Appendix J

SECTION 404(b)(1) EVALUATION REPORT

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CLEAN WATER ACT
SECTION 404 (b)(1) EVALUATION REPORT

DREDGED MATERIAL MANAGEMENT PLAN (DMMP)
FEDERAL NAVIGATION CHANNEL
CALCASIEU RIVER AND PASS
CALCASIEU AND CAMERON PARISHES, LOUISIANA

1.0 PROJECT DESCRIPTION

1.1 LOCATION

The proposed work would be performed in association with the Calcasieu River and Pass, Project, Calcasieu and Cameron Parishes, Louisiana (Figure J-1). This project is bounded on the north by Interstate 10 and on the south by the Gulf of Mexico; it reaches from Mile -32 of the Bar (Entrance) Channel in the Gulf of Mexico to River Mile 36.0 in Lake Charles, Louisiana. The project extends into the coastal marshes west of the ship channel and into Calcasieu Lake, east of the ship channel. Portions of Lake Charles, Prien Lake, Moss Lake, and Calcasieu Lake are present in the project area.

1.2 PURPOSE

The Calcasieu River and Pass, Louisiana, project does not have adequate dredged material disposal capacity needed to maintain the channel to authorized depths. Existing discharge sites are at or near capacity, and past maintenance deficiencies have resulted in substantial erosion of discharge facilities into adjacent water bodies. Other discharge sites have been lost to commercial development. Previous real estate agreements, which have enabled landowners to opt out of agreements for disposal, have resulted in some landowners rescinding permissions for their property to be used for the placement of dredged material. As a result, remaining discharge areas cannot accommodate the volume of dredged material needed to maintain the ship channel to project-authorized dimensions, and it has become necessary for CEMVN to reduce channel widths in some reaches.

Corps of Engineers Regulation (ER) 1105-2-100 requires U.S. Army Corps of Engineers Districts to prepare dredged material management plans (DMMP) for each federally authorized ship channel. Section 3-2 (b) (8) states:

> *Dredged material management planning for all Federal harbor projects is conducted by the Corps to ensure that maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, are economically warranted, and that sufficient confined discharge facilities are available for at least the next 20 years. These plans address dredging needs, discharge capabilities, capacities of discharge areas, environmental compliance requirements, potential for beneficial use of dredged material, and indicators of continued economic justification. The Dredged Material Management Plan shall be updated periodically to identify any potentially changed conditions.*

The purpose of the DMMP is for the U.S. Army Corps of Engineers, New Orleans District (CEMVN), to develop a plan for the placement of material dredged for the maintenance of the

Calcasieu Ship Channel. The actions and strategies set forth in the DMMP would provide for the management of materials dredged through operations and maintenance of the ship channel and berthing areas for a minimum period of 20 years while updating and redefining the base plan/federal standard for the project. Preparation of the DMMP would enable the CEMVN to comply with the requirement of ER 1105-2-100 to prepare a DMMP for each federally authorized navigation channel.

1.3 PROPOSED PROJECT

The proposed project includes the placement of dredged material from the Calcasieu Ship Channel into confined disposal facilities (CDFs). In addition, dredged material would be beneficially used for the restoration of subsided coastal marsh.   Figure J-1 is a map of the disposal sites. Table J-1 lists the placement areas by reach and mile section.

Confined Disposal Facilities. A CDF is an engineered structure for the containment of dredged material. CDFs are bound by confinement dikes or structures, thereby isolating the dredged material from its surrounding environment. The material is placed into the CDF either hydraulically or mechanically, where it is allowed to drain, dry, and consolidate. Effluent resulting from the settling of solids is discharged across weirs into adjacent waters of the U.S.

The proposed project includes the combination of CDFs 17 and 19 and the expansion of CDFs 17/19, D, and E into Calcasieu Lake to the approximate limits depicted in the 1976 Calcasieu River and Pass Environmental Impact Statement. Extending lakeward from these reconfigured CDFs, dredged material would be placed in Calcasieu Lake to the approximately 3-foot depth contour to create intertidal marsh. Rock would be placed along the toe of the newly constructed dikes of CDFs 17/19, 22, and 23 and at the eastern edge of the created marsh to reduce erosion from waves and currents.

Rock would be used to armor areas along the ship channel that have been shown to be susceptible to erosion from currents and ship passage. Rock would be placed along the left descending bank of the ship channel from the northern end of the foreshore dike (mile 15.6) to the proposed foreshore dike at CDF 17/19 (approximate mile 18). The Texaco Cut would remain open into Calcasieu Lake and would be armored on its north and south banks to reduce erosion resulting from boat traffic, waves, and wind-driven currents. On the right descending bank, rock armoring would be placed from approximate mile 16.5 to approximate mile18.7. See Figure J-2 (figure showing armoring areas).

Beneficial Use. A large portion of dredged material would be placed in beneficial use sites. The material would be used for the restoration of subsided and eroded coastal wetlands. All beneficial use placement areas included in this evaluation are currently available for use.

Operations for the placement of material for beneficial purposes would likely include the use of a hydraulic cutterhead pipeline dredge to remove shoal material from the ship channel during routine maintenance dredging events. Shoal material would be pumped via pipeline for confined, semi-confined, or unconfined placement within the beneficial use placement areas for shoreline stabilization, land reclamation, and marsh creation. Dredged material slurry would be discharged into shallow open water areas to an elevation conducive to the development of wetlands habitat following dewatering and compaction as determined by elevation surveys of the adjacent or nearby habitat type to be created. It is anticipated that the final result of this dredged material placement would be a combination of wetlands, mud flat, and shallow open water habitat within the placement site. Dredged material

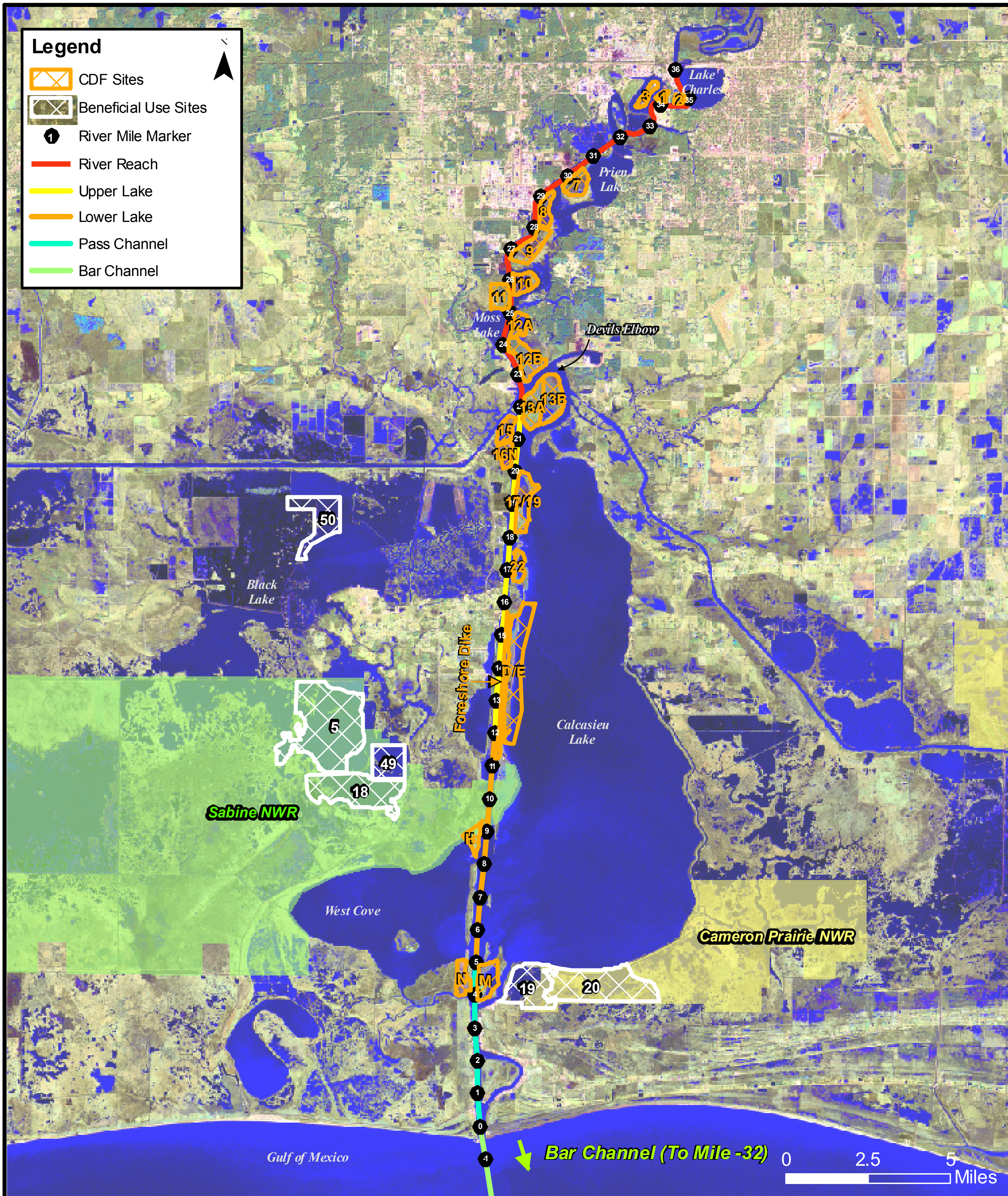

FIGURE J-1. DISPOSAL SITES

Calcasieu River and Pass, Louisiana
Dredged Material Management Plan

Landsat Thematic Mapper Satellite Image: 2002 RGB753-Pan merge, LDEQ (2002)

Date: December 2008
Scale: 1:260,000
Source: USGS/GEC/USACE
Map Author: Moore 27585101-765

Table J-1. Proposed Project

Reach	Section / River Mile	Placement Sites	Type	Quantity of Material Discharged for Beneficial Use (CY)	Quantity of Material Discharged for CDF Expansion (CY)
River	34 to 36, Coon Island, Port	1	CDF	0	0
		2	CDF	0	0
	30 to 34, Turning Basin, Clooney Isl. Loop	3	CDF	0	0
		7 (1/2)	CDF	0	0
	26 to 30	7 (1/2)	CDF	0	0
		8	CDF	0	0
		9	CDF	0	1,496,800
	22 to 26	10	CDF	0	774,400
		11	CDF	0	1,342,400
		12A	CDF	0	0
		12B	CDF	0	0
Upper Lake	21 to 22	15	CDF	0	0
		16 N	CDF	0	0
	Devil's Elbow	13	CDF	0	2,581,600
	12 to 16	17/19	CDF	0	1,936,500
		22	CDF	0	0
		Black Lake (50)	BU Site	7,219,750	0
		D	CDF	2,066,000	4,087,200
		E	CDF	2,066,000	4,087,200
		Sabine NWR (5)	BU Site	8,873,500	0
Lower Lake	9.5 to 12	Cameron Par. School Bd. (49)	BU Site	2,420,000	0
		Sabine NWR (18)	BU Site	9,276,500	0
	5 to 9.5	H	CDF	0	0
		M	CDF	0	0
		Cameron Prairie NWR (19)	BU Site	2,904,000	0
		Cameron Prairie NWR (20)	BU Site	1,165,600	0
Total				35,991,350	16,306,100

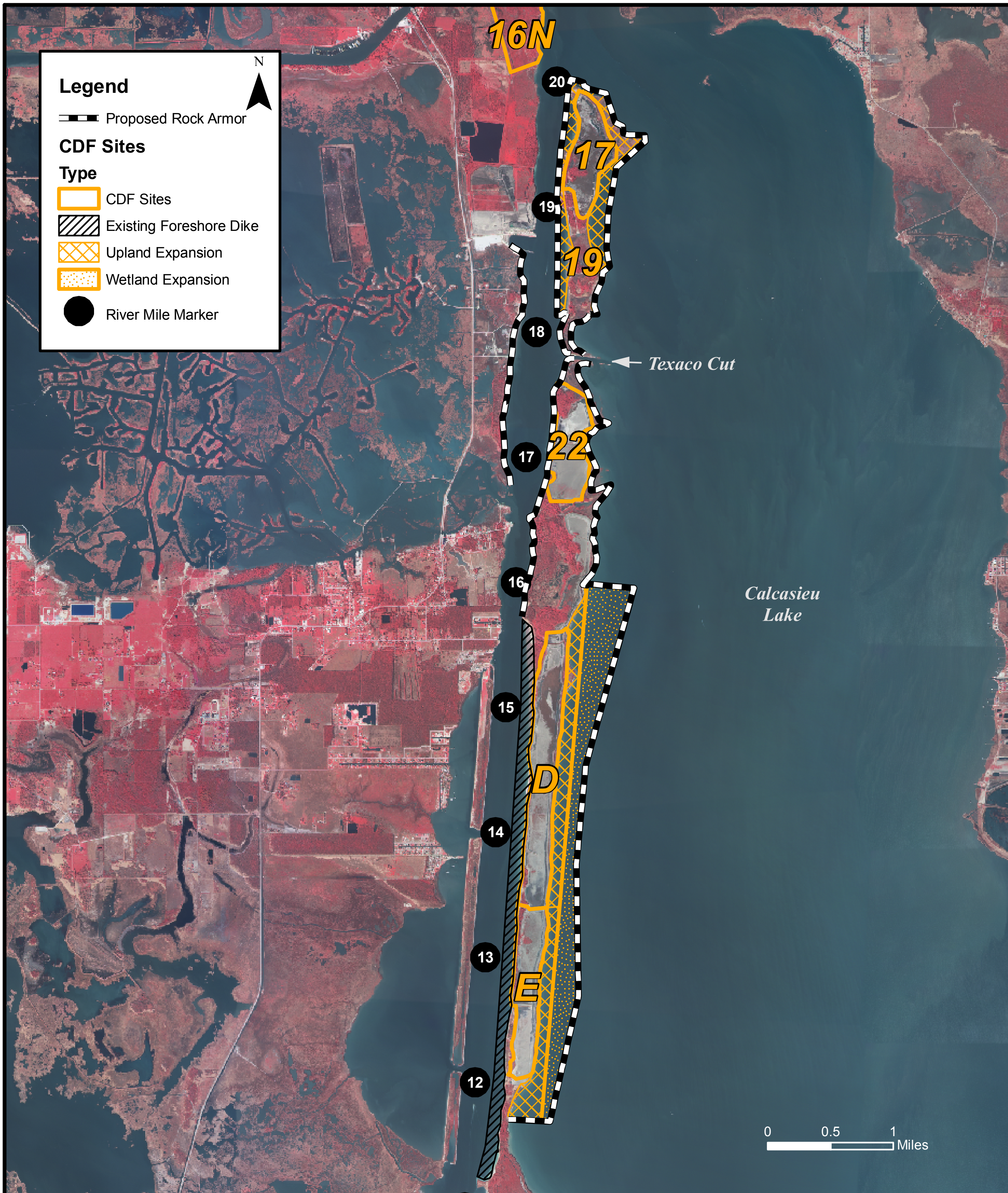

FIGURE J-2. ROCK ARMORING PLAN B

Calcasieu River and Pass, Louisiana
Dredged Material Management Plan

USGS DOQQ 2005 MOSS LAKE SW 3009362

Date: December 2008.
Scale:1:68,000
Source: USGS/GEC/USACE
Map Author: Moore 27585101-765

slurry would be allowed to overflow over existing emergent marsh vegetation within the proposed discharge areas, but would not be allowed to exceed the pumping height necessary to achieve the habitat elevation after dewatering and consolidation as determined through geotechnical investigations.

In conjunction with the discharge activities, retention dikes, deflection dikes, and/or closures may be required to prevent the flow of dredged material back into adjacent waterways and properties. Earth, rock, aggregate, shell, geotubes, sheetpile, hay bales or a combination of the above may be used for dike/closure construction or refurbishment. Interior low-level earthen weirs also may be constructed within discharge areas to facilitate the deposition of sediments in a manner that would enhance wetlands development. Borrow material for dike/closure/weir construction would be taken from within discharge areas. Earthen dikes/closures would be allowed to degrade naturally. If earthen dikes/closures do not sufficiently degrade to provide fisheries and tidal ingress/egress following appropriate settlement of dredged material placed within discharge areas, earthen dikes/closures would be mechanically breached and/or degraded as necessary.

In addition to dredged material containment features, elements that may be constructed in association with the placement of material for beneficial use include:

- <u>Access Corridors.</u> Construction access corridors from the ship channel to beneficial use sites would be a maximum of about 200 feet in width and would cross over uplands, wetlands, and shallow open water as necessary. Access corridors also may occur across or along the crown of existing levees in the project vicinity.
- <u>Flotation Access Corridors.</u> Channels would be excavated as needed in shallow open water areas to allow construction equipment to access sites. If necessary, flotation access channels would be excavated by a mechanical dredge to maximum dimensions of approximately 80 feet wide and 10 feet deep. Flotation access channel material would be used in dike/closure construction or refurbishment, to backfill flotation access channels, or would be placed adjacent to and behind the dikes and closures in shallow open water to an elevation conducive to wetlands development following consolidation of the material. Flotation access channel material used to backfill the flotation access channels following completion of discharge work would be temporarily stockpiled on water bottoms adjacent to the flotation access channels.

  If existing canals are used for access, they may be dredged to facilitate flotation of pipelines and other necessary equipment from the dredging site on the ship channel to pipeline discharge sites within the beneficial use sites. Dredged material removed from existing canals would be placed on adjacent levees and/or into shallow open water on either side of canals. Canal dredged material placed in shallow open water areas would be placed to a height conducive for natural wetlands development.

- <u>Containment Dikes</u>. Levees surrounding beneficial use sites may be degraded as necessary to provide access into the discharge site. If levees are degraded for construction access, they may be rebuilt following completion of discharge activities. Degraded levee material would be placed/stockpiled either in shallow open water adjacent to the degraded levee sections or on adjacent levees. Material degraded from levees may be used to rebuild degraded levee sections. If borrow material is required to rebuild degraded levee sections, borrow material would be excavated from adjacent shallow water. If levees are not to be rebuilt using material removed during levee degradation activities, any levee material that was placed in shallow open water would be degraded, if necessary, to a height conducive to wetlands development.

1.4 AUTHORITY

The River and Harbor Act of 24 July 1946, Document 190, 79th Congress, 2nd Session, and prior River and Harbor Acts provided for a channel 35 feet deep by 250 feet wide from the wharves of the Port of Lake Charles (including the loop around Clooney Island) to the Gulf of Mexico, via Calcasieu Lake and through Calcasieu Pass. This was supplemented by the following:

- The River and Harbor Act of 14 July 1960, House Document 436, 86th Congress, 2nd Session.
- The River and Harbor Act of 23 October 1962, House Document 582, 87th Congress, 2nd Session.
- Resolutions adopted by the Senate Public Works Committee on 27 December 1970 and the House Public Works Committee on 15 December 1970 approving the project at Devil's Elbow under the provisions of Section 201 of the Flood Control Act of 1965 (Public Law 89-298; S.D. 91-111).
- The Calcasieu River at Coon Island, Louisiana project authorized by the Secretary of the Army under Section 107 of the River and Harbor Act of 1960, as amended by Section 310 and Section 112 of the River and Harbor Acts of 1965 and 1970, respectively.

1.5 GENERAL DESCRIPTION OF DREDGED AND FILL MATERIAL

1.5.1 General Characteristics

a. Material Dredged from the Calcasieu Ship Channel. Fill material would be composed of material dredged during maintenance operations from the Calcasieu Ship Channel. Physical analyses were conducted on 35 individual sediment and soil samples collected during December 2006. Thirty-two samples were collected from mile five to mile 36 of the Calcasieu Ship Channel, and one sample was collected from the Calcasieu Lake Wetland Creation Reference Area, the Sabine National Wildlife Refuge (SNWR) Wetland Restoration Discharge/Reference Area. Samples were analyzed for specific gravity, moisture content, grain size and Atterberg Limits.

A summary of the results of the physical analyses is presented in Table J-2. Analytical results of samples collected within the reaches of the ship channel designated for a particular placement site were averaged to characterize the physical properties of the dredged material to be placed at that site. For example, the area into which CDF 9 is expanded would receive material from miles 26 to 30 of the ship channel; results of samples collected from mile 26 to 30 were averaged to characterize the material that would be placed in CDF 9.

Results of the physical analyses generally indicate a high percentage of clay and a high degree of plasticity throughout the sampled length of the channel. Upstream sediments generally have a higher moisture and organic content than downstream sediments.

b. Material Dredged to Create Access Channels. Material dredged to create access channels to CDFs would have the characteristics of the sampled material in the channel from which it is dredged.

Material dredged to create access channels to potential beneficial use sites in the SNWR and immediately north of the Sabine NWR on the west side of the ship channel is expected to have characteristics similar to the material sampled from the Sabine NWR Wetland Creation Reference Area (Table J-2). These sediments are similar to the majority of sampled channel sediments. Physical analyses indicate high moisture and clay content, high liquid limit and a high degree of plasticity.

Table J-2. Physical Analysis Summary

Placement Site	Source (River Mile)	Moisture Content %	Organic Soils %	Liquid Limit	Plasticity Index	Plastic Limit	Specific Gravity	Sand %	Silt %	Clay %
Beneficial Use Sites										
5	12-16	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
18	9.5-12	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
19	5-9.5	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
20	5-9.5	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
49	9.5-12	61.3	5.6	49.5	27.0	23.0	2.5	19.4	36.7	43.9
50	16-21	126.2	3.5	63.4	31.4	33.0	2.7	11.6	35.5	52.9
Expanded Confined Disposal Facilities										
17	16-21	126.2	3.5	63.4	31.4	33.0	2.7	11.6	35.5	52.9
19	16-21	126.2	3.5	63.4	31.4	33.0	2.7	11.6	35.5	52.9
D	12-16	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
E	12-16	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
Calcasieu Lake Wetland Creation Site	12-16	89.3	2.6	48.0	32.6	20.8	2.7	29.0	32.1	38.9
Calcasieu Lake Reference Area	--	66.8	1.0	47.0	27.0	20.0	2.7	36.1	31.0	32.9
SNWR Wetland Creation Reference Area	--	98.2	6.1	71.0	44.0	27.0	2.3	24.8	21.0	53.9

Source: GEC, 2007.

Material dredged to create access channels to the wetland creation site in Calcasieu Lake is expected to have characteristics similar to the material sampled from the Calcasieu Lake Wetland Creation Reference Area (Table J-2). These sediments have a slightly lower moisture and clay content and lower degree of plasticity than the majority of the sampled channel sediments. The reference sediments analyzed from Calcasieu Lake have nearly equal parts sand, silt, and clay, whereas the majority of channel sediments contain a higher percentage of clay.

c. Material Dredged to Create Containment at Beneficial Use Sites. Material dredged to create containment for potential beneficial use sites in the SNWR and immediately north of the Sabine NWR on the west side of the ship channel is expected to have characteristics similar to the material sampled from the Sabine NWR Wetland Creation Reference Area (Table J-2). These sediments are similar to the majority of sampled channel sediments. Physical analyses indicate high moisture and clay content, high liquid limit and a high degree of plasticity.

d. Rock for Armoring

Rock placed within Calcasieu Lake to provide armor for marsh created adjacent to CDFs D and E, and rock used to armor banks and dikes along the Calcasieu Ship Channel would be obtained from a commercial supplier and transported to the site. Although specifications for the rock would be determined during the development of plans and specifications for the project, it would be similar in nature to the existing quarry rock used for the foreshore dike along the eastern side of the ship channel.

1.5.2 Quantity of Material

a. Expanded Confined Disposal Facilities. Table J-3 lists the quantities of material estimated to be placed into CDF horizontal expansions into adjacent wetlands and open water over the 20-year life of the project.

Table J-3. Estimated Quantities of Material Placed in Expanded Confined Disposal Facilities

Facility	20-Year Gross Quantity (CY)
CDF 17/19	1,936,500
CDF D	4,087,200
CDF E	4,087,200
Foreshore Dike	8,390,000
Total:	24,696,100

b. Material Placed at Beneficial Use Sites. Table J-4 lists the quantities of material estimated to be placed at beneficial use sites over the 20-year life of the project.

c. Material Dredged to Create Access Channels. In areas of subsided marsh, access channels would be dredged as needed to provide access to beneficial use sites for pipelines transporting dredged material slurry and to provide access as necessary for the construction of containment for beneficial use sites. In Calcasieu Lake, access channels may be necessary for the expansion of CDFs 17, 19, D, and E and for the placement of rock for the armoring the toe of the dike of CDF 17/19 and the marsh creation site adjacent to the CDFs D and E.

Table J-4. Estimated Quantities of Material Placed at Beneficial Use Sites

Facility	20-Year Gross Quantity (CY)
Black Lake (50)	7,219,750
Sabine NWR (5)	8,873,500
Cameron Par. School Bd (49)	2,420,000
Sabine NWR (18)	9,276,500
CDF D Wetlands	2,066,000
CDF E Wetlands	2,066,000
Cameron Prairie NWR (19)	2,904,000
Cameron Prairie NWR (20)	1,165,600
Total:	35,991,350

- **Construction Access Corridors.** Construction access corridors from the ship channel to beneficial use sites would be a maximum of about 200 feet in width and would cross over uplands, wetlands, and shallow open water as necessary. Access corridors also may occur across or along the crown of existing levees in the project vicinity.
- **Flotation Access Corridors.** Channels would be excavated as needed in shallow open water areas to allow construction equipment to access sites. If necessary, flotation access channels would be excavated by a mechanical dredge to maximum dimensions of approximately 80 feet wide and 10 feet deep. If existing canals are used for access, they may be dredged to facilitate flotation of pipelines and other necessary equipment from the dredging site on the ship channel to pipeline discharge sites within the beneficial use sites.

Specific quantities would be determined at the time of development of plans and specifications for the sites.

d. Material Dredged to Create Containment at Beneficial Use Sites. Preliminary indications are that on the national wildlife refuges, containment would be provided around the entire area to be used during the life of the project. Dredged material would be pumped into the site and allowed to flow unrestricted across the site. For the remaining sites, it is anticipated that containment would be constructed to form cells to accommodate the dredged material for a particular dredging cycle. The quantity of material would be dependent on the sizes of the cells and, in turn, on such factors as the amount of material to be dredged from the channel during the dredging cycle. Estimates of material used for beneficial use containment would be determined during the development of plans and specifications. Following the establishment of intertidal marsh at a beneficial use site, the containment berm would either be allowed to degrade or would be actively degraded to facilitate its integration into intertidal marsh.

e. Rock for Armoring. An estimated 70,500 cubic yards of rock would be placed in Calcasieu Lake. Rock would be placed adjacent to the toe of the dike of CDFs 17/19, 22, and 23 to provide protection against wind-driven wave action. In addition, a rock dike would be constructed at approximately the 3-foot depth contour adjacent to the intertidal marsh creation site located lakeward of CDFs D and E to protect the new marsh from wave and current erosion.

Approximately 62,700 cubic yards of rock would be placed along the right descending bank of the ship channel from approximate mile 16.5 to approximate mile 18.7 to reduce bank erosion. On the left descending bank approximately 58,700 cubic yards of rock would be placed from mile 15.6 to approximate mile 18 to reduce erosion at CDFs 22 and 23.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. It is not possible at this time to estimate the volume of water that would be discharged across weirs at CDFs and beneficial use sites over the 20-year life of the project.

1.6 DESCRIPTION OF PROPOSED DISCHARGE SITES

1.6.1 Location and Size

a. Expanded Confined Disposal Facilities. With implementation of the proposed project, some of the dredged material would be placed in waters of the United States, in association with the expansion of CDFs. Acreages that would receive fill are listed in Table J-5.

b. Material Placed at Beneficial Use Sites. Dredged material would be placed in waters of the United States, for estuarine habitat enhancement. The areas of the beneficial use placement sites are listed in Table J-5.

Table J-5. Proposed Discharge Sites

Site No.	Location/Description	Site Size (Acres)
Upland Confined Discharge Sites		
CDF 17/19	Expansion of CDF into Calcasieu Lake	218
CDFs D, E	Expansion of CDF into Calcasieu Lake	293
Beneficial Use Sites		
5	West of the CWPPRA Cycle 1 Site, SNWR	3,083
18	Vicinity of Pond 1A, SNWR	1,572
19	Cameron Prairie NWR	1,026
20	Cameron Prairie NWR	1,867
49	Cameron Parish School Board Site	639
50	Black Lake	887
CDF D/E Wetlands	Wetland Creation in Calcasieu Lake	476

Sources: GEC and GBA.

c. Material Dredged to Create Access Channels.

- **Construction Access Corridors.** Construction access corridors would cross over uplands, wetlands, and shallow open water as necessary. Access corridors also may occur across or along the crown of existing levees in the project vicinity. Sizes of construction access corridors would be determined during the preparation of plans and specifications.

- **Flotation Access Corridors.** Channels would be excavated as needed in shallow open water areas to allow construction equipment to access sites. Flotation access channel material would be used in dike/closure construction or refurbishment, to backfill flotation access channels, or would be placed adjacent to and behind the dikes and closures in shallow open water to an elevation conducive to wetlands development following consolidation of the material. Flotation access channel material used to backfill the flotation access channels following completion of discharge work would be temporarily stockpiled on water bottoms adjacent to the flotation access channels. Sizes of flotation access corridors would be determined during the preparation of plans and specifications.

- **Existing Canals.** If existing canals are used for access, they may be dredged to facilitate flotation of pipelines and other necessary equipment from the dredging site on the ship channel to pipeline discharge sites within the beneficial use sites. Dredged material removed from existing canals would be placed on adjacent levees and/or into shallow open water on either side of canals. Canal dredged material placed in shallow open water areas would be placed to a height conducive for wetlands development. Canal dimensions would be determined during the preparation of plans and specifications.

d. Material Dredged to Create Containment at Beneficial Use Sites. Retention dikes, deflection dikes, and/or closures may be required to prevent the flow of dredged material into adjacent waterbodies and properties. Borrow material for dike/closure/weir construction would be taken from within discharge areas. Interior low-level earthen weirs also may be constructed within discharge areas to facilitate the deposition of sediments in a manner that would enhance wetlands development. Earthen dikes/closures would be allowed to degrade naturally. If earthen dikes/closures do not sufficiently degrade to provide fisheries and tidal ingress/egress following appropriate settlement of dredged material placed within discharge areas, earthen dikes/closures would be mechanically breached and/or degraded as necessary.

e. Rock for Armoring. Rock would be placed adjacent to placement sites on the western side of Calcasieu Lake to provide protection against wind-driven wave action. Rock would be placed adjacent to the toe of the dike of CDFs 17, 19, 22 and 23. In addition, a rock dike would be constructed in the lake at approximately the 3-foot depth contour adjacent to the intertidal marsh creation site located lakeward of CDFs D and E. The rock dike would be constructed prior to the upland expansion on the east side of CDFs D and E to prevent siltation of adjacent oyster grounds.

Rock would be placed along the right descending bank of the ship channel from approximate mile 16.5 to approximate mile 18.7 to reduce bank erosion. On the left descending bank rock would be placed from mile 16.5 to 18 to reduce erosion at CDFs 22 and 23.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Locations that would receive dredged material and from which effluent would be discharged following the settling of solids are presented in Figure J-1.

1.6.2 Type of Site/Habitat of Discharge Sites

a. Expanded Confined Disposal Facilities. Material dredged from the Calcasieu Ship Channel would be used to construct containment levees and expand CDFs 17, 19, D, and E into open water habitat of Calcasieu Lake.

b. Material Placed at Beneficial Use Sites. Adjacent to the expanded CDFs D and E, dredged material would be placed in open water of Calcasieu Lake to create wetlands extending eastward to the 3-foot bottom contour. Beneficial use areas 3, 5, 18, 19, 20, 49 and 50 are open water locations where former coastal marsh habitat has subsided and/or eroded.

c. Discharge Sites for Material Dredged to Create Access Channels. Access corridors from the ship channel to placement sites would cross over uplands, wetlands, and shallow open water sites/habitats as necessary.

d. Discharge Sites for Material Dredged to Create Containment at Beneficial Use Sites. Containment at beneficial use sites would be located in areas of subsided/eroded coastal marsh.

e. Rock for Armoring. A rock dike to provide protection to created wetlands would be placed in the open water of Calcasieu Lake at approximately the 3-foot depth contour. Rock would also be placed in Calcasieu Lake at the toe of the dike of CDFs 17, 19, 22, and 23.

Because the soft substrate along the right descending bank of the ship channel from approximate mile 16.5 to approximate mile 18.7 has been subject to erosion from vessel traffic rock armoring would be placed along this area. Rock would be placed along the left descending bank of the ship channel from the northern end of the foreshore dike (mile 15.6) to the proposed foreshore dike at Combined CDF 17/19 (approximate mile 18) to reduce erosion of the CDF dikes.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Effluent would be discharged from CDFs and beneficial use sites into the Calcasieu Ship Channel, Calcasieu Lake, and open water areas adjacent to the sites.

1.6.3 Timing and Duration of Discharge

a. **Expanded Confined Disposal Facilities.** Expansions of CDFs would occur at various times during the life of the project. Table J-6 presents the anticipated project year during which the expansion of each CDF would occur.

Table J-6. Timing of CDF Expansion

Site No.	Location/Description	Timing (Project Year)
CDFs 17, 19	Expansion of CDF into Calcasieu Lake	6
CDF D	Expansion of CDF into Calcasieu Lake	9
CDF E	Expansion of CDF into Calcasieu Lake	9

b. Material Placed at Beneficial Use Sites. Placement of material at beneficial use sites would occur during the project years shown in Table J-7.

Table J-7 Timing of Beneficial Use Site Construction

Site No.	Location/Description	Timing (Project Year)
5	West of the CWPPRA Cycle 1 Site, SNWR	0, 2, 5, 7
18	Vicinity of Pond 1A, SNWR	0, 6, 9, 12, 15, 18
19	Cameron Prairie NWR	6, 12
20	Cameron Prairie NWR	2
49	Cameron Parish School Board Site	3, 6, 9
50	West of Black Lake	0, 2, 5, 12, 17
CDF D/E Wetlands	Wetland Creation in Calcasieu Lake	9, 10*, 12*, 15*, 17*

Notes: For the creation of wetlands in Calcasieu Lake, construction would take place in year 9 of the DMMP, with pumping of dredged material to the site in the years indicated by asterisk (*).

c. Material Dredged to Create Access Channels. Access channels would be constructed as needed during construction of the placement site as shown in tables J-6 and J-7.

d. Material Dredged to Create Containment at Beneficial Use Sites. The construction of containment of beneficial use sites would take place as shown in Table J-7.

e. Rock for Armoring. Construction of the rock dike in Calcasieu Lake to protect the dikes of CDFs 17, 19, 22, and 23 would occur in year 6 of the DMMP, as shown in Table J-6. Rock for protecting intertidal marsh created in Calcasieu Lake would be placed in years 9 and 14 of the DMMP, as shown in Table J-7.

The placement of rock for armoring the CDFs and banks of the ship channel would take place during Project Years 6 through 8.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Supernatant would be discharged from CDFs and beneficial use sites annually throughout the life of the project.

1.7 DESCRIPTION OF DISCHARGE METHODS

a. Expanded Confined Disposal Facilities. Expansions of CDFs would be through the use of earthmoving equipment such as backhoes, dozers, and similar equipment.

b. Material Placed at Beneficial Use Sites. Dredging would be accomplished with cutterhead dredges, and material removed from the channel would be pumped as a slurry through pipelines to discharge sites.

c. Material Dredged to Create Access Channels. Channels would be excavated as needed in shallow open water areas to allow construction equipment to access sites. Construction would be accomplished through the use of barge-mounted suction dredges or other similar types of equipment. Access channel material would be used in dike/closure construction or refurbishment, to backfill flotation access channels, or it would be placed adjacent to and behind the dikes and closures in shallow open water to an elevation conducive to wetlands development following consolidation of the material. Flotation access channel material used to backfill the flotation access channels following completion of discharge work would be temporarily stockpiled on water bottoms adjacent to the flotation access channels.

If existing canals are used for access, they may be dredged to facilitate flotation of pipelines and other necessary equipment from the dredging site on the ship channel to pipeline discharge sites within the beneficial use sites. Dredged material removed from existing canals would be placed on adjacent levees and/or into shallow open water on either side of canals. Canal dredged material placed in shallow open water areas would be placed to a height conducive for wetlands development.

d. Material Dredged to Create Containment at Beneficial Use Sites. Low -level earthen dikes and weirs would be constructed to contain dredged material and facilitate the deposition of sediments in a manner that would enhance wetlands development. Construction would be accomplished through the use of barge-mounted backhoes or other similar types of equipment. Borrow material for dike/closure/weir construction would be taken from within discharge areas. Earthen dikes/closures would be allowed to degrade naturally. If earthen dikes/closures do not sufficiently degrade to provide tidal ingress/egress following appropriate settlement of dredged material placed within discharge areas, earthen dikes/closures would be mechanically breached and/or degraded as necessary.

e. Rock for Armoring. For the placement of rock within Calcasieu Lake, an access channel would be dredged to enable the rock to be transported to the construction site by means of barges. No access channels would be necessary for the placement of rock along the banks and CDFs of the ship channel. The rock would be offloaded from the barges and placed into position by barge-mounted draglines or similar mechanical means.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies.

2.0 FACTUAL DETERMINATIONS

2.1 PHYSICAL SUBSTRATE DETERMINATIONS

2.1.1 Substrate Elevation and Slope

a. Expanded Confined Disposal Facilities. CDFs 17, 19, D, and E would be expanded into Calcasieu Lake to the dimensions described in the 1976 Environmental Impact Statement. Following construction of the containment dikes and the pumping and consolidation of dredged material the resulting elevation would be the same as the adjacent CDF. The slopes of the containment dikes would range from 1 to 3 feet (1V:3H) to 1 to 4 feet (1V:34).

b. Material Placed at Beneficial Use Sites. The open water depth at beneficial use site and 50, located in the vicinity of Black Lake, is estimated to be approximately six to eight feet deep. The remaining beneficial use sites are estimated to be two feet deep. Following the placement of dredged material and its consolidation, the final elevations at all beneficial use sites would be conducive for wetland development, as determined by elevation surveys of the adjacent or nearby wetland habitat type to be created.

c. Material Dredged to Create Access Channels. Access channels would be dredged to depths required to enable access by construction equipment and pipelines. Material dredged to create access channels would likely be placed in shallow water adjacent to the channel. Locations and depths for the placement of material would be determined during the preparation of plans and specifications for the site to which access is needed.

d. Material Dredged to Create Containment at Beneficial Use Sites. Substrate material would be dredged to create earthen containment dikes at beneficial use sites. It is estimated that the water depth at beneficial use site 50 is approximately six to eight feet deep; water depths of the remaining beneficial use sites are estimated to be two to four feet deep.

e. Rock for Armoring. Rock used to armor CDF dikes and the banks of the ship channel would be placed at the interface between the dike and open water. It is anticipated that the depth would not be more than one to two feet deep. Rock for the armoring of the wetlands created in Calcasieu Lake would be placed at approximately the three-foot depth contour of the lake. Slopes of the rock dike would be determined during the preparation of plans and specifications.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies. Effluent discharge would not physically alter substrates in receiving waters.

2.1.2 Sediment Type

a. Expanded Confined Disposal Facilities. The use of dredged material from the ship channel for expansion of CDFs 17, 19, D, and E into Calcasieu Lake would change the characteristics of sediments (Table J-8). Dredged material placed into the CDFs is compared to a reference sample collected from a location in Calcasieu Lake minimally affected by dredged material. The dredged material has a higher clay content, a lower sand content, and a percentage of silt that approaches that of the reference sample. The organic content of the dredged material is higher than that of the reference sample; plasticity is slightly higher; and specific gravity is the same.

Table J-8. Sediment Physical Characteristics of Dredged Material for CDF Expansion

Site	Moisture Content %	Organic Soils %	Liquid Limit	Plasticity Index	Plastic Limit	Specific Gravity	Sand %	Silt %	Clay %
CDF 17	126.2	3.5	63.4	31.4	33.0	2.7	11.6	35.5	52.9
CDF 19	126.2	3.5	63.4	31.4	33.0	2.7	11.6	35.5	52.9
CDF D	107.7	3.8	61.5	34.5	27.0	2.7	12.2	40.2	47.7
CDF E	107.7	3.8	61.5	34.5	27.0	2.7	12.2	40.2	47.7
Lake Reference Area	66.8	1.0	47.0	27.0	20.0	2.7	36.1	31.0	32.9

b.   Material Placed at Beneficial Use Sites. Material dredged from the ship channel would be used for the restoration and creation of wetlands. Table J-9 presents the physical characteristics of dredged material from locations in the ship channel that would be placed in the appropriate beneficial use sites. For comparison, the table also provides the characteristics of a wetland reference area. As shown in the table, dredged material placed at the beneficial use sites would alter the sediment characteristics. Dredged material contains a higher percentage of silt, a lower percentage of sand, and an equivalent percentage of clay than is currently found in the reference sample. The wetland reference area has a higher organic content than the dredged material and similar plasticity and specific gravity.

Table J-9. Sediment Physical Characteristics of Dredged Material for Beneficial Use

Site	Moisture Content %	Organic Soils %	Liquid Limit	Plasticity Index	Plastic Limit	Specific Gravity	Sand %	Silt %	Clay %
Material Places at Beneficial Use Sites									
SNWR (5)	110.0	3.3	63.7	35.3	28.3	2.7	11.4	38.9	49.7
SNWR (18)	110.0	3.3	63.7	35.3	28.3	2.7	11.4	38.9	49.7
CPNWR (19)	110.0	3.3	63.7	35.3	28.3	2.7	11.4	38.9	49.7
CPNWR (20)	110.0	3.3	63.7	35.3	28.3	2.7	11.4	38.9	49.7
Cam Sch Bd (49)	110.0	3.3	63.7	35.3	28.3	2.7	11.4	38.9	49.7
Black Lake (50)	126.2	3.5	63.4	31.4	33.0	2.3	11.6	35.5	52.9
Wetland Reference Area	98.2	6.1	71.0	44.0	27.0	2.3	24.8	21.0	53.9
Material Placed in Calcasieu Lake for Wetland Creation									
Wetland Creation	120.1	3.4	63.5	32.9	31.3	2.7	11.5	36.8	51.7
Lake Reference Area	66.8	1.0	47.0	27.0	20.0	2.7	36.1	31.0	32.9

Dredged material placed into Calcasieu Lake to create wetlands would have a lower percentage of sand than currently exists in the lake, a higher percentage of clay, and a similar percentage of silt. The organic content of the dredged material is higher than the lake sediment; the plasticity is slightly higher; and the specific gravity is the same.

c. Material Dredged to Create Access Channels. Material discharged in association with the construction of access channels would be native material with the same physical characteristics as the material on which it would be placed.

d. Material Dredged to Create Containment at Beneficial Use Sites. Material discharged in association with the construction of low dikes for containment at beneficial use sites would be native material with the same physical characteristics as the material on which it would be placed.

e. Rock for Armoring. Rock placed in Calcasieu Lake to armor the wetland creation site adjacent to CDFs D and E and the rock used to armor the dikes along Calcasieu Lake would provide a markedly different substrate from the soft bottom sediments that occur naturally in the lake. Similarly, the rock placed along the banks and CDFs of the ship channel would provide a different substrate from the soft, erosive existing sediments.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into

Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies. Effluent discharge would not physically alter substrates in receiving waters.

2.1.3 Dredged and Fill Material Movement.

a. Expanded Confined Disposal Facilities. Dikes around expanded CDFs would be geotechnically engineered, constructed, and maintained in a manner to minimize erosion and movement of material placed in the expanded facilities. Rock would be placed adjacent to the toe of the dike of CDF 17/19 to reduce erosion from waves and currents in the lake. Therefore, little movement of fill material is expected.

b. Material Placed at Beneficial Use Sites. Earthen dikes constructed around beneficial use sites would be designed to contain dredged material until it has settled, consolidated, and become vegetated, where applicable. Rock would be used to armor the wetland creation site in Calcasieu Lake. Therefore, little movement of fill material is expected.

c. Material Dredged to Create Access Channels. Material dredged to create access channels would be generally unconfined. It may be stockpiled for later use in backfilling flotation access channels. Little movement of the material is anticipated.

d. Material Dredged to Create Containment at Beneficial Use Sites. Containment dikes at beneficial use sites, which would be constructed from adjacent native material, would be designed to degrade over time. Following the establishment of vegetation at a beneficial use site, the dike would either be allowed to degrade naturally or it would be degraded mechanically. While the degradation process involves some movement of the substrate, it is considered to be of minor consequence.

e. Rock for Armoring. Rock used to provide armor to wetlands extending into Calcasieu Lake, CDFs, and ship channel banks would be of sufficient size and density so as not to be subject to movement.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies. Effluent discharge would not physically alter substrates in receiving waters.

2.1.4 Physical Effects on Substrate.

a. Expanded Confined Disposal Facilities. Expansions of CDFs 17, 19, D, and E into Calcasieu Lake would bury the existing substrate with material dredged from the ship channel. Characteristics of the substrate at locations of expansion would be changed from wetland soils to upland soils.

b. Material Placed at Beneficial Use Sites. Placement of dredged material for the creation/restoration/enhancement of estuarine habitats would slightly alter the physical composition and characteristics of the substrate. As shown in Table J-9, material placed at beneficial use sites east of the ship channel would contain a higher percentage of silt, a lower percentage of sand, and an equivalent percentage of clay than is currently found in the existing area. In addition, the existing substrate has a higher organic content than the dredged material.

Dredged material placed into Calcasieu Lake to create wetlands would have a lower percentage of sand than currently exists in the lake, a higher percentage of clay, and a similar percentage of silt. The organic content of the dredged material is higher than the lake sediment; the plasticity is slightly higher; and the specific gravity is the same.

In addition to changes in the physical composition of the substrate, changes to the bottom contour and depth would result. For wetlands to become established, a much shallower substrate would be required. While the existing locations vary in depths of up to six to eight feet, the placement of material to facilitate the formation of intertidal marsh would subject the substrate to periodic exposure to air.

c. Material Dredged to Create Access Channels. The placement of material dredged to provide access channels would be composed of the same native material as the adjacent areas into which it would be placed. While substrate depths would be altered, the physical characteristics of the discharged material would be the same.

d. Material Dredged to Create Containment at Beneficial Use Sites.   Material dredged to construct low dikes at beneficial use sites would be composed of native material. While substrate depths would be altered, the physical characteristics of the discharged material would be the same as those on which it would be placed.

e. Rock for Armoring. Rock placed in Calcasieu Lake for armoring created marsh, as well as rock used for armoring CDFs and ship channel banks would physically alter the substrate by replacing a soft-bottom substrate with a hard substrate.

f.   Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies. Effluent discharge would not physically alter substrates in receiving waters.

2.1.5   Duration and Extent of Change.

a. Expanded Confined Disposal Facilities. Expansion of CDFs 17, 19, D, and E into Calcasieu Lake would change the characteristics of the substrate. The extent of change for each CDF is presented in Table J-10. Expansions of confined disposal facilities would result in substrate changes that would persist beyond the life of the project.

b. Material Placed at Beneficial Use Sites. Dredged material would be placed at beneficial use sites to improve aquatic and wetland habitats. The area of each beneficial use site is listed in Table J-10. The material is expected to subside over time, and at locations within beneficial use sites where vegetated wetlands become established, there would be a gradual conversion back to shallow open-water without periodic maintenance.

Table J-10. Duration and Extent of Change

Site No.	Site Size	Duration/Extent of Change
Upland Confined Discharge Site Expansions		
CDFs 17, 19	218 acres	Permanent Throughout Project Life
CDF D, E	293 acres	
Beneficial Use Sites		
SNWR (5)	3,083 acres	Gradual Subsidence Expected Throughout Project Life
SNWR (18)	2,498 acres	
CPNWR (19)	1,026 acres	
CPNWR (20)	1,867 acres	
Cameron Sch Bd (49)	639 acres	
Black Lake (50)	887 acres	
Wetland Creation in Calcasieu Lake	476 acres	
Dikes at BU Sites	Varies	Would be degraded actively or passively when marsh becomes established.
Rock for Armoring: Wetland Creation Site CDFs in Calcasieu Lake Ship Channel CDFs Ship Channel Bank	 19,701 linear feet 25,350 linear feet 24,487 linear feet 12,771 linear feet	Permanent Throughout Project Life
Access Channels	Varies	May be backfilled or allowed to silt in when no longer needed.

Note: Permanent indicates that no plans exist to restore the area to a pre-project condition, or project feature expected to be maintained throughout project life.
Sources: GEC and GBA.

c. Material Dredged to Create Access Channels. Channels would be excavated as needed in shallow open water areas, upland, and wetlands as necessary to provide access to sites. Construction access corridors from the ship channel to beneficial use sites would be a maximum of about 200 feet in width. Routes for construction access would be determined at the time of preparation of plans and specifications. If necessary, flotation access channels would be excavated to maximum dimensions of approximately 80 feet wide and 10 feet deep. Depending on the needs of the site and the access channel, material dredged to construct access corridors may be temporarily stockpiled adjacent to the access channel and used for backfill when the channel is no longer needed. Stockpiled material may not be available for other access channel sites, which would be allowed to deteriorate and/or silt in as appropriate when the channel is no longer needed.

d. Material Dredged to Create Containment at Beneficial Use Sites. Earthen dikes constructed at beneficial use sites would be allowed to degrade naturally upon the establishment of wetland vegetation. If earthen dikes/closures do not sufficiently degrade to provide for water circulation and ingress/egress of aquatic organisms, they would be mechanically breached and/or degraded as necessary.

e. Rock for Armoring. Approximately 50,700 linear feet of rock would be used for armoring the wetland creation site and dikes in Calcasieu Lake. Rock for armoring the right descending bank of the ship channel would extend a total of 12,771 linear feet, while rock would be placed along 24,487 linear feet of the left descending bank to armor CDF dikes. The stone is expected to gradually subside into the underlying sediments and may require periodic maintenance throughout the life of the project.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Material placed in CDFs and beneficial use sites would be retained to allow solids to settle; water levels and water quality would be managed with weir-boxes installed in the dikes. Effluent from the CDFs would be discharged across weirs into the Calcasieu Ship Channel or into Calcasieu Lake. Effluent from beneficial use sites would be discharged across weirs into adjacent water bodies. Effluent discharge would not physically alter substrates in receiving waters.

2.1.6 Actions Taken to Minimize Adverse Effects

Where possible, existing CDF footprints would be maintained, and expansions would be vertical; raised dikes would be designed to achieve an optimum slope to maintain stability and reduce erosion. Only where it is necessary to achieve the needed capacity would CDFs be expanded horizontally. As with vertical expansion, dikes would be designed and constructed to achieve an optimum slope to maintain stability and reduce erosion. Erosion would be further minimized through the establishment of vegetation on the dikes. Where the dikes would be exposed to erosive factors, such as waves, currents, and ship wakes, rock dikes would be constructed for protection of the dikes.

Management of the CDFs through ditching and draining of dredged materials would enable the settling out of solids prior to discharge. Dewatering would promote stabilization of the dredged material and reduce tendencies for erosion.

Earthen dikes would be constructed at beneficial use sites to confine the dredged material and prevent its release into adjacent areas. The confinement dike at the beneficial use site in Calcasieu Lake would be protected from wind and wave action by a rock dike. Beneficial use sites would be designed and operated to ensure that the maximum settlement of suspended solids is achieved within the confined area. Dikes around beneficial use sites would be allowed to degrade only after the site becomes stabilized.

2.2 WATER COLUMN DETERMINATIONS

2.2.1 Salinity

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its constituents, including salinity, would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Because beneficial use sites would initially be contained within diked areas, salinity variations associated with tidal cycles would be eliminated; salinity would be dependent on the water introduced with the slurry of dredged material from the ship channel. As vegetation becomes established and dikes are degraded and tidal access channels formed, salinity characteristics are expected to be the same as those of nearby natural wetlands.

c. Material Dredged to Create Access Channels. No effect on salinity.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its constituents, including salinity, would be eliminated at the site of the dike. Salinities outside the dikes are expected to remain unchanged, while salinities inside the dikes would depend on the characteristics of the dredged slurry from the ship channel. As dikes become degraded, salinity characteristics are expected to be the same as those of nearby natural wetlands.

e. Rock Used to Armor Placement Sites. No effect on salinity.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. The slurry of water and material dredged from the bottom of the ship channel may be more saline then receiving waters, depending on the position of the saltwater wedge in the channel. Temporary and localized increases in salinity may result as effluent is discharged into receiving waters adjacent to the disposal sites. Salinity would return to existing conditions as natural processes mix effluent with receiving waters.

2.2.2 Water Chemistry

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its constituents would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Water chemistry within beneficial use sites would initially be dependent on the water introduced with the slurry of dredged material from the ship channel. At locations within beneficial use sites where vegetation becomes established, as dikes are degraded and tidal access channels formed, water chemistry is expected to be the same as that of nearby natural wetlands.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is not anticipated to change the chemistry of the water column.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its chemistry would be eliminated at the site of the dike.

e. Rock for Armoring. The placement of rock to armor placement sites and channel banks is not anticipated to change the chemistry of the water column.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. A determinant for evaluating effects resulting from CDFs and beneficial use site effluent discharges is based on mixing zone modeling. The model used for mixing zone determinations was the CORMIX model. For mixing zones that would occur at the point of discharge from CDFs into the Ship Channel, both the riverine and tidal models were used. For discharge from CDFs to Calcasieu Lake, the tidal model was used. For the discharge of effluent from beneficial use sites into adjacent receiving waters such as Calcasieu Lake, the tidal model was also used.

For coastal lakes and bays, including the open waters of the project area, the Louisiana Department of Environmental Quality (LDEQ) requires that effluent is diluted to state water quality standards or approximate background levels within a 200-foot mixing zone extending outward from the dredged material disposal area. For tidal channels with flows greater than 100 cubic feet per second, such as the Calcasieu River, mixing zones may not exceed one third of the channel ambient flow. Considering an approximate width of 900 feet, an approximate depth of 42 feet, and a low tidal velocity of 0.79 feet per second, the regulatory mixing zone for the Calcasieu River would be approximately 9,944 feet. Predicted mixing zones required for sufficient dilution of analytes are not greater than 60 feet for Calcasieu Lake, 33 feet for Calcasieu River, and 39 feet for material placed for into eroded/subsided wetlands. The predicted mixing zones are well within LDEQ's regulatory mixing zones and the discharge of dredged material into the proposed area would have little effect on water quality in adjacent receiving waters. More detailed information regarding mixing zone modeling and dilution of detected analytes is provided in Addendum A.

2.2.3 Clarity

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its characteristics, including clarity, would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Beneficial use sites would initially be contained within diked areas. The slurry of dredged material from the ship channel would be virtually opaque at the point of discharge. However, as distance from the discharge point increases, clarity would increase. Following the completion of material placement, settling of solids, and consolidation of sediments, vegetation would become established. Dikes would then become degraded and tidal access channels would be formed, creating the condition where clarity would be the same as that of nearby natural wetlands.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels may cause temporary reductions in the clarity of the water column at the placement site. However, following construction, clarity would return to it pre-construction condition.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its characteristics, including clarity, would be eliminated at the site of the dike. The placement of material dredged to construct dikes is likely to result in temporary reductions in the clarity of the water column adjacent to the placement site. Following construction, clarity outside the dike would return to its pre-construction condition.

e. Rock for Armoring. The placement of rock to armor CDFs, channel banks, and wetland creation sites in Calcasieu Lake may cause temporary reductions in the clarity of the water column at the placement site. However, following construction, clarity would return to it pre-construction condition.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Dredged material pumped into CDFs and beneficial use sites would be retained to allow the settling of suspended materials. Discharges from these facilities are unlikely to affect the clarity of receiving waters.

2.2.4 Color

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its characteristics, including color, would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Because beneficial use sites would initially be contained within diked areas, characteristics of the water, including color, would be dependent on the water introduced with the slurry of dredged material from the ship channel. However, because of the presence of tidal, riverine, and wind-driven currents in the area, it appears unlikely that marked differences in the color exist between water of the ship channel and water in areas that have been designated to be beneficial use sites. As vegetation becomes established and dikes are degraded and tidal access channels formed, color is expected to be the same as that of nearby natural wetlands.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is not anticipated to change the color of the water.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of dredged material to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its characteristics, including color, would be eliminated at the site of the dike. Color outside the dike is likely to remain unchanged.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and wetland creation sites in Calcasieu Lake is not anticipated to affect the color of the water.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Because of the presence of tidal, riverine, and wind-driven currents, it appears unlikely that marked differences in color exist among the waters of the ship channel and the waters that would receive CDF and beneficial use site effluent. Therefore, it is expected that discharges from CDF and beneficial use sites would have little, if any, effect on the color of receiving waters.

2.2.5 Odor. No changes in odor are expected.

2.2.6 Taste. Not applicable.

2.2.7 Dissolved Gas Levels

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its constituents, including dissolved gases, would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Dredged material may contain low but variable concentrations of organic material. Decomposition of this organic material within the disposal areas following discharges may result in a temporary reduction in dissolved oxygen or release of ammonia. Management of dredged material during placement, including the use of a baffle plate at the end of the discharge pipeline, would introduce oxygen to the dredged material slurry and dissipate ammonia. Additional management strategies would be employed within the disposal areas, as needed, to further dissipate ammonia.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is not anticipated to change the dissolved gas levels of the water column.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its constituents, including dissolved gases, would be eliminated at the site of the dike.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and wetland creation sites in Calcasieu Lake is not anticipated to affect the concentrations of gases in the water column.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Effluent discharged from CDFs and beneficial use sites may contain low levels of dissolved oxygen. However, dissolved oxygen deficits are not expected to form as a result of effluent mixing with adjacent receiving waters.

2.2.8 Nutrients and Eutrophication

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its constituents, including nutrients, would be eliminated at the expansion site. Expansion of CDFs is not expected to introduce nutrients into adjacent waters.

b. Material Placed at Beneficial Use Sites. Dredged material may contain low but variable concentrations of organic material. Decomposition of organic material within the disposal areas following discharges of dredged material may result in a release of ammonia. Management strategies would be employed to assist in the transformation of ammonia into non-toxic nitrate. Nitrogen as either ammonia or nitrate may result in temporary increases in algal production within the disposal area. However, adverse or persistent algal blooms are not expected during project construction.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is likely to expose additional organic matter in sediments to the water column. Ammonia that may result from the decomposition of the exposed organic matter would enter the water column and become transformed to nitrate. While the nitrogen compounds can stimulate primary productivity, dispersal of the nutrients and the short time they would be available infer that marked increases in algal populations are unlikely.

d. Material Dredged to Create Containment at Beneficial Use Sites.   The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its constituents, including nutrients, would be eliminated at the site of the dike. Dike construction is not expected to introduce nutrients into adjacent waters.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and wetland creation sites in Calcasieu Lake would not affect the concentrations of nutrients in the water column.

f.   Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Dredged material may contain low but variable concentrations of organic material. Decomposition of organic material within the disposal areas following discharges of dredged material may result in a release of ammonia. Management strategies would be employed to assist in the transformation of ammonia into non-toxic nitrate within the disposal areas. While nitrogen as either ammonia or nitrate may be present in effluent exiting the disposal areas, adverse or persistent algal blooms are not expected in adjacent receiving waters.

2.2.9   Actions Taken to Minimize Adverse Effects

The design and construction of new and rehabilitated dikes around CDFs would emphasize stability and minimize erosion that would affect characteristics of the water column. Erosion would be further minimized through the establishment of vegetation on the dikes. Where the dikes would be exposed to erosive factors, such as waves, currents, and ship wakes, rock dikes would be constructed for protection of the dikes. CDFs would be managed to provide sufficient retention time to allow the settling of suspended solids, thereby minimizing effects on receiving waters.

Earthen dikes would be constructed at beneficial use sites to confine the dredged material for a sufficient time to allow the settling of suspended solids and prevent their release into adjacent areas. Rock placed adjacent to the confinement dike at the beneficial use site in Calcasieu Lake would provide protection from wind and wave action and minimize the effects of erosion on characteristics of the water column. Gaps in the dikes would allow water to circulate between the lake, shallow open-water fronting the shoreline, and interior marshes. As vegetation becomes established on the beneficial use platforms, nutrient cycling within the functioning marsh may benefit overall water quality in the project's vicinity.

2.3   WATER CIRCULATION, FLUCTUATION, AND SALINITY GRADIENT DETERMINATION

Hydrologic characteristics, including currents, water levels, salinity gradients, and flow rates in the Calcasieu Ship Channel and vicinity are determined largely by winds, tides, and discharges from the Calcasieu River. Erosion and subsidence of coastal wetlands has resulted in considerable areas of open water, thereby increasing tidal flows and currents over historical volumes. Hydrodynamic modeling, detailed in Appendix C of the Dredged Material Management Plan, *Hydrodynamic and Sediment Transport Study, Calcasieu River and Pass, Louisiana*, prepared in 2008 by Applied Coastal and Engineering, Inc., indicates that the project would have only minor effects on the hydrodynamics of the system.

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Because of the minor effects on hydrodynamics, it is unlikely that there would be any effects on current characteristics, stratification, or salinity gradients. No effects on stratification are expected. No effects on water level fluctuations outside the expanded CDFs are expected.

b. Material Placed at Beneficial Use Sites. The hydrological characteristics of the area contained within diked areas would be dependent, to a great extent, on the pumped slurry of dredged material from the ship channel. This action would determine currents, flows, and velocities within the dikes, inhibit stratification, and eliminate salinity gradients associated with tidal cycles.

As vegetation becomes established, dikes would be degraded and tidal access channels formed, water current patterns, circulation, flows and velocities within the beneficial use sites are expected to be similar to those of nearby natural wetlands. Natural water level fluctuations and salinity gradients would return to being dependent on winds, tides, and other natural factors.

c. Material Dredged to Create Access Channels. Temporary stockpiling of material dredged to create access channels is not anticipated to change the hydrologic characteristics of the area into which it is placed. Therefore, no effects would result to the patterns, flows, or velocities of currents. No effects would occur to any stratification that might be present, to normal water level fluctuations, or to salinity gradients.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Containment dikes would isolate the area into which dredged material would be placed from the surrounding system. Outside the containment dikes, localized alterations in the overall hydrologic regime are likely, including current circulation patterns, and flows. At beneficial use sites where considerable open water would remain, current velocity outside the dikes is likely to remain unchanged. Because of the presence of wind-driven and tidal currents it is unlikely that stratification or alteration in surrounding water level fluctuations, stratification, or salinity gradients would result. As dikes become degraded, hydrological characteristics are expected to approximate those of nearby natural wetlands.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and wetland creation sites in Calcasieu Lake is not anticipated to affect hydrological characteristics of the surrounding area.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Hydrological effects resulting from discharges from CDFs and beneficial use sites would be of negligible consequence on receiving waters. Discharges are unlikely to have any effect on current patterns, circulation, flows or velocities. Any stratification or salinity gradients that might be present are unlikely to be affected.

g. Actions Taken to Minimize Adverse Effects. By expanding CDFs vertically rather than horizontally to the extent possible, effects on the hydrodynamic characteristics of the system are reduced. Beneficial use sites would provide some alterations to the hydrological characteristics of the system, but these sites are attempts to restore some of the coastal wetlands that have been previously degraded, and their effects are considered to be beneficial rather than adverse.

2.4 SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. Therefore, the water column and its constituents, including suspended particulates, would be eliminated at the expansion site.

b. Material Placed at Beneficial Use Sites. Beneficial use sites would initially be contained within diked areas. The slurry of dredged material from the ship channel would contain a large percentage of suspended materials at the point of discharge. However, as distance from the discharge point increases, suspended particulates would settle out and turbidity would decrease. Following the completion of material placement, settling of solids, and consolidation of sediments, vegetation would become established. Dikes would then become degraded and tidal access channels would form naturally. This connectivity would allow the introduction of suspended particulates from adjacent waters.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels may cause temporary increases in suspended particulates at or near the placement site. However, following construction, the concentration of suspended solids and turbidity would return to its pre-construction condition.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of dredged material to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. Therefore, the water column and its characteristics, including suspended particulates, would be eliminated at the site of the dike. The placement of material dredged to construct dikes is likely to result in temporary increases in suspended particulates and turbidity adjacent the placement site. Following construction, the concentration of suspended particulates outside the dike would return to it pre-construction condition.

e. Rock for Armoring. Placement of rock to armor ship channel banks, CDFs, and wetland creation sites in Calcasieu Lake may cause temporary increases in suspended particulates and turbidity at the placement site. However, following construction, clarity would return to its pre-construction condition.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Dredged material discharged into CDFs and beneficial use sites would be retained to allow the settling of suspended materials. Effluent discharges from these facilities are unlikely to affect the turbidity of receiving waters beyond LDEQ regulatory mixing zones.

g. Actions Taken to Minimize Adverse Effects

To a great extent, controlling turbidity and suspended particulates is a function of controlling erosion. Where existing CDF construction footprints would be maintained and expansions would be vertical, raised dikes would be designed to achieve a slope that would maintain stability and reduce erosion. Where it is necessary to increase dredged material placement capacity, CDFs would be expanded horizontally; dikes would be designed and constructed to achieve a slope optimal for maintaining stability and reducing erosion. Erosion would be further minimized through the establishment of vegetation on the dikes. Where the dikes would be exposed to erosive factors, such as waves, currents, and ship wakes, rock dikes would be constructed for protection of the dikes.

Management of the CDFs through proper design and operation of ditching and draining facilities would enable the settling of materials suspended in the dredged material slurry, enabling the settling out of solids prior to discharge. Dewatering and consolidation of dredged material would promote stabilization of the dredged material and reduce tendencies it might have for erosion.

Earthen dikes would be constructed at beneficial use sites to confine the dredged material, promote the settling of solids prior to discharges into adjacent areas, and minimize turbid plumes in adjacent waters. Beneficial use sites would be designed and operated to ensure that the maximum settlement of suspended solids is achieved within the confined area. The confinement dike at the beneficial use site in Calcasieu Lake would be protected from wind and wave action by a rock dike. Dikes around beneficial use sites would be allowed to degrade only after the site becomes stabilized.

2.5 CONTAMINANT DETERMINATIONS

In December 2006, sediment and water were sampled along approximately 35 miles of the Calcasieu Ship Channel, and from reference areas within Calcasieu Lake and the SNWR. For purposes of sampling and analysis activities, the Calcasieu Ship Channel was divided into six dredged material management units (DMMUs). DMMUs 1 through 4 are representative of the River Reach; DMMU 5 is representative of the Upper Lake Reach; and DMMU 6 corresponds to the Lower Lake Reach. Reference samples were representative of conditions that would be expected in proposed disposal areas prior to project construction. Channel and reference materials were analyzed for the presence of metals, pesticides, herbicides, PAHs, petroleum breakdown products, volatile organic compounds, and other potential contaminants in sediment, water, and elutriates made from channel sediments and site water. Analytes detected in elutriates were compared to background concentrations in ambient waters at the reference sites and to state water quality criteria. Toxicity tests were also conducted on sensitive benthic and aquatic organisms exposed to channel sediments and elutriates; tissues of test organisms were analyzed for the same suite of analytes as sediments and elutriates to determine if certain analytes bioacumulated. The results of the sampling and analysis plan are described in Addendum A, *Calcasieu River and Pass, LA, Water Quality and Sediment Evaluation*.

a. Expanded Confined Disposal Facilities. Material placed in wetland areas for expansion of the CDFs would consist of sediment previously dredged from the Calcasieu Ship Channel that has had an opportunity to settle, consolidate, dry, and stabilize. Based on the evaluation described in Addendum A, *Calcasieu River and Pass, LA, Water Quality and Sediment Evaluation*, there is no reason to believe that material dredged during previous maintenance events would adversely affect receiving waters adjacent to the CDF.

b. Material Placed at Beneficial Use Sites. Benthic toxicity and bioaccumulation tests were conducted as described in Addendum A. The evaluation concluded:

> *The discharge of dredged material from the Calcasieu River and Pass, LA, navigation channel into the shallow open water disposal areas for wetlands development is not likely to have an unacceptable adverse effect on survival, growth or reproduction of aquatic organisms or pose a human health risk due to bioaccumulation. Neither the magnitude of bioaccumulation of metals nor the total PAH tissue residues in tissues of*

organisms exposed to sediment from the navigation channel indicate a cause for concern for aquatic organisms living at the proposed placement sites or for humans who may consume those organisms.

c. Material Dredged to Create Access Channels. Material dredged to create access channels would be placed in locations adjacent or near to the sites from which it would be dredged. While there are no indications of contaminants present in areas where channels would be dredged, any contaminants that might be present in the dredged material would likely have the same concentrations as the sediments in the area where it would be placed. Therefore, the placement of dredged material would not cause any degradation in the placement area resulting from contaminants.

d. Material Dredged to Create Containment at Beneficial Use Sites. Material dredged to construct containment at beneficial use sites would be placed in locations adjacent or near to the sites from which it would be dredged. The dredged material would not result in the introduction of contaminants not already potentially present at the site.

e. Rock for Armoring. The placement of rock would not result in the introduction of contaminants.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites.

To determine concentrations of contaminants that could be released from CDFs and beneficial use sites, an elutriate test was performed. The test involved mixing sediment and site water, allowing the heavier solid particles to settle, sampling the remaining water, and analyzing it for dissolved and bound contaminants.

Nineteen analytes were detected in elutriates, including metals, PAHs, pesticides, petroleum hydrocarbons, and ammonia. Of these, twelve (arsenic, mercury, nickel, selenium, zinc, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, endrin, gamma-BHC, heptachlor, and heptachlor epoxide) were below state and Federal water quality criteria; five (barium, chromium, antimony, delta-BHC, and GRO) are without water quality criteria; and two (ammonia and copper) exceeded acute water quality criteria.

As stated in Addendum A, Calcasieu *River and Pass, LA, Water Quality and Sediment Evaluation*:

> *Compliance with EPA WQC for ammonia would be accomplished by oxidation of ammonia by implementation of one or more management practices as follows: 1) attachment of a baffle plate to the end of the discharge pipeline to thoroughly expose the slurry to oxygen during placement in a disposal area; 2) increase the retention time within the disposal area by routing slurry through interior dikes or by managing effluent discharge from the disposal are across a weir; and 3) if possible, routing the effluent across vegetated wetlands to the disposal area prior to discharge into adjacent receiving waters.*

A determinant for evaluating effects resulting from CDFs and beneficial use site effluent discharges is based on mixing zone modeling. The model used for mixing zone determinations was the CORMIX mixing zone model. For mixing zones that would occur at the point of discharge from CDFs into the Ship Channel, both the riverine and tidal models were used. For discharge from CDFs to Calcasieu Lake, the tidal model was used. For the discharge of dredged material into receiving waters adjacent to beneficial use sites, the tidal model was also used.

The CORMIX model was used to predict the size of the mixing zones that would be required for the dilution of copper in effluents. Mixing zones extending from disposal areas seven to 60 feet into Calcasieu Lake, seven to 33 feet into the Calcasieu Ship Channel, and seven to 39 feet into the Sabine National Wildlife Refuge would provide sufficient dilution of copper in effluents.

Elutriate bioassays were performed to determine the toxicity of the dredged material elutriate. For channel elutriates demonstrating some degree of toxicity, CORMIX mixing zone models were conducted to determine if analytes present in the elutriate and without applicable water quality criteria would be sufficiently diluted to background concentrations or other benchmarks within regulatory mixing zones. Mixing zones extending from disposal areas 13 to 60 feet into Calcasieu Lake, seven to 33 feet into the Calcasieu River, and 10 to 39 feet into the Sabine National Wildlife Refuge would provide sufficient dilution. These distances are well within the Louisiana Department of Environmental Quality regulatory mixing zones, and the discharge of effluent would have little effect on water quality of adjacent receiving waters.

The *Calcasieu River and Pass, LA, Water Quality and Sediment Evaluation* concluded:

> *Analysis of elutriates and results from water quality toxicity tests (elutriate bioassays) indicate that the proposed discharge of effluent from potential disposal areas into receiving waters in broken marsh, Calcasieu Lake, or into the Calcasieu River would comply with state water quality standards or with other equivalent benchmarks within LDEQ regulatory mixing zones.*

g. Actions Taken to Minimize Adverse Effects

The proposed project would not result in the introduction of contaminants to the disposal sites or adjacent waters. The discharge of effluent into adjacent waters is not expected to adversely impact aquatic or benthic organisms.

2.6 AQUATIC ECOSYSTEM AND ORGANISM DETERMINATION

2.6.1 Effects on Plankton

a. Expansion of CDFs. The expansion of CDFs into adjacent marsh would displace the plankton community.

b. Beneficial Use Sites. At locations where the placement of dredged material would be used to create/restore wetlands, the plankton community would be displaced.

c. Material Dredged to Create Access Channels. Although dredging to create access channels and the placement of the dredged material in shallow water adjacent to the access channels may produce sufficient turbidity to inhibit the photosynthesis of phytoplankton, the effect would be localized and of a temporary nature. It is anticipated that preconstruction conditions would return following completion of the access channel.

d. Material Dredged to Create Containment at Beneficial Use Sites. Construction of containment dikes would displace components of the plankton community. Placement of material could cause localized and short-term elevations in turbidity that may interfere with phytoplankton photosynthesis.

e. Rock for Armoring. The placement of rock could cause localized and short-term elevations in turbidity that may interfere with phytoplankton photosynthesis. Following construction, phytoplankton communities are expected to return to pre-construction conditions.

f. Discharge of Effluent from CDFs and Beneficial Use Sites. Because retention of dredged material within CDFs and beneficial use sites is anticipated to facilitate the settling of suspended solids, it is expected that discharges of effluents would have little or no effect on plankton communities in adjacent waters.

2.6.1 Effects on Benthos

a. Expanded Confined Disposal Facilities. The benthic communities located within CDF expansion areas would be lost; the substrate would be converted to an upland site.

b. Material Placed at Beneficial Use Sites. Where the placement of dredged material converts open-water habitat to marsh, the nature of the benthic community would be altered. Because tidal cycles could expose the substrate to air and possible desiccation, epibenthic organisms that live on the bottom surface could be replaced by organisms that burrow into the substrate.

c. Material Dredged to Create Access Channels. Non-motile benthic organisms within the sites where material dredged to create access channels would be placed are likely to be destroyed by the proposed operations. However, recolonization and repopulation would likely occur within several months after completion. The more motile component of the benthic community may be able to avoid being covered by the placement of dredged material.

d. Material Dredged to Create Containment at Beneficial Use Sites. Non-motile benthic organisms within the sites where material would be placed to create beneficial use site containment are likely to be destroyed by the proposed operations. The more motile component of the benthic community may be able to avoid being covered by the placement of dredged material. A reestablishment of the benthic community would occur on that portion of the containment dike that remains inundated.

e. Rock for Armoring. The placement of rock would alter the nature of benthic communities. Benthic organisms where rock is placed would be buried. The rock would provide a substrate for the establishment of a hard-bottom benthic community, many of the components of which would become attached to the rocks.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Because retention of dredged material within CDFs and beneficial use sites is anticipated to facilitate the settling of suspended solids, it is expected that discharges of effluents would have little or no effect on benthic communities in adjacent waters.

2.6.3 Effects on Nekton

a. Expanded Confined Disposal Facilities. The nekton community at sites where material is placed to expand CDFs would be eliminated as the aquatic community is replaced by uplands.

b. Material Placed at Beneficial Use Sites. Where the placement of dredged material converts open-water habitat to marsh, the nature of the nektonic community is likely to be altered. Because tidal cycles could expose the substrate to air, fishes and other nektonic organisms adapted to tidal inundation of wetlands would benefit, while those species that require open water would be displaced.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is unlikely to affect the nekton. Most nektonic organisms would be able to avoid damage from the operation.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to create beneficial use site containment is unlikely to affect the nekton. Most nektonic organisms would be able to avoid injury from the operation.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and the wetland creation site in Calcasieu Lake is unlikely to affect the nekton. Most nektonic organisms would be able to avoid injury during construction operations. After placement, the rock is likely to be beneficial to the nekton by providing a more diversified habitat.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Because retention of dredged material within CDFs and beneficial use sites is anticipated to facilitate the settling of suspended solids, it is expected that discharges of effluents would have little or no effect on nektonic communities in adjacent waters.

2.6.4 Effects on Aquatic Food Web

a. Expanded Confined Disposal Facilities. The aquatic community at sites where material is placed to expand CDFs would be eliminated as the habitat becomes replaced by uplands. Therefore, the aquatic food web at these locations would be eliminated.

b. Material Placed at Beneficial Use Sites. Where the placement of dredged material converts open-water habitat to marsh, the nature of the aquatic community would be changed from an open-water habitat to a wetland. The aquatic food web would benefit from both short and long-term changes to the disposal areas, including additions in energy to basal elements of the food web, habitat preservation, and increased habitat complexity.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is unlikely to have more than a temporary effect the aquatic community or the food web. Localized and/or short-term displacements of aquatic community components are expected to recover within a few months following completion of the operation.

d. Material Dredged to Create Containment at Beneficial Use Sites. Aquatic communities at sites where material would be placed to create beneficial use site containment would be altered by the proposed operations. Therefore, the food web at the specific location would be altered. The more motile components of the community may be able to avoid being covered by the placement of dredged material, but sedentary components would be smothered. A reestablishment of the aquatic community would likely occur on that portion of the containment dike that remains under water within a few months of construction.

e. Rock for Armoring. The placement of rock to armor ship channel banks, CDFs, and the wetland creation site in Calcasieu Lake may have a localized effect on the food web. The rock would provide a substrate for the establishment of a hard-bottom benthic component of the aquatic community, which would provide localized habitat diversity. Further, the rock dike would likely provide shelter for organisms. The overall effect of introducing a rock substrate is anticipated to be beneficial to the local productivity.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Because retention of dredged material within CDFs and beneficial use sites is anticipated to facilitate the settling of suspended solids, it is expected that discharges of effluents would have little or no effect on aquatic communities or aquatic food webs in adjacent waters.

2.6.5 Special Aquatic Sites Effects

2.6.5.1 Sanctuaries and Refuges

a. Expanded Confined Disposal Facilities. The SNWR and the Cameron Prairie NWR are located in the project area. However, no CDF expansions would occur on or near the refuges. Therefore, no effects on the refuges are anticipated.

b. Material Placed at Beneficial Use Sites. Two beneficial use sites are located on the Sabine NWR and two are located on the Cameron Prairie NWR. At the Sabine NWR, the use of Site 5 would result dredged material being placed in approximately 3,083 acres of subsided marsh; Site 18 would receive fill for the restoration of approximately 1,572 acres. The Cameron Prairie NWR would have two sites affected by the project: placement of dredged material at Site 19 would involve approximately 1,026acres of eroded/subsided marsh, while the placement of material at site 20 would enhance approximately 1,867 acres.

c. Material Dredged to Create Access Channels. A determination on the need for and the locations of access channels would be made during the preparation of plans and specifications. If it is determined that access channels are necessary, coordination with the refuge manager would be undertaken. Any effects of access channels on the refuges are expected to be minimal.

d. Material Dredged to Create Containment at Beneficial Use Sites. A determination on the need for and the locations of beneficial use site containment would be made during the preparation of plans and specifications. If it is determined that containment is necessary, coordination with the refuge manager would be undertaken. Any effects of site containment structures on the refuges are expected to be minimal.

e. Rock for Armoring. No rock armoring would occur on either the Sabine NWR or the Cameron Prairie NWR.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Because retention of dredged material within beneficial use sites is anticipated to facilitate the settling of suspended solids, it is expected that discharges of effluents would have little or no effect on the refuges.

2.6.5.2 Wetlands

a. Expanded Confined Disposal Facilities. Expansion of CDFs would result in the conversion of wetlands to uplands per the following:

CDF	17/19	148 acres
CDF	D	0 acres
CDF	E	0 acres

b. Material Placed at Beneficial Use Sites. Material placed in beneficial use sites would convert open water habitat to wetlands per the following:

Site 5	3,083 total acres;	3,000 acres of wetlands
Site 18	1,572 total acres;	1,000 acres of wetlands
Site 19	1,026 total acres;	300 acres of wetlands
Site 20	1,867 total acres;	300 acres of wetlands
Site 49	639 total acres;	600 acres of wetlands
Site 50	887 total acres;	640 acres of wetlands
CDF D/E	476 total acres;	466 acres of wetlands

c. Material Dredged to Create Access Channels. The locations for dredging access channels would be determined during the preparation of plans and specifications. If it is deemed necessary to construct an access channel through a wetland area, dredged material would be stockpiled and used to backfill the channel following construction.

d. Material Dredged to Create Containment at Beneficial Use Sites. The exact locations for beneficial use area containment dikes would be determined during the preparation of plans and specifications. Containment dikes that may be constructed in wetland areas would be allowed to degrade over time (or, if necessary, mechanically degraded) to revert to a wetland condition. Therefore, the effects would be of a temporary nature.

e. Rock for Armoring. The placement of rock to armor ship channel banks and CDFs would have no direct effect on wetlands. Rock would be placed adjacent to the wetland area created in Calcasieu Lake to reduce the erosive effects of waves and currents.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. Effluents from CDFs and beneficial use sites would be discharged into adjacent water bodies. No wetlands would be affected.

2.6.5.3 Mud Flats. Not applicable.

2.6.5.4 Vegetated Shallows

Vegetated shallows are defined by the Federal Register, Volume 65, Number 47 (9 March 2000) and by 40 C.F.R. § 230.43 as permanently inundated areas of open water that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass in estuarine or marine systems as well as a number of freshwater species in rivers and lakes. No areas of vegetated shallows are known to occur in the Project Area.

2.6.5.5 Coral Reefs. Not applicable.

2.6.5.6 Riffle Pool Complexes. Not applicable.

2.6.6 Effects on Threatened and Endangered Species

The proposed project is not anticipated to cause adverse impacts to any listed threatened or endangered species or their habitat. Under Section 7 of the Endangered Species Act and the Marine Mammal Protection Act, coordination was maintained with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Both agencies have provided preliminary concurrence with the findings that the project is not likely to adversely impact threatened or endangered species.

2.6.7 Other Wildlife

a. Expanded Confined Disposal Facilities. Expansion of CDFs would convert areas of wetland and open water to uplands. These uplands could provide habitat for loafing, foraging, and nesting of birds, as well as habitat for a variety of other terrestrial wildlife, such as invertebrates, reptiles, and mammals.

b. Material Placed at Beneficial Use Sites. Dredged material would be discharged into shallow open water areas to an elevation conducive to the development of wetlands habitat. It is anticipated that the final result would be a combination of wetlands, mud flat, and shallow open water habitats that would be favorable to a wide variety of wildlife in South Louisiana, including waterfowl, mammals, reptiles, and invertebrates. Such habitats provide spawning, rearing, and foraging for numerous marine and estuarine species.

c. Material Dredged to Create Access Channels. The placement of material dredged to create access channels is unlikely to have any effect on other types of wildlife.

d. Material Dredged to Create Containment at Beneficial Use Sites. The placement of material dredged to contain beneficial use sites would change the characteristics of the placement site from an area of open water to a dike extending above the surface of the water. These sites may provide areas that could be used in the short term by birds for resting/loafing or by reptiles for sunning. As vegetation becomes established, the dikes would be allowed to become degraded, and the use by other wildlife would become diminished.

e. Rock for Armoring. The placement of rock in Calcasieu Lake would be designed to protect the wetland creation site and CDFs from erosion. Areas of rock armoring that extend above the surface of the waters may provide areas that could be used by birds for resting/loafing or by reptiles for sunning.

f. Effluent Discharged from Confined Disposal Facilities and Beneficial Use Sites. It is not expected that discharge from CDFs or beneficial use sites would have any effects on other wildlife.

2.6.8 Actions to Minimize Adverse Effects

In the planning and development of the proposed project, several actions were taken to avoid and minimize adverse effects on aquatic ecosystems. CDF expansions were incorporated into the project only where no other options for dredged material placement were available. The amount of CDF expansion was limited only to the amount considered necessary for providing sufficient capacity to maintain the Calcasieu Ship Channel. Gaps in dikes would allow nekton to access productive marsh habitats long the shoreline of CDF D/E.

An oyster survey was conducted to identify productive areas near the ship channel in Calcasieu Lake. The areas selected for expansions of CDFs into the lake and the construction of a wetland site are located in where impacts on oyster production would be minimized.

The beneficial use of dredged material to restore eroded and subsided wetlands is considered to provide an improvement in habitat over existing open water habitats. Habitat development and restoration is considered to be compensation for wetland habitat destroyed by CDF expansion.

2.7 PROPOSED DISCHARGE SITE DETERMINATIONS

In considering the mixing zones for each disposal site, Addendum A, Calcasieu *River and Pass, Louisiana, Water Quality and Sediment Evaluation*, provides the following:

> *For coastal lakes and bays, including the open waters of Calcasieu Lake and the SNWR, LDEQ requires that dilution of effluent to WQC or approximate background levels occurs within 200 feet of a dredged material disposal area. For tidal channels with flows greater than 100 cubic feet per second, such as the Calcasieu River, mixing zones may not exceed one third of the channel's ambient flow. Considering an approximate width of 900', approximately depth of 42', and a mean low tidal velocity of 0.79 feet/second, the regulatory mixing zone for the Calcasieu River is approximately 9,944 feet. Predicted mixing zones required for sufficient dilution of analytes are no greater than 60 feet for Calcasieu Lake, 33 feet for Calcasieu River, and 39 feet for SNWR. The predicted mixing zones are well within LDEQ's regulatory mixing zones, and the discharge of dredged material into the proposed disposal areas therefore would have little effect on water quality in adjacent receiving waters.*

2.8 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

2.8.1 Potential Effects on Aquatic Ecosystems

Cumulative effects of past, present, and reasonably foreseeable future projects have included an overall degradation in the quality of the ecosystem of the Calcasieu Estuary. The proposed project would allow the continued operation of the Calcasieu Ship Channel, arguably the major source of saltwater intrusion into the coastal marshes of the estuary and, therefore, a major contributor to the loss of coastal wetlands. However, direct and indirect effects include the restoration of marsh habitat through the beneficial use of dredged material. The proposed project would not produce an adverse increment to the cumulative impacts. The incremental effect of the marsh restoration would offset some of the damaging effects of earlier projects. An increase in open water habitat for plankton has resulted from subsidence and erosion of marsh habitats. This project would result in fill being placed in over 8,000 acres of subsided marsh and 638 acres of Calcasieu Lake, thereby providing a slight reduction in plankton habitat. However, this habitat reduction represents less than one percent of the open water habitat in the Calcasieu estuary, and its overall effect is considered to be negligible. A breakdown of effects of the proposed project follows:

- Expanding CDFs 17, 19, D, and E would fill 511 acres of Calcasieu Lake open water habitat, which would be incorporated into upland dredged material placement areas.
- Approximately 476 acres of Calcasieu Lake adjacent to CDFs D and E would be converted from open water habitat to wetlands.
- Placement of dredged material at open-water beneficial use sites (subsided/eroded marsh) would take place at:

  - Site 5 (Sabine NWR) 3,083 acres
  - Site 18 (Sabine NWR) 1,572 acres
  - Site 19 (Cameron Prairie NWR) 1,026 acres
  - Site 20 (Cameron Prairie NWR) 1,867 acres
  - Site 49 (Cameron Parish School Board) 639 acres
  - Site 50 (Black Lake) 887 acres

Non-motile organisms within the discharge sites are likely to be destroyed by the proposed discharge operations, but should repopulate within several months after completion.

The creation and restoration of intertidal marsh, mud flats, and shallow open-water areas would provide aquatic habitat for various motile and non-motile fauna. The marsh would provide additional nursery areas along the outer fringes suitable for fishes following the proposed activities. The increase in primary and secondary productivity resulting from marsh restoration would benefit an area extending beyond the limits of the project. Some motile benthic and pelagic fauna, such as crabs, shrimp, and fishes may be able to avoid the disturbed area and should return shortly after the activity is completed. Larval and juvenile stages of these forms may not be able to avoid the activity due to limited mobility. The return water from the dredged material placement sites would have no impact on aquatic communities.

During maintenance operations, elevated suspended sediment concentrations would occur at placement sites, but most pelagic organisms should be able to avoid detrimental impacts at the discharge point. Upon completion of maintenance operations and settlement of suspended solids, nektonic organisms would return to open-water habitats.

Alteration of habitats is expected to affect biological communities of the area. An increase in open water habitat has resulted from subsidence and erosion of marsh habitats. This project would result in the filling of over 7,000 acres of subsided marsh and 638 acres of Calcasieu Lake, thereby providing a slight reduction in nekton habitat. However, this habitat reduction represents less than one percent of the open water habitat in the Calcasieu estuary, and its overall effect is considered to be negligible.

2.8.2 Potential Effects on Human Use Characteristics

a. Significant Adverse Effects on Human Health and Welfare. The proposed project would not result in adverse effects on human health and welfare.

b. Municipal and Private Water Supply. This project would not be located near municipal water supply intakes or private water supplies.

c. Recreational and Commercial Fisheries. Because over 7,000 acres of coastal marsh would be restored, primary and secondary productivity, as well as nursery and foraging habitat for fishes, would be enhanced. The placement of rock dikes along the created marsh in

Calcasieu Lake would provide a hard substrate for the attachment of aquatic organisms thereby providing a diversification of the aquatic habitat. This is expected to lead to benefits to recreational and commercial fin-fish and shellfish fisheries.

d. Water Related Recreation. The project area is used for both consumptive (fishing and hunting) and non-consumptive (wildlife viewing, camping, boating, airboating, etc.) recreational use. Because the proposed project provides for the restoration of subsided marsh, water-related recreation is expected to be enhanced.

e. Aesthetics. Implementation of the project would beneficially affect the aesthetics of the area. Approximately 7,000 acres of subsided/eroded marsh would be restored.

f. Parks, National Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The proposed project would not result in adverse impacts on parks, national historic monuments, national seashores, wilderness areas, or research sites. Marsh restoration associated with the project is expected to contribute to improved ecological values of the Sabine and Cameron Prairie NWRs.

2.9 DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

The proposed project is not expected to have any significant secondary adverse effects on the aquatic ecosystem, other than the effects discussed in previous sections (some of which may be considered secondary)

3.0 FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

3.1 ADAPTATION OF THE SECTION 404(b)(1) GUIDELINES TO THIS EVALUATION

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

3.2 EVALUATION OF AVAILABILITY OF PRACTICABLE ALTERNATIVES TO THE PROPOSED DISCHARGE SITE THAT WOULD HAVE LESS ADVERSE IMPACT ON THE AQUATIC ECOSYSTEM

Alternatives to the proposed project were discussed and analyzed in Section 3.0 of the DMMP/SEIS, *Alternatives*. The proposed project represents the least environmentally damaging practicable alternative. No practicable alternative exists that meets the study objectives and does not involve discharge of fill into waters of the United States.

3.3 DETERMINATION OF COMPLIANCE WITH APPLICABLE WATER QUALITY STANDARDS

The proposed project has been determined to be in compliance with all applicable water quality standards.

3.4 COMPLIANCE WITH APPLICABLE TOXIC EFFLUENT STANDARD OR PROHIBITION UNDER SECTION 307 OF THE CLEAN WATER ACT

This project would be in full compliance of Section 307 of the Clean Water Act and would not violate the Toxic Effluent Standards. Appropriate evaluations of analytical and ecotoxicological testing of sediment, water column, and elutriate revealed that no adverse impacts would result from the proposed project.

3.5 COMPLIANCE WITH THE ENDANGERED SPECIES ACT OF 1973

The proposed project would not harm any threatened or endangered species or their critical habitats. Coordination in accordance with Section 7 of the Endangered Species Act has been maintained with USFWS throughout the planning process for this project.

3.6 COMPLIANCE WITH SPECIFIED PROTECTION MEASURES FOR MARINE SANCTUARIES DESIGNATED BY THE MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT OF 1972

Not Applicable.

3.7 EVALUATION OF EXTENT OF DEGRADATION OF THE WATERS OF THE UNITED STATES

The proposed placement of dredged material would not contribute to significant degradation of waters of the United States. Nor would it result in significant adverse effects on human health and welfare, including municipal and private water supplies; recreation and commercial fishing; life stages of organisms dependent on the aquatic ecosystem; ecosystem diversity, productivity, and stability; or recreational, aesthetic or economic values.

3.8 APPROPRIATE AND PRACTICABLE STEPS TAKEN TO MINIMIZE POTENTIAL ADVERSE IMPACTS OF THE DISCHARGE ON THE AQUATIC ECOSYSTEM

In the planning and development of the proposed project, several actions were taken to avoid and minimize adverse effects on aquatic ecosystems. Expansions of CDF footprints were incorporated into the project only where no other options for dredged material placement were available. The amount of CDF expansion was limited only to the amount considered necessary for providing sufficient capacity to maintain the Calcasieu Ship Channel. Where possible, expansions would be vertical by raising the surrounding dikes. Where it is necessary to further increase dredged material placement capacity, CDFs would be expanded horizontally. Dikes would be designed and constructed to achieve a slope optimal for emphasizing stability and reduce erosion and sloughing. By expanding CDFs vertically rather than horizontally to the extent possible, effects on the hydrodynamic characteristics of the system would be reduced.

To a great extent, controlling turbidity and suspended particulates is a function of controlling erosion. Erosion from reconstructed dikes would be minimized through the establishment of vegetation on the dikes. Where the dikes would be exposed to erosive factors, such as waves, currents, and ship wakes, rock dikes would be constructed for armoring adjacent to earthen dikes.

The proposed project would require an increased level of maintenance of CDFs and dredged material introduced to CDFs. Management of the CDFs through proper design and operation of ditching and draining facilities would provide sufficient retention time to enable the settling of materials suspended in the dredged material slurry prior to discharge. This would promote improved settling and dewatering of dredged materials, which would allow the material to consolidate and stabilize, thereby reducing tendencies for erosion.

Beneficial use sites would be designed, constructed, and operated to confine the dredged material and ensure that the maximum settlement of suspended solids is achieved within the confined area prior to discharges into adjacent areas. Dikes around beneficial use sites would be allowed to degrade only after the site becomes stabilized and vegetation becomes established.

Rock used to armor the bank of the ship channel, the CDF dikes along the ship channel, and at the western side of Calcasieu Lake, and the confinement dike at the beneficial use site in Calcasieu Lake would provide protection from wind and wave action and minimize the effects of erosion.

The beneficial use of dredged material to restore eroded and subsided wetlands is considered to provide an improvement in habitat over existing open water habitats. Habitat development and restoration is considered to be compensation for wetland habitat destroyed by CDF expansion. Beneficial use sites would provide some alterations to the hydrological characteristics of the system, but these sites would restore some of the coastal wetlands that have been previously degraded, and their effects are considered to be beneficial rather than adverse. Long term effects of the beneficial use sites include enhancement of water chemistry through the uptake of nutrients by restored marsh vegetation.

An oyster survey was conducted to identify productive areas near the ship channel in Calcasieu Lake. The areas selected for expansions of CDFs into the lake and the construction of a wetland site are located in where impacts on oyster production would be minimized.

4.0 EVALUATION RESPONSIBILITY

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The proposed discharges of dredged material, fill, and effluent comply with the requirements of the 404(b)(1) guidelines, with the inclusion of appropriate and practicable methods to minimize adverse effects to the aquatic ecosystem.

Date: Sept 1, 2009

Joan Exnicios

Joan Exnicios
Chief, Environmental Planning
and Compliance Branch

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ADDENDUM A:

WATER QUALITY AND SEDIMENT EVALUATION

Calcasieu River and Pass, LA
Water Quality and Sediment Evaluation

U.S. Army Corps of Engineers – New Orleans District

December 2007

Water Quality and Sediment Evaluation

Water and sediment from thirty-two (32) in-channel stations within the Calcasieu River and Pass, LA, navigation channel and from two reference areas, the Calcasieu Lake Wetland Creation Reference Area and the Sabine National Wildlife Refuge (SNWR) Wetland Restoration Disposal/Reference Area, were collected in December, 2006 and analyzed in accordance with the protocols described in Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (ITM) (USEPA/USACE, 1998) and Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities –Testing Manual (UTM) (USACE, 2003) as specified in the MVN's Sampling and Analysis Plan (Figure 1).

Physical and chemical analyses were performed on sediment from each in-channel station and the two reference areas. Reference areas were selected to represent potential wetland development disposal areas in shallow open water within broken marsh or in shallow open water in Calcasieu Lake. Chemical analyses also were conducted on ambient water from six (6) in-channel stations, from the SNWR Wetland Restoration Disposal/Reference Area, from the Calcasieu Lake Wetland Creation Disposal Area, and on an elutriate from each in-channel station. Water at the SNWR Wetland Restoration Disposal/Reference Area, at the Calcasieu Lake Wetland Creation Disposal Area, and in the Calcasieu River represent receiving waters for wetland development sites within broken marsh, wetland development areas within Calcasieu Lake, and for effluent discharged from confined disposal facilities (CDFs), respectively. Hereafter, the SNWR Wetland Restoration Disposal/Reference Area is referred to as the SNWR reference area; the Calcasieu Lake Wetland Creation Reference Area is referred to as the Calcasieu Lake reference area; and the Calcasieu Lake Wetland Creation Disposal Area is referred to as the Calcasieu Lake disposal area.

Water column toxicity tests/suspended particulate phase bioassays were performed using an elutriate dilution series from six (6) Dredged Material Management Units (Figure 1). Benthic toxicity tests/solid phase bioassays and bioaccumulation tests were performed on composited sediment from each Dredged Material Management Unit (DMMU) and both reference areas (Figure 1). DMMU 1 was comprised of in-channel stations D1-06-1 through D1-06-5 (approximate channel mile 36 to channel mile 33 and Clooney Island Loop); DMMU 2 was comprised of in-channel stations D2-06-1 through D2-06-5 (approximate channel mile 33 to channel mile 30 and Coon Island); and DMMU 3 was comprised of in-channel stations D3-06-1 through D2-06-6 (approximate channel mile 30 to channel mile 24); DMMU 4 was comprised of in-channel stations D4-06-1 through D4-06-5 (approximate channel mile 24 to channel mile 21 and Devil's Elbow); DMMU 5 was comprised of in-channel stations D5-06-1 through D5-06-5 (approximate channel mile 21 to channel mile 16); and DMMU 6 was comprised of in-channel stations D6-06-1 through D6-06-6 (approximate channel mile 16 to channel mile 5. Copies of the Final Calcasieu River and Pass, Louisiana, Dredged Material Management Plan, Phase 2, Sampling and Analysis report which includes the MVN's sampling and analysis plan; the scope of work; and the results of the analyses are available from MVN upon request.

Sediment Chemistry Summary

Results from chemical analyses of sediment from the six DMMUs within the Calcasieu River and Pass, Calcasieu Lake reference area, and the SNWR reference area revealed the presence of 13 metals, 14 PAHs, 7 pesticides, 3 petroleum hydrocarbons, 3 PCBs, 1 volatile organic compound, and ammonia (Table 1).

The concentration of most metals detected in sediments from the river was similar and within the same order of magnitude as metals detected in the reference areas, including antimony, arsenic, beryllium, chromium, copper, lead, nickel, and zinc. Barium concentrations were consistently higher in the river (69 to 180 ppm) but within an order of magnitude of concentrations observed in reference sediments (20 to 26 ppm). Four metals were detected in river sediments, but not in either reference area. Mercury was detected at all six DMMUs (0.034 to 0.114 ppm); hexavalent chromium was detected at DMMUs 2, 3, 4, and 6 (0.096 to 0.152 ppm); selenium was detected at DMMUs 4, 5, and 6 (0.25 to 0.50 ppm); and thallium was detected at DMMU 1 only (0.088 ppm).

PAHs were detected in DMMUs 1 - 5, but not in DMMU 6 or either reference area. While PAHs were more prevalent in DMMUs 1, 2, and 4, the sum of all detected PAHs was relatively low and did not exceed a total of 295 ppb at any of the DMMUs. Benzo (a)anthracene, benzo(a)Pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and phenanthrene occurred at two or more DMMUs. Anthracene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, fluorene, gamma-chlordane, and naphthalene were less common among the DMMUs.

Pesticides were detected in five DMMUs and the reference areas, but were more prevalent in DMMUs 1, 2, and 4. The concentration of 4,4'-DDT was comparable between DMMUs 1, 2, 3, 4 and 6, and the reference areas (1.2 to 2.7 ppb and 2.0 to 2.3 ppb, respectively). Delta-BHC was detected at DMMUs 1 and 2, and the reference areas (0.7 to 1.6 ppb and 1.2 to 1.3 ppb, respectively). All other pesticides were detected in river sediments only. Endosulfan II was detected at DMMUs 3, 4, and 6; heptachlor was detected at DMMUs 2 and 4; endosulfan sulfate was detected at DMMU 1; beta-BHC was detected at DMMU 2; and gamma-BHC was detected at DMMU 4.

Diesel range organics (DRO) and ammonia were common to river and reference area sediments, with concentrations nearly an order of magnitude greater in the river. DRO and ammonia tended to decrease from upper to lower reaches of the river. Gasoline and motor oil range organics (GRO and MRO) were detected in DMMUs above Calcasieu Lake, with a similar decrease in concentration from upper to lower reaches. PCB 1260 was common to DMMUs 1, 2, 3, and 4, while PCB 1016 and PCB 1254 occurred less frequently. A single volatile organic compound (tetrachloroethylene) was detected at DMMU 6.

Elutriate Chemistry Summary

Nineteen analytes were detected in elutriates prepared from Calcasieu River and Pass sediments, including metals, PAHs, pesticides, petroleum hydrocarbons, and ammonia. While state and Federal water quality criteria (WQC) are not directly applicable to elutriate chemistry, it may be assumed that analytes detected in an elutriate at concentrations below acute WQC are not expected to adversely impact receiving waters adjacent to dredged material disposal areas (Table 2). Twelve of the nineteen analytes detected in elutriates were below WQC, including arsenic, mercury, nickel, selenium, zinc, gamma-chlordane, 4'4,-DDD, 4,4'-DDE, endrin, gamma-BHC, heptachlor, and heptachlor epoxide. Ammonia and copper were the only analytes to exceed acute WQC. An additional five analytes without WQC were detected in the elutriates, including barium and chromium (all DMMUs), antimony (DMMU 1 only), delta-BHC (DMMU 2 only), and GRO (DMMUs 5 and 6).

The concentration of ammonia in elutriates from all DMMUs consistently exceeded concentrations observed at disposal area receiving waters (3,500 to 9,400 ppb and < 0.03 to 1,100 ppb, respectively). The EPA has established water quality criteria for both total ammonia ($NH_3 + NH_4^+$) and unionized ammonia, NH_3, in marine systems (EPA, 1989a). However, the criteria are dependent on water temperature, pH, and salinity, and therefore vary with conditions at receiving waters. While elevated levels of ammonia are common in anaerobic sediments underlying Louisiana's estuaries and waterways, ammonia is rapidly oxidized when exposed to oxygenated surface waters. Special management of dredged material within disposal areas can further facilitate the oxidation of ammonia prior to the release of effluent into adjacent receiving waters. Special management practices include: 1) attachment of a baffle plate to the end of the discharge pipeline to thoroughly expose slurry to oxygen prior to placement in a disposal area; 2) increase retention time within the disposal area by routing slurry through interior dikes or by managing effluent discharge from the disposal area across a weir; and 3) if possible, routing effluent across vegetated wetlands within the disposal area prior to discharge into adjacent receiving waters. Due to elevated levels of ammonia in elutriates from all DMMUs as compared to concentrations in receiving waters, as well as expected seasonal variation in acute WQC, special management practices similar to those described above would be employed during dredged material disposal operations to dissipate ammonia.

The concentration of copper in elutriates from DMMUs 3, 4, 5, and 6 ranged between 6.1 and 6.8 ppb, and exceeded the Louisiana Department of Environmental Quality (LDEQ) acute WQC for marine waters (3.63 ppb). Copper in elutriates from DMMUs 1 and 2 were below WQC (< 2.0 and 2.1 ppb, respectively). Copper in receiving waters of Calcasieu Lake (6.0 ppb) and the Calcasieu River (6.2 to 7.4 ppb) also exceeded acute WQC and concentrations therein were similar to concentrations observed in the elutriates. Copper was not detected in waters of the SNWR (< 2.0 ppb). Dilution factors were determined for copper, with dilution to within 5% of background levels observed in Calcasieu Lake and Calcasieu River, and to WQC in the SNWR (Table 3). The CORMIX model was used to predict the size of mixing zones that would be required for the dilution of copper in effluent from DMMUs 3, 4, 5, and 6 to specified dilution endpoints. Mixing zones extending from disposal areas 7 to 60 feet into Calcasieu Lake, 7 to 33 feet into the Calcasieu River, and 7 to 39 feet into the SNWR would provide sufficient dilution of copper in effluent from the DMMUs.

For coastal lakes and bays, including the open waters of Calcasieu Lake and the SNWR, LDEQ requires that dilution of effluent to WQC or approximate background levels occur within 200 feet of a dredged material disposal area. For tidal channels with flows greater than 100 cubic feet per second, such as the Calcasieu River, mixing zones may not exceed one third of the channels ambient flow. Considering an approximate width of 900', approximate depth of 42', and a mean low tidal velocity of 0.79 feet/second, the regulatory mixing zone for the Calcasieu River is approximately 9,944 feet. Predicted mixing zones required for sufficient dilution of copper are no greater than 60 feet for Calcasieu Lake, 33 feet for Calcasieu River, and 39 feet for SNWR. The predicted mixing zones are well within LDEQ's regulatory mixing zones, and the discharge of dredged material into the proposed disposal areas therefore would have little effect on water quality in adjacent receiving waters.

Water Column Toxicity Test (Elutriate Bioassay)

In water column toxicity tests, sensitive water column organisms are exposed for 96 hours to serial dilutions (100, 50, and 10%) of dredged material elutriate, a site water treatment, and a performance control treatment (reconstituted water, adjusted for salinity). If survival in the 100% dredged material elutriate treatment is at least 10% less than survival in the control, the results are evaluated statistically (t-test) to determine if the elutriate treatment is significantly more toxic than the control.

Water column toxicity tests were conducted with mysid shrimp (*Americamysis bahia*). Five replicates with 10 shrimp per test chamber were run for each elutriate treatment, site water, and control group. Temperature, pH, salinity, dissolved oxygen, and salinity were measured in all test chambers at test initiation and termination; and in select chambers at 24, 48, and 72 hours. Ammonia was also measured prior to test initiation to determine if it was within tolerable limits reported for mysid shrimp. All water quality parameters were within acceptable ranges, and are summarized in Table 4.

Mean survival was relatively high in most of the elutriate treatments (82 to 100%), site water treatment (96%), and control group (98%). There were no statistically significant differences between survival in the control compared to the 100%, 50%, and 10% elutriate treatments for DMMUs 1, 2, 4, and 5; 50% and 10% elutriate treatments for DMMUs 3 and 6; and the site water treatment (Table 5).

Significant differences in mean survival were observed between the control group (98%) and the 100% elutriate treatment for DMMUs 3 and 6 (68 and 65%, respectively). It is unlikely that the observed mortality resulted from ammonia toxicity. According to Miller *et al.* (1990), ammonia toxicity in mysids was observed under similar water quality conditions (temperature, salinity, and pH) at concentrations above 25.5 ppm total ammonia. Total ammonia from the test chambers for the 100% elutriate treatments for both DMMU 3 and 6 was 10 ppm. Moreover, no significantly reduced survival was observed in elutriates with the highest ammonia levels (DMMUs 4 and 5).

Predicted Effluent Toxicity

When statistical analyses from water column toxicity tests indicate that survival in an elutriate treatment is statistically different than survival in the control, dredged material is predicted to be acutely toxic to water column organisms. Dilution of the dredging elutriate is therefore required within a proposed disposal area and across an allowable mixing zone prior to discharge of effluent into adjacent receiving waters. Mixing zone models are evaluated to determine if analytes detected in the dredged material would be diluted within the disposal area and mixing zone to concentrations at or below established benchmarks. Benchmarks may include state or Federal WQC, other conservative screening values, background concentrations in receiving waters, or concentrations equivalent to a "no observable effects level" (NOEL) predicted from the elutriate treatments.

Significant differences in mean survival were observed between the control group and the 100% elutriate treatment for DMMUs 3 and 6. A preliminary screening of analytes detected in elutriates was conducted to reduce the number of analytes carried forward for mixing zone calculations (Table 6). Screening values included available state and Federal WQC, USEPA maximum contaminant levels for drinking water (MCL), and background concentration in receiving waters. Analytes detected in the elutriate, but at concentrations below screening values included arsenic, barium, chromium, nickel, and selenium (DMMUs 3 and 6); and mercury (DMMU 3 only). Analytes carried forward for further analysis included ammonia and copper (DMMUs 3 and 6); and GRO (DMMU 6 only).

It cannot be assumed that analytes detected in the sediment of a DMMU but below detection limits in the elutriate did not contribute to observed mortality in the water column toxicity test. For any analyte that was quantified in the sediment, but below detection limit in the elutriate, the laboratory reporting limit was assumed to represent a maximum concentration expected in the elutriate. An initial comparison of laboratory detection limits with available WQC or MCL was conducted to determine if any of the non-detected analytes should be carried forward for mixing zone calculations (Table 7). Reporting limits for antimony, beryllium, hexavalent chromium, lead, and zinc (DMMUs 3 and 6); PCB-1260 and bis(2-Ethylhexyl) phthalate (DMMU 3 only); and mercury, PCB-1016, 4,4'-DDT, endosulfan II, and tetrachloroethylene (DMMU 6 only) were below screening values and were eliminated from further analysis. DRO and endosulfan II (DMMUs 3 and 6); and chrysene, 4,4'-DDT, GRO, and MRO (DMMU 3 only) were carried forward for further analysis.

Partitioning analysis was used to estimate the concentration of pesticides and PAHs in elutriates from DMMUs 3 and 6 that were below detection limit but carried forward from the screens described above (endosulfan II from DMMUs 3 and 6; chrysene and 4,4'-

DDT from DMMU 3). When analytes exist in a sediment-water "system," they distribute between the solid and aqueous phases proportionally. This distribution occurs as a function of the solubility and hydrophobicity of the analyte, the characteristics and content of carbon-bearing phases within the sediment, length of time the phases have been in contact with each other, and other characteristics of the system. Partitioning analysis uses the known properties of the analytes to predict this distribution, and arrive at estimated dissolved concentrations of analytes in the aqueous phase. Estimated concentrations from the partitioning analysis were compared to available acute WQC and MCL (Table 8). Estimates for 4,4'-DDT and endosulfan II were below acute WQC, and the analytes were eliminated from further analysis. Screening values were not available for chrysene, and the analyte was carried forward for further analysis.

Analytes carried forward for further analysis that require dilution included ammonia, copper, DRO, and GRO (DMMUs 3 and 6); and chrysene and MRO (DMMU 3 only). Considerations for the dilution of ammonia within disposal areas are detailed above in the *Elutriate Chemistry Summary*. Dilution factors were determined for the remaining analytes, with dilution to either WQC, within 5% of background levels in receiving waters, or the predicted NOEL (Table 9). Dilution factors were typically at or below 1.0 for most analytes in DMMU 3 for discharge into Calcasieu Lake, Calcasieu River, and SNWR receiving waters. Slightly greater dilution of chrysene would be required for discharge of DMMU 3 elutriate into the Calcasieu River. Dilution factors ranged between 0.94 and 1.67 for all analytes in DMMU 6, with maximum dilution factors of 1.67 (copper) for Calcasieu Lake; 1.0 (DRO and GRO) for Calcasieu River; and 1.21 (copper) for SNWR.

The CORMIX model was used to predict the size of mixing zones that would be required for the maximum dilution of analytes in effluent from DMMUs 3 and 6 necessary for discharge into Calcasieu Lake, Calcasieu River, and SNWR receiving waters. Mixing zones extending from disposal areas 13 to 60 feet into Calcasieu Lake, 7 to 33 feet into the Calcasieu River, and 10 to 39 feet into the SNWR would provide sufficient dilution of analytes in effluent from the DMMUs.

For coastal lakes and bays, including the open waters of Calcasieu Lake and the SNWR, LDEQ requires that dilution of effluent to WQC or approximate background levels occurs within 200 feet of a dredged material disposal area. For tidal channels with flows greater than 100 cubic feet per second, such as the Calcasieu River, mixing zones may not exceed one third of the channels ambient flow. Considering an approximate width of 900', approximate depth of 42', and a mean low tidal velocity of 0.79 feet/second, the regulatory mixing zone for the Calcasieu River is approximately 9,944 feet. Predicted mixing zones required for sufficient dilution of analytes are no greater than 60 feet for Calcasieu Lake, 33 feet for Calcasieu River, and 39 feet for SNWR. The predicted mixing zones are well within LDEQ's regulatory mixing zones, and the discharge of dredged material into the proposed disposal areas therefore would have little effect on water quality in adjacent receiving waters.

Benthic Toxicity Test/Solid Phase Bioassays

Dredged material is predicted to be acutely toxic to benthic organisms when the mortality of test organisms exposed to sediment from in-channel stations is statistically greater than the mortality of test organisms exposed to sediment from the reference area, <u>and</u> exceeds mortality of organisms exposed to sediment from the reference area by at least 10% (20% for amphipods).

Results from the 10-day benthic toxicity tests/solid phase bioassays using the amphipod, *Leptocheirus plumulosus*, indicated a high level of mortality for all sediments tested, i.e., in both sediments from each DMMU and from the two reference areas (Table 10). Survival in the control sediment indicated that test conditions and health of the organisms were acceptable. Furthermore, dissolved oxygen, temperature, ammonia, pH, and salinity within the test chambers were within the recommended tolerance limits for *L. plumulosus*.

Because sediment chemistry indicated no significant levels of contamination, the test results indicated that the observed toxicity in *L. plumulosus* was likely a response to a non-contaminant confounding factor such as the grain size of the sediments. Physical characterization of the sediment from each DMMU and from the reference areas revealed that the sediments were comprised of silts and clay with high plasticity (Table 11). According to the Unified Soil Classification System, the clays in Calcasieu River and Pass sediments and in sediments at the reference areas are classified as fat clays which are inorganic clays with liquid limts > 50 and high plasticity. Fat clays can be described as cohesive and compressible, difficult to work when damp, but strong when dry. Amphipods such as *L. plumulosus* have limited tolerance to these grain size conditions (Emery et al., 1997).

Additional testing using other benthic species was performed to demonstrate that the toxicity response observed was the result of a non-contaminant effect specific to *L. plumulosus*. The goal of these tests was to determine the response of other sensitive species to the relatively uncontaminated Calcasieu River and Pass sediment. Additional 10-day solid phase bioassays were conducted using 3 species of benthic invertebrates, *L. plumulosus*, *Eohaustorius estuarius* (amphipod), and *Neanthes arenaceodentata* (polychaete) and sediment from DMMU 5. A performance control sediment was included to evaluate test performance.

Mortality of the amphipods exposed to sediment from DMMU 5 was statistically greater than the mortality of these organisms exposed to the control sediment; however, there was no statistical difference between survival of the polychaetes exposed to sediment from DMMU 5 and the control sediment (Table 12). Observed survival for *L. plumulosus* was 10% compared to 90% survival in the control sediment; survival for *E. estuarius* was 33% compared to 89% survival in the control sediment; and survival for *N. arenaceodentata* was 88% compared to 100% survival in the control sediment. Observation of organism behavior during the study revealed that *L. plumulosus* were unable to burrow into the sediment; *E. estuarius* were able to penetrate the sediment but the burrows were extremely shallow; and *N. arenaceodentata* were able to successfully burrow into the sediment. In summary, chemical analysis of sediment from DMMU 5 indicated a relatively low level or absence of chemical contaminants while the physical analysis of the sediment indicated a high percentage of clay (51.7%) with a liquid limit greater than 50 and high plasticity. The amphipods which rely on burrowing into the sediment had a low level of survival in the cohesive DMMU 5 sediments. The polychaete worm which is tolerant of cohesive sediments had a high level of survival in DMMU 5 sediment. The results of these tests and the behavioral observations indicate that the failure to burrow is a result of the inability of the amphipods to physically penetrate the sediment due to its cohesive nature and not the result of a classic sediment avoidance response to contamination.

Based on the results of the additional tests with other sensitive species, it is likely that the observed mortality in the 10-day benthic toxicity tests was a response to a physical effect produced by the cohesiveness and plasticity of the sediment in the navigation channel and at the two reference areas, rather than a response to the presence of contaminants.

Bioaccumulation Tests

According to the ITM, data from bioaccumulation tests are evaluated at two levels. First, the amount of bioaccumulation of a specific contaminant in tissues exposed to dredged material is compared to applicable Food and Drug Administration (FDA) Action or Tolerance Levels for Poisonous or Deleterious Substances in Fish and Shellfish for Human Food, when such levels have been set for the particular contaminant. If the tissue concentration of the contaminant is not less than the FDA levels, the dredged material is predicted to result in benthic bioaccumulation and there is the potential for the dredged material to have an "unacceptable adverse effect." If the tissue concentration of the contaminant is less than the FDA level, or if there is no FDA level for comparison, the contaminant concentration in tissues exposed to dredged material is compared to contaminant concentrations of tissues exposed to sediment from the reference area. If the tissue concentration of the contaminant in organisms exposed to dredged material does not statistically exceed the tissue concentration of the contaminant in organisms exposed to sediment from the reference area, the dredged material is not predicted to result in benthic bioaccumulation. If tissue concentrations of the contaminant in organisms exposed to dredged material statistically exceed those of organisms exposed to sediment from the reference area, the conclusion regarding benthic bioaccumulation is based on technical evaluations such as the following:

1. the toxicological importance of the contaminant;

2. the magnitude by which bioaccumulation in tissues of organisms exposed to dredged material exceed bioaccumulation in tissues of organisms exposed to sediment from the reference area;

3. the propensity for the contaminant to biomagnify within the aquatic food webs;

4. the magnitude by which the contaminant whose bioaccumulation from dredged material exceeds that from the reference area also exceeds the concentrations found in comparable species living in the vicinity of the proposed disposal area; and

5. the number of contaminants for which bioaccumulation from the dredged material is statistically greater than bioaccumulation from sediment from the reference area.

Chemical analysis of tissues of the clam, *Macoma nasuta*, exposed to in-channel sediment/dredged material from DMMUs 1 through 6 during the 28-day solid phase bioaccumulation tests revealed the presence of metals and PAHs (Tables 13 & 14). Tissues exposed to sediment from the reference areas revealed the presence of metals only. PAHs did not bioaccumulate in the tissues of clams exposed to sediment from either of the reference areas.

There are no applicable FDA Action Levels for Poisonous and Deleterious Substances in Fish and Shellfish for Human Food for any of the contaminants that bioaccumulated in tissues of organisms exposed to sediment from the 6 DMMUs.

Bioaccumulation of metals

The concentration of heavy metals in tissues of exposed clams is reported in Table 13 and Figure 2. The concentration of barium in tissues of clams exposed to sediments from the DMMUs (1, 2, 3,5 & 6) were significantly higher than the concentrations in clams exposed to the Calcasieu Lake reference area. Highlighted concentrations of arsenic, barium, copper, lead, and selenium in the tissues of clams exposed to sediments from the DMMUs were significantly higher than concentrations in clams exposed to the SNWR reference area sediment.

The tissue concentrations of arsenic, copper, lead and selenium in clams exposed to channel sediments exceed the concentration of those metals in clams exposed to reference sediments by factors ranging from 0.8 to 1.5 (Tables 15 & 16). Such low magnitude of difference in bioaccumulation levels suggests that the toxicological relevance of the measured statistical significant differences is negligible and does not warrant further examination of the ecological significance. The similarity of the tissue residues from all exposures rule out the metals arsenic, copper, lead and selenium as posing any potential detrimental ecological or human health effect to the disposal area.

The concentrations of barium in tissues of clams exposed to sediment from all six DMMUs were statistically greater than the concentrations of these compounds in tissues of clams exposed to sediment from the SNWR reference area. The magnitude of the difference for the significantly different bioaccumulation ranged from factors of 3.8 to 15.6 (Table 15). The concentrations of barium in tissues of clams exposed to five of the DMMUs were statistically greater than the concentrations of these compounds in tissue of clams exposed to sediment from the Calcasieu Lake reference area with magnitudes ranging from 1.8 to 7.4 (Table 16). Such magnitudes of difference suggest that the

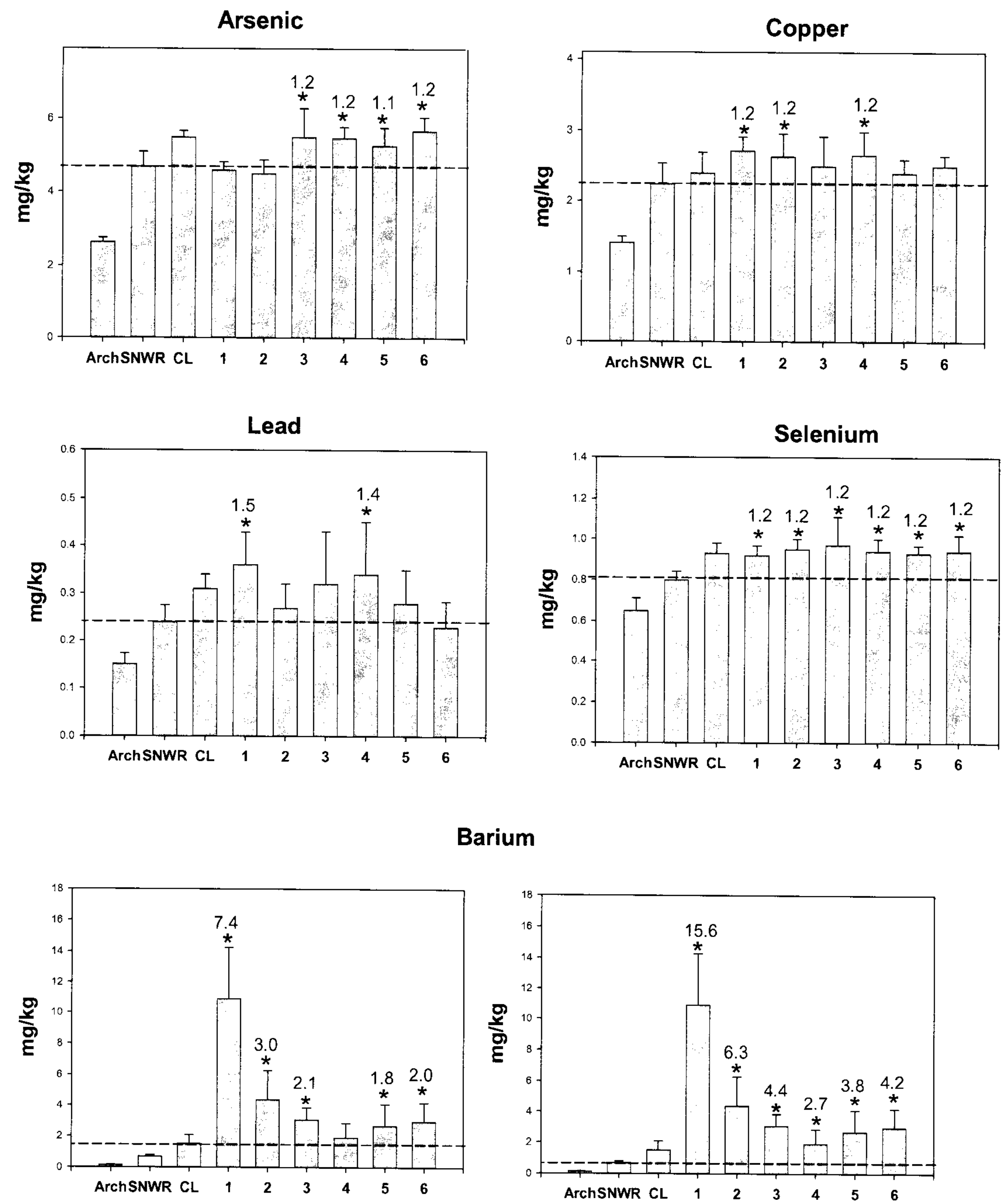

Figure 2. Tissue concentrations (average and standard deviation for 5 replicates) of metals in *Macoma nasuta* exposed to sediment from DMMUs 1 through 6 and the reference areas SNWR and CLWCRA. Concentrations in clams at the time of exposure initiation (Arch) are also reported. The dotted line is the average concentration for the SNWR samples (SNWR or CLWCRA for Barium); * denote significant difference from SNWR; the numbers over the bars denote the magnitude of difference of DMMU average relative to SNWR average (SNWR or CLWCRA for Barium). For simplicity, orders of magnitude have been rounded.

presence of barium in the dredged material may pose detrimental ecological or human health effects at the disposal area, warranting ecological and human risk evaluations of barium bioaccumulation in sediment invertebrates at the disposal site.

Ecological Risk

Although there are no studies that provide direct linkages between tissue residues of barium and adverse biological effects in aquatic organisms, an effect residue can be estimated from concentrations of barium in water producing specific biological effects. The EPA's Ecotox database (http://www/epa.gov/med/databases/databases.htmlaquire) was used to estimate the concentrations of barium at which effects occur in aquatic organisms. No Observed Effect Concentration (NOEC) of barium in water were 500 mg/l for mysid shrimp, *Americamysis bahia* (U.S. EPA, 1978), and 68 mg/l for the water flea, *Daphnia magana* (LeBlanc, 1980). The concentration of barium (Ba) in tissues associated with this effect can be estimated using the bioconcentration factor (BCF) of 100 reported by Bowen (1966) and Schroeder (1970) as follows:

68mg/l NOEC Ba X 100 (BCF) = 6,800 mg/kg Ba estimated NOEC in tissue

The highest concentration of barium in the tissues of the clams exposed to sediment from the Calcasieu River and Pass, 10.9 mg/kg, is 624 times lower than the estimated NOEC; therefore, no effects would be expected to occur in organisms exposed to the sediment proposed for dredging and placement in proposed shallow open water disposal sites for wetland development.

Human Health Risk

Although the concentrations of barium in the tissues of clams exposed to sediment from the Calcasieu River are statistically higher than the concentrations of these metals in tissues of clams exposed to sediment from the reference areas, the levels do not appear to be of toxicological significance with respect to human consumption of contaminated shellfish.

Based on methodology in the EPA's "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1" (EPA, 2000), fish screening values are as follows:

Barium – 280 mg/kg assuming average consumption for recreational fishermen (default national value 17.5 g/d)

The observed bioaccumulation of barium in clams exposed to sediment from the Calcasieu River and Pass channel are around 25 fold and 150 fold less than the EPA screening criteria, respectively.

The oral Reference Dose (RfD) is an estimate of a daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. According to the EPA's IRIS database (www.epa.gov/iris), the RfD for barium is 0.2 mg/kg/day. The acceptable human exposure through consumption of mussels at the site can be determined using the following conservative default assumptions:

- Generic quantity of fish consumed daily (6.8 g/day)
- Weight of average human (70 kg)
- RfD for barium (0.2 mg/kg/day)

Barium: 0.2 mg/kg/day RfD x 70 kg person / 6.8 g shellfish/day = 2.059 mg/g barium in shellfish or estimated maximum acceptable concentration in seafood is 2059mg Barium/kg.

The observed bioaccumulation of barium in clams exposed to sediment from the Calcasieu River are around 190 fold and 1085 fold less than the calculated estimated maximum acceptable concentrations in seafood, respectively.

Because the observed concentrations of barium in the tissues of clams exposed to sediment from the Calcasieu River and Pass are much lower than EPA's fish screening guidelines and the calculated estimated maximum acceptable concentrations in seafood, there does not appear to be a significant concern related to human health risk as a result of the observed bioaccumulation of this metal.

Bioaccumulation of PAHs

Evaluation of the potential ecological effects of the bioaccumulation of the PAHs, fluoranthene, pyrene, and chrysene, was done by direct comparison of total PAH tissue residues from clams exposed to sediment from each DMMU with the Critical Body Residue (CBR) as described by McCarty, *et. al.* (1992) and Dillion and Gibson (1992). The CBR is the whole body concentration of a chemical that is associated with a given adverse biological response (Rand, 1995) and is represented as the ratio of the mass of the chemical/toxicant to the mass of the organism, i.e., *u*mol/g. The acknowledged mode of toxicity for PAHs is narcosis, e.g., lethargy, unconsciousness, and death in extreme narcosis. According to McCarty, *et. al.* (1992), CBRs of PAHs ranging from 2 to 8 *u*mol/g can produce acute narcotic response and CBRs of PAHs ranging from 0.2 to 0.8 *u*mol/g can produce chronic narcotic response.

CBRs were calculated as the sum of the concentrations of all PAHs in tissues of clams exposed to sediment from each of the DMMUs (Tables 17 - 22). The total PAH level in tissues from clams in the DMMUs ranged from 0.00069539 *u*mol/g to 0.000779226 *u*mol/g. These values are 1000 times less than the levels at which chronic narcotic effects might be expected and 10,000 times less than the levels at which acute narcotic effect might be expected.

Further evaluation of the potential ecological effects of the bioaccumulation of PAHs was done by comparing the total PAH level in tissues from clams exposed to sediment in the DMMUs to Narcosis Final Chronic Values (FCV) developed using the target lipid model (Steevens, 2001). This model uses extensive chemical and biological data in an approach to determine the concentration of a narcotic chemical in an organism's tissue which results in an adverse effect. In this approach the % lipid in clams in each DMMU is multiplied by the FCV for PAHs (3.7g *u*mol/g) to determine the concentration that would result in an adverse effect. This FCV is then compared to the CBR in the tissues of the clams exposed to sediment from each DMMU. The calculated CBR for each DMMU is 1000 times less than the FCVs derived with the target lipid model (Table 23).

The discharge of dredged material from the Calcasieu River and Pass, LA, navigation channel into the shallow open water disposal areas for wetland development is not likely to have an unacceptable adverse effect on survival, growth or reproduction of aquatic organisms or pose a human health risk due to bioaccumulation. Neither the magnitude of bioaccumulation of metals nor the total PAH tissue residues in tissues of organisms exposed to sediment from the navigation channel indicate a cause for concern for aquatic organisms living at the proposed placement sites or for humans who may consume those organisms.

Conclusions

This evaluation will be used to make factual determinations of the potential effects of the proposed discharge of dredged material from the Calcasieu River and Pass, LA, navigation channel on the physical, chemical and biological components of the aquatic environment at proposed disposal sites. The factual determinations will determine compliance or noncompliance with the Clean Water Act Section 404 (b) (1) guidelines and specifically with relevant parts of Sections 230.10(b) (compliance with state water quality standards) and 230.10(c) (determination of potential contaminant-related impacts to aquatic resources that would result in significant degradation of the aquatic ecosystem).

Compliance with state water quality standards

Analysis of elutriates and results from water column toxicity tests (elutriate bioassays) indicate that the proposed discharge of effluent from potential disposal areas into receiving waters in broken marsh, Calcasieu Lake, or into the Calcasieu River would comply with state water quality standards or with other equivalent benchmarks within LDEQ regulatory mixing zones.

Ammonia and copper were the only analytes detected in elutriates that exceeded acute WQC. Five analytes without WQC, including barium and chromium, antimony, delta-BHC, and GRO, also were detected in the elutriates

Compliance with EPA WQC for ammonia would be accomplished by oxidation of ammonia by implementation of one or more management practices as follow: 1) attachment of a baffle plate to the end of the discharge pipeline to thoroughly expose slurry to oxygen during placement in a disposal area; 2) increase the retention time within the disposal area by routing slurry through interior dikes or by managing effluent discharge from the disposal area across a weir; and 3) if possible, routing the effluent across vegetated wetlands with the disposal area prior to discharge into adjacent receiving waters.

The CORMIX model predicted that mixing zones required for sufficient dilution of copper to state WQC are no greater than 39 feet for broken marsh and 60 feet for Calcasieu Lake. For discharges into the Calcasieu River, the model predicted sufficient dilution of copper to state WQC within 33 feet of the discharge. The predicted values are well within the LDEQ sanctioned mixing zones of 200 feet for coastal lakes and bays, and the estimate 9,944 feet for the Calcasieu River.

Impacts of COC without WQC and synergistic effects were evaluated using water column toxicity tests (elutriate bioassays). Significant differences in mean survival were observed between the control treatment and the 100% elutriate treatment for two DMMUs, 3 and 6. The CORMIX model was used to determine if analytes detected in the elutriates and sediments from these DMMUs would be diluted within the disposal area and LDEQ sanctioned mixing zone to concentrations at or below established benchmarks. Predicted mixing zones for shallow open water disposal areas within broken marsh and Calcasieu Lake were 39 feet and 60 feet, respectively. For discharge into the Calcasieu River, the predicted mixing zone was 33 feet. The predicted mixing zones are well within LDEQ's regulatory mixing zones.

Potential for contaminant-related impacts to aquatic resources that would result in significant degradation of the aquatic ecosystem

Neither the results of the benthic toxicity tests nor of the bioaccumulation tests indicate a reason to believe that discharge of dredged material from the navigation channel at potential shallow open water disposal sites in broken marsh or the Calcasieu Lake for wetland development would result in significant degradation of the aquatic ecosystem or produce an unacceptable adverse effect on survival, growth or reproduction of aquatic organisms or pose a human health risk due toxicity or bioaccumulation.

Results from the 10-day benthic toxicity tests/solid phase bioassays using the amphipod, *Leptocheirus plumulosus*, indicated high mortality in both sediment from the Calcasieu River navigation channel and from both reference areas. Because sediment chemistry revealed no significant levels of contamination, these results indicate that the observed toxicity was likely a response to a non-contaminant confounding factor such as the grain size of the sediments. Sediments from both the navigation channel and the references areas are similar physically being comprised of silts and clay with high plasticity. Clays in both sediments are classified as fat clays, characterized as inorganic clays with liquid limits greater than 50 and high plasticity. Fat clays can be described as cohesive and compressible, difficult to work when damp, but strong when dry. Additional tests with *L. plumulosus* and two other benthic species, another amphipod and a polychaete, and relatively, "clean" sediment from DMMU 5 support the conclusion that the observed mortality is a response to grain size of the sediments and not chemical contamination.

Metals and PAHs bioaccumulated in the tissues of the clam, *Macoma nasuta*, exposed to in-channel sediment during the 28-day solid phase bioaccumulation tests. Tissues exposed to sediments from the reference areas revealed only the bioaccumulation of metals. Tissue concentrations of arsenic, copper, lead, and selenium in clams exposed to channel sediments were significantly higher than concentrations of these metals in clams exposed to reference sediments but the magnitude of the difference (0.8 to 1.5) is negligible and does not warrant further examination of ecological significance.

Barium concentrations in tissues of clams exposed to sediment from the navigation channel was statistically greater than the concentrations of barium in tissues of clams exposed to sediment from both reference areas. The order of magnitude ranged from factors of 3.8 to 15.6 for SNWR reference area and 1.8 to 7.4 for Calcasieu Lake reference area. A screening level ecological risk evaluation revealed that the highest concentration of barium in tissue of clams exposed to sediment from Calcasieu River navigation channel (10.9 mg/kg) is 624 times lower than the estimated No Observed Effect Concentration (6,800 mg/kg). The observed bioaccumulation of barium also does not appear to be of toxicological significance with respect to human consumption of contaminated shellfish as the observed bioaccumulation of barium is 25 fold less than the EPA's screening criteria for use in fish advisories.

Evaluation of the results from the benthic toxicity tests/solid phase bioassays and bioaccumulation tests indicate that the discharge of dredged material from the Calcasieu River and Pass, LA, navigation channel into proposed shallow open water disposal areas for wetland development is not likely to have an unacceptable adverse effect on survival, growth or reproduction of aquatic organisms or pose a human health risk due toxicity or bioaccumulation of contaminants.

Table 1. Analytes detected in sediment from Calcasieu River and Pass Dredged Material Management Units (DMMUs), and the Calcasieu Lake (CL) and Sabine National Wildlife Refuge (SNWR) reference areas. Analytes that were below laboratory detection limits for a DMMU or reference area are noted with a dash mark (-).

	Channel Sediment						Reference Sediment		
METALS	**DMMU1**	**DMMU2**	**DMMU3**	**DMMU4**	**DMMU5**	**DMMU6**	**CL**	**SNWR**	
Antimony	0.131	0.107	0.174	0.111	-	0.101	-	0.250	(ppm)
Arsenic	1.18	1.48	2.13	2.26	2.56	2.70	3.90	1.20	(ppm)
Barium	180	142	80.8	68.6	116	101	26.0	20.0	(ppm)
Beryllium	0.280	0.326	0.403	0.396	0.564	0.440	0.380	0.340	(ppm)
Chromium	6.26	7.68	6.97	7.04	8.58	8.03	6.90	5.80	(ppm)
Copper	6.16	9.36	6.95	6.44	6.90	5.97	5.00	4.50	(ppm)
Hexavalent Chromium	-	0.106	0.13	0.152	-	0.0957	-	-	(ppm)
Lead	8.22	9.48	8.68	8.32	8.42	7.60	6.60	6.50	(ppm)
Mercury	0.0466	0.114	0.0343	0.0362	0.0335	0.0501	-	-	(ppm)
Nickel	3.38	5.40	6.62	6.92	8.54	8.46	7.70	4.30	(ppm)
Selenium	-	-	-	0.253	0.502	0.335	-	-	(ppm)
Thallium	0.0880	-	-	-	-	-	-	-	(ppm)
Zinc	19.8	29.8	26.3	24.4	26.4	25.1	23.0	10.0	(ppm)

	Channel Sediment						Reference Sediment		
PAHs	**DMMU1**	**DMMU2**	**DMMU3**	**DMMU4**	**DMMU5**	**DMMU6**	**CL**	**SNWR**	
Anthracene	-	12.8	-	-	-	-	-	-	(ppb)
Benzo(a)anthracene	12.4	36.0	-	17.6	-	-	-	-	(ppb)
Benzo(a)pyrene	13.0	27.0	-	19.2	-	-	-	-	(ppb)
Benzo(b)fluoranthene	20.8	10.0	-	21.6	-	-	-	-	(ppb)
Benzo(ghi)perylene	12.4	27.2	-	19.0	-	-	-	-	(ppb)
Benzo(k)fluoranthene	-	-	-	12.2	-	-	-	-	(ppb)
bis(2-Ethylhexyl) phthalate	-	-	21.7	-	-	-	-	-	(ppb)
Chrysene	-	61.6	13.8	19.6	-	-	-	-	(ppb)
Fluoranthene	17.6	47.6	-	20.8	14.0	-	-	-	(ppb)
Fluorene	-	12.2	-	-	-	-	-	-	(ppb)
gamma-Chlordane	0.728	-	-	-	-	-	-	-	(ppb)
Indeno(1,2,3-cd)pyrene	-	15.0	-	14.8	-	-	-	-	(ppb)
Naphthalene	-	12.0	-	-	-	-	-	-	(ppb)
Phenanthrene	-	33.6	-	13.0	-	-	-	-	(ppb)
Sum PAH	76.9	295	35.5	158	14.0	-	-	-	(ppb)

	Channel Sediment						Reference Sediment		
PESTICIDES	**DMMU1**	**DMMU2**	**DMMU3**	**DMMU4**	**DMMU5**	**DMMU6**	**CL**	**SNWR**	
4,4'-DDT	2.67	1.16	2.26	2.08	-	1.85	2.30	2.00	(ppb)
beta-BHC	-	1.15	-	-	-	-	-	-	(ppb)
delta-BHC	1.56	0.667	-	-	-	-	1.20	1.30	(ppb)
Endosulfan Sulfate	2.98	-	-	-	-	-	-	-	(ppb)
Endosulfan II	-	-	2.08	2.05	-	2.11	-	-	(ppb)
gamma-BHC	-	-	-	0.618	-	-	-	-	(ppb)
Heptachlor	-	0.585	-	0.574	-	-	-	-	(ppb)

	Channel Sediment						Reference Sediment		
OTHER	**DMMU1**	**DMMU2**	**DMMU3**	**DMMU4**	**DMMU5**	**DMMU6**	**CL**	**SNWR**	
Diesel Range Organics	41800	55600	43500	43600	34200	18157	6900	7300	(ppb)
Gasoline Range Organics	-	228	204	172	-	-	-	-	(ppb)
Motor Oil Range Organics	135600	144000	79000	50500	-	-	-	-	(ppb)
PCB-1016	-	-	-	1.99	-	0.744	-	-	(ppb)
PCB 1254	6.19	-	-	1.24	-	-	-	-	(ppb)
PCB 1260	3.60	5.92	1.68	0.927	-	-	-	-	(ppb)
Tetrachloroethylene	-	-	-	-	-	1.29	-	-	(ppb)
Ammonia	6023	48000	34833	27000	27000	24714	3500	-	(ppb)

Table 2. Analytes detected in elutriates from Calcasieu River and Pass Dredged Material Management Units (DMMUs), and background water chemistry from Calcasieu Lake (CL), Sabine National Wildlife Refuge (SNWR), and the Calcasieu River (miles 36-5). Comparison to state and Federal water quality criteria (WQC). Analytes that were below laboratory detection limits for a DMMU or reference area are noted with a dash mark (-).

Analyte	Elutriate Chemistry DMMU 1	Lowest Marine Acute WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 36-33	
Antimony	2.1	-	< 2.0	< 2.0	< 2.0	(ppb)
Arsenic	53	69[a,b]	34	< 2.0	43	(ppb)
Barium	710	-	89	2.05	72	(ppb)
Chromium	9.5	-	6.7	< 2.0	8.1	(ppb)
Mercury	0.37	1.8[a]	< 0.2	< 0.2	< 0.2	(ppb)
Nickel	15	74[a,b]	11	< 2.0	13	(ppb)
Selenium	190	290[b]	130	< 2.0	150	(ppb)
4,4'-DDD	0.0023	1.25[a,b]	< 0.0019	< 0.0019	< 0.0019	(ppb)
4,4'-DDE	0.0055	0.7[a,b]	< 0.0019	< 0.0019	< 0.0019	(ppb)
Endrin	0.0024	0.037[a,b]	< 0.0019	0.0020	0.0032	(ppb)
gamma-Chlordane	0.0019	0.09[a,b]	< 0.00094	< 0.00094	< 0.00094	(ppb)
Heptachlor epoxide	0.016	0.053[b]	0.0051	0.00095	< 0.0094	(ppb)
Ammonia	7300	Varies[c]	210	200	260	(ppb)

Analyte	Elutriate Chemistry DMMU 2	Lowest Acute Marine WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 33-30	
Arsenic	57	69[a,b]	34	< 2.0	44	(ppb)
Barium	270	-	89	4.1	62	(ppb)
Chromium	12	-	6.7	< 2.0	7.3	(ppb)
Copper	2.1	3.63[a]	6.0	< 2.0	7.2	(ppb)
Nickel	15	74[a,b]	11	< 2.0	13	(ppb)
Selenium	200	290[b]	130	< 2.0	170	(ppb)
delta-BHC	0.0016	-	< 0.00095	< 0.00094	< 0.00093	(ppb)
Endrin	0.0031	0.037[a,b]	< 0.0019	0.002	0.0036	(ppb)
gamma-BHC	0.0017	0.16[a,b]	< 0.00095	< 0.00094	< 0.00093	(ppb)
Heptachlor	0.0019	0.053[a,b]	< 0.00095	< 0.00094	< 0.00093	(ppb)
Heptachlor epoxide	0.0034	0.053[b]	0.0051	0.00095	0.0170	(ppb)
Ammonia	9400	Varies[c]	210	200	71	(ppb)

Analyte	Elutriate Chemistry DMMU 3	Lowest Acute Marine WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 30-24	
Arsenic	50	69[a,b]	34	< 2.0	53	(ppb)
Barium	150	-	89	4.1	55	(ppb)
Chromium	12	-	6.7	< 2.0	7.5	(ppb)
Copper	6.1	3.63[a]	6.0	< 2.0	6.2	(ppb)
Mercury	0.4	1.8[a]	< 0.2	< 0.2	0.69	(ppb)
Nickel	14	74[a,b]	11	< 2.0	15	(ppb)
Selenium	180	290[b]	130	< 2.0	200	(ppb)
Ammonia	7300	Varies[c]	210	200	58	(ppb)

a = LA DEQ acute water quality criteria for marine systems
b = EPA acute water quality criteria for marine systems
c = EPA acute WQC varies with temperature, salinity, and pH; acute criteria therefore vary with site specific variation.

Table 2 (continued). Analytes detected in elutriates from Calcasieu River and Pass Dredged Material Management Units (DMMUs), and background water chemistry from Calcasieu Lake (CL), Sabine National Wildlife Reserve (SNWR), and the Calcasieu River (miles 36-5). Comparison to state and Federal water quality criteria (WQC). Analytes that were below laboratory detection limits for a DMMU or reference area are noted with a dash mark (-).

Analyte	Elutriate Chemistry DMMU 4	Lowest Acute Marine WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 24-21	
Arsenic	56	69[a,b]	34	< 2.0	44	(ppb)
Barium	200	-	89	4.1	54	(ppb)
Chromium	10	-	6.7	< 2.0	9.7	(ppb)
Copper	6.3	3.63[a]	6.0	< 2.0	7.4	(ppb)
Nickel	16	74[a,b]	11	< 2.0	15	(ppb)
Selenium	200	290[b]	130	< 2.0	180	(ppb)
Zinc	7.3	90[a,b]	3.4	3.6	4.9	(ppb)
Ammonia	9300	Varies[c]	210	200	35	(ppb)

Analyte	Elutriate Chemistry DMMU 5	Lowest Acute Marine WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 21-16	
Arsenic	56	69[a,b]	34	< 2.0	55	(ppb)
Barium	170	-	89	4.1	48	(ppb)
Chromium	8.4	-	6.7	< 2.0	8.9	(ppb)
Copper	6.8	3.63[a]	6.0	< 2.0	7.0	(ppb)
Nickel	17	74[a,b]	11	< 2.0	15	(ppb)
Selenium	210	290[b]	130	< 2.0	200	(ppb)
Zinc	5.4	90[a,b]	3.4	3.6	4.8	(ppb)
Gasoline Range Organics	52	-	< 50	< 50	< 50	(ppb)
Ammonia	7900	Varies[c]	210	200	< 30	(ppb)

Analyte	Elutriate Chemistry DMMU 6	Lowest Acute Marine WQC	Receiving Water - Background Chemistry Calcasieu Lake	SNWR	River mi. 16-5	
Arsenic	56	69[a,b]	34	< 2.0	53	(ppb)
Barium	200	-	89	4.1	55	(ppb)
Chromium	8.3	-	6.7	< 2.0	7.5	(ppb)
Copper	6.8	3.63[a]	6.0	< 2.0	6.2	(ppb)
Nickel	15	74[a,b]	11	< 2.0	15	(ppb)
Selenium	200	290[b]	130	< 2.0	200	(ppb)
Gasoline Range Organics	57	-	< 50	< 50	< 50	(ppb)
Ammonia	3500	Varies[c]	210	200	58	(ppb)

a = LA DEQ acute water quality criteria for marine systems
b = EPA acute water quality criteria for marine systems
c = EPA acute WQC varies with temperature, salinity, and pH; acute criteria therefore vary with site specific variation.

Table 3. Concentration of copper in elutriates from DMMUs requiring dilution. Dilution endpoints and dilution factors for discharge into Calcasieu Lake, Calcasieu River, and Sabine National Wildlife Refuge (SNWR) disposal areas. Shaded dilution factors indicate where dilution is required for disposal of dredging elutriate into a given disposal area.

	Elutriate	Required Endpoint for Dilution (ppb)			Dilution Factor[c]		
DMMU	Copper (ppb)	Calcasieu Lake[a]	Calcasieu River[a]	SNWR[b]	Calcasieu Lake	Calcasieu River	SNWR
3	6.1	6.3	6.5	3.63	0	0	0.94
4	6.3	6.3	7.8	3.63	0	0	1.02
5	6.8	6.3	7.4	3.63	1.67	0	1.21
6	6.8	6.3	6.5	3.63	1.67	0.94	1.21

a = endpoint includes a 5% allowance above background levels.
b = acute water quality criteria; copper below detection in ambient water.
c = dilution factors were determined with the following equations:

(1a) Where background concentration exceeded WQC, $D = [C_{100\%\ Elutriate} - (1.05 \times C_{background})] / [(1.05 \times C_{background}) - C_{background}]$

(1b) Where background concentration were below WQC, $D = (C_{100\%\ Elutriate} - C_{WQC}) / (C_{WQC} - C_{background})$

Note that at the SNWR, copper was below detection limit in ambient water but detected in sediments. A conservative estimate for copper of 1.0 ppb (1/2 of the laboratory reporting limit) was assumed to represent maximum background concentration expected at the SNWR, and was included in the denominator of equation 1b.

Table 4. Water quality observations from test chambers during the elutriate bioassay.

Site ID	Treatment	Temperature (°C)	Salinity (‰)	pH (SU)	D.O. (mg/L)	Initial Ammonia (mg/L)
Performance Control (30 ‰ Instant Ocean)	NA	19.7 ± 0.2 (19.2 – 19.9)	29 ± 1 (28 – 30)	7.86 ± 0.05 (7.73 – 7.89)	7.1 ± 0.6 (6.3 – 7.9)	< 1
Site water	0%	19.9 ± 0.3 (19.6 – 20.7)	27 ± 0 (27 – 27)	8.13 ± 0.04 (8.03 – 8.17)	7.0 ± 0.9 (5.9 – 8.3)	< 1
DMMU 1	10%	19.9 ± 0.4 (19.5 – 20.8)	27 ± 0 (27 – 27)	7.98 ± 0.07 (7.92 – 8.20)	7.2 ± 1.0 (5.9 – 8.5)	NA
	50%	19.4 ± 0.8 (18.2 – 20.8)	27 ± 0 (27 – 27)	8.11 ± 0.07 (8.00 – 8.19)	7.3 ± 1.1 (5.6 – 8.8)	5
	100%	19.1 ± 1.2 (17.5 – 20.8)	27 ± 0 (26 – 27)	8.24 ± 0.10 (8.10 – 8.35)	7.3 ± 1.1 (5.8 – 8.8)	10 ‡
DMMU 2	10%	19.6 ± 0.5 (19.0 – 20.8)	28 ± 1 (27 – 29)	8.01 ± 0.02 (7.97 – 8.07)	7.3 ± 0.8 (6.3 – 8.3)	NA
	50%	19.5 ± 0.6 (18.8 – 20.6)	28 ± 1 (27 – 29)	8.25 ± 0.22 (8.11 – 8.95)	7.3 ± 1.0 (6.1 – 8.5)	5
	100%	19.4 ± 0.6 (18.5 – 20.6)	27 ± 1 (26 – 28)	8.31 ± 0.13 (8.15 – 8.44)	7.3 ± 0.9 (6.3 – 8.5)	10 ‡
DMMU 3	10%	19.5 ± 0.5 (18.8 – 20.6)	28 ± 1 (27 – 28)	7.94 ± 0.11 (7.61 – 8.02)	7.2 ± 0.8 (6.3 – 8.2)	NA
	50%	19.3 ± 0.9 (18.0 – 20.6)	28 ± 1 (27 – 29)	8.15 ± 0.12 (7.97 – 8.29)	7.4 ± 1.0 (6.3 – 8.5)	5
	100%	19.2 ± 1.1 (17.5 – 20.9)	28 ± 1 (27 – 28)	8.26 ± 0.16 (8.01 – 8.44)	7.5 ± 1.2 (6.3 – 9.2)	10 ‡
DMMU 4	10%	19.8 ± 0.2 (19.2 – 19.9)	28 ± 1 (27 – 29)	7.92 ± 0.05 (7.85 – 7.99)	7.1 ± 0.7 (6.2 – 7.9)	NA
	50%	19.7 ± 0.3 (18.9 – 19.9)	27 ± 2 (25 – 29)	8.11 ± 0.14 (7.94 – 8.26)	7.1 ± 0.5 (6.5 – 7.7)	7
	100%	19.8 ± 0.2 (19.4 – 20.0)	28 ± 1 (27 – 28)	8.23 ± 0.19 (7.99 – 8.43)	6.9 ± 0.6 (6.1 – 7.5)	14 ‡
DMMU 5	10%	19.8 ± 0.2 (19.2 – 19.9)	28 ± 1 (27 – 30)	7.93 ± 0.09 (7.70 – 8.03)	7.2 ± 0.6 (6.4 – 7.9)	NA
	50%	19.9 ± 0.2 (19.2 – 20.1)	27 ± 2 (24 – 30)	8.08 ± 0.17 (7.88 – 8.26)	7.1 ± 0.5 (6.3 – 7.9)	8
	100%	19.8 ± 0.3 (19.1 – 20.0)	27 ± 1 (25 – 29)	8.17 ± 0.26 (7.87 – 8.43)	6.9 ± 0.4 (6.5 – 7.3)	16 ‡
DMMU 6	10%	19.8 ± 0.2 (19.4 – 20.0)	28 ± 1 (27 – 30)	7.97 ± 0.08 (7.86 – 8.13)	7.3 ± 0.6 (6.5 – 7.9)	1
	50%	19.8 ± 0.2 (19.4 – 20.0)	28 ± 2 (27 – 30)	8.12 ± 0.16 (7.80 – 8.29)	7.2 ± 0.5 (6.5 – 7.7)	5
	100%	19.7 ± 0.1 (19.5 – 20.0)	28 ± 1 (27 – 30)	8.24 ± 0.19 (8.02 – 8.45)	6.9 ± 0.4 (6.5 – 7.6)	10

‡ Measurement > 8 mg/L. Extrapolated from lower concentration
NA = not available

Table 5. Survival mean, standard deviation, and range of *Americamysis bahia* from the elutriate bioassay. Statistical comparison (t-test) of survival in treatments to the performance control. An asterisk indicates treatments with significantly greater mortality than observed in the control.

Site ID	Treatment	Mean Survival		Min	Max
Performance Control (30 ‰ Instant Ocean)	NA	98 ± 4%		90%	100%
Site water	0%	96 ± 5%		90%	100%
DMMU 1	10%	100 ± 0%		100%	100%
	50%	98 ± 4%		90%	100%
	100%	96 ± 5%		90%	100%
DMMU 2	10%	94 ± 9%		80%	100%
	50%	86 ± 11%		70%	100%
	100%	86 ± 11%		70%	100%
DMMU 3	10%	98 ± 4%		90%	100%
	50%	100 ± 0%		100%	100%
	100%	68 ± 8%	*	60%	80%
DMMU 4	10%	94 ± 5%		90%	100%
	50%	90 ± 12%		70%	100%
	100%	82 ± 13%		60%	90%
DMMU 5	10%	98 ± 4%		90%	100%
	50%	98 ± 4%		90%	100%
	100%	88 ± 4%		80%	90%
DMMU 6	10%	96 ± 5%		90%	100%
	50%	94 ± 5%		90%	100%
	100% #	65 ± 13%	*	50%	80%

* Statistically reduced survival compared to site water (0% treatment)
# One replicate lost due to laboratory error. Four replicates used in data presentation and analysis.

Table 6. Analytes detected in elutriates from DMMUs 3 and 6. Comparison to screening values and receiving water chemistry at Calcasieu Lake, Calcasieu River, and Sabine National Wildlife Refuge (SNWR). Analytes were first compared to available screening values. If screening values were exceeded or were not available, analytes were compared to background concentrations. Shaded analytes were carried forward for dilution calculations.

			Screening Values		Receiving Waters - Background Chemistry			
	Analyte	Elutriate	Acute WQC[a]	EPA MCL[b]	Calcasieu Lake	Calcasieu River	SNWR	
DMMU 3	Arsenic	50	69	.	34	53	< 2.0	(ppb)
	Barium	150	.	2000	89	55	4.1	(ppb)
	Chromium	12	.	100	6.7	7.5	< 2.0	(ppb)
	Copper	6.1	3.63	.	6.0	6.2	< 2.0	(ppb)
	Mercury	0.4	1.8	.	< 0.2	0.69	< 0.2	(ppb)
	Nickel	14	74	.	11	15	< 2.0	(ppb)
	Selenium	180	290	.	130	200	< 2.0	(ppb)
	Ammonia	7300	Varies[c]	.	210	58	200	(ppb)
DMMU 6	Arsenic	56	69	.	34	53	< 2.0	(ppb)
	Barium	200	.	2000	89	55	4.1	(ppb)
	Chromium	8.3	.	100	6.7	7.5	< 2.0	(ppb)
	Copper	6.8	3.63	.	6.0	6.2	< 2.0	(ppb)
	Nickel	15	74	.	11	15	< 2.0	(ppb)
	Selenium	200	290	.	130	200	< 2.0	(ppb)
	Gasoline Range Organics	57	.	.	< 50	< 50	< 50	(ppb)
	Ammonia	3500	Varies[c]	.	210	58	200	(ppb)

a = lowest marine acute WQC available from either state or Federal criteria.

b = USEPA Maximum Contaminant Levels (MCL) for drinking water.

c = EPA acute WQC varies with temperature, salinity, and pH; acute criteria therefore vary with site specific variation.

Table 7. Analytes below detection limits in elutriates, but detected in sediments, from DMMUs 3 and 6. Comparison of reporting limits to screening values and receiving water chemistry at Calcasieu Lake, Calcasieu River, and Sabine National Wildlife Refuge (SNWR). Reporting limits were first compared to screening values. If screening values were exceeded or not available, analytes were compared to background concentrations. Shaded analytes were carried forward for partitioning analysis (where possible) or dilution calculations.

		Elutriate	Screening Values		Receiving Waters - Background Chemistry			
	Analyte	Reporting Limit	Acute WQC[a]	EPA MCL[b]	Calcasieu Lake	Calcasieu River	SNWR	
DMMU 3	Antimony	< 2.0	.	6.0	< 2.0	< 2.0	< 2.0	(ppb)
	Beryllium	< 2.0	.	4.0	< 2.0	< 2.0	< 2.0	(ppb)
	Hexavalent Chromium	< 10	1100	.	< 10	< 10	< 10	(ppb)
	Lead	< 2.0	209	.	< 2.0	< 2.0	< 2.0	(ppb)
	Zinc	< 5.0	90	.	3.4	5.6	3.6	(ppb)
	4,4'-DDT	n/a	0.13	.	0.0046	0.011	0.0029	(ppb)
	Endosulfan II	< 0.04	0.034	.	< 0.0019	< 0.0019	< 0.0019	(ppb)
	Diesel Range Organics	< 100	.	.	< 100	< 100	< 100	(ppb)
	Gasoline Range Organics	< 50	.	.	< 50	< 50	< 50	(ppb)
	Motor Oil Range Organics	< 3000	.	.	< 3000	< 3000	< 3000	(ppb)
	PCB-1260	< 0.4	.	0.5	< 0.047	< 0.047	< 0.048	(ppb)
	Chrysene	< 0.2	.	.	< 0.2	< 0.2	< 0.2	(ppb)
	bis(2-Ethylhexyl) phthalate	< 2.0	.	6.0	< 2.1	< 2.0	< 2.0	(ppb)
DMMU 6	Antimony	< 2.0	.	6.0	< 2.0	< 2.0	< 2.0	(ppb)
	Beryllium	< 2.0	.	4.0	< 2.0	< 2.0	< 2.0	(ppb)
	Hexavalent Chromium	< 10	1100	.	< 10	< 10.0	< 10	(ppb)
	Lead	< 2.0	209	.	< 2.0	< 2.0	< 2.0	(ppb)
	Mercury	< 0.2	1.8	.	< 0.2	0.69	< 0.2	(ppb)
	Zinc	< 5.0	90	.	3.4	5.6	3.6	(ppb)
	Diesel Range Organics	< 100	.	.	< 100	< 100	< 100	(ppb)
	PCB-1016	< 0.4	.	0.5	< 0.047	< 0.047	< 0.048	(ppb)
	4,4'-DDT	< 0.002	0.13	.	0.0046	0.011	0.0029	(ppb)
	Endosulfan II	< 0.04	0.034	.	< 0.0019	< 0.0019	< 0.0019	(ppb)
	Tetrachloroethylene	< 1.0	1020	.	< 1.0	< 1.0	< 1.0	(ppb)

n/a = not available

a = lowest marine acute WQC available from either state or Federal criteria.

b = USEPA Maximum Contaminant Levels (MCL) for drinking water.

Table 8. Predicted analyte concentration from partioning analysis for DMMUs 3 and 6. Comparison to screening values and receiving water chemistry at Calcasieu Lake, Calcasieu River, and Sabine National Wildlife Refuge (SNWR). Predicted concentrations for shaded analytes exceeded either screening values (when available), background analyte concentration, or water chemistry detection limits, and were carried forward for dilution calculations.

DMMU	Analyte	Elutriate Predicted Conc.	Screening Values Acute WQC[a]	Screening Values EPA MCL[b]	Receiving Waters - Background Chemistry Calcasieu Lake	Receiving Waters - Background Chemistry Calcasieu River	Receiving Waters - Background Chemistry SNWR	
3	Chrysene	0.004	.	.	< 0.2	< 0.2	< 0.2	(ppb)
	4,4'-DDT	0.001	0.13	.	0.0046	0.011	0.0029	(ppb)
	Endosulfan II	0.006	0.034	.	< 0.0019	< 0.0019	< 0.0019	(ppb)
6	Endosulfan II	0.02	0.034	.	< 0.0019	< 0.0019	< 0.0019	(ppb)

a = lowest marine acute WQC available from either state or Federal criteria.
b = USEPA Maximum Contaminant Levels (MCL) for drinking water.

Table 9. Elutriates from DMMUs 3 and 6 requiring dilution. Dilution endpoints and dilution factors for discharge into Calcasieu Lake, Calcasieu River, and Sabine National Wildlife Refuge (SNWR) disposal areas. Positive dilution factors are shaded to indicate that dilution is required for disposal of a analyte into a given disposal area.

	Analyte	Elutriate (ppb)	Required Endpoint for Dilution (ppb)			Dilution Factor[g]		
			Calcasieu Lake	Calcasieu River	SNWR	Calcasieu Lake	Calcasieu River	SNWR
DMMU 3	Copper	6.1[a]	6.3[d]	6.5[d]	3.63[e]	0	0	0.94
	Chrysene	0.004[b]	0.002[f]	0.002[f]	0.002[f]	1.0[h]	2.0[h]	1.0[h]
	Diesel Range Organics	100[c]	50[f]	50[f]	50[f]	1.0	1.0	1.0
	Gasoline Range Organics	50[c]	25[f]	25[f]	25[f]	1.0	1.0	1.0
	Motor Oil Range Organics	3000[c]	1500[f]	1500[f]	1500[f]	1.0	1.0	1.0
DMMU 6	Copper	6.8[a]	6.3[d]	6.5[d]	3.63[e]	1.67	0.94	1.21
	Diesel Range Organics	100[c]	50[f]	50[f]	50[f]	1.0	1.0	1.0
	Gasoline Range Organics	57[a]	28.5[f]	28.5[f]	28.5[f]	1.0	1.0	1.0

a = observed concentration
b = predicted concentration
c = laboratory reporting limit; analyte was not detected in the elutriate, but concentration assumed to be equivalent to the reporting limit.
d = endpoint includes a 5% allowance above background levels.
e = acute water quality criteria; copper below detection in ambient water.
f = No Observable Effects Level (NOEL); equivalent to expected analyte concentration in the 50% elutriate bioassay treatment.
g = dilution factors were determined with the following equations:

(1a) Where background concentration exceeded WQC, $D = [C_{100\%\ Elutriate} - (1.05 \times C_{background})] / [(1.05 \times C_{background}) - C_{background}]$

(1c) Where NOEL served as a dilution endpoint (WQC not available), $D = (C_{100\%\ Elutriate} - C_{NOEL}) / (C_{NOEL} - C_{background})$

h = background concentration of chrysene in reference area waters predicted from partitioning analysis (Calcasieu Lake 0 ppb; Calcasieu River 0.001 ppb; SNWR 0 ppb).

Note that for gasoline and motor oil range organics, background concentration in reference area waters was assumed to be zero because the analytes were not detected in water or sediment from the reference areas. Diesel range organics (DRO) were detected in reference area sediments, but below laboratory detection limits in ambient water. Partitioning coefficients were not available to predict surface water background concentrations - and a default assingment of 1/2 the laboratory reporting limit for DRO (equal to the NOEL dilution endpoint) would have resulted in a mathmatical error (zero denominator) in dilution equation 1c. A value of zero was therefore assigned to background concentrations of DRO in ambient waters of the reference areas.

Table 10. *Leptocheirus plumulosus* survival in benthic toxicity tests

Treatment	Percent Survival	
	Mean	STD
Control	98	2.7
DMMU 1	29	11.2
DMMU 2	60	7.9
DMMU3	14	10.2
DMMU 4	11	5.5
DMMU 5	23	20.8
DMMU 6	28	12.5
Calcasieu Lake reference	11	10.8
SNWR reference	21	11.9

Table 11. Physical characteristics of sediment

Sample Identification	Moisture Content	Total Organic Carbon	Liquid Limit	Plasticity Index	Plastic Limit	Specific Gravity	Sand	Silt	Clay
	%	%					%	%	%
D1-06-01	87.1	2.7	33	15	18	2.651	49.7	26.0	24.3
D1-06-02	154.2	4.8	91	62	29	2.677	15.7	29.0	55.4
D1-06-03	182.6	7.7	119	81	38	2.664	7.3	24.8	67.9
D1-06-04	182.3	6.6	110	76	34	2.668	15.1	29.9	55.0
D1-06-05	156.1	5.1	52	25	26	2.631	30.0	21.6	47.8
D2-06-01	182.9	4.2	118	81	37	2.222	16.4	44.3	39.2
D2-06-02	242.8	7.2	73	31	41	2.710	7.3	55.8	36.9
D2-06-03	161.6	4.2	101	70	32	2.656	19.9	46.8	33.3
D2-06-04	201.9	7.5	130	87	43	2.689	4.1	47.9	48.0
D2-06-05	220.3	6.9	142	92	50	2.519	7.7	41.0	51.3
D3-06-01	186.8	8.8	124	79	46	2.729	2.2	41.7	56.2
D3-06-02	169.3	11.4	129	85	44	2.726	8.0	41.3	50.6
D3-06-03	164.7	9.1	123	80	43	2.725	9.2	36.2	54.6
D3-06-04	163.8	8.8	122	77	46	2.736	2.6	36.7	60.7
D3-06-05	154.9	7.1	117	75	42	2.735	8.8	33.2	58.0
D3-06-06	170.1	6.9	113	74	39	2.731	12.6	33.7	53.7
D4-06-01	162.8	3.5	120	80	41	2.431	4.8	29.3	65.8
D4-06-02	173.6	5.5	126	79	47	2.716	0.8	26.3	73.0
D4-06-03	153.4	3.4	72	37	35	2.721	5.7	41.9	52.4
D4-06-04	125.7	4.2	57	30	27	2.653	26.3	29.3	44.4
D4-06-05	139.9	5.0	110	72	38	2.714	6.7	30.2	63.1
D5-06-01	132.7	4.4	61	29	39	2.723	14.6	33.7	51.7
D5-06-02	124.1	3.0	64	32	32	2.730	10.1	36.6	53.4
D5-06-03	164.7	3.7	71	35	35	2.728	3.4	38.6	58.0
D5-06-04	105.6	3.8	58	29	28	2.714	19.1	34.2	46.6
D5-06-05	104.0	2.6	63	32	31	2.757	10.7	34.5	54.8
D6-06-01	114.6	2.5	68	37	31	2.718	9.8	36.3	53.8
D6-06-02	108.9	3.7	63	37	26	2.740	9.5	39.7	50.8
D6-06-03	106.5	3.8	60	32	28	2.683	14.9	40.7	44.5
D6-06-04	95.6	2.2	57	32	25	2.724	20.1	39.3	40.6
D6-06-05	68.7	2.5	40	25	15	2.710	41.3	28.9	29.8
D6-06-06	41.5	1.1	0	NP	0	2.680	78.6	7.8	13.6
Calcasieu Lake Wetland Creation Ref Area	66.8	1.0	47	27	20	2.724	36.1	31.0	32.9
SNWR Wetland Restoration Ref/Disposal Area	98.2	6.1	71	44	27	2.322	24.8	21.0	53.9
Upland Ref Area	24.4	5.0	28	10	19	2.663	13.9	52.3	33.8

Table 12. Survival results from additional benthic toxicity tests			
Test Organism	Treatment	Mean	SD
Leptocheirus plumulosus	Control	90%	12%
	DMMU 5	10%	5%
Eohastorius estuarius	Control	89%	4%
	DMMU 5	33%	15%
Neanthes arenaceodentata	Control	100%	0%
	DMMU 5	88%	18%

Table 13 . Tissue concentrations (average and standard deviation for 5 replicates) of metals in *Macoma nasuta* exposed to sediment from DMMUs 1 through 6 and the reference areas. Concentrations in clams at the time of exposure initiation (Archive) are also reported. Shaded values are significantly higher than in tissues exposed to reference areas.

Sample	Tissue Concentration (mg/kg)																			
	Antimony		Arsenic		Barium		Chromium		Copper		Lead		Mercury		Nickel		Selenium		Zinc	
	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev	Avg	St Dev
Archive	BDL	BDL	2.64	0.11	0.15	0.02	0.20	0.08	1.42	0.08	0.15	0.02	0.06	0.01	0.38	0.02	0.65	0.06	14.00	0.45
SNWR	BDL	BDL	4.70	0.41	0.70	0.08	0.37	0.22	2.24	0.30	0.24	0.04	0.17	0.03	0.58	0.18	0.80	0.04	17.00	1.60
CLWCRA	0.13	N/A	5.50	0.17	1.50	0.58	0.38	0.10	2.40	0.30	0.31	0.03	0.19	0.08	0.79	0.09	0.93	0.05	19.00	1.30
DMMU1	BDL	BDL	4.60	0.23	10.90	3.37	0.32	0.07	2.72	0.19	0.36	0.07	0.23	0.10	0.54	0.16	0.92	0.05	17.00	0.71
DMMU2	BDL	BDL	4.50	0.38	4.38	1.90	0.29	0.09	2.64	0.32	0.27	0.05	0.17	0.10	0.41	0.13	0.95	0.05	16.00	0.55
DMMU3	BDL	BDL	5.50	0.77	3.08	0.77	0.62	0.61	2.50	0.42	0.32	0.11	0.24	0.16	0.55	0.19	0.97	0.14	19.00	2.70
DMMU4	BDL	BDL	5.48	0.30	1.90	0.95	0.30	0.06	2.66	0.33	0.34	0.11	0.15	0.07	0.77	0.34	0.94	0.06	19.00	2.70
DMMU5	0.16	N/A	5.28	0.48	2.68	1.40	0.26	0.09	2.40	0.20	0.28	0.07	0.16	0.09	0.51	0.18	0.93	0.04	16.00	1.60
DMMU6	BDL	BDL	5.68	0.36	2.96	1.20	0.32	0.15	2.50	0.15	0.23	0.05	0.23	0.10	0.53	0.23	0.94	0.08	18.00	1.10

Table 14. Tissue concentrtions (average and standard deviation of 5 replicates) of PAHs in *Macoma nasuta* exposed to DMMUs 1 through 6 and the reference areas. Concentrations in clams at the time of exposure initiation (Archive) area also reported. Shaded values are significantly higher than in tissues exposed to reference areas.

Sample	Tissue Concentration (mg/kg)					
	Chrysene		Fluoranthene		Pyrene	
	Avg	St Dev	Avg	St Dev	Avg	St Dev
Archive	BDL	BDL	BDL	BDL	BDL	BDL
SNWR	BDL	BDL	BDL	BDL	BDL	BDL
CLWCRA	BDL	BDL	BDL	BDL	BDL	BDL
DMMU1	BDL	BDL	21.2	N/A	15	6.9
DMMU2	24.4	9.1	BDL	BDL	27.8	3.6
DMMU3	BDL	BDL	BDL	BDL	18.4	8.1
DMMU4	BDL	BDL	BDL	BDL	23.6	8.7
DMMU5	BDL	BDL	BDL	BDL	BDL	BDL
DMMU6	BDL	BDL	BDL	BDL	BDL	BDL

Table 15 . Magnitude of difference of metals tissue concentrations in clams exposed to DMMUs 1 through 6 sediments to clams exposed to SNWR reference sediment.

	Magnitude of Difference (DMMU ÷ SNWR)				
	Arsenic	**Barium**	**Copper**	**Lead**	**Selenium**
DMMU1	1.0	15.6	1.2	1.5	1.2
DMMU2	1.0	6.3	1.2	1.1	1.2
DMMU3	1.2	4.4	1.1	1.3	1.2
DMMU4	1.2	2.7	1.2	1.4	1.2
DMMU5	1.1	3.8	1.1	1.2	1.2
DMMU6	1.2	4.2	1.1	1.0	1.2

Table 16 . Magnitude of diffrence of metal tissue concentrations in clams exposed to DMMUs 1 through 6 sediments to clams exposed to CLWCRA sediment.

	Magnitude of Difference (DMMU ÷ CLWCRA)				
	Arsenic	**Barium**	**Copper**	**Lead**	**Selenium**
DMMU1	0.8	7.3	1.1	1.2	1.0
DMMU2	0.8	2.9	1.1	0.9	1.0
DMMU3	1.0	2.1	1.0	1.0	1.0
DMMU4	1.0	1.3	1.1	1.1	1.0
DMMU5	1.0	1.8	1.0	0.9	1.0
DMMU6	1.0	2.0	1.0	0.7	1.0

Table 17. Comparison of Total PAH Tissue Residues for DMMU 1 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam a ug/kg**	**clam umol/kg**	**clam a umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3			21.2	0.104794859	0.000104795
pyrene	202.3		0	15.5	0.076618883	7.66189E-05
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	10	0.043802015	4.3802E-05
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
Total	3910.6		0			0.000710714
acute CBR= 2-8 umol/g						
chronic CBR= 0.2-0.8 umol/g						

COC in red are non-detects = 1/2 RL

Table 18. Comparison of Total PAH Tissue Residues for DMMU 2 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam a ug/kg**	**clam umol/kg**	**clam a umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3		0	10	0.049431537	4.94315E-05
pyrene	202.3		0	27.8	0.137419674	0.00013742
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	24.4	0.106876916	0.000106877
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
	3910.6		0			0.000779226
acute CBR= 2-8 umol/g						
chronic CBR= 0.2-0.8 umol/g						

COC in red are non-detects = 1/2 RL

Table 19. Comparison of Total PAH Tissue Residues for DMMU 3 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam a ug/kg**	**clam umol/kg**	**clam a umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3		0	10	0.049431537	4.94315E-05
pyrene	202.3		0	18.4	0.090954029	9.0954E-05
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	10	0.043802015	4.3802E-05
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
	3910.6		0			0.000669686
acute CBR= 2-8 umol/g						
chronic CBR= 0.2-0.8 umol/g						

COC in red are non-detects = 1/2 RL

Table 20. Comparison of Total PAH Tissue Residues for DMMU 4 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam a ug/kg**	**clam umol/kg**	**clam a umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3		0	10	0.049431537	4.94315E-05
pyrene	202.3		0	23.6	0.116658428	0.000116658
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	10	0.043802015	4.3802E-05
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
	3910.6		0			0.00069539
acute CBR= 2-8 umol/g						
chronic CBR= 0.2-0.8 umol/g						

COC in red are non-detects = 1/2 RL

Table 21. Comparison of Total PAH Tissue Residues for DMMU 5 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam ug/kg**	**clam umol/kg**	**clam umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3		0	10	0.049431537	4.94315E-05
pyrene	202.3		0	10	0.049431537	4.94315E-05
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	10	0.043802015	4.3802E-05
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
	3910.6		0			0.000628163
acute CBR= 2-8 umol/g						
chronic CBR= 0.2-0.8 umol/g						
COC in red are non-detects = 1/2 RL						

Table 22. Comparison of Total PAH Tissue Residues for DMMU 6 to CBR						
pahs	**mw**	**tsc ug/g**	**tsc umol/g**	**clam ug/kg**	**clam umol/kg**	**clam umol/g**
naph	128.2		0	10	0.07800312	7.80031E-05
acena	152.2		0		0	0
acena	154.2		0		0	0
fluore	166.2		0	10	0.060168472	6.01685E-05
phenan	178.2		0	10	0.056116723	5.61167E-05
anthra	178.2		0	10	0.056116723	5.61167E-05
fluora	202.3		0	10	0.049431537	4.94315E-05
pyrene	202.3		0	10	0.049431537	4.94315E-05
benzaan	228.3		0	10	0.043802015	4.3802E-05
chryse	228.3		0	10	0.043802015	4.3802E-05
benzobf	252.3		0	10	0.039635355	3.96354E-05
benzokf	252.3		0	10	0.039635355	3.96354E-05
benzoap	252.3		0	10	0.039635355	3.96354E-05
indeno	276.3		0	10	0.036192544	3.61925E-05
dibenzo	278.4		0		0	0
benzoep	252		0		0	0
perylene	252.3		0		0	0
benzoghi	276.3		0	10	0.036192544	3.61925E-05
	3910.6		0			0.000628163
acute CBR= 2-8 µmol/g						
chronic CBR= 0.2-0.8 µmol/g						
COC in red are non-detects = 1/2 RL						

Table 23. Comparison of calculated total PAH Body Residues (BR) with Narcosis Final Chronic Values (FCV)

DMMU 1			DMMU 2			DMMU 3		
% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]	% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]	% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]
0.66	0.0066	0.025014	0.67	0.0067	0.025393	0.73	0.0073	0.027667
Calculated BR = 0.000710714 µmol/g			Calculated BR = 0.000779226 µmol/g			Calculated BR = 0.000669686 µmol/g		

[1]Mean lipid concentration for all 5 replicates

[2] 3.79 umoles/g octanol X f_lipids = Narcosis FCV

DMMU 4			DMMU 5			DMMU6		
% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]	% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]	% lipids[1]	f_lipids	Narcosis FCV µmol/g tissue[2]
0.69	0.0069	0.026151	0.74	0.0074	0.028046	0.836	0.00836	0.0316844
Calculated BR = 0.00069539 µmol/g			Calculated BR = 0.000628163 µmol/g			Calculated BR = 0.000628163 µmol/g		

[1]Mean lipid concentration for all 5 replicates

[2] 3.79 umoles/g octanol X f_lipids = Narcosis FCV

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ADDENDUM B:

404 PERMIT APPLICATION

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT

(33 CFR 325)

OMB APPROVAL NO. 0710-003
Expires October 1996

Public reporting burden for this collection of information is estimated to average 5 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Service Directorate of Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 20503. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

PRIVACY ACT STATEMENT

Authority: 33 USC 401, Section 10; 1413, Section 404. Principal Purpose: These laws require permits authorizing activities in, or affecting, navigable waters of the United States, the discharge of dredged of fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. Routine Uses: Information provided on this form will be used in evaluating the application or a permit. Disclosure: Disclosure of requested information is voluntary. If information is not provided, however, the permit application cannot be processed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	***2. FIELD OFFICE CODE***	***3. DATE RECEIVED***	***4. DATE APPLICATION COMPLETED*** 6 February 2009

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME U.S. Army Corps of Engineers, New Orleans District	*8. AUTHORIZED AGENT'S NAME AND TITLE (an agent is not required)* Same as applicant
6. APPLICANT'S ADDRESS Planning Division – Environmental Branch CEMVN-PM-RS P.O. Box 60267 New Orleans, LA 70160-0267	***9. AGENT'S ADDRESS*** Same as applicant
7. APPLICANT'S PHONE NOS. W/AREA CODE	*10. AGENT'S PHONE NOS. W/AREA CODE*
a. Residence: ***b. Business*** (504) 862-1583	*a. Residence*: Same as applicant *b. Business*: Same as applicant

11. STATEMENT OF AUTHORIZATION

[signature] 2/5/09

APPLICANT'S SIGNATURE *DATE*

NAME, LOCATION AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)
Calcasieu River Dredge Material Management Plan

13. NAME OF WATERBODY, IF KNOWN (if applicable) *Calcasieu River*	*14. PROJECT STREET ADDRESS (if applicable)*
15. LOCATION OF PROJECT CAMERON/CALCASIEU LOUISIANA *PARISH* *STATE*	

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN, (see instructions)

17. DIRECTIONS TO THE SITE
From N.O.: Take I-10 West to Lake Charles

18. Nature of Activity (Description of project, include all features.)
The U.S. Army Corps of Engineers (USACE), Mississippi Valley Division, New Orleans District (CEMVN), proposes to expand existing upland confined disposal facilities (CDFs) for placement of dredged material removed during routine maintenance events, designate additional beneficial use disposal areas to restore areas of subsided marsh, and construct rock bankline protection features necessary to maintain the Calcasieu River and Pass (CR&P), Louisiana, Federal navigational project, for a period of at least 20 years.

19. Project Purpose (Describe the reason or purpose of the project, (see instruction.)
The CR&P project does not have adequate dredged material disposal capacity needed to maintain the channel to authorized dimensions. Existing discharge sites are at or near capacity, and past maintenance deficiencies have resulted in substantial erosion of discharge facilities. Other discharge sites have been lost to commercial development. Previous real estate agreements, which have enabled landowners to opt out of agreements for disposal, have resulted in some landowners rescinding permissions for their property to be used for the placement of dredged material. As a result, remaining discharge areas cannot accommodate the volume of dredged material needed to maintain the ship channel to project-authorized dimensions.

USE BLOCKS 20-22 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge
The CR&P project does not have adequate dredged material disposal capacity needed to maintain the channel to authorized dimensions. Existing discharge sites are at or near capacity, and past maintenance deficiencies have resulted in substantial erosion of discharge facilities. Other discharge sites have been lost to commercial development. Previous real estate agreements, which have enabled landowners to opt out of agreements for disposal, have resulted in some landowners rescinding permissions for their property to be used for the placement of dredged material. As a result, remaining discharge areas cannot accommodate the volume of dredged material needed to maintain the ship channel to project-authorized dimensions.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards.
Approximately 3.6 million cubic yards of dredged material removed from the CR&P between miles 30 and 22 would be discharged into CDFs 9, 10, and 11 during maintenance events scheduled for years 8, 2, and 0 (respectively). About 2.6 million cubic yards of shoal material removed from Devil's Elbow would be discharged into CDF 13 during maintenance scheduled for year 0. About 10 million cubic yards of dredged material removed between CR&P miles 20 and 16 would be placed into the expanded uplands of CDFs 17, 19, D, and E during channel maintenance scheduled for years 6 and 9. An additional 4.1 million cubic yards of shoal material removed from the CR&P mile 20 to 16 reach would be placed in CDFs D and E to create intertidal marsh during maintenance scheduled in years 10, 12, 15, and 17. About 8.4 million cubic yards of rock would be used to construct foreshore dikes and shoreline armoring features associated with CDFs 17, 19, 22, 23, D, and E and along the left-descending bank of the channel between miles 18.7 and 16.5. Rock features would be constructed along the CR&P between years 6 and 8; rock work in Calcasieu Lake would occur in years 6, 9, and 14.

In addition to intertidal marsh creation sites in Calcasieu Lake associated with CDFs D and E, six beneficial use areas are proposed as disposal sites for maintenance of the CR&P between miles 16 and 5. Dredged material from maintenance between miles 16 and 12 would be placed in an area near Black Lake and an area within the SNWR (site 5): approximately 7.2 million cubic yards would be placed at the Black Lake site during years 0, 2, 5, 12, and 17; and about 8.9 million cubic yards would be placed at the SNWR site during years 0, 2, 5, and 7. Dredged material from maintenance between miles 12 and 9.5 would be placed in an area within the SNWR (site 18) and an area immediately adjacent to the SNWR (site 49): about 9.3 million cubic yards would be placed within the SNWR in years 0, 6, 9, 12, 15, and 18; and about 2.4 million cubic yards would be placed at the site adjacent to the SNWR in years 3, 6, and 9. Dredged material from maintenance between miles 9.5 and 5 would be placed at two areas within the CPNWR (sites 19 and 20): approximately 2.9 million cubic yards would be placed at site 19 in years 6 and 12; and about 1.2 million cubic yards would be placed at site 20 in year 2. It is impossible to determine the quantity of material required to construct or refurbish dikes and closures within these disposal areas or the frequency in which these features would need to be refurbished after initial discharges. The need to construct access channels and the quantity of material removed during construction would be determined prior to channel maintenance events – it is impossible to determine these quantities and frequencies prior to the development of individual project plans and specifications.

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)
The proposed disposal sites for the expansion of CDFs 9, 10, 11, and 13 are located in marsh and shallow open-water along the CR&P between river miles 28 and 21. Expansion sites for CDFs 17, 19, D, and E are bordered to the west by the left-descending bank of the CR&P between approximate miles 20 and 12, and to the east by Calcasieu Lake. Dredged material would be placed into about 545 acres of marsh and about 511 acres of shallow open-waters of the channel and lake, converting these areas to uplands. An additional 476 acres of shallow open-water in Calcasieu Lake would be filled to intertidal marsh elevation after placement of dredged material into the lake side of CDFs D and E. Rock would be placed on about 32 acres of shallow open-water in the channel (left-descending bank) and about 48 acres of shallow lake bottom to construct shoreline protection features associated with the CDFs. An additional 13 acres of shallow open-water along the right-descending bank of the channel between approximate river miles 18.7 and 16.5 would be impacted by the construction of rock shoreline protection features.

The proposed beneficial use disposal areas located west of the CR&P are bordered by shallow open-water and fragmented marsh of black lake and the Sabine National Wildlife Refuge (SNWR). Beneficial use disposal areas east of the CR&P are bordered by shallow open-waters of Calcasieu Lake and fragmented marsh within the Cameron Prairie National Wildlife Refuge (CPNWR). Dredged material slurry would be discharged into shallow open-water within the beneficial use disposal areas to an elevation conducive to the development of wetland habitats. It is anticipated that the final result of this dredged material placement would be a combination of emergent wetland, mud flat, and shallow open water habitat within the placement site. Dredged material slurry would be allowed to overflow existing emergent marsh vegetation within the proposed disposal areas, but would not be allowed to exceed a height of about one-foot above the existing marsh elevation. Dredged material placement and associated retention features would impact about 890 acres in Black Lake; approximately 5,600 acres within the SNWR; about 640 acres immediately adjacent to the SNWR; and about 2,900 acres in the CPNWR. Over 10,000 acres of wetland habitat would be created or nourished from the proposed beneficial use of dredged material. Prior to the development of project plans, it is impossible to determine the area that would be impacted temporarily or converted to marsh elevation during the construction of access channels outside of these disposal areas.

23. Is Any Portion of the Work Already Complete? Yes ____ No _X_ IF YES, DESCRIBE THE COMPLETED WORK

24. Addresses of Adjoining Property Owners, Lessees, Etc., whose Property Adjoins the Waterbody (If more than can be entered here, please attach a supplemental list.

25. List of Other Certifications or Approvals/Denials Received from other Federal, State or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL	IDENTIFICATION NO.	DATE APPLIED	DATE APPROVED	DATE DENIED

To the best of my knowledge the proposed activity described in my permit application complies with and will be conducted in a manner that is consistent with the LA Coastal management Program.
**Would include but is not restricted to zoning, building and flood plain permits.*

26. Application is hereby made for a permit or permits to authorize the work described in this application. I certify that the information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

2/5/09

SIGNATURE OF APPLICANT | *DATE* | *SIGNATURE OF AGENT* | *DATE*

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.