Appendix D

404(b)(1) Evaluation

SECTION 404(b)(1) EVALUATION
LOUISIANA COASTAL AREA - ECOSYSTEM RESTORATION PROJECT

Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock

I. INTRODUCTION

A. Purpose and General Description.

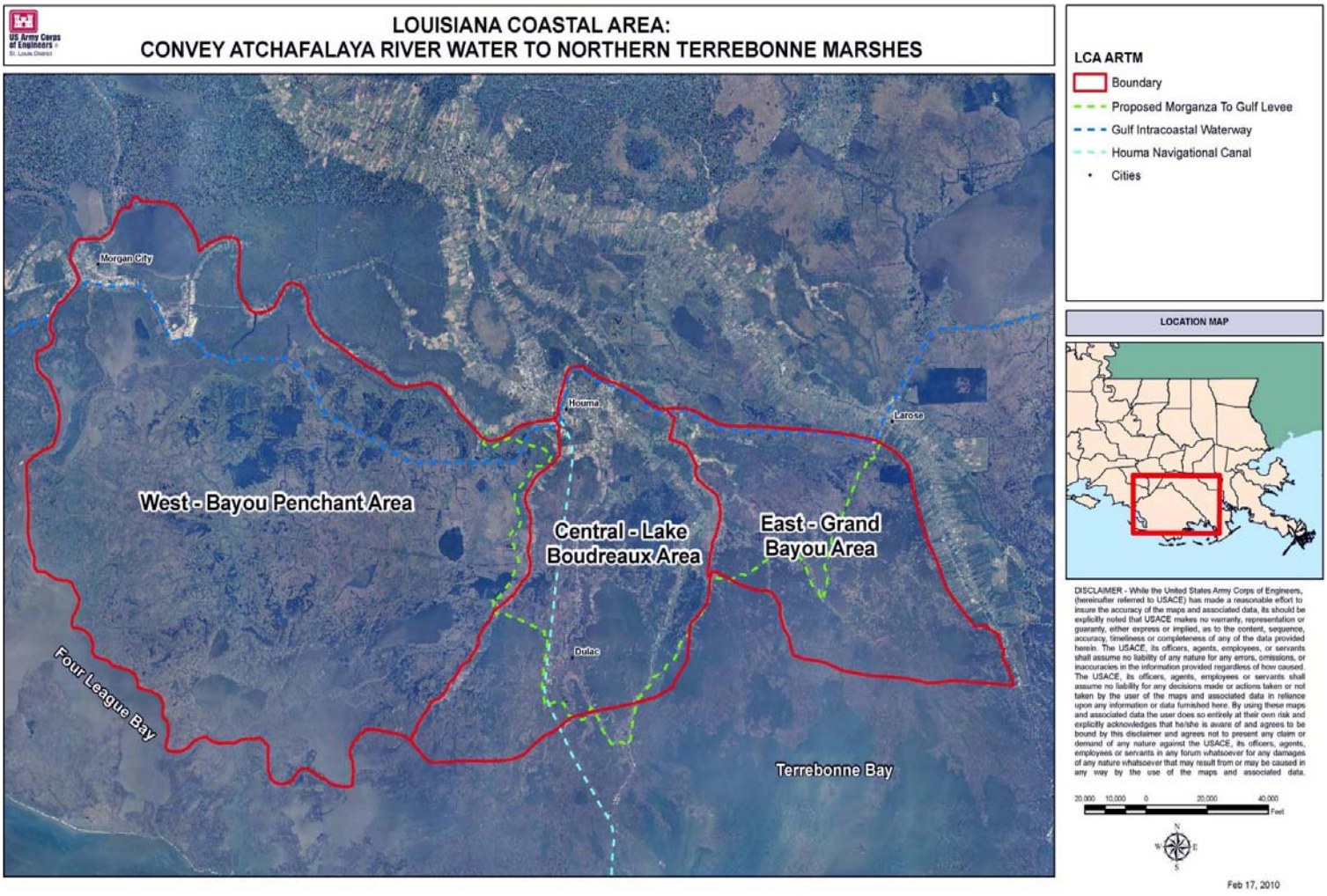
The Louisiana Coastal Area – Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock project (LCA-ARTM) project area comprises approximately 1,100 square miles (~700,000 acres) in Southern Louisiana. LCA-ARTM fits into the Louisiana Coastal Area Ecosystem Restoration Study Area, which has been identified as the Louisiana coastal area from Mississippi to Texas.

The purpose of the proposed action is to reverse the current trend of degradation of the Terrebonne Marshes, so as to contribute towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of Southern Louisiana and thus the Nation. The objective of the study is to provide additional freshwater, nutrients, and fine sediment to the area. The introduction of additional freshwater would facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. Specific project objectives include, but are not limited to: preventing, reducing and/or reversing future wetland loss; achieving and maintaining characteristics of sustainable marsh hydrology; reducing salinity levels in project area; increasing sediment and nutrient load to surrounding wetlands; increasing residence time of fresh water; and sustaining productive fish and wildlife habitat.

B. Location.

The LCA-ARTM Project Area (Figure 1) is situated in Southern Louisiana in the vicinity of the City of Houma and Terrebonne Parish. The overall project is bound to the west by the Lower Atchafalaya River and to the east by the Bayou Lafourche ridge. The project area is bound to the north by the Bayou Black ridge, from the Lower Atchafalaya River to the City of Houma, and by the Gulf Intracoastal Waterway (GIWW) from the City of Houma to the Bayou Lafourche ridge. The southern boundary of the project was based on a delineation conducted in 2007 of coastal Louisiana vegetation types. The boundary roughly follows the transition between saline and brackish marsh types identified by Sasser et al. (2008). The project area contains a complex of habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from sediments of abandoned Mississippi River deltas. Due to the magnitude of the project area, the entire LCA-ARTM study was divided into three subunits. The three subunit areas are referred to as West-Bayou Penchant Area, Central-Lake Boudreaux Area, and East-Grand Bayou Area.

Figure 1 LCA-ARTM Project Area.



The West – Bayou Penchant Area is the largest of the three subunits identified by the LCA-ARTM PDT, measuring approximately 680 square miles in size. The area envelops sections of the GIWW that connect Morgan City, Louisiana to Houma, Louisiana. The name of the subunit lends itself to the presence of the Penchant Basin, which is one of the larger, more signature features within the subunit. The boundaries of the subunit can be characterized as the following: the northern limits of the West – Bayou Penchant Area subunit follow the northern edge of Lake Palourde and extend eastward down the Bayou Black Ridge. The eastern limits are mostly bound by Bayou du Large, and the western limits trace the Lower Atchafalaya River south of Morgan City, then cut eastward and line the edge of Four League Bay. Major freshwater delivery systems within the West – Bayou Penchant Area subunit consist of the Atchafalaya River, Bayou Shaffer, Bayou Boeuf, GIWW, Bayou Chene, Bayou Penchant, Bayou Copasaw, and Minors Canal.

Other significant features located within the study subunit include portions of the proposed Morganza to the Gulf levee. The ecosystems within the West – Bayou Penchant Area can be characterized as mostly forested swamps between the GIWW and Bayou Black, floating freshwater marsh systems throughout the Penchant Basin, and intermediate marsh systems starting in the vicinity of Lake de Cade. Brackish marsh systems are also within the subunit, south of the intermediate zone.

The Central – Lake Boudreaux Area subunit, measuring approximately 210 square miles, extends south of the GIWW at Houma, Louisiana and envelops the Houma Navigation Canal. The limits of the subunit adjoin the West – Bayou Penchant Area subunit at Bayou du Large. The eastern limit of the Central – Lake Boudreaux Area subunit consists of Bayou Terrebonne. Major freshwater delivery features within the Central – Lake Boudreaux Area include the GIWW, Houma Navigation Canal, Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, and Bayou Terrebonne. Other significant features located within the study subunit include Lake Boudreaux, Lake Quitman, and the proposed Houma Navigation Canal lock complex and Morganza to the Gulf levee. The landcover within the Central – Lake Boudreaux Area can be characterized as mostly urban and agriculture along Bayou Du Large, Bayou Grand Caillou, Bayou Petit Caillou, and Bayou Terrebonne. Between the bayous, the stratification of ecosystems shifts from forested swamps in the north, to freshwater marsh systems, to intermediated systems. Brackish marshes are found around and south of Lake Boudreaux.

The East – Grand Bayou Area Subunit is located south of Larose, Louisiana and measures approximately 185 square miles. The LCA-ARTM PDT identified the northern limits of this study unit to be bound by the GIWW, the western limits to be bound by Bayou Terrebonne, and the eastern limits to be bound by the Bayou Lafourche ridge. The name of the subunit lends itself to the presence of the Grand Bayou Basin, which is one of the larger, more signature features within the subunit. Major freshwater delivery features within the East – Grand Bayou Area include the GIWW, Bayou Pointe au Chien, Grand Bayou, Bayou Blue, Grand Bayou Blue, and Cutoff Canal. Other significant features that are present within the study area include St. Louis Canal and portions of the Pointe au Chien Wildlife Management Area.

C. Authority.

Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the Louisiana Coastal Area (LCA) ecosystem restoration program. Included within that authority are requirements for comprehensive coastal restoration planning, program governance, a Science and Technology Program, a program for the beneficial use of dredged material, feasibility studies for restoration plans, project modification investigations, and restoration project construction, in addition to other program elements. This authorization was recommended by the Chief of Engineers' Report, dated January 31, 2005.

Under the 2007 WRDA Section 7006, the LCA program has authority for feasibility-level reports of six near-term critical restoration features. The excerpt below from WRDA outlines the project authority for this report for the LCA-ARTM:

SEC. 7003. LOUISIANA COASTAL AREA.

(a) IN GENERAL.-The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005.

SEC. 7006. CONSTRUCTION.

(3) PROJECTS SUBJECT TO REPORTS.—
(A) FEASIBILITY REPORTS.—Not later than December 31, 2008, the Secretary shall submit to Congress feasibility reports on the following projects referred to in the restoration plan:

(i) Multipurpose Operation of Houma Navigation Lock at a total cost of $18,100,000.
(ii) Terrebonne Basin Barrier Shoreline Restoration at a total cost of $124,600,000.
(iii) Small Diversion at Convent/Blind River at a Total cost of $88,000,000
(iv) Amite River Diversion Canal Modification at a total cost of $5,600,000.
(v) Medium Diversion at White's Ditch at a total cost of $86,100,000.
(vi) Convey Atchafalaya River Water to Northern Terrebonne Marshes at a total cost of $221,200,000.

(B) CONSTRUCTION.—The Secretary may carry out the projects under subparagraph (A) substantially in accordancewith the plans and subject to the conditions, recommended in a final report of the Chief of Engineers if a favorable report of the Chief is completed by not later than December 31, 2010.

(4) CONSTRUCTION.—No appropriations shall be made to construct any project under this subsection if the report under paragraph (2) or paragraph (3), as the case may be, has not been approved by resolutions adopted by the Committee.

The integrated feasibility study and environmental impact statement (EIS) conducted for the LCA-ARTM fulfills the reporting requirement to Congress under Section 7006(e)(3) which directs the Secretary of the Army to submit feasibility reports on the six projects included in the referenced section by December 31, 2008. The authority also provides approval to implement the projects provided a favorable Chief of Engineers' Report is completed no later than December 31, 2010.

D. <u>General Description of Dredged and Fill Material.</u>
(1) General Characteristics of Material

The interagency team composed of the Corps, USFWS, NOAA, and the State of Louisiana has tentatively selected a plan, which meets the study objectives. The selected plan referred to as the TSP reasonably maximizes ecosystem restoration benefits compared to costs. The TSP redistributes existing freshwater to benefit Terrebonne marshes using a variety of measures. The following measures to restrict, increase, and control water are proposed for each of the three subunits. In the West – Bayou Penchant Area, dredging, a sediment plug, and a weir will be utilized. In the Central – Lake Boudreaux Area, culverts, levees, dredging, marsh terraces and berms, sediment plugs, modified operation of the future HNC (Houma Navigation Canal) lock complex, and a large sluice gated box culvert are proposed. In the East – Grand Bayou Area, culverts, dredging, gaps in canal spoil banks, marsh berms, sediment plugs, and removal of a weir and soil plug are proposed. The fifty-six construction features associated with the TSP are summarized below and are summarized by activity type.

(a) Deepening and widening of existing channels and creation of new conveyance channels will be performed as part of this project (see Appendix R drawing C-339 for typical sections of channel deepening or widening and R-102 and 103 for the new conveyance channel). Unless otherwise specified, an adjacent berm will be constructed to contain dredge spoil. The dredged channels will be constructed using one of the available dredge types in the area (i.e., cutter head). Type A Dredged Channels, will be cut 5 feet or more away from the existing bankline to prevent sloughing of the bankline. Unless otherwise specified, it is assumed that all spoil material will be placed in an adjacent spoil area that is constructed by building berms from in-situ material. If it is determined that the dredge spoil can be used beneficially in other areas, the material will be used for swamp and marsh nourishment. Dredge material will consist of excavated in-situ material which is characterized as follows: surface and shallow subsurface deposits found in swamps and marshes, canals, lakes, and bayous.

(b) Plugs will be constructed with a close-graded limestone aggregate obtained from a quarried source. The aggregate will be placed to an elevation 2 feet above the water surface. The plug will be tied-in with 1 vertical to 4 horizontal slope extending to the existing ground (see Appendix R drawing C-340 for a typical section). The aggregate will be placed with a track-hoe bucket and will most likely be brought to the site via a barge or other floating vessel. It is assumed that access to the sites is available or will be made available through "flotation channels".

(c) Precast and cast-in-place concrete culverts will be placed to convey water from one area to the other. Depending upon the location, there may be multiple barrels and/or a flap gate. Those areas proposed for culverts will be excavated to 2 feet below the flow line. The trench will be filled with 2 foot aggregate bedding material and backfilled around the pipe. Culverts will be installed through roadways, natural ridges, and dredged material embankments locally known as spoil banks. It is assumed that access to the sites is available or will be made available through "flotation channels".

(d) Existing dredge spoil banks will be excavated to allow water conveyance and are referred to on the drawings as Spoil Gaps (see Appendix R drawing C-342 for details). The gaps will be excavated 50 feet long and will be excavated with track-hoes and sloped back to existing ground. The excavated material will be either hauled off by the contractor or placed adjacent to the gap. All exposed ground above the water surface will be seeded to reduce erosion. It is assumed that access to the sites will be made available through "flotation channels".

(e) Removal of existing structures will occur using equipment containing a bucket or a grapple. The material will be removed off site and disposed at the contractor's discretion. It is assumed that access to the sites is available or will be made available through "flotation channels". Two features will be removed from canals within the East Grand Bayou Area. These features include a rock weir and an existing soil plug.

(f) Diversion structure. This Central Diversion Structure (CS1) involves constructing six 10' x 10' gated box culverts on Bayou Butler under Highway 57. The structure will increase fresh water movement from the HNC to Bayou Grand Caillou/Lake Boudreaux.

(g) Levees listed on project plans as features CLV1 and CLV2 measure 5,173 linear feet and 1,760 linear feet and will be constructed and function as forced drainage levees. The levees will be created out of soil and will directly impact 23 acres of swamp through conversion to upland habitat. The proposed levees would prevent potential flooding from proposed increases in flows to Lake Boudreaux. Several project features (CC3, CC 5-15, [CD1-2, 6, 7], CLV1, CLV2, and CP2) together will work in conjunction with the Central Diversion Structure to deliver and retain fresh water and to prevent greater saltwater intrusion into Lake Boudreaux.

(h) A Weir will be constructed of limestone riprap and will be placed across the channel approximately 10 feet below the water surface. Side slopes will be 1 vertical to 5 horizontal as shown on drawing C-339 (Appendix R).

(i) Terracing berms will be constructed by excavating adjacent in-situ material and piling the material until the berm is 2 feet above the water surface. The Terraces will consist of a series of 10 foot wide parallel berms positioned approximately 90 degrees to the direction of surge (See Appendix R drawings C-341 for details). Borrow trenches will be located a minimum of 25 feet away to prevent sloughing. The exposed ground above the water surface will be vegetated to reduce erosion. It is assumed that access to the sites is available or will be made available through "flotation channels".

(j) Marsh berms will be created by borrowing adjacent in-situ material at least 25 feet from the berm toe. The material will be piled until the berm is at an elevation of +2.5 feet. All berms are expected to contain a 30 foot wide top width and any exposed ground above the water surface will be seeded for

erosion protection. It is assumed that access to the berm sites are available or will be made available through "flotation channels". Material for the berm will be obtained by excavating in-situ material adjacent to the berm location. Spill boxes will be placed in the berm to allow water to drain. The containment berm construction will require constant monitoring to ensure no dredge material is allowed to escape. The area within the containment berms will be filled with dredge material up to an elevation of +2.5 feet to +3.0 feet. Booster pumps and effluent pipes will run between the dredge borrow site and the marsh creation areas. It is assumed from similar projects that the construction fill elevation of the dredged material will settle over several years to an elevation of approximately +1.0 feet to +1.5 feet. Once this elevation is achieved, marsh vegetation can either be planted or will reestablish naturally. The containment berms will be degraded to the adjacent dredge fill elevation after settling.

(2) Quantity of Material.

(a) Dredging will occur within all three subunits. Dredging activities within the east subunit includes canal dredging to allow water movement from the GIWW to Grand Bayou basin, as well as dredging within Grand Bayou to allow water movement to East Grand Bayou marshes. The estimated quantity of dredged material from the east subunit is **17 million cubic yards**.

Dredging within the central subunit includes dredging within Bayou Provost, a portion of Bayou Butler, and Falgout Canal to increase fresh water movement from Houma Navigation Canal (HNC) to Bayou Grand Caillou/Lake Boudreaux. A new water conveyance channel will be created to convey fresh water from Bayou Pelton enlargement to north Lake Boudreaux marshes. Bayou Pelton will also be dredged to enlarge the resource and increase fresh water movement from the HNC to Bayou Grand Caillou/North Lake Boudreaux. A new secondary channel along the GIWW at Hwy 24 bridges will also be created to increase water volume moving past the GIWW constriction. An estimated **695,200 cubic yards** of material will be removed by the stated activities.

The western subunit includes dredging within a part of Carencro Bayou to create a new canal for purposes of increasing delivery of fresh water from Bayou Penchant to southeast Penchant Basin marshes. A portion of GIWW will also be dredged to eliminate constriction in this waterway. An estimated **3.23 million cubic yards** of dredged material will be removed as part of the project.

Unless otherwise specified, it is assumed that all spoil material will be placed in adjacent spoil areas that are constructed by building berms from in-situ material. If it is determined that the dredge spoil can be used beneficially in other areas, the material will be used for swamp and marsh nourishment, particularly in the vicinity of feature CD7 where approximately 92 acres of degraded marsh will be nourished with dredge disposal material from Bauyou Pelton.

(b) Close-graded aggregate will be used to create plugs within all subunits. The east subunit will contain a plug and boat bay placed in Cutoff Canal on the north bank of Bayou Pointe au Chien to retain fresh water in marshes to the north and prevent saltwater intrusion from the south. Approximately **23,360 tons** of aggregate will be used to create the plug in the east subunit. The central subunit has two plug features. One will occur at Robinson Canal and will retain fresh water in Lake Boudreaux basin while preventing saltwater intrusion from Bayou Petit Caillou. The second plug will be installed in a canal near Bayou Butler to prevent short circuiting of fresh water through the north to south Gulf South Pipeline canal. An estimated **15,000 tons** of aggregate will be placed to create the plugs. One plug is designed for the western subunit and will retain fresh water in Bayou du Large and Lake Mechant. The feature will also prevent saltwater intrusion. Approximately **7,500 tons** of aggregate is required to create the western plug.

(c) Precast and cast-in-place concrete culverts will be placed in strategic locations in the eastern and central subunits (e.g. through roadways, ridges, or dredged material embankments locally known as spoil banks). The primary purposes of the culverts will be to improve freshwater distribution. Approximately **7,700 cubic yards** of concrete will be placed in the eastern subunit, and **4,056 cubic yards** in the central subunit.

(d) Two spoil gaps will be created in existing canal spoil banks within the eastern subunit. The spoil gaps will allow movement of fresh water from the unnamed canal to marshes to the south/southwest and marshes to the east. Gaps will be excavated 50 feet long with 1 vertical on 3 horizontal side slopes. Approximately **41,620 cubic yards** of material would be removed from the existing spoil banks to create these openings.

(e) The rock weir and soil plug will be excavated from canals within the East Grand Bayou subunit. The estimated removal quantity is **4,533 tons**.

(f) The Central Diversion Structure (CS1) will be constructed under Highway 57 and will interface with Bayou Butler. The structure will consist of approximately **35,400 square feet** of precast concrete box culvert and an additional **1,050 cubic yards** of cast in place concrete.

(g) Levees (CLV1 and CLV2) will result in the discharge of approximately **296,853 cubic yards** of dredged material into 23 acres of swamp to create the elevated surface to function as the forced drainage levee.

(h) A rock filled sheet pile weir with boat openings will be installed in the western subunit and will constrict Grand Pass by 90 percent to minimize water exchange between Bayou du Large and Caillou Lake. Approximately **9,400 tons** of riprap will be placed to facilitate construction of this feature.

(i) Terraces will be constructed within the central subunit within the Lake Boudreaux area. The berms will be constructed by excavating adjacent in-situ material and piling the material until the berm is 2 feet above the water surface. The Terraces will consist of a grid of 10' wide berms perpendicular to surge for purposes of retaining fresh water and preventing saltwater intrusion. The associated excavation and discharge of dredged material is estimated at **1.1 million cubic yards**.

(j) The eastern marsh creation requires constructing linear berms perpendicular to tidal flow for purposes of slowing fresh water movement to the gulf and preventing saltwater intrusion from the south in an effort to stabilize the marshes in lower Grand Bayou basin. Soils for the berm creation will be borrowed from open water areas within 25 feet from the proposed berm toe and will be side cast to create an approximate 2.5 foot tall by 30 foot top width berm. The estimated quantity of dredged material discharged to create the eastern marsh berms is **711,187 cubic yards.**

Marsh berms within the central subunit will be created in like fashion to those in the eastern subunit. The berms will be placed perpendicular to flow and will retain fresh water in central subunit Lake Boudreaux marshes as well as prevent saltwater intrusion. A total of **821,000 cubic yards** of material will be excavated and placed to create the berms.

(3) Source of Material.

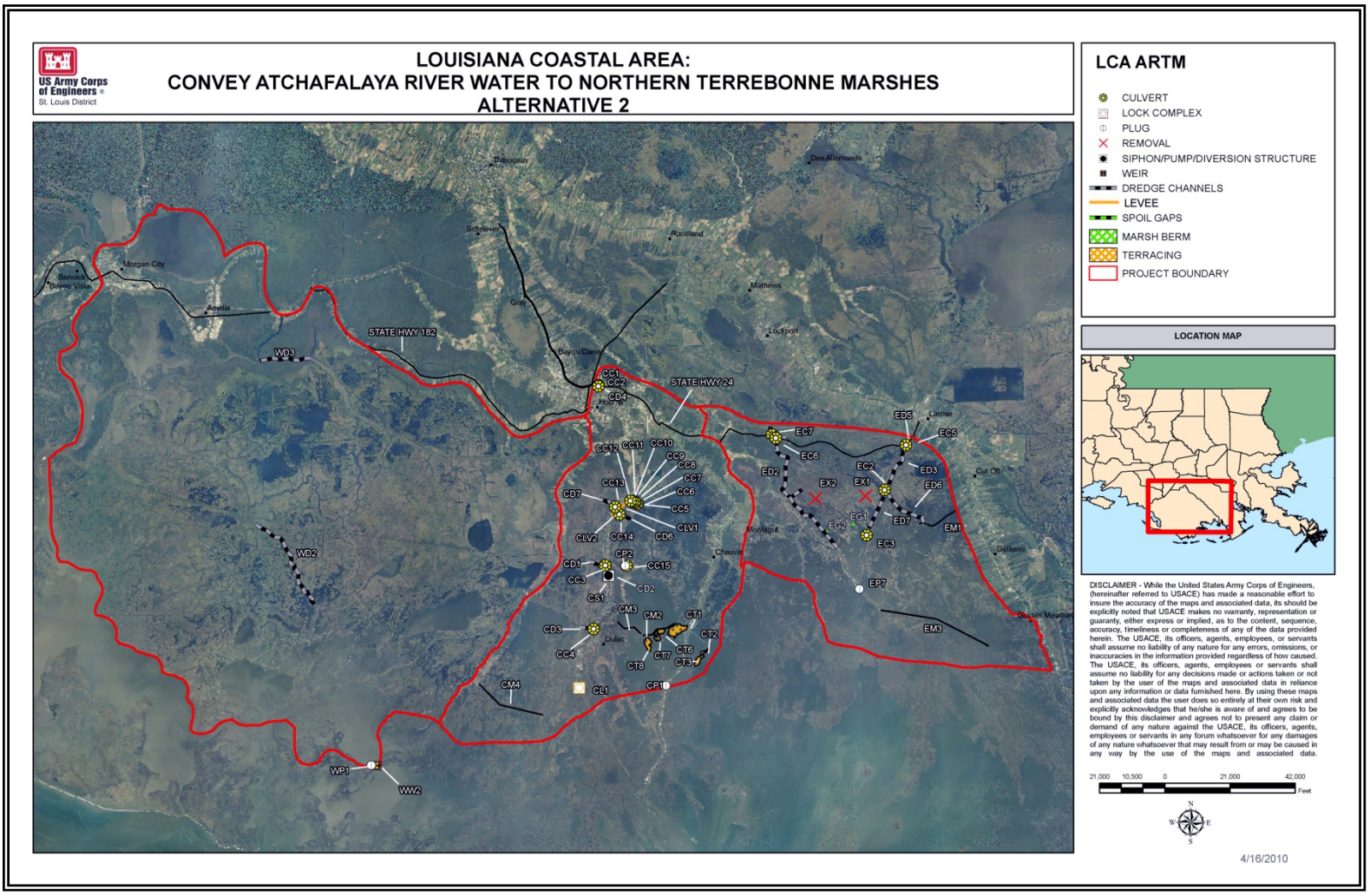
All excavated material, dredge material, and associated structure placement will occur within the project area. These soils occur as ponded, frequently flooded, and very frequently flooded, mucky and clayey, fluid soils that were formerly deposited by the Mississippi River and are found in the Bayous, canals, open water environments, marshes, and swamps that encompass the project area. Riprap and crushed aggregate must be obtained from a quarry and brought in by barge into the project area. Pre-cast concrete culverts will be obtained from a manufacturer of the product. Concrete will be ordered from a concrete supplier to construct all cast-in-place culverts.

E. Description of the Proposed Discharge Sites.

(1) Location and Size.

Figure 2 below provides an overview of the project features and their associated position in the project area. The features are more specifically depicted in subsequent figures which follow Figure 2. The relative size of each feature is discussed in this section as well.

Figure 2. Features Associated with the Proposed Action.



a) Deepening and widening of existing channels and creation of new conveyance channels include activities within the eastern and central subunits. Project measures in the eastern subunit include East Dredge Channel #5 (ED 5) which is a new 1000-foot channel to connect the GIWW to Grand Bayou. East Dredge Channel #3 (ED 3) is a 16,500-foot expansion of Grand Bayou to deliver fresh water into the Grand Bayou Basin. A box culvert (EC 2) will convey flow to the west through an existing levee along the alignment of the existing Grand Bayou which will be dredged (ED 6) for a length of 16,800 feet to provide freshwater to the eastern Grand Bayou marshes.

Dredging within the central subunit includes dredging within Bayou Provost (CD1) for 5,691 linear feet, and a portion of Bayou Butler (CD2) for 1,000 linear feet. A new water conveyance channel will be dredged to convey fresh water from Bayou Pelton to north Lake Boudreaux marshes. This feature is identified as CD6 and contains a design length of 7,014 feet and 45-foot width. Dredging activities will occur within Bayou Pelton (CD7) to enlarge the resource (6,416 linear feet by 70 feet wide) and further assist in increasing fresh water movement from HNC to Bayou Grand Caillou/North Lake Boudreaux.

b) The east subunit will contain a plug and boat bay (EP7) that will be placed in Cutoff Canal on the north bank of Bayou Pointe au Chien. The plug will cover an approximate 5,000 square foot area.

The central subunit has two plug features. One plug identified as CP1will be installed at Robinson Canal and will retain fresh water in Lake Boudreaux basin while preventing saltwater intrusion from Bayou Petit Caillou. CP1 will cover a 4,375 square foot area of Robinson Canal. The second plug (CP2) will be installed in a canal near Bayou Butler to prevent short circuiting of fresh water through the north to south Gulf South Pipeline canal. CP2 has a design area of 1,500 square feet.

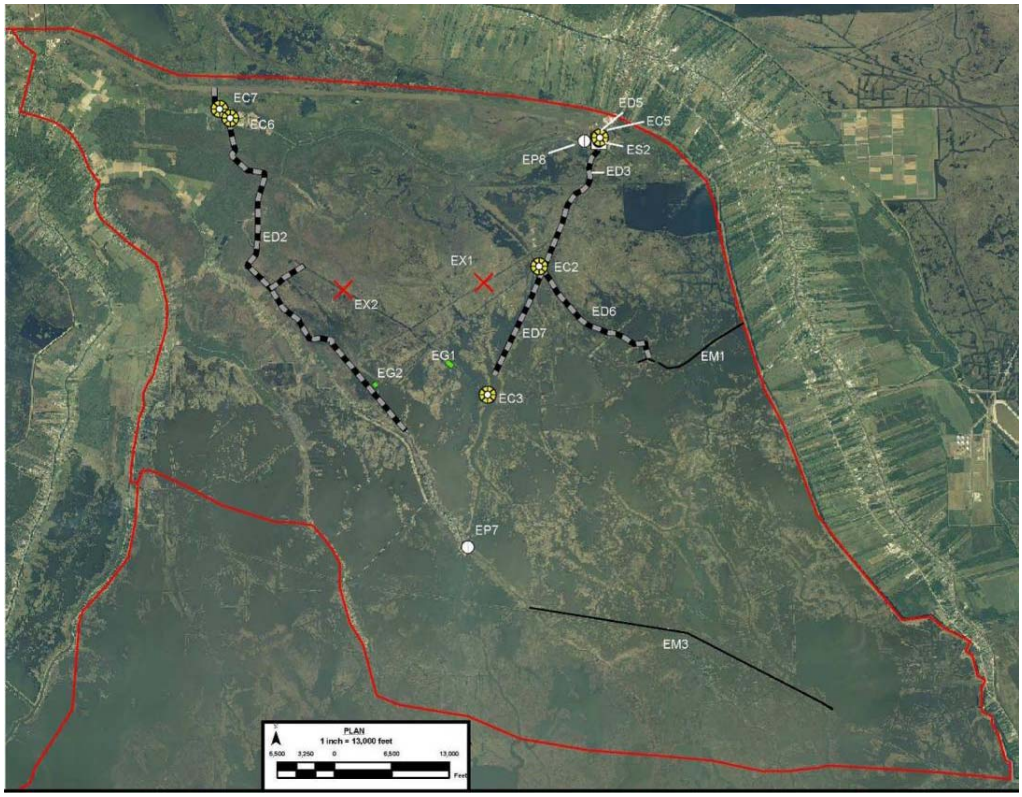
c) Culverts will be installed in the eastern and central subunits (see Table 1 for structure name and dimensions and Figures 3 and 4 for locations).

Table 1. Culvert Designation and Dimension

ID[1]	Measure Name	Description	No. of Barrels	Size/Width (ft)	Length (ft)
EC2	East Culvert #2	Box culvert	5	5x5	26
EC3	East Culvert #3	Flap gated box culverts w/variable crest outfall	10 5x5		75
EC5	East Culvert #5	Bridge construction with Obermeyer gates installed between the piers	N/A	80 x 20	552
EC6	East Culvert #6	Flap gated box culverts	8	8x8	50
EC7	East Culvert #7	Flap gated box culverts	8	8x8	40
CC1	Central Culvert #1	Box Culvert under Highway 24 Bridge	6	10x10	115
CC2	Central Culvert #2	Box Culvert under Highway 24 Bridge	6	10x10	115
CC3	Central Culvert #3	Gated control structure	6	10x10	175
CC4	Central Culvert #4	Gated control structure	6	10x10	175

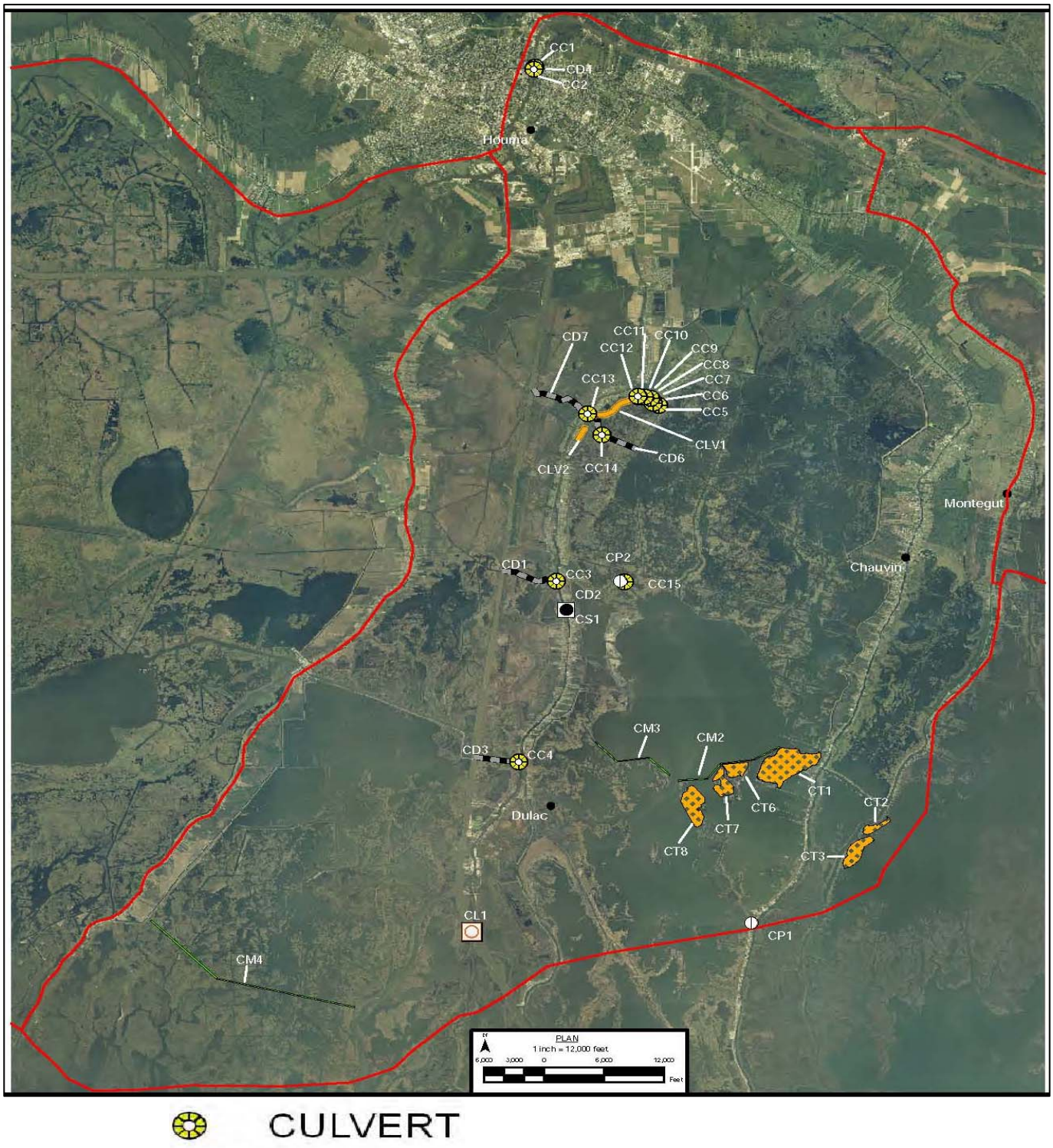
ID[1]	Measure Name	Description	No. of Barrels	Size/Width (ft)	Length (ft)
CC5	Central Culvert #5	Aluminum flap-gated culvert	1	4x4	48
CC6[3]	Central Culvert #6	Aluminum flap-gated culvert	1	4x4	48
CC7	Central Culvert #7	Aluminum flap-gated culvert	1	4x4	48
CC8	Central Culvert #8	Aluminum flap-gated culvert	1	4x4	48
CC9	Central Culvert #9	Aluminum flap-gated culvert	1	4x4	40
CC10[3]	Central Culvert #10	Aluminum flap-gated culvert	1	4x4	40
CC11	Central Culvert #11	Aluminum flap-gated culvert	1	4x4 40	
CC12	Central Culvert #12	Aluminum flap-gated culvert	1	4x4	40
CC13	Central Culvert #13	Box culverts with sluice gates under Hwy 57	6 10x1	0	175
CC14	Central Culvert #14	Flap-gates w/ stop log bays	3	4x4	45
CC15	Central Culvert #15	Timber weir w/ boat openings	N/A	68	N/A

Figure 3 East Subunit Culvert Locations



CULVERT

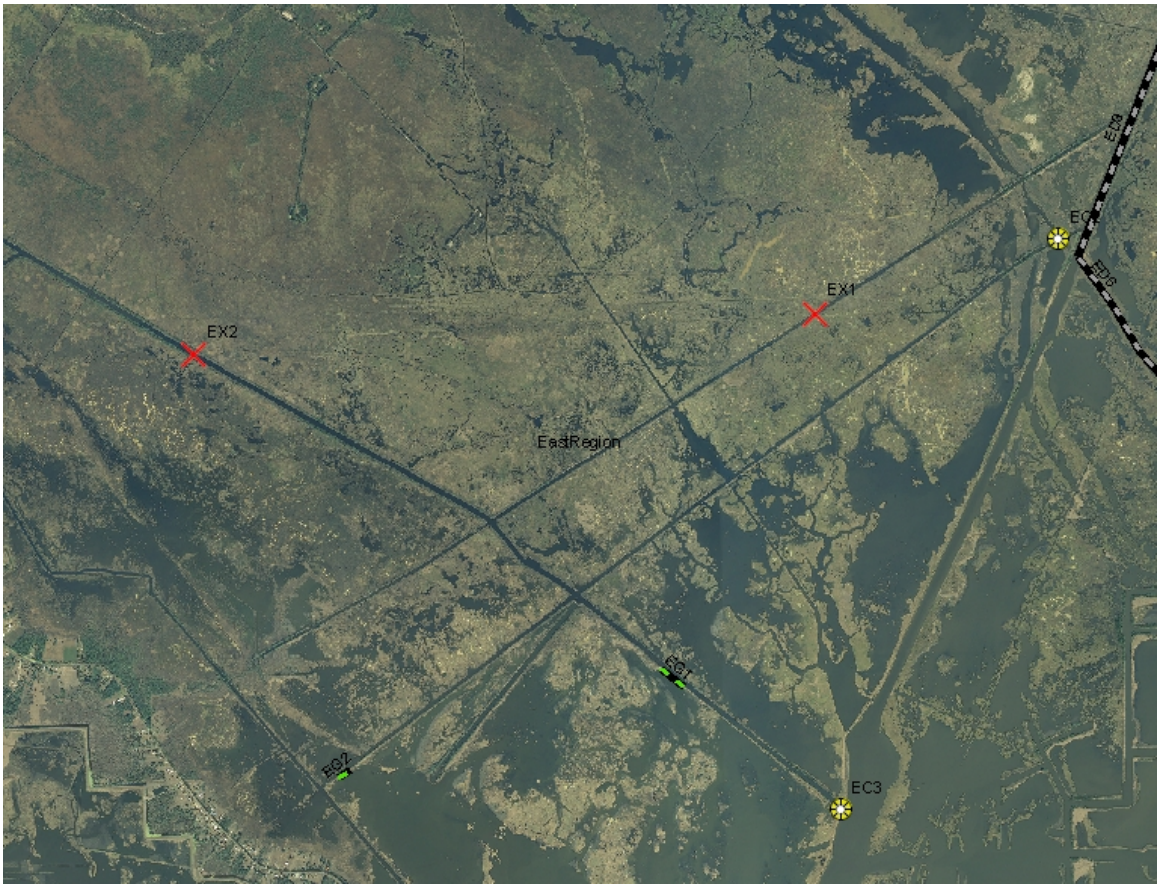
Figure 4. Central Subunit Culvert Locations



(d) Two spoil gaps (EG 1 and EG 2) will be excavated in the eastern subunit and their specific locations are shown on Figure 5 below. The EG1 footprint is

estimated at 1.7 acres and the EG2 gap is measured at 0.5 acres. The gaps will be excavated -0.5 feet below the surrounding terrain.

Figure 5. Spoil Gaps and Structure Removal Locations



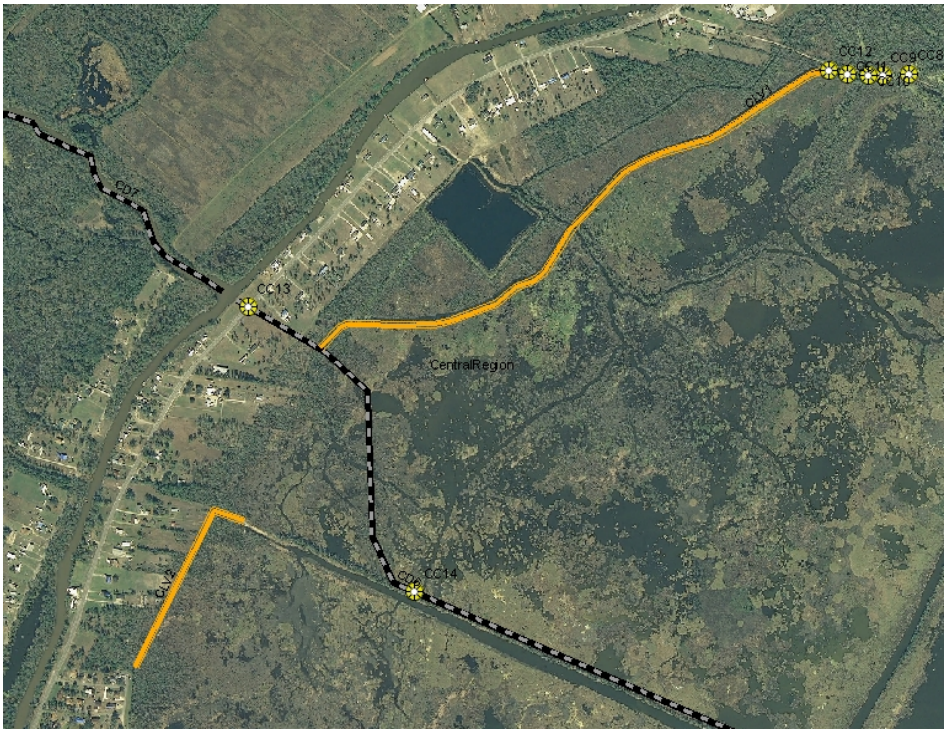
(e) Removal of a rock weir (EX 1) and a soil plug (EX 2) will increase water movement through canals within East Grand Bayou. The removal area for EX1 is 100 feet long by 50 feet wide. The soil plug EX2 covers an area that is 130 feet long by 50 feet wide (see Figure 5 above for the removal areas).

(f) The central diversion structure (CS1) is approximately 1-acre in size and is located under Highway 57 and interfaces with Bayou Butler. See Figure 6 below for the feature location.

Figure 6 Central Diversion Structure Location

(g) Two levees will be constructed within the central subunit and are labeled on Figure 7 below as CLV1 and CLV2. The levees measure 5,173 linear feet and 1,760 linear feet respectively and will cover approximately 23 acres of swamp.

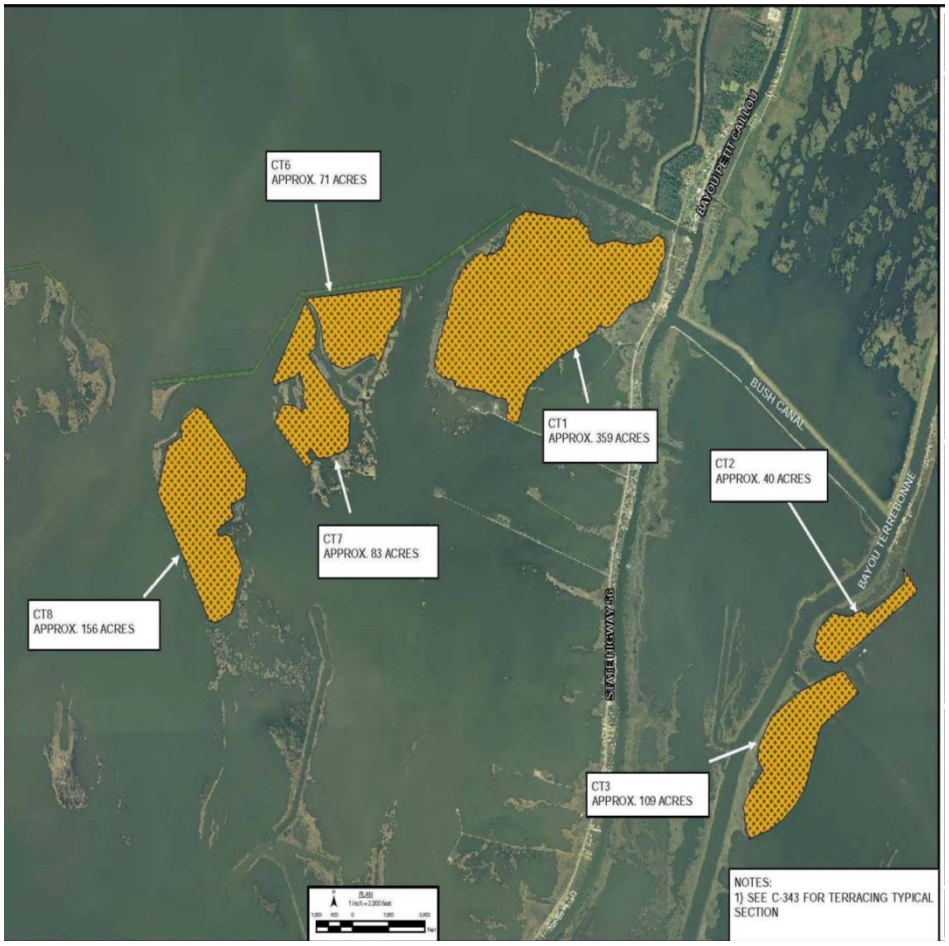
Figure 7 Levee Locations



(h) A rock filled sheet pile weir with boat openings will be installed in the western subunit and will constrict Grand Pass by 90 percent to minimize water exchange between Bayou du Large and Caillou Lake. The design dimensions for this structure are 100 feet long by 940 feet wide by 12 feet deep.

(i) Terraces will be constructed within the central subunit within the Lake Boudreaux area. See Figure 8 below for the measure name, location, and size.

Figure 8 Central Terraces, Sizes and Locations.



(j) Marsh berms will be created within the eastern and central subunits. Marsh berm (EM 1) will total 13,000 feet long by 30 feet wide. Further to the south, EM3 will be created and will total 37,000 feet long by 30 feet wide. The

location of EM1 and EM3 are shown on Figure 3 above. Marsh berms (CM2, CM3, and CM4) will be created in the central subunit (depicted in Figure 4 above). CM2 contains a design dimension of 11,255 feet long by 30 feet wide. CM3 is estimated at 8,975 feet long by 30 feet wide, and CM4 is approximately 23,458 feet long by 30 feet wide.

(2) Type of Site.

(a) Deepening and widening of existing channels and creation of new conveyance channels will occur within the bayous, canals, swamp/wetland forests, fresh marshes, intermediate marshes, and brackish marshes.

(b) Plugs will be placed within bayous and canals, both of which consist of open water environments.

(c) The culvert features will be placed within existing earthen levees, excavated channels constructed through uplands, and under roadways. Each of these structures will interface with aquatic resources to convey flow from one waterway to another.

(d) Two spoil gaps will be created in existing canal spoil banks to allow movement of fresh water from unnamed canals to adjacent marshes.

(e) Removal of a rock weir (EX1) and a soil plug (EX2) will occur in open water canals situated in the Grand Bayou area.

(f) The Central Diversion Structure (CS1) will be installed under Highway 57 and the gated box culvert structure will interface with Bayou Butler.

(g) The levees within the central subunit will cover approximately 25.5 acres with 23 acres of the area being labeled as swamp.

(h) The weir is proposed in an area known as Grand Pass which is situated between Bayou du Large and Caillou Lake. Grand Pass consists of an open water environment.

(i) Terracing Berms will be created within the shallow open waters of Lake Boudreaux.

(j) Marsh Berms created within the eastern subunit (EM1 and EM3) will primarily be created within shallow open waters of Grand Bayou. The central subunit marsh berms (CM2 and CM3) are proposed within the shallow open waters of Lake Boudreaux. Marsh berm (CM4) will traverse open water habitats and brackish marshes situated to the west of Bayou Grand Caillou.

(3) Type of Habitat.

Project related features will be constructed within the following habitat types: natural levees, lakes, swamps, marshes, canals, and bayous. The specific feature and type of habitat to be affected is addressed in Table 2 below.

Table 2. Projected disturbance area by habitat type for construction features impacting the project area.

Feature ID	Feature Name	Habitat Type
ED2	East Dredge Channel #2	Canal/Swamp Wetland Forest/Intermediate Marsh/Brackish Marsh
ED3	East Dredge Channel #3	Canal/Intermediate Marsh/Swamp/Wetland Forest/Brackish Marsh
ED5	East Dredge Channel #5	Canal/Wetland Forest
ED6	East Dredge Channel #6	Canal/Brackish Marsh
ED7	East Dredge Channel #7	Canal/Brackish Marsh
EP7	East Plug #7	Open Water
EG1	East Spoil Gap #1	Canal/Brackish Marsh
EG2	East Spoil Gap #2	Canal/Brackish Marsh
EX1	East Removal #1	Canal/Intermediate Marsh
EX2	East Removal #2	Canal/Intermediate Marsh
EC2	East Culvert #2	Canal/Brackish Marsh
EC3	East Culvert #3	Grand Bayou/Uplands/Canal
EC5	East Culvert #5	Bayou L'eau Blue/Uplands/Forested Wetland
EC6	East Culvert #6	St. Louis Canal
EC7	East Culvert #7	St. Louis Canal
EM1	East Marsh #1	Canal/Brackish Marsh
EM3	East Marsh #3	Canal/Saline Marsh
CC1	Central Culvert #1	GIWW
CC2	Central Culvert #2	GIWW
CC3	Central Culvert #3	HNC
CC4	Central Culvert #4	HNC
CC5	Central Culvert #5	Swamp/Wetland Forest
CC6	Central Culvert #6	Swamp/Wetland Forest
CC7	Central Culvert #7	Swamp/Wetland Forest
CC8	Central Culvert #8	Swamp/Wetland Forest

CC9	Central Culvert #9	Swamp/Wetland Forest
CC10	Central Culvert #10	Swamp/Wetland Forest
CC11	Central Culvert #11	Swamp/Wetland Forest
CC12	Central Culvert #12	Swamp/Wetland Forest
CC13	Central Culvert #13	HNC
CC14	Central Culvert #14	Uplands
CC15	Central Culvert #15	Brackish Marsh
CD1	Central Dredge Channel #1	Bayou Provost/Intermediate Marsh
CD1	Central Dredge Channel #1	Bayou Provost/Swamp/Wetland Forest
CD2	Central Dredge Channel #2	Bayou Butler
CD3	Central Dredge Channel #3	Falgout Canal/Intermediate Marsh
CD6	Central Dredge Channel #3	Swamp/Wetland Forest
CD6	Central Dredge Channel #3	Freshwater Marsh
CD7	Central Dredge Channel #7	Bayou Pelton/Swamp/Wetland Forest
CM2	Central Marsh Berm #2	Lake Boudreaux
CM3	Central Marsh Berm #3	Lake Boudreaux
CM4	Central Marsh Berm #4	Brackish Marsh
CP1	Central Plug #1	Robinson Canal
CP2	Central Plug #2	Canal
CS1	Central Diversion Structure #1	HNC/Upland/Bayou Grand Caillou
CT1	Central Terracing #1	Saline Marsh
CT2	Central Terracing #2	Saline Marsh
CT3	Central Terracing #3	Saline Marsh
CT6	Central Terracing #6	Saline Marsh
CT7	Central Terracing #7	Saline Marsh
CT8	Central Terracing #8	Saline Marsh
CLV1	Central Levee #1	Swamp/Wetland Forest
CLV2	Central Levee #2	Swamp/Wetland Forest
WD2	West Dredge Channel #2	Carencro Bayou/Freshwater Marsh
WD3	West Dredge Channel #2	GIWW/Swamp
WP1	West Plug #1	Saline Marsh
WW2	West Weir #2	Grand Pass Channel

(4) Timing and Duration of Discharge

The proposed project would have an initial direct impact on existing wetland vegetation, wildlife and fisheries resources, and essential fish habitat within the construction footprint. The dredge features WD2, CD1, CD3, CD6, ED2, ED3, ED6, and ED7 would result in 148 acres of swamp, 343 acres of fresh marsh, 248 acres of intermediate marsh, and 182 acres of brackish marsh being directly converted to open water. These features would also impact 614 acres of open water habitat. Levee features (CLV1 and CLV2) would also result in 23 acres of swamp being converted to upland. However, the project is expected to prevent approximately 9,655 acres of marsh habitat loss over a 50-year period of analysis.

Dredged materials removed during excavation of new and enlargement of existing conveyance channels would be deposited in a manner that would avoid disruptions of water movement, flow, circulation and quality. Dredged material deposition is not expected to result in significant or persistent water quality impacts in the vicinity of construction activities. Any minor increases in suspended sediment and turbidity levels during dredged material deposition would be temporary and highly localized. Minor reductions in dissolved oxygen levels associated with dredged material deposition would be temporary.

Several construction features (e.g., plug removal and installation, spoil gaps, weir removal and installation, diversion structure installation, culverts, terrace berms and marsh berms) associated with the proposed action would modify hydrologic and sediment transport processes. The proposed project is designed to introduce and/or divert fresh water to control salinities. Construction of the proposed structures would also convey sediment and nutrients to the Northern Terrebonne Marshes and elsewhere in the Terrebonne Basin to enhance fish and wildlife habitat and productivity, and offset land loss. Areas modified by surface alteration activities would, where applicable, be regraded and revegetated upon feature installation. Potential impacts associated with surface alteration sites would be minimized, as much as practicable, through the implementation of stormwater pollution prevention plans (SWPPPs) and other applicable best management practices (BMPs). Impacts associated with soil compaction, rutting, rill, and gully erosion at surface alteration construction sites would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, and regrading and permanent vegetation establishment at the end of construction. The occurrence of low dissolved oxygen conditions in the proposed project area waters would be temporary and minor. The proposed action would directly create 257 acres of brackish marsh and 72 acres of saline marsh as a result of features CM2, CM3, CM4, CT1, CT2, CT3, CT6, CT7, CT8, EM1, and EM3.

F. Description of Disposal Method.

(a) Dredged materials, unless otherwise specified, will be disposed of in adjacent spoil areas that are constructed by building berms. If it is determined that the

dredge spoil can be used beneficially in other areas, the material will be used for swamp nourishment, as proposed in the Bayou Pelton area (feature CD7).

(b) The plugs proposed in each subunit will be constructed from aggregate that will be placed to an elevation of 2 feet above the water surface. The plug will be tied-in with 1 vertical to 4 horizontal slopes extending to the existing ground. The aggregate will be placed with a track-hoe bucket and will most likely be brought to the site via a barge or other floating vessel. It is assumed that access to the sites is available or will be made available through "flotation channels".

(c) Those areas proposed for culverts will be excavated to 2 feet below the proposed flowline. The trench will be filled with 2 foot aggregate bedding material and backfilled around the pipe. Culverts will be installed through roadways, natural ridges, and dredged material embankments locally known as spoil banks. It is assumed that access to the sites is available or will be made available through "flotation channels".

(d) Existing dredge spoil banks will be excavated to allow water conveyance and are referred on the drawings as Spoil Gaps (see Appendix R drawing C-342 for details). The gaps will be excavated 50 feet long and will be excavated with track-hoes and back sloped to existing ground. The excavated material will be either hauled off by the contractor or placed adjacent to the gap. All exposed ground above the water surface will be seeded to reduce erosion. It is assumed that access to the sites will be made available through "flotation channels".

(e) Removal of existing structures will occur using equipment containing a bucket or a grapple. The material will be removed off site and disposed at the contractor's discretion. It is assumed that site access is available or will be made available through "flotation channels". Two features will be removed from canals within the East Grand Bayou Area. These features include a rock weir and an existing soil plug.

(f) The Central Diversion Structure (CS1) consists of cast-in-place concrete inlet and outlet monoliths supported on 14 inch by 14 inch precast prestressed concrete piles. Lateral spacing of the piles will be 6.0 feet on center, and the pile tips will be located at elevation -28.0 feet. A 4-inch stabilization slab will be placed between the cast-in-place concrete substructures and the soil foundation. A steel sheet pile scour wall will be placed around the perimeter of the inlet and outlet monoliths. The pile tip elevation of the scour walls will be elevation -30.0 feet. The precast concrete box culverts located between the inlet and outlet monoliths will be supported on a 3.0 foot thick base of compacted material.

(g) Levees (listed as features CLV1 and CLV2) will be created out of dredged disposal extracted from central canal dredge segments.

(h) Riprap used to construct the weir will be placed with a track-hoe bucket and will most likely be brought to the site via a barge or other floating vessel. It is

assumed that access to the sites is available or will be made available through "flotation channels".

(i) Terracing Berms will consist of a series of 10 foot wide parallel berms positioned approximately 90 degrees to the direction of surge (See drawings C-341 for details). Borrow trenches will be located a minimum of 25 feet away to prevent sloughing. The exposed ground above the water surface will be vegetated to reduce erosion. It is assumed that access to the sites is available or will be made available through "flotation channels".

(j) Material for marsh berm creation will be obtained by excavating in-situ material adjacent to the berm location. Spill boxes will be placed in the berm to allow water to drain. Containment berms will be filled with dredge material up to an elevation of +2.5 feet to +3.0 feet. Booster pumps and effluent pipes will run between the dredge borrow site and these marsh creation areas. It is assumed from similar projects that the construction fill elevation of the dredged material will settle over several years to an elevation of approximately +1.0 feet to +1.5 feet. Once this elevation is achieved, marsh vegetation can either be planted or will reestablish naturally. All berms are expected to contain a 30 foot wide top width and any exposed ground above the water surface will be seeded for erosion protection. It is assumed that access to the sites is available or will be made available through "flotation channels".

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations.

(1) Comparison of Existing Substrate and Fill.

(a) Dredge activities consist of the creation of two new water conveyance channels for purposes of improving fresh water delivery. One of the channels (ED5) will be installed through an area characterized as upland and has been formerly altered to support a barge fleeting area and roadway infrastructure. The second new channel (CD6) will be constructed through swamp and freshwater marsh. A third new channel (WD2) will be constructed through freshwater marsh. Swamp and marsh deposits consist mainly of very soft clays and organic clays with peat that are generally less than 20 feet thick. Direct impacts to soils and substrate from implementation of this project-related activity would primarily result from removal and disposal of the excavated material.

(b) Deepening and widening of canals, bayous, and the GIWW from identified project-related activities associated with features ED3, ED6, ED7, CD1, CD2, CD3, CD4, CD7, and WD3 will result in direct impacts to the medium to stiff silty clay substrate. The associated disposal of the dredged material will occur along the dredged channel to create spoil banks that are elevated 6 to 8 feet above the bank line. This activity will convert the smothered substrate to a non-aquatic resource. However, much of the elevated berm will consist of marsh edge species with more upland plant species colonizing the top and upper side slopes of the berm which provides plant and habitat diversity. The

spoil banks will aid in preventing saltwater intrusion and increase freshwater residence time. One exception does exist as a result of the project and that is in the area of feature CD7. This area will contain approximately 92 acres of swamp nourishment that will result in a beneficial use of dredge material by preventing the conversion of transitional wetlands to open water.

(c) Numerous channels have been dredged which cut through natural ridges increasing both drainage and tidal exchange in the project area, exposing soils to erosive forces. Three structural plugs will be installed into bayous and canals with substrates consisting of medium to stiff silty clays. The plugs will be created by discharging aggregate and sediment to a point where the feature protrudes 2 feet above the waterline. The plugs are intended to retain freshwater in marshes and prevent saltwater intrusion.

(d) Culverts will be installed through roadways, natural ridges, and existing spoil banks. The culverts will interface with canals and bayous for purposes of conveying or increasing freshwater movement into wetlands. Excavation of the canal and bayou substrate is required at the interface locations to prepare for the creation of a stable base to support the structure. The excavated area would be backfilled with aggregate and permanently covered with the culvert.

(e) Existing dredge spoil banks will be excavated to allow water conveyance and are referred to as Spoil Gaps. The excavated material will likely be placed onto existing spoil banks that lie adjacent to the created gap.

(f) Two structural features, which include a rock weir and soil plug, will be removed from canals within the East Grand Bayou Area. The materials will be transported out of the project area and disposed of at an upland location.

(g) The Central Diversion Structure (CS1) will be constructed through an upland area and will interface with the HNC and Bayou Grand Caillou. The installation of this structure will result in substrate impacts and permanent fills consistent with those addressed under culverts.

(h) Forced drainage levees CLV1 and CLV2 will be constructed through freshwater swamps and marshes. Swamp and marsh deposits consist of very soft clays and organic clays with peat that are generally less than 20 feet thick. Direct impacts to soils and substrate from implementation of this project-related activity would primarily result from fill discharged to create the elevated feature. The levees will be created out of soil and will permanently convert 23 acres of wetland substrate to uplands. These project measures are designed to work with several project features to deliver and retain fresh water and to prevent greater saltwater intrusion into Lake Boudreaux.

(i) A riprap weir will be constructed within Grand Pass. Grand Pass likely contains a medium to stiff silty clay substrate. The proposed structure will consist of a rock filled sheet pile weir with boat openings and is intended to constrict Grand Pass by 90 percent to minimize water exchange between Bayou du Large and Caillou Lake.

(j) The Lake Boudreaux area is mapped on the soil survey as containing brackish organic and mineral deltaic deposits. These bottom deposits would be excavated in a series of trenches located approximately 25 feet from the base of the proposed terrace berms. The excavated material will be side cast covering the existing substrate and creating berms that extend 2 feet above the

water surface and have a 10 foot top width. These berms are intended to support marsh creation and retain freshwater in Lake Boudreaux.

(k) The marsh berms will be placed in the Grand Bayou area, within Lake Boudreaux and brackish marsh. The substrate of Grand Bayou and Lake Boudreaux are most likely medium to stiff silty clays. The brackish marsh substrate consists of very soft clays and organic clays with peat that are generally less than 20 feet thick. Direct impacts to substrate from implementation of this project-related activity would primarily result from removal and disposal of the excavated material. The side casted material would be used to create berms that are 2.5 to 3.0 feet tall and contain a top width of 30 feet. The berms are expected to settle to an elevation of +1.0 feet to +1.5 feet. Once this elevation is achieved, marsh vegetation can either be planted or will reestablish naturally.

(2) Changes to Disposal Area Elevation.

Feature ID	Measure Name	Approximate Change in Disposal or Excavation Area Elevation (feet)
EC2	East Culvert #2	-4.5
EC3	East Culvert #3	-5.0
EC5	East Culvert #5	-14.0
EC6	East Culvert #6	-7.0
EC7	East Culvert #7	-7.0
ED2	East Dredge Channel #2	-8.0
ED3	East Dredge Channel #3	-14.0
ED5	East Dredge Channel #5	-14.0
ED6	East Dredge Channel #6	-14.0
ED7	East Dredge Channel #7	-14.0
EG1	East Spoil Gap #1	-0.5
EG2	East Spoil Gap #2	-0.5
EP7	East Plug #7	-5.0
EX1	East Removal #1	-5.0
EX2	East Removal #2	-5.0
EM1	East Marsh Berm #1	+3.0
EM3	East Marsh Berm #3	+3.0
CL1	Central Lock Complex #1	-7.0
CC1	Central Culvert #1	-20.0
CC2	Central Culvert #2	-20.0
CC3	Central Culvert #3	-10.0
CC4	Central Culvert #4	-5.0
CC5	Central Culvert #5	-5.0
CC6	Central Culvert #6	-5.0
CC7	Central Culvert #7	-5.0
CC8	Central Culvert #8	-5.0
CC9	Central Culvert #9	-5.0
CC10	Central Culvert #10	-5.0

CC11	Central Culvert #11	-5.0
CC12	Central Culvert #12	-5.0
CC13	Central Culvert #13	-10.0
CC14	Central Culvert #14	-5.0
CC15	Central Culvert #15	-3.5
CD1	Central Dredge Channel #1	-10.0
CD2	Central Dredge Channel #2	-10.0
CD3	Central Dredge Channel #3	-10.0
CD4	Central Dredge Channel #4	-20.0
CD6	Central Dredge Channel #6	-10.0
CD7	Central Dredge Channel #7	-10.0
CLV1	Central Levee #1	+8.0
CLV2	Central Levee #2	+8.0
CP1	Central Plug #1	-10.0
CP2	Central Plug #2	-10.0
CS1	Central Diversion Structure #1	-10.0
CM2	Central Marsh Berm #2	+3.0
CM3	Central Marsh Berm #3	+3.0
CM4	Central Marsh Berm #4	+3.0
CT1	Central Terracing #1	+2.0
CT2	Central Terracing #2	+2.0
CT3	Central Terracing #3	+2.0
CT6	Central Terracing #6	+2.0
CT7	Central Terracing #7	+2.0
CT8	Central Terracing #8	+2.0
WW2	West Weir #2	-12.0
WP1	West Plug #1	-10.0
WD2 We	st Dredge #2	-7.0
WD3 We	st Dredge #3	-36.0

(3) Migration of Fill.

Of the 56 construction features associated with the proposed action, hydrologic and sediment transport processes will be modified. The proposed project is designed to introduce and/or divert fresh water to control salinities, convey sediment and nutrients to the Northern Terrebonne Marshes and elsewhere in the Terrebonne Basin. The proposed project will also enhance fish and wildlife habitat and productivity, as well as offset land loss. Direct discharges of dredged or fill material are intended for permanent placement, with anticipated settling of the deposited material. The direct discharges of dredged and fill material have been thoroughly studied and will be placed to benefit to the overall ecosystem. Any minor increases in suspended sediment and turbidity levels during construction would be temporary and highly localized. Also, soil compaction, rutting, rill, and gully erosion at construction sites would occur. Impacts would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, re-grading, and permanent vegetation establishment at the end of construction.

(4) Duration and Extent of Substrate Change.

Substrate will be permanently altered in those locations where levees, spoil banks, terrace and marsh berms, culverts, plugs, weirs, and diversion structures are proposed. These structures are essential to fulfill project objectives. Substrate changes within those excavated canals and bayous generally consist of similar soil types and textures, which results in a deeper water column over the inundated soil.

(5) Changes to Environmental Quality and Value.

Protection and enhancement of the project area is dependent on providing a hydrologic regime that minimizes the physiological stress to wetland vegetation from saltwater intrusion and tidal energy and is conducive to the retention of locally provided fresh water and sediments. Several channels have been dredged which cut through the natural ridges increasing both drainage and tidal exchange in the project area, exposing the soil to erosive forces. Major navigation channels in the subprovince are the Atchafalaya River, Wax Lake Outlet, HNC, GIWW, and Lower Atchafalaya River (south of Morgan City). Each of these navigation channels introduces and/or compounds marine influences in many of the interior coastal wetlands and water bodies within the subprovince. Without action, the Wetland Value Assessment analysis predicted that approximately 102,000 acres or 18 percent of remaining vegetated wetlands in the study area would be lost over the 50-year period of analysis

The proposed action would have an initial negative direct impact on existing wetland vegetation, wildlife and fisheries resources, and essential fish habitat within the construction footprint. However, the proposed action is expected to prevent approximately 9,655 acres of wetland from being converted to open water by year 50 after project implementation. Based on the projected project benefits, the proposed action will restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them by reversing the trend of degradation and deterioration in the project area. The project is anticipated to contribute towards achieving and sustaining a larger coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the economy and well-being of the Nation.

(6) Actions to Minimize Impacts.

Cost effectiveness analysis is used to determine what project features should be built based on habitat benefits (outputs) that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps uses this analysis in the evaluation process for all ecosystem restoration planning efforts. After the cost effectiveness of identified alternatives has been established, incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output. While cost and environmental outputs are necessary factors, other factors such as the ability to construct, schedule, likelihood to achieve projected results, immeasurable environmental benefits, as well as ancillary benefits were used in selecting the preferred alternative.

The selected features have been designed to work with the natural, fluid, soft environment of coastal Louisiana. Direct wetland impacts have been minimized to the extent possible while striving to accomplish project objectives. As previously stated, one of the project goals is to improve freshwater circulation and redistribution within the study area. Project alternatives considered using various freshwater delivery systems to achieve this goal and considered channels extending from a variety of existing freshwater sources. A majority of the proposed dredging activities will follow existing shallow sediment filled channels (canals and bayous). Therefore, the proposed action reduces the length of newly constructed linear channel needed for the project which minimizes direct wetland conversions to open water conveyances.

Impacts associated with construction of features may include: increased total suspended solids and turbidity, increased dissolved nutrient levels, mobilization of existing contaminants in sediments, and decreases in dissolved oxygen levels. These impacts would be minimized, as much as practicable, through the implementation of SWPPPs and other applicable BMPs. Impacts associated with soil compaction, rutting, rill, and gully erosion at surface alteration construction sites would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, and re-grading and permanent vegetation establishment at the end of construction. The proposed action will decrease the rate of decline of various wetland types within the study area to ensure their ability to provide geomorphic and hydrologic form and function for the 50-year period of analysis. Marsh habitat for essential fish and wildlife species will be sustained, mimicking as closely as possible conditions which occur naturally in the area.

B. Water Circulation, Fluctuation, and Salinity Determinations.

(1) Alteration of Current Patterns and Water Circulation.

Major flow channels within the project area are the Atchafalaya River, the GIWW, and the HNC. Generally, stages in the lower Atchafalaya River force flow northeast through the Avoca Island Cutoff into the GIWW and Bayou Penchant. Additional flow enters the GIWW from the Verret Basin through Bayou Boeuf. Water travels eastward along the GIWW and through the Penchant basin (west subunit). A portion of this water leaves the project area through the Penchant basin along natural and man-made channels. The remaining flow continues east along the GIWW. At Houma, the GIWW intersects the HNC (central subunit). At this point, the majority of flow travels down the HNC to the Gulf of Mexico. The remaining flow continues east along the GIWW. A small amount of water enters the marshes of the Grand Bayou basin (east subunit) through two channels, Company Canal and Bayou L'Eau Blue. Finally, the flow exits the project area along the GIWW through the Bayou Lafourche ridge.

The proposed action will redistribute existing and increased flows of freshwater. To achieve this, GIWW constrictions would be eliminated. Additionally, the following measures to restrict, increase, and control water are proposed for each of the three subunits. In the West – Bayou Penchant Area, dredging, a sediment plug, and a weir will be utilized. In the Central – Lake Boudreaux Area, culverts,

levees, dredging, marsh terraces and berms, sediment plugs, modified operation of the future HNC lock complex, and a large sluice gated box culvert are proposed. In the East – Grand Bayou Area, culverts, dredging, gaps in canal spoil banks, marsh berms, sediment plugs, and removal of a weir and soil plug are proposed.

Southeastern Penchant basin marshes (west subunit) would experience a flow increase ranging from 100 to 3,000 cubic feet per second (cfs). Operation of the HNC lock for environmental purposes would increase this flow benefit by an additional 300 to 1,000 cubic feet/second (cfs). Flow through Grand Pass would be reduced by 10 to 40 percent. High and low increases would correspond with high and low Atchafalaya River stage, respectively.

Flow introduced to the Lake Boudreaux basin (central subunit) through the newly dredged channels on the west side of the basin would range from 100 to 700 cfs. With the closure of Robinson Canal and the construction of the marsh berm features within the basin, the flows in Boudreaux Canal would increase approximately 48 percent year round. High and low increases would correspond with high and low Atchafalaya River stages, respectively.

Flows in the GIWW west of Grand Bayou would generally increase with implementation of the proposed action. The increase would range from 0 to 20 percent west of Houma and could be as much as 50 percent east of Houma. These increases stop as the GIWW reaches Grand Bayou. The additional flow through Grand Bayou would cause the flow through Larose to reduce by as much as 50 percent. Flow increases into the Grand Bayou basin would range from 0 to 2,700 cfs throughout the year. Generally, the largest changes in flow would be seen during high Atchafalaya stages and the smallest during low stages.

(2) Interference with Water Level Fluctuation.

Stage impacts in the western region of the project area would be limited to the southeastern portion. Impacts of 0.1 to 0.2 feet would be seen from March to September with the highest seen in July. These impacts would be attributed to the reduced capacity of Grand Pass due to feature WW2 and from increased inflow to this area from feature WD2.

In the central region of the project area stage impacts would be limited to the Lake Boudreaux basin. Stage impacts would vary between 0.1 and 0.3 feet from March to September, with the highest seen in July. These impacts would be attributed to the increased flow into the basin through the culverts and dredged channels connecting the Boudreaux basin to the HNC and from the closure of Robinson Canal.

In the eastern region of the project area, impacts of up to 0.1 feet would be seen in the Grand Bayou basin. These impacts would vary in duration throughout the basin, with longer duration at the northern end, south of highway 24. Impacts ranging from March through September would be the longest in this portion of the project area. Stage reductions of up to 0.2 feet would also be seen along the GIWW in the western portion of the project area. These too would be seen from March to September with the largest reductions in July. Short duration impacts

near the plug in Cutoff Canal would be as much as 0.4 feet. These impacts would be highly localized to the area north of Bayou Pointe au Chien to Grand Bayou.

(3) Salinity Gradient Alteration.

Salinity levels throughout the project area are influenced by tides in the Gulf of Mexico. Saline waters advance and retreat in channels and marshes with the tidal cycle. As the land subsides and the marshes disappear, the limit of the saline water advances further north. Salinity levels can also vary with seasonal wind direction. In the fall and winter, southern winds push saline water into the marshes. During other parts of the year, northern winds push water out of the marshes, reducing salinity levels. Man made canals within the study area provide efficient conduits for salinity to enter portions of the study area. These canals include the HNC, Cutoff Canal, Robinson Canal, unnamed oil and gas exploration canals, and pipeline canals. Areas projected to experience the greatest increases in salinity are generally in the vicinity of the future location of the HNC lock complex. In the central and eastern subunit areas, wetlands would continue to be lost to subsidence, inundation of marsh plants, and subsequent erosion in brackish and saline marshes. As these marshes disappear, salt water would begin to move northward more rapidly, further stressing fresh and intermediate marshes. These marshes would likely not tolerate the increasing salinity well and would probably not convert to brackish marsh because the soils would be comprised of too much organic matter.

Long-term direct impacts to water quality associated with implementation of the proposed action would primarily be associated with changes in salinity and nutrient concentrations of receiving waters. According to modeled salinity values, changes in average annual salinities in the project area, as compared to the No Action Alternative, generally range from increases of 2.0 parts per thousand (ppt) to decreases of 4.7 ppt. Areas projected to experience the greatest decreases in salinity values include the Lake Mechant area, Lake Boudreaux, and the Grand Bayou area. In response to freshwater inputs and associated increased nutrient inputs, indirect impacts of the proposed action would include long-term reduction in losses of vegetation. Improved distribution of freshwater and nutrients would enhance vegetative productivity and optimize conditions for maintenance of all vegetative habitats. Most of the benefits from implementation of the proposed action would be seen in the Lake Pagie area, south of Falgout Canal, in the Lake Boudreaux area, and in the Grand Bayou area.

This LCA project proposes the development of an operational plan for the lock complex structure authorized under Morganza to the Gulf in order to maximize potential environmental benefits, both in terms of avoiding saltwater intrusion and optimizing flow distribution. The proposed action with a constructed lock complex (which comprises the Future-Without-Project condition for the LCA project after 2025) is to operate it in such a way that freshwater from the GIWW "escaping" down the HNC could be redirected into the surrounding wetlands. The lock itself will be operated only when the floodgates are closed to reduce salinity within the channel. Once closed, the floodgates would force water down other waterways (such as Bayou Grand Caillou). Saltwater intrusion is halted at

the gate, and freshwater flows increase in other waterways. If the HNC Lock is not constructed by 2025, the benefits of its operation would be lost and other benefits from LCA-ARTM from 2025 onward would be significantly altered.

(4) Cumulative Effects on Water Quality.

a. Salinity. Salinity levels would decrease or stabilize throughout most of the project area with slight increases in salinity levels expected in areas near the HNC lock complex. This alternative would have positive synergistic effects on salinity levels when combined with other Federal, state, local, and private restoration efforts. Changes in marsh health, stratification and mixing patterns, and flow patterns in the project due to project features could have a minor effect on tidal flows which could affect salinities. With implementation of the proposed action, the coastal plain of Louisiana would be affected by other activities and programs that would have both cumulatively beneficial and detrimental effects on water quality conditions. Some of these past, present, and foreseeable future activities include state and local water quality management programs; national level programs to address hypoxia in the northern Gulf of Mexico; oil and gas development; industrial, commercial, and residential development; and Federal, state, and local navigation and flood-damage reduction projects.

b. Clarity. Suspended sediment loads to receiving areas within the Terrebonne Basin would be increased. The southeast portions of the Penchant basin would receive additional suspended sediment loads due to feature WD2. Northern Boudreaux Basin would receive suspended sediments brought through the GIWW to the HNC. These sediments would be distributed throughout the Boudreaux Basin. An increased amount of suspended sediment would reach the Grand Bayou basin. These sediments would be distributed to the marshes east of Grand Bayou with a much smaller portion exiting the basin through Cutoff Canal due to feature EP7. Operations of the HNC lock would increase suspended sediments to the marshes between the HNC and Bayou Du Large. There would be a decreased suspended sediment load south of the HNC lock. With the delivery of increased sediment comes increased turbidity which reduces water clarity. This parameter is expected to change with the implementation of the design features.

c. Color. The proposed action will redistribute existing freshwater flows to benefit project area marshes, but this redistribution of flow would permanently alter water color from its current state due to increased sediment delivery. This change is desired as part of the proposed action to facilitate marsh nourishment and marsh platform development and reduce land loss. The primary areas where changes in water color will be most apparent is along the GIWW, connecting channel conveyances, and adjoining marshes. However, there would be a decreased suspended sediment load south of the HNC lock.

d. Water Chemistry and Dissolved Gasses. The redistribution of freshwater within the Terrebonne Basin would immediately change the water chemistry of receiving areas. Materials excavated to provide features of the proposed action would contain variable concentrations of organic material. Decomposition of organic material within the placement sites may result in a local, temporary reduction in dissolved oxygen or release of ammonia. However, hydrologic exchange between the dredged conveyances and surrounding marshes would reduce dissolved oxygen deficits and facilitate the transformation of ammonia into non-toxic nitrate. The redistribution of fresh water into the basin may increase dissolved oxygen concentrations, particularly during summer.

e. Temperature. The overall project is expected to decrease water temperatures and result in fewer water temperature fluctuations with the distribution of regular supply of freshwater. The establishment of vegetative communities will also contribute in moderating water column temperatures particularly during the growing season.

f. Nutrients. One of the stated project goals is to rebuild eroded wetlands in the area through the diversion of fresh water, sediment, and nutrients. The proposed project and all of its features will function together to elevate water quality constituents such as nutrients, thereby increasing organic/nutrient enrichment of the water column. Improved distribution of freshwater and nutrients would enhance vegetative productivity and optimize conditions for maintenance of all vegetative habitats, benefitting the extensive fish and wildlife resources of the area. In summary, nutrients help promote marsh building which suppresses the current land loss trend.

(5) Changes to Environmental Quality and Value.

Changes may be beneficial or detrimental, depending on human perceptions and the water uses. The change from a less fresh to a fresher system could be perceived as beneficial to wetland nourishment, but detrimental to recreational use because of water color changes, and possible changes in fish species assemblages in the recreational area. However, the changes in water chemistry would mimic natural conditions prior to the Northern Terrebonne Marshes' partial separation from the influence of the Atchafalaya River. Stabilization of salinity regimes would probably aid resource managers, commercial and recreational fisheries managers, and water users in making long-term decisions. Salinity could be either beneficial or detrimental, depending on the user group. Salinity is not necessarily a pollutant in coastal waters. Fresh water marshes, however, are sensitive to salinity levels, but the varying levels of salinity have positive impacts on various commercial and recreational fisheries. On balance, the stabilization of salinities, or the relocation of saltier water zones gulfward, would help to achieve the goals of the proposed project. The collective effect on water quality of the Terrebonne Basin resulting from this project would be a synergistic positive result

over and above the additive combination of impacts and benefits of the other alternatives.

(6) Actions Taken to Minimize Impacts.

The future quality of Louisiana's coastal waters depends on a responsible, watershed approach to managing these activities. There are a number of present and future activities that would continue to occur without the proposed actions of the project and would affect surface water quality conditions in the coastal plain of Louisiana. Although there are Federal, state and local regulations in place to ensure protection of Louisiana's public health and natural resources, water quality conditions would likely improve with the programs in place. There are also Federal, state, local, and private ecosystem restoration projects being studied and undertaken to improve water quality conditions within the LCA.

However, there are some activities that may potentially have negative effects on water quality and will continue to occur with or without the proposed project.

- Industrial, commercial, and residential development along the coast. With this activity comes increased point and nonpoint source pollution from sources such as wastewater treatment facilities and urban runoff from new development. Also, activities associated with maintaining and improving navigation along the coast would continue to occur.

- Flood–damage reduction projects would continue to be planned, designed, and constructed especially in areas highly susceptible to flood damages due to hurricanes and tropical storm events. With these activities, more alterations to the hydrology of the coast would potentially occur leading to areas of degraded water quality. Some projects, such as the Morganza to the Gulf Hurricane Protection Project, are incorporating resource sustainable design techniques that may aid in protecting significant resources such as surface waters of the state.

- The most notable activity that would continue to occur without the proposed LCA Plan is the ongoing erosion/subsidence or land loss of the coastal areas. This would continue to unearth the expansive oil and gas infrastructure along the coast of Louisiana. This would be a precarious situation, especially during storm events and within navigable waterways. Exposed pipelines are vulnerable to navigation vessels striking them, which could lead to discharges into the Gulf of Mexico as well as other coastal water bodies. In the event of discharges, extensive ecological damage would probably occur. The owner(s) of the infrastructure could incur expensive fines and cleanup costs and vessel operators could be seriously injured. There are other forms of infrastructure that could potentially be exposed due to coastal erosion including wastewater collection systems and other commercial industry related systems.

Therefore, there are no unavoidable adverse impacts as a result of the implementation of reasonable alternatives for this project. Where possible,

dredge channels excavated for increased fresh water conveyance will utilize currently existing canals, which will reduce the length of newly constructed linear channel needed for the project and minimize adverse impacts to wetlands associated with channel excavation.

Potential impacts associated with surface alteration sites would be minimized, as much as practicable, through the implementation of SWPPPs and other applicable BMPs. Impacts associated with soil compaction, rutting, rill, and gully erosion at surface alteration construction sites would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, and regrading and permanent vegetation establishment at the end of construction. The occurrence of low dissolved oxygen conditions in the proposed project area waters would be temporary and minor.

C. Suspended Particulate / Turbidity Determinations.

(1) Alteration of Suspended Particulate Type and Concentration.

The lack of marsh forming sediments from riverine environments has accelerated the degradation of all marsh types. Opportunities exist to re-introduce sediments from the Atchafalaya River and several bayous and to use on site sediments displaced by gulf storm events to create new marsh area. Suspended sediment loads are expected to increase within the project area as part of the design. However, suspended particulate concentrations were not analyzed as part of the study. Historically, the Atchafalaya River and Bayou Lafourche were sources of sediment to the project area. Sediments from these waters would be delivered throughout the project area during annual floods through systems of distributary channels and through overland flow.

Short-term direct impacts associated with construction of features could include increased total suspended solids and turbidity. These impacts would be minimized, as much as practicable, through implementation of appropriate Best Management Practices. Any increases in suspended solids and turbidity levels due to dredging related activities in the immediate project area would be minor, temporary, and highly localized.

(2) Particulate Plumes Associated with Discharge.

Any minor increases in suspended sediment and turbidity levels during dredge disposal would be temporary and highly localized. Minor reductions in dissolved oxygen levels associated with dredged material deposition would be temporary. Potential impacts associated with surface alteration sites would be minimized, as much as practicable, through the implementation of stormwater pollution prevention plans (SWPPPs) and other applicable best management practices (BMPs). Impacts associated with soil compaction, rutting, rill, and gully erosion at surface alteration construction sites would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, and regrading and permanent vegetation establishment at the end of construction.

(3) Changes to Environmental Quality and Value.
Based on data from Gulf of Mexico gages, regional sea level rise is approximately 0.75 feet/century and based on gages at Grand Isle and Eugene Island, subsidence in the project area is approximately 2.35 feet/century. This resource is technically significant because it is a critical element of coastal habitats, and supports vegetation growth and open-water benthic productivity.

By increasing suspended sediment loads to receiving areas, the southeast portions of the Penchant basin would receive additional suspended sediment loads due to feature WD2. Northern Boudreaux Basin would receive suspended sediments brought through the GIWW to the HNC. Theses sediments would be distributed throughout the Boudreaux Basin. An increased amount of suspended sediment would reach the Grand Bayou basin. These sediments would be distributed to the marshes east of Grand Bayou with a much smaller portion exiting the basin through Cutoff Canal due to feature EP7. Operations of the HNC lock would increase suspended sediments to the marshes between the HNC and Bayou Du Large. This activity decreases marsh fragmentation and increases overall marsh acreage while improving fish and wildlife habitat and productivity.

(4) Actions to Minimize Impacts.
Construction operations are expected to temporarily increase the concentration of suspended particulates. Particulates suspended during project construction would dissipate after construction activities are complete. Temporary increases in suspended particulates, will be minimized as much as possible through BMPs such as creating containment berms, use of silt fencing, silt curtains, and seeding, to prevent the unnecessary transport of sediments within the construction and placement areas.

D. Contaminant Determinations.

As reported in the Phase I ESA, during records research and site reconnaissance it was determined that areas adjacent to some of the project features contained Few Recognized Environmental Conditions (REC's) that presented a low to moderate risk of affecting potential project features, albeit that no REC's were noted within direct proximity of land associated with any of the potential project features. Should at anytime during the project HTRW concerns arise, the CEMVN would take immediate actions to investigate the concerns. Should an HTRW issue be determined and the development of a response action required, CEMVN would coordinate with the appropriate Federal and state authorities to implement an approved response action.

Consistent with ER 1165-2-132, an HTRW investigation of the project area was conducted. Based upon findings from this investigation, the potential for direct impacts to the project area from implementation of the proposed action would be low and would likely continue to be low into the future.

The mobilization of existing contaminants in sediments into the project area may suspend some pollutants, which include primarily trace metals and hydrophobic organic compounds from the Atchafalaya and Mississippi Rivers' streambed sediments. However, these contaminants are not expected to occur in such quantities that they would impair water quality or be harmful to humans, fish, or wildlife.

E. Aquatic Ecosystem and Organism Determinations.

(1) Effects on Plankton.

Increases in freshwater flows and associated nutrients from proposed features would be expected to change plankton abundance and species composition. Changes in plankton species assemblages would likely be similar to what is observed along present day estuarine salinity gradients except that increased freshwater flows would shift the plankton community, displacing marine species in favor of fresher and more estuarine, euryhaline species. During actual construction activities of project features there would only be short-term minor adverse impacts to plankton populations due to increases in turbidity, low dissolved oxygen, and introduction of dredged sediments into shallow open water areas. There would be long-term loss of shallow water habitats due to dredge disposal activities. However, there is an abundance of shallow open water habitat available for use by plankton. Indirect impacts to plankton resources would primarily be related to increases in the export of dissolved organic compounds and detritus from enhanced marsh habitats that would benefit local plankton populations by increasing the planktonic food web. It is unknown whether proposed diversion flows and associated nutrients would result in noxious blooms of blue-green algae, but there is likely some upper limit to the assimilation of nutrients into estuarine waters, beyond which blooms would occur.

(2) Effects on Benthos.

Smothering of non-mobile benthic organisms could occur. These impacts would be minimized, as much as practicable, through implementation of appropriate Best Management Practices. Construction of proposed features and dredging activities would destroy existing benthic communities at the proposed construction sites. In addition, introduction of additional freshwater into estuarine systems could have short-term impacts on benthic populations in receiving waters. Introduction of freshwater flows from proposed features would be expected to change benthic abundance, species composition, and species distribution. Changes in benthic species assemblages would likely be similar to what is observed along present day estuarine salinity gradients except that increased freshwater flows would shift the benthic community, displacing marine species in favor of fresher and more estuarine, euryhaline species.

Species richness of benthic communities is usually greater in higher salinity waters (Day et al. 1989*)*. Decreases in salinity would likely reduce benthic species richness as greater volumes of freshwater are pushed deeper into estuarine basins.

(3) Effects on Nekton.

Nekton comprise animals largely from three clades; vertebrates, mollusks, and crustaceans. Direct impacts to nekton from implementation of the proposed action would result from construction of project features. Impacts from construction of water control structures may include direct mortality due to burial or sudden salinity changes; injury or mortality due to increased turbidity (e.g. gill abrasion, clogging of feeding apparatus); modified behavior, and short-term displacement. Dredging and placement of borrow material associated with dredge features, terracing, and marsh creation would negatively impact benthic organisms and benthic feeders in dredge channels and disposal areas. Sessile and slow-moving aquatic invertebrates would be disturbed by the dredge or excavation activity or buried by the placed material. Construction activities would temporarily increase turbidity, temperatures, and biological oxygen demand (BOD), and decrease dissolved oxygen. These temporary conditions would likely displace more mobile nekton from the construction area. Following construction, displaced nekton would likely return to the project area.

Direct impacts to nekton would also result from changes in salinity levels in the project area as a result of water control structures. Areas projected to experience the greatest increases in salinity are generally in the vicinity of the future location of the HNC lock complex. These changes in salinities may change the distribution of fish and shellfish species based on their salinity tolerance. In areas freshened by water control structures, species assemblages would be expected to shift toward the Gulf. Less freshwater tolerant species, such as brown shrimp and spotted seatrout, may be displaced from freshened areas. Species such as Gulf menhaden, blue crab, white shrimp, and red drum that commonly utilize low to medium salinity areas and SAV habitats would likely benefit. Freshwater fishery species, such as crawfish, catfish, largemouth bass, and other sunfish should benefit from implementation of the TSP. Conversely, in areas that see an increase in salinities, more saltwater-tolerant species such as brown shrimp and spotted seatrout would move further into area estuaries. For oysters, changes in salinities outside of their optimum range (5-15ppt) could increase mortality, affect reproduction, and affect spat settlement. Likewise, in areas that are currently too fresh or too saline to support healthy oyster populations, changes in salinity due to project implementation could provide new areas for oyster production.

Indirect benefits to nekton should result from increased productivity, land building, and acreage of marsh and submerged aquatic vegetation habitats that are supportive of freshwater, estuarine, and marine fishery species. Subsidence and predicted sea level rise would be less likely to increase open water habitats. The ARTM project is designed to prevent or slow the loss of marsh habitat in the project area and generally improve conditions for SAV and other highly productive forms of essential fish habitat. Inflows of fresh water and nutrients are expected to create and maintain wetlands, which provide food and cover to juvenile fish, shrimp, crabs, oysters, and other biota. As a result, the project area would be expected to better maintain most of its current ability to support nekton as well as those that are estuarine-dependent. Potential increases in submerged

aquatic vegetation will increase the habitat required for juveniles to escape predation.

(4) Effects on the Aquatic Food Web.

Louisiana's coastal wetlands are the richest estuaries in the country for fisheries production. Commercially and recreationally important species such as brown and white shrimp, blue crabs, eastern oysters, and menhaden are abundant. Louisiana has historically been an important contributor to the Nation's domestic fish and shellfish production, and is one of the primary contributors to the Nation's food supply for protein. While Louisiana has long been the Nation's largest shrimp and menhaden producer, it has also recently become the leading producer of blue crabs and oysters.

Phytoplankton are the primary producers of the water column, and form the base of the estuarine food web. Zooplankton provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989). Although direct impacts will occur through implementation of project features, it is the indirect project impacts to plankton resources that demands attention. Indirect impacts would primarily contribute to increases in the export of dissolved organic compounds and detritus from enhanced marsh habitats that would benefit local plankton populations by increasing the planktonic food web. This resource is technically significant because plankton provide a major, direct food source for animals in the water column and in the sediments.

The associated project features will provide inflows of fresh water and nutrients which are expected to create and maintain wetlands. The wetlands will in turn provide food and cover to juvenile fish, shrimp, crabs, oysters, and other biota. As a result, the project area would be expected to better maintain most of its current ability to support Gulf of Mexico Fishery Management Council (Council-managed) species (such as white shrimp, brown shrimp, and red drum), as well as the estuarine-dependent species (such as spotted seatrout, gulf menhaden, striped mullet, and blue crab) that are preyed upon by other Council-managed species (such as mackerels, red drum, snappers, and groupers) and highly migratory species (such as billfish and sharks). Marsh habitats protected by the proposed action would serve as important and essential transitional wetland habitats used by fishery resources for spawning, foraging, cover, nursery, and other life requirements. In summary, the proposed action would have positive synergistic effects at all levels of the aquatic food web.

(5) Effects on Threatened and Endangered Species.

The No Action Alternative would result in the continued degradation and loss of important and essential fish and wildlife habitats used by many different fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. The loss and deterioration of transitional wetland habitats would continue to impact, to some undetermined degree, all listed species that potentially utilize the project area including: West Indian manatee, piping plover,

pallid sturgeon, Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle.

Continued coastal land loss and deterioration of critical coastal habitats is anticipated to impact all listed species that utilize them. This alternative would have positive synergistic effects on listed species when combined with other Federal, state, local, and private restoration efforts. The proposed action is not likely to adversely affect any threatened or endangered species or any designated critical habitat in the project area. It is unlikely that any of the features associated with implementation of proposed action would present significantly adverse indirect impacts to any threatened or endangered species or critical habitat. On the contrary, all restoration features would likely provide a net increase of coastal wetland habitats potentially used by these species.

(6) Effects on Other Wildlife.

Direct adverse impacts to wildlife resources would primarily result from construction activities associated with the various features of the proposed action. Some wildlife species could be temporarily displaced from an area as disturbance from construction activities could result in unfavorable conditions for nesting, foraging, and/or other activities. However, most species would move to an area with more favorable conditions and return after construction is completed. Permanent displacement may occur with the construction of permanent project features. Any permanent displacement would be offset by the benefits associated with restoration.

In order to minimize any potential impacts to nesting bald eagles that may be found in the project area, project implementation would follow the National Bald Eagle Management Guidelines. The guidelines recommend:

- maintaining a specified distance between the activity and the nest (buffer area)
- maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and
- avoiding certain activities during the breeding season

In order to minimize any potential impacts to colonial nesting waterbirds that may be found in the project area, a qualified biologist would inspect the proposed work site for undocumented nesting colonies during the nesting season prior to construction. To minimize disturbance to colonial nesting waterbirds, the following restrictions on activity would be observed:

- for colonies containing nesting brown pelicans, all activity occurring within 2,000 feet of a rookery would be restricted to the non-nesting period (September 15 through March 31)
- for colonies containing nesting wading birds, anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery would be restricted to the non-nesting period (September 16 through April 1)

Indirect impacts to wildlife resources resulting from the proposed project would include the creation, restoration, and protection of wetland habitats utilized by species for nesting, rearing of young, resting, and foraging activities. An increase in wetland acreage and quality (compared to the Future Without-Project conditions) would provide nesting, brood-rearing, and foraging habitat for resident avian species. Migratory avian species would also benefit from the proposed project as important stopover habitat would be protected for neotropical migrants and wintering habitat would be created/protected for waterfowl. Game mammals and furbearers would also benefit from the protection of wetland types favored by the majority of those species. Reptiles and amphibians, which prefer fresher wetland types, would also benefit from the reduction in loss of wetland acres.

In summary, the project will reverse the current trend of 1,844 acres of wetland loss per year within the project area as a result ecosystem degradation. Land loss leads to increased competition between local wetland-dependent wildlife populations for decreasing resources; displacement to other more suitable wetland areas; and localized decline in wetland-dependent wildlife populations. The project will improve habitat and would lead to increased habitat for wetland-dependent wildlife; decreased competition for resources; and localized stabilization or improvement in wetland-dependent wildlife populations.

(7) Actions to Minimize Impacts.
Formulation of project plans and designs, evaluation of alternative plans, and development of operational scenarios for the preferred alternative, have all been conducted with the objective of minimizing potential negative impacts to the aquatic ecosystem. Study alternatives were developed in accordance with Corps planning guidance at ER 1105-2-100 which directs that ecosystem restoration projects be designed to avoid the need for compensatory fish and wildlife mitigation. Formulation of project alternatives was conducted in compliance with this guidance. Only Alternative 7 would result in a net loss of emergent marsh habitat and would, therefore, require mitigation. Alternative 7 was not selected as the National Ecosystem Restoration plan or the Tentatively Selected Plan.

F. Proposed Disposal Site Determinations.
Discussions pertaining to turbidity and suspended particulates are summarized under Section II. C in this document. Contaminants were discussed previously under Section II. D of this Evaluation. Implementation of the proposed project will have no significant adverse effects on municipal or private water supplies; recreational or commercial fisheries; water related recreation or aesthetics; parks; national monuments; or other similar preserves. Any adverse impacts will be minor and of short-term duration. An application for State water quality certification under Section 401 of the Clean Water Act is being submitted to the Louisiana Department of Environmental Quality.

G. Determination of Cumulative Effects on the Aquatic Ecosystem.

Cumulative effects on the coastal ecosystem would primarily be related to the incremental impact of all past, present, and future actions affecting water quality within the Basin such as: increase in fresh water areas; stabilization or decrease in salinities; increase in sediment introduction to the coastal zone, with accompanying minor increases in trace metals associated with bed sediments; increased total suspended sediments; increased turbidity; increased organic/nutrient enrichment of the water column; disturbance and release of possible contaminants; decrease in water temperatures along with fewer water temperature fluctuations; and increased dissolved oxygen levels. Likewise, there are no adverse alterations or destructions of unique or valuable habitats, critical habitat for endangered species, important wildlife or fishery breeding or nursery areas, designated wildlife management or sanctuary areas, or forestlands. No adverse cumulative or secondary impacts to the biological productivity of wetland ecosystems are anticipated. Adverse disruptions of coastal wildlife and fishery migratory patterns are not anticipated.

The TSP would have positive synergistic effects on the aquatic environment and the vegetation and wildlife it supports particularly when this project is anticipated to function in combination with other Federal, state, local, and private restoration efforts. A net total of 9,655 acres of wetlands would be protected, created, and nourished as part of this project.

H. Determination of Secondary Effects on the Aquatic Ecosystem.

The ARTM project is designed to prevent or slow the loss of marsh habitat in the project area. This objective will be accomplished by re-introducing fresh water supplies which balances the altered salinity regime, improves the viability of fresh water marsh plant life and restores fish and wildlife habitats. These project features will change marsh health, stratification and mixing patterns, flow patterns, and increase sediment distribution through a much of the project area. These features could have a minor effect on tidal flows which affects salinities within the project area but these activities are not expected to contribute to degradation of the coastal marshes. Rather, the ecosystems response to freshwater inputs and associated increased sediment and nutrient inputs, would increase plant productivity and vertical accretion of organic soils, increase diversity of natural vegetative communities, and reduce vulnerability to invasive species threats. Indirect benefits to fish and wildlife would result from increased productivity, land building, and acreage of marsh and submerged aquatic vegetation habitats.

Therefore, the project features associated with implementation of the preferred alternative would not result in significantly adverse indirect impacts to water quality, threatened or endangered species, essential fish habitat, water bottoms, plankton, vegetation, wildlife, or fisheries.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

A. No significant adaptations of the guidelines were made relative to this evaluation

B. No practicable alternatives to the proposed discharges could be identified that would have less adverse impacts on the aquatic ecosystem.

C. Chemical constituents of the dredged material released during dredging and disposal operations are not expected to exceed LA Water Quality Standards.

D. The proposed action is compliant with the Endangered Species Act of 1973, as amended. The proposed action would not significantly affect endangered or threatened species or their critical habitats.

E. The proposed action is compliant with specified protection measures for marine sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972. All disposal sites and effects are inland waters. No effects would occur in ocean waters beyond the shoreline of the Gulf of Mexico.

F. Evaluation of Extent of Degradation of the Waters of the United States.

(1) Effects on Human Health and Welfare

a. Municipal and Private Water Supplies.

Implementation of this TSP is not anticipated to have any direct impacts to drinking water supply or agricultural water use. The additional flow into the southeastern Penchant, Lake Boudreaux, and Grand Bayou basins would work to slow salt water intrusion in these areas. Slowed marsh loss would delay the intrusion of salt water to populated portions of the project area. Decreased flow through the GIWW at Larose could increase the intrusion of salt water in Bayou Lafourche. This could result in the loss of agricultural water use in Bayou Lafourche south of Larose; however this is the outcome of the No Action Alternative.

b. Recreational and Commercial Fisheries.

Direct impacts to commercial fisheries from implementation of the TSP would primarily be related to reduced or impeded access to fishing areas. Feature WP1 would block access to a small area of saline marsh near Lake Mechant. The modified operation of the HNC lock complex (CL1) would block vessel movement in the HNC; however, other routes (e.g. Bayou Grand Caillou) would remain open. The plug in Robinson Canal would prevent vessel movement between Lake Boudreaux and Bayou Petit Caillou, limiting ingress and egress from the east to Boudreaux Canal. Feature WW2 would restrict movement of vessels with a draft greater than 12 feet. Feature EP7 would restrict movement of vessels with a draft greater than 5 feet.

Anticipated indirect impacts on commercial fisheries include affecting the location of target species. Changes in salinity levels in the project area as a result of project features would change the distribution of fish and shellfish species based on their salinity tolerance. Changes in fisheries distribution would impact commercial fishing patterns and locations. However, the project is expected to benefit commercial fisheries by decreasing the rate of marsh loss in the project area as compared to the No Action Alternative.

The Penchant marshes (west subunit) contain high quality floating marsh habitat providing prime freshwater based recreational bass fishing. Potential positive effects of redistributing freshwater flows include marsh nourishment around the Penchant basin marshes and pushing freshwater further south and east to nourish and stabilize deteriorating fresh, intermediate and brackish marsh in the east and south portions of the west subunit. Periods of high Atchafalaya River would likely result in temporary increases in turbidity, which may temporarily reduce recreational fishing success.

In the Central subunit the potential impacts from the installation of flow management features and associated redistribution of freshwater would be similar to those effects in the West region. Freshwater flows are expected to result in some reduction in salinity levels, and help to stabilize fresh, intermediate, and brackish marsh in and around Lake Boudreaux and the Central region. Therefore, freshwater based recreational fishing should improve and current levels of recreational saltwater fishing would possibly be maintained.

Improved freshwater flow measures in the east subunit would have similar effects to recreational and commercial fisheries as described for the Central region. In particular, recreational fishing and shrimping at Pointe Au Chien Wildlife Management Area would benefit as additional freshwater from the improved flow measures would improve habitat for all of these species.

c. Plankton.

Project related activities will increase freshwater flows and associated nutrients is expected to change plankton abundance and species composition. Changes in plankton species assemblages would likely be similar to what is observed along present day estuarine salinity gradients except that increased freshwater flows would shift the plankton community, displacing marine species in favor of fresher and more estuarine, euryhaline species. Therefore, the anticipated increase and preservation of marsh habitats will benefit local plankton populations by increasing the planktonic food web.

d. Fish.

The project area supports one of the most productive fisheries in the Nation. However, wetland habitat losses would decrease the productivity of Louisiana's coastal fisheries. The commercial fishing industry would suffer significant losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species erode. Job losses would occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch. Thus, changes

in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast. Declines in fishery productivity are expected to be reduced in these areas through project implementation, and the long-term sustainability of a productive fishery would be more likely than with No Action.

e. Shellfish.

Although the conversion of marsh into open water will likely provide temporary new oyster habitat, the quality of this habitat is expected to decrease as populations become stressed by increased saltwater intrusion, predation, and lack of adequate shelter resulting from marsh erosion. Once buffered by interior and barrier wetlands, oyster reefs will be exposed directly to the gulf as surrounding marshes erode. The band of intermediate salinity necessary for oyster production would likely narrow significantly leading to a net loss in oyster populations. Therefore, the seafood industry would suffer significant losses in employment as estuaries that are necessary to produce oysters, and other valuable species erode, resulting in job losses related to harvesting, processing, and shipping of the seafood. Thus, changes in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast. Implementation of the TSP is expected to benefit commercial harvest of oysters by decreasing the rate of marsh loss in the project area which assists in sustaining optimal habitat and areas of greatest productivity.

f. Wildlife.

The greatest threat to wildlife resources across the project area is the ongoing loss of coastal wetlands in the Terrebonne Basin. In the eastern Terrebonne Basin, most wildlife populations are expected to decline due to high land loss. Similarly, with less freshwater and intermediate marsh habitat, waterfowl hunting opportunities would likely decrease. Ridge habitat would also likely continue to decline, reducing opportunities for deer and other small game hunting.

Planned and on-going restoration measures along with the proposed project will likely be beneficial to the ecosystem and wildlife in numerous ways as habitat for various stages in the life-cycles are stabilized, protected, improved, and expanded. Marsh and ridge restoration will improve vegetation and habitat for birds and wildlife and will enhance opportunities for birding, hunting, and hiking. Stabilization and enhancement of fresh and intermediate marsh should enhance waterfowl hunting.

g. Special Aquatic Sites.

The study area includes the 4,212-acre Mandalay National Wildlife Refuge (NWR) which is an important stopping point for migratory birds. The habitat of

the NWR is mostly fresh marsh with access to the interior of the NWR limited to boat travel. The NWR is visited annually more than two thousand times. The most prominent recreational activities within the NWR include fishing and waterfowl hunting. Limited consumptive recreation uses include recreational crabbing, shrimping, and crawfishing. Natural ridges are also utilized for deer and small game hunting. Non-consumptive recreational activities attract far fewer participants and include wildlife observation, photography, and boating. The NWR also provides opportunities for environmental education and interpretation. The NWR is showing a slight increase in land area and no losses of aquatic habitat. No direct impacts to the NWR are anticipated from implementation of the proposed action.

The Louisiana coastal wetlands represent an ecosystem of national importance from an environmental standpoint. Subsidence, lack of sediment and nutrient deposition, erosion via tidal exchange, channelization, and saltwater intrusion have resulted in the loss of several thousand acres of solid, vegetated marsh. In general, the areas with the highest rates of land loss are the intermediate, brackish, and saline marshes in the southern and eastern sections of the study area. The swamp and fresh marsh habitats generally are exhibiting lower rates of land loss and in some cases land gain. For future without project condition determination, the current rate of land loss within each polygon was assumed to continue on a linear trend over the 50-year period of analysis. Over the entire study area, approximately 100,000 acres of marsh were projected to be lost between 2015 and 2065. Direct wetland impacts associated with the TSP would result in 148 acres of swamp, 343 acres of fresh marsh, 248 acres of intermediate marsh, and 182 acres of brackish marsh being directly converted to open water. The TSP would also result in 23 acres of swamp being converted to upland (levee). These direct impacts would be the result of dredge features WD2, CD1, CD3, CD6, ED2, ED3, ED6, and ED7 and levee features CLV1 and CLV2. The TSP would also create 257 acres of brackish marsh and 72 acres of saline marsh as a result of features CM2, CM3, CM4, CT1, CT2, CT3, CT6, CT7, CT8, EM1, and EM3. Implementation of the TSP would contribute to reducing regional rates of marsh soil loss by an estimated 9,655 acres over the 50-year period of analysis.

(2) Effects on Life Stages of Aquatic Life and Other Wildlife Dependent on Aquatic Ecosystems.

There are no long-term adverse effects associated with the discharge of fill on the life stages of aquatic life and other wildlife dependent on aquatic ecosystems within the project area. Impacts from dredging activities, disposals, and structural feature construction would be minimized, through the implementation of SWPPPs and other applicable BMPs. Impacts associated with soil compaction, rutting, rill, and gully erosion at construction sites would be kept to a minimum by use of proper construction techniques such as silt curtains, temporary vegetative cover during construction, and regrading and permanent vegetation establishment at the end of construction. Upon project completion, the features are anticipated to yield positive benefits to the aquatic environment as well as fish, wildlife, and plankton that depend upon coastal marshes for shelter, nesting, feeding, roosting, cover, nursery,

and other life requirements to sustain them and maintain their existence. Therefore, associated habitat to be created as part of the project will be beneficial to the life-cycles of plankton, fishes, shellfish, crustaceans, amphibians, reptiles, birds, and mammals.

(3) Effects on Aquatic Ecosystem Diversity, Productivity and Stability.

Construction of the TSP would result in short-term construction-related impacts within parts of the project area and would include some disturbance of fish and wildlife habitat. However, these impacts would be temporary and would occur only during construction, and are not expected to alter the long-term productivity of the natural environment.

The TSP would assist in the long-term productivity of the northern Terrebonne marshes ecological community by improving the water quantity, water quality, and nutrients delivered to area marshes as well as reduce negative impacts of Gulf storm events. This in turn would facilitate the growth and productivity of emergent marsh habitat. The TSP would also result in enhancing the long-term productivity of the natural communities throughout the region. These long-term beneficial effects of the TSP would outweigh the minimal and mitigable short-term impacts to the environment resulting primarily from project construction.

(4) Effects on Recreational, Aesthetic, and Economic Resources.

Continued wetland fragmentation and the eventual conversion to shallow open water habitat would likely have negative consequences on a variety of recreational resources in the project area. Beneficial impacts to recreational resources are expected to ultimately outweigh the negative, temporary impacts due to project construction. These projects will likely stabilize and potentially enhance recreational resources and associated economic activity well into the future. The ecosystem restoration benefits of the other ongoing and planned projects coupled with this alternative will maximize benefit to the recreational resource with increased habitat stabilization and enhancement for fish and wildlife resources.

The project features will not adversely affect aesthetics within the project area. Visual resources in the study area would be improved through the enhanced and stabilized marsh and stabilized natural ridges. In particular, the enhanced and stabilized marsh and stabilized natural ridges may be beneficial to Mandalay National Wildlife Refuge and Pointe au Chien Wildlife Management Area and along the Southern portions of the Wetlands Cultural Scenic Byway. Restored, enhanced and sustained marshes will increase opportunities for visual use which include wildlife observation, environmental interpretation, and cultural awareness.

Reducing the rate of land loss in the project area is expected to provide numerous benefits on economic resources. The economic resources and industry that would reap benefits from the project include agricultural lands used for timer production, commercial fishing and oyster industry, navigation industry, as well as oil, gas, and utility companies.

G. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem.

As stated in Section II. E. (7) of this evaluation, formulation of project plans and designs, evaluation of alternative plans, and development of operational scenarios for the TSP, have all been conducted with the objective of minimizing potential negative impacts to the aquatic ecosystem. Without further action, the project area would continue to lose approximately 2,500 acres of land per year, most of which is marsh. With continued deterioration of marshes, the area landward will be more prone to flood during storm surges and hurricanes. Additionally, the marshes of the study area represent an ecosystem of national importance from an environmental standpoint. Deterioration will continue unless preventative measures are taken. Therefore, there are no unavoidable adverse impacts as a result of the implementation of reasonable alternatives for this project. Placement of material excavated for construction of project features was designed in the context of beneficial use, to be used for marsh and ridge creation which will directly benefit habitat for wildlife and fish in the immediate vicinity of construction. Plans for operation of the diversion structures have been and will continue to be refined to maximize the beneficial effects of delivery of fresh water, sediment and nutrients to the project area while avoiding or minimizing potential negative consequences to freshwater, brackish, and saline marshes, swamps, bayous, lakes, and canals. The TSP will decrease the rate of decline of the wetlands to ensure their ability to provide geomorphic and hydrologic form and function for the 50-year period of analysis. Marsh habitat for essential fish and wildlife species will be sustained, mimicking as closely as possible conditions which occur naturally in the area.

IV. EVALUATION RESPONSIBILITY

A. Evaluation Prepared By: Shawn Sullivan

B. Evaluation Review By:

The proposed plan for the **Convey Atchafalaya River Water to Northern Terrebonne Marshes And Multipurpose Operation of Houma Navigation Lock, Lafourche, Terrebonne, St. Mary Parish, Louisiana,** which incorporates sites for dredging, excavation, disposal, and the placement of fill, complies with the requirement of guidelines, and includes appropriate and practicable methods to minimize adverse effects to the aquatic ecosystem.

Date: 10-6-10

for Joan M. Exnicios
Chief New Orleans Environmental Branch