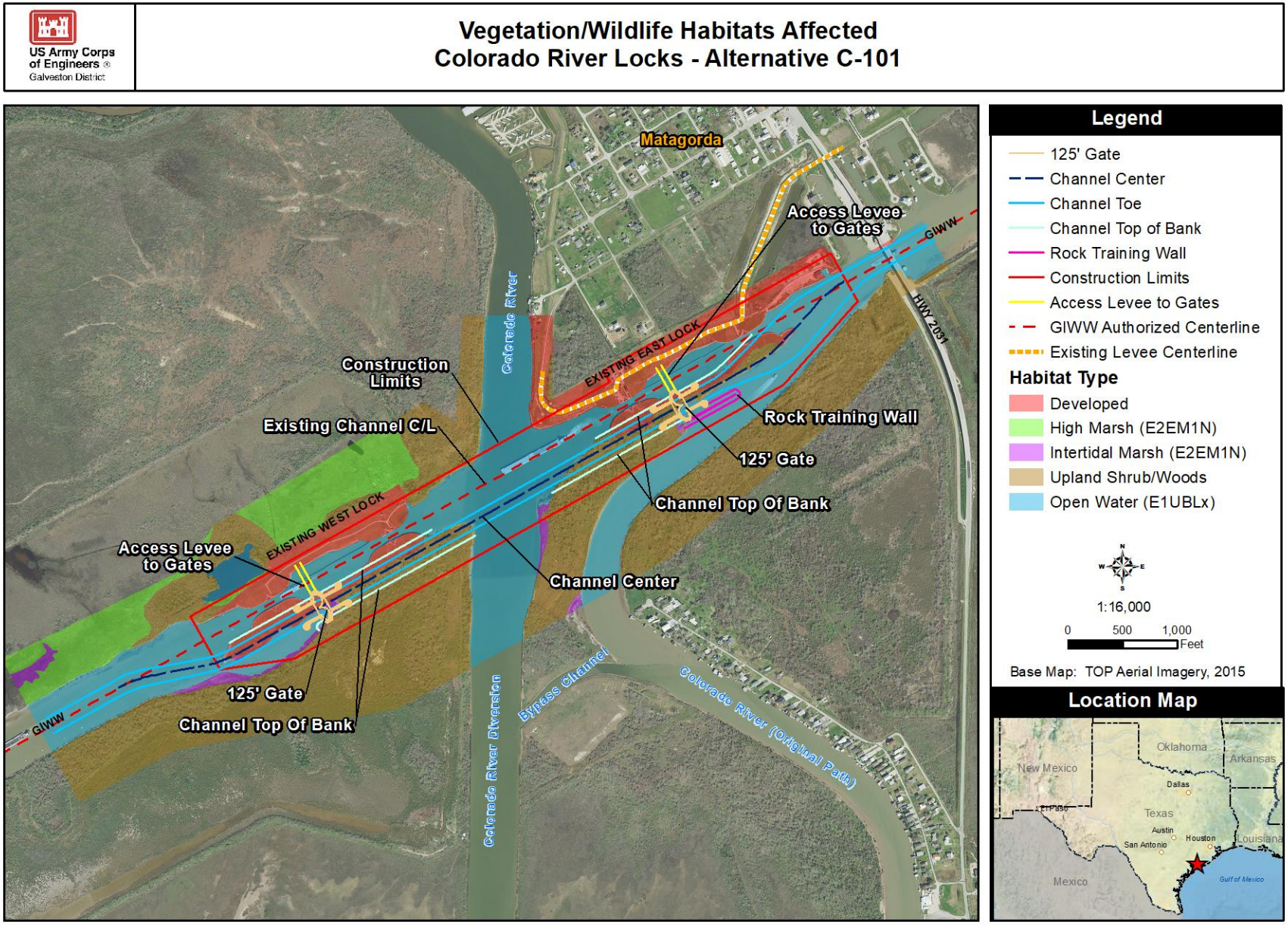

Figure 9 Vegetation/Wildlife Habitats Affected by CRL Alternative 4b.1 (Recommended Plan)

return to existing conditions after construction activities are completed. Best management practices (BMPs) would be used to reduce suspended solids from land runoff, including installation of silt fences. Similarly, turbidity screens or silt collection curtains around construction equipment would reduce the amount of sediment entrained in the water. Following construction, periodic disturbance of sediments and suspension of sediments in the water column would occur as a result of maintenance dredging operations, barge traffic, and flooding at levels similar to the existing conditions.

Changes in Sediment Budget

At the BRFG, the Recommended Plan would result in increased sediment loads in the GIWW (both east and west of the BRFG), the Brazos River basin, and Freeport Channel, which would require periodic maintenance dredging. Conversely, there would be a decrease in sediment loads in the Brazos Delta portion of the Gulf of Mexico; the annual reduction would be approximately 382,000 cubic yards of sediment, which is approximately 1% of the average annual sediment discharge to the Gulf at the Brazos River. At the CRL, sedimentation trends are expected to be similar to existing conditions and maintenance dredging would continue.

Changes in Salinity

In general, during high flows in the Brazos and Colorado Rivers, salinities in the study areas would decrease due to higher influx of freshwater, and salinities would gradually increase as river levels and freshwater inflow decrease to normal flows and low flows. Hydraulic modeling was conducted and predicted that, under the Recommended Plan, salinities in the BRFG study area would change by a decrease of up to 6 percent and an increase of as much as 16 percent. As the area experiences large fluctuations in salinities under existing conditions, no significant impacts to habitat are expected due to salinity changes. Hydraulic modeling was conducted and predicted that salinities in the CRL study area would be similar to the existing conditions; no significant changes to habitat are expected due to salinity changes.

4.0 STATUS OF THE SPECIES AND CRITICAL HABITAT

Based on a review of the USFWS' species lists for threatened, endangered, and candidate species in Brazoria and Matagorda Counties (USFWS 2017a, b, c) and the NMFS' species list for threatened, endangered, and candidate species in Texas (NMFS 2017), there are 18 threatened or endangered species and four candidates for federal listing that could occur in these counties (**Table 6**). The USFWS also listed the occurrence of designated critical habitat for the piping plover (*Charadrius melodus*) along the coastline of Brazoria and Matagorda Counties. A discussion of each listed species and candidate for federal listing is provided in the sections following **Table 6**.

Table 6 Potential for Threatened and Endangered Species to Occur in Study Areas

Listed Species		Listing Status	Jurisdiction	Potential to Occur in Study Areas?
Common Name	**Scientific Name**			
Birds				
Northern aplomado falcon	*Falco femoralis septentrionalis*	Endangered	USFWS	Yes
Piping plover	*Charadrius melodus*	Threatened	USFWS	Yes
Red knot	*Calidris canutus rufa*	Threatened	USFWS	Yes
Whooping crane	*Grus americana*	Endangered	USFWS	Yes

Table 6 Potential for Threatened and Endangered Species to Occur in Study Areas

Listed Species		Listing Status	Jurisdiction	Potential to Occur in Study Areas?
Common Name	**Scientific Name**			
Mammals				
West Indian manatee	*Trichechus manatus*	Threatened	USFWS	Yes
Fin whale	*Balaenoptera physalus*	Endangered	NMFS	No
Humpback whale	*Megaptera novaeangliae*	Endangered	NMFS	No
Sei whale	*Balaenoptera borealis*	Endangered	NMFS	No
Sperm whale	*Physeter macrocephalus*	Endangered	NMFS	No
Reptiles				
Green sea turtle	*Chelonia mydas*	Threatened	NMFS	Yes
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	USFWS; NMFS	Yes
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	USFWS; NMFS	Yes
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	USFWS; NMFS	No
Loggerhead sea turtle	*Caretta caretta*	Threatened	USFWS; NMFS	Yes
Mollusks				
Golden Orb	*Quadrula aurea*	Candidate	USFWS	No
Smooth pimpleback	*Quadrula houstonensis*	Candidate	USFWS	No
Texas fawnsfoot	*Truncilla macrodon*	Candidate	USFWS	No
Texas pimpleback	*Quadrula petrina*	Candidate	USFWS	No
Corals				
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	No
Elkhorn coral	*Acropora palmata*	Threatened	NMFS	No
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	No
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	No

Sources: NMFS 2017; USFWS 2017a, b, c

4.1 Terrestrial Species

4.1.1 Northern Aplomado Falcon

The northern aplomado falcon (*Falco femoralis septentrionalis*) is a medium-sized raptor with a weight of approximately 6 to 14 ounces, a body length of 14 to 18 inches, and a wingspan of 2.5 to 3 feet. Males and females have a similar appearance of rust-colored underparts, a gray back, a long-banded tail, and black markings on the top of the head, around the eyes, and extending down its face. The falcon was listed as endangered on February 25, 1986 (51 FR 6690) and was formerly distributed across the southwestern U.S. and northern Central America (Peregrine Fund 2017, USFWS 2007). Landscape alterations and pesticide use may have led to its extirpation throughout much of its range in the U.S.; currently it is limited to reintroduced populations in the central portion of southeastern New Mexico and south Texas. Captive-bred northern aplomado falcons have been released at select locations often referred to as "hack sites" with a goal of restoring the species to its historical range in the U.S. (USFWS 2014a). Some of these hack sites are located in south Texas at Brownsville and Matagorda Island, and in the Chihuahuan Desert region of west Texas (USFWS 2014a). No critical habitat is designated for this species.

Northern aplomado falcons are permanent residents in south Texas occurring in savannahs, open woodlands, grassy plains, coastal prairies, and desert grasslands. In the Gulf Coast region of Texas and

Mexico, the species occupies coastal prairie habitat, coastal savannahs, marshes, and tidal flats with few trees, mesquite, yucca and cactus, or other tall succulent shrubs. In northern Mexico, southeastern Arizona, New Mexico, and west Texas, the species has a strong association with Chihuahuan desert grasslands with scattered tall yuccas (USFWS 2014a). In the southwestern U.S., the northern aplomado falcon uses old nests of ravens and other raptors. Nests can be found in Spanish dagger (*Yucca treculeana*), mesquite (*Prosopis* spp.), and manmade structures like power poles. Nests built in Spanish dagger are typically 6 to 10 feet off the ground and average 1 to 3 feet in diameter. Nesting/breeding activities occur between February 1 and August 31; however, this species is territorial and pairs may stay near and defend their nest or nest site throughout the year. Their diet consists primarily of birds, but also includes insects, small snakes, lizards, and rodents (Keddy-Hector 2000).

The nearest population of northern aplomado falcons, which contains approximately 14 territorial pairs, exists on Matagorda Island and adjacent San Jose Island, located 32 miles southwest of the CRL study area. Individual sightings of the species have been recorded aboiut 9 miles west of the BRFG study area at San Bernard NWR and about 3 miles west of the CRL study area\ at Mad Island WMA (**Figures 10 and 11**) (eBird 2017). The study areas contain open habitats that could be used by aplomado falcons, but no nesting falcons are expected based on the current known nesting range.

4.1.2 Piping Plover

The piping plover is a small, pale sand-colored shorebird with a weight of 1.5 to 2.5 ounces, a body length of 7 inches, and a wingspan of 15 inches (Palmer 1967, Elliot-Smith and Haig 2004). Plumage differs in breeding and wintering seasons by the presence of a single black breast band, often incomplete, and a black bar across the forehead in the breeding season. The bill color may also turn from orange to black. The piping plover is a migratory species with a breeding distribution within the Great Lakes region and Atlantic coast and along central North America from Alberta, Canada to Colorado and Oklahoma (USFWS 2012). The non-breeding or wintering distribution occurs mainly coastal from North Carolina to Florida and the Gulf Coast states including Texas (USFWS 2012).

The piping plover was listed as threatened in Texas wintering grounds on January 10, 1986 (USFWS 1985). The primary threats to the species occur in the breeding areas of this species, where it is listed as federally endangered. Population declines were historically due to hunting and are currently due to habitat alteration at nesting grounds, nest depredation, and nest disturbance on beach habitat. Wintering habitats on the Texas Gulf Coast are threatened by industrial activities, urban development, and maintenance activities for commercial waterways, with the potential for pollution from spills of petrochemicals or other hazardous materials also being a concern (Campbell 1995). Human activity on beaches can also disturb wintering piping plovers and degrade habitat conditions (Campbell 1995, USFWS 2003a). The Texas wintering population census indicates a fluctuating to increasing trend in populations from 1,904 plovers in 1991 to 2,145 plovers in 2011 (Haig et al. 2005, USFWS 2012). Fluctuations may be due to localized effects of weather conditions; changes in roosting, foraging, or nesting habitats; or variance in survey efforts among observers.

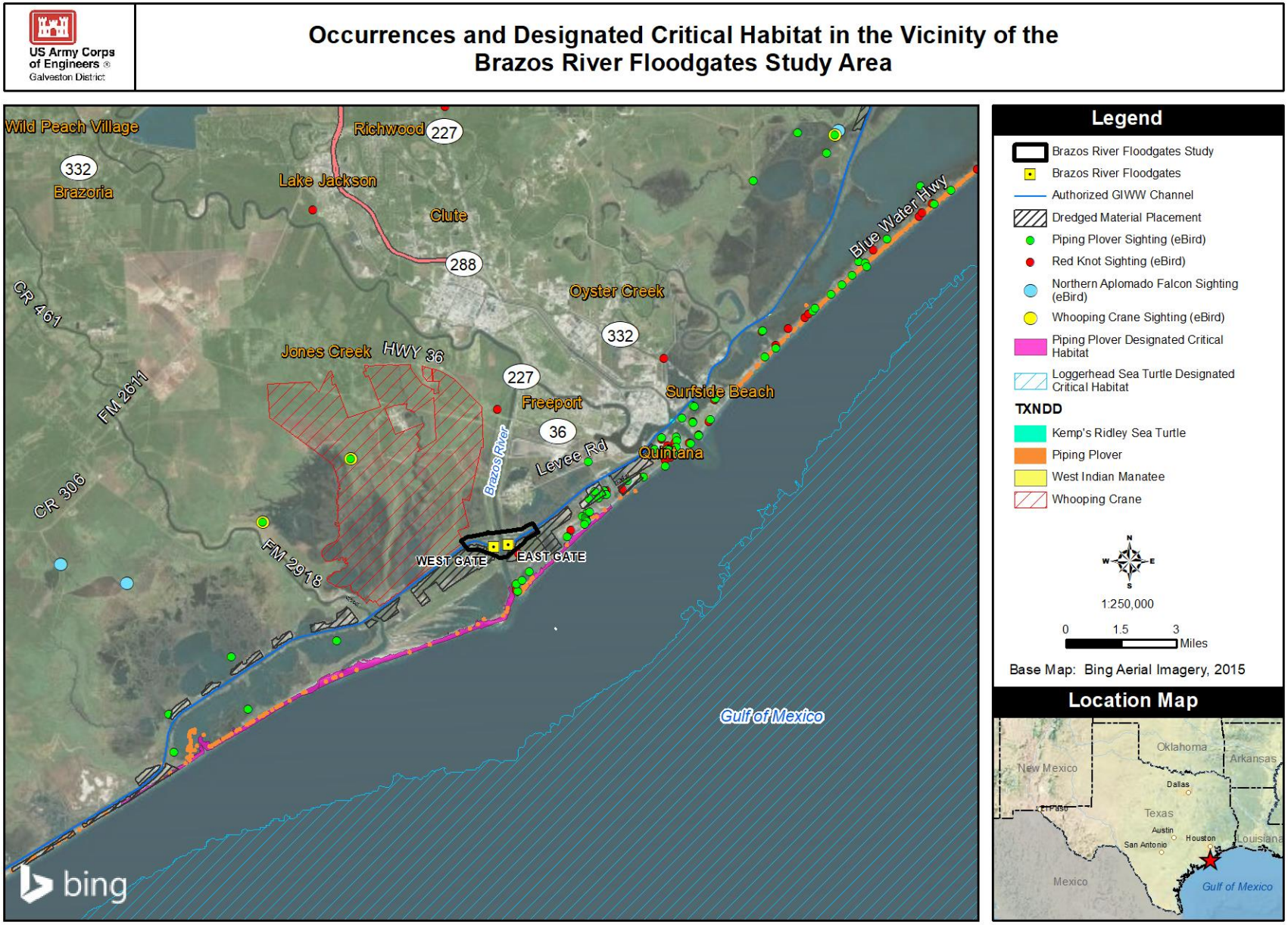

Figure 10 Occurrences and Designated Critical Habitat in the Vicinity of the BRFG Study Area

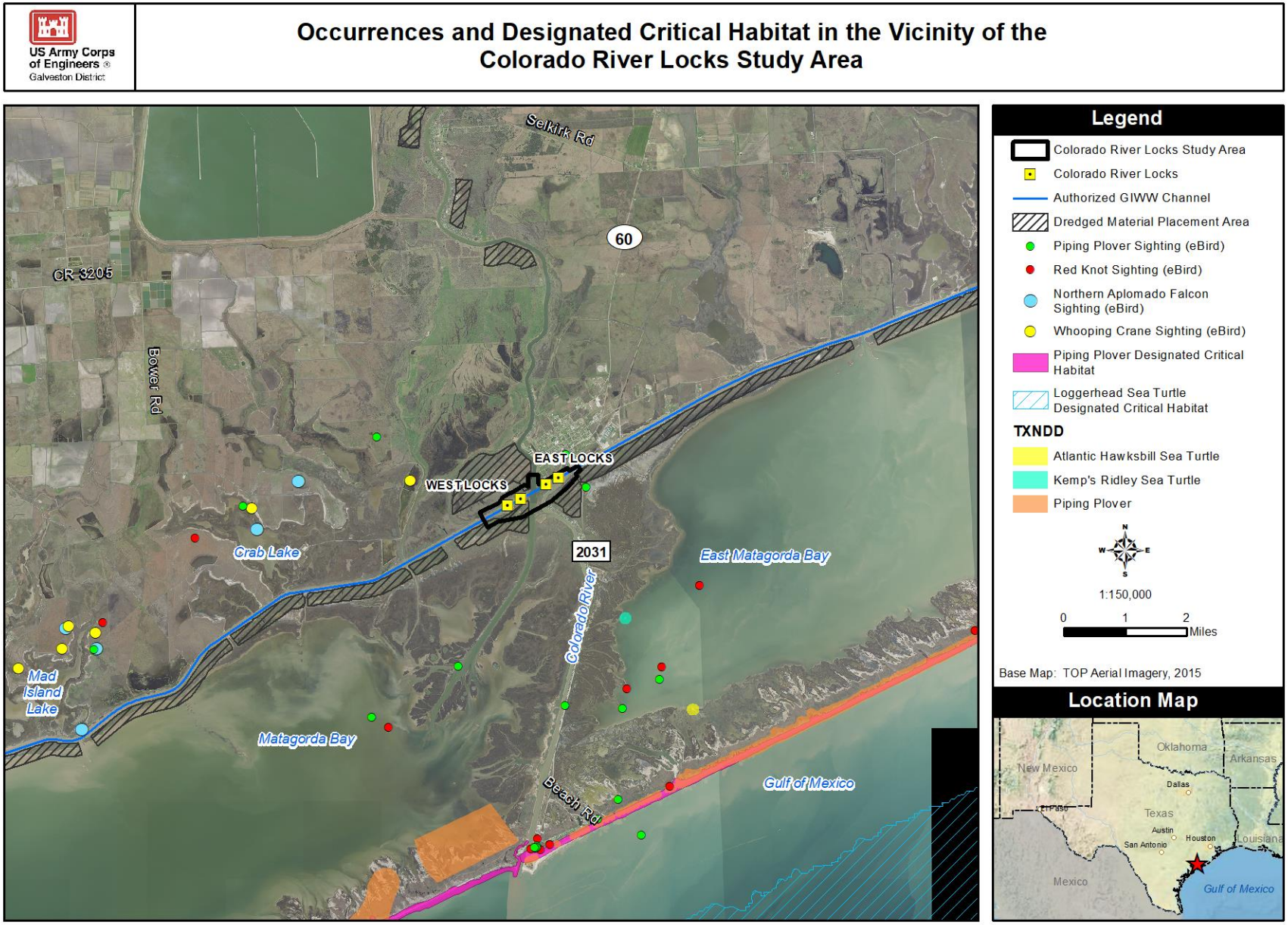

Figure 11 Occurrences and Designated Critical Habitat in the Vicinity of the CRL Study Area

Piping plovers nest on wide, gravelly beaches with little vegetation in alkali lakes and wetlands, inland lakes, reservoirs, and major rivers in the northern Atlantic coast, Great Lakes region, and around waterbodies of the Great Plains and Canada. Wintering habitat includes beaches, tidal sand flats, mud flats, algal mats, washover passes, and small dunes, where they feed primarily on small invertebrates (Campbell 2003). The migration and wintering period may last as long as 10 months (mid-July through mid-May) (USFWS 2012). Migration to breeding grounds may occur from mid-February through mid-May, with peak migrations in March (USFWS 2012). The piping plover exhibits intra- and inter-annual wintering site fidelity (Drake et al. 2001, Noel and Chandler 2008, Stucker et al. 2010), and the mean-average home-range size for piping plovers in south Texas is 4.9 square miles with a core area of 1.1 square miles. They may move 2 miles between sites within a season (Drake et al. 2001). Piping plovers can also be seen foraging along sandy, wet areas along waterways and wetlands beaches. Wintering piping plovers forage on invertebrates located on top of the sand or just below the surface along wrack lines (organic material including seaweed, seashells, driftwood, and other materials deposited on beaches by tidal action). Specific prey items may include polychaete marine worms, crustaceans, fly larvae, beetles, and bivalve mollusks (USFWS 2012).

Piping plovers have been recorded near both study areas (**Figures 10 and 11**; eBird 2017, Texas Natural Diversity Database [TXNDD] 2017). Critical habitat for the wintering population of piping plovers was designated in July 2001, and is currently divided into 141 units totaling over 250,000 acres across eight states (USFWS 2001a, 2008, 2009a). Eighteen (18) of these units are located along the Texas coastline and comprise roughly 139,000 acres. Designated critical habitat for the piping plover is present along the Gulf beach near both study areas, as well as in the Colorado River delta in West Matagorda Bay (USFWS 2017a, b, c) (**Figures 10 and 11**). The USFWS has idenitified primary constituent elements (PCEs) for each critical habitat unit; PCEs are habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components (USFWS 2009a). Critical habitat units in the vicinities of both study areas support the following PCEs:

- PCE 1: Intertidal sand beaches (including sand flats) or mud flats [between the mean lower low water (MLLW) and annual high tide] with no, or very sparse, emergent vegetation for feeding. In some cases, these flats may be covered or partially covered by a mat of blue-green algae.

- PCE 3: Surf-cast algae for feeding.

- PCE 4: Sparsely vegetated backbeach, which is the beach area above mean high tide seaward of the dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or road. Backbeach is used by plovers for roosting and refuge during storms.

- PCE 7: Unvegetated washover areas with little or no topographic relief for feeding and roosting. Washover areas are formed and maintained by the action of hurricanes, storm surges, or other extreme wave actions.

4.1.3 Red Knot

The red knot (*Calidris canutus rufa*) is a medium to large shorebird with a weight of 5 ounces, a body length of 9 to 10 inches, and a wingspan of 20 to 22 inches. During the breeding season, it has a rust-colored face, chest, and undersides, and dark brown wings. In winter, it has a gray head, chest, and upperparts and a white belly. It has long greenish legs and a pointed black bill. Males and females look similar, and juveniles resemble nonbreeding adults. The red knot was listed as threatened on December 11, 2014 (79 FR 73706). The greatest threat to the red knot population is habitat loss in the U.S., followed by reduction of preferred prey items in nesting areas and along migration routes (USFWS 2014b). The red knot breeds in tundra habitat of the central Canadian arctic, between May and mid-July, and winters along the U.S. coastline from North Carolina to Texas and south to Tierra del Fuego in South America between July and May; however, non-breeding red knots are known to remain in Texas year-round. Wintering habitat includes tidal flats, beaches, and oyster reefs, where they feed primarily on small invertebrates, particularly clams (Newstead 2012, Newstead et al. 2013, USFWS 2011a).

Long-term systematic population surveys are lacking for this species, but current estimates suggest Texas wintering populations may range between 50 and 2,000, with numbers increasing from survey counts in the early 1990s to recent counts in 2012 (USFWS 2014b). The increase in numbers does not necessarily reflect an increase in the population, but may be due to an increase or variation in survey effort. Although rigorous population estimates are lacking, preliminary trends indicate prolonged decline followed by stabilization of small populations (USFWS 2014b).

Based on similar habitat preferences between the red knots and piping plovers, the same potential habitat areas mapped for the piping plover were assumed to be potential habitat for the red knot. Red knots have been observed in the vicinity of both study areas (**Figures 10 and 11**; eBird 2017).

4.1.4 Whooping Crane

The whooping crane (*Grus americana*) occurs only in North America and is North America's tallest bird, with males approaching 5 feet when standing erect. The whooping crane adult plumage is snowy white except for black primaries, black or grayish alula (specialized feathers attached to the upper leading end of the wing), sparse black bristly feathers on the carmine crown and malar region (side of the head from the bill to the angle of the jaw), and a dark gray-black wedge-shaped patch on the nape (Canadian Wildlife Service [CWS] and USFWS 2007). The whooping crane was listed as endangered on March 11, 1967 (32 FR 4001) and whooping crane critical habitat first designated on May 15, 1978 (43 FR 20938). The main threat to whooping cranes in the wild is the potential of a hurricane or contaminant spill destroying their wintering habitat on the Texas Coast. Collisions with power lines and fences are known hazards to wild whooping cranes. Historic population declines resulted from habitat destruction, shooting, and displacement by activities of man.

Whooping cranes currently exist in the wild at three locations and in captivity at 12 sites. There is only one self-sustaining wild population, the Aransas-Wood Buffalo National Park population, which nests in Wood Buffalo National Park (WBNP) and adjacent areas in the Northwest Territories and Alberta provinces of Canada, and winters mainly in and adjacent to Aransas NWR along the central Texas coast in Aransas,

Calhoun, and Refugio Counties. This population size was estimated at 431 whooping cranes during the winter of 2016-2017 (USFWS 2017d). The cranes migrate during spring and fall through an approximately 200-mile-wide corridor between Aransas NWR and WBNP. The migration corridor basically follows a straight line through the Great Plains, with the cranes traveling through Alberta, Saskatchewan, extreme eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas (CWS and USFWS 2007). Whooping cranes migrate primarily during daylight hours, relying heavily on tailwinds and thermal currents to aid their flight. They normally migrate at altitudes between 1,000 and 6,000 feet (Kuyt 1992) and typically fly from 200 to 400 miles per day and land at night (USFWS 2009b). Approximately 12 to 15 stopovers are made during migration (Kuyt 1992). The birds begin to arrive at their wintering grounds in mid-October, with most birds arriving from late October through mid-November (CWS and USFWS 2007). Spring migration generally begins in late March, with some birds remaining on the wintering grounds into early May.

Whooping cranes use a variety of habitats during migration, including croplands for feeding and wetlands for roosting (Howe 1987, 1989; Lingle 1987; Lingle et al. 1991). According to Austin and Richert (2001), the migrant whooping cranes observed at feeding sites have primarily been recorded in upland cropfields, including row crop stubble, small grain stubble, and green crops such as winter wheat (*Triticum aestivum*) and alfalfa (*Medicago sativa*). Whooping cranes have also been observed feeding in palustrine wetlands, seasonally flooded habitats, permanent water, pastures, and meadows (Austin and Richert 2001).

Austin and Richert (2001) report that migrant whooping cranes roost predominantly in palustrine or riverine wetland systems, with these types of wetlands accounting for 91.5% of roost sites recorded. Most palustrine roost sites were adjacent to cropland or grassland; less than 8% of palustrine roost sites were reported as occurring adjacent to woodland (Austin and Richert 2001). When using riverine habitat, whooping cranes roost on submerged sandbars in wide, unobstructed channels ranging from 249 to 1,500 feet wide (Armbruster 1990). Austin and Richert (2001) report that remaining roost sites were mostly lacustrine wetlands (7.8% of occurrences) or flooded cropland (2.8% of occurrences). Studies of whooping cranes in migration indicate that they prefer to roost in wetlands that are less than 10 acres in size, have good horizontal visibility, have water depth of 12 inches or less, and generally occur adjacent (or within 0.62 mile) of cropland feeding areas (Howe 1987, 1989; CWS and USFWS 2007; USFWS 2009b). Studies cited by CWS and USFWS (2007) suggest landscapes characterized as "wetland mosaics" provide the most suitable stopover habitat.

Whooping cranes also overwinter on the Texas coast, mostly in the area surrounding the Aransas NWR located about 30 miles southwest of the CRL study area. They utilize salt marshes and tidal flats on the mainland and barrier islands. Salt marsh habitat is present in both study areas, and whooping cranes have been recorded within 5 miles of both study areas at Justin Hurst WMA, San Bernard NWR, and Mad Island WMA (**Figures 10 and 11**; TXNDD 2017, eBird 2017).

4.2 Marine and Aquatic Species

4.2.1 West Indian Manatee

West Indian manatees (*Trichechus manatus)* have large, seal-shaped bodies with paired flippers and a round, paddled-shaped tail (USFWS 2015b). This species is found in marine, estuarine, and freshwater environments and feeds opportunistically on a wide variety of plants, including submerged, floating, and emergent vegetation. In coastal areas, seagrasses appear to be a staple of their diet, with preferences for water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillata*), and smooth cordgrass (USFWS 2001b, Whitaker 1996).

The West Indian manatee is a migratory marine mammal of Florida, the Greater Antilles, Central America, and South America (USFWS 2003b, 2017e). Texas is the extreme western edge of this species' distribution (USFWS 2003b). Based on a 2011 survey, West Indian manatees numbered over 4,800 individuals (USFWS 2015b), and in 2015 the southeastern U.S. population was estimated at 6,350 (USFWS 2016). Occurrences in Texas are occasional to rare and thus this species is unlikely to occur in the study areas (USFWS 2003b; Texas Marine Mammal Stranding Network 2016).

The Texas Marine Mammal Standing Network has recovered fewer than 10 manatees along the Texas coast since 1980 (Houston Chronicle 2012). One historical manatee record is in the GIWW near Oyster Creek just north of Freeport. Historical records from Texas waters also include Cow Bayou, Sabine Lake, Copano Bay, the Bolivar Peninsula, and the mouth of the Rio Grande (Natural Science Research Laboratory 2017). In October 2012, live manatee sightings were recorded near Galveston and near Corpus Christi (Houston Chronicle 2012). The TXNDD includes one observation of a West Indian manatee in the GIWW near Surfside Beach (**Figures 10**); this observation was made in 2011 (TXNDD 2017). A West Indian manatee could occur in the GIWW or rivers in the study areas; however, the likelihood of their occurrence is considered low due to their rare occurrence in Texas.

4.2.2 Whales

NMFS identifies four endangered whale species of potential occurrence in the Gulf of Mexico – the fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). These whale species are generally restricted to deeper offshore waters; therefore, it is unlikely that any of these four species would venture into the study areas (NMFS 2017); therefore, this project would have *no effect* on the fin whale, humpback whale, sei whale, or sperm whale, and they are not considered further in the analysis.

4.2.3 Sea Turtles

There are five sea turtles listed by USWFS and NMFS as having the potential to occur in the counties associated with the study areas (USFWS 2017c). These five species include the green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), the Kemp's ridley sea turtle (*Lepidochelys kempii*), the leatherback sea turtle (*Dermochelys coriacea*), and the loggerhead sea turtle (*Caretta caretta*). All but the Kemp's ridley sea turtle have global distributions either in the tropics, subtropics, or temperate waters.

The Kemp's ridley sea turtle distribution is limited to the Gulf of Mexico, though juveniles may be found along the U.S. Atlantic coast (NMFS et al. 2011, National Park Service [NPS] 2016).

In Texas, the five sea turtle species can be found in inshore and near-shore coastal waters, although leatherback sea turtles are less common in coastal waters than the other species (Landry n.d.). The loggerhead sea turtles are known to occur in the inshore Texas waters in relative abundance (Landry n.d.). Green sea turtles are known to frequent South Texas coastal waters (Coyne 1994). During adult non-nesting and juvenile stages, these species occur in pelagic, coral reefs, or near-shore coastal areas for foraging and breeding.

Sea turtle nesting occurs on coastal beaches. Primary nesting areas for all species are located outside of Texas. However, Kemp's ridley sea turtles regularly nest along the Texas coast, including the upper Texas coast. In 2017, 353 Kemp's ridley sea turtle nests were confirmed along the Texas coast, including three nests at Surfside Beach, one nest at Quintana Beach, and seven nests along the Matagorda Peninsula (Turtle Island Restoration Network 2017). Loggerhead sea turtles also occasionally nest on Texas beaches, including on the upper Texas coast. One loggerhead sea turtle nest was confirmed at Surfside Beach in 2017 (Turtle Island Restoration Network 2017). These species exhibit site fidelity, returning to the same nesting area annually and across generations. Although there are slight temporal differences in the specific nesting dates for each species, most nesting occurs during the summer months (March – November) with peak activities from May to July.

Green sea turtles also regularly nest on the lower Texas coast but are not known to nest on the upper Texas coast. Hawksbill and leatherback sea turtles are not known to nest on the Texas coast.

In 2014, NMFS designated 38 occupied marine areas within the range of the Northwest Atlantic Ocean Distinct Population Segment of loggerhead sea turtles as critical habitat (NMFS 2014). These areas contain one or a combination of habitat types: nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat. Critical habitat is mapped in the Gulf of Mexico offshore from Brazoria and Matagorda Counties, but is not located within the study areas (**Figures 10 and 11**). No critical habitat has been designated for the green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, or leatherback sea turtle in the vicinity of the study areas.

The TXNDD includes records of Kemp's ridley and hawksbill sea turtles occurring in the study area vicinities (**Figures 10 and 11**). The waters in the study areas consist primarily of the GIWW and Brazos and Colorado River channels. The study areas do not contain preferred foraging areas such as seagrass beds, and occurrence of sea turtles in the study areas is expected to be temporary.

4.3 Mollusks

There are four mussel species that are candidates for federal listing and have the potential to occur in Brazoria and Matagorda Counties. The golden orb (*Quadrula aurea*) is a filter feeder and is found in firm mud, sand, and gravel substrate in flowing waters in medium-sized rivers (USFWS 2015a). This species historically occurred in the Nueces-Frio and Guadalupe-San Antonio River systems, and is now known

from nine locations in four rivers (USFWS 2015a). Extant populations have been recorded in Lake Corpus Christi and in the Guadalupe, San Marcos, and San Antonio Rivers.

The smooth pimpleback (*Quadrula houstonensis*) is a filter feeder and is found in mud, sand, and fine gravel substrate in medium-to-large rivers and some reservoirs. This species is native to the Brazos and Colorado River basins of central Texas, and has also been reported from other drainages, including the Trinity River and rivers outside of Texas. As of 2015, the smooth pimpleback has been nearly extirpated from the Colorado River basin and a few small populations persist in the Brazos River basin (USFWS 2015a). Extant populations in the lower Brazos River have been recorded in Austin, Waller, and Fort Bend Counties.

The Texas fawnsfoot (*Truncilla macrodon*) is a filter feeder and, based on a recently discovered population in the Brazos River, this species is assumed to occur in rivers with soft, sandy sediment and moderate water flow (USFWS 2011b). However, little information is available about the species' habitat preferences because the species was not found alive for many years. This species historically occurred throughout the Colorado and Brazos river basins but, as of 2015, was known from only five locations (USFWS 2015a). The farthest downstream collection of Texas fawnsfoot in the Brazos River in recent years was in Austin and Waller Counties (USFWS 2011b).

The Texas pimpleback (*Quadrula petrina*) is a filter feeder and is found in moderately sized rivers, usually in mud, sand, gravel, and cobble, and occasionally in gravel-filled cracks in bedrock slab bottoms. This species is endemic to the Colorado and Guadalupe-San Antonio river basins of central Texas. The species has declined range wide and extant populations are known from only four streams: San Saba River, Concho River, Guadalupe River, and San Marcos River (USFWS 2011b). These populations are disjunct, small, and isolated.

These four mussel species are freshwater species that are not expected to occur in the tidal and brackish waters of the Brazos River, Colorado River, or other waters in or near the study areas due to salinity fluctuations, and have not been recorded in the study areas. This project would have ***no effect*** on the golden orb, smooth pimpleback, Texas fawnsfoot, or Texas pimpleback, and they are not considered further in the analysis.

4.4 Corals

NMFS identifies four species of threatened corals, the boulder star coral (*Orbicella franksi*), elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), and mountainous star coral (*Orbicella faveolata*), that have the potential to occur in the Gulf of Mexico (NMFS 2017). These species occur offshore in the Gulf of Mexico and are not located within the study areas; therefore, this project would result in ***no effect*** to these species and they are not considered further in the analysis.

5.0 EFFECTS OF THE RECOMMENDED PLAN

The ESA prohibits "take" of any federally listed species [16 United States Code (USC) §1538(a))], where take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt

to engage in any such conduct" (16 USC §1532(19)). The ESA requires that federal agencies ensure that any activity that an agency funds, authorizes, or carries out does not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat (16 USC §1536). The USFWS and NMFS have legislative authority under the ESA to list and monitor the status of wildlife species whose populations are considered to be imperiled (16 USC §1533). Species listed as "endangered" or "threatened" by the USFWS and NMFS (henceforth, "listed species") are provided full protection. This protection not only prohibits the direct take of a protected species, but also includes a prohibition of indirect take, such as destruction of designated critical habitat. Federal listings for protected animals and plants are provided in separate chapters of the CFR: 50 CFR 17.11 for animals and 50 CFR 17.12 for plants. The federal process also includes identifying "candidates" for listing under the ESA. While on the candidate list, species are not provided any federal protection but may be protected by state law. ESA implementing regulations (50 CFR 402) require federal agencies to complete a BA to determine whether a proposed project may affect a listed species.

In addition to direct and indirect effects, a BA also considers cumulative effects, which include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area, which is defined as the area that will be affected by a proposed activity or project. Future federal actions that are unrelated to the proposed action are not considered because they would require separate consultation pursuant to Section 7 of the ESA (USFWS and NMFS 1998).

For listed species, one of three possible determinations of effect is made (USFWS and NMFS 1998):

- *No effect*—the proposed action will have no adverse or beneficial effects on the species or critical habitat.

- *May affect, but is not likely to adversely affect*—the proposed action may affect listed species and/or critical habitat; however, the effects are expected to be discountable, insignificant, or beneficial.

- *May affect, is likely to adversely affect*—adverse effects to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent activities, and the effect is not discountable or insignificant.

The Recommended Plan was evaluated and the anticipated effects of the action determined in accordance with the ESA. The following sections discuss the anticipated direct and indirect effects of the Recommended Plan on each species that has the potential to occur in the study area.

5.1 Northern Aplomado Falcon

Open habitats in the study areas are limited to coastal marshes that could be used by foraging aplomado falcons, but are not their preferred habitats. No nesting sites have been documented in the study areas, and no nesting falcons are expected based on the current known nesting range and lack of suitable nesting habitat. While there is potential for the northern aplomado falcon to occur in the study areas, no nesting habitat or preferred habitat for this species is present and the species is no more likely to occur in the study

areas than in other similar habitats in the region. Therefore, the Recommended Plan is expected to have ***no effect*** on northern aplomado falcons.

5.2 Piping Plover, Red Knot, and Piping Plover Designated Critical Habitat

Given shared habitat preferences of beaches, tidal flats, algal mats, washover passes, small dunes, and herbaceous wetlands, the piping plover and red knot are discussed together. Both species return to the same general wintering grounds each year (Drake et al. 2001; Noel and Chandler 2008; Stucker et al. 2010; Buchanan et al. 2012). These wintering habitats provide foraging, roosting, and sheltering for piping plovers and red knots. Although no substantial habitat is located within the study areas, designated critical habitat for the piping plover is present along the Gulf beach near both study areas, as well as in the Colorado River delta in West Matagorda Bay. The Recommended Plan could affect sediment budget to these areas; in particular, the 1% reduction in average annual sediment deposition in the Brazos Delta portion of the Gulf of Mexico may lead to a reduction in available sediment at critical habitat unit TX-32, which is located along the Gulf beach between the Brazos and San Bernard rivers. This change in sediment deposition could have minor effects on beach-shaping and associated biological processes that contribute to the productivity of the critical habitat; however, the 1% reduction in sediment is not expected to cause significant and detrimental changes to the sediment input and, therefore, is not expected to destroy or adversely modify the critical habitat or adversely affect the species. Direct effects of habitat loss on the piping plover and red knot from the project are not anticipated.

Construction activities will temporarily elevate noise levels; however, this is not expected to contribute to any permanent noise disturbances for these species. Construction noise may cause these species to temporarily avoid adjacent habitats; however, there are no preferred habitats immediately adjacent to the proposed work areas.

Overall, activities associated with the Recommended Plan could have some minor but discountable effect on these species; therefore, the project ***may affect, but is not likely to adversely affect*** piping plovers and red knots. As stated above, the project is not expected to destroy or adversely modify the designated critical habitat for piping plovers.

5.3 Whooping Crane

The study areas contain foraging habitats of the whooping crane, including shoreline wetlands. No nesting sites occur in Texas and the anticipated impact to salt marshes (foraging habitats) in the study areas is considered low compared to the availability of salt marshes in the region. Most whooping crane wintering occurs well south of the study areas; therefore, direct effects of the project on the whooping crane due to habitat loss are not anticipated.

Construction activities will create temporary, short-term increases in noise levels. However, whooping cranes prefer to forage away from human disturbance and would, therefore, not be likely to occur in the study areas during typical operations and maintenance of the existing facilities, nor are they expected to be present during construction activities or maintenance dredging activities. Overall, the project ***may effect, but is not likely to adversely affect*** whooping cranes.

5.4 West Indian Manatee

A West Indian manatee could occur in the GIWW or rivers in the study areas; however, the likelihood of their occurrence is considered low due to their rare occurrence in Texas. Increased noise levels during construction could disturb manatees, but they appear relatively unresponsive to human noise (NoiseQuest 2016) and do not startle readily. This, coupled with the fact that occurrence of a West Indian manatee would be rare and temporary, indicates that noises from the project are not expected to affect this species.

Marine traffic during water-based construction activities could result in a higher incidence of collision with marine species. West Indian manatees are vulnerable to collisions with boats in narrow waterways and shallow water areas. In addition, although boat channels may provide deeper waters for manatees to avoid or escape oncoming boats, manatees do not always move out of the way of approaching boats (USFWS 1999). However, as the occurrence of the West Indian manatee in the study areas is unlikely, collisions are not expected. Therefore, the project is expected to have ***no effect*** on the West Indian manatee.

5.5 Sea Turtles

Habitat Loss

The five sea turtle species are distributed worldwide in tropical, subtropical, and colder waters and are found in coastal and off-shore habitats. Leatherback sea turtles are uncommon in Texas coastal waters and are not expected to occur in the study areas; likewise, green sea turtles occur in South Texas but are not known to occur regularly on the upper Texas coast. The Recommended Plan is not expected to result in habitat loss for any sea turtle species. The open water habitats in the study areas are largely associated with the GIWW and river crossings and do not provide notable preferred foraging habitats for sea turtles.

Noise and Vibration

Vessel traffic, namely barge tows, contributes to existing noise levels in the study areas. The Recommended Plan is not expected to increase vessel traffic through the area, although there will be a temporary increase in vessel traffic during construction due to the addition of construction-related vessels. However, vessel traffic noise is not known to cause mortality or potential mortal injury to sea turtles (Popper et al. 2014). Likewise, noise from dredging equipment during construction is not expected to adversely affect sea turtles.

To estimate noise pressure levels resulting from proposed pile-driving activities, the USACE used the NMFS Greater Atlantic Regional Fisheries Office (GARFO) publicly available model (NMFS 2016), which was developed by NMFS as an in-house tool for assessing potential effects on federally listed species from elevated levels of underwater sound produced during pile driving. For sea turtles, the GARFO model considers behavioral and physiological thresholds of 166 and 180 decibels (dB) re 1 micro-Pascal root-mean square (μPaRMS), respectively, and predicts the distance to those effects thresholds from pile driving activities, depending on pile type and size, hammer type, and water depth.

Table 7 provides estimated worst-case sound levels resulting from pile driving activities that may occur at the BRFG and CRL under the Recommended Plan. *Note that in some cases, actual sound levels should be lower because the "proxy" used in GARFO involved larger pile size than is proposed.* The estimated noise

levels for all proposed pile types except guidewall timber piles exceed the injury threshold for sea turtles; this injury noise level would occur up to 30-40 meters from the pile driving.

Table 7 Estimated Distances to Sea Turtle Injury and Behavioral Thresholds

Project Component	Pile Size and Type	Hammer Type	Distance (m) to 180 dB RMS (injury)	Distance (m) to 166 dB RMS (behavior)
Gate Structure Foundation	24" Steel Pipe	Impact	40.0	86.7
Guidewalls	12-14" Timber	Cushioned Impact	NA	18.0
End Cells	20" Steel Pipe[1]	Impact	33.3	80.0
	24" AZ Steel Sheet[2]	Impact	30.0	58.0
Needle Girder Storage	24" Concrete	Impact	NA (on land)	NA (on land)
Reservation Buildings	12-14" Timber	Impact	NA (on land)	NA (on land)
Flow Separator	24" AZ Steel Sheet[2]	Vibratory	NA	NA

[1] 20" steel pipe used as a proxy; actual pile size proposed for the end cells is 18".
[2] 24" AZ steel sheet used as a proxy; actual sheet pile size/type proposed for the end cells is 20" PS-31 sheet pile.

Although estimated noise levels exceed injury thresholds for sea turtles, measures that can be put into place as needed to avoid impacting sea turtles if they occur in the GIWW during construction. Measures include:

- Implement a "soft start" for up to 20 minutes to allow sea turtles to leave the project vicinity before sound pressure increases above injury thresholds. Once the noise level is above the 166 dB RMS threshold for behavioral, sea turtles are expected to leave the area and not re-enter.

- Install piles within dewatered cofferdam, which provides for 5 to 10 dB reduction in noise levels.

- Use a vibratory hammer or cushioned impact hammer to reduce noise levels. As is seen in **Table 8** below, the GARFO model estimates that noise levels would be below injury thresholds for all anticipated pile driving if a vibratory hammer is used.

Table 8 Estimated Distances to Sea Turtle Injury/Behavioral Thresholds – *Vibratory Hammer*

Project Component	Pile Size and Type	Hammer Type	Distance (m) to 180 dB RMS (injury)	Distance (m) to 166 dB RMS (behavior)
Gate Structure Foundation	24" Steel Pipe	Vibratory	NA	53.3
Guidewalls	12-14" Timber	Vibratory	NA	NA
End Cells	20" Steel Pipe[1]	Vibratory	NA	46.7
	24" AZ Steel Sheet[2]	Vibratory	NA	NA
Needle Girder Storage	24" Concrete	Vibratory	NA (on land)	NA (on land)
Reservation Buildings	12-14" Timber	Vibratory	NA (on land)	NA (on land)
Flow Separator	24" AZ Steel Sheet[2]	Vibratory	NA	NA

[1] 20" steel pipe used as a proxy; actual pile size proposed for the end cells is 18".
[2] 24" AZ steel sheet used as a proxy; actual sheet pile size/type proposed for the end cells is 20" PS-31 sheet pile.

Dredging

Dredging associated with the project would be completed using mechanical dredges and cutterhead suction dredges, and sea turtles are not known to be vulnerable to entrainment in these dredge types (NMFS 2003). As a result, adverse effects on sea turtles from dredging are discountable.

Turbidity

Although turbidity increases are expected due to in-water activities such as dredging and pile driving, turbidity is not expected to affect sea turtle foraging habitat, as none is located in the study area. Since sea turtles breathe air, they are not particularly susceptible to increased turbidity. Based on the temporary and localized nature of turbidity increases, lack of foraging habitat in the study area, and anticipated infrequency of sea turtles entering the construction area, effects of turbidity on sea turtles are discountable.

Summary of Effects Determination for Sea Turtles

Since the study areas do not contain preferred foraging habitat for sea turtles, occurrence of sea turtles in the study areas would be temporary, and measures could be implemented as needed to avoid impacting sea turtles during pile driving activities, the USACE has determined that the project ***may affect, but is not likely to adversely affect*** green sea turtles, hawksbill sea turtles, Kemp's ridley sea turtles, and loggerhead sea turtles. The project is expected to have ***no effect*** on leatherback sea turtles because they are uncommon in Texas coastal waters and are not likely to occur in the study areas.

5.6 Interdependent and Interrelated Actions

An interdependent action has no independent utility apart from the proposed action that is subject to consultation. No interdependent actions have been identified; therefore, no interdependent effects to any of the listed species would occur.

Interrelated actions are those that are part of the larger action and dependent on the larger action for their justification. Interrelated actions include operation and maintenance dredging within the study areas. Potential impacts of such dredging are included in the discussions above.

5.7 Cumulative Effects

Cumulative effects under the ESA [50 CFR § 402.02] are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the study areas. Future federal actions that are unrelated to the proposed action are not considered in this section, as they require separate consultation pursuant to Section 7 of the ESA.

Because future activities with a federal nexus are not included in the cumulative effects analysis in a BA, planned activities with the most potential to affect federally listed species in the vicinities of the BRFG and CRL are not addressed here. Examples of such activities could include, but are not limited to, further expansion of national wildlife refuge lands, additional placement areas, or deepening and widening of existing channels. Many of the future projects will likely require a federal authorization (e.g., a permit under Section 404 of the Clean Water Act), in which case they will be subject to future ESA consultation.

No future non-federal actions that have the potential to affect the subject species have been identified in the study areas.

6.0 SUMMARY OF RECOMMENDED DETERMINATION OF EFFECTS

The proposed Recommended Plan is anticipated to have *no effect* on 15 of the 22 federally listed threatened or endangered species, or candidate species, and is anticipated to have a *may affect, but not likely to adversely affect* determination for the remaining seven species (**Table 9**). The project will not modify designated critical habitat for any listed species.

Table 9 Anticipated Effects of Project on Threatened and Endangered Species

Listed Species		Listing Status	Jurisdiction	Potential to Occur in Study Areas?	Recommended Plan Effect Determination
Common Name	**Scientific Name**				
Birds					
Northern aplomado falcon	*Falco femoralis septentrionalis*	Endangered	USFWS	Yes	No Effect
Piping plover	*Charadrius melodus*	Threatened	USFWS	Yes	May Affect, Not Likely to Adversely Affect
Red knot	*Calidris canutus rufa*	Threatened	USFWS	Yes	May Affect, Not Likely to Adversely Affect
Whooping crane	*Grus americana*	Endangered	USFWS	Yes	May Affect, Not Likely to Adversely Affect
Mammals					
West Indian manatee	*Trichechus manatus*	Threatened	USFWS	Yes	No Effect
Fin whale	*Balaenoptera physalus*	Endangered	NMFS	No	No Effect
Humpback whale	*Megaptera novaeangliae*	Endangered	NMFS	No	No Effect
Sei whale	*Balaenoptera borealis*	Endangered	NMFS	No	No Effect
Sperm whale	*Physeter macrocephalus*	Endangered	NMFS	No	No Effect
Reptiles					
Green sea turtle	*Chelonia mydas*	Threatened	NMFS	Yes	May Affect, Not Likely to Adversely Affect
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	USFWS; NMFS	No	No Effect
Loggerhead sea turtle	*Caretta caretta*	Threatened	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Mollusks					
Golden Orb	*Quadrula aurea*	Candidate	USFWS	No	No Effect
Smooth pimpleback	*Quadrula houstonensis*	Candidate	USFWS	No	No Effect
Texas fawnsfoot	*Truncilla macrodon*	Candidate	USFWS	No	No Effect
Texas pimpleback	*Quadrula petrina*	Candidate	USFWS	No	No Effect
Corals					
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	No	No Effect
Elkhorn coral	*Acropora palmata*	Threatened	NMFS	No	No Effect
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	No	No Effect

Table 9 Anticipated Effects of Project on Threatened and Endangered Species

Listed Species		Listing Status	Jurisdiction	Potential to Occur in Study Areas?	Recommended Plan Effect Determination
Common Name	**Scientific Name**				
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	No	No Effect

Sources: NMFS 2017; USFWS 2017a, b, c

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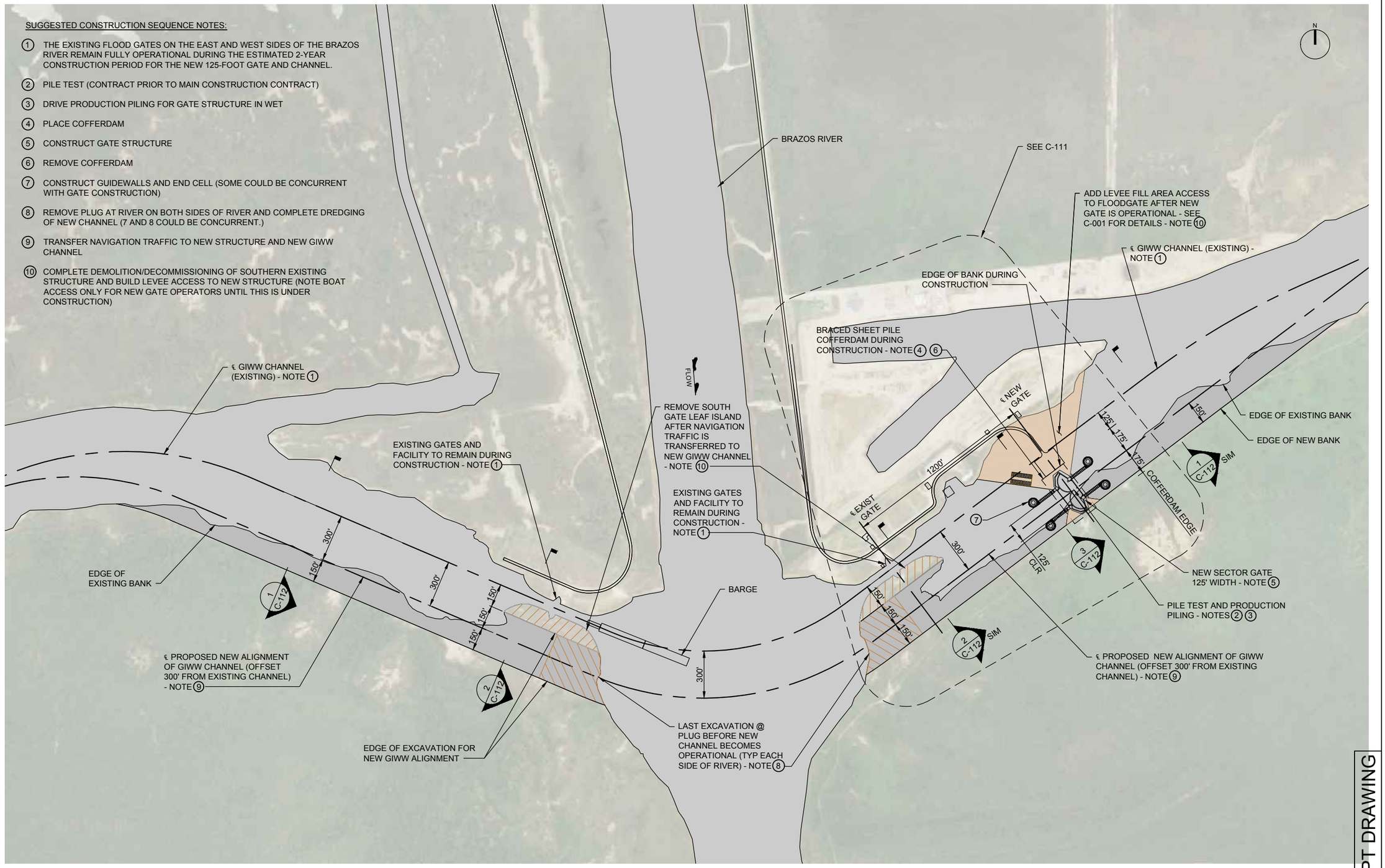
ATTACHMENT 1

ENGINEERING DRAWINGS OF PROPOSED PLANS

SUGGESTED CONSTRUCTION SEQUENCE NOTES:

1. THE EXISTING FLOOD GATES ON THE EAST AND WEST SIDES OF THE BRAZOS RIVER REMAIN FULLY OPERATIONAL DURING THE ESTIMATED 2-YEAR CONSTRUCTION PERIOD FOR THE NEW 125-FOOT GATE AND CHANNEL.
2. PILE TEST (CONTRACT PRIOR TO MAIN CONSTRUCTION CONTRACT)
3. DRIVE PRODUCTION PILING FOR GATE STRUCTURE IN WET
4. PLACE COFFERDAM
5. CONSTRUCT GATE STRUCTURE
6. REMOVE COFFERDAM
7. CONSTRUCT GUIDEWALLS AND END CELL (SOME COULD BE CONCURRENT WITH GATE CONSTRUCTION)
8. REMOVE PLUG AT RIVER ON BOTH SIDES OF RIVER AND COMPLETE DREDGING OF NEW CHANNEL (7 AND 8 COULD BE CONCURRENT.)
9. TRANSFER NAVIGATION TRAFFIC TO NEW STRUCTURE AND NEW GIWW CHANNEL
10. COMPLETE DEMOLITION/DECOMMISSIONING OF SOUTHERN EXISTING STRUCTURE AND BUILD LEVEE ACCESS TO NEW STRUCTURE (NOTE BOAT ACCESS ONLY FOR NEW GATE OPERATORS UNTIL THIS IS UNDER CONSTRUCTION)



PLAN - TSP ALTERNATIVE 3A.1 - SOUTH SHIFT OF ALIGNMENT

SCALE: 1"=300'-0"

0 300' 600'

CONCEPT DRAWING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE:	9/10/2018
SOLICITATION NO.:	
CONTRACT NO.:	
DESIGNED BY:	J. KIKUTA
DRAWN BY:	V.ROUSE
CHECKED BY:	G.KATZENBERGER
SUBMITTED BY:	G.KATZENBERGER
SIZE	ANSI D

GALVESTON DISTRICT
P.O. BOX 1229
GALVESTON, TX 77553-1229

TETRA TECH
400 112TH AVENUE NE
SUITE 300
BELLEVUE, WA 98004

BRAZOS RIVER FLOODGATES
FEASIBILITY STUDY
BRAZORIA COUNTY, TX

TSP ALTERNATIVE 3A.1
SOUTH SHIFT OF ALIGNMENT
PLAN

SHEET ID

C-110

%STATUS%

TSP SITE PLAN
SCALE: 1"=100'-0"

100' 0' 100' 200' 300'

CONCEPT DRAWING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: 9/10/2018
SOLICITATION NO.:
CONTRACT NO.:

DESIGNED BY: J. KIKUTA
DRAWN BY: V.ROUSE
CHECKED BY: G.KATZENBERGER
SUBMITTED BY: G.KATZENBERGER
SIZE: ANSI D

GALVESTON DISTRICT
P.O. BOX 1229
GALVESTON, TX 77553-1229

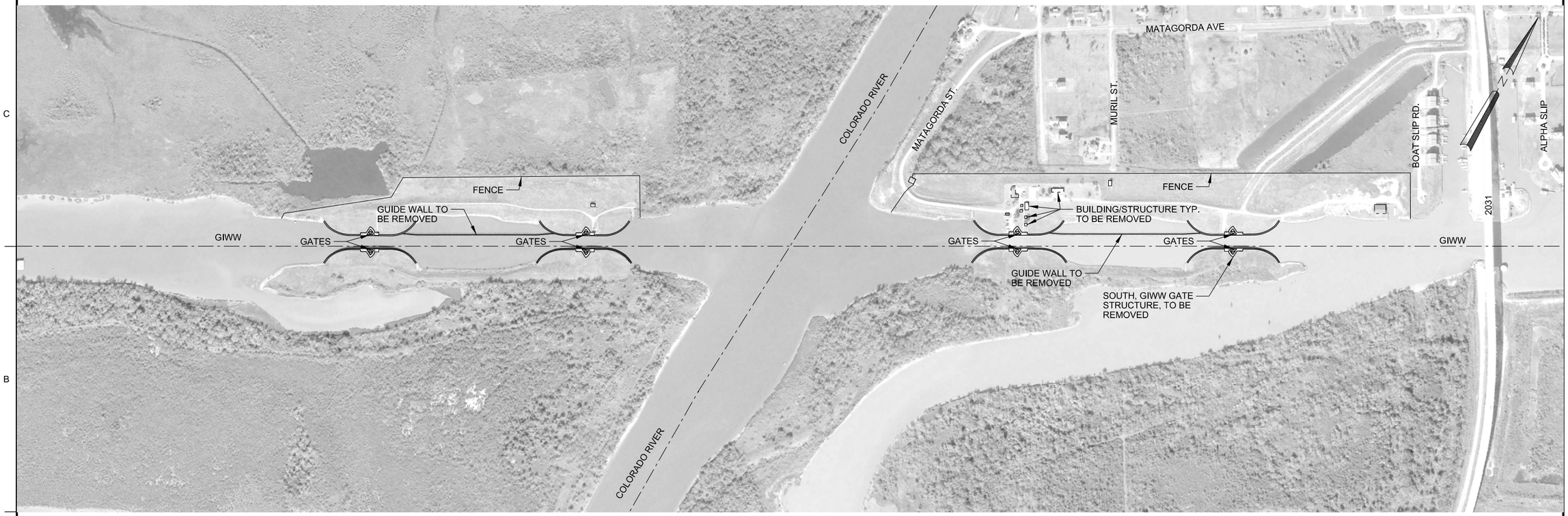
TETRA TECH
400 112TH AVENUE NE
SUITE 300
BELLEVUE, WA 98004

BRAZOS RIVER FLOODGATES
FEASIBILITY STUDY
BRAZORIA COUNTY, TX

TSP SITE PLAN

SHEET ID
C-111

%STATUS%



EXISTING SITE PLAN

SCALE:1"=300'

0 300' 600'

US Army Corps of Engineers®
GALVESTON DISTRICT

MARK	DESCRIPTION	DATE	APPR.

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
GALVESTON, TEXAS

DESIGNED BY: Joe A. Designer		DATE: DD-MON-YYYY	
DWN BY: D.J.S.	CKD BY: XXX	SOLICITATION NO.: N/A	
SUBMITTED BY: Bob A. Submitter		CONTRACT NO.: N/A	
PLOT SCALE: 1=1	PLOT DATE: DD-MON-YYYY	FILE NUMBER: Feasibility	
SIZE: ANSI D	FILE NAME: C-101.dgn		

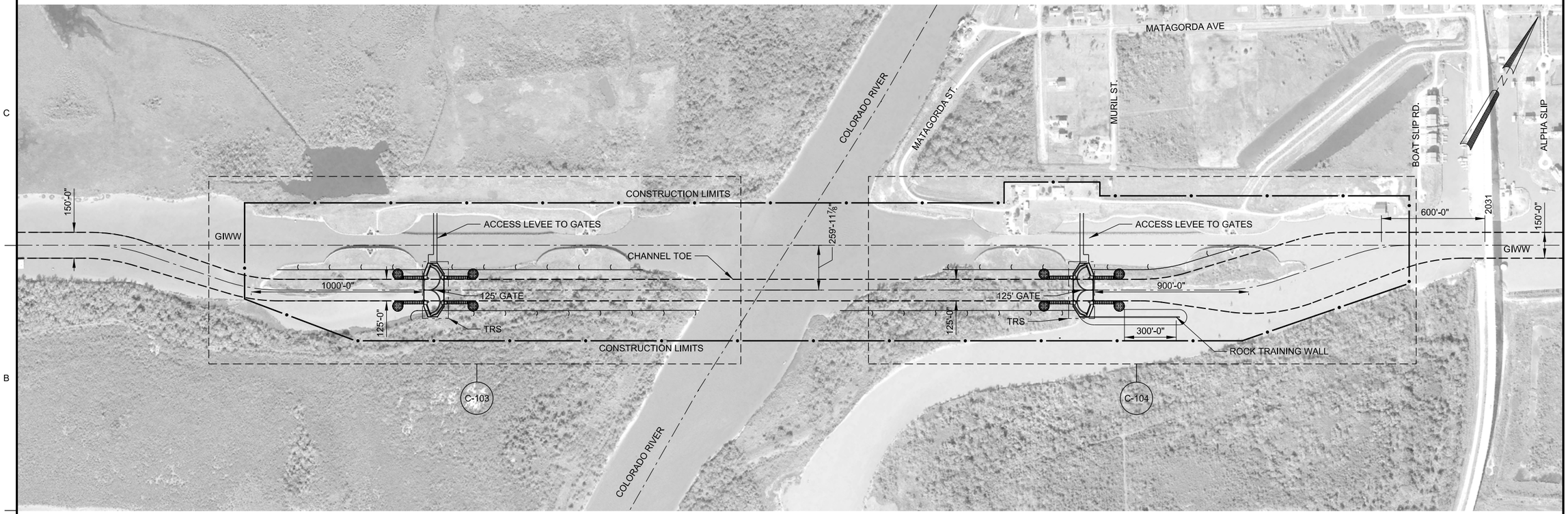
GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO
RIVER LOCKS SYSTEMS, FEASIBILITY STUDY
ENGINEERING APPENDIX DRAWINGS

EXISTING SITE PLAN

SHEET IDENTIFICATION
C-101

CONSTRICTION SEQUENCE

1. PILE TEST
2. DREDGE ACCESS CHANNEL ON GIWW SIDE OF EACH STRUCTURE FOR CRANE ACCESS.
3. DRIVE PRODUCTION PILING FOR GATE STRUCTURE IN WET.
4. PLACE COFFERDAM
5. CONSTRUCT GATE STRUCTURE
6. REMOVE COFFERDAM
7. CONSTRUCT GUIDE WILLS AND END CELLS (SAME CONCURRENT WITH GATE CONSTRICTION)
8. CONSTRUCT REACH BERM
9. COMPLETE DREDGING OF NEW CHANNEL
10. TRANSFER NAVIGATION TO NEW STRUCTURE
11. COMPLETE DEMOLITION/BUILD ACCESS LEVEE



FINAL SITE PLAN

SCALE:1"=300'

0 300' 600'

US Army Corps of Engineers
GALVESTON DISTRICT

MARK	DESCRIPTION	DATE	APPR.

MARK	DESCRIPTION	DATE	APPR.

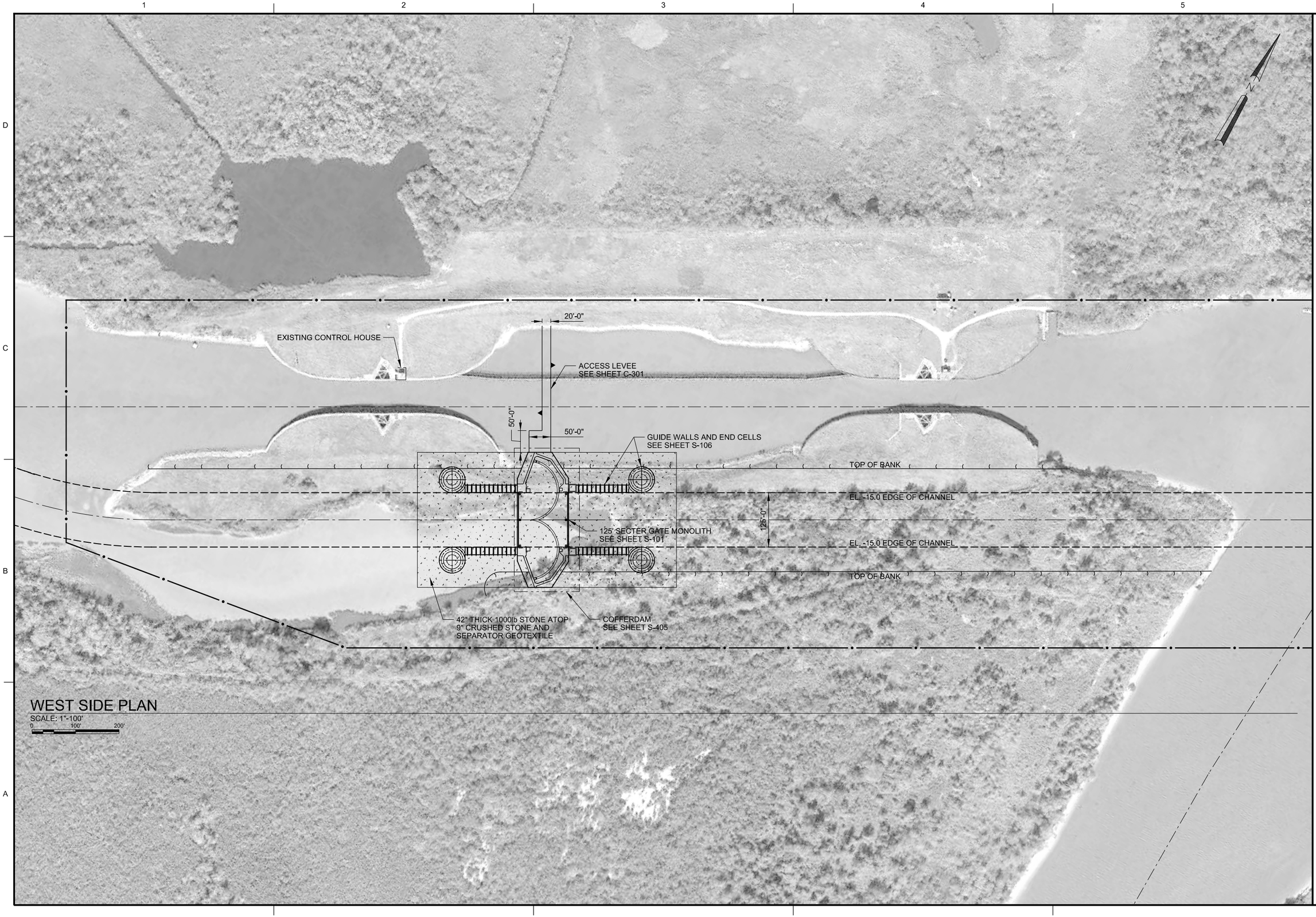
U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
GALVESTON, TEXAS

DESIGNED BY: Joe A. Designer	CKD BY: XXX	DATE: DD-MO[n]-YYYY	
DWN BY: D.J.S.	SUBMITTED BY: Bob A. Submitter	SOLICITATION NO.: N/A	CONTRACT NO.: N/A
PLOT SCALE: 1=1	PLOT DATE: MM-DD-YYYY	FILE NUMBER: Initial-submit	
SIZE: ANSI D	FILE NAME: C-102.dgn		

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO RIVER LOCKS SYSTEMS, FEASIBILITY STUDY
ENGINEERING APPENDIX DRAWINGS

COLORADO RIVER
FINAL SITE PLAN

SHEET IDENTIFICATION
C-102



WEST SIDE PLAN

SCALE: 1"-100'

0 100' 200'

US Army Corps of Engineers
GALVESTON DISTRICT

MARK	DESCRIPTION	DATE	APPR.

MARK	DESCRIPTION	DATE	APPR.

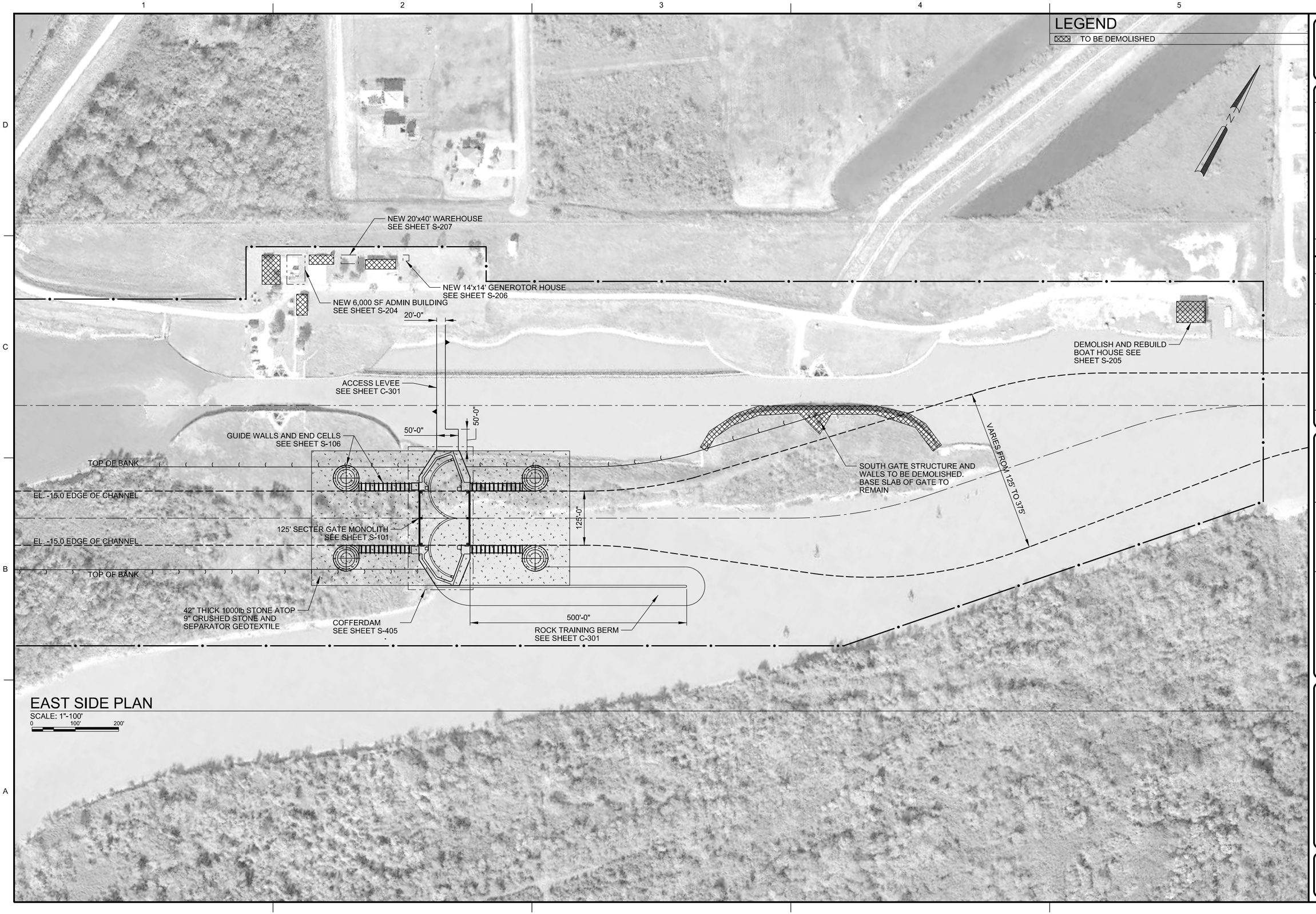
DESIGNED BY: Jon A. Designer
DWN BY: D.J.S.
CKD BY: XXX
SUBMITTED BY: Bob A. Submitter
PLOT SCALE: 1:1
PLOT DATE: DD-MON-YYYY
SIZE: ANSI D
DATE: DD-MON-YYYY
SOLICITATION NO.: N/A
CONTRACT NO.: N/A
FILE NUMBER: Initial-submit
FILE NAME: C-103.dgn

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
GALVESTON, TEXAS

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO
RIVER LOCKS SYSTEMS, FEASIBILITY STUDY
ENGINEERING APPENDIX DRAWINGS

COLORADO RIVER
WEST FINAL SITE PLAN

SHEET IDENTIFICATION
C-103



US Army Corps of Engineers®
GALVESTON DISTRICT

MARK	DESCRIPTION	DATE	APPR.
MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
GALVESTON, TEXAS

DESIGNED BY: Joe A. Designer		DATE: DD-MON-YYYY	
DWN BY: D.J.S.	CKD BY: XXX	SOLICITATION NO.: N/A	
SUBMITTED BY: Bob A. Submitter		CONTRACT NO.: N/A	
PLOT SCALE: 1=1	PLOT DATE: DD-MON-YYYY	FILE NUMBER: Folder\file	
SIZE: ANSI D	FILE NAME: C-104.dgn		

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO
RIVER LOCKS SYSTEMS, FEASIBILITY STUDY
ENGINEERING APPENDIX DRAWINGS

COLORADO RIVER
WEST FINAL SITE PLAN

SHEET
IDENTIFICATION
C-104