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SAVANNAH HARBOR EXPANSION PROJECT CHATMAN COUNTY, GEORGIA AND JASPER COUNTY, SOUTH CAROLINA: FINAL GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT JANUARY 2012

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

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PART 13 OF 15

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FINAL
ENVIRONMENTAL IMPACT STATEMENT
SAVANNAH HARBOR EXPANSION PROJECT
Chatham County, Georgia and Jasper County, South Carolina

January 2012
(Revised July 2012)

Appendix B
to
Appendix M

Volume 4

US Army Corps of Engineers
Savannah District
South Atlantic Division

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX B: Biological Assessment of Threatened and Endangered Species

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

(Revised July 2012)

US Army Corps
of Engineers
Savannah District
South Atlantic Division

Biological Assessment of Threatened and Endangered Species

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BIOLOGICAL ASSESSMENT
OF THREATENED AND ENDANGERED SPECIES
FOR THE SAVANNAH HARBOR EXPANSION PROJECT
CHATHAM COUNTY, GEORGIA AND JASPER COUNTY, SOUTH CAROLINA
UNDER THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

1.00 PROJECT DESCRIPTION

1.1 EXISTING -42 FOOT DEPTH (EXISTING CONDITION or NO ACTION ALTERNATIVE). The No Action alternative serves as the baseline from which potential project impacts are measured. This plan is also the Without Project Condition; those actions which would occur even if the alternative proposed in this EIS is not implemented. The Plan consists of continued operation and maintenance of the Savannah Harbor Navigation Project at the existing -42 Foot Depth. This includes annual dredging to maintain authorized depths in the channel and associated areas. Federal use would continue for the existing confined disposal areas, the EPA-approved ocean disposal site (Savannah Harbor ODMDS), and Site 2 and Site 3 located adjacent to the entrance channel. As approved in the LTMS, suitable maintenance material could also be placed in the nearshore feeder berm sites off Tybee Island or directly on Tybee Island Beach.

Cargoes would continue to move through the harbor. The volumes and types of those cargoes would depend on both the demand for those goods and options for ways in which those demands can be met (sources of supply, transportation methodologies and routes, etc.). Previous investigations indicate that demand for goods moving through Savannah Harbor, particularly as containerized cargos, will increase in the future. In addition, due to ongoing ship-building trends, the size of the vessels calling at ports along the US east coast is expected to increase. These trends are described in detail in the Economics Appendix of the GRR. Table 1-1 below illustrates the fleet expected to call on the Port of Savannah if the proposed harbor deepening does not occur compared to the fleet that would call at the various depth alternatives.

Table 1-1. Summary of Container Vessel Calls (One Way)
Arriving at Garden City Terminal

2016	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	134	483	1,171	505	2,293
-44 feet	267	293	1,116	505	2,181
-45 feet	266	292	1,094	505	2,157
-46 feet	265	292	1,084	505	2,145
-47 feet	265	292	1,079	505	2,141
-48-feet	265	292	1,079	505	2,141

Table 1-1. Continued

2020	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	271	866	778	593	2,509
-44 feet	533	478	700	593	2,304
-45 feet	527	474	671	593	2,265
-46 feet	524	471	658	593	2,247
-47 feet	524	471	649	593	2,238
-48-feet	524	471	649	593	2,238

2025	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	382	1,006	1,122	758	3,267
-44 feet	761	471	992	758	2,982
-45 feet	753	467	952	758	2,930
-46 feet	749	465	932	758	2,903
-47 feet	749	462	924	758	2,892
-48-feet	749	462	924	758	2,892

2030	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

2066	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

1.01 EXISTING -42' DEPTH

The existing Savannah Harbor Federal Navigation Project can be described as follows (see paragraphs a through k, below):

a. General Description. Savannah Harbor is a deep-draft harbor on the South Atlantic coast 75 statute miles south of Charleston Harbor and 120 miles north of Jacksonville Harbor, Florida. Within the inner harbor limits, the Savannah River is generally divided into two channels by a series of islands. From the Atlantic Ocean (Station 0+000) to Station 52+800 (River Mile 10), where the river converges, the harbor is separated into South and North Channels. Within this area, the navigation channel is maintained in North Channel. After divergence of the river into Front and Back Rivers at Station 58+080 (River Mile 11), the navigation channel is maintained in Front River and passes by the business district of the City of Savannah. The navigation channel is maintained in Front River to the upper limits of the harbor at Station 112+500 (River Mile 21.3).

Figure 1-1 shows the station numbering convention that is used in the harbor. The ocean ward extent of the ocean bar channel presently ends at Station -60+000B (or 60,000 feet east or ocean ward of the river entrance at Fort Pulaski and B stands for Ocean Bar Channel). The entrance to the river is at Station 0+000 (or near the Fort Pulaski National Monument in Georgia). Upstream of the river entrance is Fort Jackson and the CSS Georgia at Stations 55+000 to 60+000 (or 55,000 to 60,000 feet upstream of the Fort Pulaski National Monument). The upstream end of the proposed deepening of the harbor at the Garden City Terminal is at Station 103+000 (or 103,000 feet upstream of the river entrance).

A separate navigation project – the Savannah River below Augusta Project – extends from the upper limits of the harbor to River Mile 202.6 at Augusta, Georgia. The authorized channel is 9-feet deep and 90-feet wide, although it has not been maintained since 1978.

The Atlantic Intracoastal Waterway (AIWW) crosses the deep-draft navigation channel at approximately Station 26+000 (River Mile 5). The authorized depth of that channel is 12-feet deep, while the width varies from 90-feet in land cuts to 150-feet in open waters.

b. Inner Harbor (Stations 112+500 to 0+000). The authorized navigation channel in the inner harbor is 42-feet deep Mean Low Water and 500-feet wide upstream of Station 0+000 to Station 103+000. From Station 103+000 (River Mile 19.5) to the upstream end of the Argyle Island Turning Basin Station 105+000 (River Mile 19.9), the channel is 36-feet deep and 400-feet wide upstream. From Station 105+000 (River Mile 19.9) to the harbor's upstream limit at Station 112+500 (River Mile 21.3), the channel is 30-feet deep and 200-feet wide.

Figure 1-1. Overview map of Savannah Harbor.

The Federal channel was last modified in 2006 through two small realignments in the upper portion of the harbor (USACE 2006). These actions consisted of a realignment of the Federal navigation channel along Ranges 37 and 38 (here on referred to as the CB-8 realignment) and a separate realignment along Ranges 41, 42, and 43 (here on referred to as the Upper Harbor realignment). The CB-8 realignment consisted of a 1,652-foot realignment in the area of Ranges 37 and 38 across from the Georgia Ports Authority (GPA) Container Berth 8 (CB-8). The 1,652-foot segment of the channel was moved roughly 53 feet to the north. The realignment occurred in an area that was dredged in 2005 during construction of the GPA CB-8, therefore; no new dredging was required. The Upper Harbor realignment consisted of a 100-foot realignment in the area of Ranges 41 through 43, which create a bend in the Savannah River upper harbor near Port Wentworth (downstream of Station 103+000). That action increased the width in the bend along the northern edge of the existing channel. Width changes on the three ranges making up the bend vary from 50 to150 feet. The centerline and the southern edge of the channel did not change. The proposed widening is located in an area with natural depths at or below the authorized project depth, so no new dredging was required.

Sections of eroding shoreline along the CDFs located in South Carolina have been protected through several actions since 1996. The most recent of these was rock protection work that occurred along portions of CDFs 13A, 13B, 14A and 14B from 2006 to 2011. Environmental approvals for this work were obtained through prior agency approvals of the Long Term Management Strategy (LTMS). The work included bank protection along 4,400 feet of eroding riverbank in five non-continuous areas between Stations 43+700 and 55+250. The river shoreline along the Jones/Oysterbed Island CDF will be protected with rock starting in FY12, with completion scheduled for FY 13.

The commercially-owned, Southern Liquefied Natural Gas-El Paso (SLNG-El Paso) Terminal, on Elba Island, near Station 36+000 expanded its facility when it completed construction of a fourth storage tank in 2005. This expansion included construction of a berthing slip to accommodate larger Liquefied Natural Gas (LNG) carriers. SLNG-El Paso recently constructed a fifth storage tank to further expand the Elba Island Facility and expects to place that tank in service in 2012. These facility expansions are expected to result in increases in the number of LNG vessels calling at the SLNG-El Paso Terminal. The Economics Appendix in the GRR provides more detailed information on the expected extent of that growth.

c. Outer Harbor or Ocean Bar Channel (Stations 0+000 to -60+000B). Station 0+000 is located at the mouth of the harbor near the Fort Pulaski National Monument in Georgia. The entrance channel is located north of Tybee Island and proceeds out to deep water in the ocean. The existing navigation channel is 44 feet deep and 600 feet wide from deep water in the ocean (mile 11.17B or Station -60+000B) to the channel between the jetties (mile 2.6B or Station -14+000B), thence 42 feet deep and 500 feet wide to the harbor entrance (River Mile 0.0 Station 0+000). The existing project includes allowable overdepth and advance maintenance dredging (see Section e and Table 3-1, below).

d. Annual Maintenance Dredging. Approximately 7 million cubic yards of sediments are removed each year from the Savannah Harbor Navigation Project. The dredged sediments are placed in areas which have been designated for use for the project: the CDFs, Site 2 and Site 3 adjacent to the Ocean Bar Channel, and/or the Savannah Harbor ODMDS. As approved in the LTMS, suitable maintenance material could also be placed in the nearshore feeder berm sites off Tybee Island or directly on Tybee Island Beach.

e. Allowable Overdepth and Advance Maintenance Dredging. The following information is provided pursuant to Guidance Memorandum dated January 17, 2006 and ER 1130-2-520: *Congress specifically authorizes Federal navigation channels by specific depth and width. There is inherent imprecision in dredging processes which vary with the physical conditions (tides, currents, and waves); the dredged material characteristics (silt, clay, sand, gravel, rock, etc.); the channel design (depths being dredged, side slopes, etc.); and the type of dredging equipment (mechanical, hydraulic, hopper, etc.). Due to these variables and the resulting imprecision associated with the dredging activity, Corps engineering design, cost estimating and construction contracting documents recognize that dredging below the Congressionally authorized project dimensions will occur and is necessary to assure the required depth and width as well as cost effective operability. To balance project construction requirements against the need to limit dredging and disposal to the minimum required to achieve the designed dimensions, a paid or allowable overdepth (including side slopes) is incorporated into the project-dredging prism. Material removed from this allowable overdepth is paid under the terms of the dredging contract. Material removed beyond the limits of the allowable overdepth is not paid.*

Dredging contracts for the Savannah Harbor include a - 2 foot allowable overdepth. To ensure the contractor obtains the required dredging template, the Corps pays the contractor for up to 2-feet of sediment that he may remove below that required depth.

Depending on the type of dredging equipment used, an additional depth of sediments may be disturbed in the dredging process but not removed. This depth is greater with the larger cutterhead dredges. The rotating cutterhead that loosens the deposited sediments extends below the elevation of the suction pipe. The suction is not sufficient to lift sediments up into the pipe for removal through the pipe to the dredge, but only enough to remove sediments which have been loosened and slurried by the rotating cutterhead. This results in sediments below the elevation of the suction pipe being disturbed by the rotating cutterhead, but not removed through the dredge pipe line. The disturbance can result in the mixing of sediments above and below the removal depth. For the large 30-inch cutterhead dredges, this disturbance depth can be 3 feet. Equipment such as hopper dredges or clamshell dredges would have a disturbance depth of less than 1 foot.

Advance maintenance extends the length of time during which authorized channel depths are available. This reduces the frequency of dredging, thereby increasing dredging efficiency, reducing disturbance to the environment, and reducing overall maintenance costs. This sediment management technique is performed by enlarging the channel cross-section to provide storage for deposited sediments outside the authorized navigation channel prism. This storage is typically below the elevation of the navigation channel, but can be on the side of a channel if sediment deposition patterns reveal that such a design would be effective. This technique

increases dredging efficiency by concentrating the sediments to be removed. This lowers the unit cost of dredging, reducing overall maintenance costs. Under present Corps policy, a District office must request approval for all advance maintenance from higher Corps offices. Decisions to implement advance maintenance can be made at any time upon review of sediment accumulation records, and they are effective until future information indicates they are no longer necessary or cost effective. Compliance with all environmental, engineering, and economic criteria is required prior to implementation of authorized advance maintenance features.

The currently authorized advance maintenance is found in Table 1-2, below.

Table 1-2. Present Advance Maintenance Sections

Begin Station	End Station	Authorized Advanced Maintenance (feet)	Required Contract Depth (feet MLLW)
Inner Harbor			
112+500	105+500	2.0	32.0
105+500	103+000	2.0	38.0
103+000	102+000	0.0	42.0
102+000	100+000	2.0	44.0
100+000	79+600	2.0	44.0
79+600	70+000	2.0	44.0
70+000	50+000	4.0	46.0
50+000	37+000	4.0	46.0
37+000	35+000	6.0	48.0
35+000	24+000	4.0	46.0
24+000	0+000	2.0	44.0
Port Wentworth TB		0.0	30.0
Argyle Island TB		0.0	30.0
Kings Island TB		8.0	50.0
Marsh Island TB		0	34.0
Fig Island TB		4.0	38.0
Entrance Channel			
0+000	-14+000(B)	2	44.0
-14+000(B)	-60+000(B)	0	44.0

No advance maintenance is presently performed between Stations 58+000 and 59+000 to reduce potential impacts to the CSS GEORGIA, which is located along that reach.

f. Turning Basins. Six authorized turning basins are located along the navigation channel to allow ships to be turned before transiting the harbor. There is also a private turning basin at Elba Island between the Jones/Oysterbed and Fig Island turning basins. This basin is used by the LNG vessels calling at Elba Island. The turning basins are described in Table 1-3, below.

Table 1-3. Existing Turning Basins in Savannah Harbor (see Figure 1-1)

Name	Length (Feet)	Width (Feet)	Depth (Feet, MLLW)	River mile	Station
Port Wentworth	600	600	30	20.9	111+363 to 109+757
Argyle Island	600	600	30	19.6	104+185 to 103+085
Kings Island	1,600	1,500	50	18.8	103+085 to 97+750
Marsh Island	900	1,000	34	17.1	91+610 to 89+485
Fig Island	1,500	1,000	34	13.0	69+740 to 67+386
Elba Island (LNG Private)	2,300	1,500	42	6.8	Not Maintained
Oysterbed Island	1050	1,200	40	0.7	4+395 to 2+345
Rehandling Basin	5,000	300	40		10+175 to 4+395

g. Existing upland Confined Disposal Facilities (CDFs). The Georgia DOT (non-Federal sponsor) has provided seven confined upland disposal facilities for use in the Savannah Harbor. Those areas are shown in Table 1-4.

Table 1-4. Existing CDFs in Savannah Harbor

Area Number	Area Name	Location (Channel Stations)	Size (Acres)
---	Jones/Oysterbed	0+000 to 27+000	754
14B	---	28+000 to 37+000	765
14A	---	38+000 to 42+000	815
13B	---	43+000 to 47+800	628
13A	---	47+800 to 6+500BR	1,307
12A	---	6+500BR to 10+100BR	1,123
2A	Argyle-Hutchinson	93+000 to 103+000	185
1N	Onslow-North	107+500 to 112+600	130

NOTES: "BR" indicates the Stationing up Back River as shown on the Annual Survey. Historic Area 12B was combined with 13A in 2010. The enlarged cell is now referred to as "13A."

h. Overall Management Strategy for CDFs. Savannah District is working with the Georgia Department of Transportation, the Project's non-Federal sponsor, to maximize the useful life of the dredged material placement areas. As an overall strategy, beneficial uses are pursued for the dredged sediment to reduce the ultimate storage volume required and increase secondary benefits resulting from the storage and/or disposal operations. To reduce the required storage volume, sediments deposited in the CDFs are used when fill material is needed to raise the height of the confining dikes. Disposal Area 1N is not regularly used. The site is within the Savannah National Wildlife Refuge, and the Refuge managers have requested the Corps only deposit sands at that site so they can be readily reused and removed. Disposal Area 1S is no longer used because it is not diked. Disposal Area 2A is limited to about 125,000 cubic yards of maintenance material every three years and will be closed in 2027. Underdrains have been installed in Disposal Areas 12A, 13A, and 13B to shorten the sediment drying time. This aids the sediment consolidation process, thereby extending the useful life of the sites. A rotational program is being followed at Disposal Areas 12A, 13A, 13B, 14A, 14B, and Jones/Oysterbed Island to provide flooded acreage for wildlife habitat while the site is active and allow sufficient time for drying of the sediment so that construction equipment can safely work on the floor of the CDFs to remove sediments for dike raising. The District uses a suspended solids content standard of 500 mg/l for acceptability of its weir effluents. This ensures the discharges do not cause unacceptable impacts to aquatic life in the receiving waters. Selective placement of Bar Channel and other suitable sediments may be pursued when beneficial uses would be derived. As a component of the design process for maintenance dredging work, a review would be conducted of potential beneficial uses -- specifically alternative placement sites -- for sediments to be excavated during that contract. The placement location to be used for a specific dredging contract would be decided during project design and the award would be based on identification of the least cost, environmentally-acceptable option. If placement at a certain location is found to be more desirable for environmental or other reasons but would be more costly than one of the other acceptable options, it can be pursued with appropriate cost sharing using Section 933 (WRDA 1986) or Section 204 (WRDA 1992) authorities.

i. Unconfined Placement Sites. The USEPA-designated Savannah Ocean Dredged Material Disposal Site (ODMDS) is the primary unconfined placement site used in the harbor. Additional authorized unconfined placement sites are a feeder berm system within the nearshore area off Tybee Island, and two sites adjacent to the ocean bar channel (see Figure 1-2). The ODMDS was designated by EPA for sediment placement under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), as amended (40 CFR Parts 220 to 228). The nearshore feeder berm sites off Tybee island and adjacent to the entrance channel were authorized through the Savannah Harbor Navigation Project's Long Term Management Strategy (LTMS) study under Section 404 of the Clean Water Act. As shown in Figure 1-3 below, there were five submerged berm sites (Sites 2-6) adjacent to the entrance channel that could be used for the placement of maintenance material. However, the USEPA recently indicated that any dredged material placement sites located outside of the three-mile limit should be designated as ocean disposal sites under the MPRSA. Consequently, any future use of the sites along the entrance channel outside the three-mile line would require that they be designated as ocean dredged material disposal sites. Exceptions to this requirement are Site 2 and Site 3 which are within the 3-mile limit. Site 2 and Site 3 would continue to be available for the placement of maintenance material from the entrance channel.

Although these dredged material placement sites have not been used in the past, the LTMS also authorized placement of maintenance material into nearshore feeder berm sites off Tybee Island as well as direct placement on the beach at Tybee Island. More discussion of these sites is provided in subsequent paragraphs.

In 1987, EPA completed formal designation and approval of an offshore site (Savannah ODMDS) located 3.7 nautical miles east of the coastline and about 0.25 nautical miles (1,500 feet) south of the navigation channel as a dredged material disposal site. The site's center is located at 31 56'54"N and 80 45'34"W (Figure 1-2). The designated site was the one which

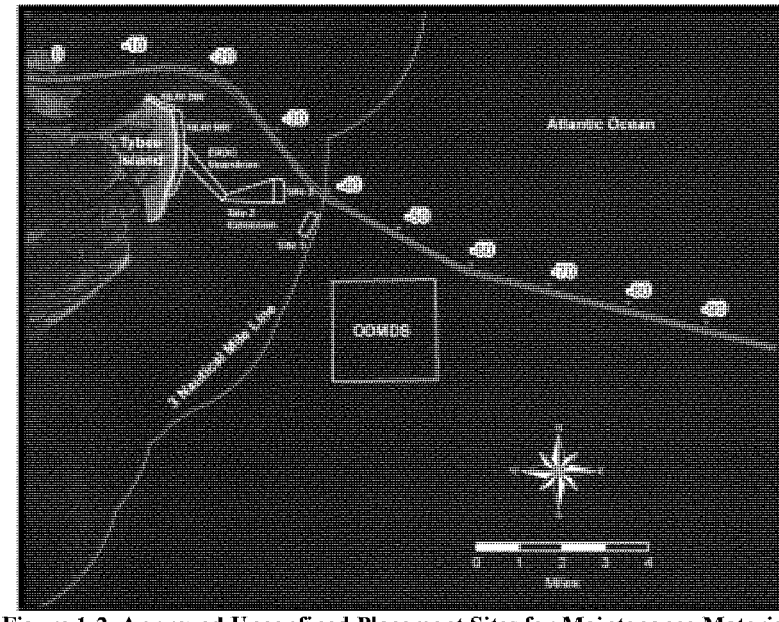


Figure 1-2. Approved Unconfined Placement Sites for Maintenance Material.

Savannah District had been using for many years for placement of sediments removed from the Bar Channel. Sediments are typically excavated from the Bar Channel by hopper dredges and then transported to the Savannah ODMDS for disposal. This procedure was previously evaluated in 1991 for new work sediments and determined to meet the criteria established to implement Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), as amended (40 CFR Parts 220 to 228). This EIS contains an update of that evaluation in Appendix R, SECTION 103 Ocean Disposal Evaluation. More details on the historic use of the site can be found in that portion of this document. The site's designation as a sediment placement site extends until the site is full.

The LTMS (USACE 1996) authorized the placement of dredged maintenance sediment in feeder berm sites in the nearshore area off Tybee Island and adjacent to the entrance channel. The nearshore area is the shallow area immediately oceanward of the ocean shoreline. As shown in Figure 1-3, maintenance sediments dredged from the Bar Channel were authorized to be deposited in sites (Sites 2-6) adjacent to that channel to construct and maintain underwater berms in that nearshore environment.

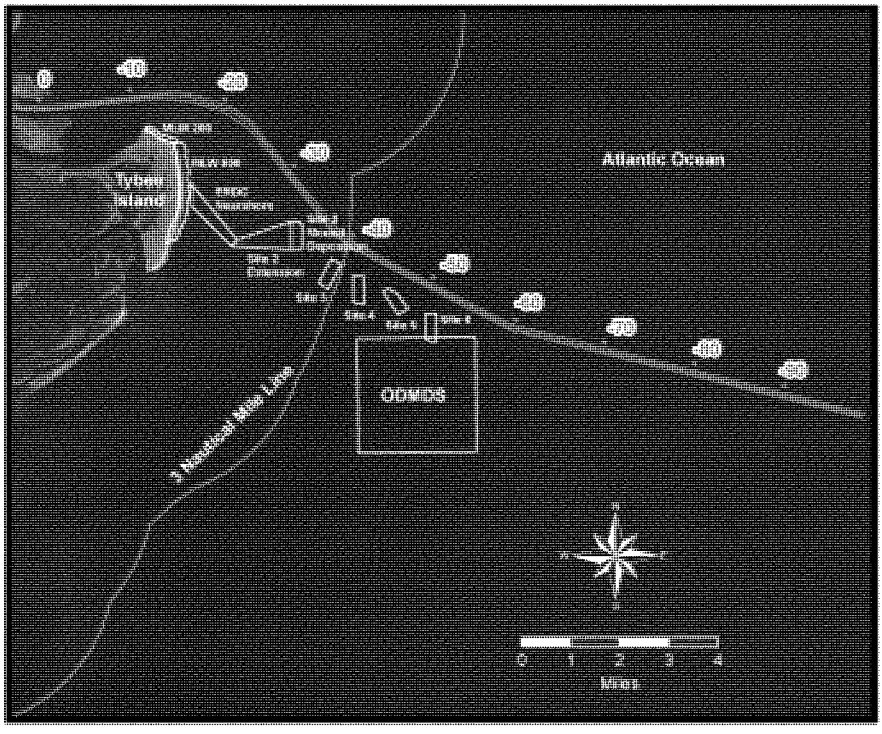


Figure 1-3. Location of Savannah Harbor Placement Sites (Site 2 through Site 6) as authorized by 1996 LTMS.

The sites where these submerged berms would have been constructed would effectively serve as nearshore placement sites for use by hydraulic dredges maintaining the Bar Channel. Presently, that portion of the project is dredged by hopper dredges, but the four-month window during which the sea turtle restrictions allow hopper dredges to be used severely limits the ability of the District to respond to rapidly forming or shifting shoals in that channel. There are no seasonal restrictions on hydraulic dredges since that equipment does not adversely affect sea turtles. Sites 2-6 provided a cost-effective place for the hydraulic dredges to deposit the dredged sediments since they would be located relatively close to the channel. Some of the sites adjacent to the channel are too shallow for use by hopper dredges. Using a mooring barge and the pumpout

capability of some hopper dredges would make such placement technically feasible, but would probably increase the placement costs to unacceptable levels.

Sites 2-6 are located south of and at least 2,000 feet away from the channel, in water averaging about 15 feet deep. Deposition on the berms would occur when their size has been significantly reduced, but in no case would it be performed on a yearly basis. When constructed, the berms would be either round or elliptical and oriented away from the channel so that tidal currents which converge and diverge from the channel are not significantly restricted. The minimum 2,000 foot spacing between the toes of adjacent berm sites is a design feature to ensure that tidal currents are not significantly restricted. The crest of the berm would not exceed about -5 feet MLLW to ensure recreational boats could pass over the berms unaffected. No hard structures are used in the formation or maintenance of the berms so that nothing would snag shrimp nets which may be dragged over the berms. If sediments are transported to the site through use of a hydraulic pipeline dredge, the discharge point would be below the water surface to reduce turbidity. The sites are located at least 4,000 feet offshore, so turbidity increases at the beach would not be significant.

Site 5 was used in FY06, FY08, and FY10 and has received about 523,000 cubic yards of dredged material. Site 6 was used in FY08, FY09, and FY10 and has received about 1,021,000 cubic yards of material. As discussed previously, only Site 2 and Site 3 are available for future use at this time. Site 3, Site 4, Site 5, and Site 6 are beyond the 3-mile line and would require site designation studies and additional approval by EPA for use as approved ocean dredged material disposal sites.

The 1996 LTMS also authorized the placement of suitable maintenance sediments into the nearshore area off Tybee Island as well as directly on the beach. The initial plan for placement of maintenance material into the nearshore area off Tybee Island involved the construction of a submerged feeder berm. The proposed feeder berm would have been constructed parallel to Tybee beach, about 4,000 to 7,000 feet offshore, in water with an average depth of about 8 feet MLLW. The berm's crest would have been up to 500 feet wide and at a depth of 5 feet MLLW. Restricting the berm height to -5 feet MLLW would ensure that pleasure boats could safely pass over the berm. The berm would have been located at least 5,000 feet away from the channel. It was determined that approximately 66,000 CY of fill material would be needed per 1,000 linear feet of berm. Assuming side slopes of 1(H) to 30(V) and a 50 percent loss of material volume during placement, 132,000 CY of channel dredging would have been placed per 1,000 linear feet of berm.

The shallow depth of the area in which the feeder berm would be constructed would result in the berm being dispersive, with the deposited sediments subsequently being moved offsite by waves. The relatively close proximity of the berm to the beach would increase the likelihood that the sediments would migrate to the beach. As waves expend energy moving material from the berms, the waves will have less energy to erode the Tybee Island shoreline. This would increase the stability of that barrier island.

No hard structures would be used in the formation or maintenance of the feeder berm so that nothing would snag shrimp nets which may be dragged over it. As with the submerged berms,

the feeder berm would effectively serve as a nearshore placement area for use by hydraulic dredges working in the Bar Channel. Sediments would be transported and deposited at the site through use of a hydraulic pipeline. The discharge point would be below the water surface to reduce turbidity. The sites would be located at least 4,000 feet offshore, so turbidity increases at the beach would not be significant.

After completion of the 1996 LTMS study, further studies were conducted to refine the plan for placing maintenance sediments into the nearshore area off Tybee. This included model studies conducted by ERDC (2003).

During SHEP studies, it became apparent that placement of new work material from construction of the project into the nearshore area off Tybee Island might also be advantageous. Rather than placing the new work dredged sediment from the Entrance Channel into the offshore Savannah Harbor ODMDS, the Corps proposed to place dredged sediment back into the nearshore zone of Tybee Island as a beneficial use to restore sand to the nearshore sand sharing system (USACE 2007). These sediment placement mounds would dampen wave action and provide protection from storm events, and increase bird and fish habitat.

Savannah District followed an iterative process to develop a plan for placement of sediments from the entrance channel. The work started with an engineering determination of the quantity of sediments to be removed at various channel depths and the percent fines / percent sands of those sediments. The Corps reviewed previous information, including the Draft 2003 ERDC Report on Nearshore Placement at Tybee Island; the previously environmentally-approved placement areas on the south side of the entrance channel; and the changes to the GA CZM Program that incorporates Georgia HB 727.

The Corps started by developing a placement plan with a priority placed on low cost. The plan was also reviewed from an environmental perspective. The Corps consulted GA DNR-CRD, who provided several alternate placement scenarios. The plan was also discussed with the coastal engineering consultant to Tybee Island to obtain his engineering views and learn, in general terms, what he would advise Tybee Island concerning the various issues and proposals. The Corps revised the plan to incorporate the views of GA DNR-CRD and Tybee's consultant. During that period, cost engineers were also consulted to learn what would be reasonable from a cost perspective (keep pumping distances under the length where booster pumps would be needed), and what placement designs would not cause adverse currents or result in rapid migration of deposited sediments toward the shipping channel. Using that information, a revised sediment placement plan was developed.

The plan was coordinated with staff of GA DNR-CRD and CRD and Tybee's coastal engineering consultant. The Corps revised the plan again based on the results of this coordination. The revised plan included the following assumptions:

a. A 30-inch pipeline dredge can pump material a total distance of about 3 miles without a booster pump. The design would be based on there not being a need for a booster pump.

b. Hopper dredges (with pump ashore capability) may not be effective since the nearshore water depths off Tybee Island are less than 15 feet mean high water. A loaded hopper dredge generally needs about 25 feet of water under its keel.

c. For each Entrance Channel reach from Stations 4+000 to -97+680, the dredge quantities in cubic yards for the greatest dredging depth (i.e., -47 foot depth) was used for all disposal sites.

As a result of the extensive coordination with GA DNR-CRD and the City of Tybee Island, the Corps proposed in the DEIS to place new work and maintenance sediments in the nearshore area off Tybee Island which would provide beneficial use of dredged material and comply with the Georgia Coastal Management Program, including the changes that incorporate Georgia HB 727. The proposed dredged material placement plan also included two sites (Site 11 and Site 12) which would have been constructed from material from the entrance channel extension to provide additional fish habitat in the area. The sediment placement sites identified in this plan are shown in Figure 1-3 and described below:

a. MLW 200 has a total capacity of 217,000 cubic yards and is located west of the North Groin on Tybee Island. The sediment would be deposited at the mean low water (MLW) line and be allowed to mound up to mean sea level (MSL) or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 200 feet wide and 3,200 feet long.

b. MLW 500 has a total capacity of 1.8 MCY and is located south of the North Groin on Tybee Island. The sediment would be deposited at the MLW line and be allowed to mound up to MSL or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 500 feet wide and 11,000 feet long.

c. ERDC Nearshore has a total capacity of 1.2 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be -4 feet so as not to interfere with boaters but allow potential for movement of material towards the Tybee Island shoreline by wave action.

d. Site 2 has a total capacity of 3.2 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be at mean high water (Elevation +8 feet MLW). Site 2 would also provide bird and fish habitats.

e. Site 2 Extension has a total capacity of 4.3 MCY and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -4 feet MLW.

f. Sites 2, 3, 4, 5 and 6 are located south of the entrance channel and between Site 2 and the ODMDS. These four sites were authorized through the LTMS (USACE 1996).

g. Savannah Harbor Ocean Dredged Material Disposal Site (ODMDS). The USEPA-approved ODMDS is a 4.26 square mile (or 2,726.4 acres) site and is centered at 31 56' 54" N

and 80 45' 34" W. Total capacity is about 56,8 MCY and at capacity the top elevation would be -26 feet MLW.

h. Site 11 has a total capacity of 2.1 MCY and is located south of the proposed channel extension. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat.

i. Site 12 has a total capacity of 3.0 MCYand is located south of the proposed channel extension. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat. This site would provide habitat by establishing a variation in contours of the water bottoms.

Based on comments received after coordination of the DEIS, the placement plan described above has been revised. Both the City of Tybee Island and the GADNR-CRD expressed concern over the quality (fines content) of the new work material proposed to be placed in the nearshore area, and they requested that the nearshore feeder berms off Tybee not be constructed. The GADNR also expressed concerns about adverse effects to recreational and commercial fishing associated with the use of Sites 11 and 12. Also, the EPA commented that Sites 4, 5, 6, 11, and 12 were beyond the 3-mile line and would require site designation studies and their site designation approval as dredged material ocean disposal sites before they could be used. Consequently, all new work material removed from the entrance channel would be placed in either a CDF or the ODMDS.

From a maintenance perspective, placing inner harbor maintenance sediments into the seven upland CDFs and entrance channel maintenance sediments into the Savannah Harbor ODMDS or Site 2 and Site 3 is the least-cost environmentally acceptable disposal alternative (Base Plan) for long-term maintenance of the proposed harbor deepening project. However, suitable maintenance sediments from both the inner harbor and entrance channel of the deepened project could be used for beach renourishment or placed into the nearshore feeder berms authorized in the LTMS. A non-Federal sponsor would be required to pay the expected additional costs to deposit the O&M sediments in areas that are not included in the Base Plan. Figure 1-2 shows the approved dredged material placement sites for maintenance material from the entrance channel as well as suitable material from the first portion of the inner harbor channel.

Before sediment is initially placed in a nearshore site, Savannah District would perform confirmatory surveys to ensure that no hard-bottom communities and/or cultural resources are located at the proposed construction sites. If any hard-bottom areas are located, no maintenance sediments will be placed within these areas. Should any cultural resources be identified, the Georgia SHPO would be consulted. Deposition of dredged sediment on any unknown submerged cultural resource would not adversely affect it, but would instead provide additional protection from wave- or current-induced exposure and erosion.

The LTMS (USACE 1996) also authorized a nearshore bird island (Tomkins Island) that was subsequently constructed approximately 10,000 feet offshore of Turtle Island, about 3,000 feet north of the north jetty in South Carolina waters that averaged 6 feet of depth. The island is horseshoe in shape with flat crown at +14 feet MLLW with a minimum size of 2 acres. The side

slopes from EL 14 to 8 are roughly 1:10, with the slopes below +8 feet MLLW being 1:35. The island provides a very productive habitat setting for colonial nesting birds and regularly provides one of the most successful nesting sites in South Carolina for several shorebird species.

j. Sediment Control Works. The Sediment Control Works were authorized separately, but are features of the Savannah Harbor Navigation Project. Authorized sediment control works in the harbor consist of the Tidegate structure across Back River and a Sediment Basin immediately downstream of the Tidegate. These structures were designed to concentrate sedimentation outside the navigation channel in a location close to confined disposal facilities. Both the concentration of sediment and the short pumping distance reduced the cost of sediment removal in the harbor. The Sediment Basin was authorized at a 40-foot depth, 600-foot width and approximately 2-mile length, with an entrance channel 38 feet deep and 300 feet wide. The Tidegate became operative in May 1977, but was taken out of service due to adverse environmental impacts in October 1990. A drainage canal, known as New Cut, located across Argyle Island was constructed along with the Tidegate. New Cut was closed in 1990 to reduce salinity levels in the Savannah National Wildlife Refuge, restore approximately 4,000 acres of freshwater marsh, and reduce the flushing of striped bass eggs and larvae into the Front River.

k. Freshwater Control Works. The Sediment Control Works also include a Freshwater Control System. During the development of the harbor deepening and sediment control features in the 1970's, it was recognized that the saltwater wedge would move farther upstream as a result of these projects. This would have produced unacceptable salinity levels at the Savannah National Wildlife Refuge's (SNWR) freshwater intake on Little Back River and adverse impacts on freshwater marshes in the Savannah National Wildlife Refuge (NWR) and adjacent private lands. To offset these impacts, a freshwater supply system was included in the project. This system had the following five components:

(1) 5,500-foot long canal through McCoombs Cut to provide freshwater to the Savannah NWR (Figure 4). The canal was constructed with a 200-foot bottom width at EL -7' MLLW and 2H:1V side slopes. The design flow through McCoombs Cut was 4,000 CFS.

(2) a channel in Middle River with a 90-foot bottom width at EL -6' MLLW and 2H:1V side slopes. The design flow in Middle River was 1,500 CFS.

(3) a channel in Little Back River with a 200-foot bottom width at EL -5.1' MLLW and 2H:1V side slopes. The design flow in Little Back River was 2,500 CFS.

(4) 28,000-foot long freshwater supply canal with a 28-foot bottom width at EL -4' MLLW, 2H:1V side slopes, and water control structures.

(5) 3,700-foot long connecting canal with a 6-foot bottom width at EL -4' MLLW, 2H:1V side slopes.

Congress also authorized a freshwater canal extending from the Savannah NWR to private lands located north of the US Highway 17A Bridge on the South Carolina side of the river. That canal was designed with a 6-foot bottom width at EL -4' MLLW and 2H:1V side slopes.

The Federal government is responsible for maintenance of the Diversion Canal, the channels in Little Back River and Middle River, and the canals and control works for the Refuge. Although annual maintenance has been performed on this system, the maintenance costs have exceeded what was originally envisioned. The salinity levels corrode equipment, requiring more rapid replacement. The non-Federal project sponsor, the Georgia Department of Transportation, is responsible for the canal serving private lands southeast of the Refuge. In 1982, the non-Federal sponsor entered into a supplemental agreement with the private property owners, transferring responsibility for normal dike maintenance for facilities on the private lands to those property owners. The sponsor has delivered sand to the area for the property owners' use in dike maintenance. Recently, the Corps performed the first major rehabilitation of the water control features of the system. The Corps began rehabilitation of water control structures located on the SNWR in May 2010 to restore them to their original operating condition; that work is now complete. Work on water control structures located on the adjacent private lands will begin soon.

1.02 ALTERNATIVES.

Six alternatives (i.e., No Action Alternative or the Without Project Condition, which is the existing project depth of -42 feet MLLW, -44 feet MLLW, -45 feet MLLW, -46 feet MLLW, -47 feet MLLW, and -48 feet MLLW) were considered in detail for Savannah Harbor. Please see Figure 1-4 below for a review of the project vicinity. All of the harbor deepening alternatives would include widening of the existing Kings Island Turning Basin , deepening eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), implementing two meeting areas (see Table 1-5), and implementing four bend wideners (see Table 1-6). The length of the bar channel extension varies with the proposed depth alternative (Table 1-7).

All of the proposed deepening alternatives would produce a narrower channel at the project depth than currently exists by maintaining the existing side slopes. By slightly decreasing the channel width (by maintaining the existing side slopes at different depths), the adjacent marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, the effects on sedimentation and shoaling within the new deeper channel would be minimized.

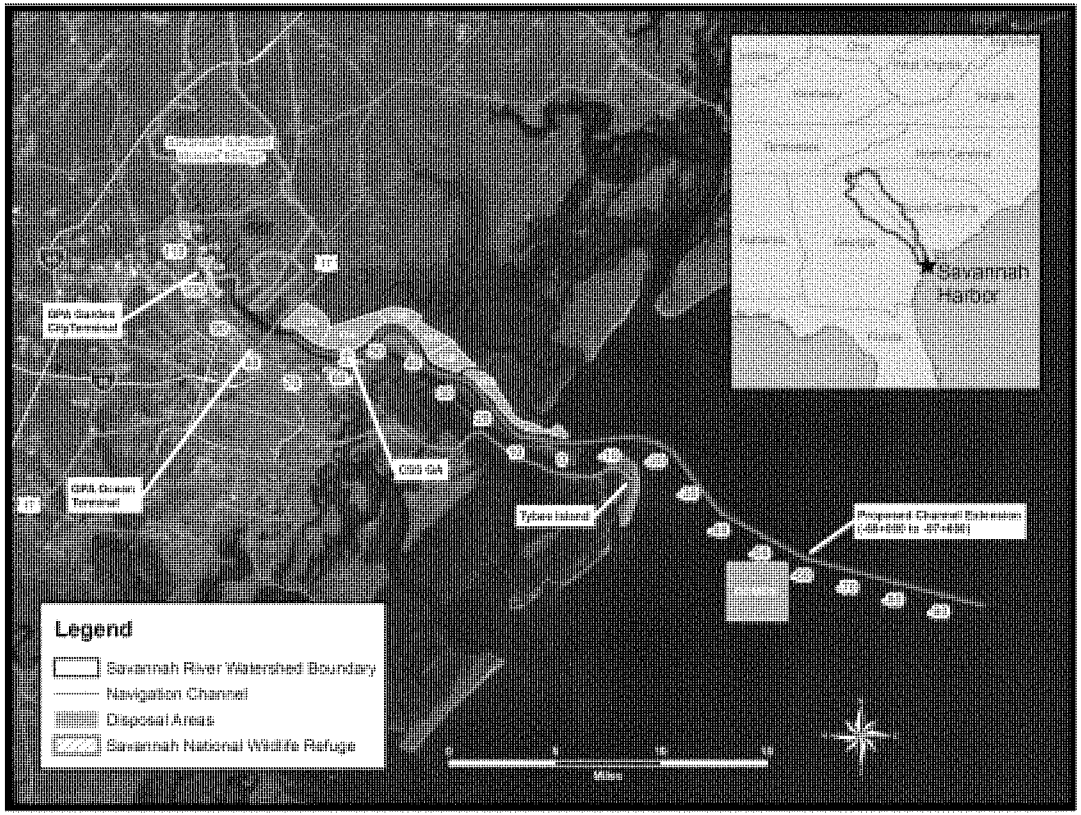


Figure 1-4 Project vicinity map.

The navigation channel side slopes will be 5H:1V in the ocean bar area (Stations 0+000 to -98+600B) and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V means for every 5 and 3 feet of horizontal distance there would be a change of 1 foot of vertical distance.

For all dredging alternatives, dredging depths will include 2 feet of allowable overdepth and advanced maintenance. The allowable overdepths and advance maintenance allow for dredging inaccuracies and help the project remain at project depth between maintenance events (see detailed description of these terms, below).

1.02.1 -44-FOOT ALTERNATIVE (2 FEET DEEPER)

This plan would involve dredging the inner harbor (described in Section 1.2, above) to -44 feet (2 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Harbor channel deepening would also require the construction of two meeting areas (see Table 1-5, below), and three bend wideners (see Table 1-6, below). Improvements in the entrance channel would involve deepening of the existing channel to -46 feet MLLW from Stations 0+000 to -60+000B. The depth of -46 feet MLLW would extend an additional 35,680 feet for the ocean bar channel extension (from Stations -60+000B to -95+680B). The total volume of excavated sediment associated with this project is about 10.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

1.02.2 -45-FOOT ALTERNATIVE (3 FEET DEEPER)

This plan would involve dredging the inner harbor (described in Section 1.2, above) to -45 feet MLLW (3 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Harbor channel deepening would also require the construction of two meeting areas (see Table 1-5, above), and three bend wideners (see Table 1-6, above). Improvements in the entrance channel would involve deepening of the existing channel to -47 MLLW from Stations 0+000 to -60+000B. The depth of -47 feet MLLW would extend an additional 36,880 feet for the ocean bar channel extension (from Stations -60+000B to -96+800B). The total volume of excavated sediment associated with this project is about 14.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

Table 1-5. Proposed Two New Meeting Areas (see Figure 1-1)

Location	Description
GA waters: Station 14+000 to 22+000	The existing 400 foot wide channel would be widened 100 feet on the south to provide an average width of 500 feet. Side slopes would be 3H:1V.
GA and SC waters: Station 55+000 to 59+000	The existing 400 foot wide channel would be widened 100 feet to the north to provide an average width of 500 feet. Side slopes would be 3H:1V.

Table 1-6. Proposed New Channel Bend Wideners (see Figure 1-1)

Widener	Location	Description
1	SC waters: Stations -23+000 to -14+000	76-foot bottom width plus side slope of ~20 feet. North side of channel.
2	GA waters: Stations 27+700 to 31+500	156-foot bottom width plus side slope of less than 100 feet. North side of channel.
3	SC waters: Stations 52+250 to 55+000	76-foot bottom width plus side slope of less than 100 feet. North side of channel.

Table 1-7. Length of Bar Channel Extension Required for Depth Alternatives

Length of Bar Channel Extension Required for Depth Alternatives		
Depth (Feet)	Bar Channel Extension (Stations)	Length of Extension (Feet)
44	-60+000B to -95+680B	35,680
45	-60+000B to -96+880B	36,880
46	-60+000B to -97+510B	37,510
47	-60+000B to -97+680B	37,680
48	-60+000B to -98+600B	38,600

1.02.3 -46-FOOT ALTERNATIVE (4 FEET DEEPER)

This plan would involve dredging the inner harbor (described in Section 1.2 above) to -46 feet MLLW (4 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Harbor channel deepening would also require the construction of two meeting areas (see Table 1-5, above), and three bend wideners (see Table 1-6, above). Improvements in the entrance channel would involve deepening of the existing channel to -48 feet MLLW from Stations 0+000 to -60+000B. The depth of -48 feet MLLW would extend an additional 37,510 feet for the ocean bar channel extension (from Stations -60+000B to -97+510B). The total volume of excavated sediment associated with this project is about 19.0 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

1.02.4 -47-FOOT ALTERNATIVE (5 FEET DEEPER)

This plan would involve dredging the inner harbor (described in Section 1.2, above) to -47 feet MLLW (5 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Harbor channel deepening would also require the construction of two meeting areas (see Table 1-5, above), and three bend wideners (see Table 1-6, above). Improvements in the entrance channel would involve deepening of the existing channel to -49 feet MLLW from Stations 0+000 to -60+000B. The depth of -49 feet MLLW would extend an additional 37,680 feet for the ocean bar channel extension (from Stations -60+000B to -97+680B). The total volume of excavated sediment associated with this project is about 23.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

1.02.5 -48-FOOT ALTERNATIVE (6 FEET DEEPER)

This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -48 feet MLLW (6 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Harbor channel deepening would also require the construction of two meeting areas (see Table 1-5, above), and three bend wideners (see Table 1-6 above). Improvements in the entrance channel would involve deepening of the existing channel to -50 feet MLLW from Stations 0+000 to -60+000B. The depth of -50 feet MLLW would extend an additional 38,600 feet for the ocean bar channel extension (from Stations -60+000B to -98+600B). The total volume of excavated sediment associated with this project is about 28.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

1.03 SELECTED PLAN

The District developed and evaluated five channel deepening alternatives, in addition to the No Action Alternative. Each channel deepening alternative contains mitigation features to address adverse environmental impacts that they would otherwise produce. With inclusion of the mitigation features, each depth alternative is environmentally acceptable. The 47-foot depth alternative is the National Economic Development (NED) Plan, the plan that maximizes net economic benefits to the Nation (See GRR). Under current Federal planning policy, the NED plan would be recommended for implementation unless there are overriding considerations that favor recommendation of another plan. Benefits that would accrue from the deepening of Savannah Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The economic benefits increase with each additional increment of channel deepening. Environmental impacts associated with a shallower depth would be less than those associated with the NED plan, but the lesser impacts of the 44-foot depth, 45-foot depth, and 46-foot depth alternatives are not considered sufficient to justify recommendation of these alternatives instead of the NED Plan.

The State of Georgia asked the Corps to consider the 48-foot depth alternative as the Locally Preferred Plan. After reviewing the comments received on the Draft GRR and DEIS, and discussions with the State, the Corps elected to not select the 48-foot depth alternative for implementation.

Selected Plan: -47-Foot Depth Alternative.

Deepening of the existing channel from the ocean bar to the Georgia Port Authority's Garden City Terminal is the central feature of the proposed action. The total length of improvements is approximately 38.2 miles (from the upstream river end near Station 103+000 to end of the ocean bar channel -97+680B). The proposed five foot deepening (-47 feet MLLW) of the Federal navigation channel would require the removal of approximately 23.63 MCY of material. Subject to the availability of funds, the construction period for the entire project would be about four years.

The recommended project provides for an ocean bar navigation channel at -49-feet MLW and 600-foot wide (Station -97+680B) from the Atlantic Ocean to the channel between the jetties (Station -14+000B). The ocean bar channel would continue at -49-feet MLLW and 500-foot wide from the jetties to the harbor entrance just north of Tybee Island (Stations -14+000B to 0+000). From the harbor entrance (Station 0+000) to the upstream limit of the proposed improvements (Station 103+000) the river navigation channel would continue at -47-feet MLLW and about 500-foot wide. The eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), three channel bend wideners and two meeting areas would also be deepened to -47-feet MLW. The existing Kings Island Turning Basin would be deepened to 47 feet. Given the 8 feet of advanced maintenance that is authorized within the Kings Island Turning Basin, the final depth would be 55 feet MLLW. The recommended deepening project ends near the Garden City Terminal (Station 103+000), but the upstream terminus of the Savannah Harbor Federal Navigation Project extends to Station 112+500.

Channel side slopes from the oceanward end of the bar channel would be 5H:1V. Side slopes for the remaining project (including Kings Island Turning Basin, the eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), three channel bend wideners and two meeting areas would be 3H:1V. Because the side slopes of the navigation channel do not change, the estimated average annual maintenance dredging would remain about 7.1 MCY.

Two feet allowable overdepth and advance maintenance (see Table 1-2, above) would be included for the proposed action.

Dredging and Sediment Placement Methods

Excavation methods include use of cutterhead pipeline, mechanical (i.e., bucket and barge), and hopper dredges. A cutterhead pipeline dredge and/or mechanical dredge will be used to deepen the Inner Harbor channel (from Stations 4+000 to 103+000) and a hopper dredge, mechanical and/or ocean certified pipeline dredges will be used to deepen the Entrance Channel (from Stations 4+000 to -97+6800B). About 13.0 MCY of newly excavated material from the Inner Harbor channel will be placed in the seven upland CDFs. Approximately 10.6 million cubic yards of newly excavated material from the entrance channel would be placed in the Savannah Harbor ODMDS (Figure 1-2) or upland CDF.

Dredging and sediment placement methods for maintenance of the completed project would be similar to that used for construction. All maintenance material from the inner harbor would be placed in the seven CDFs. Maintenance material from the entrance channel would be placed in the ODMDS or Sites 2 and 3 adjacent to the entrance channel. This constitutes the Base Plan, the most cost effective and environmentally acceptable plan for maintenance of the 47-foot project. Suitable maintenance material from the entrance channel could also be placed into the feeder berm sites off Tybee Island or directly onto the beach on Tybee Island provided a non-Federal sponsor paid the additional costs for placement in areas not included in the Base Plan.

2.00 AFFECTED ENVIRONMENT

A detailed description of the affected environment can be found in Section 4 of the Environmental Impact Statement.

3.00 PRIOR COORDINATION

Potential impacts on listed species have also been identified previously for other projects in Savannah Harbor. Biological Assessments for Threatened and Endangered Species (BATES) were written for the Savannah Harbor Deepening Feasibility Report in 1991 and for the Savannah Harbor Long Term Management Strategy (LTMS), Chatham County, Georgia and Jasper County, South Carolina in 1996. USFWS has not issued any formal biological opinions for nesting sea turtles (i.e., leatherback, loggerhead, Kemp's ridley, hawksbill, and green sea turtles) in the Savannah Harbor area. By letter dated October 9, 1990, the USFWS concurred with the Corps' determination that the proposed deepening of the Savannah Harbor by four feet (to – 42 feet MLLW) was not likely to adversely affect these threatened and endangered species since the

Corps would abide by the conditions and restrictions found in the BATES dated September 1990. By letter dated May 8, 1991, the NOAA, National Marine Fisheries Service, concurred with the Corps determination that the proposed 4-foot deepening of the Federal Navigation channel was not likely to adversely affect these threatened and endangered species since the Corps would abide by NMFS Biological Opinion for the Deepening of the Savannah Harbor.

The National Marine Fisheries Service (NMFS) Southeast Regional Office, St. Petersburg, FL., issued a Regional Biological Opinion (RBO) on September 25, 1997, concerning the continued hopper dredging of channels and borrow areas in the Southeastern United States. That opinion was written to amend their 1995 opinion and supersede the 1997 interim opinion. It set an annual (FY) documented incidental take for the region of seven Kemp's ridleys, seven greens, two hawksbills, thirty-five loggerheads, and 5 Shortnose sturgeon, and clarified monitoring requirements for beach nourishment projects. Furthermore, the hopper dredge windows, as established in the 1995 opinion, were incorporated into the 1997 RBO for hopper dredging along the South Atlantic coast, provided the Corps continued to minimize sea turtle takes by refining the turtle deflecting dragheads, work in the cool water months to the maximum extent practicable, and shut down operations when high numbers of turtle takes occur before approaching the incidental take limit for a given species. Work is presently underway to update that RBO.

4.00 SPECIES CONSIDERED UNDER THIS ASSESSMENT

4.01 Updated lists of Federally Threatened and Endangered (T&E) species for the project area

Obtained from NMFS (Southeast Regional Office, St. Petersburg, FL) and the USFWS (Field Office, Charleston, SC and Athens, GA). These were combined to develop the following composite list, which includes Federally-listed T&E species that could be present in the area based upon their geographic range (see Table 4-1). However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors.

Table 4-1. Federally Threatened and Endangered Species Potentially Present in Chatham County, Georgia and Jasper County, South Carolina

Species Common Names	Scientific Name	Federal Status
Marine Turtles		
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened

Mammals		
North Atlantic right whale	*Eubaleana glacialis*	Endangered
Blue whale	*Balaena musculus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
West Indian Manatee	*Trichechus manatus*	Endangered
Anadromous and Marine Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon	*Acipenser oxrinchus oxyrinchus*	Endangered
Vertebrates		
Kirtlands warbler	*Dendroica kirtlandii*	Endangered
Bachman's warbler	*Vermivora bachmanii*	Endangered
Piping plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Wood stork	*Mycteria americana*	Endangered
Eastern indigo snake	*Drymarchon corais couperi*	Threatened
Flatwoods salamander	*Ambystoma cingulatum*	Threatened
Vascular Plants		
Pondberry	*Lindera melissifolia*	Endangered
Chaffseed	*Schwalbea americana*	Endangered
Canby's dropwort	*Oxypolis candyi*	Endangered

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

KEY:

Status	**Definition**
Endangered	A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened	A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

4.02 Updated list of Georgia's Known Occurrences of Conservation Areas and Special Concern Animals and Plants On or Near Savannah Harbor Navigation Project, Chatham County, Georgia.

This list was obtained from the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section, in an email dated January 4, 2010.

Table 4-2. Georgia's Known Occurrences of Conservation Areas and Special Concern Animals and Plants On or Near Savannah Harbor Navigation Project, Chatham County, Georgia

Animals

Scientific Name	Common Name	GRANK	SRANK	USESA	SPROT
Acipenser brevirostrum	Shortnose Sturgeon	G3	S2	LE	E
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	G3T3	SNR		
Ambystoma cingulatum	Frosted Flatwoods Salamander	G2	S2	LT	T
Ammodramus maritimus	Seaside Sparrow	G4	S3		
Caretta caretta	Loggerhead Sea Turtle	G3	S2	LT	E
Charadrius melodus	Piping plover	G3	S1	LT	T
Charadrius wilsonia	Wilson's Plover	G5	S2		T
Chelonia mydas	Green Sea Turtle	G3	S1	LT	T
Clemmys guttata	Spotted Turtle	G5	S3		U
Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	G4	S4		
Dermochelys coriacea	Leatherback Sea Turtle	G2	S1	LE	E
Eubalaena glacialis	Northern Atlantic Right Whale	G1	S1	LE	E
Gopherus polyphemus	Gopher Tortoise	G3	S2		T
Haematopus palliatus	American Oystercatcher	G5	S2		R
Haliaeetus leucocephalus	Bald Eagle	G5	S2		
Himantopus mexicanus	Black-necked Stilt	G5	S3		
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	G4T3Q	S3		
Lasiurus intermedius	Northern Yellow Bat	G4G5	S2S3		
Lepidochelys kempii	Kemp's or Atlantic Ridley	G1	S1	LE	E
Moxostoma robustum	Robust Redhorse	G1	S1		E
Mycteria americana	Wood Stork	G4	S2	LE	E
Nyctanassa violacea	Yellow-crowned Night-heron	G5	S3S4		
Nycticorax nycticorax	Black-crowned Night-heron	G5	S4		
Passerina ciris	Painted Bunting	G5	S3		
Picoides borealis	Red-cockaded Woodpecker	G3	S2	LE	E
Pseudacris brimleyi	Brimley's Chorus Frog	G5	S1		
Pseudorca crassidens	False Killer Whale	G4	SNRN		
Rana capito	Gopher Frog	G3	S3		R
Rynchops niger	Black Skimmer	G5	S1		R
Stereochilus marginatus	Many-lined Salamander	G5	S3		
Sterna antillarum	Least Tern	G4	S3		R
Trichechus manatus	Manatee	G2	S1S2	LE	E
Umbra pygmaea	Eastern Mudminnow	G5	S2S3		

Plants

Scientific Name	Common Name	GRANK	SRANK	USESA	SPROT
Acacia farnesiana	Sweet Acacia	G5	S1		
Forestiera segregata	Florida Wild Privet	G4	S2		R
Hibiscus grandiflorus	Swamp Hibiscus	G4?	S2		
Lindera melissifolia	Pond Spicebush	G2G3	S2	LE	E
Physostegia leptophylla	Narrowleaf Obedient Plant	G4?	S2S3		
Rhynchospora punctata	Pineland Beaksedge	G1?	S1?		
Sageretia minutiflora	Climbing Buckthorn	G4	S2		T
Sapindus marginatus	Soapberry	G5	S1S2		R
Sarracenia minor var. minor	Hooded Pitcherplant	G4T4	SNR		U
Scutellaria mellichampii	Mellichamp's Skullcap	G3G4	S2?		
Sporobolus pinetorum	Pineland Dropseed	G3	S2?		
Vigna luteola	Wild Yellow Cowpea	G5	S2?		

Conservation Areas

Fort Pulaski National Monument [National Park Service]	Adjacent to project area
Greenspace [Chatham County]	Near project area
Hunter Army Airfield [U.S. Department of Defense]	Near project area
Little Tybee-Cabbage Island Natural Area [Georgia DNR]	Near project area
Savannah NWR [U.S. Fish and Wildlife Service]	On site
Savannah River [High Priority Stream]	On site
Skidaway Island State Park [Georgia DNR]	Near project area
Tybee Island Tract [Georgia DNR]	Near project area
Wormsloe Historic Site [Georgia DNR]	Near project area
Tybee NWR [U.S. Fish and Wildlife Service]	On site

G RANK: The Nature Conservancy rating of degree of global endangerment:

- G1 - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction
- G2 - Imperiled globally because of rarity or factor(s) making it vulnerable
- G3 - Either very rare throughout its range or found locally in a restricted range, or having factors making it vulnerable
- G4 - Apparently secure globally, though it may be rare in parts of its range
- G5 - Demonstrably secure globally, though it may be rare in parts of its range
- GH - Of historical occurrence throughout its range, with possibility of rediscovery
- GX - Extinct throughout its range
- G? - Status unknown
- T# - Status of infraspecific taxa (subspecies or varieties). Rankings similar to G#.

S RANK: The Nature Conservancy rating of degree of state endangerment:

- S1 - Critically imperiled state-wide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation
- S2 - Imperiled state-wide because of rarity or factor(s) making it vulnerable

S3 - Rare or uncommon in state, found only in a restricted range, or factors making it vulnerable
S4 - Apparently secure in state: Uncommon but not rare, and usually widespread
S5 - Secure: Common, widespread, and abundant
SA - Accidental in state (usually birds or butterflies that are far outside normal range)
SE - Exotic established in state
SH - Of historical occurrence in state, with possibility of rediscovery
SN - Regularly occurring in state, but in a migratory, non-breeding form
SR - Reported in state, but without good documentation
SX - Extirpated from state
S? - Rank not yet assessed.

Other Qualifiers:

B - Breeding
N - Non-breeding
? - Denotes inexact or uncertain numeric rank

USESA is the US Endangered Species Act listed species designated as "LE" Listed Endangered or "LT" Listed Threatened.

SPROT "Species Protected, Rare or Threatened" are the protected species in the state of Georgia. For SPROT they may have a listing as T - Threatened, E-Endangered, R-Rare, or U-Unknown.

** "US" indicates species with federal status (Protected, Candidate or Partial Status). Species that are federally protected in Georgia are also state protected. "GA" indicates Georgia protected species. All other are "species of concern" in Georgia.

4.03 Updated lists of South Carolina's Rare, Threatened, and Endangered Species of Jasper County and Adjacent Counties

Table 4-3. South Carolina's Rare, Threatened, and Endangered Species of Jasper County (Taken from SC Dept. of Natural Resources, Heritage Trust Program. Date of information – 4 January 2010)**

ANIMALS

LEGAL STATUS	GLOBAL RANK	STATE RANK	SCIENTIFIC NAME	COMMON NAME
FE/SE	G3	S3	*ACIPENSER BREVIROSTRUM*	SHORTNOSE STURGEON
SC	G3	S3	*AIMOPHILA AESTIVALIS*	BACHMAN'S SPARROW
FT/SE	G2G3	S1	*AMBYSTOMA CINGULATUM*	FLATWOODS SALAMANDER
SC	G4	S?	*ANODONTA COUPERIANA*	BARREL FLOATER
ST	G5	S5	*CLEMMYS GUTTATA*	SPOTTED TURTLE
SE	G3G4	S2?	*CORYNORHINUS RAFINESQUII*	RAFINESQUE'S BIG-EARED BAT
SC	G4	S3	*CROTALUS ADAMANTEUS*	EASTERN DIAMONDBACK RATTLESNAKE
SC	G2G3	S?	*ELASSAMA OKATIE*	BLUEBARRED PYGMY SUNFISH
SC	G4	S?	*ELLIPTIO CONGARAEA*	CAROLINA SLABSHELL
SE	G3	S1	*GOPHERUS POLYPHEMUS*	GOPHER TORTOISE
SE	G4	S2	*HALIAEETUS LEUCOCEPHALUS*	BALD EAGLE
SC	G2	S?	*HETERODON SIMUS*	SOUTHERN HOGNOSE SNAKE
SC	G5	S5	*HYLA AVIVOCA*	BIRD-VOICED TREEFROG
SC	G5	S?	*KINOSTERNON BAURII*	STRIPED MUD TURTLE
SC	G4	SA	*KOGIA BREVICEPS*	PYGMY SPERM WHALE
SC	G3G4	S?	*LAMPSILIS CARIOSA*	YELLOW LAMPMUSSEL
SC	G3	S?	*LAMPSILIS SPLENDIDA*	RAYED PINK FATMUCKET
FE/SE	G4	S1S2	*MYCTERIA AMERICANA*	WOOD STORK
SC	G5	S3S4	*NEOTOMA FLORIDANA*	EASTERN WOODRAT
SC	G3	S?	*OPHISAURUS MIMICUS*	MIMIC GLASS LIZARD
FE/SE	G3	S2	*PICOIDES BOREALIS*	RED-COCKADED WOODPECKER
SC	G4T3?	S2	*PITUOPHIS MELANOLEUCUS MUGITUS*	FLORIDA PINE SNAKE
ST	G5	S2	*PSEUDOBRANCHUS STRIATUS*	DWARF SIREN
SC	G5T4	S3S4	*PSEUDOTRITON MONTANUS FLAVISSIMUS*	GULF COAST MUD SALAMANDER
SC	G5	S?	*PYGANODON CATARACTA*	EASTERN FLOATER
SC	G5	S4	*SCIURUS NIGER*	EASTERN FOX SQUIRREL
SC	G5	S?	*SEMINATRIX PYGAEA*	BLACK SWAMP SNAKE
ST	G4	S3	*STERNA ANTILLARUM*	LEAST TERN
SC	G5	S?	*UTTERBACKIA IMBECILLIS*	PAPER PONDSHELL
SC	G4	S?	*VILLOSA DELUMBIS*	EASTERN CREEKSHELL

SC	G5	S4	*TYTO ALBA*	BARN OWL
SC	G5	S?	*PLEGADIS FALCINELLUS*	GLOSSY IBIS
SE	G5	S2	*ELANOIDES FORFICATUS*	AMERICAN SWALLOW-TAILED KITE
SC	G5	S?	*MELANERPES ERYTHROCEPHALUS*	RED-HEADED WOODPECKER
SC	G4	S1S2	*PELECANUS OCCIDENTALIS*	BROWN PELICAN
ST	G5	S3?	*CHARADRIUS WILSONIA*	WILSON'S PLOVER
SC	G5	S4	*ICTINIS MISSISSIPPIENSIS*	MISSISSIPPI KITE
SC	G5	S3?	*ACCIPITER COOPERI*	COOPER'S HAWK

PLANTS

SC	G4?	S?	*AGALINIS LINIFOLIA*	FLAX LEAF FALSE-FOXGLOVE
SC	G4G5	S1	*AGARISTA POPULIFOLIA*	CAROLINA DOG-HOBBLE
SC	G4G5	S?	*ALETRIS OBOVATA*	WHITE COLICROOT
SC	G4	?	*ANDROPOGON BRACHYSTACHYUS*	SHORT-SPIKE BLUESTEM
SC	G5T3T4	S1	*ANDROPOGON PERANGUSTATUS*	NARROW LEAVED BLUESTEM
SC	G4Q	S1	*ANDROPOGON GYRANS VAR STENOPHYLLUS*	ELLIOTTS BLUESTEM
SC	G5	S?	*ANTHAENANTIA RUFA*	PURPLE SILKYSCALE
SC	G4?	S?	*ARISTIDA CONDENSATA*	PIEDMONT THREE-AWNED GRASS
SC	G3G5	S1	*BACOPA CYCLOPHYLLA*	COASTAL-PLAIN WATER-HYSSOP
SC	G4	S?	*BALDUINA UNIFLORA*	ONE-FLOWER BALDUINA
SC	G4?	S4	*CANNA FLACCIDA*	BANDANA-OF-THE-EVERGLADES
SC	G5	S?	*CAREX AMPHIBOLA*	NARROWLEAF SEDGE
SC	G4	S?	*CAYAPONIA QUINQUELOBA*	CAYAPONIA
SC	G4G5	S?	*CLIFTONIA MONOPHYLLA*	BUCKWHEAT-TREE
SC	G3G5	S?	*COREOPSISGLADIATA*	SOUTHEASTERN TICKSEED
SC	G5	S?	*CROTONOPSIS LINEARIS*	NARROWLEAF RUSHFOIL
SC	G4?	S1	*CYPERUS TETRAGONUS*	PIEDMONT FLATSEDGE
SC	G4G5	S1	*DICERANDRA ODORATISSIMA*	ROSE BALM
SC	G4G5	S?	*DICHANTHELIUM ACICULARE*	BROOMSEDGE
SC	G2G3	SR	*EUPATORIUM ANOMALUM*	FLORIDA THOROUGH-WORT
SC	G4	S1	*FORESTIERA SEGREGATA*	SOUTHERN PRIVET
SC	G5	S1	*HALESIA DIPTERA*	TWO-WING SILVERBELL
SC	G?	S?	*HALESIA PARVIFLORA*	SMALL-FLOWERED SILVERBELL-TREE
RC	G2G3	S1	*HYPERICUM ADPRESUM*	CREEPING ST. JOHN'S WORT
SC	G4G5	S?	*LEPUROPETALON SPATHULATUM*	SOUTHERN LEPUROPETALON
SC	G4G5	S?	*LICANIA MICHAUXII*	GOPHER-APPLE
SC	G4	S?	*LISTERA AUSTRALIS*	SOUTHERN TWAYBLADE

SC	G3	S3	*LITSEA AESTIVALIS*	PONDSPICE
SC	G5	S1	*LYONIA FERRUGINEA*	RUSTY LYONIA
SC	G5	S1	*LYSIMACHIA HYBRIDA*	LAND-LEAF LOOSESTRIFE
SC	G2G3	S?	*MACBRIDEA CAROLINIANA*	CAROLINA BIRD-IN-A-NEST
SC	G4G5	S?	*NYSSA OGECHE*	OGEECHEE TUPELO
SC	G3G4	S?	*ORBEXILUM LUPINELLUM*	SAMPSON SNAKEROOT; SCURF PEA
SC	G5?	SR	*PANICUM NEURANTHUM*	
SC	G4	SNR	*PHYSOSTEGIA LEPTOPHYLLA*	SLENDER LEAVED DRAGON HEAD
SC	G4	S1	*PINCKNEYA PUBENS*	HAIRY FEVER TREE
SC	G3	S?	*PLANTAGO SPARSIFLORA*	PINELAND PLANTAIN
SC	G3G4	S2	*PLATANTHERA INTEGRA*	YELLOW FRINGELESS ORCHID
SC	G3	S1	*POLYGALA HOOKERI*	MILKWORT
SC	G5	S1S2	*POLYGALA NANA*	DWARF MILKWORT
SC	G5	S?	*POTAMOGETON FOLIOSUS*	LEAFY PONDWEED
SC	G2	S2	*PTEROGLOSSASPIS ECRISTATA*	CRESTLESS PLUME ORCHID
SC	G5?	S?	*PYCNANTHEMUM NUDUM*	PINELANDS MOUNTAIN MINT
SC	G5	S?	*QUERCUS MYRTIFOLIA*	MYRTLE-LEAF OAK
SC	G3G5	S1	*RUDBECKIA MOLLIS*	SOFT-HAIR CONEFLOWER
SC	G4	S2	*SAGERETIA MINUTIFLORA*	TINY-LEAVED BUCKTHORN
SC	G5T2	S?	*SAGITTARIA GRAMINEA VA WEATHERBIANA*	GRASSLEAF ARROWHEAD
FE/SE	G2	S2	*SCHWALBEA AMERICANA*	CHAFFSEED
SC	G4	S1S2	*SCLERIA BALDWINII*	BALDWIN NUTRUSH
SC	G3	S?	*SPIRANTHES LONGILABRIS*	GIANT SPIRAL LADIES' TRESSES
SC	G3	SR	*SPOROBOLUS FLORIDANUS*	FLORIDA DROPSEED
SC	G4	S?	*THALIA DEALBATA*	POWDERY THALIA
SC	G5T4T5	SR	*XYRIS DIFFORMIS VAR FLORIDANA*	FLORIDA YELLOW-EYED GRASS
SC	G3G4	SR	XYRIS SEROTINA	ACID-SWAMPYELLOW-EYED GRASS

G RANK: The Nature Conservancy rating of degree of global endangerment:

- G1 - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction
- G2 - Imperiled globally because of rarity or factor(s) making it vulnerable
- G3 - Either very rare throughout its range or found locally in a restricted range, or having factors making it vulnerable
- G4 - Apparently secure globally, though it may be rare in parts of its range
- G5 - Demonstrably secure globally, though it may be rare in parts of its range
- GH - Of historical occurrence throughout its range, with possibility of rediscovery
- GX - Extinct throughout its range
- G? - Status unknown

T# - Status of infraspecific taxa (subspecies or varieties). Rankings similar to G#.

S RANK: The Nature Conservancy rating of degree of state endangerment:

S1 - Critically imperiled state-wide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation
S2 - Imperiled state-wide because of rarity or factor(s) making it vulnerable
S3 - Rare or uncommon in state, found only in a restricted range, or factors making it vulnerable
S4 - Apparently secure in state: Uncommon but not rare, and usually widespread
S5 - Secure: Common, widespread, and abundant
SA - Accidental in state (usually birds or butterflies that are far outside normal range)
SE - Exotic established in state
SH - Of historical occurrence in state, with possibility of rediscovery
SN - Regularly occurring in state, but in a migratory, non-breeding form
SR - Reported in state, but without good documentation
SX - Extirpated from state
S? - Rank not yet assessed.

Other Qualifiers:

B - Breeding
N - Non-breeding
? - Denotes inexact or uncertain numeric rank

STATUS: legal status:

FE - Federal Endangered
FT - Federal Threatened
NC - Of Concern, National (unofficial - plants only)
RC - Of Concern, Regional (unofficial - plants only)
SE - State Endangered (official state list - animals only)
ST - State Threatened (official state list - animals only)
SC - Of Concern, State
SX - State Extirpated
DM -- Delisted Taxon, Recovered, Being Monitored First Five Years
PE/PT/C-Proposed or candidate for federal listing

Communities		
Common Name	**Global Rank**	**State Rank**
Bottomland hardwoods	G5	S4
Brackish marsh	G5	S5
Coastal Plain Mesic Beech Water Oak Forest	G3	SNR
Longleaf pine flatwoods	GNR	SNR
Maritime forest	G2	S2
Pine - scrub oak sandhill	G4	S4
Pine savanna	G3	S2
Pond cypress savanna	G3	S2
Salt marsh	G5	S5
Southern mixed hardwood forest	GNR	S1
Upland pine - wiregrass woodland	G3	S3
Xeric sandhill scrub	G5	S3

5.00 DREDGING METHODS

For the purposes of this assessment, dredging methods discussed will be those, which lend themselves capable of placing sediment within the seven upland confined disposal areas (CDFs) or the Savannah Ocean Dredged Material Disposal Site (ODMDS).

5.01 Hydraulic Dredges

Hydraulic dredges are characterized by their use of a centrifugal pump to excavate sediment and transport a slurry of dredged material and water to identified discharge areas. The ratio of water to sediment within the slurry mixture is controlled to maximize efficiency. The main types of hydraulic dredges are pipeline and hopper dredges.

5.01.1 Pipeline Dredges - Cutterhead Suction Dredge

Pipeline dredges are designed to handle a wide range of materials including clay, hardpan, silts, sands, gravel, and some types of rock formations without blasting. They are used for new work and maintenance in projects where suitable placement areas are available and operate in an almost continuous dredging cycle resulting in maximum production, economy, and efficiency. Pipeline dredges are capable of dredging in shallow or deep water and have accurate bottom and side slope cutting. Limitations of pipeline dredges include relative lack of mobility, long mobilization and demobilization, inability to work in high wave action and currents, and are impractical in high traffic areas.

Pipeline dredges are rarely self-propelled and; therefore, must be transported to and from the dredge site. Pipeline dredge size is based on the inside diameter of the discharge pipe, which commonly range from 6" to 36." They require an extensive array of support equipment including pipeline (floating, shore, and submerged), boats (crew, work, survey), barges, and pipe

handling equipment. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Some cutterheads are rugged enough to break up rock for removal (Figure 5-1).

During the dredging operation a cutterhead suction dredge is held in position by two spuds at the stern of the dredge, only one of which can be on the bottom while swinging. There are two swing anchors some distance from either side of the dredge, which are connected by wire rope to the swing wenches. The dredge swings to port and starboard alternately, passing the cutter through the bottom material until the proper depth is achieved. The dredge advances by "walking" itself forward on the spuds. This is accomplished by swinging the dredge to the port, using the port spud and appropriate distance, then the starboard spud is dropped and the port spud raised. The dredge is then swung an equal distance to the starboard and the port spud is dropped and the starboard spud raised.

Cutterhead pipeline dredges work best in large areas with deep shoals, where the cutterhead is buried in the bottom sediment. A cutterhead removes dredged sediment through an intake pipe and then pushes it out the discharge pipeline directly into the disposal site. Most, but not all, pipeline dredging operations involve upland disposal of the dredged sediment. Therefore, the discharge end of the pipeline is connected to shore pipe. When effective pumping distances to the disposal site become too long, a booster pump is added to the pipeline to increase the efficiency of the dredging operation (USACE, 1993).

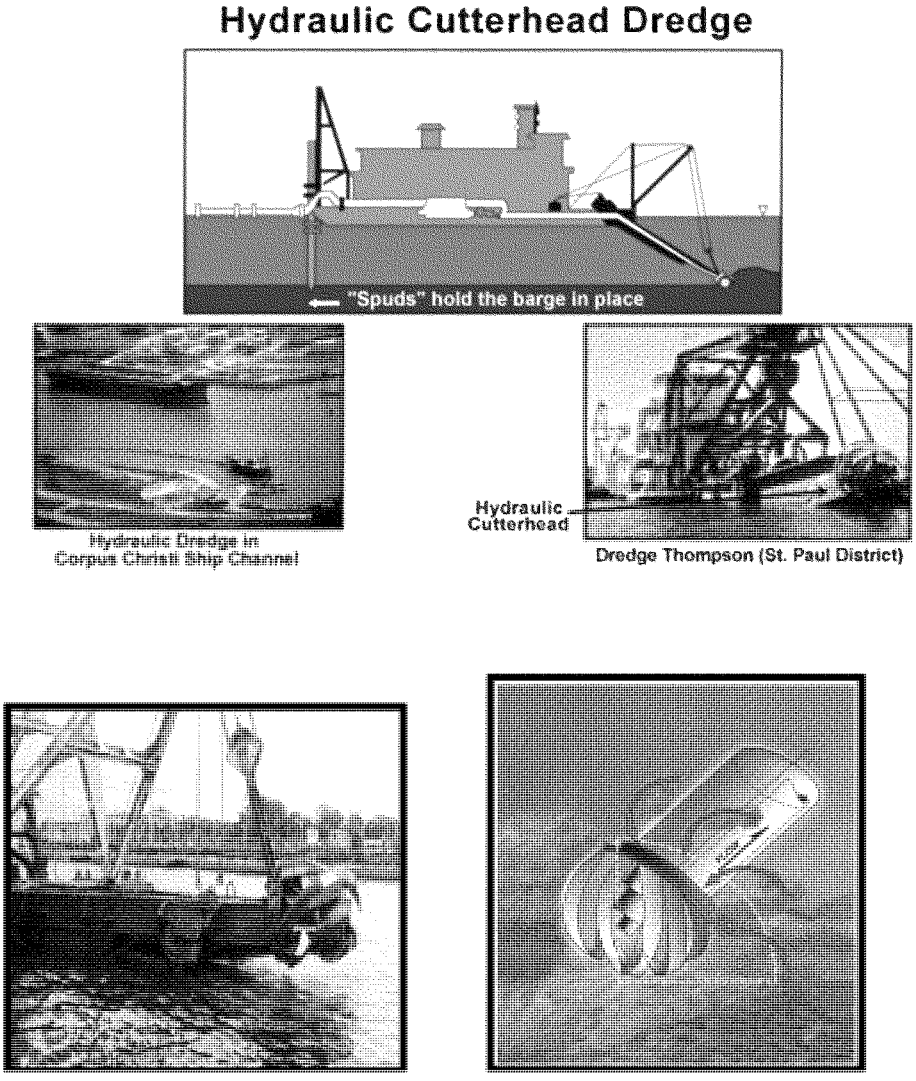


Figure 5-1. Cutterhead pipeline dredge schematic.

5.01.2 Hopper Dredge.

The hopper dredge, or trailing suction dredge, is a self-propelled ocean-going vessel with a section of the hull compartmented into one or more hoppers. Fitted with powerful pumps, the dredges suck sediment from the channel bottom through long intake pipes, called drag arms, and store it in the hoppers. Normal hopper dredge configuration has two dragarms, one on each side of the vessel. A dragarm is a pipe suspended over the side of the vessel with a suction opening called a draghead for contact with the bottom. The dredged slurry is pumped into the vessel's hopper and allowed to settle and the water portion of the slurry discharged from the vessel through its overflow system. When the hopper attains a full load, dredging stops and the ship travels to an in-water disposal site, where the dredged sediment is discharged through the bottom of the ship by splitting the hull. Some hopper dredges are capable of pumping the material back out of the vessel through a series of shore-pipe to a designated placement location.

Hopper dredges are well suited to dredging relatively thin layers of sediment. They can maintain operations safely, effectively, and economically in relatively rough seas and because they are mobile, they can be used in high-traffic areas. They are often used at ocean entrances and offshore, but cannot be used in confined or shallow areas. Hopper dredges can move quickly to placement sites under their own power, but since the dredging stops during the transit to and from the placement area, the operation loses efficiency if the haul distance is too far. Hopper dredges also have several limitations. Considering their normal operating conditions, hopper dredges cannot dredge continuously. The precision of hopper dredging is less than other types of dredges; therefore, they have difficulty dredging steep side banks and cannot effectively dredge around structures.

In order to minimize the risk of incidental takes of sea turtles, the Corps requires the use of sea turtle deflecting dragheads on all hopper-dredging projects where the potential for sea turtle interactions exist. The leading edge of the deflector is designed to have a plowing effect of at least 6" depth when the drag head is being operated. Appropriate instrumentation is required on board the vessel to insure that the critical "approach angle" is attained in order to satisfy the 6" plowing depth requirement (USACE, 1993).

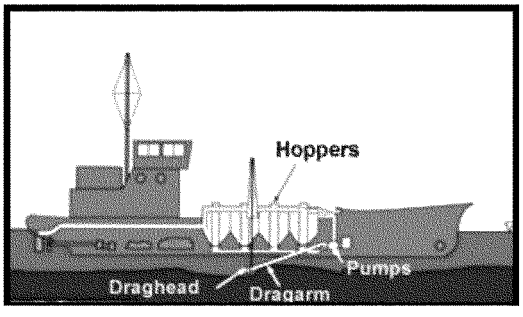


Figure 5-2. Hopper dredge schematic.

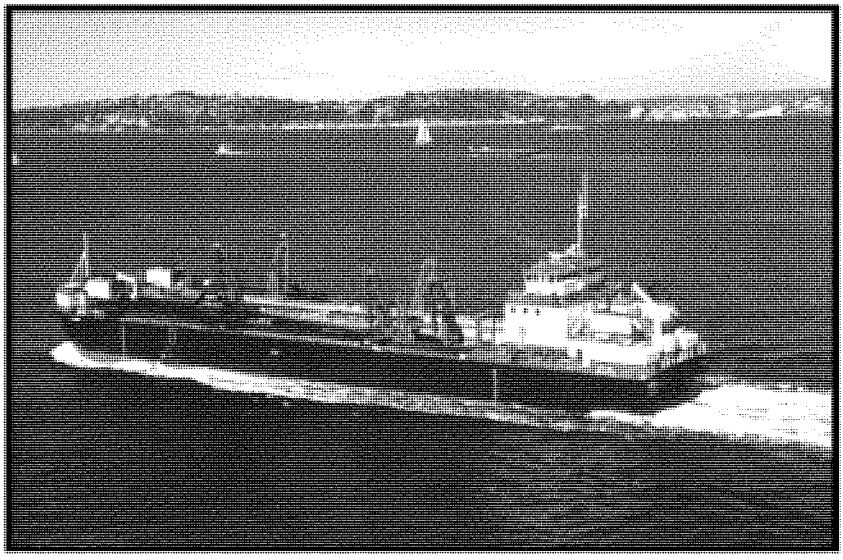


Figure 5-3. Photograph taken from Manson Construction Company, Hopper Dredge Bayport.

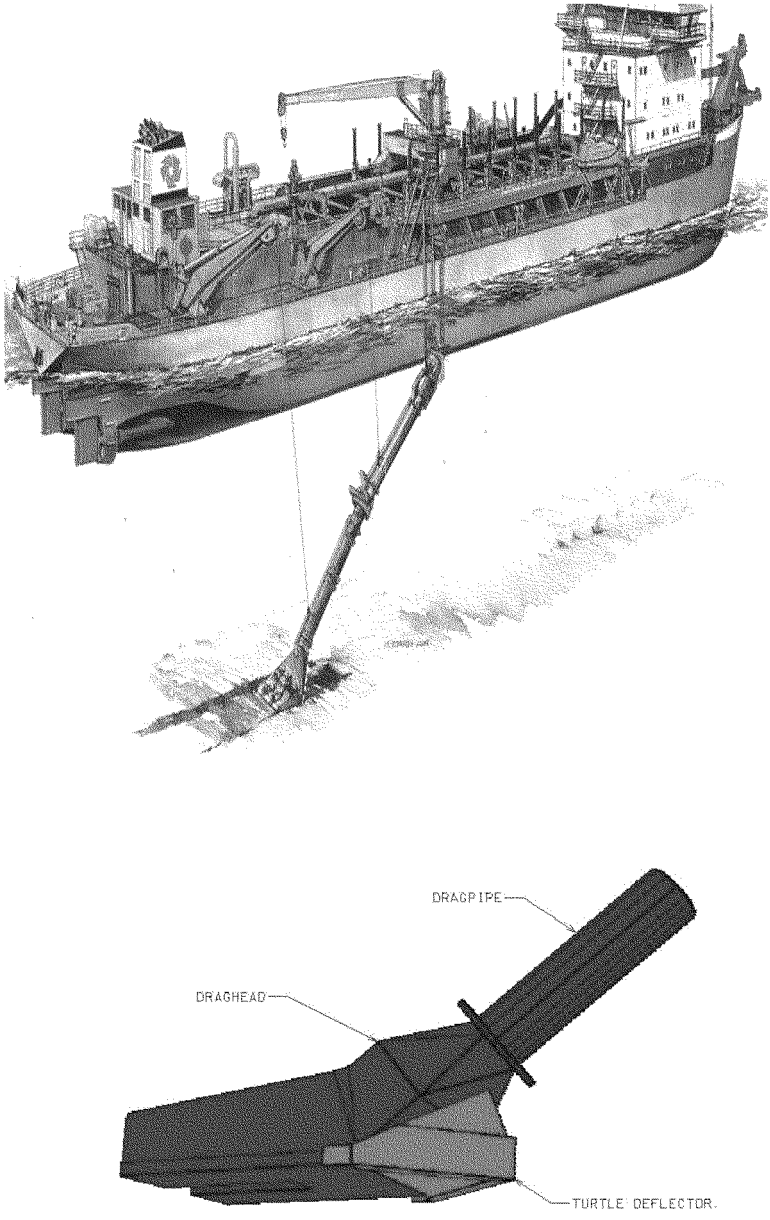


Figure 5-4. Hopper dredge in operation and figure of draghead with turtle deflector.

5.02 Mechanical Dredges

Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom sediment. They remove sediment by scooping it from the bottom and then placing it onto a waiting barge or directly into a placement area. Mechanical dredges work best in consolidated, or hard-packed, materials and can be used to clear rocks and debris. Dredging buckets have difficulty retaining loose, fine materials, which can be washed from the bucket as it is raised. Special buckets have been designed for controlling the flow of water and sediment from buckets and are used when dredging contaminated sediments. Mechanical dredges are rugged and can work in tightly confined areas. They are mounted on a large barge and are towed to the dredging site and secured in place by anchors or spuds. They are often used in harbors, around docks and piers, and in relatively protected channels, but are generally not well suited for areas of rough seas.

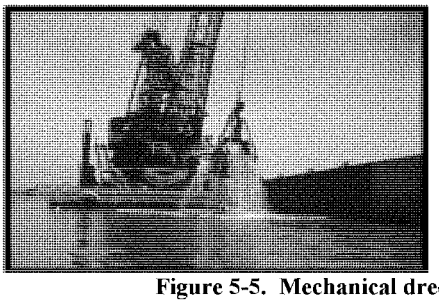
Dipper dredges and clamshell dredges, named for the scooping buckets they employ, are the two most common types. A bucket dredge begins the digging operation by dropping the bucket in an open position from a point above the sediment. The bucket falls through the water and penetrates into the bottom material. The sides of the bucket are then closed and sediment is sheared from the bottom and contained in the bucket compartment. The bucket is raised above the water surface, swung to a point over the barge, and then released into the barge by opening the sides of the bucket. Usually two or more disposal barges, called dump scows, are used in conjunction with the mechanical dredge. While one barge is being filled, another is being towed to the placement site by a tug and emptied. If a diked disposal area is used, the sediment must be unloaded using mechanical or hydraulic equipment. Using numerous barges, work can proceed continuously, only interrupted by changing dump scows or moving the dredge. This makes mechanical dredges particularly well suited for dredging projects where the placement site is many miles away. The dipper dredge is essentially a power shovel mounted on a barge. It can dig hard materials and has all the advantages of the bucket dredge, except for its deep digging and sea state capabilities. Similar to the bucket dredge operation, the dipper dredge places sediment into a barge, which is towed to a disposal area (USACE, 1993).

5.03 Bed Levelers

A bed leveler is a device pulled or pushed along a dredged or dredged material placement area to smooth or remove humps of sediment lying above a target elevation. It can be used in place of a dredge during clean-up operations.

A bed leveler would only be used after it has been demonstrated to NOAA Fisheries satisfaction that the device and method employed would be expected to result in no additional take of endangered species when compared to the alternative for accomplishing the required work.

Photograph taken from Great Lakes Dredge & Dock Company, Dredge No. 52



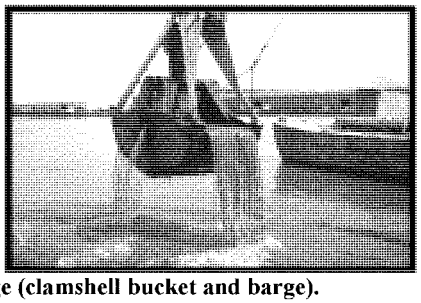


Figure 5-5. Mechanical dredge (clamshell bucket and barge).

5.04 Impacts of Hydraulic Dredges, Mechanical Dredges, and Bed-Levelers

5.04.1 General Impacts. Dredging and placement of sediment have the potential to adversely affect animals and plants in a variety of ways. These include actions of the dredging equipment (i.e., cutting, suction, sediment removal, hydraulic pumping of water and sediment, and noise); physical contact with dredging equipment and vessels (i.e., impact); physical barriers imposed by the presence of dredging equipment (i.e., pipelines); and placement of excavated sediment in various placement locations (i.e., covering, suffocation). Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

All the proposed work will occur in either the Savannah Inner Harbor (from near Stations 103+000 to 0+000) or Savannah Outer Harbor (Ocean Bar Channel from Stations 0+000 to -97+680B). Hydraulic cutter head pipeline dredges and/or mechanical dredges would be used to deepen the

inner harbor, while hopper, hydraulic, and/or mechanical dredges would be used to deepen the outer harbor. The pipeline dredges would pump the excavated sediment either to the existing seven confined disposal areas (CDFs). The hopper dredges and mechanical dredges would place any excavated material in the EPA-approved Ocean Dredged Material Disposal Site (ODMDS).

5.04.2 Pipeline Dredges - Cutterhead Suction Dredge, Hopper Dredge and Mechanical Dredge.

A. Lighting During Construction. Dredge plants and associated tugs and barges are required to meet Corps, US Coast Guard, and OSHA lighting standards for safety. With regard to sea turtles, lighting is only an issue during hatching. The hatchlings may be disoriented by bright lights and head toward those lights instead of toward the ocean. However, since hatching only occurs during the warmer months and no dredging operations near the beaches are proposed during that period, lighting on dredge equipment will not affect sea turtles. During this dredging project, additional lighting impacts may occur on the CDFs, floating pipeline (near the dredge and placement area) and associated heavy equipment working on the site to move anchors, etc. Ample lighting on a hopper dredge is specifically required for the observers on board to provide safe access at night to the inflow boxes and screens.

B. Dredge plume. Studies performed by Dr. D.F. Hayes in 1986 on a hydraulic cutterhead dredge operating in Savannah Harbor indicated that average suspended sediment concentrations within 1,600 feet of the dredge were generally raised less than 200 mg/l in the lower water column and less than 100 mg/l and 50 mg/l in the middle and upper water column, respectively. The Savannah River has a naturally high suspended sediment load which during storm events increases well beyond the 200 mg/l increase created by a hydraulic dredge. In addition, during storm events the higher suspended sediment loads would likely be more uniform throughout the water column due to mixing as the plume proceeds down stream.

Hopper dredges would predominantly be used within the ocean bar channel (Stations 0+000 to -97+680) of the harbor. Hopper dredge suction arms hydraulically remove sediment from the navigation channel and discharge the material into the storage hoppers on the dredge. During filling, fine sediments (primarily silt, clays, and fine-sands) are washed overboard to maximize the load of coarse sediments transported to the placement site. This washing and overflow process is a source of turbidity plumes and sedimentation generated by the hopper dredge. The distance that sediment plumes may extend is dependent upon the type of dredge, how it is operated, currents, and the nature of the sediments within the excavation area. Elevated sediment levels from hopper dredge operations have been recorded at about 1,100 feet from an excavation site (Blair *et al.* 1990). Furthermore, according to Neff (1981 and 1985), concentrations of 1000 ppm immediately after discharge decreased to 10 ppm within one hour. The minimal impact of settling particles from hopper dredge turbidity plumes was further supported by a study from Poopetch (1982), which found that the initial hopper dredge overflow concentrations of 3,500 mg/l were reduced to 500 mg/l within 50 meters. Another source of turbidity and sedimentation from hopper dredges is through the deposition of their sediment loads at the placement sites.

Mechanical dredges could be used throughout the proposed project (Station 103+000 to -97+680B). The primary time when turbidity would be generated would be when the full bucket travels through the water column to the surface and is empted into an adjacent barge. However, the magnitude of the river flows (i.e., the Savannah River has an average discharge of 11,290 cubic feet per second) indicate that rapid dilution of effects can be expected. Moreover, turbidity within the ocean bar would be quickly dissipated due to currents, wind and wave action.

D. Bed Leveler. Bed-levelers are currently permitted for certain reaches of the upper harbor with conditions required to minimize turbidity impacts. The use of bed levelers is requested as a part of this biological assessment. If approved by NOAA, the Corps will abide by any conditions associated with their use. The project proposes to also authorize their use in the Bar Channel. Furthermore, their use would be restricted to the leveling of high spots in the channel or placement area where use of a hopper dredge for such work would be expected to result in equal or greater take of endangered species.

E. Noise. Within any harbor there are a number of noise sources. Ships arriving and departing (including tugs, etc.), recreational boats, dredges (cutterhead suction, mechanical, and hopper), wharf/dock construction (pile driving, etc.), wharf/dock operations (loading and unloading vessels), and natural (wind, storms, biological, etc.) all make up the harbor ambient noise. The following information was taken from ATM (2004): "*High levels of noise are generated from pile driving (either impact hammer or vibratory hammer). Impact pile driving according to Carlson (1997) on timber piles ranged from 160.8 to 1995.5 dB and Widener (2002) on steel piles ranged from 191.1 to 212.4 dB. According to the NOAA fisheries (NOAA 2001), the Biological Opinion (BO) for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project considered noise an adverse effect to salmon at the following levels:*

150 dB (0.03 kPa)	*the level of take*
180 dB (1kPa)	*the level of physical harm*
204 dB (over 10kPa)	*the level of instantaneous death*

To comply with this NOAA Biological Opinion a fisheries biologist needed to be present to monitor pile driving noise (ATM 2004). No additional monitoring was needed if hydroacoustic monitoring from the first five piles did not indicate noise levels exceeding 150 dB at three meters depth and 10 meters away. If noise levels exceeded 150 dB 50% of the time or less and was not greater than 180 dB for the first five pilings, work could continue with monitoring in place. If noise levels exceeded 180 dB, then sound attenuation devices (i.e., sheet pile coffer cell, bubble curtain, etc.) would be required (ATM 2004)".

In order to deepen the Wilmington Harbor navigation channel in the Cape Fear River, rock was blasted to attain the authorized depth. Anadromous fish (Striped Bass, American shad, Hickory shad, blueback herring, etc), Shortnose sturgeon, and marine mammals are found within that portion of the river that was to be deepened by blasting. Moser (1999) and Rickman (2000) conducted a study within the Cape Fear River setting off test blasts and measuring the effects and blast pressure on caged fish (white mullet, cyprinodontids, and hatchery reared Striped bass and Shortnose sturgeon) arranged certain distances from the blast. ATM (2004) indicated that the underwater blasts were measured at 75 psi (234 dB peak) and 18 psi root mean square (RMS)

impulse of (221 dB impulse). Bubble curtains were used in some of the tests, but failed to be effective due to the river current deflecting them. Greater than 140-feet from the blast, there was no impact to the caged fish when compared to the control (Moser 1999).

Richardson (Richardson et al 1995) speculates that for marine mammals the following underwater noise levels may be detrimental:

Prolonged Exposure of 140 dB re 1 micro Pascals (continuous manmade noise), at 1 km may cause Permanent Hearing Loss*

Prolonged Exposure of 195 to 225 dB re 1 micro Pa (intermittent noise), at a few meters or tens of meters, may cause Immediate Hearing Damage*

Richardson states that "*Many marine mammals would avoid these noisy locations, although it is not certain that all would do so.*" According to Richardson et al (1995), received noise levels diminish by about 60 dB between the noise source and a radius of 1 km. For marine mammals to be exposed to a received level of 140 dB at 1 km radius, the source level would have to be about 200 dB re 1 micro Pa-m (Richardson et al 1995). Richardson et al (1995) states that few human activities emit **continuous** sounds at source levels greater than or equal to 200 dB re 1 micro Pa-m.

According to Richardson et al (1995) supertankers and icebreakers may exceed the 195 dB noise levels. According to Clarke (Clarke et al 2002), the underwater noise from a cutterhead suction dredge is continuous and muted. The noise is generated from the cutterhead rotating within the soft bottom sediment and from the pumps used to transport the effluent to the placement area. The majority of the sound generated was from 70 to 1,000 Hz and peaked at 100 to 110 dB range. Noise from the cutterhead suction dredge became almost inaudible at about 500 meters (Clarke et al 2002 unpublished). These results from Clarke et al are preliminary and have not been published.

The noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the underwater noise is generated from the dragarm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Like the cutterhead suction dredge, the noise ranged from 70 to 1,000 Hz and peaked at 120 to 140 dB (Clarke et al 2002). These results from Clarke et al are preliminary and have not been published.

The underwater noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. Once the barge is full, it is towed by a tug offshore and empted either in the submerged berms adjacent to the ocean bar channel or the Savannah ODMDS. According to discussions with Doug Clarke and Charles Dickerson, US Army Engineer Research and Development Center for mechanical dredges the maximum underwater noise spike is when the bucket hits the bottom. All other noises from this operation (i.e., winch motor, spuds, etc.) are insignificant. The sediment within Savannah Harbor is predominantly sand/silt/mud/clay mixture. No rock, gravel, or cobbles are

located within the portion of the navigation channel to be deepened. According to Clarke et al (2002), the peak amplitude for the bucket hitting the rocky, gravel, cobble bottom at Cook Inlet, Alaska was about 120 dB. Both Doug Clarke and Charles Dickerson (US Army Engineer Research and Development Center) stated that this peak amplitude of the bucket hitting the existing sand/silt/mud substrate of Savannah Harbor would be significantly less than 120dB.

6.00 PROPOSED CONDITIONS

Dredging and disposal methods associated with the proposed deepening of the Savannah Harbor Navigation Project are generally similar to current maintenance dredging methods. At this time, approximately 7 million cubic yards of sediments are removed each year from the Savannah Harbor Navigation Project by the Corps. The dredged sediment is placed in one of the seven CDFs which have been designated for use for the project, the nearshore feeder berm sites off Tybee Island and adjacent to the ocean bar channel or the Savannah ODMDS. These methods have been addressed in a number of previous environmental documents (USACE 1991 and USACE 1996), including biological assessments and biological opinions rendered regarding threatened and endangered species.

A more detailed description of the existing conditions is located in Section 4.0 of the EIS.

The Selected Plan would deepen the existing -42 foot authorized Federal navigation channel to -47 feet. The Corps will use pipeline and/or mechanical dredges within the inner harbor (Stations 103+000 to 4+000) and pipeline, mechanical, and/or hopper dredges in the outer harbor (Stations 4+000 to -97+680B).

The proposed construction would not place any excavated dredged sediment from the harbor deepening on Tybee Island beach or in any of the nearshore feeder berm sites off Tybee Island or Sites 2 and 3 adjacent to the entrance channel. The Corps proposes to place new work sediments from the harbor deepening in the existing CDFs or the ODMDS. Maintenance sediments may be placed on Tybee Island beach or in the nearshore feeder berm sites off Tybee Island or Sites 2 and 3 adjacent to the entrance channel. Within the outer harbor (Stations 4+000 to -97+680B) the following equipment would work:

1. A pipeline and/or mechanical dredge would work throughout the year.

2. A hopper dredge would work from 1 December to March 31 of any year as stated in the Biological Opinion.

The occurrence of a particular protected species within the project area depends upon the availability of suitable habitat, the season of the year relative to the species' temperature tolerance and migratory habits, and other factors.

7.00 IMPACTS TO GEORGIA AND SOUTH CAROLINA PROTECTED SPECIES AND SPECIAL CONCERN ANIMALS AND PLANTS AND NATURAL COMMUNITIES

Section 8.0 discusses impacts to Federally-listed T&E species and will not be duplicated in Section 7.0.

7.01 Primary and Secondary Impacts.

The proposed deepening and continued maintenance of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats will occur as a result of excavation during the proposed action. No wet Savannas, Carolina Bays, vernal pools, wet pine flats, sandhills, or oak/pine flats would be excavated by the proposed action. The vast majority of work occurring on uplands would take place at the existing seven CDFs which the Corps uses annually for the placement of harbor maintenance sediments. More detailed information is found in Section 3.01 of the EIS.

Sediment sampling and analyses conducted in 2005 concluded that the only sediment contaminant of concern that would be dredged during construction of the Savannah Harbor Expansion Project is naturally-occurring cadmium found in Miocene clays. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average of 6.67 mg/kg) are found between Stations 45+000 to 94+000 (River Mile 8.5 to 17.8). The sediment evaluation for the proposed deepening of the Federal navigation channel found minimal potential for contaminant-related impacts to estuarine and marine species within the Savannah River.

About 7.8 MCY cubic yards of dredged sediment contain cadmium (from Stations 6+375 to 45+000, 51+000 to 57+000, and 80+125 to 90+000). All of the cadmium-laden sediments would be placed and retained in existing CDF 14A and/or 14B and covered with about 2-feet of dredged sediment taken from the Federal navigation channel where cadmium concentrations are thought to be 4 mg/kg or less. This new work dredged sediment within CDFs 14A and 14B will not be used for future dike raisings or used for borrow material.

Direct impacts of the proposed deepening would include an upstream shift in salinity and reduced dissolved oxygen (DO) levels in deepened channel waters. The upstream limit of the increased salinity and lowered DO would remain downstream of the I-95 bridge across the Savannah River (about Station 155+000). Therefore, the proposed action will not affect any adjacent freshwater marsh and/or wetlands upstream of the I-95 bridge.

The pages that follow describe potential impacts to individual species from construction and maintenance of the proposed work. Part of the description includes identification of present conservation status of the species. The conservation status scale used in this analysis was obtained from NatureServe.org whenever possible, and listed at the state (S) geographic level. Status assessments are based on the best available information, and consider a variety of factors such as abundance, distribution, population trends, and threats. The scale has the following definitions:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

? = Inexact Numeric Rank—Denotes some uncertainty about the numeric rank (e.g. S3? - Believed most likely a S3, but some chance of either S2 or S4).

S#S# = Range Rank —A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

SNR = Unranked— State/province conservation status not yet assessed.

SH or NH = Possibly Extirpated (Historical)—Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.

7.02 Species Listed for Chatham County, Georgia.

The following animal species will not be adversely affected by the proposed deepening because their habitat is either upland (i.e., sandy longleaf pine ridges, etc.), isolated wetlands (i.e., bogs, Carolina Bays, etc.), or river substrate that is sandy to rocky:

Brimley's Chorus Frog (*Pseudacris brimleyi*)
Gopher Tortoise (*Gopherus polyphemus*)

The following animal species will not be adversely affected by the proposed deepening because, although the species has been recorded twice in the areas, it is not expected to be present on a regular basis: Gray Kingbird (*Tyrannus dominicensis*).

GEORGIA ANIMALS

7.02.1 Spotted Turtle (*Clemmys guttata*)

a. Status. S3 Vulnerable

b. Background. Mostly unpolluted, small, shallow bodies of water such as small marshes, marshy pastures, bogs, fens, woodland streams, swamps, small ponds, and vernal pools; also occurs in brackish tidal streams. Ponds surrounded by relatively undisturbed meadow or undergrowth are most favorable. Favors waters with soft bottom and aquatic vegetation. Often basks along water's edge, on brush piles in water, and on logs or vegetation clumps. May spend much time on land in some areas during certain seasons. When inactive, hides in bottom mud and detritus, or in muskrat burrow.

c. Project Impact. No alterations to marsh/wetlands or shallow water habitats are expected that would be detrimental to this species.

d. Effect Determination. No effect.

7.02.2 American Oystercatcher (*Haematopus palliatus*)

a. Status. S2 Imperiled

b. Background. Georgia habitat is sandy beaches, tidal flats, and salt marshes.

c. Project Impact. No new work dredged material would be placed onto beaches or tidal flats or into salt marshes. Maintenance material could be placed in the feeder berm sites in the nearshore area off Tybee Island or on the beach at Tybee Island. This could provide a temporary interruption to use of the beach as foraging habitat for the American oystercatcher.

d. Effect Determination. May affect, not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.3 Black-necked stilt (*Himantopus mexicanus*)

a. Status. S3 Vulnerable

b. Background. Feeds in shallow salt or fresh water with soft muddy bottom; grassy marshes, wet savanna, mudflats, shallow ponds, flooded fields, borders of salt ponds. Nests along the shallow water of ponds, lakes, swamps, or lagoons. May also nest on the ground or in shallow water on a plant tussock.

c. Project Impact. This species sometimes feeds in intertidal areas and tidal pools. Black-necked stilts commonly use the CDFs for breeding, feeding, and loafing. Sediment deposition within the CDFs provides nesting and feeding habitat for stilts and would be conducted in a manner to minimize interference with nesting stilts. It is expected that some birds may feed

along the edges of the CDFs in which cadmium-containing sediments would be placed. Since the sediments would be held underwater and the cover placed while the sediments are inundated, cadmium exposure is expected to be minimal.

d. Effect Determination. May affect, not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.4 Black-crowned Night-heron (*Nycticorax nycticorax*)

a. Status. S4 Apparently secure

b. Background. The breeding season begins in mid-March, peaks in mid-April to mid-May, and extends until the middle of June. Breeding habitat consists of wetland areas, including swamps, mangroves, and marshes. The species nests in colonies, with many birds nesting in the same area together. Non-breeding habitat is associated with wetlands. The diet includes fish, aquatic invertebrates, eggs and young birds, and other small vertebrates. The Black-crowned Night-heron captures aquatic prey by standing in or near the water to capture food.

c. Project Impact. This species feeds primarily in wetlands, marshes and intertidal areas. Black-crowned Night-herons use the CDFs for breeding, feeding, and loafing. Sediment deposition within the CDFs provides feeding habitat for the birds. It would be conducted in a manner to not interfere with nesting herons. The project is not expected to impact food resources or habitat used by this species.

d. Effect Determination. May affect, not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.5 False Killer Whale (*Pseudorca crassidens*)

a. Status. Georgia Species of Special Concern

b. Background. Habitat is open ocean.

c. Project Impact. Hopper dredging of the ocean bar channel could lead to an encounter with this species. However, the conditions in the current NMFS Regional Opinion dated 1997 and the SAD Protocol, which the District would also abide by as long as the opinion is in effect, include the following: Monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between December 1 and March 31. During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to 5 knots or less (or lowest safe speed) when transiting between areas if whales have been spotted within 15 nautical miles (nm) of the vessel's path within the previous 24 hours. (Contractors will be required to use daily available information on the presence of whales in the project area.) One hundred percent dedicated daytime whale/endangered species observer coverage is required between December 1 and March 31.

With or without the proposed harbor deepening, the total number of vessels is expected to increase in the future in response to rising demands for exports and imports. Vessels would be able to load more deeply under the improved conditions, so (when comparing With and Without Project conditions) fewer vessels would be required to carry the cargo in a given year. This reduction in the number of vessels with the deepening project would reduce the number of potential ship/whale encounters.

d. Effect Determination. Because of the habitat preferences of this species, potential effects are expected to be minimal. Since the number of vessels calling on the harbor is expected to decrease as a result of the proposed project, no effects are expected on this species. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.6 Black Skimmer (*Rynchops niger*)

a. Status. S1 Critically Imperiled

b. Background. The breeding season begins in early May and lasts through mid-August. Skimmers nest on beaches or sandy islands. The nest is a scrape created by both the male and female. The young have mandibles of equal length when they are young, which helps them pick up insects and food from the adults. The young gain their unequal mandible length when they are old enough to forage on their own. In winter, most of this bird's time is spent resting on the beaches of the coast or skimming over the water. When a food item is found, the Black Skimmer "nods" its head to close the prey in its bill. It eats fish, aquatic invertebrates, and crustaceans.

c. Project Impact. No new work dredged material would be placed onto beaches or sandy islands. Maintenance material could be placed in the nearshore feeder berm sites off Tybee Island or on the beach at Tybee Island. To protect nesting sea turtles, this placement could only occur from 1 August to 30 April of any year. This placement period would also avoid impacts to nesting Black skimmers.

d. Effect Determination. This species nests on interior islands within the CDFs. Suitable nesting habitat will be maintained yearly so that the proposed action will not affect breeding, nesting or loafing areas. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.7 Least Tern (*Sterna antillarum*)

a. Status. S3 Vulnerable

b. Background. Habitat is sandy beaches and sandbars.

c. Project Impact. Least terns commonly use the CDFs for breeding, feeding, and loafing. Sediment deposition within the CDFs produces feeding habitat for the terns and would be conducted in a manner to not interfere with nesting terns, in compliance with the Migratory Bird Treaty Act. Specifically, management of the CDFs for birds has been and will continue to be

performed in accordance with the 1996 LTMS. In essence, the LTMS states that when the existing CDFs are used for sediment placement, they will remain wet for 3 years and then dry for 3 years. Thus, generally about half the CDFs are wet and the other half dry at any given time, and some CDFs will be available for breeding, feeding and loafing each year. The CDFs are monitored for colonial nesting birds and Black-necked Stilts. The dredger is required to set his head section so he won't flood any nests on sands around the head section. The Corps also holds water in the CDFs as high as possible prior to the onset of nesting to force the stilts to nest as high as possible in the areas so their nests won't be impacted by subsequent sediment disposal operations conducted during the nesting season.

Construction of the project would not involve the placement of any new work material into the nearshore area off Tybee Island or onto Tybee Island beach. However, these areas could be used for placement of maintenance material from the project. This could temporarily impact use of these sites by this species.

d. Effect Determination. The proposed action may affect breeding, nesting or loafing areas (within the CDFs). May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.8 Seaside Sparrow (*Ammodramus maritimus*)

a. Status. S3

b. Background. Seaside Sparrow (*Ammodramus maritimus*), a sparrow that is almost always found in salt and brackish marshes, occurs along the Atlantic Coast of the United States from New Hampshire to central Florida (where it is now extirpated as a breeder), and along the Gulf Coast from central Florida to central Texas.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur as a result of excavation during the proposed action. The marsh that will be excavated is primarily smooth cordgrass growing along the shoreline of the river and would not adversely impact this species.

d. Effect Determination. This species nests on interior islands within the CDFs. Suitable nesting habitat will be maintained yearly so that the proposed action will not affect breeding, nesting or loafing areas. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.9 Wilson's Plover (*Charadrius wilsonia*)

a. Status. S2

b. Background. Wilson's Plovers nest on sparsely vegetated saline areas, including beaches above high tide, dune areas, and edges of lagoons. They are territorial during the nesting season but engage in group defense of their nesting areas. During the nonbreeding season, individuals

congregate in groups of up to 30 or more, sometimes with other species of small plovers, for roosting and foraging. Wilson's Plovers feed primarily on crustaceans, particularly fiddler crabs (*Uca* spp.).

c. Project Impact. Project impacts to this species are expected to be minimal.

d. Effect Determination. This species nests regularly in open or lightly vegetated areas of the CDFs. Continued operation of the CDFs is necessary to produce nesting habitat for this species. The Corps plans to continue monitoring nesting of this species within the CDFs to avoid impacts to nests and foster continued nesting success. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.10 Eastern Diamondback Rattlesnake (*Crotalus adamanteus*)

a. Status. S4

b. Background. *Crotalus adamanteus* can be found in the palmetto flatwoods and dry pinelands of South Eastern United States. It can be found from the coastal lowlands of southeast North Carolina to the extreme east of Louisiana, with the main concentration located in the state of Florida. This species is regularly observed in the CDFs located in South Carolina. This species has also been known to venture into salt water.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action. Sediment deposition in the CDFs occurs slowly allowing individuals to escape from the ponded water. When the dikes are raised, heavy equipment is used to move and shape dirt on the dikes. The vibrations from this heavy equipment may be sensed by the species, allowing them to avoid the activity. The project intends to continue to include conditions in its construction specifications requiring there be no intentional harming or killing of this species.

d. Effect Determination. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.11 Bald Eagle (*Haliaeetus leucocephalus*)

a. Status. S2

b. Background. The Bald Eagle prefers habitats near seacoasts, rivers, large lakes, oceans, and other large bodies of open water with an abundance of fish.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action. Bald Eagles are periodically observed foraging at the CDFs. The proposed continued use of the CDFs should not measurably affect this foraging activity.

d. Effect Determination. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.12 Migrant Loggerhead Shrike (*Lanius ludovicianus migrans*)

a. Status. S3

b. Background. Shrikes are characteristically birds of open country (e.g., pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, agricultural fields, riparian areas, and open woodlands. They occur from deserts and prairies in the West to pastures and fields in the East. Longleaf pine (*Pinus palustris*) savannas and open, mature stands of loblolly pine (*P. taeda*)-shortleaf pine (*P. echinata*) also provide suitable habitat for the shrike in the Southeast. The species occurs irregularly within the disposal areas, but has been observed outside of the dikes. There is one summer record (one individual on July 6, 2006) and about forty-four fall and winter records of single individuals from August 14 (1 in 2003) to March 8 (1 in 2007). There are three records of two individuals on October 27, 2007, November 17, 2007, and November 18, 2007.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats will also occur during the proposed action.

d. Effect Determination. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.13 Northern Yellow Bat (*Lasiurus intermedius*)

a. Status. S2 S3

b. Background. Northern yellow bats (*Lasiurus intermedius*) are foliage roosting bats. Foliage roosting bats hang under leaves and branches, or, in the case of northern yellow bats, often under Spanish moss. These bats forage over open areas, such as fields, pastures, golf courses, marshes and along lake and forest edges. This species has not been observed in the CDFs.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats will also occur during the proposed action.

d. Effect Determination. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.14 Robust Redhorse (*Moxostoma robustum*)

a. Status. S1

b. Background. Habitat loss and disruption of spawning migrations resulting from dams and impoundments, predation by introduced non-native species, and significant deterioration of water quality due to sedimentation and pollution are believed to have contributed to the decline of the species. The robust redhorse is uncommon in the Ocmulgee, Savannah and Pee Dee rivers.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Constructing the fish bypass at New Savannah Bluff Lock and Dam would allow passage to historic upstream spawning areas at the Augusta Shoals (which would provide additional spawning habitat to this species).

d. Effect Determination. Minor beneficial effect on this species. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.15 Yellow Crowned Night Heron (*Nyctanassa violacea*)

a. Status. S3 S4

b. Background. Breeding habitat is wetland areas, including swamps, marshes, bottomland forests, and river systems. The diet is primarily crustaceans, especially crayfish and crabs, but also includes fish, aquatic invertebrates, eggs and young birds, and other small vertebrates. The Yellow-crowned Night-heron captures aquatic prey by standing in or near the water. This species forages at night and roosts during the day.

c. Project Impact. Yellow Crowned Night Heron commonly use the CDFs for breeding, feeding, and loafing. Sediment deposition within the CDFs produces feeding habitat for these species and would be conducted in a manner to not interfere with nesting Yellow Crowned Night Herons.

Specifics regarding the management of the CDFs to minimize impacts to birds are included above, in Section 7.02.7.

d. Effect Determination. The proposed action may affect breeding, nesting or loafing areas (within the CDFs). May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.16 Painted Bunting (*Passerina ciris*)

a. Status. S3

b. Background. The Painted Bunting is found in thickets, woodland edges and brushy areas, along roadsides, in suburban areas, and gardens. Painted Bunting depends on young shrub and grassland habitat for breeding and nesting primarily in upland maritime shrub-scrub habitat of

the South Atlantic Coastal Plain from North Carolina to northeastern Florida. Painted Buntings can also use shrub-scrub habitat in open pine and maritime oak forests.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action. The continued use of the CDFs should not adversely affect this species.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.17 Gopher Frog (*Rana capito*)

a. Status. S3

b. Background. Gopher Frogs frequently inhabit the occupied or unoccupied burrows of Gopher Tortoises (*Gopherus polyphemus*) in the Deep South. These frogs can be found at night, feeding or calling outside of their burrows in pine flatwoods and other dry habitats, and can be found during the breeding season in ponds associated with these habitats. Fishless ponds are required for successful reproduction to occur. This species has not been observed at the CDFs.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action.

d. Effect Determination. May affect, but not likely to adversely affect any of its presently designated critical habitat.

7.02.18 Many Lined Salamander (*Stereochilus marginatus*)

a. Status. S3

b. Background. Many Lined Salamander can be found in the cypress and gum swamps, small ponds in pine forests, large drainage ditches, and sluggish streams. Adults occur in moss or under leaf debris in water, or under objects at water's edge. It is primarily freshwater aquatic. Eggs are laid in or under logs or attached to plants in or near water.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.19 Eastern Mudminnow (*Umbra pygmaea*)

a. Status. S2 S3

b. Background. Occur in quiet freshwater streams, sloughs, swamps and other wetlands over sand, mud and debris, often among dense vegetation. Juveniles also found among aquatic vegetation.

c. Project Impact. The proposed deepening of the Savannah Harbor Navigation Project will primarily affect palustrine, estuarine and marine habitats. Some direct impacts to marsh and/or wetlands, and adjacent shallow water habitats would also occur during the proposed action. Some of the proposed mitigation activities would occur in freshwater areas, so there is the potential to encounter this species.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

GEORGIA PLANTS

The following plant species will not be adversely effected by the proposed deepening because their habitat is either upland (i.e., sandy ridges, longleaf pine savannas, etc.), wet savannas or isolated wetlands (i.e., bogs, Carolina Bays, etc.).

Sweet Acacia (*Acacia farnesiana*)
Florida Privet (*Forestiera segregata*)
Pineland Beaksedge (*Rhynchospora punctata*)
Climbing Buckthorn (*Sageretia minutiflora*)
Soapberry (*Sapindus marginatus*)
Hooded Pitcherplant (*Sarracenia minor*)
Skullcap (*Scutellaria mellichampii*).
Pineland Dropseed (*Sporobolus pinetorum*)

7.02.20 Narrowleaf Obedient Plant (*Physostegia leptophylla*)

a. Status. S2 Imperiled

b. Background. Georgia habitat is freshwater and brackish tidal marshes; disjunct in wet savannas of extreme Southwest Georgia. This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area and would not be expected to occur within the area, but its habitat is similar to what is found in portions of the estuary.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.21 Swamp Hibiscus (*Hibiscus grandiflorus*)

a. Status. S2

b. Background. Tidal marshes, coastal flatwoods; wet savannas. This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.
c. Project Impact. This species is not known to exist within the project area and would not be expected to occur within the area, but its habitat is similar to what is found in portions of the estuary.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.02.22 Wild Yellow Cowpea (*Vigna luteola*)

a. Status. S2?

b. Background. Open swamps; maritime beaches and tidal flats. This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area and would not be expected to occur within the area, but its habitat is similar to what is found in portions of the estuary.

d. Effect Determination. If this species is present, the project may affect, but is not likely to adversely affect the species or any of its presently designated critical habitat.

7.03 Conservation Areas, Chatham County, Georgia

The following conservation areas in Chatham County, Georgia will not be adversely affected by the proposed deepening of the navigation channel since they are located on uplands or some distance from the project site (Greenspace in Chatham County, Little Tybee Island and Cabbage Island, Skidaway Island State Park, Wormsloe Historic Site, which is located on the Isle of Hope, about ten miles south of Savannah).

The following conservation areas may be affected by the proposed action:

Fort Pulaski National Monument [National Park Service]. By deepening the proposed Federal navigation channel, the ongoing erosion of the riverine shoreline could be increased by ship-generated wakes. The Corps conducted ship wake and bank erosion studies and determined that no significant impacts to shoreline erosion are expected from the proposed action (see Engineering Appendix to the GRR).

Savannah National Wildlife Refuge (NWR) [U.S. Fish and Wildlife Service]. By deepening the Federal navigation channel, increased salinity is expected to impact existing freshwater tidal marsh within the Savannah NWR. The effects would be mitigated by various components of the mitigations plans, including the flow re-routing features and the land acquisition and preservation. A portion of the Savannah NWR is located in South Carolina.

Savannah River [High Priority Stream]. The Savannah River will be adversely impacted by increased salinity impacts from the proposed action. As a result of the mitigation plan (see Appendix C), the overall effect on the river and its fisheries are not expected to be significant. The dissolved oxygen within the harbor will be maintained and slightly improved by oxygen injection. A portion of the Savannah River is located in South Carolina.

7.04 Species Listed for Jasper County, South Carolina.

The following animal species will not be adversely effected by the proposed deepening because their habitat is either upland (i.e., caves, sandy longleaf pine ridges, etc.), isolated wetlands (i.e., bogs, Carolina Bays, etc.), or river substrate that is sandy to rocky.

Rafinesque's big-Eared Bat* (*Corynorhinus rafinesquii*)
Eastern Diamondback rattlesnake (*Crotalus adamanteus*)
Gopher tortoise (*Copherus polyphemus*)
Southern hognose snake (*Heterodon simus*)
Eastern Woodrat (*Neotoma floridana*) (*Neotoma floridana floridana*)
Mimic glass lizard (*Ophisaurus mimicus*)
Florida pine snake (*Pituophus melenoleucus mugitus*)
Eastern fox squirrel (*Sciurus niger*)
Rayed pink fatmucket (*Lampsilis splendida*)
Bird voiced treefrog (*Hyla avivoca*)

*Note: Rafinesque's Big-Eared Bat (*Corynorhinus rafinesquii*), roosts in bottomland hardwood trees, which could be affected by salinity.

SOUTH CAROLINA ANIMALS

7.04.1 Bachman's Sparrow (*Aimophila aestivalis*)

a. Status. S3 Vulnerable

b. Background. Habitat specialist. Historically, found in mature to old growth southern pine woodland subject to frequent growing-season fires; a fugitive species, breeding wherever fires created suitable conditions. Requires well-developed grass and herb layer with limited shrub and hardwood midstory components. Ideal habitat was originally the extensive longleaf pine woodlands of the south. In the southeastern U.S., Coastal Plain breeding habitat usually is open pine woods with thick cover of grasses or saw palmetto. In South Carolina, higher densities

were recorded in mature (more than 80 years old) pine stands than in young stands. These habitats are not present within the immediate project area.

c. Project Impact. No impact to feeding, nesting, or loafing areas.

d. Effect Determination. No effect.

7.04.2 Barrel Floater (*Anodonta couperiana*)

a. Status. Not ranked/ Under review.

b. Background. Freshwater mussel, habitat is slow streams, mud and sand substrate. Has been recorded in Jasper County, but there are "no known occurrences" of the barrel floater in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the immediate project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. If the species is present, the change from freshwater to brackish habitat may affect this species. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.3 Spotted Turtle (*Clemmys guttata*)

a. Status. S5 Secure

b. Background. Mostly unpolluted, small, shallow bodies of water such as small marshes, marshy pastures, bogs, fens, woodland streams, swamps, small ponds, and vernal pools; also occurs in brackish tidal streams. Ponds surrounded by relatively undisturbed meadow or undergrowth are most favorable. Favors waters with soft bottom and aquatic vegetation. Often basks along water's edge, on brush piles in water, and on logs or vegetation clumps. May spend much time on land in some areas during certain seasons. In South Carolina, gravid female spotted turtles spent a considerable amount of time on or at the edge of a powerline right-of-way, and they nested on the edge of the powerline and in relatively recent clearcuts (Litzgus and Mousseau 2004). This species has not been observed in the CDFs.

c. Project Impact. No direct alterations to marsh/wetlands or shallow water habitat used by this species are expected that would be detrimental to this species.

d. Effect Determination. If this species is present the project may affect, but is not likely to adversely affect the species or any of its presently designated critical habitat.

7.04.4 Bluebarred pygmy sunfish (*Elassoma okatie*)

a. Status. Not ranked/ Under review

b. Background. The bluebarred pygmy sunfish inhabits drainage ditches, stagnant ditches and the backwaters of creeks and rivers. It is found in shallow water with abundant submerged and/or emergent vegetation that is rooted in soft detritus-rich substrate. This species often inhabits disturbed areas such as roadside ditches and backwaters near boat ramps. Small range in quiet waters of the Edisto, New, and Savannah River systems in South Carolina; not much threatened but vulnerable to habitat alteration and pollution. Known from three areas in the Edisto, New, and Savannah river drainages, southern South Carolina; most specimens have been taken from roadside drainage ditches in Jasper County, New and Savannah river drainages (Rohde and Arndt 1987). Localized and uncommon (Page and Burr 1991).

c. Project Impact. No direct impact to drainage ditches or the backwaters of creeks and rivers.

d. Effect Determination. The project may affect this species if it is present, but it is not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.5 Carolina slabshell (*Elliptio congaraea*)

a. Status. Not ranked/ Under review

b. Background. This mussel typically inhabits small streams and rivers with preference for sandy substrates. In South Carolina, the Carolina slabshell is found in a variety of habitats, including rivers and small streams, however, there are "no known occurrences" of the species in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.6 Striped mud turtle (*Kinosternon baurii*)

a. Status. Not ranked/ Under review

b. Background. Prefer slow moving or still bodies of fresh water with soft bottom (sand or mud). May be found from Florida to Virginia.

c. Project Impact. This species may inhabit freshwater pools within the project area.

d. Effect Determination. Increase in salinity or flow may affect this species if it is present, however, only minor construction would occur on the banks of freshwater areas. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.7 Pygmy sperm whale (*Kogia breviceps*)

a. Status. SC

b. Background. The pygmy sperm whale (*Kogia breviceps*) is a pelagic, deep-water species that inhabits the areas near the continental shelf edge, slope, and deep oceanic waters.

c. Project Impact. Hopper dredging of the ocean bar channel could cause an encounter with this species. However, the conditions in the current NMFS regional opinion dated 1997 and the SAD Protocol, which the District would also abide by as long as the opinion is in effect, include the following: Monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between December 1 and March 31. During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to 5 knots or less (or lowest safe speed) when transiting between areas if whales have been spotted within 15 nautical miles (nm) of the vessel's path within the previous 24 hours. (Contractors will be required to use daily available information on the presence of whales in the project area.) One hundred percent dedicated daytime whale/endangered species observer coverage is required between November 1 and April 30.

Decreases in ship traffic are expected to occur in the future (when comparing With and Without Project conditions) as the larger Post-Panamax vessels come into service and replace the older, smaller vessels. Less shipping traffic should decrease the potential for a ship encounter with this species. Such encounters would be expected to be extremely rare since the pygmy sperm whale is a pelagic, deep-water species that inhabits the areas near the continental shelf edge, slope, and deep oceanic waters

d. Effect Determination. No increases in vessel traffic are expected to result from the proposed project. Vessel traffic at the Port of Savannah is expected to decrease with the proposed project (when comparing With and Without Project conditions) because the larger vessels can carry a greater amount of cargo. Because of the habitat preferences of this species, potential effects are expected to be minimal. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.8 Yellow lampmussel (*Lampsilis cariosa*)

a. Status. Not ranked/ Under review

b. Background. Occurs from the Ogeechee River Basin in Georgia to Nova Scotia and is found in gravel bars, stream margins, and cracks in bedrocks in both medium to large freshwater rivers.

Records indicate populations have declined in the Savannah River and are "no known occurrences" of the yellow lampmussel in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species may occur in the freshwater reaches of the river. Increasing salinity in these reaches could impact this species; however, this species is not known to exist within the project area.

d. Effect Determination. If present, the project may affect, but is not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.9 Dwarf siren (*Pseudobranchus striatus*)

a. Status. S2 Imperiled

b. Background. Habitat is cypress, gum swamps, and wetlands with dense vegetation. Occurs from coastal South Carolina to north Florida, however, there are "no known occurrences" of the dwarf siren in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This salamander species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.10 Gulf coast mud salamander (*Pseudotriton montanus flavissimus*)

a. Status. S3S4 Vulnerable/ Apparently secure

b. Background. Habitat is freshwater streams and swamps. Has been recorded in Jasper County. This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.11 Eastern floater (*Pyganodon cataracta*)

a. Status. Not ranked/ Under review

b. Background. This species of mussel is common and wide ranging in the Atlantic drainages from the Lower St. Lawrence River basin south to the Altamaha River basin, Georgia, and in the Alabama-Coosa River drainage, and the Apalachicola and Choctawhatchee River basins, Georgia. Habitats are freshwater streams and swamps. Recently, this species was found in 3 sites in Great Pee Dee River and Lynches River in South Carolina (Catena Group, 2006), however there are "no known occurrences" of the eastern floater in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). In South Carolina, it is wide ranging from the Savannah, Cooper-Santee, Pee Dee, and Waccamaw River basins (Bogan and Alderman, 2004). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. If the species is present, the change from freshwater to brackish habitat may have an effect. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.12 Black swamp snake (*Seminatrix pygaea*)

a. Status. Not ranked/ Under review

b. Background. Habitats include swamps, bayheads, Carolina bays, ponds, marshes, grassy wet prairies, sphagnum bogs, sluggish streams, ditches, canals, and lakes with abundant floating or emergent vegetation. Sometimes this species has been found in salt marshes or brackish tidal water. Usually this snake is found among vegetation in water or in or under debris at the water's edge, including matted vegetation of round-tailed muskrat houses. It may travel on land after heavy summer rains or when pond basins dry. Adult population size is unknown but presumably exceeds 100,000. This snake was the most abundant snake species in two long-term studies in South Carolina and Florida (Dodd 1993, Seigel et al. 1995). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of

McCoy's Cut in the Front, Middle or Back Rivers, the proposed action could increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.13 Least tern (*Sterna antillarum*)

Covered in Section 7.02.7

7.04.14 Paper pondshell (*Utterbackia imbecillis*)

a. Status. S5 Secure

b. Background. Habitat is muddy sand in moderate current and muddy sand and muddy substrates of reservoirs.

c. Project Impact. This species of mussel is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater habitat to a brackish habitat.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.15 Eastern creekshell (*Villosa delumbis*)

a. Status. Not ranked/ Under review.

b. Background. Freshwater mussel in flowing water over a variety of substrates including mud, sand, or gravel substrate. In South Carolina, it can be found in the Savannah, Salkehatchee-Cumbahee, Edisto, Cooper-Santee, Pee Dee, and Waccamaw River basins (Bogan and Alderman, 2004). Has been recorded in Jasper County, however, there are "no known occurrences" of the eastern creekshell in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). Recently, this species was found in 18 (of 61) sites in Pee Dee River drainage in South Carolina (Catena Group, 2006) including the Waccamaw River, Black River, Pocotaligo River, Lynches River, and Great Pee Dee River. This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater to a brackish habitat.

d. Effect Determination. The change from freshwater to brackish habitat may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

PLANTS

The following plant species will not be adversely effected by the proposed deepening because their habitat is either upland (sandy ridges, hammocks, longleaf pine/wire grass uplands, etc.), dry prairie ecosystems, isolated wetlands (Carolina bays, bogs, wet savannas, etc.) or upstream of McCoy's Cut/Station 155+000 (upper end of potential project effects).

Flaxleaf False Foxglove (*Agalinis linifolia*)
Carolina doghobble (*Agarista populifolia*)
White colicroot (*Aletris obovata*)
Short-spike bluestem (*Andropogon brachystachyus*)
Narrow leaved bluestem (*Andropogon perangustatus*)
Elliott's Bluestem (*Andropogon gyrans var stenophyllus*)
Purple silkyscale (*Anthaenantia rufa*)
Piedmont three-awned grass (*Aristida condensata*)
One flower balduina (*Balduina uniflora*)
Bandana of the Everglades (*Canna flaccida*)
Narrowleaf sedge (*Carex amphibola*)
Southeastern tickseed (*Coreopsis gladiata*)
Narrowleaf rushfoil (*Crotonopsis linearis*)
Piedmont flatsedge (*Cyperus tetragonus*)
Rose balm (*Dicerandra odoratissima*)
Broomsedge (*Dichanthelium aciculare*)
Florida thorough-wort (*Eupatorium anomalum*)
Southern privet (*Forestiera segregata*)
Two wing silverbell (*Halesia diptera*)
Small flowered silverbell tree (*Halesia parviflora*)
Southern lepuropetalon (*Lepuropetalon spathulatum*)
Gopher apple (*Licania michauxii*)
Southern twayblade (*Listera australis*)
Pondspice (*Litsea aestivalis*)
Rusty lyonia (*Lyonia ferruginea*)
Land leaf loosestrife (*Lysimachia hybrida*)
Carolina bird in a nest (*Macbridea caroliniana*)
Ogeechee Tupelo (*Nyssa ogeche*)
Sampson Snakeroot; Scurf Pea (*Orbexilum lupinellum*)
Panic grass (*Panicum neuranthum*)
Pineland plantain (*Plantago sparsiflora*)
Yellow fringeless orchid (*Platanthera integra*)
Milkwort (*Polygala hookeri*)

Dwarf milkwort (*Polygala nana*)
Crestless plume orchid (*Pteroglossaspis ecristata*)
Pinelands Mountain Mint (*Pycnanthemum nudum*)
Myrtle-leaf oak (*Quercus myrtifolia*)
Soft-hair coneflower (*Rudbeckia mollis*)
Tiny-leaved buckthorn (*Sageretia minutiflora*)
Baldwin nutrush (*Scleria baldwinii*)
Giant spiral ladies tresses (*Spiranthes longilabris*)
Florida dropseed (*Sporobolus floridanus*)
Powdery thalia (*Thalia dealbata)*

7.04.16 Coastal Plain water hyssop (*Bacopa cyclophylla*)

a. Status. S1 Critically imperiled

b. Background. Habitat is shallow freshwater swamps, blackwater river bottomland hardwoods, or brownwater river bottomland hardwoods. Has been recorded in Jasper County, however, there are "no known occurrences" of the Coastal Plain water hyssop in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh habitat to a brackish marsh.

d. Effect Determination. The proposed deepening may affect this species if it is present. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.17 Cayaponia (*Cayaponia quinqueloba*)

a. Status. S1? Critically imperiled

b. Background. Habitat is shallow freshwater swamps, blackwater river bottomland hardwoods or brownwater river bottomland hardwoods.

c. Project Impact. Has been recorded in Jasper County. However, this species is not known to exist within the project area. Furthermore, its habitat has not been identified within and is not expected to occur within the potential area of effect.
d. Effect Determination. No effect.

7.04.18 Buckwheat tree (*Cliftonia monophylla*)

a. Status. SH Possibly extirpated

b. Background. Habitat is non-riverine swamp forest or swamp hardwoods.

c. Project Impact. Has been recorded in Jasper County. However, this species is not known to exist within the project area. Furthermore, its habitat is not known to occur and would not be expected to occur within the area of potential project effect.

d. Effect Determination. No effect.

7.04.19 Creeping St. John's Wort (*Hypericum adpressum*)

a. Status. S2 Imperiled

b. Background. Habitat is depression marsh or freshwater marsh. This species' range includes most of the eastern portion of the United States but populations are widely scattered across that range. It is not common in any state, and has been extirpated or possibly extirpated in at least 5 states. The species has a specific habitat preference (seasonal, groundwater-driven depressional wetlands); this habitat is sensitive to disturbance and is frequently threatened by draining and filling for agriculture and development. Has been recorded in Jasper County.

c. Project Impact. This species is not known to exist within the project area. Its preferential habitat of seasonal, groundwater-driven depressional wetlands has not been identified within the potential area of impact.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.20 Leafy pineweed (*Potamogeton foliosus*)

a. Status. Not ranked/ Under review

b. Background. Habitat is lakes, streams, and ponds. Has been recorded in Jasper County.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh habitat to a brackish marsh habitat.

d. Effect Determination. May affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.21 Grassleaf arrowhead (*Sagittaria graminea var weatherbiana*)

a. Status. S1 Critically Imperiled

b. Background. Habitat is tidal freshwater marsh. Has been recorded in Jasper County, however, there have been "no known occurrences" of the grassleaf arrowhead in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh to a brackish marsh.

d. Effect Determination. If the species is present, the project may affect, but is not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.22 Florida yellow-eyed grass (*Xyris difformis var floridana*)

a. Status. S2 Imperiled

b. Background. Habitat is a wet prairie, freshwater marsh, and depression meadow. There are "no known occurrences" of the Florida yellow-eyed grass in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh to a brackish marsh.

d. Effect Determination. If the species is present, the project may affect, but is not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.23 Acid swamp yellow-eyed grass (*Xyris serotina*)

a. Status. SC S2 Imperiled

b. Background. Habitat is a wet prairie, freshwater marsh, and depression meadow. Has been recorded in Jasper County, but there are "no known occurrences" of the acid swamp yellow-eyed grass in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh to a brackish marsh.

d. Effect Determination. If the species is present, the project may affect, but not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.24 Slender leaved Dragon Head (*Physostegia leptophylla*)

a. Status. SNR

b. Background. Species may be found within tidal bald cypress – tupelo gum swamp. There are "no known occurrences" of the slender leaved dragon head in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh to a brackish marsh.

d. Effect Determination. If the species is present, the project may affect, but is not likely to adversely affect this species or any of its presently designated critical habitat.

7.04.25 Hairy Fever Tree (*Pinckneya pubens*)

a. Status. S 1

b. Background. Species may be found in wet areas, swamps and the understory of moist woods. There are "no known occurrences" of the hairy fever tree in the project area (Personal Communication, Julie Holling, SC Department of Natural Resources, Heritage Trust Program, March 1, 2011). This species has ecological value, but since this species is not a federally listed threatened or endangered species, a detailed survey is not warranted.

c. Project Impact. This species is not known to exist within the project area, but its habitat is similar to what is found in portions of the estuary. If this species is found downstream of McCoy's Cut in the Front, Middle or Back Rivers, the proposed action would increase salinity and change the tidal freshwater marsh to a brackish marsh.

d. Effect Determination. If the species is present, the project may affect, but is not likely to adversely affect this species or any of its presently designated critical habitat.

7.05 Conservation Areas, Jasper County, South Carolina

The following conservation areas in Jasper County, South Carolina will not be adversely affected by the proposed deepening of the navigation channel since they are located on uplands or some distance from the project site (Greenspace in Jasper County). The following conservation areas may be affected by the proposed action:

Savannah National Wildlife Refuge (NWR) [U.S. Fish and Wildlife Service]. By deepening the Federal navigation channel, increased salinity is expected to impact existing freshwater tidal marsh within the Savannah NWR. The effects would be mitigated by various components of the mitigations plans, including the flow re-routing features and the land acquisition and preservation. A portion of the Savannah NWR is located in Georgia.

Tybee National Wildlife Refuge (NWR) [U.S. Fish and Wildlife Service]. By deepening the proposed Federal navigation channel, the ongoing erosion of the riverine shoreline may be increased by ship-generated wakes. The Corps conducted ship wake and bank erosion studies and determined that no significant impacts to shoreline erosion are expected from the proposed action (see Engineering Appendix to the GRR).

Turtle Island is located in Jasper County, South Carolina. It is located just north of the navigation channel near the entrance of the inner harbor. The main potential threat to Turtle Island would be increased erosion. Turtle Island is protected from any erosion caused by vessels in the inner harbor since it is sheltered from the navigation channel by the entrance channel jetties and Jones/Oysterbed Island. Wave action and subsequent erosion on Turtle Island from vessels in the entrance channel is not a major problem because of its distance from the entrance channel. Also, ship wake and erosion studies conducted during SHEP studies indicate that harbor deepening would have very little impact on shoreline erosion rates in the vicinity of the project.

Savannah River [High Priority Stream]. The Savannah River will be adversely impacted by increased salinity impacts from the proposed action. As a result of the mitigation plan (see Appendix C), the overall effect on the river and its fisheries is not expected to be significant. The dissolved oxygen within the harbor will be maintained and slightly improved by oxygen injection. A portion of the Savannah River is located in Georgia.

8.00 IMPACTS TO FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

8.01 General Impacts

Dredging operations and placement of sediments within the existing CDFs or the ODMDS have the potential to adversely affect animals and plants in a variety of ways. These include actions of the dredging equipment (i.e., cutting, suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels (i.e. impact); physical barriers imposed by the presence of dredging equipment (i.e. pipelines); and placement of dredged sediment in various locations (i.e. covering, compaction, etc.). Potential impacts vary according

to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

All the proposed dredging activities will occur within the existing Savannah Harbor Navigation Project with the exception of the channel improvements in Middle River and Little Back River designed to facilitate the flow of freshwater down these streams. Any potential dredging impacts on Federally listed threatened and endangered species would primarily be limited to those species that occur in habitats occurring in those areas (i.e., within estuarine and marine habitats). A small amount of work associated with the mitigation plan would occur in tidal, freshwater areas and on lands adjacent to the rivers (features such as the DO systems).

The proposed work would generally not affect any listed species which generally reside in forested, moist pine flatwoods, well drained sandy soils, or bottomland hardwood habitats, which would include the red-cockaded woodpecker, American chaffseed, Pondberry, Canby's dropwort, Kirtland's warbler, Bachman's warbler, eastern indigo snake, and flatwoods salamander. Bottomland hardwoods would be acquired and preserved as part of the mitigation plan. This action would protect the habitat of listed species, which use those areas.

Species which could be present in the project area during the proposed action are the finback whale, humpback whale, right whale, sei whale, blue whale, sperm whale, West Indian manatee, Piping plover, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, Shortnose sturgeon, Atlantic sturgeon, Piping Plover, and wood stork. The accounts, which follow, will summarize information about these species as it applies to the proposed action.

Dredging and sediment placement methods associated with the proposed action are similar to current maintenance dredging methods. These methods have been addressed in a number of previous environmental documents, including biological assessments and biological opinions rendered regarding endangered and threatened species (see Section 3.0 Prior Coordination).

Impacts in the project area are discussed in Sections 2.0 and 5.0 of the BATES. Additional information on the affected environment and impacts of the project is found in Sections 4 and 5 of the EIS and the Mitigation Plan found in Appendix C of the EIS.

8.02 Species Accounts

8.02.1 Red-cockaded woodpecker, American chaffseed, Pondberry, Canby's dropwort, Kirtland's warbler, Bachman's warbler, Eastern indigo snake, and Flatwoods salamander.

a. Status. Red-cockaded woodpecker is Endangered, American chaffseed is Endangered, Pondberry is Endangered, Canby's dropwort is Endangered, Kirtland's warbler is Endangered, Bachman's warbler is Endangered, Eastern indigo snake is Threatened, and Flatwoods salamander is Threatened.

b. Background. The proposed project would not affect these species for the following reasons:

1. Red-cockaded woodpecker. This species requires forested habitat of at least 50 percent pine that is 30 years or older. No habitat that could potentially be used by this species would be impacted by the project. No known colony of these woodpeckers is located along the Savannah Harbor or on adjacent properties. The project would not destroy or modify any habitat determined critical for the species' survival.

2. American chaffseed. This species occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. It is generally found in habitats described as open, moist pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (Source: *Endangered and Threatened Species of the Southeastern United States (The Red Book)* FWS Region 4 -- As of 1/95). No habitat that could potentially be used by this species would be impacted by the project.

3. Pondberry. This species occurs in freshwater wetland habitats such as interior bottomland hardwoods, and the margins of sinks, ponds and other depressions in the more coastal sites (Source: *Endangered and Threatened Species of the Southeastern United States (The Red Book)* FWS Region 4 -- As of 2/91). No habitat that could potentially be used by this species would be impacted by the project.

4. Canby's dropwort is a herbaceous perennial with tuberous roots and pale, fleshy rhizomes. Its habitat is moist areas in the coastal plain and sandhills such as Carolina bays, wet meadows, and wet pineland savannas. Best occurrences are in open bays and ponds with minimal cover that are wet for most of the year. No habitat that could potentially be used by this species would be impacted by the project.

5. Kirtland's warbler. The endangered Kirtland's warbler is one of the rarest members of the wood warbler (Parulidae) family. It nests in just a few counties in Michigan's northern Lower and Upper peninsulas, in Wisconsin and the province of Ontario. The winter range of the Kirtland's warbler was discovered in 1879 when a specimen was collected on Andros Island in the Bahama Islands archipelago. All sightings or collections of wintering Kirtland's warblers since then have been in the Bahamas and in the Turks, Caicos, and Hispaniola islands. Kirtland's warblers are one of more than 200 neo-tropical migratory species that nest in North America and winter in the tropics. No habitat that could potentially be used by this species would be impacted by the project.

6. Bachman's warbler. Historic records indicate the Bachman's warbler nest in low, wet forested areas containing variable amounts of water, but usually with some water that was permanent. These areas were described in general as being forested with sweet gum, oaks, hickories, black gum, and other hardwoods; and where there was an opening in the forest canopy, the ground being covered with dense thickets of cane, palmetto, blackberry, gallberry, and other shrubs and vines. Most authorities agree that if the Bachman's warbler still exists it is most likely in the I'On Swamp area in Charleston and Berkeley Counties, South Carolina (Source: *Endangered and Threatened Species of the Southeastern United States (The Red Book)* FWS Region 4 -- As of 6/91). No habitat that could potentially be used by this species would be impacted by the project.

7. Eastern indigo snake seems to be strongly associated with high, dry, well-drained sandy soils, closely paralleling the sandhill habitat preferred by the gopher tortoise. During warmer months, indigos also frequent streams and swamps, and individuals are occasionally found in flat woods (Source: *Endangered and Threatened Species of the Southeastern United States (The Red Book)* FWS Region 4 -- As of 1/91). No habitat that could potentially be used by this species would be impacted by the project.

8. Flatwoods salamander. Optimum habitat for the flatwoods salamander is an open, mesic (moderate moisture) woodland of longleaf/slash pine (*Pinus palustris/P. elliottii*) flatwoods maintained by frequent fires. Pine flatwoods are typically flat, low-lying open woodlands that lie between the drier sandhill community upslope and wetlands down slope (Wolfe et al. 1988). No habitat that could potentially be used by this species would be impacted by the project.

c. Project Impacts. The proposed deepening of the Savannah Harbor, will only impact palustrine, estuarine and/or marine habitats. No upland habitats (i.e., sandhills, Carolina bays, wet savannas, flatwoods, etc.) will be adversely affected by the proposed action. The proposed plan would not destroy or modify any habitat determined critical for the species' survival. Bottomland hardwoods would be acquired and preserved as part of the mitigation plan. This action would protect the habitat of listed species which use those areas.

d. Effect Determination. Since these eight species generally do not reside within palustrine, estuarine and marine habitats, the proposed action is expected to have No Effect on the following species -- Red-cockaded woodpecker, American chaffseed, Pondberry, Canby's dropwort, Kirtland's warbler, Backman's warbler, Eastern indigo snake, and Flatwoods salamander -- or their habitats.

8.02.2 Wood stork

a. Status. Endangered

b. Background. Wood storks are known to frequent the more protected palustrine and estuarine areas of the region for both feeding and nesting. Wood stork rookeries are located on hammocks and along the edges of the marsh behind the barrier islands. This species has been observed in the Savannah Harbor area, particularly at the Savannah National Wildlife Refuge and in the Wright River adjacent to the confined dredged material disposal facilities. They occasionally rest within the CDFs and feed there when conditions are right. Woodstorks have been recorded in the areas from April 25 (1 in 2007) to January 27 (1 in 2007), and they are found feeding in the areas primarily from late summer to early winter. In most years, individuals are more likely to be seen flying over the areas in the spring, rather than feeding in them: (Five birds on February 28, 2001 and three birds on April 25, 2001). They are most abundant (counts over 100) from early July to late October and occasionally late November. The high count feeding in the CDF areas was 415 recorded on October 17, 2008. A high number of 55 individuals were observed feeding in the disposal areas on 23 September 1995 (Personal Conversation, Steve Calver, USACE, Savannah District). These birds have a unique feeding technique and require higher prey concentrations than other wading birds. Optimal water regimes for the wood stork

involve periods of flooding, during which prey (fish) population's increase, alternating with dryer periods during which receding water levels concentrate fish at high densities. Fish trapped in the CDFs during maintenance dredging may provide a source of food for wood storks once dewatering of the disposal areas is near completion.

c. Project Impacts. The proposed action would deepen the existing navigation channel and would not impact any habitat critical to the Wood stork. Continued use of upland CDFs for sediment placement could be considered a minor enhancement of Wood stork feeding habitat. Specifics with regard to management of the CDFs to minimize impacts to birds are included above, in Section 7.02.7. All cadmium-laden sediment would be placed in CDFs 14A/14B and covered with 2-foot of sediment taken from areas of the channel where concentrations of cadmium in the sediment are expected to be 4 mg/kg or less. Therefore, birds feeding in CDF 14A/14B would not be exposed to cadmium-laden sediments.

d. Effect Determination. The proposed project may affect but is not likely to adversely affect this species or any of its presently designated critical habitat.

8.02.3 Piping plover

a. Status. Threatened

b. Background. The Atlantic Coast Piping plover population breeds on coastal beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the Atlantic Coast (from North Carolina south), the Gulf Coast, and in the Caribbean where they spend a majority of their time foraging. Since being listed as threatened in 1986, only 800 pairs were known to exist in the three major populations combined and by 1995 the number of detected breeding pairs increased to 1,350. The 2008 report cites 1848 nesting pairs for the Atlantic coast. This population increase can most likely be attributed to increased survey efforts and implementation of recovery plans.

Piping plovers typically nest in sand depressions on un-vegetated portions of the beach above the high tide line on sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes. They head to their breeding grounds in late March or early April and nesting usually begins in late April; however, nests have been found as late as July (Potter, *et al.*, 1980). Feeding areas include intertidal portions of ocean beaches, washover areas, mud flats, sand flats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS, 1996). Prey consist of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates (Bent, 1928).

Loss and degradation of habitat due to development and shoreline stabilization have been major contributors to the decline of Piping plovers in southeast. The current commercial, residential, and recreational development has decreased the amount of coastal habitat available for Piping plovers to nest, roost, and feed. Furthermore, beach erosion and the abundance of predators, including wild and domestic animals as well as feral cats, have further diminished the potential for successful nesting of this species.

A majority of the existing shoreline throughout the state of Georgia is heavily developed and is experiencing significant shoreline erosion from both anthropogenic and natural causes. Habitat loss from coastal development, long-shore and cross-shore shoreline erosion, shoreline erosion impacts from hard structure protection measures (i.e. jetties, groins, etc.), and heavy public use has led to the degradation of Piping plover habitat throughout the State. As erosion and development persist throughout the coast of Georgia, Piping plover roosting and foraging habitat loss continues.

Cross-island transport of sediment and subsequent washover fan formation is considered a primary constituent element used in defining Piping plover critical habitat. These low lying sand flats contain sparse vegetation and offer optimum habitat for Piping plovers. Though eroded roosting habitat may be restored with the placement of beach fill, an increase in the width and height of the constructed berm, as well as the potential incorporation of a protective dune, hard structure, etc., may function as a barrier to cross island transport of sediment during significant erosion events resulting in long-term washover foraging habitat loss.

The formation of sand bars and emergent sand spit islands within inlet complexes serve as valuable habitat for Piping plovers and other shorebird species. In many cases these sites contain the important mosaic of habitat types including algal flats, sand flats, mud flats, etc. Though these formations are highly dynamic, they are often protected and isolated from human development pressures and associated disturbances; thus, they offer valuable roosting and foraging habitat. The size and frequency of occurrence is dependent on the sediment budget within an individual inlet complex and the interval period for inlet bypassing of sediment. Inlet bypassing of accreted sediments within inlet complexes is intended to mitigate down-drift erosion, and subsequent habitat loss, resulting from the interruption of longshore transport of sediments from hard structures and deep navigation channels. However, the resultant habitat from the bypassing of sediment on down-drift beaches is, in some cases, dependent on the removal of sediment accretion within the inlet. Bypassing of sediment to down-drift beaches may help mitigate lost intertidal foraging grounds for Piping plovers and other shorebirds. Similarly, placement of sediments in the nearshore area which either protect the existing shore or make their way to the adjacent shore would benefit Piping plovers by stabilizing their intertidal foraging habitat.

Piping plovers feed along beaches and intertidal mud and sand flats. Primary prey includes polychaete worms, crustaceans, insects, and bivalves. Literature dating back to the early 1970's along the southeast coast indicate that opportunistic infauna species (ex. *Emerita, Donax, Haustorius spp., etc.*) found in the nearshore areas are subject to direct mortality from burial; however, recovery often occurs within 1-3 years, (Hayden and Dolan, 1974; Saloman, 1984; Van Dolah *et al.*, 1992; Van Dolah *et al.*, 1993; Jutte, P.C. *et al.*, 1999) especially if compatible material is placed on the beach (Hayden and Dolan, 1974; Reilly and Bellis, 1978; Saloman, 1984; Nelson and Dickerson, 1989; Van Dolah *et al.*, 1992; Van Dolah *et al.*, 1993; Hackney *et al.*, 1996; Jutte, P.C. *et al.*, 1999; Peterson *et al.*, 2000). A literature review of polychaete annelid species affected by beach placement activities, performed by Hackney *et. al.* (1996), indicates that sediment disturbance has a strong negative effect on tube-building and sedentary polychaetes; however, minimal effects and, in some cases, enhancing effects of some mobile taxa. Some studies indicate that following beach placement activities, a population shift may

occur as an enhanced abundance of some polychaete species occurs within disturbed areas (Coastal Science Associates, 2003; Lindquist and Manning, 2001; Peterson and Manning, 2001).

Critical Habitat for Wintering Piping Plover Designation

Critical habitat receives protection under Section 7 of the Endangered Species Act through the prohibition against destruction or adverse modification of critical habitat. This prohibition applies to actions carried out, funded, or authorized by a Federal agency. Section 7 requires consultation on Federal actions that are likely to result in the destruction or adverse modification of critical habitat.

The Piping Plover is a fairly common winter resident along the Atlantic Coast of Georgia and South Carolina where they spend a majority of their time foraging. When not foraging, plovers can be found roosting, preening, bathing, in aggressive encounters, and moving among available habitat locations (Zonick and Ryan, 1996). On July 10, 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the Piping plover where they spend up to 10 months of each year on the wintering grounds. Piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. A few individuals can be found in the wintering grounds throughout the year, but sightings are rare in late May, June, and early July. Constituent elements for the Piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in coastal areas that support intertidal beaches and flats (mud flats, sand flats, algal flats, and washover passes) and associated dune systems and flats above annual high tide. Important components of intertidal flats include sand and/or mudflats with no or very sparse emergent vegetation. Adjacent non- or sparsely-vegetated sand, mud, or algal flats above high tide are also important, especially for roosting Piping plovers. Important components of the beach/dune ecosystem include surf cast algae, sparsely vegetated back beach and salt pans, spits, and washover areas. Designated critical habitat does not include existing developed sites consisting of buildings, marinas, paved areas, boat ramps, exposed oil and gas pipelines, and similar structures (Federal Register/Vol. 66, No 132, July 10, 2001). The USFWS designated the north end of Tybee Island, Georgia (Georgia Unit GA -1, see Figure 8-1 below) as critical habitat for the wintering Piping plover. The major threat to the birds use of the area during the winter months would be continued degradation of beach foraging habitat. Daufuskie Island has not been designated as critical habitat for the wintering Piping plover.

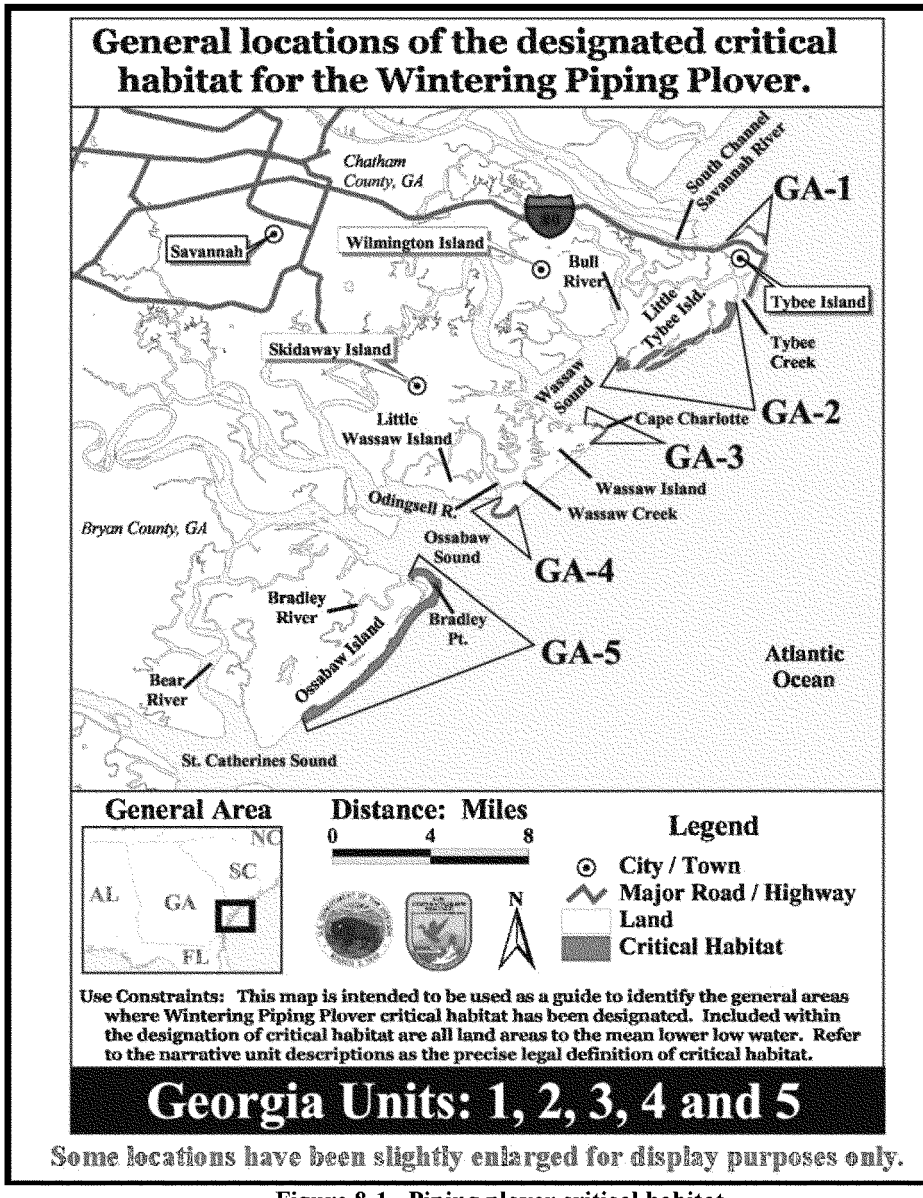


Figure 8-1. Piping plover critical habitat.

The USFWS has defined textual unit descriptions to designate areas within the critical habitat boundary. These units describe the geography of the area using reference points, include the areas from the landward boundaries to the MLLW, and may describe other areas within the unit that are utilized by the Piping plover and contain the primary constituent elements (Federal Register/Vol. 66, No 132, July 10, 2001).

c. Project Impacts.

(1) Habitat

No new work dredged material would be placed in Piping plover habitat. Maintenance material from the entrance channel could be placed in the feeder berm sites within the Tybee nearshore or the beach on Tybee Island. This placement may temporarily affect foraging habitat for the species.

(2) Critical Habitat

The USFWS designated the north end of Tybee Island, Georgia (Georgia Unit GA -1) as critical habitat for the Wintering Piping plover. Should maintenance material be placed on the Tybee Beach, some of the material may be placed in the area designated as critical habitat. The major threat to the bird's use of the area during the winter months would be continued degradation of beach foraging habitat. The BATES was coordinated with the USFWS who state:

"The Service designated the north end of Tybee Island, Georgia, adjacent to the project, as critical habitat for the wintering piping plover. Some dredge sediments are planned to be placed in nearshore areas to migrate on-shore for beach renourishment. The placement may have temporary adverse impacts on foraging habitat. Small portions of the habitat would be directly affected short-term at any point in time and adjacent habitat will be available. Because erosion of the Tybee shoreline would be reduced, the intertidal areas that provide foraging habitat to the piping plover would experience a long term benefit."

d. Effect Determination.

The proposed action may affect, but is not likely to adversely affect the Piping plover or its critical habitat. The USFWS concurred with this determination.

8.02.4 West Indian Manatee

a. Status. Endangered.

b. Background.

The West Indian manatee (*Trichechus manatus*), also known as the Florida manatee, is a Federally-listed endangered aquatic mammal protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), the Marine Mammal Protection Act of 1972, as amended (16 U.S.C 1461 et seq.), and the Florida Manatee Sanctuary Act of 1978, as amended.

Manatees inhabit both salt and fresh water and can be found in shallow (5 ft to usually <20 ft), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS, 1991) throughout their range. The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce.

During the cooler months between October and April, Florida manatees concentrate in areas of warmer water. Manatees are thermally stressed at water temperatures below 18°C (64.4°F) (Garrott *et al.*, 1995); therefore, during winter months, when ambient water temperatures approach 20°C (68°F), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water industrial outfalls as far north as southeast Georgia. Records in Georgia are primarily random sightings and carcass finds and are not the result of systematic research. Systematic aerial surveys were initiated in 1976, and sight records have been increasing in south Georgia in recent years. The US Fish and Wildlife Service has reported that several were observed in the Savannah Harbor in the summer of 1987. The Georgia population is primarily migratory in nature and, therefore, fluctuates with season. The majority are sighted southward along the Georgia coast from Chatham County toward Florida. Manatees have been observed infrequently in the Savannah River as far upstream as the King's Island Turning Basin (Rathbun et al., 1981). The occurrence of manatees in the Savannah River estuary is characterized as a small summer resident population. Manatees are found in Georgia and South Carolina mainly during the warmer months of the year.

Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges. During summer months, they may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico and appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water (USFWS, 1983). Annual migratory circuits of some individuals through the intracoastal waterway of the Atlantic Coast are 1,700 km round trips at seasonal travel rates as high as 50 km/day (Reid *et al.*, 1991)

Manatee population trends are poorly understood, but deaths have increased steadily. A large percent of mortality is due to collisions with watercrafts, especially of calves. Another closely related factor in their decline has been the loss of suitable habitat through incompatible coastal development, particularly destruction of sea grass beds by boating facilities (USFWS, 2001).

From 1974 through 1994, 2,456 manatee carcasses were recovered in the southeastern U.S. Eight hundred and two (33 percent) were attributed to human-related causes. Of these, 613 were caused by collisions with watercraft, 111 were flood gate/canal lock-related, and another 78 were categorized as other human-related (USFWS, 2000). By email September 6, 2008, representatives from the Georgia Department of Natural Resources, Nongame Conservation Section indicated that they had recovered three male manatee carcasses in the Savannah River. All three were located at the downtown Savannah waterfront and apparently died from ship propeller lacerations (e.g. one was cut in half). Field necropsies were conducted on each.

Critical Habitat

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c. Project Impacts.

(1) Habitat.

Direct effects on manatees from the project construction should be minor. (See Section 5.0) Additionally, the project would not adversely affect any site-specific conditions relating to habitat requirements such as sea grass beds and critical habitat designations.

Vessel traffic, including crew boats, tugs, barges, etc., will be a component of all dredging operations and; therefore, the potential for collision may exist. To ensure that dredging does not affect manatees, Savannah District has adopted and would implement on this project the "Standard State and Federal Manatee Protection Conditions." Those standard operating procedures are described as follows:

Manatee Protection Conditions:

1. The Contractor shall instruct all personnel associated with the project of the potential presence of manatees, the need to avoid collisions with these animals and the need to be on constant lookout for manatees during all phases of operation.

2. All construction personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees and right whales which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act. The Contractor shall be held responsible for any manatee harmed, harassed, or killed as a result of construction activities.

3. If siltation barriers are used, they shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exit from essential habitat.

4. All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four foot clearance from the bottom and vessels shall follow routes of deep water whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category where navigational safety permits.

5. If a manatee(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. If a manatee is closer than 50 feet to moving equipment or the project area, the equipment shall be shut down and all construction activities shall cease to ensure protection of the manatee. Construction activities shall not resume until the manatee has departed the project area.

6. Prior to commencement of construction, each vessel involved in construction activities shall display at the vessel control station or in a prominent location, visible to all employees operating the vessel, a temporary sign at least 8 1/2" x 11" reading, "Caution: Manatee Habitat/Idle Speed is Required in Construction Area." In the absence of a vessel, a temporary 3' x 4' sign reading "Caution: Manatee Area" will be posted adjacent to the issued construction permit. A second temporary sign measuring 8½" X 11" reading "Caution: Manatee Habitat. Equipment Must Be Shut down Immediately If A Manatee Comes Within 50 Feet Of Operation" will be posted at the dredge operator control station and at a location prominently adjacent to the displayed issued construction permit. The Contractor shall remove the placards upon completion of construction.

7. Any collisions with a manatee or sighting of any injured or incapacitated manatee shall be reported immediately to the Corps of Engineers. The order of contact within the Savannah District shall be as follows:

Table 8-1. Order of Contact of Corps Personnel for Dredging Contractor to Report Manatee Death or Injury

Title	Order of Contact	Telephone Numbers	
		Work	After Hours
Dredge Inspector (CESAS-OP-[])	*1*	*On Site*	*Lodging Location*
Contracting Officer's Representative, (CESAS-OP-[ ])	*2*	*TBP*	*TBP*
Environmental Team Member (CESAS-PD)	*3*		
Project Manager (CESAS-PM-C)	*4*		*TBP*

The Contractor shall also immediately report any take of a manatee to Georgia Nongame-Endangered Wildlife Program coastal office at (800) 272-8363 during work hours or (800) 241-4113 after hours or on weekends as well as the U.S. Fish and Wildlife Service, [Charleston Field Station at Phone 843-727-4707x211)

8. The Contractor shall maintain a daily log detailing sightings, collisions, or injuries to manatees occurring during the contract period. The data shall be recorded on forms provided by the Contracting Officer (sample form is appended to the end of this section). All data in original form shall be forwarded directly to the Chief of Environment and Resources Branch within 10

days of collection and copies of the data will be supplied to the Contracting Officer. Within 15 days, following project completion, a report summarizing the above incidents and sightings, including a list and addresses of all observers utilized during the construction will be submitted to the following:

Georgia Nongame-Endangered Wildlife Program

Chief, Planning Division
U.S. Army Corps of Engineers (CESAS-PD)

Contracting Officer's Representative
U.S. Army Corps of Engineers (CESAS-OP-[ ]

U.S. Fish and Wildlife Service
Brunswick, GA

Furthermore, during hopper dredge operations, National Marine Fisheries Service-approved observers will be on board 24 hours a day and will serve as a lookout to alert the vessel pilot of the occurrence of manatees in the project areas. If a manatee is observed, collisions shall be avoided either through reduced vessel speed, course alteration, or both. During the evening hours, when there is limited visibility due to fog, or when there are sea states of greater than Beaufort 3, the dredge must slow down to 5 knots or less when transiting between areas if manatees have been spotted within 15 nm of the vessel's path within 24 previous hours.

With deepening, the total number of vessels would decrease (when comparing With and Without Project conditions) as vessels would be able to load more deeply under the improved conditions. Therefore, fewer ships would call on the port (when comparing With and Without Project conditions). Manatees are generally found in shallow water (<20 feet deep), but large ships must use the deep navigation channel. For these reasons, ship traffic is not expected to impact manatees more than under existing conditions.

d. Effect Determination.

Considering that the "Manatee Protection Conditions" will be adhered to and NMFS-approved observers will be on board all hopper dredge operations, the proposed action may affect but is not likely to adversely affect the manatee or any of its presently designated critical habitat.

8.02.5 North Atlantic Right Whale, Finback Whale, Humpback Whale, Sei Whale, Blue Whale, and Sperm Whale

Of the six species of large whales being considered under this assessment, the North Atlantic right whale, sperm, and humpback whale would normally be expected to occur within the project area during the construction period. The blue, finback, and sei whales are not discussed in detail in this assessment as they are unlikely to be within the vicinity of the coastal action area since they are typically offshore species, residing in deep water, and the activities conducted by the Corps are coastal in nature. Additional information on blue, finback, and sei whales can be found in Blaylock *et al.* 1995; Waring *et al.* (1997, 1998, 1999, 2000, 2001, 2002, 2003, 2006, and 2007). Due to the rarity of sightings of these three whale species in the project area, the

Corps believes that any effects to them by the proposed dredging operations are discountable. Discountable effects under Section 7 of the ESA are those "extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur."

In support of this determination, the Corps has reviewed recent consultations conducted by NMFS on Naval, Coast Guard and Corps operations and for those consultations, NMFS has also found that vessel operations and naval ordinance operations were likely to have a discountable effect on the blue, finback, and sei whales (NMFS, 2003b; NMFS, 2002a; NMFS, 2000a; NMFS, 1998a, NMFS 1997c) within the Savannah Harbor Expansion project consultation boundaries.

Therefore, the proposed action may affect but is not likely to adversely affect the Finback Whale, Sei Whale, and Blue Whale or any of their presently designated critical habitats.

a. Species Biology for the Humpback Whale, Sperm Whale, and North Atlantic Right Whale

1. Humpback Whale *(Megaptera novaeangliae)*

Life History and distribution

Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. Humpback whales feed on krill and small schooling fish on their summer grounds. The whales occupy tropical areas during winter months when they are breeding and calving and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill.

In the Atlantic Ocean, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Six separate feeding areas are utilized in northern waters after their return. These areas are within the biologically important area defined by the 200-m (656-ft) isobath on the North American east coast. These areas are outside of the project's potential impact area. Humpback whales also use the mid-Atlantic as a migratory pathway and apparently as a feeding area, at least for juveniles. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993). Biologists theorize that non-reproductive animals may be establishing a winter-feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean.

Humpback whale reproductive activities occur primarily in winter. They become sexually mature at age four to six. Annual pregnancy rates have been estimated at about 0.40-0.42 (NMFS unpublished and Nishiwaki, 1959). Cows will nurse their calves for up to 12 months. The age distribution of the humpback whale population is unknown, but the portion of calves in various populations has been estimated at about 12% (Chittleborough 1965, Whitehead 1982, Bauer 1986, Herman *et al.* 1980, and Clapham and Mayo 1987).

The information available does not identify natural causes of death among humpback whales or their number and frequency over time, but potential causes of natural mortality are believed to include parasites, disease, entrapment in ice, and predation (killer whales, false killer whales, and sharks). Other causes of mortality include: biotoxins, ship strikes, and entrapment in fishing or other gear.

Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes (particularly sand lance and Atlantic herring), euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollack, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. In the waters west of the Attu Islands and south of Amchitka Island, Atka mackerel were preferred prey of humpback whales (Nemoto 1957). Invertebrate prey includes euphausiids, mysids, amphipods, shrimps, and copepods. They target fish schools and filter large amounts of water for the associated prey. Humpback whales have also been observed feeding on krill.

Diving and social behavior

In Hawaiian waters, humpback whales remain almost exclusively within the 1820 m isobath and usually within 182 m. Maximum diving depths are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton *et al.* 1997). They may remain submerged for up to 21 min (Dolphin 1987). Dives on feeding grounds ranged from 2.1-5.1 min in the north Atlantic (Goodyear unpubl. manus.). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California humpback whale dive times averaged 3.5 min (Strong 1989). Because most humpback prey is likely found above 300 m depths, most humpback dives are probably relatively shallow.

Clapham (1986) reviewed the social behavior of humpback whales. They form small unstable groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long periods of times. There is good evidence of some territoriality on feeding grounds (Clapham 1994, 1996), and on wintering ground (Tyack 1981). On the breeding grounds males sing long complex songs directed towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996). Inter-male competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds that may be as high as 2.4:1.

Humpbacks produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne 1970; Winn *et al.* 1970a; Thompson *et al.* 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson *et al.* 1979). The songs appear to have an effective range of approximately six to 12 miles (10 to 20 km). Animals in mating groups produce a variety of sounds (Tyack 1981; Tyack and Whitehead 1983, Silber 1986). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB

(Thompson *et al.* 1986). These sounds are attractive and appear to rally animals to the feeding activity (D=Vincent *et al.* 1985; Sharpe and Dill 1997). In summary, humpback whales produce at least three kinds of sounds: 1) complex songs with components ranging from at least 20Hz B 4 kHz with estimated source levels from 144 B 174 dB, which are mostly sung by males on the breeding grounds (Payne 1970; Winn *et al.* 1970a; Richardson *et al.* 1995); 2) social sounds in the breeding areas that extend from 50Hz B more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and 3) Feeding area vocalizations that are less frequent, but tend to be 20Hz B 2 kHz with estimated sources levels in excess of 175 dB re 1 µPa-m (Thompson *et al.* 1986; Richardson *et al.* 1995). Sounds often associated with possible aggressive behavior by males (Tyack 1983; Silber 1986) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983). Humpback whales respond to low frequency sound. They have been known to react to low frequency industrial noises at estimated received levels of 115 B 124 dB (Malme *et al.* 1985), and to conspecific calls at received levels as low as 102dB (Frankel *et al.* 1995). Humpback whales apparently reacted to 3.1 B 3.6 kHz sonar by changing behavior (Maybaum 1990 1993). Malme *et al.* (1985) found no clear response to playbacks of drill ship and oil production platform noises at received levels up to 116dB re 1 µPa. Studies of reactions to airgun noises were inconclusive (Malme *et al.* 1985). Humpback whales on the breeding grounds did not stop singing in response to underwater explosions (Payne and McVay 1971). Humpback whales on feeding grounds did not alter short-term behavior or distribution in response to explosions with received levels of about 150dB re 1 µPa/Hz at 350Hz (Lien *et al.* 1993; Todd *et al.* 1996). However, at least two individuals were likely killed by the high intensity, impulse blasts and had extensive mechanical injuries in their ears (Ketten *et al.* 1993; Todd *et al.* 1996). The explosions may also have increased the number of humpback whales entangled in fishing nets (Todd *et al.* 1996). Frankel and Clark (1998) showed that breeding humpbacks showed only a slight statistical reaction to playback of 60 B 90 Hz bounds with a received level of up to 190 dB. While these studies have shown short-term behavioral reactions to boat traffic and playbacks of industrial noise, the potential for habituation, and thus the long-term effects of these disturbances are not known.

Population and Listing Status

Humpback whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for the species.

As of March 2007, NMFS' Stock Assessment report on the North Atlantic population (including the Gulf of Maine stock) of humpback whales, the stock is currently estimated to be 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463) (Waring *et al*, 2007). The minimum population estimate for the Gulf of Maine stock is 647. According to the stock assessment, current data suggests that the Gulf of Maine stock is steadily increasing in size. PBR for the Gulf of Maine humpback whale is calculated to be 1.3 whales.

More detailed information on humpback whales can be located in the NMFS Stock Assessment reports under the MMPA (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the Recovery Plan

for Humpback Whale (*Megaptera novaeangliae)*
(http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_humpback.pdf).

Impacts of human activity on this species

In the 1990s, no more than 3 humpback whales were killed annually in U.S. waters by commercial fishing operations in the Atlantic and Pacific Oceans. Between 1990 and 1997, no humpback whale deaths have been attributed to interactions with groundfish trawl, longline and pot fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska (Hill and DeMaster 1999). Humpback whales have been injured or killed elsewhere along the mainland U.S. and Hawaii (Barlow *et al.* 1997). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill *et al.* 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone.

Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham *et al.* 1993, Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman *et al.* 1980, Watkins *et al.* 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979b, Dean *et al.* 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.* 1993; Wiley *et al.* 1995).

Humpback whales are killed by ship strikes along both coasts of the U.S. On the Atlantic coast, 6 out of 20 humpback whales stranded along the mid-Atlantic coast showed signs of major ship strike injuries (Wiley *et al.* 1995). Almost no information is available on the number of humpback whales killed or seriously injured by ship strikes outside of U.S. waters.

Critical Habitat

No critical habitat has been designated for humpback whales under the ESA.

2. Sperm Whale (*Physeter macrocephalus*)

Life History and distribution

There are estimated to be approximately two million sperm whales worldwide. In the western North Atlantic they range from Greenland to the GOM and the Caribbean. The sperm whales that occur in the eastern US EEZ are believed to represent only a portion of the total stock (Blaylock, et al. 1995). Sperm whales generally occur in waters greater than 180 meters in depth. While they may be encountered almost anywhere on the high seas their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). Waring, et al. (1993) suggest sperm whale

distribution is closely correlated with the Gulf Stream edge. Like swordfish, which feed on similar prey, sperm whales migrate to higher latitudes during summer months, when they are concentrated east and northeast of Cape Hatteras. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters many of the larger mature males return in the winter to the lower latitudes to breed.

In the Atlantic Ocean, NMFS' most recent stock assessment report notes that sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. There is also a very large population of sperm whales found in the Gulf of Mexico near the Mississippi River delta.

Female sperm whales take about 9 years to become sexually mature (Kasuya 1991, as cited in Perry *et al.* 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 month's gestation and nurse their calves for 2 - 3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry *et al.* 1999). Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollack, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the Gulf of Alaska in the 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 - 4% of their total body weight (Lockyer 1976b, Kawakami 1980).

Population Dynamics and Status

Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for sperm whales.

As of the NMFS December 2005 Stock Assessment Report on the North Atlantic Stock of sperm whales population is currently estimated at approximately between 3,539 and 4,804 (CV=0.38). According to the stock assessment, there is insufficient data to determine the population trend for the species. Potential Biological Removal (PBR) for the western North Atlantic sperm whale is calculated to be 7.0 whales.

More detailed information on sperm whales can be located in the NMFS Stock Assessment reports under the MMPA (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the *Draft Recovery Plan for Sperm Whale* (Physeter macrocephalus). (http://www.nmfs.noaa.gov/pr/pdfs/recovery/draft_spermwhale.pdf).

Threats

Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson *et al.* 1987). In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991-1995 (Barlow *et al.* 1997). Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longlines in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear.

Critical Habitat

No critical habitat has been designated for sperm whales under the ESA.

3. North Atlantic Right Whale (*Eubaleana glacialis*)

Effective April 7, 2008, the NMFS listed the endangered northern right whale (*Eubalaena spp.*) as two separate, endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*). Therefore, for the purposes of this assessment, the right whale will be discussed as the North Atlantic right whale and all references to critical habitat designations will be for the North Atlantic right whale as set forth on June 3, 1994 (59 FR 22805).

Life History and Distribution

North Atlantic right whales (NARW) are highly migratory, summering in feeding and nursery grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf (Waring *et al*, 2001). They migrate southward in winter to the northeastern coast of Florida. The breeding and calving grounds for the right whale occur off of the coast of southern Georgia and north Florida and have been designated as critical habitat under the ESA in 1994 (59 FR 28793). The critical habitat does not extend to the Savannah Harbor area. During the winter months, right whales are routinely seen close to shore in the critical habitat area. There have been two sightings of northern right whales that migrated into the Gulf of Mexico. The first was a mother-calf pair (#2360 and calf – New England Aquarium Right Whale Database) sighted north of the Port of Miami on January 30, 2004, swimming toward the south and was later seen

on several occasions that spring in the Gulf of Mexico off Panama City, Florida. These two animals were re-sighted in the Great South Channel near Massachusetts in May 2004. In December 2005, a mother/calf pair right whale that was seen off central Florida and later documented in the Corpus Christi ship channel, Corpus Christi, Texas in January 2006. This animal was also confirmed as being a member of the north Atlantic stock, NARW # 2503 and her calf. These two animals were re-sighted in the Bay of Fundy in the summer of 2006 (Amy Knowlton, New England Aquarium, 2008 pers. Comm.). These sightings mean that these two right whales and their calves passed by several very active east coast ports not once, but twice during their transit to and from the Gulf of Mexico. While North Atlantic right whales have been historically reported in south Florida and the Gulf of Mexico, these sightings are extremely rare (Dan O'Dell, Hubbs-Sea World Research Institute, 2002, personal communication; New England Aquarium North Atlantic right whale Catalog, accessed January 2008).

Kraus et al. (1993) has found the area around the Florida/Georgia border and Jacksonville, Florida, in the widest area of the shallow-water shelf in the Georgia Bight, to be the primary and probably only calving ground for western North Atlantic right whales. They found cow/calf pairs to be primarily limited to the coastal waters between latitudes 27 degrees 30 minutes N and 32 degrees N. They also report right whales to be concentrated between Daytona Beach, Florida and Brunswick, Georgia. Highest densities are around Jacksonville, Florida, and the Florida/Georgia border. Most whale sightings occur between December and February within 15 miles of shore (but can be seen between November and late March). A few sightings have been reported as early as September and as late as June. This study documents six right whale sightings between Brunswick and Savannah. They quote an earlier estimate that no more than 350 right whales survive in the western North Atlantic and state that there have been 272 sightings of 87 identified non-calf right whales and 66 calves between 1980 and 1992. They further state that 74 percent of the known reproducing females have been documented off the southeast coast for the period 1980 to 1992.

In a Wildlife Trust report that was prepared for NOAA, Schulte and Taylor (2009) reported, "*A total of 56 surveys were flown from November 15, 2008, to April 15, 2009, and extended from North Myrtle Beach, South Carolina (33.82°N) to St. Catherine's Island, Georgia (31.58°N). Preliminarily, 49 right whale sightings consisting of 121 right whales were documented (including resights of 21 individuals and two individuals sighted three times). Sightings consisted of 19 cow/calf pairs, 12 single whales, and 19 groups of two or more adult/juvenile right whales (one of which also included a cow/calf pair). Preliminary photo analysis has resulted in the confirmed identification of 14 individual cow/calf pairs and 28 of the individual adult/juvenile whales. The individuals documented include 27 males, 30 females, and 38 individuals of unknown gender (including calves), for a total of 95 individual whales in the study area. Of the 30 females seen, 21 gave birth to new calves this season, although only fourteen were seen with their calves within the study area. The remaining seven females were seen while pregnant prior to giving birth further south. Preliminary sightings of note include sixteen individuals that were unique to the study area and not sighted by other survey teams to the south. Other notable sightings include the first cow/calf pair of the season; eleven surface active groups; and a sighting of Ruffian (EGNO 3530), a whale with prior severe injuries.*" Using a photo-identification technique to estimate the minimum population size of individual whales, Kraus et al. (2001) identified 291 right whales in 1998. Based on this estimated population size, current

models suggest that, if current trends continue, the population could go extinct in less than 200 years (Caswell et al., 1999). Ship strikes are a major cause of mortality and injury to right whales within several major shipping corridors on the eastern U.S. and southeastern Canadian coasts. From 1997-2001 the average reported mortality and serious injury due to ship strikes was 0.8 whales per year (Kraus 1990; Knowlton and Kraus 2001). According to Jensen and Silber (2003), a total of 292 large whale ship strikes have occurred worldwide from 1975-2002 of which 38 (13%) were right whales (~1.4 whales per year). Based on the data provided for each strike, the average ship speed was 18.1 knots. Ship strikes are responsible for over 50 percent of known human-related right whale mortalities and are believed to be one of the principal causes for the lack of recovery of the population (Federal Register/Vol. 69, No. 105).

Known occurrences of right whales in the Savannah area

a. 1992 (Dec 1992 to Mar 1993). Aerial surveys for right whales were conducted by the Savannah District during Savannah Harbor bar channel dredging. During the December 1992 bar channel dredging, aerial surveys were conducted by Christopher Slay, New England Aquarium, from November 30 to December 20, 1992. Surveys were flown on all but one day, December 19, 1992. One right whale was spotted during the survey (December 8, 1992). These data indicate that 5 percent of the survey days resulted in detection of a right whale.

b. 1993 (Dec 1993 to Mar 1994). Two right whales were spotted by a pilot boat and the pre-dredge turtle survey crew on December 4, 1993. Aerial surveys were flown every day that weather permitted from 12/12/93 to 2/22/94 (58 days flown out of 73 possible). Whales were spotted on 12/12/93 (3 subadults), 12/18/93 (cow/calf pair), 01/23/94 (cow/calf pair). These data indicate that 5 percent of the survey days resulted in detection of right whales. However, 2 out of 19 survey days in December (11 percent) resulted in detection of right whales.

c. 1994 (Dec 1994 to Mar 1995). Aerial surveys were conducted as weather allowed between December 1 and 31, 1994. Twenty complete surveys were flown and one whale was spotted on December 5, 1994 (5 percent of survey days).

d. 1995 (Dec 1995). No aerial survey was conducted. No whales were sighted from the dredge during the Bar Channel dredging performed from December 5 to 26, 1995.

e. Analyses by Kraus et al., 1993, on the mean latitude of whale sightings by week, indicate that areas at or north of Savannah fall within one standard deviation of the mean for December 1 to January 4. This is also true for the weeks of March 16 through April 5. In other words, sightings data at that time indicated right whales were most likely to be encountered in the Savannah area during those timeframes.

Ship strikes are known to be a major cause of anthropogenic mortality in the right whale (NMFS, 1991), although there are no documented strikes by ships associated with any southeastern dredging project (NMFS, 1991). Most right whales spotted in the southeast are found from 1 to 15 nautical miles from shore (Kraus et al., 1993, Ellis et al., 1993). Kraus et al. 1993, found that swimming speeds of cow-calf pairs averaged 0.41 km/hr and whales not accompanied by calves averaged 0.51 km/hr. Movements of individual cow-calf pairs ranged from less than 1 km/day to 38.8 km/day. One statistical test found that non-cow right whales travel significantly farther and faster than right whales accompanied by a calf. They also found that cows with calves are more

active at the surface than other classes of right whales in the region. It appears that the behavior of this species, including its swimming speed, makes it particularly susceptible to impact from collisions with ships. A review of the "Large Whale Ship Strike Database" (Jensen and Silber, 2003) found five recorded ship strikes of NARW's offshore of Florida, all between Fernandina and Jacksonville from 1975 – 2002. There have been at least two additional ship strikes (one in 2003 and one in 2006) in that same area since 2002.

Available data indicate that right whales can be expected to transit the Savannah entrance channel primarily during the month of December for the fall migration and for the spring migration to begin transit in mid-March.

The current distribution and migration patterns of the eastern North Atlantic right whale population are not completely defined. However, sighting surveys from the eastern Atlantic Ocean suggest that right whales are rarely present in this region. Based on a census of individual whales identified using photo-identification techniques and the assumption that whales not seen for 7 years are dead, the western North Atlantic stock size was estimated to be 295 individuals in 1992 (Knowlton *et al.*, 1994); an updated analysis using the same method gave an estimate of 299 animals in 1998 (Kraus *et al.*, 2001).

The National Recovery Plan for the Northern right whale, dated May 2005 (NMFS, 2005) , defines the coastal waters of the southeastern United States and, especially, the shallow waters from Savannah, Georgia, south to Cape Canaveral, Florida, as the wintering ground for a small but significant part of the North Atlantic right whale population. According to the Recovery Plan, most records of sighting involve adult females, many of them accompanied by very young calves, although a few juveniles and males have been sighted in the region. The majority of individuals in the western North Atlantic population range from wintering and calving areas in coastal waters off the southeastern United States to summer feeding and nursery grounds in New England waters and north to the Bay of Fundy and Scotian Shelf. Five areas of "high use" were identified by NMFS in 1991, reconfirmed in the 2005 Recovery Plan and are still key habitat areas for right whales:

1. Coastal Florida and Georgia (Sebastian Inlet, Florida to the Altamaha River, Georgia)
2. The Great South Channel (east of Cape Cod)
3. Massachusetts Bay and Cape Cod Bay
4. The Bay of Fundy, and
5. The Scotian Shelf, including Browns and Baccaro Banks, Roseway Basin and areas to the east

Note: These key habitat areas do not include the Port of Savannah Area

While recent data may indicate other calving locations (RWC, 2007), Kraus et al. (1993) found the area around the Florida/Georgia border and Jacksonville, Florida, in the widest area of the shallow-water shelf in the Georgia Bight, to be the primary calving ground for western North Atlantic right whales. They found cow/calf pairs to be primarily limited to the coastal waters between latitudes 27 degrees 30 minutes N and 32 degrees N. They also report North Atlantic right whales to be concentrated between Daytona Beach, Florida and Brunswick Georgia. Highest densities are around Jacksonville, Florida, and the Florida/Georgia border. Most whales

occur between December and February within 15 miles of shore (but can be seen between November and late March). A few sightings have been reported as early as September and as late as June.

Population Dynamics and Status

Right whales are one of the most critically endangered whale species in the world and are protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The North Atlantic right whale was listed as endangered under the Endangered Species Conservation Act in June 1970, the precursor to the ESA. The species was subsequently listed as endangered under the ESA in 1973, and designated as depleted under the MMPA.

The official population of north Atlantic right whales stated in the Annual NMFS Marine Mammal Stock Assessment (Waring *et al*, 2007) is listed as 205 animals in 2001. More recent data from the North Atlantic Right Whale Consortium in 2006 and 2007 states that the minimum estimated population within the north Atlantic Region is between 179 and 176 animals (NARC, 2006; NARC, 2007). This estimate is based solely on the whales cataloged as alive in 2005 and 2006 in the New England Aquarium's right whale identification catalog. The conservative middle estimate of population is between 296 and 393 individual whales. This is based on the 2005 and 2006 survey data which is the sum of the cataloged whales presumed alive in 2005/06, the intermatch whales that were likely to be added to the catalog, calves from 2004 to 2006 that were also likely to be added to the catalog. The high estimate of the current population of North Atlantic right whales is between 591 and 579 individuals. This is a sum, based on 2005 and 2006 survey data, of the cataloged whales, minus known dead individuals; active intermatch animals without calves and calves (2004 – 2006 calves) minus the known dead. These numbers are based on completed analysis of 2005/06 survey data and were presented at the annual Right Whale Consortium meeting held in New Bedford, Ma November 2006 and 2007 (http://www.rightwhaleweb.org/papers/pdf/NARWC_Report_Card2006.pdf and http://www.rightwhaleweb.org/papers/pdf/NARWC_Report_Card2007.pdf)

As of the NMFS March 2007 Stock Assessment report on the NARW, the minimum population size is currently estimated at approximately 306 animals known alive in 2001 (based on the NE Aquarium sighting catalog) (Waring *et al*, 2007). No estimate of abundance with an associated coefficient of variability is available. There is disagreement in the literature over whether the population is growing, stagnant or in decline. Potential Biological Removal (PBR) for the western Atlantic right whale is calculated to be zero whales.

Threats and Outlook

Based on the current estimated population size, current models suggest that, if current trends continue, the population could go extinct in less than 200 years (Caswell *et al.*, 1999). Ship strikes are known to be a major anthropogenic cause of mortality for North Atlantic right whales within several major shipping corridors on the eastern U.S. and southeastern Canadian coasts (NMFS, 1991c). The number of deaths from natural causes is unknown at the present time.

Most North Atlantic right whales spotted in the southeast are found from 1 to 15 nautical miles from shore (Kraus *et al.*, 1993; Ellis *et al.*, 1993). Kraus *et al.* 1993, found that swimming

speeds of cow-calf pairs averaged 0.41 km/hr and whales not accompanied by calves averaged 0.51 km/hr. Movements of individual cow-calf pairs ranged from less than 1 km/day to 38.8 km/day. One statistical test found that non-cow North Atlantic right whales travel significantly farther and faster than North Atlantic right whales accompanied by a calf. They also found that cows with calves are more active at the surface than other classes of North Atlantic right whales in the region. It appears that the behavior of this species, including its swimming speed, makes it particularly susceptible to impact from collisions with ships. From 1997-2001 the average reported mortality and serious injury due to ship strikes was 0.8 whales per year (Kraus 1990; Knowlton and Kraus, 2001). According to Jensen and Silber's (2003) large whale ship strike database, a total of 292 large whale ship strikes have occurred worldwide from 1975-2002 of which 38 (13%) were North Atlantic right whales (~1.4 whales per year). Based on the data provided for each strike, the average ship speed was 18.1 knots. Ship strikes are responsible for over 50 percent of known human-related North Atlantic right whale mortalities and are believed to be one of the principal causes for the lack of recovery of the population (Federal Register/Vol. 69, No. 105). It should be noted that a review of Jensen and Silber, as well as the Corps' own records has not found any ship strike attributed to a Corps-owned or Corps-contracted vessel. The number of deaths from natural causes is unknown at the present time.

Additional threats to North Atlantic right whales may include habitat degradation, contaminants, climate and ecosystem change, and predators such as large sharks and killer whales. Disturbance from such activities as whale watching and noise from industrial activities may affect the population. These impacts would continue to increase even if the proposed harbor deepening project takes place.

A complete assessment of NARW recovery efforts and activities is reviewed in the Recovery Plan for the "North Atlantic Right Whale (Eubalaena glacialis)" (NMFS, 2005) http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_right_northatlantic.pdf.

Speed Restrictions

Final Rule - Speed Restrictions: Federal Register / Vol. 73, No. 198/ Friday, October 10, 2008; RIN 0648-AS36

On October 10, 2008, the NMFS implemented regulations for mandatory vessel speed restrictions of 10 knots (about 11 mph) or less on vessels 65 feet or greater in overall length in certain locations and at certain times of the year along the east coast of the US Atlantic seaboard. The purpose of this rule is to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships. Under an agreement between NMFS, US Coast Guard, US Navy and the Corps of Engineers, vessels operated by Federal agencies, or are under contract to Federal agencies are exempt from the proposed regulations; however, operation of these vessels will be subject to guidance provided through consultations under the ESA.

The rule divides the US east coast into three large sub-areas: Southeast US, Mid-Atlantic US, and Northeast US. Within each, NMFS seasonal rules restrict vessels speed to 10 knots or less.

The areas, and the times in which they would be in effect, are as concisely and specifically defined as possible to reflect the known occurrences or right whales.

Mandatory Speed Restriction Areas

(1) Southeast U.S.: Vessels shall travel at a speed of 10 knots or less during the period of November 15 to April 15 each year in the area bounded by: the shoreline, 31° 27'N lat, 29° 45'N lat., and 80° 51.6'W long. (Figure 8-2)

(2) Mid-Atlantic U.S.: Vessels shall travel 10 knots or less in the period November 1 to April 30 each year (Figure 8-3).

(i) Within 30 nautical mile radius at the:

(A) Ports of New York/New Jersey

(B) Delaware Bay (Ports of Philadelphia and Wilmington);

(C) Entrance to the Chesapeake Bay (Ports of Hampton Roads and Baltimore);

(D) Ports of Morehead City and Beaufort, NC;

(E) Port of Wilmington, NC

(F) Port of Georgetown, SC;

(G) Port of Charleston, SC;

(H) Port of Savannah, GA; and

(ii) In Block Island Sound, in the area with a 30 nm width extending south and east of the mouth of the sound.

District-Specific Information on Speed Restrictions

The Savannah District has been engaged in efforts to protect the Right Whale for many years. The District has participated in Southeast Regional Implementation Plan meetings and has helped to fund the Early Warning System aerial surveys. The District views the aerial surveys as both a means of lessening the potential for vessel collisions but more importantly as a means of assessing Right Whale abundance and population health in the southeast. In accordance with past Regional Opinions, the District also requires endangered species observers on all hopper dredges contracted by the District.

In accordance with past practices regarding efforts to protect the North Atlantic Right Whale, the Savannah District intends to conduct the proposed project and future maintenance activities in accordance with the terms of the South Atlantic Region Biological Opinion (SARBO) that is in effect at that time. The District participated in and reviewed the draft South Atlantic Region Biological Assessment provided to the NMFS by CESAD as part of the consultation process for the new Biological Opinion. The District intends to comply with the new SARBO (and subsequent versions) once it is finalized and implemented.

Savannah District reviewed data from the FY09/10 hopper dredging maintenance contract for the Savannah Harbor entrance channel – the most recent contract. No whales were spotted in the Savannah entrance channel during that contract performance period. In that contract, the small hopper dredge (5,000 CY capacity) made 150 trips to the ODMDS to remove 623,000 CY of

sediment. The average distance to the ODMDS was 3.25 miles. The maximum speed of the dredge was 12 knots. Assuming the dredge needed to comply with a 10-knot speed restriction, sailing time will increase by approximately 1 day and incur approximately $22,000 in additional annual dredging costs.

The Corps and NOAA Fisheries are jointly developing a new SARBO to replace the 1997 version. NOAA Fisheries has expressed a desire to include additional speed restrictions in the new SARBO for hopper dredges that operate during the right whale calving season of 15 November through 15 April. In the event that construction on SHEP is initiated prior to the resolution of the region-wide speed restriction issue, the Corps agrees to implement a non-precedential, interim measure during construction of the Savannah Harbor Expansion Project as follows: hopper dredges will comply with a 10-knot speed limit during calving season in accordance with recent NMFS recommendations. The District would abide by the terms of new SARBOs when they are finalized.

Right Whale "Early Warning System (EWS)"

Aerial surveys and photo-identification of right whales have been conducted in the Southeast at least since 1984 (Kraus, 1985). In 1988, right whales were observed on two separate occasions (February 6, 1988 and April 11, 1988) by hopper dredges in transit to the offshore disposal area while dredging the Kings Bay entrance channel (NMFS BO for Brunswick Harbor channel deepening, included with May 8, 1991 NMFS letter to the Savannah District). NMFS stated in the BO that, "during the February 6, 1988, encounter, the whale exhibited unexpected behavior when the vessel approached to within 100 yards. The animal oriented itself facing the vessel head on. If this behavior is the normal defense mechanism of this species, the possibilities of night collisions between vessels and right whales are greatly increased because the animals may take no action to avoid approaching vessels." That BO also contained the following language: "NMFS concludes that the proposed activities are not likely to jeopardize the continued existence of the right whale (*Eubalaena glacialis*). This conclusion is based on assurances that measures will be taken to ensure that whales are not impacted by this activity." This position by NMFS encouraged development of methods by which whales could be detected.

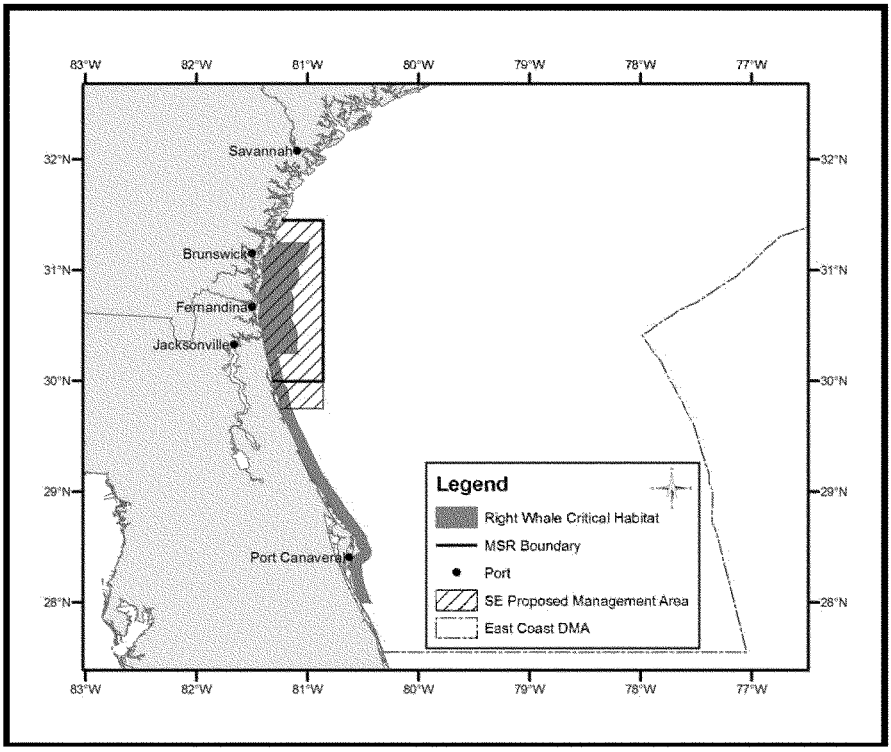

Figure 8-2. Proposed Southeastern US area mandatory speed restrictions November 15th through April 15th (calving and nursery grounds).

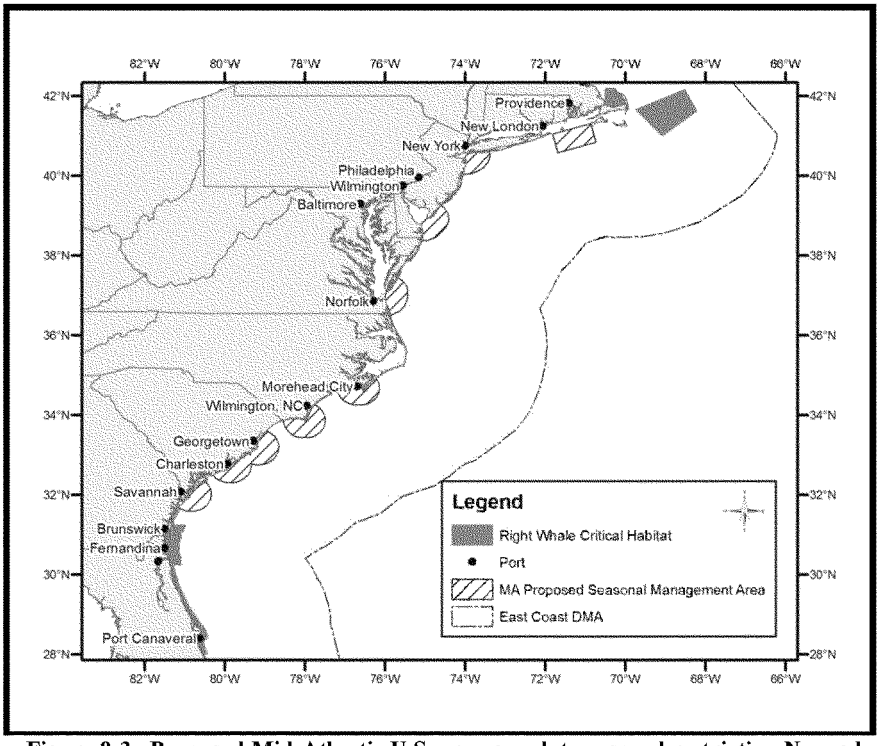

Figure 8-3. Proposed Mid-Atlantic U.S. area mandatory speed restriction November 1 through April 30 (migratory route).

The Savannah District required its hopper dredging contractors to conduct aerial surveys during dredging work during the winter of 1992-1993. During the summer of 1993, the NMFS organized meetings through which agreement was reached under a Memorandum of Understanding between the Corps, Navy, Coast Guard, and NMFS to conduct coordinated aerial surveys. Due to an inability of NMFS to accept funding from the Corps in time for the 1993-1994 dredging season, the Corps was forced to fund aerial surveys associated only with its dredging projects. An expanded program funded jointly by the four agencies was established by the 1994-1995 dredging season. This expanded program of aircraft surveys for right whales was renamed the right whale "Early Warning System (EWS)." (M. Brown in Kraus and Rolland, 2007) (Figure 20). The original focus area of the EWS was limited to the coastal waters from Jacksonville, Florida north to Brunswick, Georgia. The funding for the aerial surveys continues to be provided by both the Savannah and Jacksonville Districts of the Corps, the Coast Guard, and the Navy, and for FY2008 is approximately $180,000 per agency. Based on the current contract between NOAA and the New England Aquarium this annual cost is expected to climb to as high as $200,000 before the current contract expires on September 30, 2011. Since FY 1999, the Corps has provided approximately $1.4 million to the EWS and the Jacksonville District has

contributed an additional $200,000 toward the volunteer sighting network run by the Marineland Right Whale project and Associated Scientists of Woods Hole, which contributes right whale sighting information to the EWS.

The original Early Warning System was modified in 2003, splitting the main survey area into three survey areas and expanding the survey areas further offshore (Figure 8-4). This modification emphasized the dual nature of the survey efforts as focusing on ship strike avoidance and demographic surveys. The three survey areas are now known as the Central, Southern and Northern EWS areas. The Northern and Southern survey areas are not paid for by Corps funding.

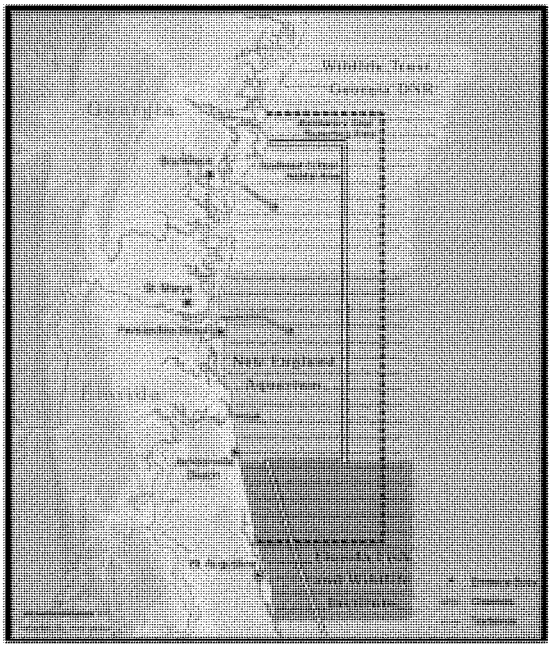

Figure 8-4. The three aerial early warning system zones – Northern, Central and Southern denoted by color changes (north – green; central – red, and southern – blue).

The Central EWS surveys are flown daily, weather permitting, from the beginning of December through the end March, covering over 1000 square miles of ocean encompassing the St. Mary's and St. John's rivers, which cover the Kings Bay, Fernandina, Mayport and Jaxport project areas and any shore protection projects in that area. The Brunswick and Savannah entrance channels area covered by Northern EWS. The survey team is comprised of two observers, and two pilots. A 1000' grid pattern over the water is used searching for right whales and documenting the presence of commercial, military and dredge vessel traffic. Right whale locations are radioed to

the team's ground station that relays the information to the FASFACSJAX EWS system – Navtex, etc for locations to the vessels in the area so that course and speed changes may be made, as needed to avoid whales (Zani *et al.*, 2006).

All of the aerial surveys are flown by a contractor to detect right whales in the calving grounds and relay their locations immediately via a digital pager system to the funding agencies, harbor pilots, mariners in the area of sightings, Georgia and Florida state agencies, and others. Through this communication, vessel captains avoid collisions and can maintain an efficient speed into and out of the ports. It has also facilitated the gathering of important behavioral data on calf production, movement and other habitat related data. Furthermore, it has been suggested that monitoring the population on the wintering/calving grounds may be the best way to assess the population size and trends, thus the surveillance data is vitally important for several reasons.

Detailed EWS reports and right whale sighting information can be found at: -
http://rwhalesightings.nefsc.noaa.gov/
http://whale.wheelock.edu/Welcome.html.

Savannah District Contract Specifications

Beyond the aerial surveys funded by the Savannah District, the District has a specific set of specifications that deal with large whale (and sometimes specifically right whale) protection measures. These specifications apply to Savannah Harbor and require a NMFS-approved Endangered Species Observer approved for whale monitoring be onboard each hopper dredge during the time that right whales may be in the area. Savannah District's specification language is included below.

WHALES

a. No incidental take of right whales is authorized. Normal vessel speeds may be used at the Contractor's discretion, except as noted below, for the duration of this Contract during daylight hours (sunrise to sunset). However, the Contractor shall restrict dredge and attendant vessel speeds to 5 knots or less (or minimum safe speed) during night (sunset to sunrise) operations unless there is no information from the right whale early warning system (RWEWS) or any other observations/information that reveals any right whales within 15 nautical miles of the project area. If aerial surveys for right whales show no sightings on a particular day, the vessel speeds will be unrestricted during the following nighttime operations. If a right whale is determined through any means to be in the project area on a particular day, negative results from any other type of survey on that same day shall not serve to cancel that night's restriction of dredge and attendant vessel speeds. For Savannah Harbor, the project area is defined as the Savannah Harbor Entrance Channel (Stations 0+000 to -60+000B), the designated offshore disposal areas shown on the Contract drawings, and transit routes. For Brunswick Harbor, the project area is defined as the Brunswick Harbor Entrance Channel (Stations 0+000 to -53+000B), the designated offshore disposal areas shown on the Contract drawings, and transit routes. If right whale occurrence/distribution information is not available from the RWEWS due to severe weather restrictions, then vessel speeds will be restricted to 5 knots (or minimum safe speed) during night operations. It is currently expected that the RWEWS will be in effect from December through March for both Savannah and Brunswick. No aerial survey is required when the

RWEWS is not in effect. Nighttime speeds will still be restricted to 5 knots or less (or minimum safe speed) when the RWEWS is not in effect if other information indicates right whales are in the project area.

b. The requirement for nighttime speed restrictions are available from the COR (OP-NN) or the RWEWS on a daily basis. Previous right whale monitoring along the Georgia coast indicates that for Savannah Harbor the Contractor might expect up to 8 nights of reduced speed operations between 1 December and 31 March. For Brunswick Harbor, the Contractor might expect up to 13 nights of reduced speed operations between 1 December and 31 March. Contractor should also expect at least 22 days of additional reduced speed operations between the period of 1 December and 31 March due to weather restricting RWES aerial surveys.

c. During daylight hours, the dredge operator shall take necessary precautions to avoid whales. If whales have been spotted within 15 nautical miles of the project area in the previous 24 hours, then the dredge shall slow down to 5 knots or less (or minimum safe speed) when transiting to and from the dump site during evening hours or during daylight hours when there is limited visibility due to fog or sea states of greater than Beaufort 3.

d. The hopper dredge shall not get closer than 500 yards to right whales.

Note: These standard specifications would be revised to include the longer entrance channel if the harbor is deepened.

Critical Habitat

Published in the Federal Register on 03 June, 1994, NMFS designated critical habitat for the Northern right whale. By this final rule, NMFS designated areas essential for the reproduction, rest and refuge, health, continued survival, conservation and recovery of the northern right whale population. The following areas are designated as critical habitat:

Great South Channel: The area designated as critical habitat in these waters is bounded by the following coordinates: 41 deg.40'N/ 69 deg.45'W; 41 deg.00'N/69 deg.05'W; 41 deg.38'N/68 deg.13'W; 42 deg.10'N/68 deg.31'W.

Cape Cod Bay: The area designated as critical habitat in these waters is bounded by the following coordinates: 42 deg.04.8'N/ 70 deg.10.0'W; 42 deg.12'N/70 deg.15'W; 42 deg.12'N/70 deg.30'W; 41 deg.46.8'N/70 deg.30'W; and on the south and east, by the interior shoreline of Cape Cod, MA.

Southeastern United States: The area designated as critical habitat (Figure 8-5) in these waters encompasses waters between 31 deg.15'N (approximately located at the mouth of the Altamaha River, GA) and 30 deg.15'N (approximately Jacksonville, FL) from the shoreline out to 15 nautical miles offshore; and the waters between 30 deg.15'N and 28 deg.00'N (approximately Sebastian Inlet, FL) from the shoreline out to five nautical miles.

For the purposes of this assessment, no critical habitat is found within the Savannah Harbor Expansion Project and potential impact area.

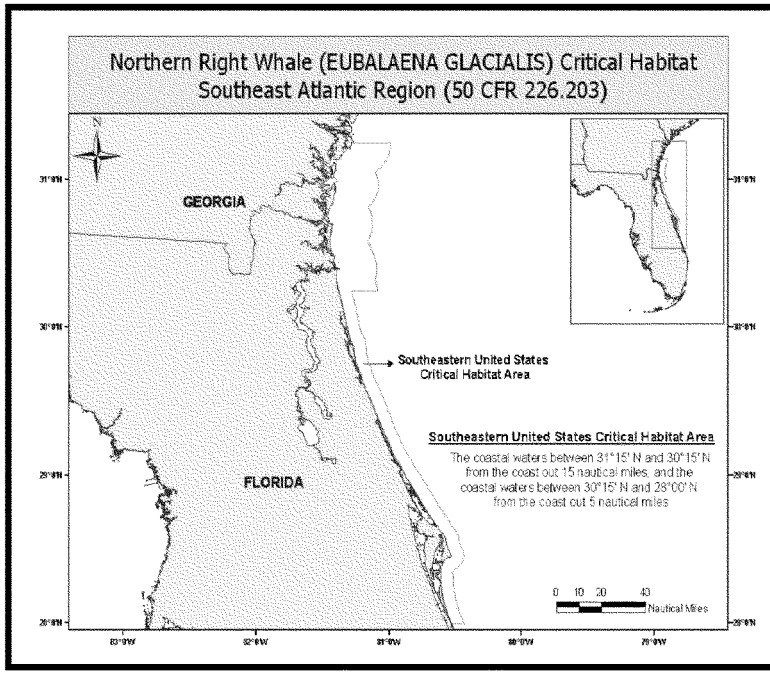

Figure 8-5. Northern right whale critical habitat areas defined for the Southeastern United States.

Preliminary Coordination with NMFS Concerning Right Whale

In the fall of 2009, the Corps conducted a hydrographic survey beyond the terminus of the current project design. That confirmed that sufficient water depths would not be continuously available on that alignment for the 48-foot depth alternative. This prompted the Corps to consider alternatives for the alignment of the bar channel extension. On November 12, 2009, the NMFS provided the Corps with comments concerning the extension of the ocean bar channel in the Savannah Harbor Expansion Project. On December 9, 2009, the USACE provided the NMFS with an assessment of the alternative and preferred alignments, which included an assessment of potential effects to right whale.

The Corps consulted the Savannah Harbor Pilots to ensure the proposed alignments would satisfy safety requirements for deep-draft vessel maneuverability and operations. Upon review of the initial extension designs, the harbor pilots advised that alignments should be avoided that

include bends and/or sharp angles. Alternatively, they recommended a relatively linear and contiguous bar channel alignment that would ensure maximum safety and stability for vessels located at the outer end of the entrance channel. The USACE subsequently eliminated some alignments that had sharper bends. Ultimately a new alignment for the extension (S-8), which is an approximately 14% offset from the original project design (S-1), was selected (Figure 8-6).

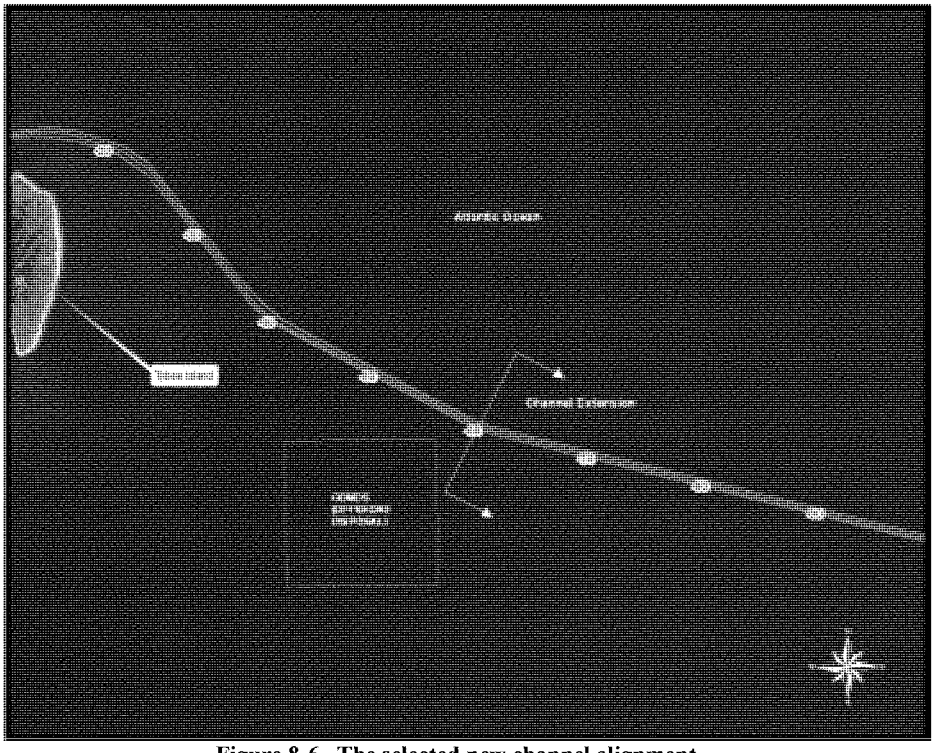

Figure 8-6. The selected new channel alignment.

Comparison of Dredge Disposal Activities for Both Alignments:

The USACE considered construction and maintenance dredging activities associated with the original project design (S-1) and the proposed alignment (S-8) of the bar channel extension (Table 8-2).

Table 8-2. Comparison of Sediment Disposal Activities for Alternate Alignments of the Proposed Bar Channel Extension

Construction (CY)	S-1 2,413,715				S-8 4,613,909			
Vessel Capacity	# Trips	Trips/Day	# Days	# Months	# Trips	Trips/Day	# Days	# Months
2,000	1207	3	403	13	2307	3	769	26
3,000	805	3	269	9	1538	3	513	17
3,600	671	3	224	7	1282	3	428	14
4,000	604	3	202	7	1154	3	385	13
6,000	403	3	135	5	769	3	257	9

Annual Maintenance (CY)	S-1 8,400				S-8 12,460			
Vessel Capacity	# Trips	Trips/Day	# Days	# Months	# Trips	Trips/Day	# Days	# Months
2,000	5	3	2	0	7	3	3	0
3,000	3	3	1	0	5	3	2	0
3,600	3	3	1	0	4	3	2	0
4,000	3	3	1	0	4	3	2	0
6,000	2	3	1	0	3	3	1	0

With respect to construction, the total cubic yards (CY) of new work sediments for the proposed alignment (S-8) would be approximately twice the amount of the original design (S-1). The number of trips (i.e., hopper dredge movements) required to deposit the sediment is contingent upon the barge size and the total amount of sediment to be removed (depth alternative selected). For purposes of estimating, the USACE considered hopper dredges with capacities in the range of 2,000-6,000 CY and a project depth of approximately -50 mean lower low water (MLLW). We believe it is more likely that a contractor would use a hopper dredge with a capacity of 3,600-4,000 CY *(See response to NMFS Comment #1 in the following section)*. For the initial construction, the total number of hopper trips is estimated to range from 403 to 1207 and from 769 to 2307 for S-1 and S-8, respectively. Assuming approximately 3 trips per day, the project duration was estimated in the range of 5-13 and 9-26 months for S-1 and S-8, respectively (Table 8-1). The current construction schedule now includes hopper dredge activities in the entrance channel for approximately 4 months per year over a 2-year period.

The estimated project duration for both alignments are comparable to the estimated construction time reported in the November 2008 Biological Assessment (BA) for the Naval Station (NAVSTA) Mayport project (i.e., 13-18 months). Unlike the NAVSTA Mayport project, however, the S-8 alignment is not located in an area designated as NARW critical habitat. Moreover, the BA indicates dredging for the NAVSTA Mayport project would occur during the 5-month period (15 November – 15 April) when NARW are located in the critical habitat.

With respect to hopper dredge movements, the distance required to transport dredged sediment from the project area to the placement area is virtually identical for the S-1 and S-8 configurations. The average distance traveled from S-1 and S-8 to the placement site would be 17,009' ± 6,381' and 16,513' ± 5,293', respectively. On average, this represents less than a 3% difference in transit length with the S-8 configuration being the shorter distance.

Differences in maintenance dredging requirements were also evaluated. The annual amount of maintenance sediment expected for the extension would be approximately 8,400 CY and 12,480 CY for the S-1 and S-8 configuration, respectively. Assuming the same hopper dredge capacities and 3 disposal trips per day, the project duration for both configurations would equate to no more than 1-3 days effort.

Finally, the fleet forecast for the 48-foot depth alternative was compared to the total number of hopper dredge movements that would occur during the construction period. For the S-1 and S-8 alignments, the estimated number of hopper dredge trips would result in an approximately 5-15% and 10-29% increase, respectively, in vessel traffic for the project area for a period of less than a week. This includes inbound and outbound trips of deep-draft vessels through the Savannah Harbor Entrance Channel. The resulting percent increases were based on an estimate of the annual number of vessels that would call on the Port of Savannah during the construction phase of the project; a period of time when hopper dredging activity would be greatest. When comparing the two alignments, there is a negligible variation in construction-related disturbances, which includes the associated increase in hopper dredge movements. Moreover, there is a negligible difference with respect to activities required to maintain the S-1 or S-8 alignment.

Comparison of Vessel Approach and Departure Vectors:

There has been no reported incident of a right whale being struck by commercial shipping vessels calling at the Port of Savannah. That suggests the Port of Savannah's approach and departure vectors, which are used by the ship captains and/or harbor pilots, are appropriately configured with respect to minimizing the risk of ship strike to NARW. The new bar channel extension-alignment would result in a 14 degree offset from the extension's original orientation and/or approach. With respect to the already-established vessel travel corridors in the area, the 14 degree offset for the extension constitutes a negligible correction factor for the Bar Channel, and the new alignment would not introduce any additional variability to the existing approach and departure vectors (i.e., vessel tracks) currently used by ship traffic. If the existing shipping corridors/tracks have not resulted in a recorded NARW strike, and the new bar channel extension-alignment does not result in substantial changes to the shipping corridors/tracks, then the new extension alignment does not warrant any additional studies to evaluate the risk of vessel strike on NARW.

Review of Garrison Paper dated October 14, 2005

The 2005 Garrison paper entitled, "Applying a spatial model to evaluate the risk of interaction between vessels and right whales in the southeastern United States critical habitat," provides information on a model that was developed to evaluate risk of vessel-whale interaction in the designated critical habitat of NARW. In brief, the author provides an equation that expresses the cumulative risk of interaction as a function of total vessel track and predicted whale density. Model results for the predicted whale sightings are provided in Figures 2 and 3 of the paper. Of note, the relative density of "Predicted Sightings Per Unit Effort" *and* the associated distance of those cells from the shoreline are comparable for offshore areas adjacent to the Port of Brunswick and the Port of Savannah. When evaluating the relative risk for the Port of

Brunswick, Garrison states, "*the benefits of potential routing are less pronounced for Brunswick (Figure 15*) [Actually Figure 14 in paper provided to USACE]. *There are relatively few approaches that result in reduced risk relative to the status quo. This results primarily from the fact that Brunswick is in an area where the relative densities of right whales are predicted to be high well offshore. The best approaches into Brunswick are generally those approaching from nearly due east.*" Given the similarities in the relative location of projected whale densities for Brunswick and Savannah (Figures 2 and 3), the conclusion that Garrison reached for Brunswick could be applied to the Port of Savannah. That is, ships traveling east (i.e., generally perpendicular to the projected whale densities along Georgia's coast) spend less time in high density areas and cross fewer "high-density" cells. The existing east/west vessel travel corridor minimizes the risk of whale strike. As described in previous paragraphs, the design of the bar channel extension maintains the general east/west alignment, and consequently ships would still be oriented to minimize interaction with right whales. Furthermore, the associated approach and departure vectors for deep-draft vessels (i.e., vessel tracks) would not change as a result of the minor variation in alignment.

Garrison's paper also provides additional information of interest, which further substantiates the use of the aforementioned "extrapolation" rationale to validate the proposed alignment for the bar channel extension. Figure 1 in Garrison's paper illustrates the total right whale sightings within each spatial cell across the entire time series (i.e., December 1-March 30 for 1992/1993 and 2000/2001). For the Port of Savannah, only two (2) 4x4 km cells are identified with 1-2 right whale sightings, and these cells are approximately 8 km and 12 km, respectively, from the entrance channel (Figure 1-Garrison's paper). Alternatively, the number of cells and frequency of sighting are considerably more numerous for the Ports of Jacksonville and Brunswick (Figure 1-Garrison's paper).

Subsequent Coordination with NMFS

On February 4, 2010, the NMFS provided specific questions and comments concerning the extension of the bar channel. The following information is provided in response to those comments.

1. NMFS Comment: For your analysis, you assume that a hopper dredge with a capacity of 3,600-4,000 CY would most likely be used during the dredging of the channel extension. You also state that the range of hopper dredge volumes that may be used is as small as 2,000 CY. Unless such a small dredge is unrealistic, would it not be more conservative to conduct the analysis assuming smaller dredges with more transits?

USACE Response: The USACE has identified seven of the hopper dredges that have recently worked the Port of Savannah. Table 8-2 illustrates the capacity of those hopper dredges. It can be reasonably assumed that these vessels, or dredges with similar capacities, would be responsible for dredging new work and maintenance sediments is support of a deeper harbor.

Table 8-3. Hopper Dredges Expected to Dredge New Work and Maintenance Sediments

Hopper Dredge (Name)	Capacity (CY)
Liberty Island	6,500
Victorian Island	6,340
Bayport	4,850
Newport	4,000
Mighty "Glenn Edwards"	13,500
RN Weeks	4,000
BE Lindholm	4,000
Average Capacity	**6,170**

Thus, the capacity of the hopper dredges expected to work on the proposed deepening project is much larger than 2,000 CY, so a range of 3,600-4,000 CY was included in the analysis. Larger hopper dredges than those considered in the calculations would significantly reduce the number of movements originally estimated to occur.

2. *NMFS Comment: The report states the project is likely to take anywhere from 9 to 26 months. Could the timing of construction activities be structured to avoid calving seasons?*

USACE Response: As reported by NMFS, the Mid-Atlantic Seasonal Management Area has a NARW migratory route to the calving grounds occurs from 1 November through 30 April. Presently, the USACE construction schedule has been designed such that hopper dredge activity will occur from 1 December to 31 March over a two-year time frame. This period of dredging activity coincides with the construction window that has been implemented by the Corps and NMFS to avoid impacting sea turtles. To date, there has been no recorded incident of a hopper dredge striking a right whale or disrupting migratory patterns. Since there is greater likelihood of increased turtle takes by hopper dredges operating outside the construction window, it is reasonable to conclude that the 1 December – 31 March period represents the most opportune time for hopper dredge operations. The Savannah District requires hopper dredges to operate within specific conditions that protect right whales. These specifications apply to Savannah Harbor and require a NMFS-approved Endangered Species Observer approved for whale monitoring be onboard each hopper dredge during the time that right whales may be in the area. Please see the Section entitled, "Savannah District Contract Specifications-Whales" for more detailed information pertaining to the hopper dredge specifications.

3. *NMFS Comment: Where is the "placement area" that is referred to in the comparison of dredge movement distances between the S-1 and S-8 bar channel alignments?*

USACE Position: The USACE utilized Site 12 as the "placement area" that would be utilized by the hopper dredges for depositing new work derived from the S-1 or S-8 alternative alignments (Figure 1-2 and Figure 8-7). Other placement areas such as the ODMDS or Site 11 might also be

used (Figure 1-2). However, the difference in transit lengths would still be < 5% for either channel configuration. The larger hopper dredge capacities further minimize the frequency with which hopper dredges would transit from the preferred channel alignment and any of the placement areas. (Note: The proposed use of Sites 11 and 12 have been removed from project plans).

4. *NMFS Comment: It is unclear how much longer the channel will be or how much farther offshore the pilot boarding area will be located. Could a clearer map or shapefile be provided that shows these areas?*

USACE Response: The Bar Channel would extend from its current terminal point at Station -60+000B to Station -98+600B. This additional length constitutes approximately 38,600 feet (7.3 miles). Figure 8-7 illustrates the location of the existing and newly proposed pilot boarding areas relative to the channel alignment. The new boarding area would be approximately 25,500 feet (4.8 miles) seaward of the existing boarding area.

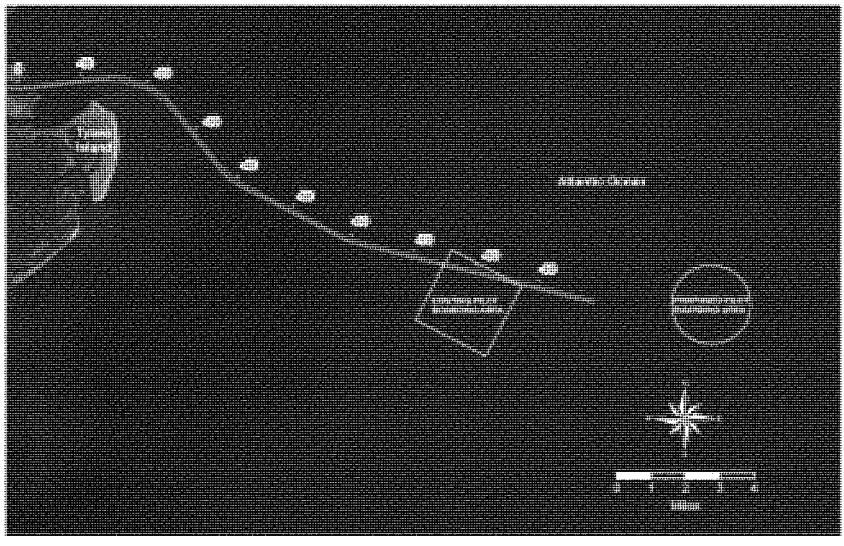

Figure 8-7. Location of bar channel alignment and pilot boarding areas.

5. *NMFS Comment: How will a channel extension affect harbor pilot operation? What is the frequency of trips to the boarding area and how fast does the pilot boat travel to and from its destination?*

USACE Response: The newly proposed boarding area is approximately 4.8 miles seaward of the existing boarding area. Both boarding areas would be utilized for future shipping operations, and the draft of the vessel calling on the Port of Savannah will dictate the area where pilots board the

ships. The frequency of trips to the boarding area is dependent on the number of ships that call on the Port of Savannah. With respect to the existing depth of the harbor, future-projected container vessel calls (one way) arriving at Garden City Terminal are expected to decrease with construction of a deeper navigation channel (Table 1-1). Thus, the proposed deepening project would reduce the number of container ships that call upon the Port of Savannah, and the action would similarly reduce the number of vessel movements required by the harbor pilots to access and serve those ships. The speed of the pilot vessels vary and can be affected by external factors such currents, weather, and available time. However, vessels used by the harbor pilots are greater than 65 feet in length, and therefore, these vessels are required to slow to speeds of 10 knots or less while operating in the Mid-Atlantic Seasonal Management Area.

6. *NMFS Comment: We know ship collisions are one of two primary human-induced sources of mortality in right whales. The number of documented deaths may be as little as 17% of the actual number of deaths (Kraus et al., 2005). Additionally, when right whale carcasses are discovered, the location represents where the carcass was discovered and not where the mortality occurred. Therefore, no reports of right whale ship strikes in the Savannah area does not mean the approach and departure vectors are aligned to minimize risk to right whales from ship strikes or that right whales have not been ship struck in that area.*

USACE Response: On November 12, 2009, the NMFS provided the USACE with a copy of the Garrison paper for use in evaluating the proposed channel extension alignment. The USACE still asserts that the results of the Garrison paper justify that the proposed channel extension/alignment pose a negligible risk to the NARW population. Model results for the predicted whale sightings at the Port of Brunswick are provided in Figures 2 and 3 of the Garrison paper. Of note, the relative density of "Predicted Sightings Per Unit Effort" *and* the associated distance of those cells from the shoreline are comparable for offshore areas adjacent to the Port of Brunswick and the Port of Savannah. When evaluating the relative risk for the Port of Brunswick, Garrison states, "*the benefits of potential routing are less pronounced for Brunswick (Figure 15)*[Actually Figure 14 in paper provided to USACE]. *There are relatively few approaches that result in reduced risk relative to the status quo. This results primarily from the fact that Brunswick is in an area where the relative densities of right whales are predicted to be high well offshore. The best approaches into Brunswick are generally those approaching from nearly due east.*" Given the similarities in the relative location of projected whale densities for Brunswick and Savannah (Figures 2 and 3), the same conclusion for Brunswick could be extrapolated for the Port of Savannah. That is, ships traveling east (i.e., generally perpendicular to the projected whale densities along Georgia's coast) spend less time in high density areas and cross fewer "high-density" cells. The existing east/west vessel travel corridor minimizes the risk of whale strike. The new design of the bar channel maintains the general east/west alignment, and consequently ships would still be oriented to minimize interaction with right whales. Furthermore, the associated approach and departure vectors (i.e., vessel tracks) would not change as a result of the minor variation in alignment.

7. *NMFS Comment: Garrison's analysis did not include air survey data from the upper coast of Georgia and lower South Carolina coast; these data should be included when considering the Savannah area. Without looking at those data, we don't know if right whale distribution there is*

even or clumped (i.e., S-8 or S-1 alignment may/may not funnel traffic over an area with a higher occurrence of right whales).

USACE Response: On February 16, 2010, the NMFS provided a composite of right whale data from aerial surveys that reflects right whale sightings per unit effort (SPUE). The data were reported in terms of whale sightings per km^2 per flight. Figure 8-8 illustrates the NMFS results. The spectrum from blue to red illustrates an increasing number of whale sightings per unit effort.

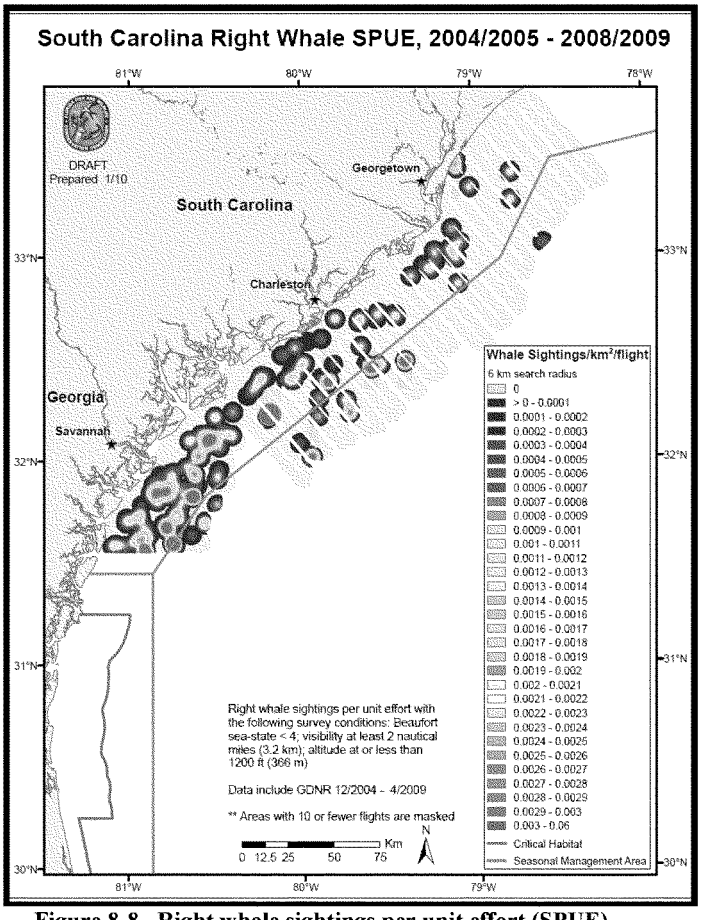

Figure 8-8. Right whale sightings per unit effort (SPUE).

As illustrated in Figure 8-8, there are several areas off the coast of Georgia that trend toward the yellow, orange and red colors. A review of the data sets used to derive this analysis suggest that the numbers of whales observed at one site during one aerial survey (i.e., the numerator of the

SPUE calculation) is the principle factor in determining the intensity of the output. That is, it is the number of whales observed at one point in time and location, *and not the frequency (i.e., reoccurring event) of observation at any one site*, that determines the intensity of the results in Figure 8-8. The raw data for the 2007-2008 and 2008-2009 clearly illustrate that point (Sayre and Taylor, July 2008; Schulte and Taylor, 2009). During the 2007-2008 survey period, 3 cow/calf pairs, 12 single whales, and **21 groups of two or more** adult/juvenile right whales were documented. Similarly, in the 2008-2009 timeframe, 19 cow/calf pairs, 12 single whales, and **19 groups of two or more** adult/juvenile right whales were documented (Figure 8-9 and 8-10) (Sayre and Taylor, July 2008; Schulte and Taylor, 2009). When comparing Figures 8-9and 8-10 with Figure 8-8, it is clear that the red intensity colors indicating greater SPUE correlate with a larger numbers of whales (red triangles) recorded during a single observation.

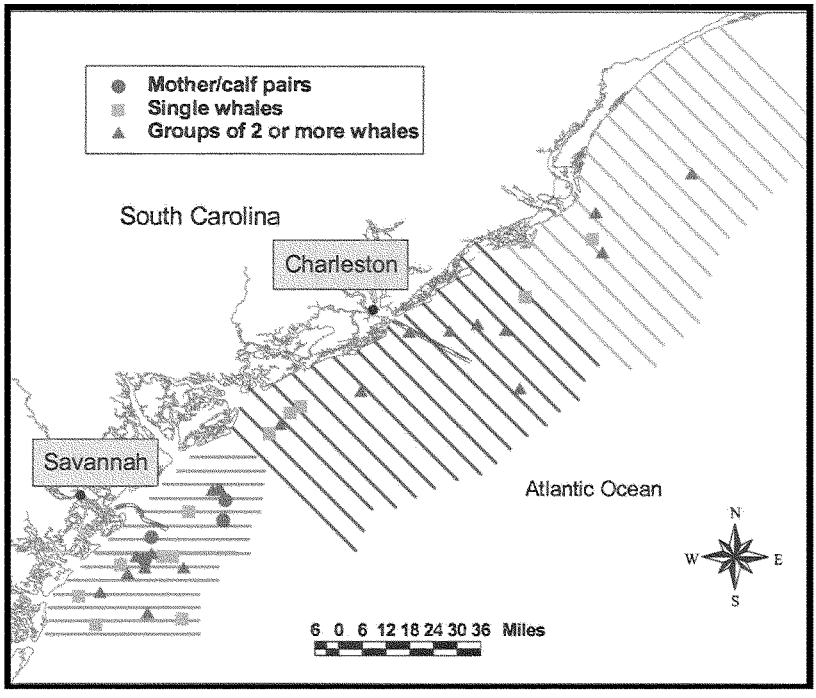

Figure 8-9. 2007-2008 Right whale calving season data.

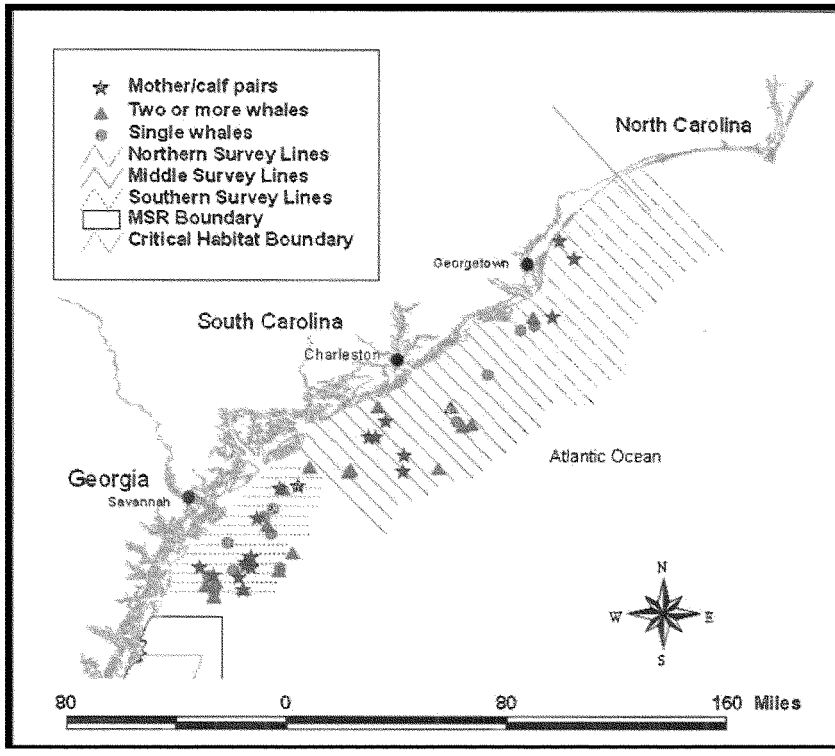

Figure 8-10. 2008-2009 Right whale calving season data.

Raw data from the two reports also confirm that as many as 13 and 12 different whales were observed at a single latitude/longitude location *and* at the same time during the 2007-2008 and 2008-2009 calving season, respectively. This fact is important since the data do not demonstrate a reoccurrence of right whale sightings at a single point over time (i.e., many observations at the same location over several time periods). If numerous sightings are not recorded at the same position over time, then the data set illustrated in Figure 8-8 provides no conclusive way to identify "hot spot" locations where whales may transit during their migration to and from the calving grounds. That is, there is no evidence to suggest that the intensity values illustrated in Figure 8-8 are indicative of locations that right whales would frequent on a re-occurring basis. The randomness of observations is also validated upon inspection of data points observed in Figure 8-9 and 8-10. When compared to Figures 8-9 and 8-10, data obtained as recently as March 2010 also illustrate the randomness of whale sightings with respect to time and spatial occurrence (Figure 8-12). Figure 8-11 also illustrates the number of sightings that occurred relative to the channel extension/alignment. To date, the sightings that have occurred during the 2009-2010 calving season are a considerable distance from the project site (Figure8-12). In

addition, the frequency of whale sightings/distribution is weighted more heavily in the area of the Georgia/Florida border, which has been identified as critical habitat.

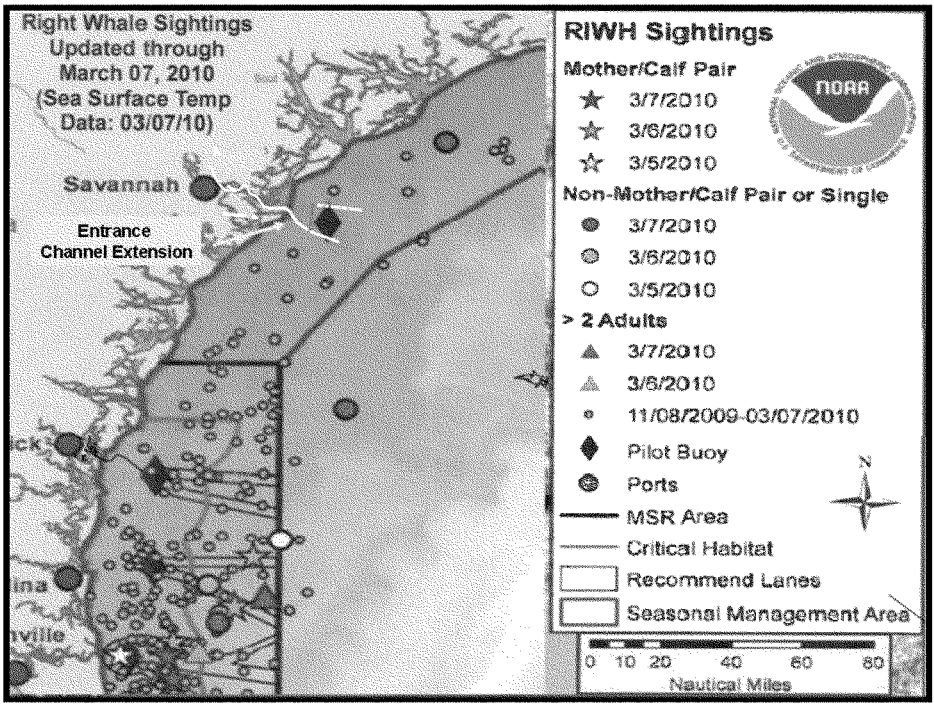

Figure 8-11. Right whale sightings through March 2010.

There is also no evidence to suggest that the number of whales historically recorded per observation (individual, mother/calf pair, or group) at a given location would remain the same from year to year. The association of these groupings with a given location is highly variable as illustrated in a comparison of Figures 8-9, 8-10 and 8-11. In order to evaluate the *frequency* of actual sighting events (independent of individual, mother/calf pair, or group numbers) occurring at a given location and time, the Corps plotted the historical data obtained from the 2007-2008 and 2008-2009 calving season. If more than one whale was observed at a specific time and location, then only one data point was plotted. Figure 8-12 illustrates the results of the analysis. Within the box, four independent observations of whales occurred within the vicinity of the proposed channel extension over a four year period, and the distance between those sightings and the channel varied from 3,000 to 10,460 feet (Figure 8-12).

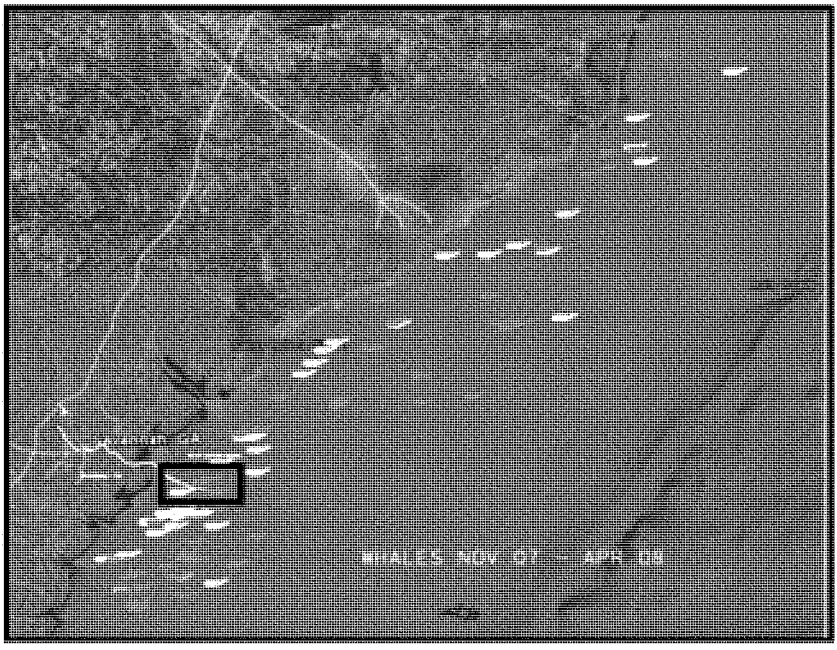

Figure 8-12. Plotted frequency of Right whale sighting events.

In summary, the Corps believes the previously identified data and analysis demonstrates: (1) the randomness of whale movements and sightings; (2) the high variability (i.e., infrequency) associated with observed spatial locations over time; and (3) the location of the proposed channel extension is far removed from a more dense profile of whale sightings significantly south of the project area. Thus, the channel extension would have a minimal impact on right whale movements or migration patterns during the calving season.

8. NMFS Comment: Speed restrictions to protect North Atlantic Right Whales (50CFR224.i05) will only be a temporary protection measure because the speed rule is effective only through Dec. 9, 2013, but the channel will be long-lasting/permanent.

USACE Response: It is premature to assume that the speed restrictions to protect North Atlantic Right Whales will be temporary. The Record of Decision for the speed restrictions (signed October 6, 2008) contained a five-year sunset provision which stated, "*While industry stakeholders were, in general, supportive of the five-year sunset, environmental organizations and many individuals were not. Environmental organizations commented on the sunset provision, raising issues such as limited funding that may interfere with the research NMFS will conduct to assess the effectiveness of the rule and that it would take decades for right whales to show signs of recovery. Other commenters indicated that the sunset provision provides a*

disincentive for voluntary reporting of a collision by the shipping industry. Stakeholders from both groups urged NMFS to quantitatively and qualitatively monitor the effectiveness of the measures during the five-year period. To the extent possible with existing resources, NMFS will synthesize existing data, gather additional data, or conduct additional research on ship-whale interactions to assess the effectiveness of the measures during their period of application. NMFS will also review the economic consequences of the measures. Based on this analysis, NMFS will determine what further steps may be required." In a press release published in December 2008, NOAA also stated, "*Scientists will assess whether the speed restrictions are effective before the rule expires in 2013."*

If the acquired data demonstrate that speed restrictions have been successful in preventing right whale strikes, then there is a high likelihood that NOAA would continue with the 10 knot speed restriction for an additional time. Language in the press release suggests that NOAA would render a decision of continuing with the 10 knot speed restriction (if deemed successful) before the end of the current sunset provision. Therefore, there would be no lapse in the requirements of vessels greater than 65 feet in length to adhere to the 10 knot speed restriction.

9. NMFS Comment: Aerial surveys in Savannah are not considered "Early Warning System" surveys because surveys over Savannah are flown too infrequently.

USACE Response: The following paragraph was identified in both the 2007-2008 and 2008-2009 Final Report to NOAA documenting spatial and temporal distribution of North Atlantic Right Whales off South Carolina and Northern Georgia (Sayer and Taylor, 2008; Schulte and Taylor, 2009).

"Upon completing data collection for each right whale sighting, the aircraft would immediately use the aircraft satellite phone to call a designated ground contact. The ground contact would then relay the right whale sighting information via email to distribution lists which included harbor pilots, USCG, Navy, and other stakeholders and interested parties. The information sent included date, time, latitude, longitude, number of adults and calves, direction of movement, and distance in nm from the closest sea buoy. In addition, the information was sent to all other military and non-military interests via an alphanumeric pager system (Taylor and Brooks 2002) including all aerial survey teams, ship channel pilots, USCG NAVTEX, and state agencies. The communication system supported real-time notification of right whale presence to ships in order to minimize the probability of right whale death or injury due to ship strike. It also facilitated verification of sighting reports by aerial survey teams from other sources such as military ships and aircraft."

Although the flights may occur too infrequently by NMFS standards to be considered an Early Warning System, it does provide ships in the area with real-time information on whale locations so avoidance measures can be initiated. Therefore, these flights do constitute a method of protection for the species.

EFFECTS OF PROPOSED ACTION ON SPECIES AND CRITICAL HABITAT

Dredging Methods and Associated Impacts for the Humpback Whale, Sperm Whale, and North Atlantic Right Whale

Direct Impacts

Impacts from dredging operations, whether it be a hopper dredge, cutterhead/clamshell with tug/scow transport to offshore disposal area are expected to be consistent with previous findings by NMFS in 1991a and 1995a. Since these consultations were completed; (1) the estimated number of right whales has increased based on the data presented in the NMFS annual stock assessments and the numbers of whales reported by the New England Aquarium in their annual "Right Whale Report Card", (2) the implementation of the Early Warning System associated with operations near or within the calving grounds has been solidified by Memorandum of Agreement and has been in place for 21 years (beginning in the Jacksonville District in 1989), and (3) the Corps' involvement with and awareness of right whale issues has increased significantly. Based on these factors, the Corps expects that dredging operations will have a minimal effect on right whales. Additionally, a review of the NMFS large whale strike database does not indicate any records of large whale ship strikes associated with any dredging equipment. There is an account of a dredge/whale interaction observed in 1988 when a dredge approached within 100 yards of a right whale. This situation is unlikely to occur in the future, since dredges now maintain a distance of 500 yards from the known position of right whales, consistent with federal marine mammal approach regulations. The Corps has been a key partner in right whale protection, and as a carry over, all large whales observed in the vicinity of project areas. By requiring observers, as well as being a partner in aerial surveys of high use whale areas, USACE continues to demonstrate significant successful efforts to greatly diminish the potential interactions between large baleen whales and dredging equipment.

Indirect Impacts

Within any harbor or open water coastal environment, there are a number of underwater ambient noise sources such as: commercial and recreational vessel traffic, dredges, wharf/dock construction (pile driving, etc.), natural sounds (storms, biological, etc.), etc. There have been many studies on the potential underwater noise associated effects of vessels on cetaceans; however, until recently few data existed that adequately characterized sounds emitted by dredge plants.

To better assess potential species impacts (i.e. disturbance of communication among marine mammals) associated with dredge-specific noise from navigation maintenance or deepening operations, Clarke *et al.* (2002) performed underwater field investigations to characterize sounds emitted by bucket, hydraulic cutterhead, and hopper dredge operations. A summary of results from this study are presented below and are a first step towards the development of a dredge sounds database which will encompass a range of dredge plant sizes and operational features:

Cutterhead Suction Dredge

Noise generated by a cutterhead suction dredge is continuous and muted and results from the cutterhead rotating within the bottom sediment and from the pumps used to transport the effluent to the placement area. The majority of the sound generated was from 70 to 1,000 Hz and peaked at 100 to 110 dB range. Though attenuation calculations were not completed, reported field observations indicate that the cutterhead suction dredge became almost inaudible at about 500 meters (Clarke *et al.*, 2002).

Hopper Dredge

The underwater noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the noise is generated from the dragarm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Similar to the cutterhead suction dredge, most of the produced sound energy fell within the 70 to 1,000 Hz range; however peak pressure levels were at 120 to 140 dB (Clarke *et al.*, 2002).

Bucket Dredge

Bucket dredges are relatively stationary and produce a repetitive sequence of sounds generated by winches, bucket impact with the substrate, bucket closing, and bucket emptying. The underwater noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. Based on the data collected for this study, which included dredging of coarse sands and gravel, the maximum noise spike occurs when the bucket hits the bottom (120 dB peak amplitude). A reduction of 30 dB re 1 μPa/m occurred between the 150 m and 5,000 m listening stations with faintly audible sounds at 7-km. All other noises from this operation (i.e., winch motor, spuds, etc.) were relatively insignificant (Clarke *et al.*, 2002).

According to Richardson *et al.* (1995) the following noise levels may be detrimental to marine mammals:

Prolonged Exposure of 140 dB re 1 μPa/m (continuous manmade noise), at 1 km may cause Permanent Hearing Loss

Prolonged Exposure of 195 to 225 dB re 1 μPa/m (intermittent noise), at a few meters or tens of meters, may cause Immediate Hearing Damage

According to Richardson *et al.* (1995), "Many marine mammals would avoid these noisy locations, although it is not certain that all would do so." In a study evaluating specific reaction of bowhead whales to underwater drilling and dredge noise, Richardson *et al.* (1990) also noted that bowhead whales often move away when exposed to drillship and dredge sound; however, the reactions are quite variable and may be dependent on habituation and sensitivity of individual animals. According to Richardson *et al* (1995), received noise levels diminish by about 60 dB

between the noise source and a radius of 1 km. For marine mammals to be exposed to a received level of 140 dB at 1 km radius, the source level would have to be about 200 dB re 1 micro Pa-m. Furthermore, few human activities emit continuous sounds at source levels greater than or equal to 200 dB re 1 micro Pa-m; however, supertankers and icebreakers may exceed the 195 dB noise levels.

According to Clarke *et al.* (2002), hopper dredge operations had the highest sustained pressure levels of 120-140 dB among the three measured dredge types; however, this measurement was taken at 40 m from the operating vessel and would likely attenuate significantly with increased distance from the dredge. Based on: (1) the predicted noise impact thresholds noted by Richardson *et al.* (1995), (2) the background noise that already exists within the marine environment, and (3) the ability of marine mammals to move away from the immediate noise source, noise generated by bucket, cutterhead, and hopper dredge activities will not affect the migration, nursing/breeding, feeding/sheltering or communication of large whales. Although behavioral impacts are possible (i.e., a whale changing course to move away from a vessel), the number and frequency of vessels present within a given project area is small and any behavioral impacts would be expected to be minor. Furthermore, for hopper dredging activities, endangered species observers (ESOs) will be on board and will record all large whale sightings and note any potential behavioral impacts.

Vessel Traffic

The Corps' economics evaluations indicate that deepening the Federal navigation channel would not increase vessel traffic using Savannah Harbor, but would instead allow a decrease in the number of vessel calls. The Fleet Forecast found within the Economic Appendix in the GRR, states that over the 50-year project time (from 2015 to 2065) the projected number of vessels arriving at Savannah Harbor would be substantially higher for the existing -42 foot depth than for the proposed deepening project. The reason for this decrease of vessels with a deeper navigation channel is the same volume of cargo could be carried by fewer, larger vessels as could be carried by a vessel fleet with a higher proportion of smaller vessels. In addition, in excess of 70 percent of the vessels presently do not call on Savannah Harbor at their maximum capacity or design draft. The "light loading" of vessels increase costs to the shipper, which are eventually passed onto the consumer. The proposed deeper channel would allow these "light loaded" vessels to increase their loads to their maximum capacity, thereby decreasing the number of vessels calling on the Port of Savannah.

Elba Island Liquefied Natural Gas (LNG) Terminal

The commercially-owned, Southern Liquefied Natural Gas-El Paso (SLNG-El Paso) Terminal, on Elba Island, near Station 36+000 expanded its facility when it completed construction of a fourth storage tank in 2005. This expansion included construction of a berthing slip to accommodate larger Liquefied Natural Gas (LNG) carriers. SLNG-El Paso is presently constructing a fifth storage tank to further expand the Elba Island Facility. This tank is expected to be placed in service by 2012. These facility expansions are expected to result in increases in the number of LNG vessels calling at the SLNG-El Paso Terminal. The Economics Appendix in the GRR provides more detailed information on the expected extent of that growth.

Conservation Measures

To ensure that maintenance dredging operations does not adversely affect the North Atlantic right whale, humpback whale, or the sperm whale, the Corps has fully adopted the Terms and Conditions (T&C) set forth in the 1991 (T&C #2) and 1995 (T&C's #'s 6-9) SARBO's, and reiterated in the 1997 SARBO.

The Corps has established precautionary collision avoidance measures to be implemented during dredging and sediment placement operations that take place during the time North Atlantic right whales are present in waters offshore of the Savannah Harbor project. These include:

a. Before the initiation of the project, at the pre-construction/partnering meeting, the Corps briefs the contractor on the presence of the species, and reviews the requirements for right whale protection.

b. Each contractor will be required to instruct all personnel associated with the dredging/construction project about the possible presence of endangered North Atlantic right whales in the area and the need to avoid collisions. Each contractor will also be required to brief his personnel concerning the civil and criminal penalties for harming, harassing or killing species that are protected under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972. Dredges and all other disposal and attendant vessels are required to stop, alter course, or otherwise maneuver to avoid approaching the known location of a North Atlantic right whale. The contractor will be required to submit an endangered species watch plan that is adequate to protect North Atlantic right whales from the impacts of the proposed work.

c. Monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between December 1 and March 31. During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to safe navigable speed when transiting between areas if whales have been spotted within 15 nm of the vessel's path within the previous 24 hours. (Contractors will be required to use daily available information on the presence of North Atlantic right whales in the project area.) If the Early Warning System (EWS) is operational at the time of the project, it will be deemed to provide adequate information on the presence of whales during dredging operations.

d. The Corps will notify the program manager for the EWS of projects that are likely to take place during calving season, likely beginning, ending and duration of the proposed projects.

Effect Determination

Potential hopper dredging activities for these projects will continue to be accomplished under the Terms and Conditions (T&C's) set forth in the 1991, 1995 and 1997 NMFS South Atlantic Regional Biological Opinions and the SAD Hopper Dredging Protocol, which address North Atlantic right whale interactions. These T&C's and protocols have been more than protective of large whales and specifically North Atlantic right whales for 19 years. The Corps believes that continued adherence to these protective measures will continue to afford the whales the needed protections while not preventing the Corps from completing projects in a timely, cost effective and environmentally protective manner. Based on the implementation of these terms and conditions, as well as the conservation measures outlined above, the proposed activities may affect but are not likely to adversely affect North Atlantic right, humpback or sperm whales or their critical habitat.

8.02.6 Sea Turtles.

a. Status.

Leatherback	*Dermochelys coriacea*	Endangered
Loggerhead	*Caretta caretta*	Endangered
Kemp's Ridley	*Lepidochelys kempii*	Endangered
Hawksbill	*Eretmochelys imbricata*	Endangered
Green	*Chelonia mydas*	Threatened[1]

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

Leatherback

The leatherback sea turtle was listed as endangered throughout its global range on June 2, 1970. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans (Ernst and Barbour, 1972). Leatherback sea turtles are the largest living turtles and range farther than any other sea turtle species. The large size of adult leatherbacks and their tolerance to relatively low temperatures allows them to occur in northern waters such as off Labrador and in the Barents Sea (NMFS and USFWS, 1995). Adult leatherbacks forage in temperate and sub-polar regions from 71°N to 47°S latitude in all oceans and undergo extensive migrations to and from their tropical nesting beaches. Estimates for Leatherback turtle populations are not precise. In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard, 1982). That number, however, is probably an overestimation as it was based on a particularly good nesting year (1980) (Pritchard, 1996). By 1995, the global population of adult females had declined to 34,500 (Spotila *et al.* 1996). Pritchard (1996) also called into question the population estimates from Spotila *et al.* (1996), and felt they may be somewhat low, because it ended the modeling on data from a particularly bad nesting year (1994) while excluding nesting data from 1995, which was a good nesting year. However, the most recent population estimate for leatherback sea turtles from

just the North Atlantic breeding groups is a range of 34,000-90,000 adult individuals (20,000-56,000 adult females) (TEWG, 2007).

In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (NMFS SEFSC, 2001a). Female leatherbacks nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (NMFS SEFSC, 2001a). Previous genetic analyses of leatherbacks using only mitochondrial DNA (mtDNA) resulted in an earlier determination that within the Atlantic basin there are at least three genetically different nesting populations; the St. Croix nesting population (U.S. Virgin Islands), the mainland nesting Caribbean population (Florida, Costa Rica, Suriname/French Guiana), and the Trinidad nesting population (Dutton *et al.*, 1999). Further genetic analyses using microsatellite markers in nuclear DNA along with the mtDNA data and tagging data has resulted in Atlantic Ocean leatherbacks now being divided into seven groups or breeding populations: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG, 2007). When the hatchlings leave the nesting beaches, they move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the *Sargassum* areas as are other species. Leatherbacks are deep divers, with recorded dives to depths in excess of 1,000 m (Eckert *et al.* 1999, Hayes *et al.* 2004).

Life History and Distribution

Leatherbacks are a long-lived species, living for well over 30 years. It has been thought that they reach sexual maturity somewhat faster than other sea turtles (except Kemp's ridley), with an estimated range from 3-6 years (Rhodin, 1985) to 13-14 years (Zug and Parham, 1996). However, some recent research using sophisticated methods of analyzing leatherback ossicles has cast doubt on the previously accepted age to maturity figures, with leatherbacks in the western North Atlantic possibly not reaching sexual maturity until as late as 29 years of age (Avens and Goshe, 2007). Continued research in this area is vitally important to understanding the life history of leatherbacks and has important implications in management of the species.

They nest frequently (up to 10 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, they produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz, 1975). However, a significant portion (up to approximately 30 percent) of the eggs can be infertile. Thus, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. The eggs incubate for 55-75 days before hatching. Based on a review of all sightings of leatherback sea turtles of <145 cm curved carapace length (ccl), Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm ccl.

Although leatherbacks are the most pelagic of the sea turtles, they enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated. Leatherback sea turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates.

Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between boreal, temperate, and tropical waters (NMFS and USFWS, 1992). A 1979 aerial survey of the outer continental shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Leatherbacks were sighted in waters where depths ranged from 1-4,151 m, but 84.4 percent of sightings were in areas where the water was less than 180 m deep (Shoop and Kenney, 1992). Leatherbacks were sighted in waters of a similar sea surface temperature as loggerheads; from 7-27.2°C (Shoop and Kenney, 1992). However, this species appears to have a greater tolerance for colder waters because more leatherbacks were found at the lower temperatures (Shoop and Kenney, 1992). This aerial survey estimated the in-water leatherback population from near Nova Scotia, Canada to Cape Hatteras, North Carolina at approximately 300-600 animals.

General differences in migration patterns and foraging grounds may occur between the seven nesting assemblages, but data are limited. Per TEWG 2007: "*Marked or satellite tracked turtles from the Florida and North Caribbean assemblages have been re-sighted off North America, in the Gulf of Mexico and along the Atlantic coast and a few have moved to western Africa, north of the equator. In contrast, Western Caribbean and Southern Caribbean/Guianas animals have been found more commonly in the eastern Atlantic, off Europe and northern Africa, as well as along the North American coast. There are no reports of marked animals from the Western North Atlantic assemblages entering the Mediterranean Sea or the South Atlantic Ocean, though in the case of the Mediterranean this may be due more to a lack of data rather than failure of Western North Atlantic turtles moving into the Sea. The tagging data coupled with the satellite telemetry data indicate that animals from the western North Atlantic nesting subpopulations use virtually the entire North Atlantic Ocean in the South Atlantic Ocean, tracking and tag return data follow three primary patterns. Although telemetry data from the West African nesting assemblage showed that all but one remained on the shallow continental shelf, there clearly is movement to foraging areas of the south coast of Brazil and Argentina. There is also a small nesting aggregation of leatherbacks in Brazil, and while data are limited to a few satellite tracks, these turtles seem to remain in the southwest Atlantic foraging along the continental shelf margin as far south as Argentina. South African nesting turtles apparently forage primarily south, around the tip of the continent.*"

Population Dynamics and Status

The status of the Atlantic leatherback population has been less clear than the Pacific population. This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion and reformation of nesting beaches in the Guianas (representing the largest nesting area), a lesser degree of nest-site fidelity than occurs with the hardshell sea turtle species and inconsistencies in the availability and analyses of data. However, recent coordinated efforts at data collection and analyses by the Leatherback Turtle Expert Working Group have helped to clarify the understanding of the Atlantic population status (TEWG, 2007).

The Southern Caribbean/Guianas stock is the largest known Atlantic leatherback nesting aggregation (TEWG, 2007). This area includes the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela, with the vast majority of the nesting occurring in

the Guianas and Trinidad. Past analyses had shown that the nesting aggregation in French Guiana had been declining at about 15 percent per year since 1987 (NMFS SEFSC, 2001). However, from 1979-1986, the number of nests was increasing at about 15 percent annually which could mean that the current decline could be part of a nesting cycle which coincides with the erosion cycle of Guiana beaches described by Schultz (1975). It is thought that the cycle of erosion and reformation of beaches has resulted in shifting nesting beaches throughout this region. This was supported by the increased nesting seen in Suriname, where leatherback nest numbers have shown large recent increases concurrent with declines elsewhere (with more than 10,000 nests per year since 1999 and a peak of 30,000 nests in 2001), and the long-term trend for the overall Suriname and French Guiana population was thought to possibly show an increase (Girondot 2002 in Hilterman and Goverse 2003). In the past many sea turtle scientists have agreed that the Guianas (and some would include Trinidad) should be viewed as one population and that a synoptic evaluation of nesting at all beaches in the region is necessary to develop a true picture of population status (Reichart *et al.* 2001). Genetics studies have added support to this notion and have resulted in the designation of the Southern Caribbean/Guianas stock. Using both Bayesian modeling and regression analyses, the TEWG (2007) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate (using nesting females as a proxy for population). This positive growth was seen within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007).

The Western Caribbean stock includes nesting beaches from Honduras to Columbia. The most intense nesting in that area occurs in Costa Rica, Panama, and the Gulf of Uraba in Columbia. The Caribbean coast of Costa Rica and extending through to Chiriqui Beach, Panama, represents the fourth largest known leatherback nesting locations in the world (Troëng *et al.*, 2004). Examination of data from three index nesting beaches in the region (Tortuguero, Gandoca, and Pacuare, in Costa Rica) using various Bayesian and regression analyses indicated that the nesting population was likely not growing over the 1995-2005 time series of available data (TEWG, 2007), though modeling of the nesting data for Tortuguero indicates a possible 67.8% decline between 1995 and 2006 (Troëng *et al.* in press).

Nesting data for the Northern Caribbean stock is available from Puerto Rico, the U.S. Virgin Islands (St. Croix), and the British Virgin Islands (Tortola). In Puerto Rico the primary nesting beaches are at Fajardo, and on the island of Culebra. Nesting between 1978-2005 has ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1 (TEWG, 2007). At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has fluctuated from a few hundred nests to a high of 1008 in 2001, and the average annual growth rate has been approximately 1.1 from 1986-2004 (TEWG, 2007). Nesting in Tortola is limited, but has been increasing from 0-6 nests/year in the late 1980's to 35-65/year in the 2000's, with an annual growth rate of approximately 1.2 between 1994-2004 (TEWG, 2007).

The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance; with total nests between 800-900 per year in the 2000's following nesting totals fewer than 100 nests per year in the 1980's (Florida Fish and Wildlife Conservation

Commission, unpublished data). Using data from the Index Nesting Beach Surveys, the TEWG (2007) has estimated a significant annual nesting growth rate of 1.17 between 1989 and 2005.

The West African nesting stock of leatherbacks is a large, important, but mostly unstudied aggregation. Nesting occurs in various countries along Africa's Atlantic coast, but much of the nesting is undocumented and the data is inconsistent. However, it is known that Gabon has a very large amount of leatherback nesting, with at least 30,000 nests laid along their coast in one season (Fretey *et al.* in press). Fretey *et al.* (in press) also provide detailed information about other known nesting beaches and survey efforts along the Atlantic African coast. Because of the lack of consistent effort and minimal available data, trend analyses were not possible for this stock (TEWG, 2007).

Two other small but growing nesting stocks include Brazil and South Africa. For the Brazilian stock the TEWG (2007) analyzed the available data and determined that between 1988 and 2003 there was a positive annual average growth rate of 1.07 using the regression analyses, and 1.08 using Bayesian modeling. The South African stock has an annual average growth rate of 1.06 based on regression modeling and 1.04 using the Bayesian approach (TEWG, 2007).

Estimates of total population size for Atlantic leatherbacks are difficult to ascertain due to the inconsistent nature of the available nesting data. In 1996, the entire western Atlantic population was characterized as stable at best (Spotila *et al.* 1996), with numbers of nesting females reported to be on the order of 18,800. A subsequent analysis by Spotila (pers. comm.) indicated that by 2000, the western Atlantic nesting population had decreased to about 15,000 nesting females. Spotila *et al.* (1996) estimated that the leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa totaled approximately 27,600 nesting females, with an estimated range of 20,082-35,133. This is similar to the estimated figures of 34,000-95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females) determined by the TEWG (2007).

Threats

Zug and Parham (1996) pointed out that the main threat to leatherback populations in the Atlantic is the combination of fishery-related mortality (especially entanglement in gear and drowning in trawls) and the intense egg harvesting on the main nesting beaches. Other important ongoing threats to the population include pollution, loss of nesting habitat, and boat strikes.

Of sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, possibly their method of locomotion, and perhaps their attraction to the lightsticks used to attract target species in longline fisheries. They are also susceptible to entanglement in gillnets and pot/trap lines (used in various fisheries) and capture in trawl gear (e.g., shrimp trawls).

Leatherbacks are exposed to pelagic longline fisheries in many areas of their range. Unlike loggerhead turtle interactions with longline gear, leatherback turtles do not usually ingest longline bait. Instead, leatherbacks are typically foul hooked by longline gear (e.g., on the flipper or shoulder area) rather than getting mouth hooked or swallowing the hook (NMFS SEFSC, 2001). A total of 24 nations, including the U.S. (accounting for 5-8 percent of the hooks fished), have fleets participating in pelagic longline fisheries in the area. Basin-wide, Lewison *et al.* (2004) estimated that 30,000-60,000 leatherback sea turtle captures occurred in Atlantic pelagic longline fisheries in the year 2000 alone (note that multiple captures of the same individual are known to occur, so the actual number of individuals captured may not be as high). Genetic studies performed within the Northeast Distant Fishery Experiment indicate that the leatherbacks captured in the Atlantic highly migratory species pelagic longline fishery were primarily from the French Guiana and Trinidad nesting stocks (over 95 percent). Individuals from West African stocks were surprisingly absent (Roden *et al.* in press).

Leatherbacks are also susceptible to entanglement in the lines associated with trap/pot gear used in several fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine (Dwyer *et al.* 2002). Additional leatherbacks stranded wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer *et al.* 2002). Fixed gear fisheries in the mid-Atlantic have also contributed to leatherback entanglements. In North Carolina, two leatherback sea turtles were reported entangled in a crab pot buoy inside Hatteras Inlet (D. Fletcher, pers. comm. to S. Epperly in NMFS SEFSC 2001). A third leatherback was reported entangled in a crab pot buoy in Pamlico Sound near Ocracoke. This turtle was disentangled and released alive; however, lacerations on the front flippers from the lines were evident (D. Fletcher, pers. comm. to S. Epperly in NMFS SEFSC 2001). In the Southeast, leatherbacks are vulnerable to entanglement in Florida's lobster pot and stone crab fisheries. In the U.S. Virgin Islands, where one of five leatherback strandings from 1982 to 1997 was due to entanglement (Boulon, 2000), leatherbacks have been observed with their flippers wrapped in the line of West Indian fish traps (R. Boulon, pers. comm. to J. Braun-McNeill in NMFS SEFSC 2001). Because many entanglements of this typically pelagic species likely go unnoticed, entanglements in fishing gear may be much higher.

Leatherback interactions with the southeast Atlantic shrimp fishery, which operates predominately from North Carolina through southeast Florida (NMFS, 2002b), have also been a common occurrence. Leatherbacks, which migrate north annually, are likely to encounter shrimp trawls working in the coastal waters off the Atlantic coast from Cape Canaveral, Florida, to the Virginia/North Carolina border. Leatherbacks also interact with the Gulf of Mexico shrimp fishery. For many years, TEDs required for use in these fisheries were less effective at excluding leatherbacks than the smaller, hard-shelled turtle species. To address this problem, on February 21, 2003, the NMFS issued a final rule to amend the TED regulations. Modifications to the design of TEDs are now required in order to exclude leatherbacks and large and sexually mature loggerhead and green turtles.

Other trawl fisheries are also known to interact with leatherback sea turtles. In October 2001, a Northeast Fisheries Science Center observer documented the take of a leatherback in a bottom otter trawl fishing for Loligo squid off of Delaware; TEDs are not required in this fishery. The

winter trawl flounder fishery, which did not come under the revised TED regulations, may also interact with leatherback sea turtles.

Gillnet fisheries operating in the nearshore waters of the Mid-Atlantic states are also suspected of capturing, injuring, and/or killing leatherbacks when these fisheries and leatherbacks co-occur. Data collected by the NEFSC Fisheries Observer Program from 1994 through 1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54 to 92 percent.

Poaching is not known to be a problem for nesting populations in the continental U.S. However, in 2001 the NMFS Southeast Fishery Science Center (SEFSC) noted that poaching of juveniles and adults was still occurring in the U.S. Virgin Islands and the Guianas. In all, four of the five strandings in St. Croix were the result of poaching (Boulon, 2000). A few cases of fishermen poaching leatherbacks have been reported from Puerto Rico, but most of the poaching is on eggs.

Leatherback sea turtles may be more susceptible to marine debris ingestion than other species due to their pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding areas and migratory routes (Lutcavage *et al.* 1997, Shoop and Kenney 1992). Investigations of the stomach contents of leatherback sea turtles revealed that a substantial percentage (44 percent of the 16 cases examined) contained plastic (Mrosovsky, 1981). Along the coast of Peru, intestinal contents of 19 of 140 (13 percent) leatherback carcasses were found to contain plastic bags and film (Fritts, 1983). The presence of plastic debris in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and plastic debris (Mrosovsky, 1981). Balazs (1985) speculated that the object might resemble a food item by its shape, color, size or even movement as it drifts about, and induce a feeding response in leatherbacks.

It is important to note that, like marine debris, fishing gear interactions and poaching are problems for leatherbacks throughout their range. Entanglements are common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line. Leatherbacks are reported taken by many other nations that participate in Atlantic pelagic longline fisheries, including Taipei, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, U.K., Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland (see NMFS SEFSC 2001, for a description of take records). Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.* 1994, Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback sea turtle population in French Guiana (Chevalier *et al.* 1999), and gillnets targeting green and hawksbill turtles in the waters of coastal Nicaragua also incidentally catch leatherback turtles (Lagueux *et al.* 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio-M, 2000). A study by the Trinidad and Tobago's Institute for Marine Affairs (IMA), in 2002 confirmed that bycatch of leatherbacks is high in Trinidad. IMA estimated that more than 3,000 leatherbacks were captured incidental to gillnet fishing in the coastal waters of Trinidad in 2000. As much as one half or more of the gravid turtles may be killed (Lee Lum,

2003). However, many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS SEFSC, 2001).

Summary of Leatherback Status

In the Atlantic Ocean, the scientific understanding of the status and trends of leatherback turtles is somewhat more confounded, although the overall trend appears to be stable to increasing, compared to the bleak situation in the Pacific. These data indicate increasing or stable nesting populations in all of the regions except West Africa (no long-term data are available) and the Western Caribbean (TEWG, 2007). Some of the same factors that led to precipitous declines of leatherbacks in the Pacific also affect leatherbacks in the Atlantic: leatherbacks are captured and killed in many kinds of fishing gear and interact with fisheries in state, federal, and international waters. Poaching is a problem and affects leatherbacks that occur in U.S. waters. Leatherbacks also appear to be more susceptible to death or injury from ingesting marine debris than other turtle species.

Critical Habitat

No critical habitat has been designated by the NMFS for Leatherback sea turtles in the project area.

Loggerhead Sea Turtle

The loggerhead sea turtle was listed as an endangered species throughout its global range on March 10, 2010. It was listed because of direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat. Loggerhead sea turtles inhabit the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. In the Atlantic, developmental habitat for small juveniles is the pelagic waters of the North Atlantic and the Mediterranean Sea (NMFS and USFWS, 1991a). Within the continental United States, loggerhead sea turtles nest from Texas to New Jersey. Major nesting areas include coastal islands of Georgia, South Carolina, and North Carolina, and the Atlantic and Gulf of Mexico coasts of Florida, with the bulk of the nesting occurring on the Atlantic coast of Florida.

On November 16, 2007, the NMFS received a petition from Ocean and the Center for Biological Diversity requesting that loggerhead turtles in the western North Atlantic Ocean be reclassified as a Distinct Population Segment (DPS) with endangered status and that critical habitat be designated. On March 5, 2008, the NMFS position was published in the Federal Register indicating that a re-classification of the loggerhead in the western North Atlantic Ocean as a DPS and listing of the DPS as endangered may be warranted (Federal Register/Vol. 73, No. 44/Wednesday, March 5, 2008/Proposed Rules). An affirmative 90-day finding requires that the NMFS commence a status review on the loggerhead turtle. Upon completion of this review, the NMFS will make a finding on whether reclassification of the loggerhead in the western North Atlantic Ocean as endangered is warranted, warranted but precluded by higher priority listing actions, or not warranted. As of March 2010, final action on the establishment of loggerhead DPSs and uplisting the western North Atlantic DPS as endangered was temporarily delayed

while some additional analysis and discussion occurs (Dennis Klemm-NOAA Protected Resource Division, Personal Communication).

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. There are at least five western Atlantic subpopulations, divided geographically as follows: (1) A northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29°N; (2) a south Florida nesting subpopulation, occurring from 29°N on the east coast to Sarasota on the west coast; (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez, 1990; TEWG, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS 2001a). Additionally, there is evidence of at least several other genetically distinct stocks, including a Cay Sal Bank, Western Bahamas stock; a Quintana Roo, Mexico stock, including all loggerhead rookeries on Mexico's Yucatan Peninsula; a Brazilian stock; and a Cape Verde stock (SWOT Report, Volume II, The State of the World's Sea Turtles, 2007). The fidelity of nesting females to their nesting beach is the reason these subpopulations can be differentiated from one another. Fidelity for nesting beaches makes recolonization of nesting beaches with sea turtles from other subpopulations unlikely.

Life History and Distribution

Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer *et al.*, 1994), with the benthic immature stage lasting at least 10-25 years. However, based on data from tag returns, strandings, and nesting surveys (NMFS 2001a), NMFS estimates ages of maturity ranging from 20-38 years with the immature stage lasting from 14-32 years.

Mating takes place in late March through early June in the southeastern United States, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/individual (Murphy and Hopkins, 1984). Nesting of an individual female loggerhead is usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd, 1988). Generally, loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years or more. Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length they begin to live in coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico, although some loggerheads may move back and forth between the pelagic and benthic (i.e., nearshore) environment (Witzell, 2002). Benthic immature loggerheads (sea turtles that have come back to inshore and nearshore waters), the life stage following the pelagic immature stage, have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in Northeastern Mexico.

Tagging studies have shown loggerheads that have entered the benthic environment undertake routine migrations along the coast that are limited by seasonal water temperatures. Loggerhead sea turtles occur year round in offshore waters off North Carolina where water temperature is influenced by the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to immigrate to North Carolina inshore waters (e.g., Pamlico and Core Sounds) and also

move up the coast (Epperly *et al.*, 1995a; Epperly *et al.,* 1995b; Epperly *et al.*, 1995c), occurring in Virginia foraging areas as early as April and on the most northern foraging grounds in the Gulf of Maine in June. The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September but some may remain in mid-Atlantic and Northeast areas until late fall. By December loggerheads have emigrated from inshore North Carolina waters and coastal waters to the north to waters offshore North Carolina, particularly off Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles ($\geq$ 11°C) (Epperly *et al.*, 1995a; Epperly *et al.*, 1995b; Epperly *et al.,* 1995c). Loggerhead sea turtles are year-round residents of central and south Florida.

Pelagic and benthic juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988). Sub-adult and adult loggerheads are primarily coastal dwelling and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

Population Dynamics and Status

A number of stock assessments (TEWG, 1998; TEWG, 2000; NMFS 2001a; Heppell *et al.* 2003) have examined the stock status of loggerheads in the waters of the United States, but have been unable to develop any reliable estimates of absolute population size. Based on nesting data of the five western Atlantic subpopulations, the south Florida-nesting and the northern-nesting subpopulations are the most abundant (TEWG 2000; NMFS 2001a). Between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182 annually with a mean of 73,751 (TEWG 2000). On average, 90.7 percent of these nests were of the south Florida subpopulation and 8.5 percent were from the northern subpopulation (TEWG 2000). The TEWG (2000) assessment of the status of these two better-studied populations concluded that the south Florida subpopulation was increasing at that time, while no trend was evident (may be stable but possibly declining) for the northern subpopulation. A more recent analysis of nesting data from 1989-2005 by the Florida Wildlife Research Institute indicates there is a declining trend in nesting at beaches utilized by the south Florida nesting subpopulation (McRae letter to NMFS, October 25, 2006). Nesting data obtained for the 2006 nesting season are also consistent with the decline in loggerhead nests (Meylan pers. comm. 2006). It is unclear at this time whether the nesting decline reflects a decline in population, or is indicative of a failure to nest by the reproductively mature females as a result of other factors (resource depletion, nesting beach problems, oceanographic conditions, etc.).

For the northern subpopulations, recent estimates of loggerhead nesting trends in Georgia from standardized daily beach surveys showed significant declines ranging from 1.5 to 1.9 percent annually (Mark Dodd, Georgia Department of Natural Resources, pers. comm., 2006). Nest totals from aerial surveys conducted by the South Carolina Department of Natural Resources showed a 3.3 percent annual decline in nesting since 1980. Another consideration that may add to the importance and vulnerability of the northern subpopulation is the sex ratios of this subpopulation. NMFS scientists have estimated that the northern subpopulation produces 65 percent males (NMFS 2001a). However, new research conducted over a limited time frame has found opposing sex ratios (Wyneken *et al.* 2004), so further information is needed to clarify the issue. Since nesting female loggerhead sea turtles exhibit nest fidelity, the continued existence

of the northern subpopulation is related to the number of female hatchlings that are produced. Producing fewer females will limit the number of subsequent offspring produced by the subpopulation.

Sea turtle nesting occurs throughout the States of Georgia and South Carolina in all coastal counties. The stranding records for Chatham County, Georgia indicate that 4 turtles were stranded in the county from January 1 to June 30, 1989 and 212 stranding occurred in the State of Georgia during 1989. Approximately 95 percent of these stranding occurred from May to November. Table 8-4 shows the number of loggerhead sea turtle (*Caretta caretta*) nests in Georgia for 2006:

Table 8-4. Number of Loggerhead Sea Turtle (*Caretta caretta*) Nests in Georgia for 2006

Location	Loggerhead Nest
Tybee Island	10
Little Tybee Island	7
Wassaw Island	141
Ossabaw Island	202
St. Catherine Island	124
Blackbeard Island	227
Sapelo Island	82
Little St. Simon Island	58
Sea Island	64
St. Simon Island	1
Jekyll Island	137
Little Cumberland Island	23
Cumberland Island	323
TOTAL	**1,399**

Within the Savannah project area primarily only one species of sea turtle, the loggerhead sea turtle (*Caretta caretta*) nests regularly on the adjacent beaches of Tybee and Daufuskie Islands (Personal Communication, Mark Dodd and DuBose Griffin, Georgia and South Carolina Sea Turtle Program Coordinators, respectively 2006). According to Mr. Mark Dodd, the Georgia Sea Turtle Program Coordinator, with the Georgia Department of Natural Resources, Table 8-5 provides the sea turtle nest totals for Tybee Island, Georgia through 2009:

Table 8-5. Sea Turtle Nest Totals; Tybee Island, GA, 1989-2009

Year	Loggerhead Nests	Leatherback Nests	Kemp's ridley	Green Turtle	Hawksbill Turtle
1989	7	0	0	0	0
1990	7	0	0	0	0
1991	7	0	0	0	0
1992	9	0	0	0	0
1993	0	0	0	0	0
1994	4	0	0	0	0
1995	8	0	0	0	0
1996	14	0	0	0	0
1997	4	0	0	0	0
1998	3	0	0	0	0
1999	8	0	0	0	0
2000	1	0	0	0	0
2001	3	0	0	0	0
2002	6	0	0	0	0
2003	6	0	0	0	0
2004	5	1	0	0	0
2005	4	0	0	0	0
2006	10	0	0	0	0
2007	10	0	0	0	0
2008					
2009*	3				

*Georgia 2009 Turtle Nesting data taken from the following website:
http://www.seaturtle.org/nestdb/

Ms. DuBose Griffin, South Carolina Sea Turtle Program Coordinator, SC Department of Natural Resources, Wildlife and Freshwater Fisheries Division provided the data illustrated in Table 8-6:

Table 8-6
Loggerhead Sea Turtle Nest Totals for Daufuskie and Turtle Islands

Island	Length (km)	2006	2007	2008	2009*
Daufuskie	~ 8.0	23	15	62	31
Turtle	~ 1.0	0	0	0	0

*South Carolina 2009 Turtle Nesting Data taken from the following website:
http://www.seaturtle.org/nestdb/

The remaining three subpopulations – Dry Tortugas, Florida Panhandle, and Yucatán – are much smaller, but also relevant to the continued existence of the species. Nesting surveys for the Dry Tortugas subpopulation are conducted as part of Florida's statewide survey program. Survey effort has been relatively stable during the 9-year period from 1995-2003 (although the 2002 year was missed). Nest counts ranged from 168-270 but with no detectable trend during this period (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide Nesting Beach Survey Data). Nest counts for the Florida Panhandle subpopulation are focused on index beaches rather than all beaches where nesting occurs. Currently, there is not enough information to detect a trend for the subpopulation (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Index Nesting Beach Survey Database). Similarly, nesting survey effort has been inconsistent among the Yucatán nesting beaches and no trend can be determined for this subpopulation. However, there is some optimistic news. Zurita *et al.* (2003) found a statistically significant increase in the number of nests on seven of the beaches on Quintana Roo, Mexico, from 1987-2001 where survey effort was consistent during the period.

Threats

The diversity of a sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the benthic environment, and in the pelagic environment. Hurricanes are particularly destructive to sea turtle nests. Sand accretion and rainfall that result from these storms as well as wave action can appreciably reduce hatchling success. For example, in 1992, all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton *et al.* 1994). Also, many nests were destroyed during the 2004 hurricane season. Other sources of natural mortality include cold stunning and biotoxin exposure.

Anthropogenic factors that impact hatchlings and adult female turtles on land, or the success of nesting and hatching include: beach erosion, beach armoring, and nourishment, artificial lighting, beach cleaning, increased human presence, recreational beach equipment, beach driving, coastal construction and fishing piers, exotic dune and beach vegetation, and poaching. An increase in human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (e.g., raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (e.g., Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerhead sea turtles are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation, marine pollution, underwater explosions, hopper dredging, offshore artificial lighting, power plant entrainment and/or impingement, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, poaching, and fishery interactions. Loggerheads in the pelagic environment are exposed to a series of longline

fisheries, which include the Atlantic highly migratory species (HMS) pelagic longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various longline fleets in the Mediterranean Sea (Aguilar *et al.* 1995; Bolten *et al.* 1996). Loggerheads in the benthic environment in waters off the coastal United States are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries.

Summary of Status for Loggerhead Sea Turtles

In the Atlantic Ocean, absolute population size is not known, but based on extrapolation of nesting information, loggerheads are likely much more numerous than in the Pacific Ocean. NMFS recognizes five subpopulations of loggerhead sea turtles in the western north Atlantic based on genetic studies. The Northern subpopulation is the DPS that would be most affected by the proposed action. The South Florida subpopulation may be critical to the survival of the species in the Atlantic Ocean because of its size (over 90 percent of all U.S. loggerhead nests are from this subpopulation). In the past, this nesting aggregation was considered second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross, 1979; Ehrhart, 1989; NMFS and USFWS, 1991a). However, the status of the Oman colony has not been evaluated recently and it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections for sea turtles (Meylan *et al.*, 1995). Given the lack of updated information on this population, the status of loggerheads in the Indian Ocean basin overall is essentially unknown.

All loggerhead subpopulations are faced with a multitude of natural and anthropogenic effects that negatively influence the status of the species. Many anthropogenic effects occur as a result of activities outside of U.S. jurisdiction (i.e., fisheries in international waters).

Critical Habitat

No critical habitat has been designated by the NMFS for loggerhead sea turtles in the project area.

Kemp's Ridley Sea Turtle

The Kemp's ridley was listed as endangered on December 2, 1970. Internationally, the Kemp's ridley has been considered the most endangered sea turtle (Zwinenberg, 1977; Groombridge, 1982; TEWG 2000). Kemp's ridleys nest primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State. This species occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean. Occasional individuals reach European waters (Brongersma, 1972). Adults of this species are usually confined to the Gulf of Mexico, although adult-sized individuals sometimes are found on the east coast of the United States.

Life History and Distribution

The TEWG (1998) estimates age at maturity from 7-15 years. Females return to their nesting beach about every 2 years (TEWG 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western Gulf of Mexico, near Rancho Nuevo in southern

Tamaulipas, Mexico. Nesting also occurs in Veracruz, Mexico, and Texas, U.S., but on a much smaller scale. The mean clutch size for Kemp's ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Little is known of the movements of the post-hatchling stage (pelagic stage) within the Gulf of Mexico. Studies have shown the post-hatchling pelagic stage varies from 1-4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell, 1997). Benthic immature Kemp's ridleys have been found along the eastern seaboard of the United States and in the Gulf of Mexico. Atlantic benthic immature sea turtles travel northward as the water warms to feed in the productive, coastal waters off Georgia through New England, returning southward with the onset of winter (Lutcavage and Musick, 1985; Henwood and Ogren, 1987; Ogren, 1989). Studies suggest that benthic immature Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, 1995).

Stomach contents of Kemp's ridleys along the lower Texas coast consisted of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver, 1991). Pelagic stage Kemp's ridleys presumably feed on the available *Sargassum* and associated infauna or other epipelagic species found in the Gulf of Mexico.

Population Dynamics and Status

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the Rancho Nuevo beaches (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963). By the mid-1980s nest numbers were below 1,000 (with a low of 702 nests in 1985). However, observations of increased nesting with 6,277 nests recorded in 2000, 10,000 nests in 2005, and 12,143 nests recorded during the 2006 nesting season (Gladys Porter Zoo nesting database) show the decline in the ridley population has stopped and the population is now increasing.

A period of steady increase in benthic immature ridleys has been occurring since 1990 and appears to be due to increased hatchling production and an apparent increase in survival rates of immature sea turtles beginning in 1990. The increased survivorship of immature sea turtles is attributable, in part, to the introduction of turtle excluder devices (TEDs) in the United States and Mexican shrimping fleets and Mexican beach protection efforts. As demonstrated by nesting increases at the main nesting sites in Mexico, adult ridley numbers have increased over the last decade. The population model used by TEWG (2000) projected that Kemp's ridleys could reach the Recovery Plan's intermediate recovery goal of 10,000 nesters by the year 2015.

Next to loggerheads, Kemp's ridleys are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June (Keinath *et al.*, 1987; Musick and Limpus, 1997). The juvenile population of Kemp's ridley sea turtles in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997). These juveniles frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus, 1997). Kemp's ridleys

consume a variety of crab species, including *Callinectes spp.*, *Ovalipes spp.*, *Libinia sp.*, and *Cancer spp.* Mollusks, shrimp, and fish are consumed less frequently (Bjorndal, 1997). Upon leaving Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus, 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds, as well as smaller juveniles from New York and New England, to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Musick and Limpus, 1997; Epperly *et al.*, 1995a; Epperly *et al.*, 1995b).

Threats

Kemp's ridleys face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, natural predators at sea, and oceanic events such as cold stunning. Although cold stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. For example, in the winter of 1999-2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green turtles were found on Cape Cod beaches (R. Prescott, pers. comm., 2001). Annual cold-stunning events do not always occur at this magnitude; the extent of episodic major cold-stunning events may be associated with numbers of turtles utilizing Northeast waters in a given year, oceanographic conditions, and the occurrence of storm events in the late fall. Many cold-stunned turtles can survive if found early enough, but cold-stunning events can still represent a significant cause of natural mortality.

Although changes in the use of shrimp trawls and other trawl gear have helped to reduce mortality of Kemp's ridleys, this species is also affected by other sources of anthropogenic impacts similar to those discussed above. For example, in the spring of 2000, five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. Cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gill net fishery operating offshore in the preceding weeks. The five ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction because it is unlikely that all of the carcasses washed ashore.

Summary of Kemp's Ridley Status

The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr, 1963). The number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3 percent per year from 1985 to 1999. Current totals are 12,059 nests in Mexico in 2006 (August 8, 2006, e-mail from Luis Jaime Peña - Conservation Biologist, Gladys Porter Zoo). Kemp's ridleys mature at an earlier age (7-15 years) than other chelonids, thus "lag effects" as a result of unknown impacts to the non-breeding life stages would likely have been seen in the increasing nest trend beginning in 1985 (NMFS and USFWS, 1992).

The largest contributors to the decline of Kemp's ridleys in the past were commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the Gulf of

Mexico trawl fisheries. The advent of TED regulations for trawlers and protections for the nesting beaches has allowed the species to begin to rebound. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests and potential threats to the nesting beaches from such sources as global climate change, development, and tourism pressures.

Critical Habitat

No critical habitat has been designated by the NMFS for Kemp's ridley sea turtles in the project area.

Hawksbill Sea Turtle

The hawksbill turtle was listed as endangered under the precursor of the ESA on June 2, 1970, and is considered Critically Endangered by the International Union for the Conservation of Nature (IUCN). The hawksbill is a medium-sized sea turtle, with adults in the Caribbean ranging in size from approximately 62.5 to 94.0 cm straight carapace length. The species occurs in all ocean basins, although it is relatively rare in the Eastern Atlantic and Eastern Pacific, and absent from the Mediterranean Sea. Hawksbills are the most tropical of the marine turtles, ranging from approximately 30°N to 30°S latitude. They are closely associated with coral reefs and other hard-bottom habitats, but they are also found in other habitats including inlets, bays and coastal lagoons (NMFS and USFWS, 1993). There are five regional nesting populations with more than 1,000 females nesting annually. These populations are in the Seychelles, Mexico, Indonesia, and two in Australia (Meylan and Donnelly, 1999). There has been a global population decline of over 80 percent during the last three generations (105 years) (Meylan and Donnelly, 1999).

Life History and Distribution

In the Western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Peninsula of Mexico (Garduño-Andrade *et al.*, 1999). With respect to the United States, nesting occurs in Puerto Rico, the USVI, and the southeast coast of Florida. Nesting also occurs outside of the United States and its territories in Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan, 1999). Outside of the nesting areas, hawksbills have been seen off of the U.S. Gulf of Mexico states and along the eastern seaboard as far north as Massachusetts, although sightings north of Florida are rare (NMFS and USFWS, 1993).

The best estimate of age at sexual maturity for hawksbill sea turtles is about 20-40 years (NMFS, 2004b). Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to their nesting beach or to courtship stations along the migratory corridor (Meylan, 1999). Females nest an average of 3-5 times per season (Meylan and Donnelly, 1999). Clutch size is larger on average (up to 250 eggs) than that of other turtles (Hirth, 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites.

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm in straight carapace length (Meylan and Donnelly, 1999), followed by residency in developmental habitats (foraging areas where juveniles reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over several years (Van Dam and Díez, 1998).

The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan, 1988). Other food items, notably corallimorphs and zooanthids, have been documented to be important in some areas of the Caribbean (Leon and Díez, 2000).

Population Dynamics and Status

Estimates of the annual number of nests at hawksbill sea turtle nesting sites are of the order of hundreds to a few thousand. Nesting within the southeastern United States and U.S. Caribbean is restricted to Puerto Rico (>650 nests/yr), the USVI (~400 nests/yr), and, rarely, Florida (0-4 nests/yr) (Meylan, 1999; Florida Fish and Wildlife Conservation Commission; Florida Marine Research Institute's Statewide Nesting Beach Survey data 2002). At the two principal nesting beaches in the U.S. Caribbean where long-term monitoring has been carried out, populations appear to be increasing (Mona Island, Puerto Rico) or stable (Buck Island Reef National Monument, St. Croix, USVI) (Meylan, 1999).

Threats

As described for other sea turtle species, hawksbill sea turtles are affected by habitat loss, habitat degradation, fishery interactions, and poaching in some parts of their range. There continues to be a black market for hawksbill shell products ("tortoiseshell"), which likely contributes to the harvest of this species.

Summary of Status for Hawksbill Sea Turtles

Worldwide, hawksbill sea turtle populations are declining. They face many of the same threats affecting other sea turtle species. In addition, there continues to be a commercial market for hawksbill shell products, despite protections afforded to the species under U.S. law and international conventions.

Critical Habitat

No critical habitat has been designated by the NMFS for Hawksbill sea turtles in the project area.

Green Sea Turtle

Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered. The nesting range of the green sea turtles in the southeastern United States includes

sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina, the U.S. Virgin Islands (USVI) and Puerto Rico (NMFS and USFWS, 1991b). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties (Ehrhart and Witherington, 1992). Green sea turtle nesting also occurs regularly on St. Croix, USVI, and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz, 1996).

Life History and Distribution

The estimated age at sexual maturity for green sea turtles is between 20-50 years (Balazs, 1982; Frazer and Ehrhart, 1985). Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Females usually have 2-4 or more years between breeding seasons, whereas males may mate every year (Balazs, 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas (Bjorndal, 1997).

Green sea turtles are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.
Green sea turtle foraging areas in the southeastern United States include any coastal shallow waters having macroalgae or sea grasses. This includes areas near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth, 1997; NMFS and USFWS, 1991b). Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty, 1984; Hildebrand, 1982; Shaver, 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr, 1957; Carr, 1984), Florida Bay and the Florida Keys (Schroeder and Foley, 1995), the Indian River Lagoon System, Florida (Ehrhart, 1983), and the Atlantic Ocean off Florida from Brevard through Broward counties (Wershoven and Wershoven, 1992; Guseman and Ehrhart, 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs.

Population Dynamics and Status

The vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Meylan *et al.* 1995; Johnson and Ehrhart 1994). Green sea turtle nesting in Florida has been increasing since 1989 (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute Index Nesting Beach Survey Database). Current nesting levels in Florida are reduced compared to historical levels, reported by Dodd (1981). However, total nest counts and trends at index beach sites during the past years suggest the numbers of green sea turtles that nest within the southeastern United States are increasing.

Although nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging and developmental grounds. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatán Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth, 1997). The summer developmental habitat for green turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus, 1997).

There are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas (where they come to forage) of the southeastern United States. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant (they have averaged 215 green sea turtle captures per year since 1977) in St. Lucie County, Florida (on the Atlantic coast of Florida) show that the annual number of immature green sea turtles captured has increased significantly in the past 26 years (FPL, 2002).

It is likely that immature green sea turtles foraging in the southeastern United States come from multiple genetic stocks; therefore, the status of immature green sea turtles in the southeastern United States might also be assessed from trends at all of the main regional nesting beaches, principally Florida, Yucatán, and Tortuguero. Trends at Florida beaches were previously discussed. Trends in nesting at Yucatán beaches cannot be assessed because of a lack of consistent beach surveys over time. Trends at Tortuguero (ca. 20,000-50,000 nests/year) showed a significant increase in nesting during the period 1971-1996 (Bjorndal *et al.* 1999), and more recent information continues to show increasing nest counts (Troëng and Rankin, 2004). Therefore, it seems reasonable that there is an increase in immature green sea turtles inhabiting coastal areas of the southeastern United States; however, the magnitude of this increase is unknown.

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the over-exploitation of green sea turtles for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. However, there are still significant and ongoing threats to green sea turtles from human-related causes in the United States. These threats include beach armoring, erosion control, artificial lighting, beach disturbance (e.g., driving on the beach), pollution, foraging habitat loss as a result of direct destruction by dredging, siltation, boat damage, other human activities, and interactions with fishing gear. Sea sampling coverage in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. There is also the increasing threat from green sea turtle fibropapillomatosis disease. Presently, this

disease is cosmopolitan and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst, 1994; Jacobson, 1990; Jacobson *et al.*, 1991).

Summary of Status for Atlantic Green Sea Turtles

Green turtles range in the western Atlantic from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare in benthic areas north of Cape Hatteras (Wynne and Schwartz, 1999). Green turtles face many of the same natural and anthropogenic threats as for loggerhead sea turtles described above. In addition, green turtles are also susceptible to fibropapillomatosis, which can result in death. In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart, 1979). Recent population estimates for the western Atlantic area are not available. Between 1989 and 2006, the annual number of green turtle nests at core index beaches ranged from 267 to 7,158 (Florida Marine Research Institute Statewide Nesting Database). While the pattern of green turtle nesting shows biennial peaks in abundance, there is a generally positive trend since establishment of index beaches in Florida in 1989.

Critical Habitat

No critical habitat has been designated by the NMFS for this species in the project area.

Dredging Methods and Associated Impacts for Sea Turtles

Hopper Dredge

Hopper dredging along the southeastern USA potentially impacts five species of threatened or endangered sea turtles (i.e., leatherback, loggerhead, Kemp's ridley, hawksbill, and green). In the Savannah Harbor project area, Table 8-7 indicates a total of 37 incidental takes (incidents of mortalities or injuries) of sea turtles have been documented from hopper dredging activities in the project area.

Table 8-7. Total Incidental Sea Turtle Takes by Species for SAD (NC/VA border through Key West, FL) from 1980-2007

SOUTH ATLANTIC DIVISION (NC/VA BORDER - KEY WEST, FL) DREDGING RELATED SEA TURTLE INCIDENTS 1980-2007					
Southeastern Atlantic (Jacksonville USACE District)					
Dredging Location	**Loggerhead**	**Green**	**Kemp's**	**Unknown**	**Total**
Dade County Shore Protection Project Miami, FL	0	0	0	0	0
Duval County Shore Protection Project, FL	1	0	0	0	1
Palm Beach Harbor, FL	8	3	0	0	11
Jupiter Island Inlet, FL	2	0	0	0	2
Ft. Pierce, FL	0	1	0	0	1
Melbourne, FL	0	0	0	0	0
Canaveral, FL	77	22	0	50	149
Brevard County Shore Protection Project, FL	5	0	0	0	5
Hutchinson Island Shore Protection, FL	0	0	0	0	0
Melbourne, FL	0	0	0	0	0
St. Augustine Harbor, FL	0	0	0	0	0
Jacksonville Harbor, FL	2	1	0	0	3
Mayport Naval Station, FL	2	2	0	0	4
Kings Bay Entrance Channel, FL	51	6	9	2	68
Key West, FL	0	0	0	0	0
Total	**148**	**35**	**9**	**52**	**244**
South Atlantic (Savannah USACE District)					
Dredging Location	**Loggerhead**	**Green**	**Kemp's**	**Unknown**	**Total**
Brunswick Harbor, GA	41	0	6	1	48
Savannah Harbor, GA	**32**	**0**	**5**	**0**	**37**
TOTAL	**73**	**0**	**11**	**1**	**85**

South Atlantic (Charleston USACE District)					
Dredging Location	**Loggerhead**	**Green**	**Kemp's**	**Unknown**	**Total**
Port Royal, SC	2	0	0	0	2
Charleston Harbor, SC	17	1	0	0	18
Georgetown Harbor, SC	1	0	0	0	1
Myrtle Beach, SC	9	0	0	0	9
Arcadian Shores Private Shore Protection, SC	1	0	0	0	1
TOTAL	**30**	**1**	**0**	**0**	**31**
South Atlantic (Wilmington USACE District)					
Dredging Location	**Loggerhead**	**Green**	**Kemp's**	**Unknown**	**Total**
Wilmington Harbor, NC	8	1	1	0	10
Military Ocean Terminal Sunny Point (MOTSU)	4	0	0	0	4
Morehead City Channel, NC	15	1	0	0	16
Bogue Banks Beach Nourishment, NC	3	0	3	0	6
Oregon Inlet, NC	0	0	0	0	0
Indian Salter Path Beach (Morehead City), NC	0	0	0	0	0
Kure & Carolina Beach Shore Protection, NC	0	0	0	0	0
TOTAL	**30**	**2**	**4**	**0**	**36**
TOTAL SOUTH ATLANTIC DIVISION	**281**	**38**	**24**	**53**	**396**

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POINT OF CONTACT: Dena Dickerson, 3909 Halls Ferry Road, Vicksburg, MS
(601-634-3772, FAX: 601-634-3205),
dena.d.dickerson@erdc.usace.army.mil

The take of sea turtles by hopper dredges was first identified as a potential problem in the late 1970's and NMFS requested that the Corps initiate ESA Section 7 consultation on the probable impacts of maintenance and construction dredging to sea turtles residing in Canaveral Harbor. On January 22, 1980 NMFS issued a biological opinion for Canaveral Harbor concluding that "dredging may result in the loss of large numbers of loggerhead sea turtles but is not likely to result in jeopardizing either the loggerhead or Atlantic ridley sea turtle stocks." As required by this biological opinion, NMFS approved observers were required on board dredges to monitor for turtle takes. Between 11 July and 30 November 1980, a total of 71 turtle takes by hopper dredges was documented in the Canaveral channel; thus, the Corps acknowledged that hopper dredging posed a problem to sea turtles and the need to modify and/or improve operations to minimize impacts was recognized. Over the last 26 years, an increasing number of navigation projects have been monitored for incidental takes. Currently, 77 project sites in the southeastern United States are monitored. Of these locations, 44 have had documented incidental takes of sea turtles. Additionally, throughout the South Atlantic, all hopper dredging operations within designated offshore borrow sites for shore protection projects are monitored by NMFS approved observers.

Since 1980, the Corps and dredging industry have worked to develop protocols, operational methods, and modified dredging equipment to reduce dredging impacts to sea turtles. Engineering and biological studies were completed to develop a suite of protective tools to reduce dredging impacts on marine turtles. These investigations have included sea turtle relative-abundance, behavioral, acoustic-detection and dispersal, and dredging equipment development. In addition to gaining valuable data for understanding sea turtle biology, these studies helped to establish environmental windows, draghead modifications, and draghead turtle deflectors. Furthermore, the USACE has established, and continues to update and improve an internet-based database to centralize and archive historical and future data regarding sea turtle impacts from dredging activities for long-term continuity and evaluation of these data (http://el.erdc.usace.army.mil/seaturtles/index.cfm). In a report to the World Dredging Conference in 2004, Dickerson *et. al.* reviewed the hopper dredge take history and the reduction of take over time, including the measures implemented by the Corps to reduce hopper dredge impacts to sea turtles. Although the overall impacts to sea turtles from dredging activities is relatively small, the USACE and dredging industry are committed to the continued pursuit of efforts to further reduce dredging impacts on sea turtles. Current conservation measures implemented by the Corps to reduce impacts to sea turtles during hopper dredging operations are discussed in Section 4.02.5, below.

Hydraulic Cutterhead

The potential impacts of hydraulic cutterhead dredging on sea turtles have been considered by NMFS in their 1991, 1995, and 1997 SARBOs. Under each Biological Opinion the NMFS determined that cutterhead pipeline dredging may affect but is not likely to adversely affect sea turtles. In contrast to hopper dredges, pipeline dredges are relatively stationary and therefore act on only small areas at any given time. The cutterhead works most efficiently buried within thick sediment deposits and moves relatively slowly across the channel floor. Turtles can avoid the slow moving cutterhead. Therefore, for a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead within the sediment and be caught in the suction. This type of

behavior is unlikely but may be possible if the turtle is cold stunned or brumating. On 29 December 2004, while conducting maintenance dredging of the Brownsville Entrance Channel in Texas, a live stranded green sea turtle was discovered outside of the dredge discharge area with a cracked plastron and carapace. This stranding was one of 42 cold-stunned green sea turtle strandings in the area relative to an arctic cold front that swept through South Texas on December 22. Though it is unlikely that this turtle was taken by the pipeline dredge, it is possible that an increased potential for take may occur if dredging is being conducted where cold-stunned turtles are present.

In the 1980s, observer coverage was required by the NMFS at pipeline outflows during several dredging projects that used pipeline dredges along the Atlantic coast. No turtles or turtle parts were observed in the outflow areas. Additionally, the Corps' South Atlantic Division (SAD) office in Atlanta, Georgia, charged with overseeing the work of the individual Corps Districts along the Eastern Seaboard from North Carolina through Florida, provided documentation of hundreds of hours of informal observation by Corps inspectors during which no takes of listed species were observed. Additional monitoring by other agency personnel, conservation organizations or the general public has never resulted in reports of turtle takes by pipeline dredges (NMFS, 1991a).

Mechanical Dredging - Clamshell (Bucket) Dredge

The impacts of mechanical dredging operations on sea turtles have been previously assessed by the NMFS (NMFS, 1991a; NMFS, 1995a; NMFS 1997b; NMFS, 2003c) in the various versions of the SARBO. The 1991 SARBO states that "clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low..." (NMFS, 1991a). NMFS also determined that "Of the three major dredge types, only the hopper dredge has been implicated in the mortality of endangered and threatened sea turtles." This determination was repeated in the 1995 and 1997 SARBO's (NMFS, 1995a and 1997). No new information is available that suggests increased risk of sea turtle take by clamshell dredges since the 1991, 1995, and 1997 SARBOs were received.

Lighting

Potential impacts from lighting would apply to all types of dredging and associated construction equipment. The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process, including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. Sea turtles rely on vision to find the sea upon completion of the nesting process and use a balance of light intensity within their eyes to orient towards the brightest direction (Ehrenfeld, 1968); thus, misdirection by lighting may occur resulting in more time being spent to find the ocean. Hatchlings rely almost exclusively on vision to orient to the ocean and brightness is a significant cue used during this immediate orientation process after hatch out (Mrosovsky and Kingsmill, 1985; Verheijen and Wilschut, 1973; Mrosovsky and Shettleworth, 1974; Mrosovsky *et al.*, 1979). Hatchlings that are mis-oriented (oriented away from the most direct path to the ocean) or disoriented (lacking directed orientation or frequently changing direction or

circling) from the sea by artificial lighting may die from exhaustion, dehydration, predation, and other causes. Though hatchlings use directional brightness of a natural light field (celestial sources) to orient to the sea, light from artificial sources interferes with the natural light cues resulting in misdirection (Witherington and Martin, 2003).

Female sea turtles approaching nesting beaches and neonates (i.e., hatchlings) emerging from nests and exiting their natal beaches, may be adversely affected by lighting associated with dredges and equipment operating in the nearshore (0-3 nmi) environment. Females approaching the beach to nest could be deterred from nesting by bright lights in the nearshore environment. Hatchlings emerging from their nests could be attracted away from the shortest path to the water and instead crawl or swim toward the bright lights of a nearshore dredge or associated anchored equipment (instead of crawling or swimming seaward toward the open horizon), thus increasing their exposure time to predation. Though the risk of disorientation from dredge associated lighting has been documented, as identified in a survey conducted in 2006 by the Florida Fish and Wildlife Conservation Commission on percentages of light sources contributing to disorientation events in Florida, boats (dredges were not specifically identified) were identified as contributing to 0.07% (N=1) of the total disorientation events recorded in the state (http://myfwc.com/seaturtle/Lighting/Light_Disorient.htm).

For dredging vessels, appropriate lighting is necessary to provide a safe working environment during nighttime activities on deck (endangered species observers, etc.). In compliance with the US Army Corps of Engineers Safety and Health Requirements Manual (USACE, 2003), a minimum luminance of 30 lm/ft^2 is required for outside work performed on board the dredge during nighttime dredge operations. To reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches, while still adhering to minimum luminance requirements, light emanating from offshore equipment will be minimized through reduced wattage, shielding, lowering, and/or use of low pressure sodium lights to the extent practicable. Shielded low-pressure sodium vapor lights have been identified by the FWCC as the best available technology for balancing human safety and security, roadway illumination, and endangered species protection. They provide the most energy efficient, monochromatic, long-wavelength, dark sky friendly, environmentally sensitive light of the commercially available street lights and will be highly recommended for all lights on the beach or on offshore equipment (Gallagher, 2006). Removal of the use of the nearshore dredged material placement sites off Tybee Island for new work placement has eliminated much of this concern.

Conservation Measures

Hopper dredges working in the Savannah District will implement the following conservation measures prior to any work being accomplished:

a. Draghead Deflector

The sea turtle deflecting draghead evolved from engineering studies performed in the 1980's to modify draghead designs to minimize sea turtle takes (Figure 8-13).

Since its conception, turtle deflecting dragheads have been used on almost all hopper dredging projects in the South Atlantic and have significantly minimized the risk of sea turtle take (Nelson and Shafer 1996; Clausner et al. 2004; Dickerson et al. 2004). Specifically, Contractors are required to equip dragheads with rigid sea turtle deflectors which are rigidly attached to the draghead. In order to assure that the turtle deflecting draghead is engineered and installed correctly, the Contractor provides the Corps with drawings and calculations for the project depth to be dredged. These submittals are approved by the Corps prior to project commencement.

Specifically, the leading V-shaped portion of the deflector must have an included angle of less than 90 degrees. Internal reinforcement must be installed in the deflector to prevent structural failure of the device. The leading edge of the deflector must be designed to have a plowing effect of at least 6" depth when the drag head is being operated so that turtles located in front of the draghead are pushed away by the resultant sand wave. The dragtender must have the appropriate instrumentation on board the dredge to assure that the critical "approach angle" is maintained during dredging operations. The design "approach angle" or the angle of lower drag head pipe relative to the average sediment plane is very important to the proper operation of a deflector. If the lower drag head pipe angle in actual dredging conditions varies tremendously from the design angle of approach used in the development of the deflector, the 6" plowing effect does not occur and the risk of sea turtle interactions increases. As a component of the Contractor's pre-project submittal to the Corps, approach angle calculations (relative to dredge specific draghead configurations and project specific dredging depths) are provided.

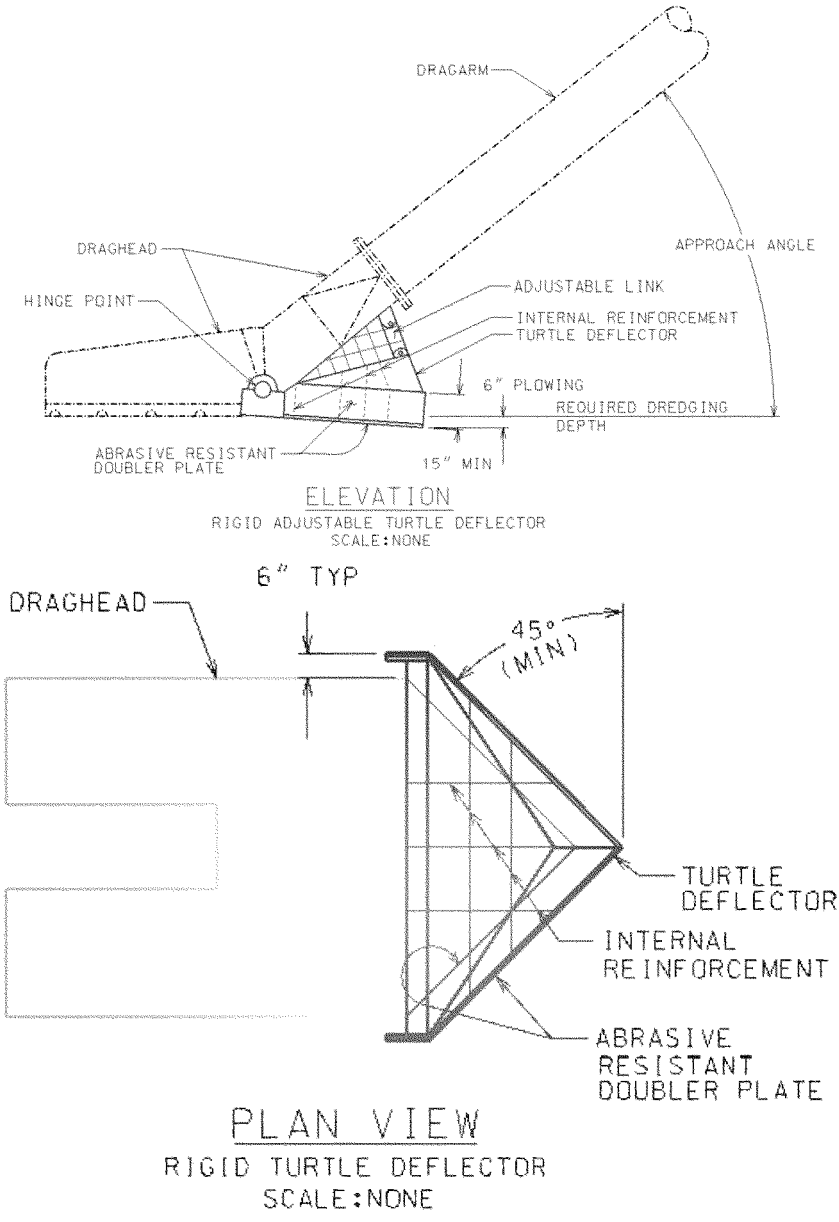

Figure 8-13. Example design drawings of rigid adjustable turtle deflector.

Studies from US dredging projects have demonstrated that, due to the mode of operation for the trailing suction draghead, sea turtles most at risk for entrainment are those that are on or actually nestled into the sea floor sediment. If the dragtender allows the draghead to rise up or bounce along the bottom during suction dredging, turtles that are on or in the sea floor can become trapped underneath the draghead and suctioned into the pumps. Turtles swimming in the water column are not at risk for entrainment, primarily due to the extremely small area of suction influence around the draghead (< ½ meter). However, a turtle might be entrained if it happened to swim directly underneath (within ½ meter) a draghead suspended in the water column with the suction pumps still engaged.

To minimize the risk of impingement or entrainment of sea turtles in the open water column, hopper dredge contract specifications require that dredge pumps not be operated when the dragheads are not firmly on the bottom, to the maximum extent practicable. Furthermore, pumping water through the drag heads is not allowed while maneuvering or during travel to/from the disposal area. During turning operations the pumps must either be shut off or reduced in speed to the point where no suction velocity or vacuum exists. If the required dredging section includes compacted fine sands or stiff clays, a properly configured arrangement of teeth is recommended to enhance dredge efficiency, which reduces total dredging hours and "turtle takes." Pipe plugging shall not be corrected by raising the drag head off the bottom to increase suction velocities; therefore, dredge operators are required to configure and operate their equipment to eliminate the potential for low level suction velocities. An example recommendation for providing additional mixing water to the suction line is through the configuration of water ports openings on top of the drag head or on raised stand pipes above the drag head. All waterport configurations are required to be screened before they are utilized on the dredging project.

To assure that these conditions are understood and implemented by the Contractor, the Corps requires that the Contractor develop a written operational plan to minimize turtle takes and submit it as part of the Environmental Protection Plan for approval prior to project commencement. Furthermore, in order to assure contractor compliance with all sea turtle protection measures during hopper dredge operations, detailed quality assurance inspections are performed by Corps personnel on each hopper dredge contract as well as after each sea turtle take.

b. Environmental Windows

To minimize risk of sea turtle incidental takes by dredges, environmental windows were established by NMFS, and further refined by the Corps, which restrict dredging to periods when turtles are least abundant or least likely to be affected by dredging. The environmental windows for turtle-safe dredging have targeted the winter months since sea turtle abundance is dramatically reduced at water temperatures below 13°C and typically absent during temperatures below 11°C (Matthew Godfrey, personal communication; Moon *et al.*, 1997; STAC, 2006; USACE Sea Turtle Data Warehouse (http://el.erdc.usace.army.mil/seaturtles/allowed.cfm)). The recommended environmental window for most navigation hopper dredging activities (where sea turtle presence is controlled by water temperature) within the project area is from 1 December through 31 March of any year as indicated in the Biological Opinion.

No new work material would be placed into the nearshore area or on the beach at Tybee Island. However, maintenance material could be placed into these areas at some time in the future. In accordance with USFWS directives, placement of dredged material into these areas would be restricted to 1 August to 30 April of any year.

c. Inflow/Overflow Screening and Observers

Inflow/Overflow Screening

In accordance with the Reasonable and Prudent Measures (RPM's) outlined in previous (1995 and 1997) NMFS SARBO's, all SAD hopper dredging contracts require 100% inflow screening throughout the duration of each contract. If possible, 100% overflow screening is also recommended; however, the configuration of the overflow for each hopper dredge is different and 100% overflow screening, in some cases, may not be possible. Nonetheless, if 100% inflow screening is not possible, 100% overflow screening is enforced.

The configuration of inflow and overflow screening is hopper dredge specific, resulting in multiple Contractor configurations to meet Corps contract screening requirements. Corps hopper dredging contracts require a 4"x 4" screen mesh size for both inflow screening to allow biotic and abiotic debris to be screened and evaluated by endangered species observers before being allowed into the hopper (Figure 8-14). The same screen mesh size is used for overflow screening. The efficacy of this inflow and overflow screening mechanism depends on the dredge specific configuration. Some configurations are more prone to clogging with debris; thus, resulting in reduced monitoring efficiency and coverage. In some cases, debris accumulation in the inflow boxes is so significant that effective observer coverage is not possible and the Corps must replace the inflow screening with 100% overflow screening. Depending on the type of debris encountered, overflow screening may become clogged with floating debris and compromise the safety of the vessel. The Corps has consulted with the NMFS on a case-by-case basis to address these site specific circumstances.

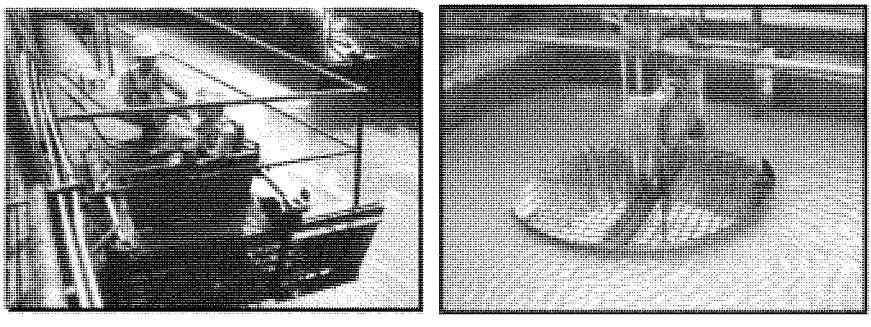

Figure 8-14. Photographs of hopper dredge inflow (left) and overflow (right) screening.

Observers

During hopper dredging operations, observers approved by the National Marine Fisheries Service (NMFS) for sea turtles, sturgeon, and whales are required to be aboard the hopper dredge to monitor for the presence of the species where appropriate. Specific observer requirements throughout the South Atlantic are outlined in Table 3 of the 1997 SARBO; however, the USACE SAD currently encourages a more stringent protocol of one hundred percent (24hr/day) observer coverage conducted year round for hopper dredge operations. During transit to and from offshore borrow or placement areas, the observer monitors from the bridge during daylight hours for the presence of endangered species, especially the right whale, during the period December through March. During dredging operations, while dragheads are submerged, the observer continuously monitors the inflow and/or overflow screening for turtles and/or turtle parts. Upon completion of each load cycle, dragheads are monitored as the draghead is lifted from the sea surface and is placed on the saddle in order to assure that sea turtles that may be impinged within draghead are properly accounted. Physical inspections of dragheads and inflow and overflow screening/boxes for threatened and endangered species take are performed to the maximum extent practicable.

d. Dredging Quality Management (DQM) Program (Formerly known as Silent Inspector)

The DQM program is an automated dredge monitoring system comprised of both hardware and software developed by the Corps. The Corps developed the DQM as a low cost, repeatable, impartial system for automated dredge monitoring. Currently, DQM is required for all Corps hopper and scow contracts; however, it is not on all Government-owned dredges yet. The DQM system integrates various automated systems to record digital dredging and disposal activities for both government-owned and contract dredges. Both DQM systems collect and record measurements from shipboard sensors, calculate the dredging activities, and display this information using standard reports and graphical displays.

On hopper dredges, DQM monitors the operating conditions of the dredge in near real time. Once loaded in to the DQM database, graphical displays can be generated to help assure contractor compliance with the draghead operating requirements, as outlined in Section 4.02.5, in order to minimize sea turtle take risk. Visual graphs can be used (Figure 8-15) to display dredging data variables such as draghead elevation, slurry density, slurry velocity, etc. Specifically, if a sea turtle take occurs, these data can be used to generate graphs that may help in developing risk assessments to assess what the conditions of the dragheads were during any given load cycle (See paragraph (g) of Section 4.02.5). If a sea turtle take can be correlated to incompliance with contract specification requirements through DQM, it is possible to correct the Contractor of his actions in order to minimize the risk of taking another turtle.

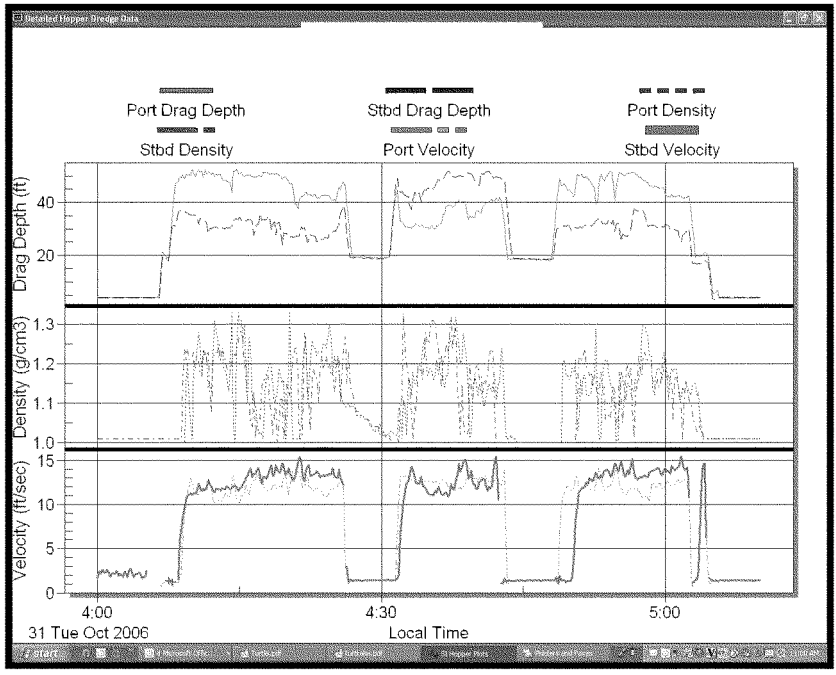

Figure 8-15. Example graphic generated by DQM to help assess contractor compliance with sea turtle operating condition requirements during hopper dredging operations. Specific time periods when the dragheads are off the bottom with the pumps still on can be identified using this DQM tool.

Effect Determination

A. Hydraulic Hopper Dredge

Hopper dredges may be used to deepen the entrance channel (from Stations 0+000 to -97+680B). All hopper dredging will be generally scheduled for 1 December through 31 March, and the following conditions will apply*:

1. One hundred percent inflow screening is required, and 100 percent overflow screening is recommended when sea turtle observers are required on hopper dredges in areas and seasons when sea turtles may be present. If conditions disallow 100 percent inflow screening, inflow screening can be reduced, but 100 percent overflow screening is required, and an explanation must be included in the preliminary dredging report.

2. The sea turtle deflecting draghead is required for all hopper dredging.

3. To prevent impingement of sea turtles within the water column, every effort should be made to keep the dredge pumps disengaged when the dragheads are not firmly on the bottom.

4. A trained turtle observer will be placed on the hopper dredges to monitor for sea turtles for 100 percent of the period from 1 through 31 March.

5. The water intake ports on the top of the draghead shall be screened with metal elliptical cages, or other suitable means to exclude sea turtles from entering the drag arm. No dredging shall be performed by a hopper dredge without a turtle deflector device in place.

6. Dredging shall be suspended upon the taking of more than two turtles in any 24-hour day, the taking of one hawksbill turtle, or once three turtles are taken. Dredging operations will not commence, again, until coordination with South Atlantic Division and the NMFS has taken place and any remediation requirements are implemented, such as relocation trawling with a shrimp boat, to ensure compliance with the Endangered Species Act.

7. A report summarizing the take of sea turtles will be submitted to the National Marine Fisheries Service (NMFS) immediately following completion of the project.

NOTE: *These are the conditions currently being followed in accordance with the NMFS 1997 Biological Opinion for Navigation Channels in the Southeast, and additional guidance provided by South Atlantic Division. Should a new Regional Biological Opinion be issued, the District would consider the conditions listed here void, and would abide by the conditions as stated in that opinion and any further guidance provided by South Atlantic Division.

B. Other Hydraulic and Mechanical Dredging Operations

Though the potential exists for impacts to loggerhead, Kemp's ridley, hawksbill, and green sea turtles from other dredging operations such as mechanical dredging and cutterhead (pipeline) dredging, no sea turtle species are known to have been specifically taken by these operations.

Therefore, they continue to be considered as dredging alternatives which may affect, but are not likely to adversely affect sea turtle species.

With deepening, the total number of vessels in the Harbor would decrease (when comparing With and Without Project conditions) as vessels would be able to load more deeply under the improved conditions. Therefore fewer ships would be calling on the Port of Savannah (when comparing With and Without Project conditions) and shipping is not expected to impact sea turtles more than under existing conditions.

Summary of Critical Habitat for Sea Turtles in the Project Area

NMFS has not designated any critical habitat designation for leatherback, loggerhead, Kemp's ridley, hawksbill, and green sea turtle species in the project area. Therefore, the proposed activities will not adversely modify designated critical habitat for leatherback, loggerhead, Kemp's ridley, hawksbill, and green sea turtle species.

Summary Effect Determination

With implementation of the conservation measures and construction windows mentioned above, the use of hopper, pipeline, and mechanical dredges in the project area "may affect, but is not likely to adversely affect" the leatherback, loggerhead, Kemp's ridley, hawksbill, and green sea turtles.

8.02.7 Atlantic Sturgeon and Shortnose Sturgeon

The Shortnose and Atlantic sturgeon are different species. However, considering their similarities in habitat use, distribution throughout the proposed action area, foraging behavior and prey base, and subsequent risk of take relative to dredging and trawling operations (based on documented incidental take records), this assessment will consider impacts from the proposed activity to Shortnose and Atlantic sturgeon together. Information on these species can be obtained from the following link and other sources: http://sero.nmfs.noaa.gov/pr/sturgeon.htm On February 6, 2012, NOAA Fisheries Service issued a final determination to list the South Atlantic and Carolina population sement of Atlantic sturgeon as endangered under the Endangered Species Act (effective date of April 6, 2012). NOAA Fisheries Service recently conducted status reviews for five Atlantic sturgeon distinct population segments off the US East Coast (New York Bight, Chesapeake Bay, Carolinas, Gulf of Maine and South Atlantic). In February 2012, NOAA also reached decisions about the other East Coast population segments, listing the New York Bight and Chesapeake Bay populations as endangered, and the Gulf of Maine population as threatened.

Shortnose Sturgeon

Life History and Distribution

Life History

The Shortnose sturgeon is an anadromous species restricted to the east coast of North America. Throughout its range, Shortnose sturgeon occur in rivers, estuaries, and the sea. It is principally a riverine species and is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional overwintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt.) salinity or greater) as adults during the winter. The majority of populations have their greatest abundance and are found throughout most of the year in the lower portions of the estuary and are considered to be more abundant now than previously thought (NMFS, 1998a).

The Shortnose sturgeon is a suctorial feeder and its preferred prey is small gastropods. Sturgeon forage by slowly swimming along the bottom, lightly dragging their barbels until they feel something that may resemble food, at which time they suck it up in their protrusible mouths. The non-food items are expelled through their gills. Juveniles may be even more indiscriminate, and just vacuum their way across the bottom. Soft sediments with abundant prey items such as macroinvertebrates are thought to be preferred by Shortnose sturgeon for foraging, so established benthic communities are important. They are thought to forage for small epifaunal and infaunal organisms over gravel and mud. A few prey studies have been conducted and prey include small crustaceans, polychaetes, insects, and mollusks (Moser and Ross 1995; NMFS, 1998a), but they have also been observed feeding off plant surfaces and on fish bait (Dadswell *et al.* 1984). Hall et al., 1991, mention the small clam Corbicula as being a possible prey item for the Shortnose sturgeon in the lower Savannah River. Three sites just upstream of the project upper limit were identified as feeding areas River Mile 24.6, 22.4, and 22.2 (rkm 39.6, rkm 36, and rkm 35.7).

The species' general pattern of adult seasonal movement (spawning) involves an upstream migration from late January through March when water temperatures range from 9° C to 12° C. Post-spawning fish begin moving back downstream in March and leave the freshwater reaches of the river in May. Juvenile and adult sturgeon use the area located 1 to 3 miles from the freshwater/saltwater interface throughout the year as a feeding ground. During the summer, this species tends to use deep holes at or just above the freshwater/saltwater boundary (Flournoy *et al.*, 1992; Rogers and Weber; 1994, Hall *et al.*, 1991). Juvenile Shortnose sturgeon generally move upstream for the spring and summer seasons and downstream for fall and winter; however, these movements usually occur above the salt- and freshwater interface of the rivers they inhabit (Dadswell *et al.* 1984, Hall *et al.* 1991). Adult Shortnose sturgeon prefer deep, downstream areas with soft substrate and vegetated bottoms, if present. Because they rarely leave their natal rivers, Kieffer and Kynard (1993) considered Shortnose sturgeon to be freshwater amphidromous (*i.e.* adults spawn in freshwater but regularly enter saltwater habitats during their life).

As with most fish, southern populations of Shortnose sturgeon mature earlier than northern ones: females reach sexual maturity at approximately 6 years, and males reach it at 3 years. In early

February to late March, Shortnose sturgeon spawn far upstream in freshwater. In most population segments, sturgeon spawn at the uppermost river reaches that are accessible. Damming rivers has blocked passage to many spawning grounds as a result; fortunately, the Savannah River is not dammed until just below the fall line. Hall et al. (1991) identified potential spawning sites at river kilometer (RKM) 179 to 190 and 275 to 278. Spawning habitat is well upstream of the project influence, in channels and curves in gravel sand, and log substrate in the Savannah River (Hall et al. 1991). Other suitable substrates include riffles near limestone bluffs with gravel to boulder-sized substrate (Rogers and Weber 1995). Spawning lasts for about 3 weeks, beginning when water temperatures are at about 8 to 9° C, and ending when it reaches approximately 12 to 15° C. The spent fish migrate downriver from March to May, and spend the summer from June to December in the lower river (Hall et al. 1991). Females likely do not spawn every year, while males may do so. Adult Shortnose sturgeon have been found at the base of the New Savannah Bluff Lock and Dam (the lowest dam on the Savannah River) during the spring months. The demersal, adhesive eggs hatch in freshwater, and develop into larvae within 9 to 12 days. Larvae start swimming and initiate their slow downstream migrations at about 20 mm in length (Richmond and Kynard, 1995).

Shortnose sturgeon in the northern portion of the species' range live longer than individuals in the southern portion of the species' range (Gilbert, 1989). The maximum age reported for a Shortnose sturgeon in the St. John River in New Brunswick is 67 years (for a female), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years in the Connecticut River, 20 years in the Pee Dee River, and 10 years in the Altamaha River (Gilbert 1989 using data presented in Dadswell *et al.* 1984). Male Shortnose sturgeon appear to have shorter life spans than females (Gilbert, 1989).

The current best estimate (Collins et al 2001 and Collins et al. 2002) is that adult sturgeon can be expected throughout the year somewhere within the area from River Mile 3.4 to 29.5 (river kilometers 5.5 to 47.5) and juvenile sturgeon from River Mile 19.3 to 29.5 (river kilometers 31.2 to 47.5), respectively.

Adult Life Stage

Adult Shortnose sturgeons migrate extensively throughout an individual river system and may also migrate between different river basins (Wrona *et al.*, 2007; Cooke and Leach, 2004). In 1999 and 2000, Collins *et al.* (2001) tracked adult and juvenile sturgeon in the Savannah River and identified distinct summer and winter habitats in terms of location and water quality (Table 8-8). Observations indicate that they seek relatively deep, cool holes upriver for sanctuary from warm temperatures (and possibly to escape low dissolved oxygen coupled with salinity stress), and in the winter, they migrate downstream to the estuary, perhaps to feed or escape extreme cold. When temperatures are below 22° C, it appears that both adult and juvenile sturgeon stay in the lower river. During warmer periods when temperatures exceed 22° C, telemetry observations and gill net surveys indicate that sturgeon use the upper estuary. While they are known to occur in 4 to 33° C, sturgeon show signs of stress at temperatures above 28°, and this stress may be exacerbated by low dissolved oxygen conditions during summer critical months. Sturgeon may seek thermal refuges during these periods, deep cool waters where salinity conditions are appropriate and food is available with minimal foraging movements. For

example, Flournoy *et al.* (1992) found that sturgeon may use spring-fed areas for summer habitat in the Altamaha River system. The synergistic effects of high temperatures and low dissolved oxygen should be considered in any impact analysis, and the analysis for this project included these parameters. Based on work done in the Chesapeake Bay, sturgeon may suffer an "oxygen squeeze" in the summer when they seek deep cool areas that also have low dissolved oxygen (Secor and Niklitschek, 2001).

Table 8-8. Mean Water Temperature, Salinity, and Dissolved Oxygen (D.O.) by Season at Locations where Adult Shortnose Sturgeon were Found (reproduced from Collins *et al.* 2001)

Season	°C	Salinity (ppt)	D.O. (mg/L)
Spring	19.9	1.4	7.84
Summer	27.3	2.0	6.36
Fall	21.1	3.3	7.06
Winter	12.3	5.4	8.36

Juvenile Life Stage

Juvenile Shortnose sturgeon mature at approximately 3 to 6 years of age, and they live in the salt/fresh interface in most rivers. After spending their first year in the upper freshwater reaches, they adopt the adult migratory lifestyle and go upriver in the summer and down in the winter. Like adults, they need sand or mud substrate for foraging (Hall *et al.* 1991). They are less tolerant of low dissolved oxygen and high salinity than the adults and appear to migrate accordingly within the river system. According to Collins *et al.* (2001), when temperatures exceeded 22° C in the Savannah River, juveniles spent the summer in deep (5 to 7 m) holes with 0 to 1 ppt salinity levels (Table 8-9). During the winter, they use the warmer estuarine-influenced lower river. For example, they move into more saline areas (0 to 16 ppt) when temperatures dropped below 16° C in the Ogeechee River. Warm summer temperatures over 26° limit movement of juveniles who may not be able to forage extensively during summers. Tolerance to both dissolved oxygen and salinity is thought to increase with age; very young sturgeon are known to be extremely sensitive to both (Jenkins *et al.*, 1993). Jenkins *et al* (1993) reported that in a 6-hour test, fish 64 days old exhibited 86% mortality when exposed to dissolved oxygen concentrations of 2.5 mg/L. However, sturgeon >100 days old were able to tolerate concentrations of 2.5 mg/L with <20% mortality. Jenkins also reported that dissolved oxygen at less than 3 mg/L causes changes in sturgeon behavior: Fish hold still and pump water over their gills, an apparent adaptation to survive low dissolved oxygen conditions. If fish spawn in the spring, it is believed that late age individuals encounter these low dissolved oxygen conditions in the lower estuary. The Environmental Protection Agency (Chesapeake Bay Program Office) recently revised its D.O. criteria for living resources in Chesapeake Bay tributaries from 2.0 mg/L to 3.5 mg/L to be protective of sturgeons (Secor and Gunderson, 1998; Niklitschek and Secor, 2001). It is possible that 3.5 mg/L may be acceptable, but 4.0 mg/L would be safer for the higher temperatures in this southern river. As with adults, temperatures above 28° reduce tolerance to low dissolved oxygen (Flournoy *et al.* 1992).

Table 8-9. Mean Water Temperature, Salinity, and Dissolved Oxygen by Season at Locations where Juvenile Shortnose sturgeon were Found (reproduced from Collins *et al.* 2001)

Season	°C	Salinity	D.O.
Spring	20.4	2.4	7.58
Summer	28.5	0.3	6.80
Fall	21.7	4.7	6.45
Winter	12.5	8.6	8.63

Egg and Larval Life Stages

The demersal, adhesive eggs hatch in freshwater, and develop into larvae within 9 to 12 days. Larvae start swimming and initiate their slow downstream migrations at about 20 mm in length. It is generally agreed that Shortnose sturgeon larvae are not in the project impact area. No Shortnose sturgeon larvae (including ichthyoplankton and ichthyofauna) were found in the 2-year study in the Savannah River estuary ("Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary") conducted by UGA for this project. However, an Atlantic sturgeon (*A. oxyrinchus*) larva was found at approximately RKM 41 during a recent ichthyoplankton study (Reinert et al. 1998). The maintained harbor extends up to RKM 34.3. In addition to existing information, an extensive monitoring study in the SE US is being funded by NOAA on the Atlantic and Shortnose sturgeon. This effort began in the spring of 2011 and is scheduled to last for 5 years. The work in the Savannah River is being conducted by SC DNR. (http://www.nmfs/noaa.gov/pr/conservation/states/funded.htm). As information becomes available, the Corps and NOAA Fisheries will consider it.

Present Conditions. Based on the known effects of dissolved oxygen, temperature, and salinity during the critical summer months, a safe threshold for suitable habitat for Shortnose sturgeon appears to be approximately 4.0 mg/L in the bottom meter of the water column when temperatures exceed 26°C and 3.5 mg/L when they do not exceed that temperature threshold (Secor and Gunderson, 1998; Niklitschek and Secor, 2001; and Flournoy *et. al.* 1992). Prolonged exposure to low oxygen levels may not produce acute impacts to fish health, but would result in extended periods of stress that would likely result in chronic or delayed complications to fish health that could influence condition, reproduction or survival.

Salinity criteria are more complicated due to the migration patterns of sturgeon and various tolerance levels by life stage. For juveniles at age 1, salinity levels between 0 and 4 ppt could be considered suitable habitat. For adults, salinity from 0 to 17 ppt could be considered appropriate. However, for both juveniles and adults, salinity tolerances are likely related to temperature.

During the winters of 1999-2000, juvenile Shortnose sturgeon consistently utilized a deep hole in Middle River near the confluence with the Front River. These juveniles enter and exit the Middle River area through its connection with the Front River.

The Fisheries Interagency Coordination Team (composed of representatives from USFWS, NOAA Fisheries, South Carolina DNR, Georgia DNR, and the Corps) developed criteria for acceptable Shortnose sturgeon habitat in the Savannah Harbor for impact evaluation purposes on this project. Those criteria are indicated in Table 8-10.

Table 8-10. Summary of Shortnose sturgeon Habitat Suitability Criteria in the Savannah River Estuary

Life Stage	Adults	Adults	Juveniles
Time of Year	Winter	Summer	Winter
Salinity	<= 25 ppt	<= 10 ppt	<= 4 ppt
D.O. Exceedance	10 %	Same	Same
Dissolved Oxygen	3.5 mg/L	4.0 mg/L	3.5 mg/L
D.O. Exceedance	5 %	Same	Same
Dissolved Oxygen	3.0 mg/L	3.0 mg/L	3.0 mg/L
D.O. Exceedance	1 %	Same	Same
Dissolved Oxygen	2.0 mg/L	2.0 mg/L	2.0 mg/L
Temperature	Normal January	Normal August	Normal January
River Flow	Normal January	Normal August	Normal January
Location – depth	Bottom layer	Same	Same
Location – width	Where Hydrodynamic Model is 3 cells wide, use deepest cell; where >3 cells wide, use deepest 2 cells	Same	Same

Species' Description, Distribution, and Population Structure

Shortnose sturgeon occur within most major river systems along the Atlantic Coast of North America, from the St. John River in Canada to the St. Johns River in Florida. In the southern portion of the range, they are found in the St. Johns River in Florida; the Altamaha, Ogeechee, and Savannah Rivers in Georgia; and, in South Carolina, the river systems that empty into Winyah Bay and the Santee/Cooper River complex that forms Lake Marion. Data are limited for the rivers of North Carolina. In the northern portion of the range, Shortnose sturgeon are found in the Chesapeake Bay system, Delaware River from Philadelphia, Pennsylvania to Trenton, New Jersey; the Hudson River in New York; the Connecticut River; the lower Merrimack River in Massachusetts and the Piscataqua River in New Hampshire; the Kennebec River in Maine; and the St. John River in New Brunswick, Canada (http://www.nmfs.noaa.gov/pr/species/fish/Shortnosesturgeon.htm#distribution). The Shortnose sturgeon recovery plan describes 20 Shortnose sturgeon population segments that exist in the wild. Two additional, geographically distinct populations occur behind dams in the Connecticut River (above the Holyoke Dam) and in Lake Marion on the Santee-Cooper River system in South Carolina (above the Wilson and Pinopolis Dams). Although these populations are geographically isolated, genetic analyses suggest that individual Shortnose sturgeon move between some of these populations each generation (Quattro *et al.* 2002, Wirgin *et al.* 2005) (Table 8-10).

At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Kennebec and Androscoggin Rivers. At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between 1 and 10 individuals per generation, with the highest rates of exchange between the Ogeechee and Altamaha Rivers (Wirgin *et al.* 2005). Wirgin *et al.* (2005) concluded that rivers separated by more than 400 km were connected by very little migration, while rivers separated by no more than 20 km (such as the rivers flowing into coastal South Carolina) would experience high migration rates. Coincidentally, at the geographic center of the Shortnose sturgeon range, there is a 400 km stretch of river with no known populations occurring from the Delaware River, New Jersey to Cape Fear River, North Carolina (Kynard, 1997) (Table 8-11). However, Shortnose sturgeon are known to occur in the Chesapeake Bay, and may be transients from the Delaware River via the Chesapeake and Delaware Canal (Skjeveland *et al.* 2000, Welsh *et al.* 2002) or remnants of a population in the Potomac River.

Several authors have concluded that Shortnose sturgeon populations in the southern end of the species geographic range are extinct. Rogers and Weber (1994), Kahnle *et al.* (1998), and Collins *et al.* (2000) concluded that Shortnose sturgeon are extinct from the St. Johns River in Florida and the St. Marys River along the Florida and Georgia border. Historical distribution has been in major rivers along the Atlantic seaboard from the St. John River in Canada, south to the St. Johns River in Florida and rarely in the off-shore marine environment. Currently, Shortnose sturgeon are more prominent in northern river systems and severely depleted in southern river systems.

Table 8-11. Known Shortnose Sturgeon Population Densities (table adapted from NMFS 2007 Biological Opinion for the issuance of Permit #1447)

Population/Sub population	Distribution	Datum	Estimate	Confidence Interval	Authority
Neuse River	NC	2001-2002	Extirpated		Oakley 2003
Cape Fear River	NC	1997	>100		Kynard 1997, NMFS 1998
Winyah Bay	NC, SC	No data			
Waccamaw - Pee Dee River	SC	No data			
Santee River	SC	No data			
Cooper River	SC	No data			
ACE Basin	SC	No data			
Savannah River	SC,GA		1,000-3,000		Bill Post, SCDNR 2003
Ogeechee River	GA	1990s	266		Bryce *et al.* 2002
		1993	266	236-300	Kirk *et al.* 2005
		1993	361	326-400	Rogers and Weber 1994
		1999/2000	195		Bryce *et al.* 2002
		2000	147	105-249	Kirk *et al.* 2005
		2004	174	97-874	Kirk *et al.* 2005
Altamaha River	GA	1988	2,862	1,069-4,226	NMFS 1998
		1990	798	645 – 1, 45	NMFS 1998
		1993	468	315 – 903	NMFS 1998
		2003-2005	6,320	4,387-9,249	DeVries 2006
Satilla River	GA		Extirpated		Kahnle *et al.* 1998
Saint Mary's River	FL		Extirpated		Kahnle *et al.* 1998, Rogers and Weber 1994
Saint Johns River	FL		extirpated		Rogers and Weber 1994; FWC 2007

Population Dynamics and Status

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001) pursuant to the Endangered Species Preservation Act of 1966. Shortnose sturgeon remained on the list as endangered with the enactment of the ESA in 1973. Shortnose sturgeon were first listed on the International Union for Conservation of Nature and Natural Resources Red List in 1986 where it is still listed as vulnerable and facing a high risk of extinction based in part on: an estimated range reduction of greater than 30% over the past three generations, irreversible habitat losses, effects of habitat alteration and degradation, degraded water quality and extreme fluctuations in the number of mature individuals between rivers.

Despite the longevity of adult sturgeon, the viability of sturgeon populations are highly sensitive to juvenile mortality that result in reductions in the number of sub-adults that recruit into the adult, breeding population (Anders *et al.*, 2002; Gross *et al.*, 2002; Secor *et al.*, 2002). Sturgeon populations can be grouped into two demographic categories: populations that have reliable (albeit periodic) natural recruitment and those that do not. The Shortnose sturgeon populations without reliable natural recruitment are at the greatest risk (Secor *et al.*, 2002). Alternatively, several authors have also demonstrated that sturgeon populations generally, and Shortnose sturgeon populations in particular, are much more sensitive to adult mortality than other species of fish (Boreman, 1997; Gross *et al.*, 2002; Secor *et al.*, 2002). These authors concluded that sturgeon populations cannot survive fishing related mortalities that exceed five percent of an adult spawning run and they are vulnerable to declines and local extinction if juveniles die from fishing related mortalities.

Threats

The construction of dams throughout the Shortnose sturgeon's range probably reduced their reproductive success by reducing the volume of suitable spawning habitat. Dredging activities have been known to take individual sturgeon and have the potential to alter the quality of their feeding, rearing, and overwintering habitat (http://www.nmfs.noaa.gov/pr/species/fish/shortnosesturgeon.htm). More recently, larval and juvenile Shortnose sturgeon in the different populations along the Atlantic have been killed after being impinged on the intake screens or entrained in the intake structures of power plants on the Delaware, Hudson, Connecticut, Savannah and Santee rivers (Dadswell *et al.*, 1984). Sturgeon populations have also been reduced further by habitat fragmentation and loss, siltation, water pollution, decreased water quality (low D.O., salinity alterations), bridge construction, and incidental capture in coastal fisheries (Dadswell *et al.*, 1984; Collins *et al.*, 1996; NMFS, 1998a; Secor and Gunderson, 1998; Collins *et al.*, 2000; Newcomb and Fuller, 2001).

Construction of dams and pollution of many large northeastern river systems during the period of industrial growth in the late 1800's and early 1900's may have resulted in substantial loss of suitable habitat. In addition, habitat alterations from point source discharges, dredging or disposal of material into rivers, or related development activities involving estuarine/riverine mudflats and marshes, remain constant threats. Commercial exploitation of Shortnose sturgeon occurred throughout its range starting in colonial times and continued periodically into the 1950's.

Critical Habitat

No critical habitat rules have been published for the Shortnose sturgeon

Atlantic Sturgeon

The following sections were taken from the 2007 NMFS Status Review of Atlantic Sturgeon:

Life History and Distribution

Life History

Although specifics vary latitudinally, the general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, estuarine dependent, anadromous species. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (Murawski and Pacheco, 1977; Smith and Clugston, 1997).

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron *et al.*, 2002). In some southern rivers, a fall spawning migration may also occur (Rogers and Weber, 1995; Weber and Jennings, 1996; Moser *et al.*, 1998).

Atlantic sturgeon spawning is believed to occur in flowing water between the fresh/salt water interface and fall line of large rivers, where optimal flows are 46-76 cm/s and depths of 11-27 meters (Borodin, 1925; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Bain *et al.*, 2000). Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert, 1989; Smith and Clugston, 1997).

Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters (Murawski and Pacheco, 1977; Smith, 1985), where populations may undertake long range migrations (Dovel and Berggren 1983, Bain 1997, T. King supplemental data 2006). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon wander among coastal and estuarine habitats, undergoing rapid growth (Dovel and Berggren, 1983; Stevenson, 1997). These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10-50m) nearshore areas dominated by gravel and sand substrate (Stein *et al.*, 2004). Coastal features or shorelines where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina, which presumably provide better foraging opportunities (Dovel and Berggren, 1983; Johnson *et al.*, 1997; Rochard *et al.*, 1997; Kynard *et al.*, 2000; Eyler *et al.*, 2004; Stein *et al.*, 2004; Dadswell, 2006).

Species' Description, Distribution, and Population Structure

Assessment of the current distribution and abundance of Atlantic sturgeon is based on a comprehensive review of the literature and interviews with provincial, state, and Federal fishery management personnel regarding historic and ongoing sampling programs which targeted or incidentally captured Atlantic sturgeon. Water bodies where no information is available, either historic or current, were assessed as to whether Atlantic sturgeon could use the present habitat based on the geomorphology of the system and expert opinion. Riverine systems where gravid Atlantic sturgeon or young-of-year (YOY)(< age-1; ≤ 41 cm TL or 35 cm FL) have been documented within the past 15 years were considered to contain extant spawning populations, as this is the average period of time to achieve sexual maturity. The presence of juveniles greater than age-0 (YOY) does not provide evidence of spawning within a river because subadults are known to undertake extensive migrations into non-natal riverine systems.

Comprehensive information on current or historic abundance of Atlantic sturgeon is lacking for most river systems. Data are largely available from studies directed at other species and provide evidence primarily of presence or absence. Historic and current spawning populations of Atlantic sturgeon in East Coast estuarine systems of the United States are summarized in Table 8-12. Size and age data were used to indicate how a particular habitat (i.e., spawning, nursery, or migrating habitat) is utilized by sturgeon. The presence of multiple year classes demonstrates successful spawning in multiple years but not necessarily in that system. Available quantitative data on abundance and, where available, data that document changes in abundance of sturgeon populations are included in the 2007 status review.

Table 8-12. Historic and Current Spawning Populations of Atlantic sturgeon in East Coast Estuarine Systems of the United States

State	River	Historical Spawning Status	Current Spawning Status	Use of River by Atlantic Sturgeon
QE	Saint Lawrence	Yes	Yes	Spawning, Nursery
NB	Miramichi	Unknown	Unknown	Nursery
NS	Avon	Yes	No	Unknown
NS	Annapolis	Yes	Yes	Spawning, Nursery
NB	Saint John	Yes	Yes	Spawning, Nursery
NB/ME	Saint Croix	Yes	Possibly	Nursery
ME	Penobscot	Yes	Possibly	Nursery
ME	Kennebec	Yes	Yes	Spawning, Nursery
ME	Androscoggin	Yes	Possibly	Nursery
ME	Sheepscot	Yes	Possibly	Nursery
NH	Piscataqua	Unknown	No	Unknown
NH/MA	Merrimack River	Yes	No	Nursery
MA/RI	Taunton	Yes	No	Nursery
RI/CT	Pawcatuck	Unknown	No	Unknown
MA/RI/ CT	Thames	No	No	Unknown
CT	Connecticut	Yes	No	Nursery
CT	Housatonic	Unknown	No	Unknown
NY	Hudson	Yes	Yes	Spawning, Nursery
DE/NJ/ PA	Delaware	Yes	Yes	Spawning, Nursery
MD/PA	Susquehanna	Yes	No	Nursery
MD/VA	Potomac	Yes	No	Nursery
VA	James	Yes	Yes	Spawning, Nursery
VA	York	Yes	Possibly	Spawning, Nursery
VA	Rappahannock	Yes	No	Nursery
VA	Nottoway	Yes	Unknown	Unknown
NC	Roanoke	Yes	Yes	Spawning, Nursery
NC	Tar-Pamlico	Yes	Yes	Spawning, Nursery
NC	Neuse	Yes	Possibly	Spawning, Nursery
NC	New Brunswick	Yes	Yes	Spawning, Nursery
SC	Waccamaw	Yes	Yes	Spawning, Nursery
SC/NC	Great Pee Dee	Yes	Yes	Spawning, Nursery
SC	Black	Unknown	Unknown	Unknown
SC	Santee	Yes	Yes	Spawning, Nursery
SC	Cooper	Yes	Yes	Spawning, Nursery
SC	Ashley	Yes	Unknown	Nursery
SC	Ashepoo	Unknown	Unknown	Nursery
SC	Combahee	Yes	Yes	Spawning, Nursery
SC	Edisto	Yes	Yes	Spawning, Nursery
SC	Sampit	Yes	No	Nursery
SC	Broad-Coosawatchie	Yes	Unknown	Unknown
SC/GA	Savannah	Yes	Yes	Spawning, Nursery
GA	Ogeechee	Yes	Yes	Spawning, Nursery
GA	Altamaha	Yes	Yes	Spawning, Nursery
GA	Satilla	Yes	Yes	Spawning, Nursery
GA/FL	St. Mary's	Yes	No	Nursery
FL	St. John's	Unknown	No	Nursery

Population Dynamics and Status

In 1998, in response to a petition to list Atlantic sturgeon under the ESA, NMFS and the U.S. Fish and Wildlife Service (USFWS) published a determination that listing the species was not warranted at that time. In order to continue to monitor its status, the NMFS retained the Atlantic sturgeon on its candidate species list and later transferred it to its species of concern list. In 2003, a workshop sponsored by the NOAA Fisheries Service and U.S. Fish and Wildlife Service (USFWS) was held to review the status of Atlantic sturgeon. The workshop provided an opportunity to gain additional information to determine if a new review of the status of the species was warranted. The 2003 workshop attendees concluded that some populations seemed to be recovering while other populations continued to be depressed.

As a result, NOAA Fisheries Service initiated a second status review of Atlantic sturgeon in 2005 to reevaluate whether this species required protection under the Endangered Species Act (ESA). Following two separate workshops in 2005 which highlighted ongoing concerns regarding the current status of Atlantic sturgeon, NMFS initiated a third status review. A biological review team (BRT) was formed comprised of representatives from NMFS, USFWS, and the U.S. Geological Survey to compile information on the status of Atlantic sturgeon. In 2007 the Status Review Team (SRT) made its status review report available to the public. The SRT concluded that Atlantic sturgeon populations should be divided into five distinct population segments (DPS's): (1) Gulf of Maine, (2) New York, (3) Chesapeake Bay, (4) Carolina, and (5) South Atlantic (Figure 8-16). These Atlantic sturgeon populations are markedly separated based on physical, genetic, and physiological factors; are located in a unique ecological setting; have unique genetic characteristics; and would represent a significant gap in the range of the taxon if one of them were to become extinct.

Using an extinction risk analysis (ERA), the SRT concluded that three of the five DPSs (Carolina, Chesapeake, and New York Bight) were likely (> 50% chance) to become endangered in the foreseeable future (20 years). The SRT recommended that these three DPSs should be listed as threatened under the ESA. The remaining DPSs (South Atlantic and Gulf of Maine) were found to have a moderate risk (<50% chance) of becoming endangered in the next 20 years. However, the SRT did not provide a listing recommendation for these remaining DPS's as available science was insufficient to allow a full assessment of these populations.

In the fall of 2010, NOAA Fisheries proposed that populations of Atlantic sturgeon along the southeast Atlantic coast be listed as endangered under the federal Endangered Species Act. On February 6, 2012, NOAA Fisheries Service issued a final determination to list the South Atlantic and Carolina population sements of Atlantic sturgeon as endangered under the Endangered Species Act (effective date of April 6, 2012). NOAA also reached decisions about the other East Coast population segments, listing the New York Bight and Chesapeake Bay populations as endangered, and the Gulf of Maine population as threatened.

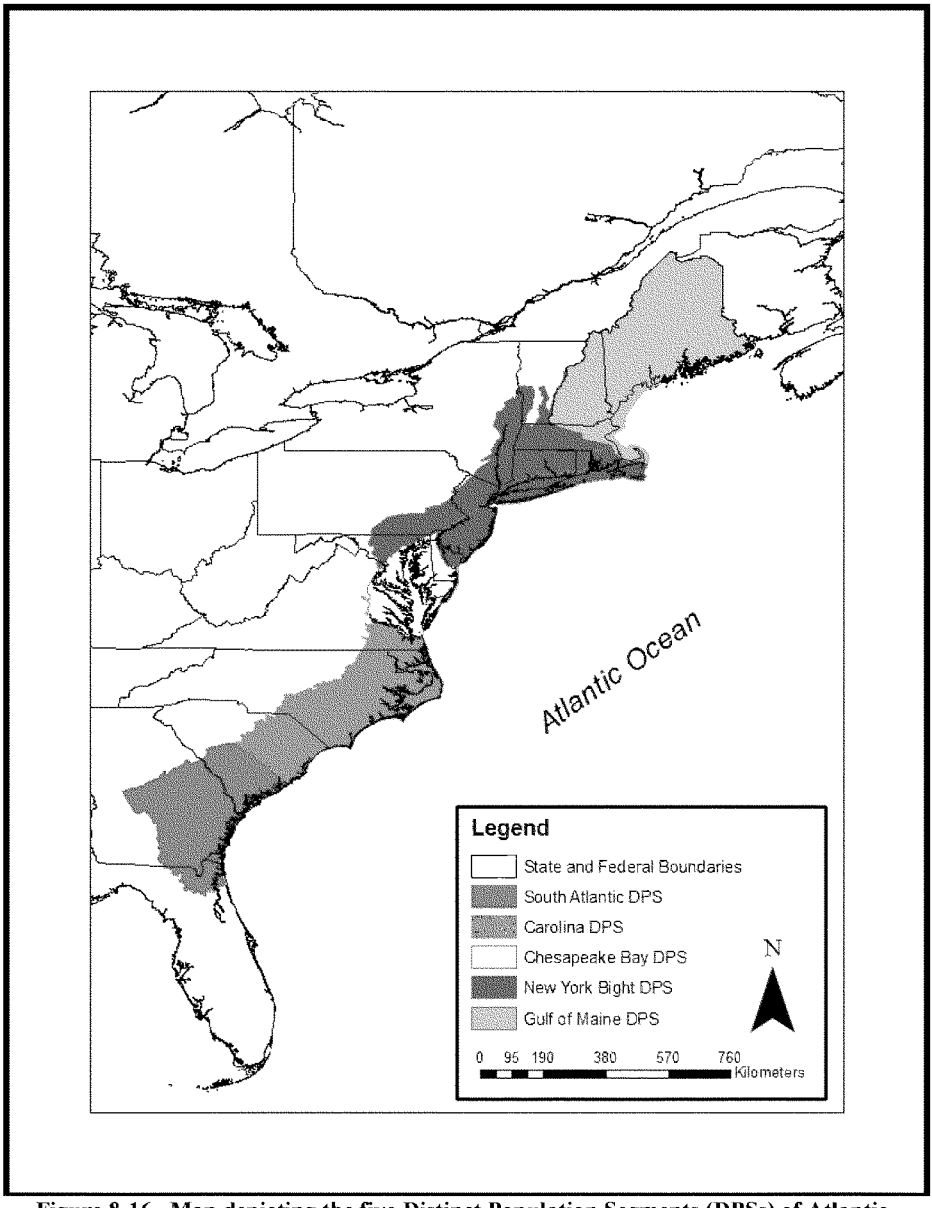

Figure 8-16. Map depicting the five Distinct Population Segments (DPSs) of Atlantic sturgeon: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. Threats

Of the stressors evaluated, bycatch mortality, water quality, and dredging activities were most often identified as significant threats to the viability of Atlantic sturgeon populations. Additionally, some populations were impacted by unique stressors, such as habitat impediments (e.g., Cape Fear and Santee-Cooper rivers) and apparent ship strikes (e.g., Delaware and James Rivers).

Critical Habitat

No critical habitat rules have been published for the Atlantic sturgeon

Dredging Methods and Associated Impacts

According to the Shortnose sturgeon recovery plan (NMFS, 1998) and Atlantic sturgeon status review (Atlantic Sturgeon Status Review Team, 2007), projects that may adversely affect sturgeon include dredging, pollutant or thermal discharges, bridge construction/removal, dam construction, removal and relicensing, and power plant construction and operation. Potential direct and indirect impacts associated with dredging that may adversely impact sturgeon include entrainment and/or capture of adults, juveniles, larvae, and eggs by dredging and trawling activities, short-term impacts to foraging and refuge habitat, water quality, and sediment quality, and disruption of migratory pathways.

A. Hydraulic Hopper dredge

Hopper dredges can lethally harm sturgeon by entraining them in dredge dragarms and impeller pumps. Hopper dredging activities throughout the Atlantic and Gulf coasts of the US are known for incidentally taking sturgeon species. Documented incidental takes of Atlantic (n=9), Shortnose (n=5), and Gulf (n=2) sturgeon have occurred during hopper dredging activities since 1990 throughout the Atlantic (North and South) and Gulf coasts.

Hopper dredges are used within known sturgeon habitat throughout the proposed project area, including the ocean bar channels. In SAD, only 9 incidental takes have occurred during hopper dredging operations, all of which were Atlantic sturgeon. Considering that Atlantic sturgeon primarily lead a marine existence, with the exception of their spawning migration, and hopper dredging operations are often utilized in ocean bar channels or offshore borrow areas, it is likely that the risk of entrainment by hopper dredges is higher for Atlantic sturgeon than Shortnose sturgeon. It is often less economical to use a hopper dredge in upstream environments where Shortnose sturgeon predominantly spend their time. The unit of effort with respect to hopper dredging in Shortnose sturgeon habitat is less than Atlantic sturgeon habitat and; thus, the risk of Shortnose sturgeon take with a hopper dredge is likely less than Atlantic sturgeon in the South Atlantic region.

As identified in Section 5.01.2, the use of the "turtle deflecting draghead" reduces the potential for take of benthic oriented species (i.e. sea turtles and sturgeon) by creating a sand wave in front of the draghead and pushing animals out of the way that were otherwise at risk of entrainment. Though the use of the "turtle deflecting draghead" likely reduces potential risk of sturgeon entrainment based on the understanding of its operating conditions, it is likely that takes can still occur due to dragtender operator error, uneven bottom contours, difficult dredging conditions (currents, slope, etc.), etc. Few studies exist that evaluate entrainment risk relative to sturgeon behavior, size class, life cycle, etc; though effects of entrainment on adult fish are presumed low (Dickerson *et al.,* 2004).

Hopper dredges have been known to impact Shortnose sturgeons. The current best estimate (Collins et al 2001 and Collins et al. 2002) is that adult sturgeon can be expected throughout the year somewhere within the area from River Mile 3.4 to 29.5 (river kilometers 5.5 to 47.5) and juvenile sturgeon from River Mile 19.3 to 29.5 (river kilometers 31.2 to 47.5), respectively. Therefore, impacts from hopper dredges may occur if hopper dredges were used upstream of River Mile 3 (roughly Station 16+000). There have been no documented takes of Shortnose sturgeon in Savannah Harbor by dredge operations. Shortnose sturgeon are not likely to be present near the river's mouth (downstream of Station 16+000) and in the entrance channel (from Station 0+000 to -98+600B), therefore, impacts from hopper dredges working in that portion of the channel are not anticipated to occur.

B. Hydraulic Cutterhead Dredge (Pipeline)

Adult and juvenile sturgeons are believed to be very mobile, even when occupying resting areas during the summer months (deep holes and other deep areas). Though five Shortnose sturgeon takes by a pipeline (hydraulic cutterhead) have been documented, the potential for significant numbers of adult and juvenile fish being hit by the cutterhead is fairly low. According to a shortnose sturgeon habitat suitability model review conducted by Applied Technology and Management, Inc. (ATM, 2003) for the SHEP Fisheries Interagency Coordination Team, it is generally agreed that Shortnose sturgeon larvae are not in the project impact area. No shortnose sturgeon larvae were found in a 2-year study in the Savannah River estuary. However, an Atlantic sturgeon larva was found at approximately RKM 41 during a recent ichthyoplankton study (Reinert et al. 1998). The maintained harbor extends up to RKM 34.3. Therefore, no impacts to sturgeon eggs or larvae are expected. In addition to existing information, an extensive monitoring study in the SE US is being funded by NOAA on the Atlantic and Shortnose sturgeon. This effort began in the spring of 2011 and is scheduled to last for 5 years. The work in the Savannah River is being conducted by SC DNR.

C. Mechanical Dredges – Clamshell (bucket) Dredge

Though rare, documented incidental take of Shortnose and Atlantic sturgeon by mechanical dredges have been reported. Clamshell dredges operate by dropping an open bucket into the water column which slowly descends to the bottom where the bucket closes, ascends, and discards the dredged material into a scow, barge, etc.

Since 1990, for all mechanical dredging operations throughout the North Atlantic, South Atlantic, and Gulf waters a total of three sturgeon (one Shortnose and two Atlantic) have been reported as captured by clamshell dredge operations. Of the three documented captures by a clamshell, one occurred in SAD on 12/03/00 while performing work for the Wilmington Harbor deepening project in the Cape Fear River, NC. Though this sturgeon was cited in various reports as a lethal incidental take, the endangered species incident report prepared by Coastwise Consulting indicated that the "bucket brought up an Atlantic Sturgeon, Acipenser oxyphyncus, entangled in a net. The specimen was decomposing." Assuming that the specimen was killed by entanglement in a net prior to being captured by the bucket, this documented "take" can be discounted. Detailed information is not available for the other two mechanical dredge takes. Given the mobility of sturgeon, the lack of a suction field from mechanical dredging, and the small area of active dredging by a bucket during each load, the likelihood of mechanical dredging to incidentally take sturgeon species is small. Furthermore, compared to other hydraulic dredging techniques, mechanical dredging is often recommended by NMFS as the preferred dredging technique for minimizing incidental take of sea turtles and sturgeon. Though clamshell dredge operations have reported capture of larger sturgeon (adult/juvenile), it is unlikely that clamshell dredging operation would impact small juvenile and larval sturgeon since there is no suction field generated by mechanical dredges.

Direct impacts

Few studies exist that specifically evaluate dredging impacts to sturgeon. However, based on known incidental take history from both Endangered Species Observer (ESO) and non-ESO reporting, maintenance dredging of federal navigation channels using hydraulic (cutterhead and hopper) and mechanical (clamshell) dredge types may adversely affect Shortnose and Atlantic sturgeon populations. From 1990-2007 a total of 24 sturgeon takes (11 Atlantic, 11 Shortnose, and 2 Gulf) have been documented for hopper (n=16), cutterhead (n=5), and clamshell (n=3) dredging activities along the Atlantic (North and South) and Gulf coasts. Of all documented incidental takes, 15 were lethal, 8 were non-lethal, and 1 was unknown. All 11 Shortnose sturgeon takes occurred in NAD (Delaware River – 5; Kennebec River – 6) during cutterhead (n=5 (all lethal)), hopper (n=5), and clamshell (n=1) dredging operations (Figure 8-17 and 8-18). Though incidental take of sturgeon have been documented for hydraulic and mechanical dredging, only hydraulic hopper dredge operations are capable of effectively screening for incidental take and have included ESOs to monitor and report incidental take since 1995. The proportion of hydraulic cutterhead and clamshell dredging operations being observed (using ESOs or other observing method) are unknown, but probably relatively small; thus, take data do not consider equal observer coverage for all dredging operations. Based on the current understanding of the different dredging operations relative to sturgeon behavior, clamshell and

hydraulic cutterhead dredges are still considered by NMFS as alternative dredge types to reduce potential entrainment impacts to sturgeon (NMFS, 1998)

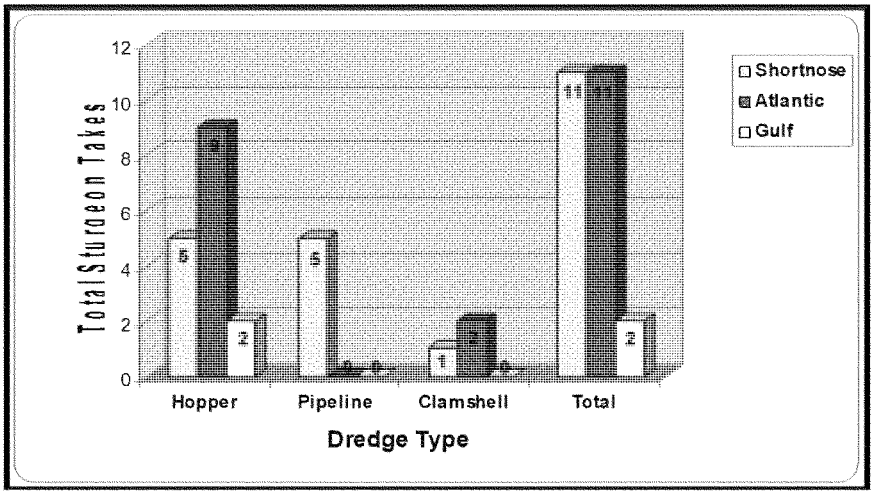

Figure 8-17. Total sturgeon (Shortnose, Atlantic, and Gulf) incidental takes documented from 1990-2007 for hopper, pipeline (hydraulic cutterhead), clamshell dredging techniques.

Throughout CESAD (including Savannah Harbor), only 10 sturgeon takes have been documented since 1990, all of which were Atlantic sturgeon and consisted of 1 take by a clamshell dredge and 9 by a hopper dredge. Though pipeline (hydraulic cutterhead) take of Shortnose sturgeon have been documented in CENAD (n=5) no incidental take of Shortnose or Atlantic sturgeon have been documented by pipeline (hydraulic cutterhead) dredging activities in CESAD (Figure 8-18).

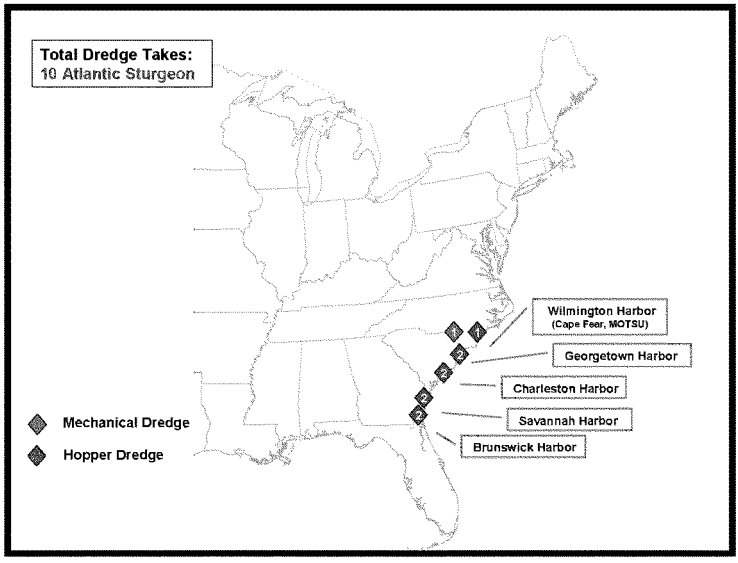

Figure 8-18. Distribution of sturgeon incidental take by dredge type and channel location since 1990 throughout the South Atlantic Division (SAD) (Only Atlantic sturgeon were documented with no reported pipeline (hydraulic cutterhead) take).

Hoover (2005) evaluated the risk of entrainment of paddlefish and lake and pallid sturgeon by comparing the suction velocities generated by dredges, or "flow fields" with swimming performance data (i.e. rheotaxis, endurance, and behavior). Intake water velocity data are known for simulations of flow fields created by hydraulic dredges. For any given point within a flow field, entrainment risks presented by a given water velocity were determined based on swimming performance data for tested fish species. Calculated risk estimates can be used to identify species and size classes of sturgeon potentially susceptible to entrainment by various types and sizes of dredges. Though this type of assessment does not consider cumulative risk associated with behavioral, physiological, and demographic data; it does provide some insight towards escape probabilities for individual species. Additional data for other sturgeon species could help develop support for low risk dredging alternatives for areas where high sturgeon abundance is known.

Atlantic and Shortnose sturgeon are both anadromous fish species; however, their habitat ranges, as a component of their migration cycle, are slightly different. Atlantic sturgeon spawn in freshwater but primarily lead a marine existence; whereas, Shortnose sturgeon spawn in freshwater but rarely occur in the marine environment aside from seasonal migrations to estuarine waters. When evaluating potential impacts, this difference in habitat range is most significant when considering the effects of hopper dredging activities to sturgeon species. As discussed in Section 2.04.1.2, hopper dredges are maneuverable sea going vessels that are capable of dredging in more dynamic environments, including open ocean and inlet systems.

Furthermore, because of the increase in cost for transport of dredged material to offshore dredged material disposal sites (ODMDS) via a hopper dredges from upstream riverine reaches, mechanical (clamshell) and/or pipeline (hydraulic cutterhead) dredging techniques are often the preferred dredging mechanism in upstream reaches. Considering that Atlantic sturgeon spend significantly more time in the nearshore marine environment than Shortnose sturgeon, the opportunity for hopper dredge interactions with Atlantic sturgeon are more significant. This could explain the predominance of Atlantic sturgeon taken by a hopper dredge identified in Figure 8-18.

Indirect impacts

Indirect impacts to sturgeon from either mechanical or hydraulic dredging include (1) short-term impacts to benthic foraging and refuge habitat, (2) short-term impacts to water and sediment quality from resuspension of sediments and subsequent increase in turbidity/siltation, (3) disruption of spawning migratory pathways, and (4) long term changes to water quality parameters that effect sturgeon habitat. These potential impacts will be discussed in the following paragraphs.

A. Benthic Foraging

At individual dredged channels and ports throughout the South Atlantic, it is not known how extensively the channels and turning basins are used by sturgeon as feeding areas. Specific aggregation areas for spawning, feeding, resting, etc. have not been identified for all dredging locations throughout the distribution range for Shortnose and Atlantic sturgeon. However, since channel maintenance activities remove the bottom sediments and any benthos that reside there, these actions likely decrease sturgeon foraging habitat for a period of time. Benthos will recruit to the newly exposed bottom surface from adjacent river bed. Channels maintained at frequent dredging intervals are not expected to be used extensively for feeding or other activities (EA, 2008). This would be essentially the same for existing and maintenance conditions after the harbor is deepened. As identified in the 2007 Status Review of Atlantic Sturgeon, "Hatin *et al.* (*in press*) tested whether dredging operations affected Atlantic sturgeon behavior by comparing Catch Per Unit Effort (CPUE) before and after dredging events in 1999 and 2000. The authors documented a three to seven-fold reduction in Atlantic sturgeon presence after dredging operations began, indicating that sturgeon avoid these areas during operations."

Though initial loss of benthic resources are likely, quick recovery between 6-months (McCauley *et al.*, 1977; Van Dolah *et al.*, 1979; Van Dolah *et al.*, 1984; and Clarke and Miller-Way, 1992) to two years (Bonsdorff, 1980; Ray, 1997) is expected; thus, the impacts to sturgeon foraging habitat are expected to be short-term. Recent benthic studies in Savannah Harbor, just prior to annual maintenance dredging, have shown primarily healthy benthic communities both inside and outside the navigation channel. For most sediment types, average abundance and biomass were found to be higher inside the channel compared to locations outside the channel with the exception of silt-sand substrates (USACE, 2008). Sturgeon foraging sites with soft mud bottoms and oligohaline or mesohaline salinities tend to recover quickly, likely due to the dominance of opportunistic species assemblages (e.g., *Streblospio benedicti, Capitella capitata, Polydora Ligni*) (Ray, 1997). Recovery in dredged sites occurs by four basic mechanisms: remnant

(undredged) materials in the sites, slumping of materials with their resident fauna into the site, adult immigration, and larval settlement. Remnant materials, sediments missed during the dredging operation, act as sources of "seed" populations to colonize recently defaunated sediments. Adult immigration can occur as organisms burrow laterally throughout the sediments, drift with currents and tides, or actively seek out recently defaunated sediments (Ray, 1997). Likewise materials slumping or falling into the site from channel slopes provide organisms for colonization (Kaplan *et al.*, 1975).

For benthic assemblages in estuarine and riverine systems, the distribution of individual species is consistent with their known sediment and salinity preferences (polyhaline, mesohaline, and oligohaline). The distribution of each of these assemblages varies depending on the intensity of river flow, often correlated with season (Ray, 1997; Posey *et al.*, 1996). Therefore, in addition to the anthropogenic dredging impacts to benthic assemblages, natural community shifts are correlated with river flow rates. Considering the ephemeral nature of this environment, benthic assemblages consist of opportunistic species which are capable of adapting to natural fluctuations in the environment (Ray, 1997). Assuming that natural benthic community shifts are an inherent component of sturgeon foraging behavior, it is possible that post-dredging movements to more productive foraging grounds are not far outside of the normal foraging behavior response to natural benthic community shifts.

Impacts from cadmium-laden sediment. Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built on the results of the previous work. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 to 94+000 (River Mile 8.5 to 17.8). As indicated above, the current best estimate (Collins et al 2001 and Collins et al. 2002) is that adult sturgeon can be expected throughout the year somewhere within the area from River Mile 3.4 to 29.5 (river kilometers 5.5 to 47.5) and juvenile sturgeon from River Mile 19.3 to 29.5 (river kilometers 31.2 to 47.5), respectively.

Initially, dredging of the navigation channel may expose these prey/food species to cadmium. If prey/food species uptake cadmium from Stations 16+000 to 45+000, then it could adversely affect the adult Shortnose sturgeon. Several factors could influence the degree to which cadmium might move from channel bottom sediment to benthics to the aquatic food chain: (a) would clay sediment with elevated cadmium be exposed so that benthics growing in the clay could support an aquatic food chain, (b) can Miocene clays support benthic organisms, and (c) would cadmium in the bottom sediments be available to benthic organisms such that the organisms would accumulate cadmium and pass it through the food chain?

EA Engineering, Science, and Technology (EA, 2008) conducted a benthic community assessment of the river bottom both inside and outside the channel. They found a substantial benthic community within the channel bottom. In addition, they found that the course sand/gravel/clay substrate was used by benthic organisms, although they were unable to

determine to what extent benthic organisms might burrow into the clay. They found that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. However, the limited availability of exposed high cadmium sediments within the navigation channel, as discussed above, limits the potential for clay dwelling benthic input to the riverine ecosystem. EA found that the clay substrate does support benthic organisms, but this substrate presently comprises less than 28 percent of the channel bottom between Stations +16+000 and +60+000. This finding indicates that benthic organisms residing in exposed Miocene clays should present a relatively small fraction of the benthic organisms within the channel ecosystem. Because of the predicted small fraction of available habitat, potential impacts through bioaccumulation of cadmium by benthic organisms within the Miocene clays appear to be minor, but not zero. To be conservative, the potential for bioaccumulation of cadmium by benthic organisms is addressed in section 4.2.5 of the Final Sediment Quality Evaluation Savannah Harbor Expansion Project, dated April 2008 (Appendix M in the DEIS).

Potential contaminant impacts associated with exposed high cadmium sediments within a deepened channel would be minimal, primarily because sediment cadmium was found to be unavailable and bioaccumulation tests found cadmium uptake below levels of concern. The essentially anoxic state of the channel sediments should preclude significant movement of cadmium to the environment. Furthermore, it is expected that exposure of the riverine environment to high cadmium clays would be restricted, since the majority of the exposed clays are expected to be covered by O&M sediments.

Appendix M contains copies of the Final Sediment Quality Evaluation Savannah Harbor Expansion Project (SHEP), US Army Corps of Engineers, April 2008 and Savannah Harbor Expansion Project, Phase II Sediment Evaluation, Prepared by the USACE, Savannah District using data and analyses provided by EA Engineering, Science, and Technology, Sparks, Maryland 21152, January 2008.

B. Water Quality – Turbidity

Extensive studies have been conducted on the behavioral responses of fish to increased turbidity. These studies measured reactions such as cough reflexes, swimming activity, gill flaring, and territoriality that may lead to physiological stress and mortality; however, specific studies on sturgeon responses are limited. The effects of suspended sediment on fish should be viewed as a function of concentration and exposure duration (Wilber and Clarke, 2001). The behavioral responses of adult salmonids for suspended sediment dosages under dredging-related conditions include altered swimming behavior, with fish either attracted to or avoiding plumes of turbid water (Newcombe and Jensen, 1996)

Turbidity impacts to sturgeon as a result of proposed dredging activities are expected to be temporary, with suspended particles settling out within a short time frame. These sediment disturbance impacts are expected to be minimal in nature and are not expected to have a measurable effect on water quality beyond the frequent natural increases in sediment load. Refer to Section 5.04.2 of this appendix as well as Section 5.07.1.1 of the EIS for more information regarding the impacts of dredging.

Impacts due to changes in salinity and/or dissolved oxygen. The Hydrodynamic and Water Quality models completed by Tetra Tech Inc (Tetra Tech 2006) for this project indicate that portions of the Front River may increase in salinity and decrease in oxygen to an extent that could affect both juvenile and adult Shortnose sturgeon (without mitigation). Using the habitat suitability criteria developed in consultation with the Interagency Fisheries Coordination Team, the Corps evaluated the effects of these changes on Shortnose sturgeon habitats in the Savannah River system. The following table (without mitigation) shows the impacts to adult and juvenile Shortnose sturgeon habitat (in January and August 1999) at the various depths for the 50%-tile salinity (Table 8-13):

Table 8-13. Summary of Project-Related Impacts Without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
	Loss (-) of Acceptable Habitat				
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)

After the expected impacts to these resources were identified, the Corps used the hydrodynamic and water quality models to evaluate ways to reduce those impacts. A flow re-rerouting plan was developed for each depth alternative to minimize impacts to freshwater tidal wetlands, the resource which the agencies identified as being most at risk from this project. The Corps adopted the findings of a separate study which identified injection of oxygen as being the best method to improve D.O. levels in the harbor.

Using the selected flow-re-routing plans, the water quality model was rerun to identify the impacts to fishery resources after all components of the mitigation plan were included. The table below summarizes the impacts of the depth alternatives after avoiding and reducing project impacts (Table 8-14).

Table 8-14: Snmmary of Project-Related Impacts With Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
	Loss (-) of Acceptable Habitat				
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	-4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	- 6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+19.0 % (+260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	-+6.5 % (+89.0)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	- 6.7% (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6% (-251.0 acres)	-11.5 % (-376.0 acres)

Substantial adverse impacts would remain to Shortnose sturgeon after the flow re-routing and D.O. system components are included. Because of those remaining impacts, additional mitigation consisting of replacement or compensation is appropriate (see Conservation Measures, below).

For Shortnose sturgeon, the maximum expected reduction in habitat acreage would be approximately 11.0 percent [439.0 acres], but actual losses vary by channel depth, life stage, and season. The adverse effects are most pronounced in the adult life stage during January. When the hydrodynamic modeling results indicated that the impacts would not be substantially reduced by the initial mitigation plan components, the Corps consulted natural resource agencies about potential ways to address remaining impacts. Neither the Corps nor the agencies could identify any measures that could be implemented in the estuary that would restore sturgeon habitat or enhance existing habitats. The habitat suitability analysis indicated that the main issue determining the quantity of acceptable sturgeon habitat in the estuary is salinity. The reductions in volume of acceptable habitat stem from increases in salinity to unacceptable levels at sites that presently provide suitable habitat characteristics. The fish could move further upstream to areas possessing lower salinity levels. Dial-Cordy and Associates (2010) conducted a study for the Corps to identify the bottom substrates in the Front River between Middle River and Interstate 95, where sturgeon are known to go during the summer when they leave poor habitat conditions in the harbor. The study found the bottom substrate to be primarily sand, which is the substrate type known to support diverse and vibrant benthic populations.

The Corps consulted natural resource agencies about potential ways to address remaining adverse impacts to Shortnose sturgeon. See Section 5.16 for more details on impacts along with Tables 3-6 and 3-7 in Section 3 and EIS-Appendix C. Neither the Corps nor the agencies could identify any measures that could be implemented in the estuary that would restore sturgeon habitat or enhance existing habitats. The Corps acknowledged that removal of the lowest dam on the river, the New Savannah Bluff Lock and Dam (NSBL&D) at Augusta, Georgia, would be the preferred method to allow sturgeon and other anadromous fish to access upstream spawning habitat. The Corps also acknowledged that removal of the lock and dam would benefit the ecosystem. However, removal of the New Savannah Bluff Lock and Dam is not a feasible mitigation alternative for the following reasons:

1) The lock and dam is a Congressionally-authorized project; therefore, the Corps is obligated to maintain the project as Congress provides funding for such actions.
2) The current authorization language (WRDA 2000) amended in Omnibus Act 2001 calls for repair and rehabilitation of the lock and dam structure, construction of a fish passage, and conveyance of Lock and Dam to the City of North Augusta.
3) Removal of the structure would adversely impact the freshwater supply of eight major users.

Since removing the NSBL&D is not feasible, , the Corps suggested an action that had previously been identified on the Savannah River that would increase the extent of sturgeon habitat – a method of allowing fish to move by the lowest dam on the river, the New Savannah Bluff Lock & Dam (NSBL&D) at Augusta, Georgia. A fishway around the structure would allow migrating fish to move past the dam. That would open up an additional 20 miles of habitat upstream of the dam to Shortnose sturgeon, portions of the river that they had used in the past. The structure would also open up the river to American shad and Striped bass (some of the Striped bass population in the Savannah River is thought to spawn near the fall line), thereby helping those populations.

Substrate data indicates that this portion of the Savannah River contains suitable Shortnose sturgeon habitat. In the 20-mile area, of the 57 sites where substrate data were observed/collected in Augusta Shoals/Savannah Rapids upstream of the New Savannah Bluff Lock and Dam, the combined frequency of sites associated with substrate types considered suitable by for sturgeon spawning (NMFS 2007) was 40% and the combined frequency of marginally suitable sites was 37%. Approximately 33% of sites appeared to have unsuitable substrates (Table 8-15).

Table 8-15. Benthic Substrate Frequency in Augusta Shoals Study Area

Class	Benthic substrate	SI[1]	Number of Sites	Frequency (%)
1	Mud, soft clay/fines	0.0	0	0
2	Silt, sand (diameter < 2.0 mm)	0.0	7	12
3	Sand, gravel (diameter > 2.0 mm to < 64 mm)	0.5	0	0
4	Cobble/gravel (diameter > 64 mm to < 250 mm)	1.0	3	5
5	Boulder (diameter 250 mm to 4,000 mm)	0.8	20	35
6	Bedrock w/ fissures w/ gravel/cobble mixtures	0.6	21	37
7	Bedrock smooth w/ few fissures or gravel	0.2	6	11

[1] 1.0 indicates highest suitability; 0.0 the lowest.

The following link contains the full report of the investigation of shortnose sturgeon spawning habitat, in the Savannah River, Georgia and South Carolina:
http://www.sas.usace.army.mil/plnew.html

The previously-approved horseshoe rock ramp design was proposed as a means of allowing Shortnose sturgeon and other anadromous species of fish to move pass the NSBL&D during spawning season. The fishway was designed to be located around the South Carolina abutment of the dam. It would operate continuously and pass 600 CFS during low flow conditions (95% exceedance). The 600 CFS minimum attraction flow is 5 percent of the mean river flow during upstream spawning migration period of February through June. Higher attraction flows are probably better, but Parasiewicz et al. 1998 indicated that 5% of the river flow should be an adequate attraction flow for most fish. The fishway would pass higher flows when the river flows are higher. Flows in the fishway are designed to be self-regulating over a two-foot headwater variation, including a range of river flows from 3,600 to 20,000 CFS. The horseshoe rock ramp would have roughly a 75-foot width across the base and use boulder weirs at approximately a 25-foot spacing. There would be roughly a 9-inch drop per weir along the length of the fishway. The water depth would range between 3.5 and 5.5 feet in the fishway.

Shortnose sturgeon have not been documented using constructed rapids fishways because none have been constructed within the shortnose sturgeon population range. However lake sturgeon have been observed passing constructed rapids covering the entire river width and in natural rapids in the upper mid-west. Some of these observations have been when water depths were shallower than the proposed water depth (3.5 to 5.5 feet) for the fish passage at the New Savannah Bluff Lock and Dam (Aadland 2010). Lake sturgeon are larger than shortnose sturgeon so the shortnose should also be able to pass similar rapids. In June 2007, representatives of the resource agencies agreed that a fishway at the NSBL&D appears to be the only measure within the basin to effectively compensate for the predicted loss in Shortnose sturgeon habitat in the estuary.

The Corps conducted a preliminary review of the 2001 fishway design and confirmed that conditions had not changed that would reduce its effectiveness or implementability. Also in 2010, the Corps consulted the Federal and State regional natural resource agencies to determine if the state-of-the-art had advanced substantially since the design was completed for the fish passage structure at the NSBL&D. No fishery experts in the regional natural resource agencies identified any specific change to the proposed design that should be made as a result of recent documented fish passage research. The rock ramp design was provided to the cost estimators, who updated the cost for constructing the fishway. That fishway was added as a feature of the mitigation plan at an estimated ROM cost of $4.3 million (2006 price levels).

A horseshoe rock ramp bypass design was presented in the DEIS with input from the Fisheries ICT. The horseshoe rock ramp bypass design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages. In their comments on the EIS, some of the agencies expressed a belief that the bypass would need to carry more of the river flow to successfully pass Shortnose sturgeon. As a result, the Corps convened an interagency workshop on April 25-27 2011 to discuss and evaluate mitigation options available. Numerous options were evaluated in regards to fish passage at the NSBL&D. Using the input from the agencies at the workshop, the Corps screened the potential fish passage options and prepared preliminary designs for three fish passage alternatives: (1) Full River Rock Ramp, (2) Off-Channel Rock Ramp, and (3) Hybrid Rock Ramp. Although not specifically considered at the interagency workshop, the Corps considers the Off-Channel

Rock Ramp to be a variation of the Full River and Hybrid Rock Ramp designs since they would all transport roughly the same amount of water for Shortnose sturgeon to use while moving through that site on the river. These alternatives differ by their location across the channel's cross-section. For all three alternatives, a rock ramp would be constructed to allow Shortnose sturgeon to swim to the upstream pool. In each design, large boulders would be used to create pools with local areas of lower velocities. All three designs would also accommodate the larger Atlantic sturgeon and readily pass other anadromous species such as American Shad and Striped bass.

Table 8-16 shows a comparison of three designs. The Full River Rock Ramp would capture all of the river flow (up to 10,000 cfs) 73% of the time from February-June (which is the Shortnose sturgeon spawning season). Flows over 10,000 cfs would flow through the flood bypass channel and the ramp. The Off-Channel Rock Ramp Design would capture all of the river flow (up to 8,000 cfs) 64% of the time from February-June, while the Hybrid Rock Ramp Design would capture all of the river flow (up to 9,000 cfs) 70% of the time. Since all three designs would achieve the objective of Shortnose sturgeon passage at the NSBL&D, the Off-Channel Rock Ramp Design was selected as the preferred design because it would be the most cost effective. Figure 8-19 shows the design for the Off-Channel Rock Ramp Design. A complete discussion of the analysis of fish passage alternatives at NSBL&D can be found in Appendix C.

Table 8-16. Comparison of Fish Passage Alternatives

Parameter	Full River Rock Ramp	Off-Channel Rock Ramp	Hybrid Rock Ramp
100% of flow through ramp up to X cfs	10,000 cfs	8,000 cfs	9,000 cfs
Crest elevation of Rock Ramp	109 ft	109 ft	109.5 ft
Number of gates operational	0	5	3
Modification to existing Lock & Dam structure	Major	Minor	Moderate
Modification to existing Lock & Dam project	Major	Minor	Moderate
Percent of time ramp captures all of river flow (February - June)	73%	64%	70%
Effectiveness in fish passage (Upstream)	90%	75%	80%
Effectiveness in fish passage (Downstream)	100%	85%	90%
Effectiveness in fish passage (Overall)	Acceptable	Acceptable	Acceptable
ROM cost	$100 mil	$32 mil	$41 mil
Cost Effectiveness (Cost /% SNS passage effectiveness)	$1,050,000	$325,000	$480,000

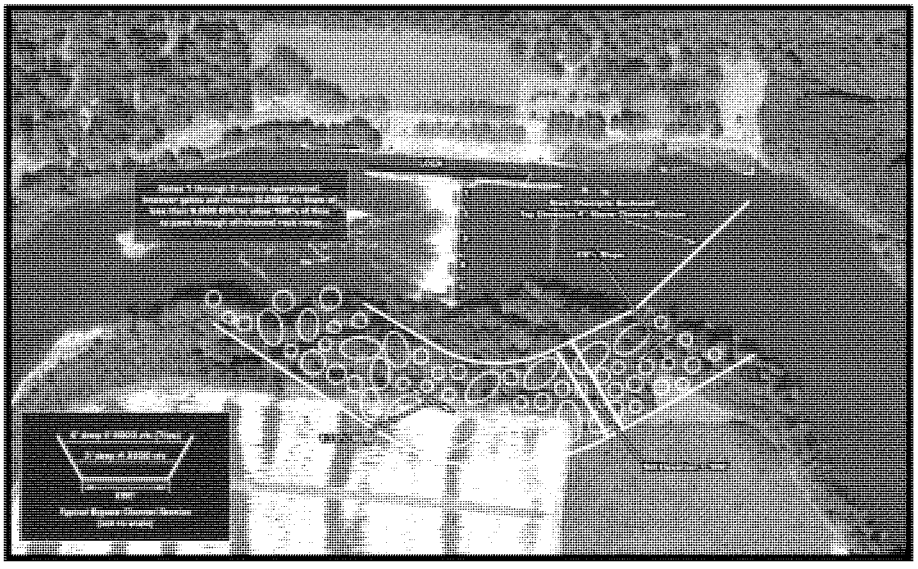

Figure 8-19. Conceptual side channel fish passage design.

The project's Monitoring Plan includes studies to evaluate Shortnose sturgeon distribution at the NSBL&D, as well as the success of the fish passage structure. During the pre-construction monitoring, the movement of SNS at the NSBL&D would be monitored for one year. This monitoring would include capturing, tagging and tracking Shortnose sturgeon and possibly other representative species of fish indigenous to that area (Striped bass, Robust redhorse, and American shad). Fish would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be collected within one km of the dam. The fish would be monitored continuously in the vicinity of the dam using a fixed station radio receiver. In addition, the river would be searched weekly during migration season between NSBL&D and Jackson, SC Landing and between NSBL&D and the Augusta Diversion Dam. The Savannah River would also be searched from the Kings Island Turning Basin to the NSBL&D and above to the Augusta Diversion Dam on a monthly basis. When located, species, identification number and location would be recorded. Temperature would be recorded several times daily at locations above and below the dam. Dissolved oxygen, turbidity, and river stage at the dam would be recorded at least weekly and dam discharge recorded daily.

This study would be continued during the Post-Construction monitoring for the project during years 1-5 and 9 of the post-construction monitoring program. The original scope of the study would be supplemented with additional tasks that would concentrate on SNS passage at NSBL&D. The results of this study would help the Corps determine if changes to the fish passage structure are warranted. If so, adaptive management funds would be available to make any required modifications.

Effect Determination.

Hydraulic (cutterhead and hopper) and mechanical dredge techniques have been documented to directly impact Shortnose and Atlantic sturgeon species through entrainment in the cutterhead or draghead or capture in the clamshell bucket. Hydraulic and mechanical dredging techniques may also indirectly impact sturgeon species through (1) short-term impacts to benthic foraging and refuge habitat, (2) short-term impacts to water and sediment quality from re-suspension of sediments and subsequent increase in turbidity/siltation, and (3) disruption of spawning migratory pathways

Long term changes to water quality parameters (salinity and dissolved oxygen) as a result of channel deepening would also affect sturgeon habitat. These impacts would be reduced by the flow reduction and dissolved oxygen component of the mitigation plan. However, substantial impacts would still remain. Additional mitigation is still warranted. No other habitat improvement technique could be identified in the estuary. Construction and operation of the fish passage around the New Savannah River Bluff would greatly benefit the species and provide adequate mitigation for the project impacts.

9.0 SUMMARY EFFECT DETERMINATION

Since these eight species generally do not reside within palustrine, estuarine and marine habitats, the proposed action is not likely to adversely affect them -- Red-cockaded woodpecker, American chaffseed, Pondberry, Canby's dropwort, Kirtland's warbler, Backman's warbler, Eastern indigo snake, and Flatwoods salamander -- or their habitats.

Continued use of upland CDFs could be considered a minor enhancement of wood stork feeding habitat. There would be no measureable difference with and without project to this species. All cadmium-laden sediment will be placed in CDF 14A/14B and capped/covered with 2-foot of clean sediment. Therefore, birds feeding in CDF 14A/14B would not be exposed to cadmium-laden sediments after construction is complete. Finally, since no critical habitat has been designated for this species, the proposed plan would not destroy or modify any habitat determined critical for the wood stork species' survival. The proposed action may affect but is not likely to adversely affect the wood stork or its critical habitat.

All new work dredged material from the project would be deposited in either existing CDFs or the ODMDS, except for construction of the submerged broad berm at the downstream end of the Sediment Basin. The placement of project construction sediments into the nearshore off Tybee Island has been deleted from the proposed action. However, maintenance material could be placed into the nearshore off Tybee Island or on the beach in the future. This could have temporary adverse impacts on foraging habitat for the Piping plover. However, since placement of material into these areas would be designed to reduce the erosion of the Tybee Island shoreline, there could be some long-term benefits to Piping plover foraging habitat. The USFWS would be consulted prior to any placement of any dredged material into these areas. The project "may affect, but is not likely to adversely affect" the Piping plover or its critical habitat.

Considering that the "Manatee Protection Conditions" will be included in the Corps dredging contracts and NMFS-approved observers will be on board all hopper dredge operations, Savannah District believes that the proposed project "may affect, but is not likely to adversely affect" the manatee or its critical habitat.

Potential hopper dredging activities for construction and maintenance of the project will be accomplished under the Terms and Conditions (T&C's) set forth in the 1991, 1995 and 1997 NMFS South Atlantic Regional Biological Opinions, CESAD Hopper Dredging Protocol, which address North Atlantic right whale interactions, and the NMFS Biological Opinion for SHEP dated November 2011. In the event that construction on SHEP is initiated prior to the resolution of the region-wide speed restriction issue, the Corps agrees to implement a non-precedential, interim measure during construction of the Savannah Harbor Expansion Project as follows: hopper dredges will comply with a 10-knot speed limit during calving season in accordance with recent NMFS recommendations. The District would abide by the terms of new SARBOs when they are finalized. Based on the implementation of these terms and conditions, as well as the conservation measures outlined above, the proposed project may affect, but is not likely to adversely affect North Atlantic right, humpback or sperm whales or their critical habitat. If/when new NMFS South Atlantic Regional Biological Opinion and CESAD Hopper Dredging Protocol are signed, the project would follow the conditions of those new documents.

With implementation of the conservation measures and construction windows mentioned above, the proposed project "may affect, but is not likely to adversely affect" the leatherback, loggerhead, Kemp's ridley, hawksbill, and green sea turtles or their critical habitat.

With implementation of the conservation measures and Terms and Conditions (T&C's) set forth in the 1991, 1995 and 1997 NMFS South Atlantic Regional Biological Opinions and the CESAD Hopper Dredging Protocol, and implementation of the mitigation plan (specifically the sill in Middle River and fish passage at New Savannah Bluff Lock and Dam), the proposed project may affect, but is not likely to adversely affect Shortnose or Atlantic sturgeon or their critical habitat. If/when new NMFS South Atlantic Regional Biological Opinion and CESAD Hopper Dredging Protocol are signed, the project would follow the conditions of those new documents.

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ENVIRONMENTAL IMPACT STATEMENT
APPENDIX B: Biological Assessment of Threatened and Endangered Species

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

ADDENDUM

Responses to US Fish and Wildlife Service Comments

US Army Corps of Engineers
Savannah District
South Atlantic Division

RESPONSES TO US FISH AND WILDLIFE SERVICE COMMENTS

BIOLOGICAL ASSESSMENT OF THREATENED AND ENDANGERED SPECIES

The USFWS provided its views on the Corps' Biological Assessment of Threatened and Endangered Species (BATES) in a letter dated 28 April 2011. That letter is included in Appendix Z of the EIS. This Addendum provides the Corps' responses to the USFWS comments and conditions in that letter.

COMMENT: The Service designated the north end of Tybee Island, Georgia, adjacent to the project, as critical habitat for the wintering piping plover. Some dredged sediments were planned to be placed in nearshore areas to migrate on-shore for beach renourishment. The placement may have temporary adverse impacts on foraging habitat. Small portions of the habitat would be directly affected short-term at any point in time and adjacent habitat will be available. Because erosion of the Tybee shoreline would be reduced, the intertidal areas that provide foraging habitat to the piping plover would experience a long-term benefit.

RESPONSE: The Corps concurs that placement of dredged material into nearshore sites MLW 200 and MLW 500 which are in Georgia Unit GA-1 would increase and stabilize the shoreline of this wintering habitat for the piping plover. However, the use of the Tybee nearshore dredged sediment placement sites has been removed from project plans. Sediments that would have been placed in these sites would have contained 20% or less fines. The City of Tybee Island and the Georgia DNR-CRD preferred sediments with a fines content of 10% or less. Consequently, they have requested that these sites not be used as placement sites for dredged material.

COMMENT: Wood storks feed and loaf in the existing confined disposal facilities (CDFs) for the Savannah Harbor Navigation Project. Continued use of upland CDFs for sediment placement could be considered a minor enhancement of wood stork feeding habitat. Procedures for sediment placement should insure birds would not be exposed to cadmium-laden sediments.

RESPONSE: Concur. Wood storks have been observed feeding in the CDFs during the fall months. However, they generally prefer feeding in the CDFs that are in the process of being dried out since they can take advantage of shallow water that increases their ability to catch prey. Sediment placement plans for CDFs 14A and 14B provide for cadmium-laden sediments to remain covered with water until a cover/cap of sediment can be placed that has a cadmium concentration of 4 mg/kg or less. Consequently, the Corps does not believe that many wood storks will use 14A and 14B for feeding during sediment placement because the water depth will be too deep to make them attractive for wood stork feeding.

COMMENT: The West Indian Manatee has site fidelity to summer habitat in the Savannah River. Manatees feed in shallow water on saltmarsh cordgrass (*Spartina alterniflora)*. As the dredging will occur in the deepest part of the channel, direct effects on manatees from the dredging operation and the placement of sediment should be minor. Additionally, the project would not adversely affect any conditions relating to habitat requirements such as the cordgrass. A large percentage of manatee mortality is due to collisions with watercraft. The dredging operations will involve various vessels presenting the potential for collisions. The USACE will implement "Standard State and Federal Protection Conditions" to insure that the project does not affect manatees.

RESPONSE: Concur. These conditions are listed on Pages 84-86 of the BATES, and they would be implemented during project construction.

COMMENT: Of the five sea turtle species that may be found in the waters of the project, only the loggerhead nests regularly on the adjacent beaches of Tybee and Daufuskie Islands. Sea turtles have site fidelity to their nesting beaches. The presence of artificial lighting on dredge equipment near nesting beaches is detrimental to critical behavioral aspects of the nesting process, including nesting female emergence, nest site selection, and the nocturnal sea-fining behavior of both hatchlings and nesting females. While still adhering to minimum luminance requirements, light emanating from equipment will be minimized to reduce the potential harmful effects. To minimize risk of sea turtle impacts due to dredges, environmental windows were established which restrict dredging to periods when turtles are least abundant or least likely to be affected by dredging. Environmental windows allow dredging in the winter months when sea turtle abundance is dramatically reduced and generally outside of the nesting period. Turbidity is produced by nearshore placement that can adversely affect sea turtles. The primary concern is disorientation of female turtles trying to reach the nesting beach. There are also concerns about potential impacts to hatchlings entering the ocean. Although ambient turbidities in the nearshore Tybee Island are already high because of the Savannah River, to reduce potential impacts, the USACE would restrict sediment placement in this area to the period from 1 August to 30 April. The proposed nearshore placement of sediments is not expected to adversely impact the beach nesting activities of sea turtles.

RESPONSE: Concur. The Corps implements all measures to protect endangered sea turtles including minimizing light emanating from offshore equipment, the use of draghead deflectors on hopper dredges, reduction of hopper dredge pump operations when the dragheads are not firmly on the bottom, and limiting hopper dredge work to the period 1 December through 31

March. As stated previously, the project no longer includes the use of the Tybee nearshore placement sites.

COMMENT: Based on the information summarized above, the BATES concludes that the proposed action "may affect, but is not likely to adversely affect" piping plover, wood stork, West Indian manatee, right and humpback whales, sea turtles, and shortnose sturgeon that may be present within the area. The BATES includes conditions that would be followed to protect endangered species during construction and operation of the project. We concur with your determination for the piping plover, wood stork, West Indian manatee, and nesting sea turtles. We believe that the requirements of Section 7 of the ESA have been satisfied for these species when they are under our responsibility. However, obligations under Section 7 of the ESA must be reconsidered if (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered in this assessment; (2) this action is subsequently modified in a manner which was not previously considered in this assessment; or (3) a new species is listed or critical habitat determined that may be affected by the identified action.

RESPONSE: The Corps acknowledges the concurrence of the USFWS with the findings of the BATES (Appendix B) with respect to piping plover, wood stork, West Indian manatee and nesting sea turtles for the SHEP.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX C: Mitigation Planning
SAVANNAH HARBOR EXPANSION PROJECT
Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps
of Engineers
Savannah District
South Atlantic Division

Mitigation Planning

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SAVANNAH HARBOR EXPANSION PROJECT MITIGATION PLANNING

I FRAMEWORK

From a broad perspective, mitigation planning consists of the following three major steps:

- Avoid Impacts
- Reduce Impacts
- Replacement/Compensation

The Corps began the mitigation process early in the General Re-evaluation process and it became one of the main focus areas as the study neared completion. The process included both the normal steps the Corps follows during a typical civil works study and additional steps taken as a result of the conditional authorization of this project. Highlights from the normal steps are described in the following section titled "Avoiding Impacts". The additional steps consisted primarily of working with the Stakeholder Evaluation Group (SEG) to identify potential mitigation measures and then explaining the findings of the Corps' mitigation planning as the work progressed.

II PREDICTING IMPACTS

Although the Corps hopes to avoid adverse impacts to the environment, rarely can a major construction project be implemented without causing some adverse effects. The type, location, and level of these impacts must be known before actions can be evaluated to avoid those impacts, reduce those impacts or provide appropriate mitigation. Most impacts that could be expected to occur from this proposed project would result from either loss of uplands adjacent to the (expanded) navigation channel or changes to the aquatic environment within the harbor. Other potential impacts could also result, such as changes in shoreline erosion, salinity intrusion into the groundwater, air emissions, traffic levels, etc.

For impacts to uplands adjacent to the deeper navigation channel, Savannah District retained the Corps' Engineering Research and Development Center (ERDC) to conduct a ship simulation study. That study is described in detail in the Engineering Appendix of the GRR. The study uses (1) state-of-the-art computer models, and (2) ship pilots from the Savannah Pilots Association who maneuver vessels through the harbor on a daily basis to identify how vessels would handle in various flow and weather conditions. The study identified the minimum size channel needed to safely pilot the design draft vessel through the harbor. This includes the width of the channel and required bend wideners. It also provides information on the value of meeting areas within the channel. This study confirmed most of the initial design features (channel width, size of turning basin) and indicated that some bend wideners would not be necessary. This increased the confidence in the effectiveness and safety of the proposed design, while also minimizing impacts associated from construction of unneeded features. The District conducted a second ship simulation study of the entrance channel in 2010 to evaluate two designs for

extending the entrance channel. The study confirmed either design would be acceptable from the standpoint of engineering design criteria.

The District conducted two studies to identify potential impacts to riverine shorelines. The first was a Ship Wake Study conducted by the Corps' Engineering Research and Development Center. They measured the waves produced at four critical locations in the harbor – Tybee North Beach, Fort Pulaski, South Carolina side of the Bight, and City Front – and predicted changes to those waves resulting from the fleet of larger vessels expected to call at the port with a deeper harbor. That study is described in detail in the Engineering Appendix to the GRR. Soils engineers within the District took that information and evaluated the effects on the adjacent shores from those changes in waves. Although most of those four locations presently experience substantial erosion, the District's soils engineers concluded that the proposed harbor deepening would not cause noticeable changes in the ongoing erosion.

For potential impacts to the nearby shorelines, Savannah District divided the issue into two distinct areas – one the ocean shoreline and the other the riverine shoreline. These two areas retain separate and distinct qualities from an engineering perspective, and the causes of erosion differ greatly between them. For the ocean shoreline, the District again secured the assistance of the Corps' Engineering Research and Development Center (ERDC). That organization conducted a Coastal Erosion Study that is described in detail in the Engineering Appendix of the GRR. The study concluded that deepening of the entrance channel as envisioned in any of the deepening alternatives would not measurably increase erosion that is occurring at Tybee Island or other adjacent barrier islands.

For potential impacts to the groundwater, Savannah District conducted a substantial study of the geology beneath the river and the water moving through the various layers of that resource. The scope of the study was reviewed by natural resource agencies and scientists involved in the study of the Floridan aquifer prior to it being implemented to ensure those experts believed that it was sufficient to address the issues. The District performed much of the physical sampling, as it possessed the needed open-water drilling equipment, and it retained the consulting and engineering firm of CDM to conduct the computer modeling portions of the study. That study is described in detail in the Engineering Appendix of the GRR. The conclusions of the study are that the proposed channel deepening is not expected to increase the downward migration of salinity into the drinking water aquifer in any measurable amount. The study identified the large volume of water withdrawn in Savannah as the primary source of the present cone of depression that exists in the aquifer and extends outward from that location.

For potential impacts to air quality, Savannah District evaluated air emissions from container vessels using the harbor. After EPA reviewed the results of that study, the District expanded it to include all vessels calling at the port, the landside equipment that handle the cargoes transported by those vessels, and air toxics in those emissions. The evaluation is based on the vessel fleet and cargo projections developed for the economic analysis. The District followed procedures outlined by EPA for air quality analyses at ports. The analysis did not identify any significant adverse impacts to air quality that would result from implementation of the proposed harbor deepening alternatives. The Air Emission Inventory is included as a separate appendix (Appendix K) in the EIS.

For changes to the aquatic system, Savannah District followed a combined approach of consultants and in-house staff to enhance and apply state-of-the-art hydrodynamic and water quality models to assess potential impacts from the project. The District and the Cooperating Agencies followed this approach to produce the best information that could reasonably be developed to identify changes that could be expected from the project. Development and approval of use of these models on this project, which took from 1999 through 2005, is described in detail in the Engineering Appendix that accompanies the GRR. As the models were being developed, the Corps consulted with natural resource agencies to determine what type of information they would need to evaluate all aspects of the proposed project. After the agencies approved use of the models, the tools were applied and the modeling was performed (2006 and 2007). This was somewhat of an iterative process. On occasion, the agencies discovered their requested model runs and analysis were not helpful. Subsequently, the agencies identified other informational needs that did enable a thorough evaluation of project impacts. Several reports were ultimately produced as a result of this process. On occasion, several versions of a particular report were produced as more information became available, or if the Corps later responded to agency requests for additional data and different perspectives. The hydrodynamic-related impacts predicted from the various alternatives are described in detail in the Environmental Consequences section of the EIS. The major hydrodynamic-related reports that were provided to the agencies during the course of the study are shown in the table on the following page.

Table 1. Savannah Harbor Expansion Project – Modeling Reports

Report	Title	Author	Date
Water Quality Mitigation	*Oxygen Injection Design Report Savannah Harbor Expansion Project*	Tetra Tech, Inc.	October 2010
Model Calibration (EFDC & WASP)	*Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	January 2006
Fishery Impacts	*Habitat Impacts of the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	October 2006
Chloride Model Development (Superseded)	*Savannah Harbor Expansion Project – Chloride Data Analysis and Model Development*	Tetra Tech, Inc.	November 2006
Water Quality Impacts	*Water Quality Impacts of the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	February 2007
Marsh Modeling Report	*Simulations of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia*	US Geological Survey	June 2006
Chloride Impacts	*Chloride Impact Evaluation Impacts of Harbor Deepening Only*	USACE Savannah District SAS-EN	February 2007
Hurricane Surge Impacts	*Hurricane Surge Modeling*	USACE Savannah District SAS-EN	September 2005
Chloride Impacts (Superseded)	*Savannah Harbor Expansion Project Evaluation of Chloride Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	December 2007
Fishery Impacts (SNS Impacts Superseded)	*Savannah Harbor Expansion Project Evaluation of Fishery Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	January 2010
Hurricane Surge Impacts	*Savannah Harbor Expansion Project Evaluation of Hurricane Surge Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	December 2007
Wetland Impacts	*Savannah Harbor Expansion Project Evaluation of Marsh/Wetland Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	November 2007

Report	Title	Author	Date
Water Quality Impacts	*Savannah Harbor Expansion Project Evaluation of Water Quality Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts	*Savannah Harbor Expansion Project Mitigation Evaluation for Marsh/Wetland Impacts*	USACE Savannah District SAS-EN	November 2007
Wetland Impacts (Sensitivity Analysis)	*Savannah Harbor Expansion Project Sensitivity Analysis of Proposed Navigation Meeting Areas*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts (Sensitivity Analysis Obsolete)	*Savannah Harbor Expansion Project Sensitivity Analysis of Proposed Sill on Middle River*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts	*Wetland/Marsh Impact Evaluation*	USACE Savannah District SAS-EN	February 2007
Wetland Impacts (Obsolete)	*Savannah Harbor Deepening Project ATM Marsh Succession Model Marsh/Wetland Impact Evaluation*	USACE Mobile District SAM	May 2007
Wetland Impacts (Obsolete)	*Savannah Harbor Deepening Project USGS/USFWS Marsh Succession Model Marsh/Wetland Impact Evaluation*	USACE Mobile District SAM	June 2007
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Adult SNS (Summer) Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS	March 2011
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Adult SNS (Winter) Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS	March 2011
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Juvenile SNS (Winter) Habitat Impacts with Proposed Mitigation*	USACE Savannah District SAS	March 2011
Chloride Model Development	*Chloride Modeling Savannah Harbor Expansion Project*	Tetra Tech, Inc. & Advanced Data Mining Services, LLC	December 2010
Chloride Impacts	*Assessment of Chloride Impact from Savannah Harbor Deepening*	Arthur Freedman Associates, Inc.	April 2011

The hydrodynamic-related impacts of the harbor deepening alternatives without mitigation are summarized as follows:

Table 2. Summary of Project-Related Impacts without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres
Brackish Marsh (Loss)	- 7.2 acres	Same	Same	Same	Same
Dissolved Oxygen	Reductions at mid-depth and bottom	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater amount	Same effect, but greater amount
Fisheries	**Loss (-) of Acceptable Habitat**				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (185.0)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 77 mg/L	Max hourly increase of 105 mg/L	Max hourly increase of 121 mg/L	Max hourly increase of 149 mg/L	Max hourly increase of 170 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, max increase in WSE of 0.3 feet	Minor, max increase in WSE of 0.5 feet	Minor, max increase in WSE of 0.6 feet	Minor, max Increase in WSE of 0.8 feet	Minor, max increase in WSE of 0.9 feet
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

III AVOIDING IMPACTS

A. CHANNEL DESIGN. The first major step that was taken was a decision on the channel design to maintain the existing side slopes and extend them downward rather than maintaining the existing bottom width and extending the side slopes outward. These two options are shown in Figure 1. The major effect of this decision is a reduction in the amount of dredging that would be required on the side slopes and removal of the need for a uniform increase in top width of the dredged channel. This minimizes impacts to adjacent high ground and structures located along the riverbank. This design also reduces the effective width of the navigation channel by the design vessel. The implications of that change were checked during the economic evaluation to confirm that one-way traffic of vessels the size of the design vessel did not cause unacceptable adverse economic impacts.

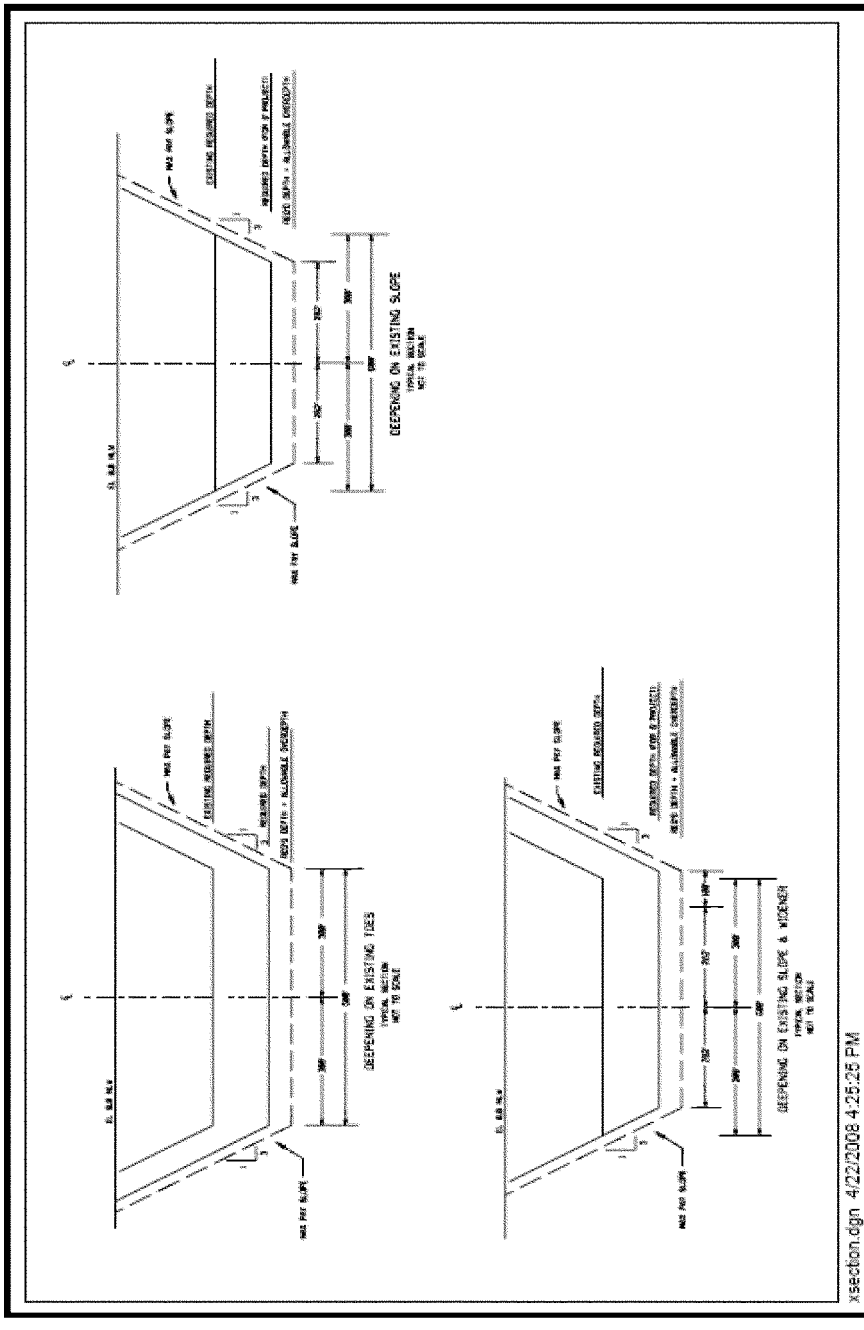


Figure 1. Conceptual channel designs.

B. PLACEMENT OF DREDGED SEDIMENTS. A second major step was a decision to use existing confined disposal facilities (CDFs) rather than create and use new ones for this project. The Savannah Harbor Navigation Project has seven CDFs that it has developed and uses on a regular basis (see Figure 2). If those sites could be used for placement of new work sediments from this project as well, the economic and environmental costs of developing new CDFs could be avoided. Siting a new CDF is difficult in this harbor and adverse environmental impacts are usually substantial and significant. Use of the existing sites requires coordination with ongoing operations and assessment of the effects of deposition of these sediments on the useful life of those CDFs.

Sediments that would be excavated from the entrance channel would be deposited in the existing Ocean Dredged Material Disposal Site (ODMDS). Use of that existing site would also reduce the economic and environmental costs of developing a new ODMDS.

C. SEDIMENT QUALITY. A third major step was taken later in the study process when sediment quality evaluations revealed elevated levels of naturally-occurring cadmium existing in some inner harbor sediments below the bottom of the existing channel. The cadmium is not uniformly distributed, but some locations showed concentrations at levels that have previously led to adverse environmental impacts. The plan had been to excavate the new work sediments and deposit them in the closest CDF that was available for this project. Decisions were reached on two fronts. First, additional studies would be conducted to determine if the cadmium found in Savannah would be likely to lead to adverse environmental impacts if deposited as originally planned. Second, the project would proceed on the assumption that the sediments were likely to lead to adverse environmental impacts and therefore should be deposited in a central location and isolated. Isolation of the sediments through capping/covering would ensure that the cadmium is not available to biota either on or adjacent to the site after the initial construction is completed. Deposition into a central location and capping would increase the project cost, but would avoid long term adverse environmental impacts. An optional plan (consisting of normal placement of the sediments) was also carried through the cost estimating process in case the additional sediment testing indicated that these sediments were <u>not</u> likely to produce unacceptable adverse environmental impacts if handled in the normal manner.

D. SEDIMENT BASIN. A fourth impact avoidance measure occurred during coordination with natural resource agencies about potential mitigation measures. During the initial discussions about the potential filling of the Sediment Basin, agencies expressed substantial concern about water quality aspects of such a measure. They were concerned that sediment placement using a large hydraulic dredge would (1) exacerbate recurring low dissolved oxygen levels in that portion of the harbor and (2) allow fine-grained sediments to spread up into shallower portions of Back River, leading to sedimentation in that critical area. Because of these concerns, the Corps minimized the extent of the sediment placement that would be included in

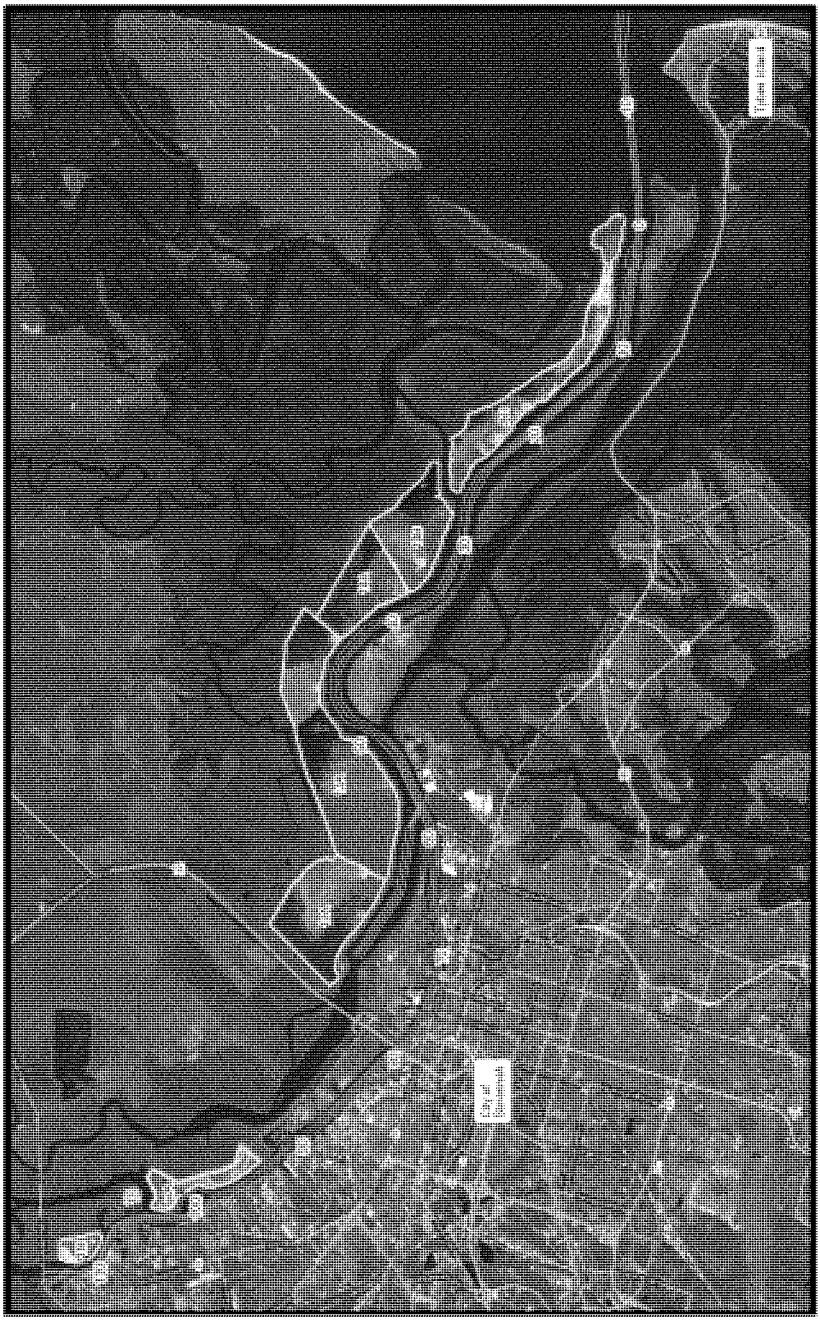


Figure 2. Savannah Harbor.

the design. Hydrodynamic modeling indicated that a narrow sill at the downstream end of the Basin would still allow salinity to cross over and move upstream. This would negate the intent of the measure, which is to reduce the movement of salinity up Back River. The final design consists of a broad berm that would restrict upstream salinity movement. The placement of new work sediments is included but would be minimized to avoid the potential adverse impacts identified by the natural resource agencies.

IV REDUCING IMPACTS

The second major step in mitigation planning is reducing impacts. This consists of ways to reduce the adverse impacts that are predicted if the basic project alternatives were implemented. The Corps reviewed the list of conceptual mitigation measures that had been developed in 2002 to identify techniques that still seemed appropriate, given the information now known about how the estuary functioned from a hydrodynamic and water quality perspective. That list is shown on the following 3 pages. It contains measures that could conceivably be implemented to improve conditions for the following resources: wetlands; fisheries; water quality; groundwater; sediment placement & beach erosion; and cultural & historic resources. The SEG and the natural resource agencies, in conjunction with the Corps of Engineers, reviewed the list of conceptual mitigation actions and identified those alternatives that warranted detailed analysis. Some of the conceptual mitigation actions were eliminated from detailed consideration because of obvious issues associated with their implementation. As an example, the reallocation of water from the Corps' three major lakes on the Savannah River (Hartwell, Richard B. Russell, and J. Strom Thurmond) to reduce downstream salinity levels would not be possible due to the effect on lake levels in those water bodies. It became obvious that any proposed mitigation alternative to reduce salinity levels, improve dissolved oxygen, etc. would have to be implemented in the Savannah Harbor estuary.

A. HYDRODYNAMIC AND WATER QUALITY MODELING. The Corps used the hydrodynamic and water quality models to evaluate measures that could be used to reduce project-induced impacts. Since tidal freshwater marshes were identified by the USFWS as the single most critical natural resource in the harbor, the Corps focused on reducing project impacts to that resource. The other natural resource agencies concurred with this priority. Salinity is the primary determining factor in the conversion of tidal freshwater marshes, so that parameter was identified as the focus of the mitigation modeling efforts. In addition to directly determining the type of marsh that would occur on a site, salinity also affects dissolved oxygen levels, another parameter of high importance in deeper areas of the harbor. The intent was to identify alterations that could be made in rivers and tidal creeks to reduce salinity levels in critical areas of the estuary. If such measures could be identified, those alterations would be expected to provide long term sustainable beneficial effects. The vertical extent of the tide (tidal range) is also important in determining the vitality of a tidal marsh system. This parameter became important during evaluation of some potential mitigation measures.

The Corps evaluated numerous potential alterations to water flow in the estuary. We analyzed a total of 38 alterations at 7 locations. Those locations are shown in Figure 3. Natural resource agencies reviewed initial modeling results in July 2006 and the interagency team jointly identified alterations to pursue further. After some additional modeling work was performed, the Corps determined what design (size) would be most effective at each location. That

determination was based on the extent to which salinity would be decreased coupled with reductions in adverse effects which may appear in other portions of the estuary.

SAVANNAH HARBOR EXPANSION PROJECT

CONCEPTUAL MITIGATION ACTIONS

WETLANDS

Restore sites where tidal freshwater wetlands previously existed
Restore sites where saltwater wetlands previously existed
- Remove sediments deposited on Jones/Oysterbed (J/O) Island outside the dikes (continue to use J/O CDF)

Enhance restricted flows to existing tidal freshwater wetlands
- Remove existing dikes
- Install additional drainage pipes under roads
- Enlarge ditches/creeks into the sites

Enhance restricted flows to existing saltmarsh
- Remove existing dikes
- Install additional drainage pipes under roads
- Enlarge ditches/creeks into the sites

Excavate high ground areas to create sites suitable for freshwater wetlands
Excavate high ground areas to create sites suitable for saltwater wetlands
Increase releases from upstream reservoirs to reduce salinity in the estuary
- Reallocate water from the Corps lakes upstream of Augusta
- Construct upstream off-channel impoundments for additional storage of water

Acquire and preserve tidal freshwater wetlands
Acquire and preserve bottomland hardwoods
Isolate Front River from Middle River (MR) and Back River (BR) to reduce salinity levels in MR and BR
- Close lower entrance of Middle River
- Install a flexible curtain as a barrier to block tidal flood flows up Middle River
- Construct berms along Front River to restrict high water flows across the marsh

Block Rifle Cut to eliminate higher salinity water from MR entering BR.
Block Drakies Cut and restore flows through Steamboat River to lengthen the passage of saline tidal waters up the Savannah River
Cease operation of the Sediment Basin to reduce movement of salinity up Back River (fill in the Sediment Basin)
Begin operation of the Tidegate with gates installed to only allow downstream flow, with no upriver movement of saltwater
Improve flows down the freshwater canals in Savannah National Wildlife Refuge
Increase flows down Bear Creek, Collis Creek, Mill Creek or Abercorn Creek
Create saltwater wetlands between the navigation channel and the riverbank

Install dike from railroad to Clydesdale dike (convert brackish marsh to FW wetland)
Remove the Tidegate

FISHERY RESOURCES

Increase dissolved oxygen levels in Front River
Increase releases from upstream reservoirs to reduce salinity in the upper estuary during periods of lower flow
- Reallocate water from the Corps lakes upstream of Augusta
- Construct upstream off-channel impoundments for additional storage of water

Increase freshwater flows down Back River to improve striped bass habitat (velocities and salinity) during spawning
Modify the Tidegate into a fishing pier
Install oyster shell beds in tidal creeks
Install fish habitat structures
- In tidal creeks
- In nearshore area

Construct a fishing pier to improve access
Construct a boat ramp to improve access
Increase flows down Bear Creek, Collis Creek, Mill Creek or Abercorn Creek
Construct Middle River sill to reduce salinity at location of juvenile Shortnose sturgeon.

WATER QUALITY

Add air or oxygen to low Dissolved Oxygen waters
- Install air injection system on bottom of river
- Install floating aerators
- Install D.O. injection system on bottom of river
- Construct D.O. injection system on Hutchinson Island

Mix low Dissolved Oxygen waters on the bottom with higher D.O. surface waters
- Inflatable weir
- Pumps

Increase releases from upstream reservoirs
- To increase D.O. levels in upper harbor
- To dilute chloride levels in upstream portion of estuary

Block Drakies Cut and restore flows through Steamboat River to lengthen the passage of saline tidal waters up Front River (Decrease chloride levels at City of Savannah's I&D water intake)
Relocate City of Savannah's I&D water intake to a location further upriver with lower chloride levels
Improve the quality of industrial discharges (reduce D.O. loads on the river)
Install oyster shell beds in tidal creeks (oysters filter turbidity and contaminants)
Increase flows down Bear Creek, Collis Creek, Mill Creek or Abercorn Creek
- To decrease chloride levels at City of Savannah's I&D water intake
- To improve water quality in those tidal creeks

GROUNDWATER

Deposit channel sediments in nearshore areas where the groundwater aquifer is near the ocean floor
Acquire but not use a permit from the State to withdraw fresh water from the Floridan aquifer
Reduce pumping of groundwater by acquiring – but not using -- permitted rights from industries to remove fresh water from the Floridan aquifer

SEDIMENT PLACEMENT & BEACH EROSION

Place new work sediments into nearshore area
Place new work sediments onto beach
Place O&M sediments into nearshore area
Place O&M sediments onto beach
Place sediments from Jones/Oysterbed Island CDF into nearshore area
Place sediments from Jones/Oysterbed Island CDF onto beach
Construct a sand bypass system (increase sand reaching south side of entrance channel)
Elongate north Federal groin (increase protection to a portion of Tybee ocean shoreline)
Construct a new Confined Disposal Facility in the upper harbor
Deposit channel sediments on nearshore areas where the groundwater aquifer is close to the surface
Remove sediments from CDF 2A to extend it useful life
Construct nearshore/offshore islands to provide shorebird habitat
Create wetlands between the navigation channel and the riverbank
Increase the wildlife value of the existing project's CDFs
Increase public access to view wildlife at the project's CDFs
Allow removal of sediments from the project CDFs by government agencies for use as fill in construction projects
Allow removal of sediments from the project CDFs by private organizations for commercial operations

CULTURAL & HISTORIC RESOURCES

Document existing condition of an impacted resource
Investigate and document the historical importance of an impacted resource
Create public access to cultural/historic resources that will be impacted and preserved
- Curate and display at Coastal Heritage Society

Create a public venue to explain the historic importance of shipping to Savannah

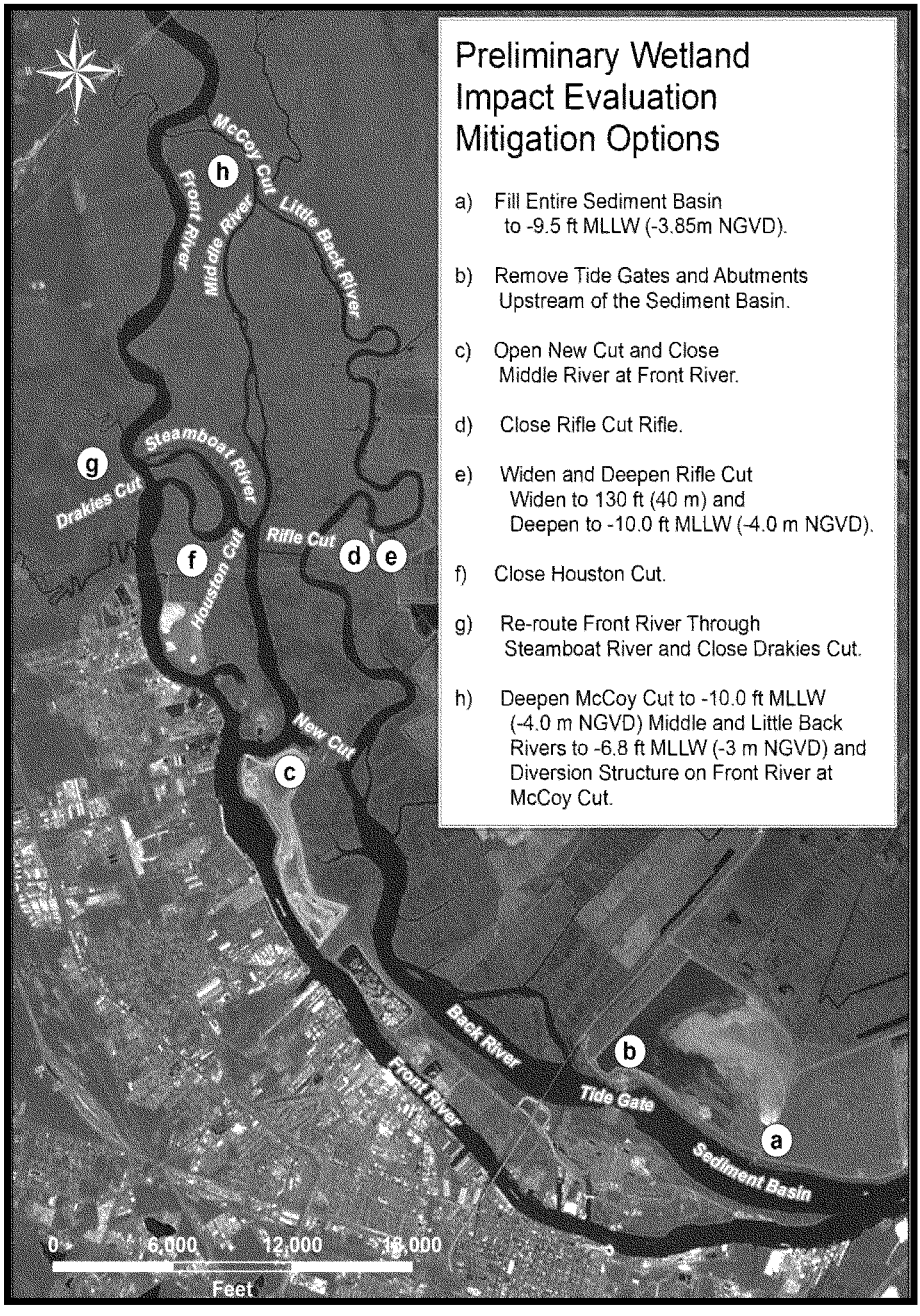


Figure 3. Potential flow-altering mitigation measures.

Based on the effectiveness observed in the initial modeling and preliminary estimates of construction cost, the Corps ranked the 5 best measures in the order of decreasing cost effectiveness, as shown below.

Table 3. Mitigation Measures

Mitigation Option	Component Added
C	Deepen McCoys Cut
D	Fill Sediment Basin
A	Close Middle River, Open New Cut, Close Houston Cut
E	Remove Tidegate
B	Reroute flow through Steamboat River

The Corps followed an incremental approach to evaluate how these measures could be combined. Since some measures result in similar effects, the order in which they are combined was found to be important. As a result of additional modeling performed after the interagency meeting and considering potential implementation difficulties, the Corps developed the dual approach shown below. The dual approach primarily resulted from uncertainties about the potential adverse effects of both (1) filling the Sediment Basin on harbor maintenance activities, and (2) relocating the downstream end of Middle River in Mitigation Option A. After additional modeling was performed, a decision would be made whether the path with Plans 1-2-3 or Plans 1-4-5 was more effective. After making that determination, the Corps would then evaluate two other Mitigation Options, removing the Tidegate (Option E) and rerouting flow through Steamboat River (Option B). The natural resource agencies concurred in this approach in August 2006.

Table 4. Mitigation Plans

Mitigation Plan	Mitigation Combination	Component Added
1	C	McCoys Cut
2	C + D	Sediment Basin
3	C + D + F	Rifle Cut
1	C	McCoys Cut
4	C + A	Middle River, New Cut, Houston Cut
5	C + A + D	Sediment Basin
6	3 or 5 + E	Tidegate
7	3 or 5 + B	Steamboat River

With the various channel depths considered, over 160 modeling runs were required to evaluate the effects of each mitigation plan. The modeling was conducted for each of the five depth alternatives. The results of the modeling are summarized in the following table prepared for the 6-foot deepening alternative.

Table 5. Wetland/Marsh Mitigation Evaluation
Average River Flows
50% Salinity Exceedance Values
6-Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)		1,932
Plan 1		988
Plan 2		988
Plan 3		834
Plan 4		1,334
Plan 5		325

Similar information was developed for the three alternative scenarios, which were considered as sensitivity analyses. One scenario used 2001 drought flows, rather than the average river flows. Two other scenarios included different amounts of sea level rise (25 or 50 cm) over the 50-year life of the project. The adverse impacts to freshwater wetlands were the same or less in two of the three sensitivity analyses. That trend did not hold up when the 50-cm of sea level rise was considered. Under that scenario, the flow re-routing plans would not be as effective in reducing adverse impacts to freshwater wetlands. Some of those wetlands would have already been converted to brackish marshes as a result of the saltwater intrusion from the sea level rise, even without further harbor deepening. In general, the table above shows the largest amount of adverse impacts to tidal freshwater wetlands of the four scenarios that were considered.

The Corps discussed the results of this modeling at an interagency meeting in June 2007. Several agreements were reached at the meeting, including the following:

- 50%-tile exceedance value was identified as the best single characterization of modeled salinity for any given point across the range of river stations and river flows.
- Use average river flows for the basic impact evaluation since that flow better represents the entire range of flows.
- Use existing sea level for the basic impact evaluation since it best represents what occurs near the time of construction.
- The path with Mitigation Plans 1-4-5 appears to be unacceptable because it substantially reduces the height of the tide range in critical areas of the estuary.
- Use Mitigation Plan 3 as a base for analysis of Plans 6 and 7.
- All tidal freshwater marshes within the estuary possess the same ecological value.
- Evaluate the feasibility of grading down a high ground site to produce tidal freshwater wetlands.

- An oxygen injection system should remove the impacts identified to American shad and likely result in net improvements in habitat volume.
- An oxygen injection system should remove the impacts identified to Southern flounder and likely result in net improvements in habitat volume.
- Average river flows (50%-tile) are appropriate for identifying project impacts to Striped bass.
- Further increases in flow are also not likely to be effective at increasing Striped bass habitat, since even flows at the 80% cumulative frequency level do not reduce the adverse effects of a harbor deepening.
- Training walls are not likely to be equally effective each year at increasing Striped bass habitat because the spawning location likely shifts with river flows, rendering the structures ineffective during some flow conditions.
- Examine closing the lower arm of McCoys Cut as a means of increasing Striped bass habitat.
- Examine including a flow partitioning structure at the junction of Little Back and Middle Rivers as a potential adaptive management tool to increase Striped bass habitat.

The Corps then conducted additional modeling of the flow-altering components of the mitigation plans. The Corps modelers developed additional plans to try and identify a plan that would be more effective in reducing wetland impacts. They developed the following variations to existing plans – Plans 3A, 3B, 3C, 6A, and 6B. While not a complete listing, Figures 4 through 11 show examples of how the flow-altering measures were combined into plans for analysis.

In September and October 2007 results became available on the effectiveness of the flow-altering features in reducing impacts to wetlands in the project area. The agencies suggested a slightly different methodology to graphically quantify impacts to the wetlands. The Corps used that alternate approach for the remainder of the study, so the numerical results of this iteration are not directly comparable with the initial impact quantification. The results for the second modeling iteration are shown after Figure 12.

After coordination of these modeling results, the USFWS proposed an additional plan, which was designated as Plan 8. That plan is shown in Figure 12. Initial modeling found that this plan would not be particularly effective at mitigating impacts to freshwater wetlands. It would result in a lower tidal range in the upper portion of Middle River, which would likely adversely affect wetlands located there. Therefore, this plan was not considered further.

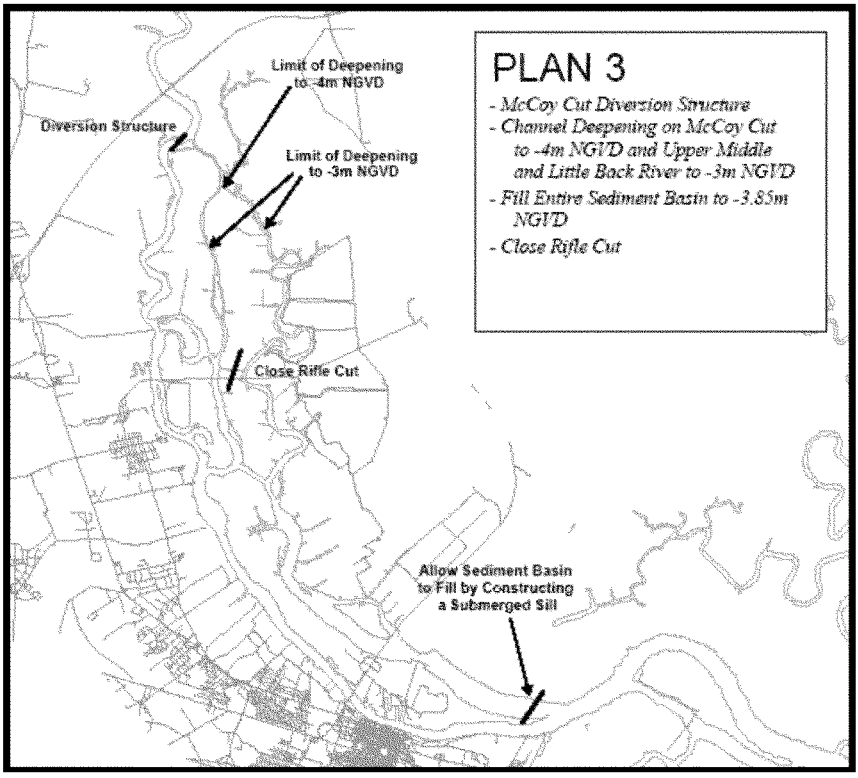


Figure 4. Plan 3

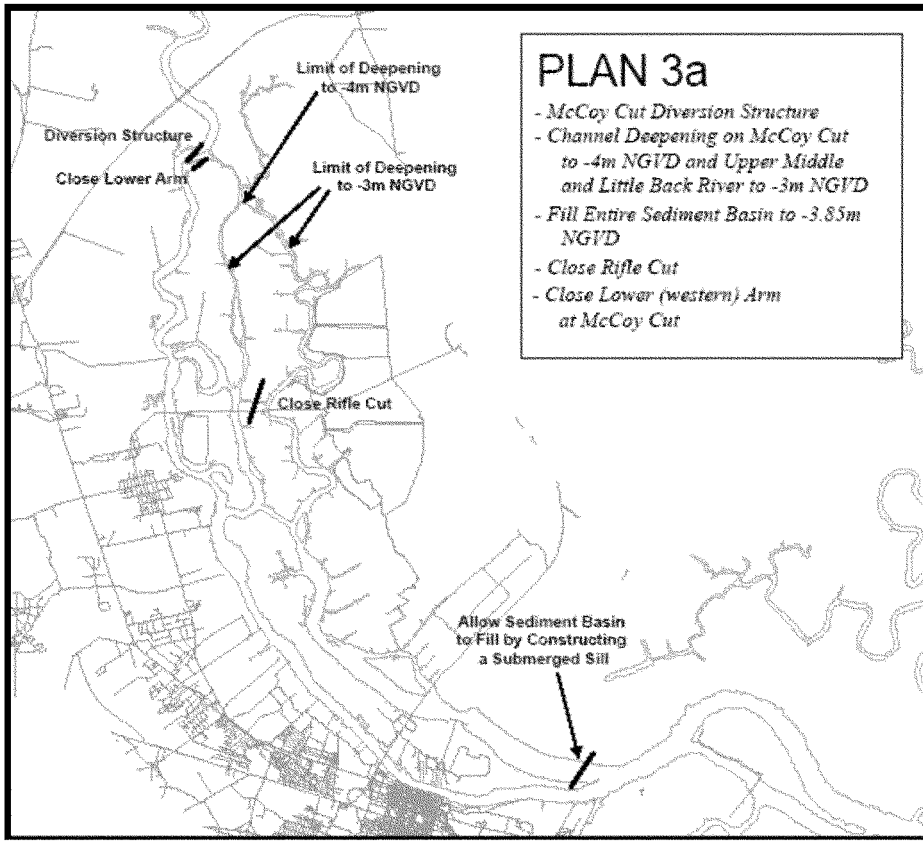


Figure 5. Plan 3a

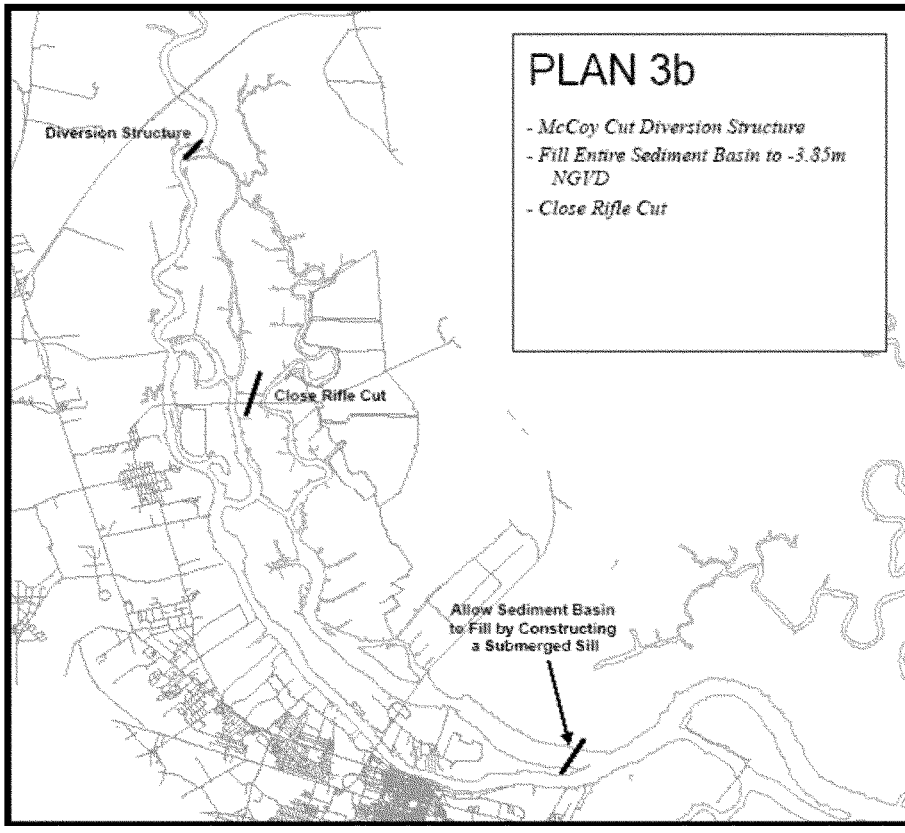


Figure 6. Plan 3b

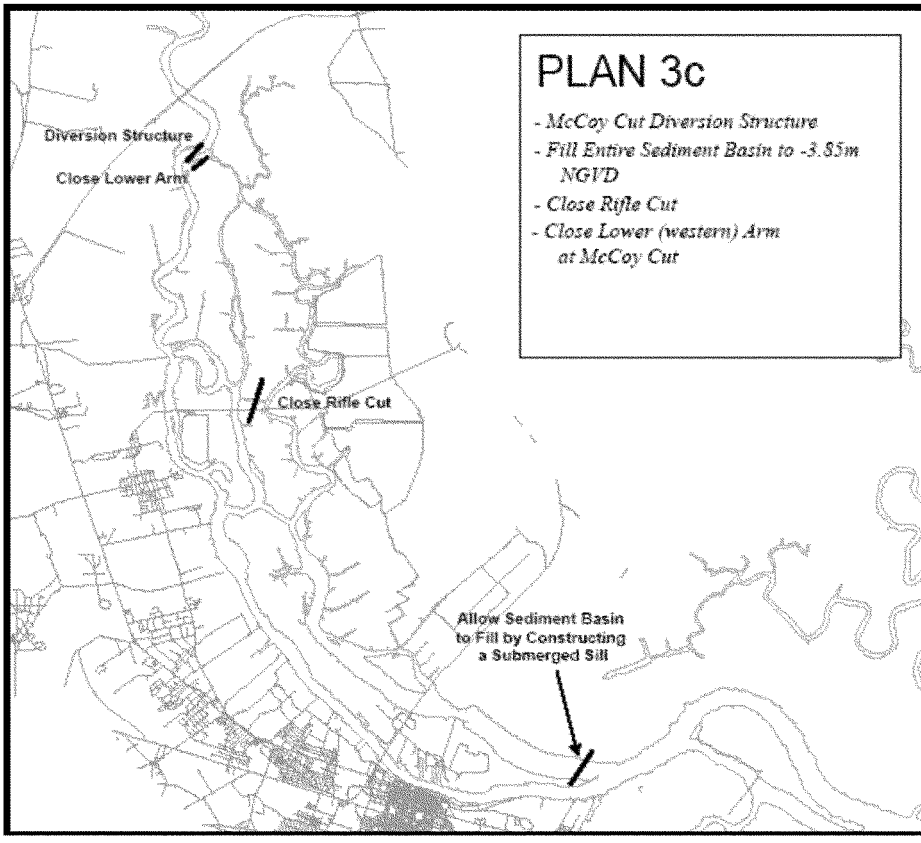


Figure 7. Plan 3c

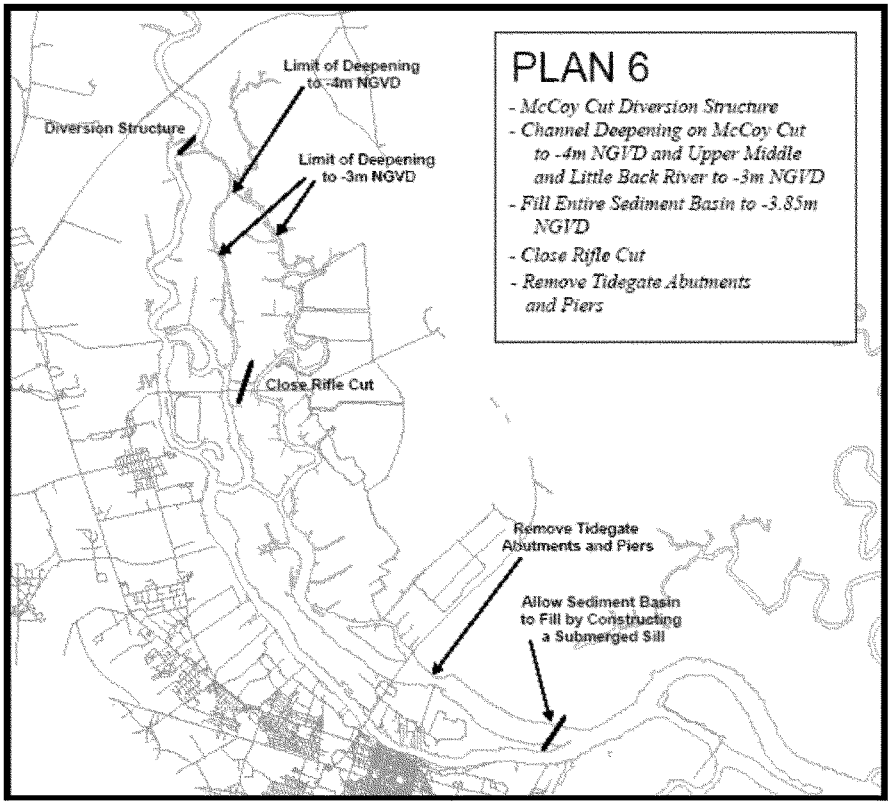


Figure 8. Plan 6

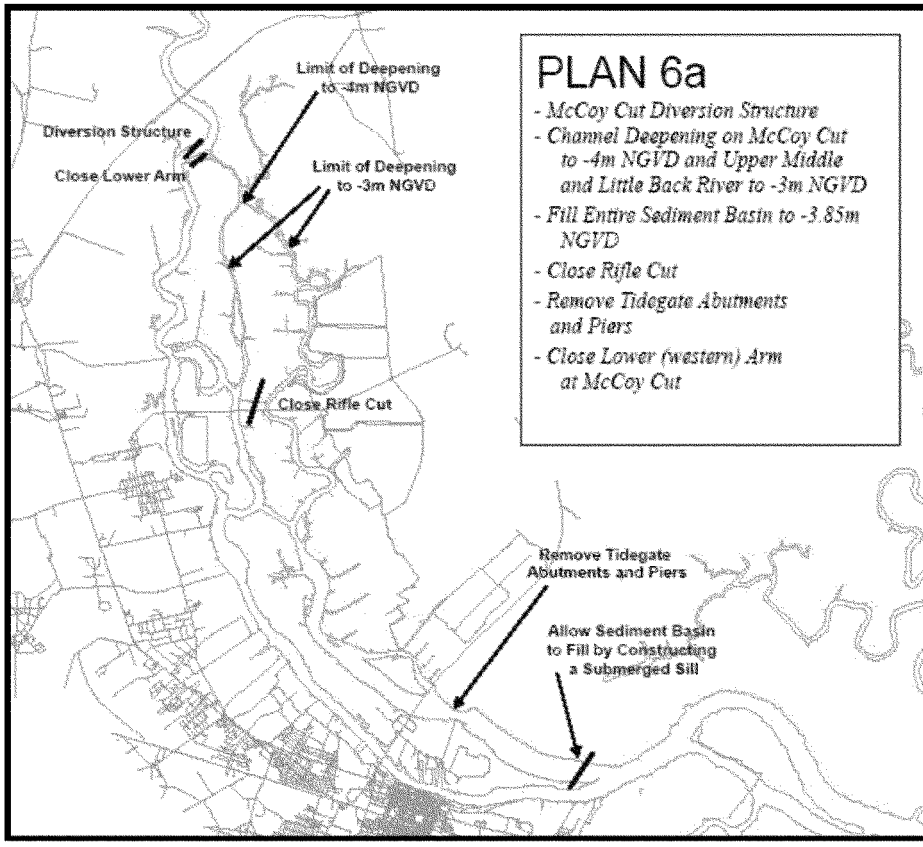


Figure 9. Plan 6a

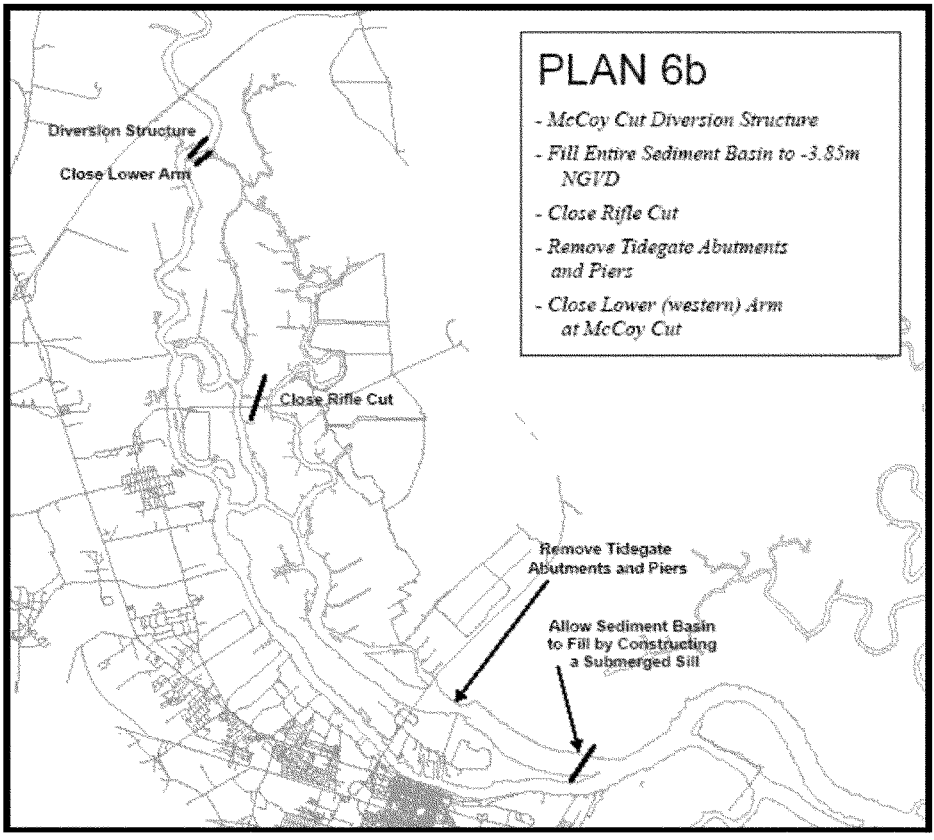


Figure 10. Plan 6b

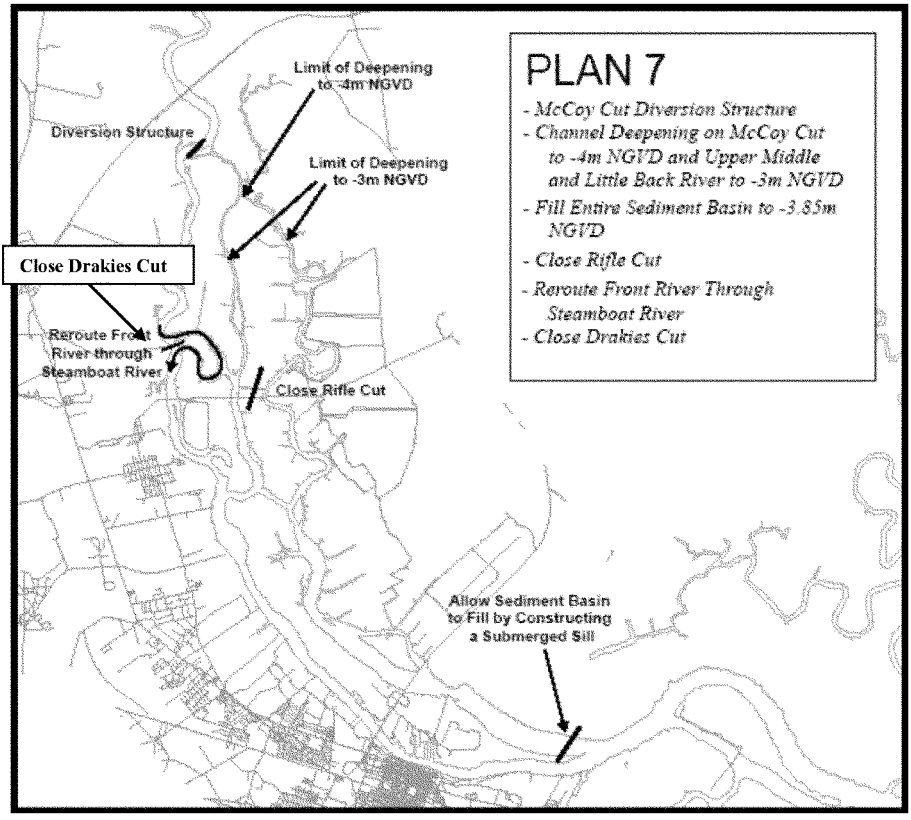


Figure 11. Plan 7

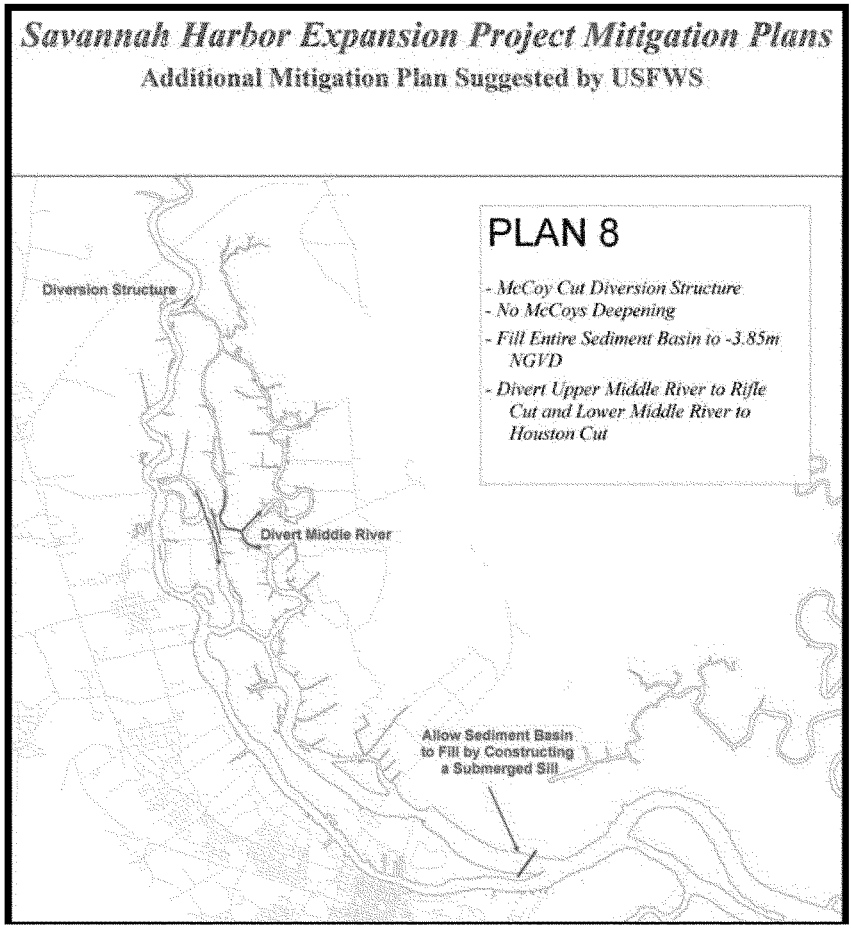


Figure 12. Plan 8

The effectiveness of these plans at reducing adverse impacts from the harbor deepening alternatives to freshwater marshes (<0.5 ppt) is displayed in the following table.

Table 6. Wetland/Marsh Mitigation Evaluation
Average River Flows
50% Salinity Exceedance Values
2-Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)	3,521	551
Plan 3	4,093	-21
Plan 3A	3,973	99
Plan 3B	3,821	251
Plan 3C	3,872	200
Plan 6	4,792	-720
Plan 6A	4,844	-772
Plan 6B	4,394	-322

NOTE: Negative adverse impact numbers means that the plan would result in positive effects of freshwater marshes.

Table 7. 3- Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)	3,105	967
Plan 3	3,718	354
Plan 3A	3,798	274
Plan 3B	3,572	500
Plan 3C	3,626	446
Plan 6	4,038	34
Plan 6A	4,040	32
Plan 6B	3,865	207

Table 8. 4- Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)	3,015	1,057
Plan 3	3,753	319
Plan 3A	3,840	232
Plan 3B	3,521	551
Plan 3C	3,599	473
Plan 6	3,817	255
Plan 6A	3,871	201
Plan 6B	3,610	462
Plan 7	4,285	-213

Table 9. 5- Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)	2,895	1,177
Plan 6A	3,849	223

Table 10. 6- Foot Deepening Alternative

	Marsh Acreage	Net Acres Adversely Impacted
Existing Conditions	4,072	------
Deepening Only (No Mitigation)	2,860	1,212
Plan 3	3,584	488
Plan 3A	3,531	541
Plan 3B	3,406	666
Plan 3C	3,383	689
Plan 6	3,715	357
Plan 6A	3,735	337
Plan 6B	3,610	462
Plan 7	3,772	300

In addition to the effectiveness of a measure in reducing project impacts, the Corps must also consider the cost of the measure. Preliminary cost estimates were developed for each of the flow-altering measures. Those costs were combined to estimate the cost of the entire flow-altering plan. Information on the cost effectiveness of those plans for the 6-foot depth and 2-foot depth alternatives is as follows:

Table 11. Cost Effectiveness of Flow-Altering Mitigation Plans
6- Foot Deepening Alternative

	Net Acres Adversely Impacted	Acres Mitigated	Preliminary Construction Cost (1,000s)	Cost/Acre Mitigated
Plan 3	488	724	$50,500	$70,000
Plan 3A	541	671	$51,700	$77,000
Plan 3B	666	546	$30,400	$56,000
Plan 3C	689	523	$32,600	$62,000
Plan 6	357	855	$51,600	$60,000
Plan 6A	337	875	$52,900	$60,000
Plan 6B	462	750	$32,800	$44,000
Plan 7	300	912	$196,400	$215,000

Table 12. 2- Foot Deepening Alternative

	Net Acres Adversely Impacted	Acres Mitigated	Preliminary Construction Cost (1,000s)	Cost/Acre Mitigated
Plan 3	-21	597	$50,500	$85,000
Plan 3A	99	478	$51,700	$108,000
Plan 3B	251	325	$30,400	$94,000
Plan 3C	200	376	$32,600	$84,000
Plan 6	-720	1,296	$51,600	$40,000
Plan 6A	-772	1,348	$52,900	$39,000
Plan 6B	-322	898	$32,800	$37,000
Plan 7		576 *	$196,400	$341,000

NOTE: *The acres mitigated by Plan 7 are assumed to be 100% of the impacted acreage.

Plan 7 (Re-routing flows through Steamboat River) was not evaluated using the hydrodynamic model with all depth alternatives. For comparison purposes in the 2- and 3-foot deepening alternatives, the acres mitigated by Plan 7 were assumed to be 100% of the impacted acreage. Actual values would be less than the assumed value, so the cost per acre would be greater than shown in the table and its cost effectiveness would be lower.

Although Plan 7 may have other possible ecological benefits, this information indicates that it would be quite expensive. The Corps expects the remaining impacts to other resources could be mitigated at a lower total cost than what would occur with Plan 7. Therefore, this plan was deemed as not being cost-effective and was dropped from further consideration. For the 45-, 46-,

47- and 48-foot depth alternatives, Plan 6B was found to be the least cost per acre, but the impact acreage was determined to be unacceptable.

Using this information, including consideration of impacted acreage, the Corps determined that Plan 6A is the most cost-effective flow-altering component for the 45-, 46-, 47- and 48-foot depth alternatives, while Plan 6B is better for the 44-foot depth alternative.

The Corps then proceeded with the mitigation planning using those flow-altering components as the basis of an overall mitigation plan for each of the channel depth alternatives.

The regional agency-coordinated preferred level of mitigation for the 47-foot depth alternative is based on a base year impact of 223 acres. Corps policy requires calculation of project impacts on an average annual basis throughout the period of analysis. A waiver would be required should the agency-coordinated level of mitigation be recommended. This waiver was requested, and it has been approved.

One of the features of Plan 6A or 6B is removal of the Tidegate and its abutments. The Tidegate is a concrete structure across Back River that was constructed in the late 1970's. Removal of that structure could require blasting. If blasting is required, restrictions would be used to ensure the safety of both the workers and environmental resources. Those restrictions are as follows:

1. If it is determined than blasting may be needed, a test blast program shall be conducted by the Contractor to design an efficient blast program that minimizes potential effects on protected species. The purpose of the test program is to allow the Contractor to determine with as much accuracy as practicable the explosive charge type, size, charge configuration, charge separation, and initiation methods. Data from these tests shall be used to determine the distance from the blast array needed to limit blast pressure to 178 – 180 dB. This distance will be defined as the "danger zone." At the conclusion of the test blast program, the Contractor shall examine all reports, surveys, test data, and other pertinent information, and the conclusions reached shall be the basis for developing a completely engineered procedure for blasting (Operational Blasting Plan).

2. The Contractor shall provide an Environmental Monitoring Plan for the job site, including land, water, air, and noise monitoring. Special emphasis shall be provided for the monitoring of wildlife resources (manatees and marine mammals).

3. All construction personnel will be advised there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972, and the Endangered Species Act of 1973. The Contractor may be held responsible for any manatee harmed, harassed, or killed as a result of blasting activities.

4. If the Contractor uses blasting, the following additional conditions shall be required:

    - Open water blasting will be allowed from November 1 through February 28 subject to all of the following conditions.

- The "danger zone" (as identified from test blast data) shall as a minimum be completely and continuously surveyed for manatees and marine mammals by qualified observers located in watercraft (minimum of two vessels) for at least one hour immediately before, during, and one half hour after detonation, in a circular safety zone at least 3 times the radius of the danger zone. The surveys shall be conducted in accordance with the Blast Area Environmental Monitoring Plan, standard operating procedures, and established observer protocols.

- Open water blasting will be allowed from March 1 through October 31 subject to the following conditions:

  - When blasting, every attempt shall be made to clear the waters around the blast area of any manatees or marine mammals by using accepted methods that will, in themselves, not adversely affect protected species. One such method used by others in the past would be to place blasting caps 15 feet apart and 5 feet below water, arranged in a line 100 yards from the main blast shall be set off one minute before each blasting event. Note: No blasting activities are allowed if manatees or marine mammals are sighted within the safety zone. Warning blasts would only be used if no such organisms have been sighted within the safety zone.

  - The "danger zone" (as identified from test blast data) shall as a minimum be completely and continuously surveyed for manatees and marine mammals by qualified observers located in watercraft (minimum of two vessels) for at least one hour immediately before, during, and one half hour after detonation, in a circular safety zone at least 3 times the radius of the danger zone. The surveys shall be conducted in accordance with the Blast Area Environmental Monitoring Plan, standard operating procedures, and established observer protocols.

5. Based on industry standards and USACE, Safety and Health Regulations, the weight of the explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately fracture the concrete. Drill patterns are restricted to an eight-foot minimum separation from a loaded hole and blast holes shall be stemmed with clean washed crushed stone. Hours of blasting are restricted to the time period of two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species.

6. The Contractor shall hire a Blasting Specialist who will coordinate and be responsible for all blasting activities. The Blasting Specialist will deliver daily pre- and post-blasting reports to the Contracting Officer's Representative (COR).

7. Blast events shall not be conducted if weather conditions such as high winds, precipitation, fog or any other situation prevent any observer from conducting an effective survey watch. Blasting operations shall not be conducted when there is a temperature inversion (as determined by the Blasting Specialist from the local weather forecast of observation) or heavy low cloud cover (as determined by the Contracting Officer or Blasting Specialist).

8. The Contractor shall monitor the blast-induced water pressure waves for each blast, at a monitoring location located either 140 feet upstream or downstream of the perimeter of the blast array and at monitoring locations located 2,000 feet upstream and downstream of the perimeter of the blast array. The monitoring locations shall be in water of similar depth to the blast array. The COR may require that the outer distance be adjusted to conform to the danger zone after coordination with relevant resource agencies.

9. All blasting and blasting related activities shall cease with the sighting of manatee(s) or marine mammals within the danger zone or the circular safety zone. The blast event shall not take place until the animal(s) moves away from the area under its own volition (it is a violation of Federal law to harass an endangered species or marine mammal, including trying to make it move). If the animal(s) is not sighted a second time, the event may not resume until at least 30 minutes after the initial sighting.

10. If a manatee or marine mammal is injured or killed during blasting, all blasting operations shall be suspended and shall not resume until the contractor obtains written permission from the Contracting Officer. The District will coordinate the take with the NMFS to determine the appropriate course of action.

11. All drilling, blasting, and the storage of explosives will be conducted in strict accordance with local, state, and federal safety procedures and procedures for marine wildlife protection, protection of existing structures, and blasting programs coordinated with federal and state agencies.

B. MARSH SUCCESSION MODELING. As part of the impact and mitigation modeling process, the Corps attempted to develop and use Marsh Succession Models (MSM). These models were intended to use salinity information from the hydrodynamic model as input and produce information on the wetland species or vegetative community expected at a given location. Two versions of these models were developed -- one by a consulting firm called Applied Technology and Management (ATM), and the other by the USGS Fish and Wildlife Cooperative Research Unit in Gainesville, Florida (USGS Coop Unit). Those two groups collected field data in the Savannah tidal marshes and surrounding estuarine wetlands. ATM collected its field data from 1999 to 2002, while the USGS extended their sampling period to cover from 1999 to 2005. These two organizations used different data collection techniques and different site locations. Using the information they collected, each developed relationships between observed parameters and wetland vegetation and community types occurring at a given site.

Both versions of the MSM used as input salinity information from the hydrodynamic model which had been processed by a Model-To-Marsh linkage (M2M). That linkage was developed by the USGS office in Columbia, SC. The M2M took salinity values from the tidal creeks, distributed them across the marsh surface, and generated output values expected in the marsh root zone. The relationships between salinity levels in the creeks, marsh surface, and marsh root zone were developed from data collected by the USGS Coop Unit in the Savannah estuary. The USGS produced a report describing their M2M linkage, and the report received an independent technical review within USGS.

ATM produced a report describing the Marsh Succession Model they developed. The Corps' Mobile District produced a report describing the MSM that the USGS Coop Unit developed. Each report explained how its model was developed and its accuracy and reliability. A panel of external reviewers reviewed the reports. The reviewers generally found both models to be acceptable.

Problems appeared when the Corps applied the Marsh Succession Models to some of the mitigation plans. The models produced unreliable results when they were used to evaluate mitigation plans that substantially altered flows in the tidal creeks. Changes in salinity were predicted by the hydrodynamic model in certain areas but corresponding changes were not forecast by the Marsh Succession Models. The problems were traced to the way in which the Model-To-Marsh linkage extrapolates salinity values from the rivers and distributes them across the surface of the marsh. The limited number of points, which the M2M uses to make its extrapolations, results in the linkage not being sensitive to salinity changes in localized portions of the estuary. Salinity changes predicted to occur in the river produced no corresponding change in salinity levels in adjacent marshes. In March 2007, the Federal Cooperating Agencies discussed a USGS proposal to revise the linkage to increase its usefulness for evaluating potential mitigation measures. The agencies did not believe the effort to satisfactorily revise the linkage would necessarily be successful or that the predicted improvements would be sufficient for the needs of the project. Therefore, the Federal Cooperating Agencies decided to abandon the planned use of the Marsh Succession Models to evaluate the mitigation proposals. The Marsh Succession Models could still be used as a check on the predictions of salinity levels made by the hydrodynamic model.

C. IMPACTS FROM EXCAVATION OF WETLANDS. In addition to the salinity impacts to wetlands, there would also be direct adverse impacts (15.68 acres) to wetlands from dredging along the shoreline of the navigation channel. Six locations would be impacted in this way. Two of the locations (the first two in the table below) are within the Savannah National Wildlife Refuge (Approximately 2.2 acres of brackish marsh would be excavated at Station 102+600 and approximately 0.8 acres of brackish marsh would be removed for the Kings Island Turning Basin expansion (Figure 13). Two of the sites are located on the west side of Hutchinson Island where approximately 3.4 acres of brackish marsh would be removed at Station 88+000 and about 0.8 acres of brackish marsh would be removed at Station 70+000 (Figure 14). Removal of the Tidegate Structure abutments on the Georgia side of the river would result in the excavation of approximately 7.63 acres of brackish marsh and removal of the abutments on the South Carolina side of the river would result in the loss of about 0.85 acres on the South Carolina side of the river. (Figure 15). The extent of the impacts would not differ substantially between channel depth alternatives and is summarized as follows:

Table 13. Direct Impacts to Wetlands

Location (Channel Station)	Affected State	Wetland Acres Affected by Excavation
Refuge Lands		
102+600	Georgia	2.2
Kings Island Turning Basin	Georgia	0.8
Non-Refuge Lands		
88+000	Georgia	3.4
70+000	Georgia	0.8
Tidegate	Georgia	7.63
Tidegate	South Carolina	0.85
	Total	**15.68 acres**

Of the total 30 acres affected by excavation, 15.68 acres could be considered brackish wetlands. The other 15.92 acres are considered high ground. The Corps would mitigate for the direct impacts to these wetlands (See Section V in this Appendix).

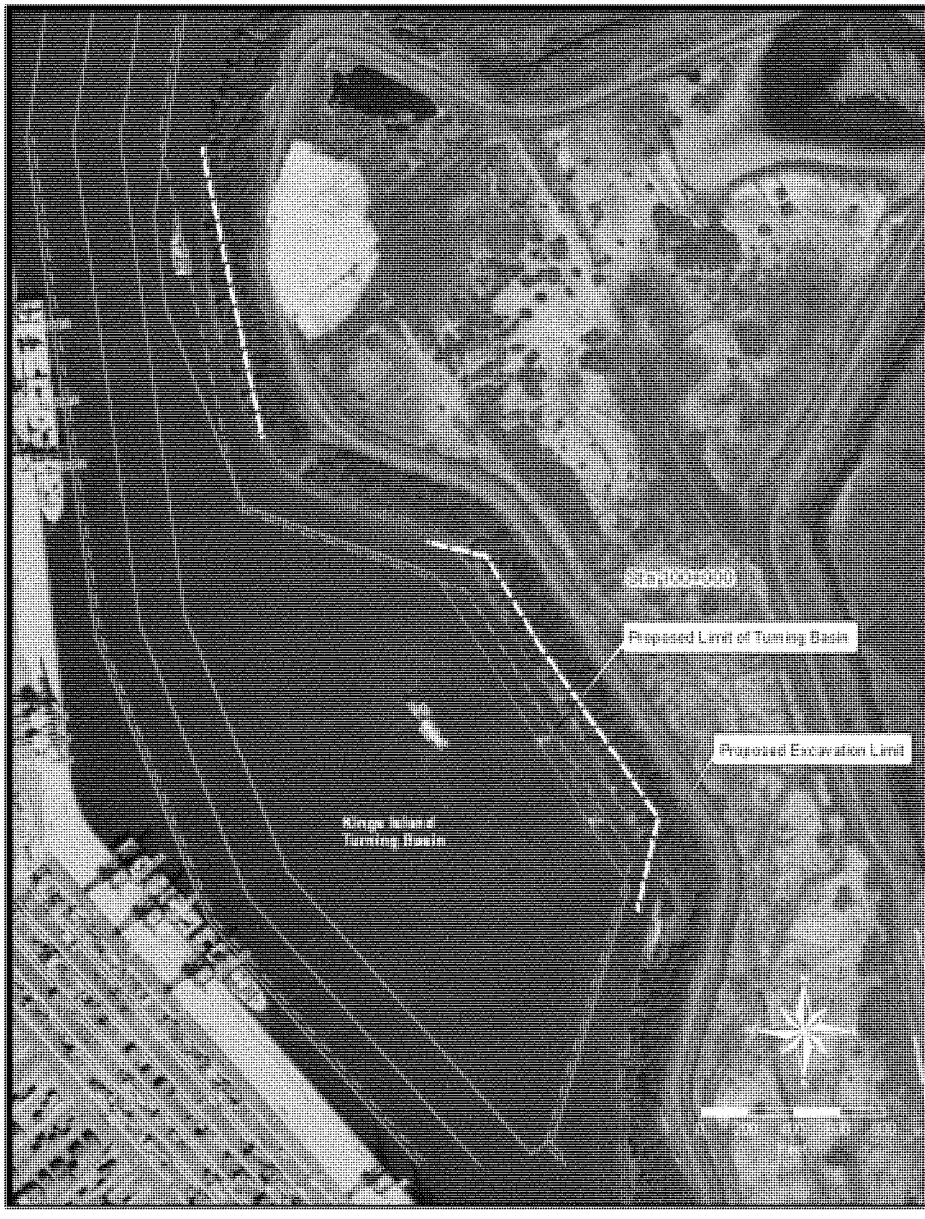


Figure 13. Excavation areas near Kings Island Turning Basin.

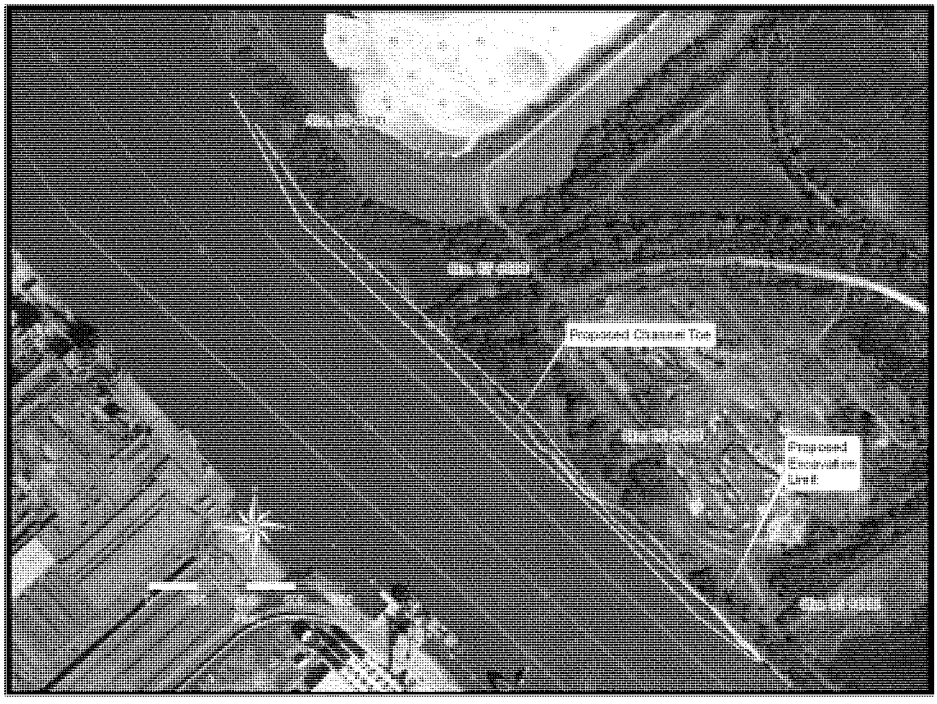


Figure 14. Excavation areas near Hutchinson Island.

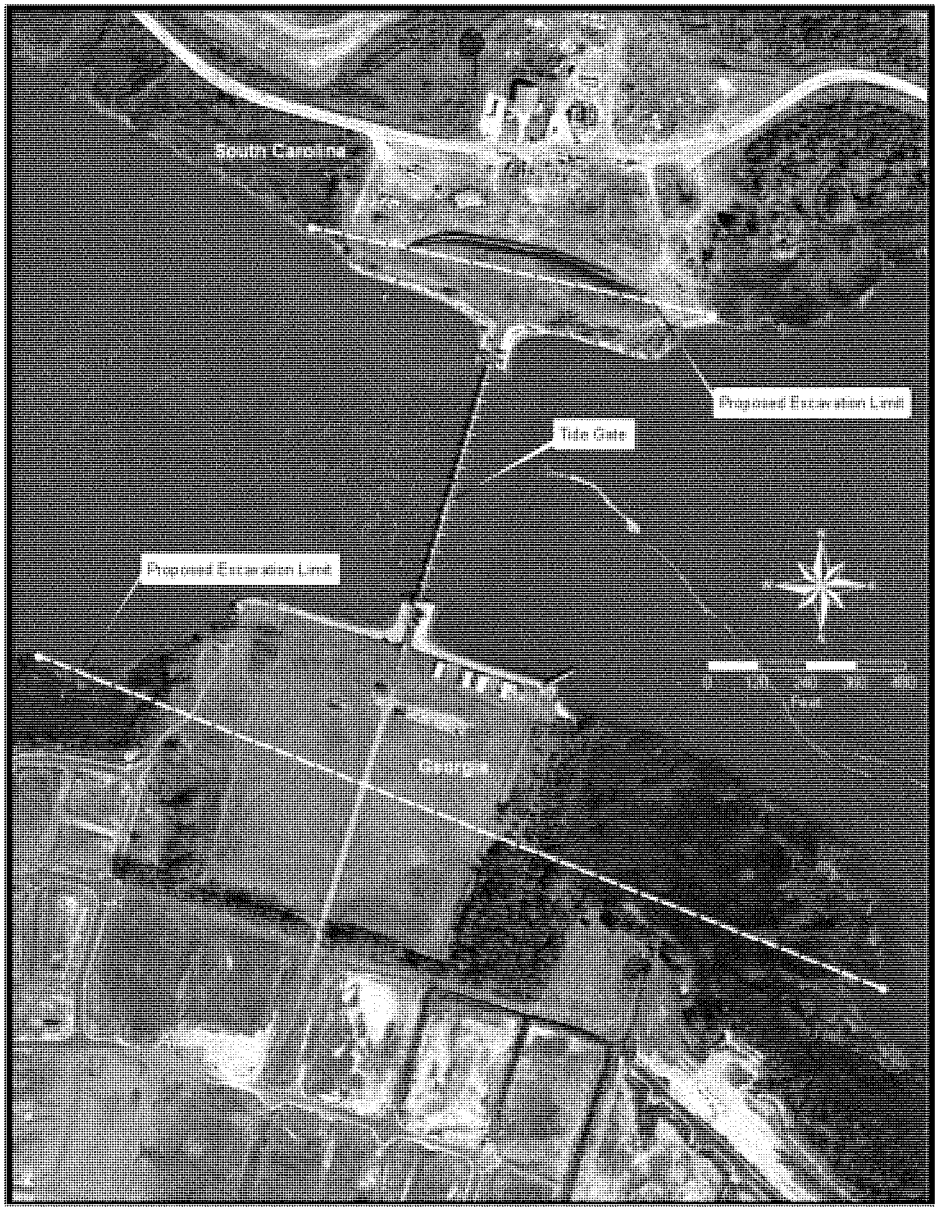


Figure 15. Excavation areas near the Tidegate.

D. IMPROVEMENTS TO DISSOLVED OXYGEN. The Corps also investigated measures to improve dissolved oxygen levels in the harbor. This is a critical resource in the harbor that experiences problems during the warm summer months. EPA issued a "no discharge" dissolved oxygen TMDL for the harbor in 2006 due to the severity of the problem. They published a Revised Draft TMDL in April 2010. The Draft TMDL requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand (UOD) to about 130,000 lbs/day. The States of Georgia and South Carolina are working cooperatively with EPA to implement that TMDL. This cooperation included the development of an acceptable water quality standard in Georgia for dissolved oxygen levels in the harbor.

The findings of studies conducted for the Savannah Harbor Ecosystem Restoration Study were incorporated into this project. As part of that study, Savannah District funded MACTEC to examine different methods of improving dissolved oxygen (D.O.) levels in Savannah Harbor. In 2005, MACTEC completed its report, having examined 25 different methods of improving dissolved oxygen levels. They considered the following methods:

OXYGEN IMPROVEMENT TECHNIQUES EXAMINED BY MACTEC IN 2005

- Membrane Filtration of Effluents
- Cascade Aerator
- CleanFlo-Natural Inversion
- Coarse Bubble Diffuser
- Fine Bubble Diffuser
- Linde-Soaker Hose
- Mechanical Surface Aerators
- Rolling Maintenance Shutdown during Critical Season
- Increased Releases from Upstream Reservoirs
- ECO2-SuperOxygenation (Speece Cone)
- Fine Bubble Diffuser using High Purity Oxygen
- Hydroflo-Aero Transfer System
- Praxair-In-Situ Oxygenation
- Sidestream Pressurized Oxygenation
- U-Tube Oxygenation
- Venturi Oxygenation
- Aquatic Treatment Systems
- Constructed Wetland Treatment Systems
- Discharge Collection Network With Supplemental Oxygen Injection
- Inflatable Weir
- Land Treatment Systems/Water Reuse
- Mechanical Pumps
- Seaward Pipeline with Timed Tidal Discharge

- Storage and Controlled Discharge System
- Tidal Gate

The MACTEC report concluded that oxygen injection is the most cost-effective method for raising D.O. levels in the harbor. The daily use of the harbor by deep-draft vessels preclude use of measures that float on the surface of the water or are suspended within the water column. The rapid shoaling in the harbor eliminates most measures that rest on the bottom of a waterbody. The SH Expansion Project used those findings and designed systems that could remove the incremental effects of the deepening alternatives. Preliminary designs were developed in 2006 and discussed with the natural resource agencies and the public. Those designs consisted of oxygen injection systems at up to 4 locations as summarized below:

Table 14. Dissolved Oxygen Summary

Depth Alternative	Number of Locations	Capacity to Increase D.O. (kg/day)
44-foot	4	7,000
45-foot	4	8,000
46-foot	3	10,000
48-foot	3	15,000

One location identified in the initial designs was judged by the natural resource agencies to be unnecessary – the most upriver location at Mill Stone Landing -- due to improvements in areas that are only minimally impacted by a harbor deepening. Another location was also judged to be unacceptable – the McCombs Cut location -- since it is within the Savannah National Wildlife Refuge where no land access exists or power is available.

After the flow re-routing components of the mitigation plan were identified, additional hydrodynamic and water quality modeling was performed to refine the D.O. system design. The modeling was based on average river flows, as these conditions were found in the previous work to require a larger sized system (than would drought flows) to remove the incremental effects of a deeper channel. That work is described in the report titled "Final Report, Design of Dissolved Oxygen Improvement Systems in Savannah Harbor, April 24, 2008".

The Georgia Ports Authority funded MACTEC to conduct a full-scale demonstration project of a dissolved oxygen injection system during the summer of 2007. The summer is typically a time of low dissolved oxygen levels in the harbor. They conducted the demonstration to obtain information of the effectiveness of this design and, hopefully, address concerns expressed by natural resource agencies with application of this general design in an estuarine environment. Agencies had expressed concern about (1) whether an injection system could be effective in the harbor, and (2) whether dissolved oxygen levels would be too high near the discharge site and adversely affect fishery resources.

MACTEC's January 2008 monitoring report (titled "Savannah Harbor ReOxygenation Demonstration Project Report") included the following findings:

- The injection system could increase D.O. levels within a three-mile target segment that typically possessed low concentrations of D.O.;
- A 20,000 lb/day D.O. injection system was effective in reducing D.O. deficit levels by 0.6 mg/l within the target area;
- D.O. injection takes about three days to begin to reduce mid-channel D.O. deficits and the oxygen improvement near the injection site extends for at least seven days after oxygen addition ceases;
- The super-oxygenated water dispersed quickly into the river and excessively high D.O. levels were not observed near the injection point; and
- Tidal flow brought new water into the injection area and no short-circuiting was observed.

MACTEC concluded that the demonstration "confirmed that the Speece Cone technology can effectively add the required D.O. mitigation amount to the harbor and reduce instream DO deficits during critical summer conditions. The demonstration also confirmed the soundness of the prototype design."

During development of the oxygen injection system conceptual design, the USGS disagreed with some of the conclusions in the initial MACTEC demonstration project report. To address their concerns and expand the data analysis, MACTEC issued a follow-on report entitled *Savannah Harbor Reoxygenation Demonstration Project, Supplemental Data Evaluation Report* (2009). The state and local environmental agencies that participated in the demonstration project and did not express any further concerns. The MACTEC supplemental data evaluation report is included in the Engineering Appendix of the GRR, Attachment 3.

After reviewing the proposed facility locations and coordinating with the natural resource agencies, the Corps engaged TetraTech in 2009 to refine the system design to determine if placing the systems in different locations would be more effective. In February 2010, the Corps met with natural resources agencies to discuss preliminary results and obtain further guidance on design criteria. The updated design indicates that a revised system design would be as effective as the original design and would be preferred by the natural resource agencies.

That work is described in the report titled "Oxygen Injection Design Report, Savannah Harbor Expansion Project, October 15, 2010". That modeling concluded that a more efficient oxygen injection system could be implemented. Based on additional evaluations conducted since release of the Draft EIS, the design of the oxygen injection system is summarized as follows:

Table 15. Dissolved Oxygen Injection Comparison

Depth Alternative	Number of Injection Locations	Number of Cones Operated	Number of Cones Installed	Capacity to Increase D.O. (lbs/day)
44-foot	3	9	11	36,000
45-foot	3	8	10	32,000
46-foot	3	9	11	36,000
47-foot	3	10	12	40,000
48-foot	3	11	13	44,000

The locations identified for these systems are shown in Figure 16. Two of the systems would be co-located on Hutchinson Island, while the third would be located upstream near Georgia Power's Plant McIntosh. The systems would be land-based, with water being withdrawn from the river through pipes, then supersaturated with oxygen and returned to the river. The location of the most upstream site is near the Plant McIntosh facility, while land on Hutchinson Island is owned by the International Paper Company. The Hutchinson Island site would serve as the location of two co-located facilities -- one serving Front River and the other serving Back River. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and would not extend out into the authorized navigation channel. A site design is shown on the following page (Figure 17).

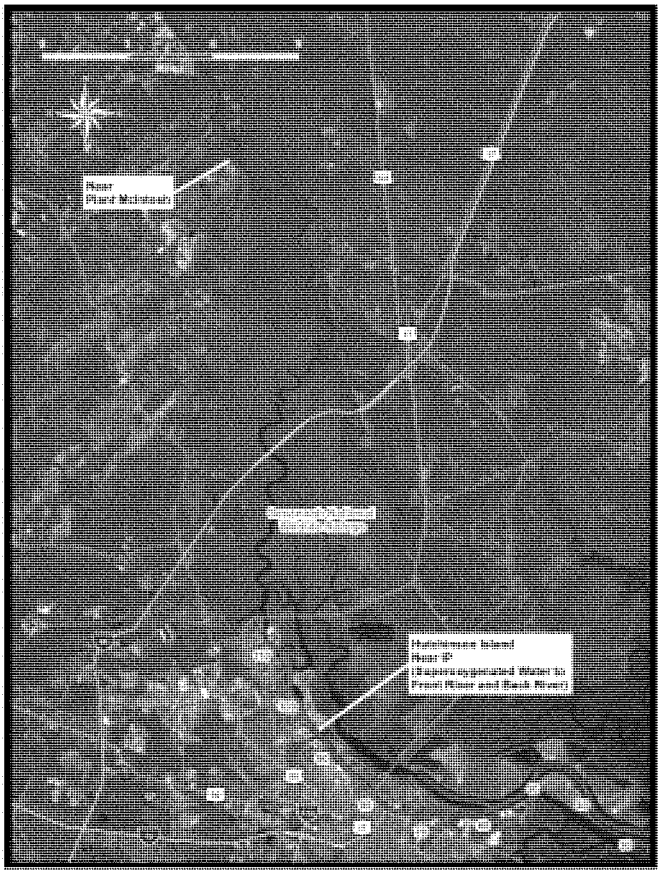


Figure 16. Locations for dissolved oxygen injection systems.

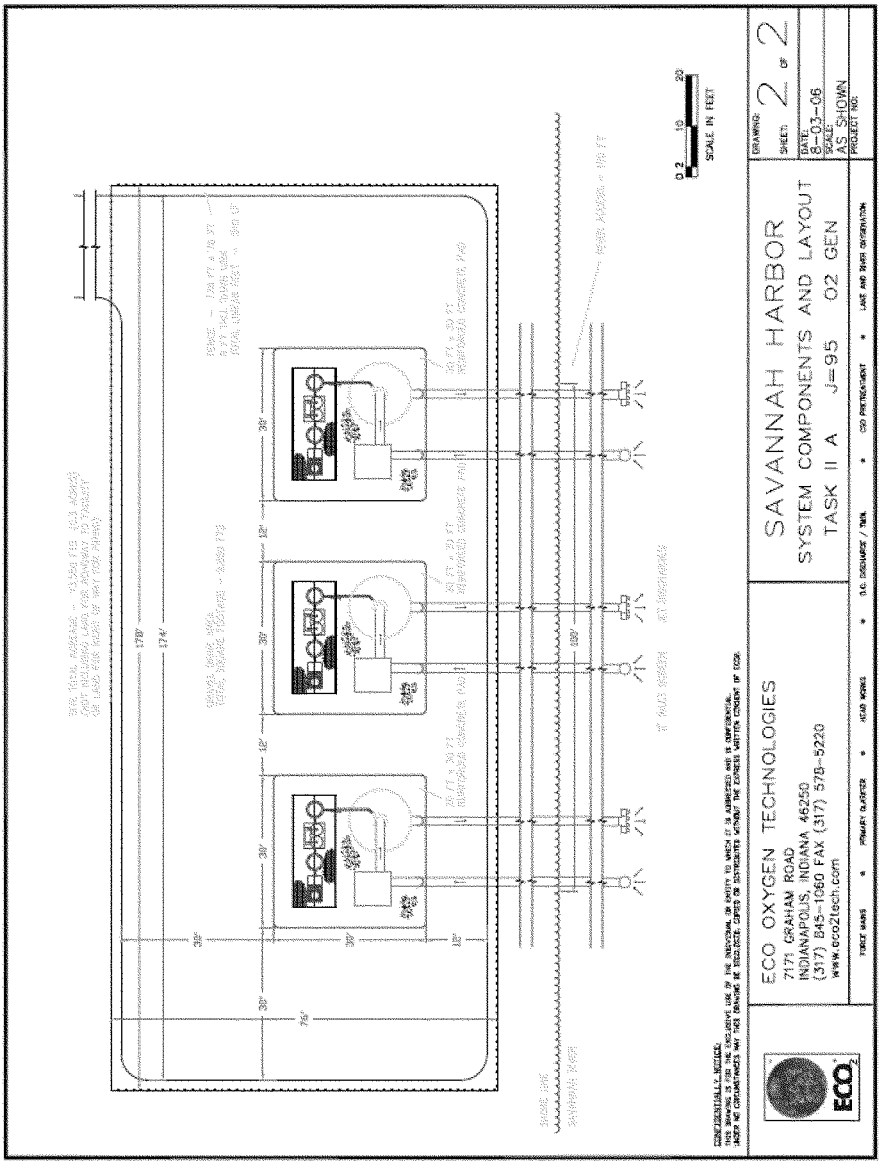


Figure 17. Typical site design for dissolved oxygen injection system.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the site increases. Removing the incremental project effect at a great distance from injection site requires substantially greater amounts of oxygen. A tradeoff results between the amount of oxygen required and the distance from the injection site. Ultimately, this becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity of maintaining numerous systems also increases. The District believes the present system designs provide the best balance of system spacing, size and effectiveness, when the issues of operating complexity, existing land uses, and over-compensation of impacts are considered. The D.O. system configuration is designed to remove the incremental effect of a deeper channel in 95 percent of the water volume in the hydrodynamic model. The District believes that level of performance recognizes the limitations of the hydrodynamic and water quality models in distinguishing small differences between different run conditions.

As stated previously, dissolved oxygen levels would be higher near the injection site and taper off to lower levels as distance from the site increases. The Corps analyzed the model outputs and found that the systems would increase D.O. levels above their present levels over much of the harbor. Such improvements are an incidental and secondary benefit of a system that is designed to remove the incremental effect of a deeper channel in 95 percent of the water volume. The information on the following page shows the extent of the improvements that would occur.

Table 16. Percent of Cells with Improvement in D.O. Levels Over Existing Conditions with the D.O. Improvement Systems

	Vertical Layer	44 ft depth	45 ft depth	46 ft depth	47 ft depth	48 ft depth
5th percentile	Surface	99.9	99.7	99.9	99.9	99.9
	Mid-Depth	94.4	98.3	98.1	98.7	98.5
	Bottom	97.2	97.4	97.8	98.1	97.2
	Water Column	98.3	99.9	99.9	99.9	99.9
10th percentile	Surface	99.9	99.9	99.8	99.9	99.9
	Mid-Depth	95.3	99.2	99.1	99	99.1
	Bottom	97.5	97.5	97.9	98.4	97.1
	Water Column	98.4	99.9	99.9	99.9	99.9
25th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	95.5	99.4	99.3	99.1	99.2
	Bottom	97.9	97.7	98	98.1	97.7
	Water Column	98.7	99.9	99.9	99.9	99.9
50th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	96.3	97.7	97.7	98.1	97.8
	Bottom	98	98.4	97.8	97.2	97.1
	Water Column	99.1	99.9	99.8	99.8	99.9

The Corps is required to evaluate the cost effectiveness and perform an incremental cost analysis of it potential mitigation plans. Dissolved oxygen is a critical issue for the Savannah River. Because of seasonally-degraded conditions in the river, EPA recently issued a TMDL that would substantially reduce the amount of oxygen-depleting substances that municipalities and industries may discharge into the river. The State of Georgia recently revised its dissolved oxygen standard for the harbor to address a longstanding legal issue. Since a harbor deepening project will require water quality certification (from two States), the project must fully address its impacts to this critical resource. The initial design developed by the engineers to fully address those impacts was described above. The Corps could have chosen to construct only portions of the proposed system design, such as adding oxygen at only one or two of the locations instead of the three recommended sites, or it could add less oxygen than was identified as needed at a given location. However, the Corps chose to implement all of the recommended dissolved oxygen system design to fully compensate for the effects of the individual depth alternatives on this critical resource. HQUSACE provided policy guidance early in the process that stated that mitigation proposed in this project could only compensate for the impacts of this project and could not be recommended as a means of addressing impacts of any previous harbor deepening project. Therefore, the alternatives could not provide more than 100 percent of the oxygen needed to address the impacts they would otherwise produce.

The hydrodynamic modeling determined the amount of oxygen that would be needed to remove the adverse effects of a deeper channel on dissolved oxygen. The amount of oxygen that would need to be added is the result of both the extent of the impact (which depth alternative) and the location where the oxygen would be added. Modelers initially developed a design that minimized the amount of oxygen that would need to be added. The District and natural resource agencies found that design to be unacceptable because some locations did not have sufficient high ground, road access, or some other factor that rendered the site unusable. The modelers revised the design to use sites that were suitable for development. After coordination with the natural resource agencies, the Corps redesigned the systems with the following protocol: (1) focus the initial site in the locations with the most DO impact, (2) co-locate facilities if possible to serve multiple needs, and (3) locate other facilities needed to address remaining DO impact areas near existing development. That design approach led to the design that was included in the EIS with the bulk of the DO addition occurring in Front River from Hutchinson Island near the International Paper wastewater treatment lagoon, co-locating equipment at that site that would add oxygen to Back River, and locating a final site upriver near Georgia Power's Plant McIntosh to address DO impacts that occur further upstream.

The basic unit of design for the DO systems would be a Speece cone, with its supporting equipment. Two alternatives were evaluated to supply oxygen: (A) one using a liquid oxygen supply tank, and (B) one using on-site generation of oxygen. The costs were very similar on an average annual basis. The District chose to use onsite generation to increase the long term reliability of performance. In recent years the District has experienced difficulties at other project sites with an inability to obtain liquid oxygen in the summer at any price. On-site generation would remove that potential problem.

The District agreed to use an effective capacity for each Speece cone of 4,000 pounds of oxygen added per day. The costs for each cone (without contingencies) are estimated to be as follows:

Speece cone	$ 720,000
Oxygen Generator	$ 240,000
Side Stream Pump	$ 45,000
Site development	$1,300,000
Total	$2,305,000

Some minimal savings may occur from multiple cones being constructed at a given location, but those potential savings were not identified.

The Corps clearly considered the cost effectiveness and evaluated incremental costs in its analysis and design of the dissolved oxygen systems. Based on information presented above, it is not necessary to develop and display the cost effectiveness of various increments of the amount of oxygen to be added, design alternatives, or construction methods as is included in a typical CE/ICA. The incremental cost per unit of output would be constant until the full mitigation need is reached.

E. SUMMARY. The Corps used the hydrodynamic and water quality models to identify many of the impacts to natural resources from the proposed project alternatives. These included impacts to salinity, water quality, wetlands, and fisheries. Impacts to other resources were evaluated using separate analyses. Those evaluations included potential impacts to the drinking water aquifer, adjacent ocean beaches, river shorelines, and air quality.

After the expected impacts to the aforementioned resources were identified, the Corps used the hydrodynamic and water quality models to evaluate ways to reduce impacts. A flow re-rerouting plan was developed for each depth alternative that minimized impacts to freshwater tidal wetlands, the resource which the agencies identified as being most at risk from this project. The Corps decided to adopt the findings of a separate study which identified injection of dissolved oxygen as being the best method to remove the incremental effects of harbor deepening on the D.O. levels in the harbor.

Using the selected flow-re-routing plans (See Figures 4-12), the water quality model was run to determine the need for and design of the D.O. injection systems. Subsequently, the D.O. modeling results were used to identify the remaining impacts to fishery resources.

This modeling revealed that the proposed mitigation features (flow-altering plans and D.O. injection systems) would substantially reduce project impacts to freshwater wetlands, dissolved oxygen, American shad, and Southern flounder. The table on the following page summarizes the impacts of the depth alternatives after avoiding and reducing project impacts.

However, substantial adverse impacts would remain to freshwater wetlands, Shortnose sturgeon, and Striped bass. Because of those remaining impacts, additional mitigation consisting of replacement or compensation was determined to be appropriate. Those actions are the third step in the mitigation planning process.

Table 17. Summary of Project-Related Impacts with Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary up Front River	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater Amount	Same effect, but greater amount
Freshwater Wetlands (Conversion)	+ 322 acres	- 32 acres	- 201 acres	-223 acres	- 337 acres
Brackish Marsh (Conversion)	+ 488 acres	+ 861 acres	+959 acres	+964 acres	+1068 acres
Salt Marsh (Conversion)	- 808 acres	-828 acres	-757 acres	-740 acres	-730 acres
Brackish Marsh (Loss)	-15.68 acres	Same	Same	Same	Same
Dissolved Oxygen	Minimal Net improvement	Same	Same	Same	Same
Fisheries	**Loss (-) or Gain (+) of Acceptable Habitat**				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	-4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	- 6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+19.0 % (+260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	-+6.5 % (+89.0)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	- 6.7% (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6% (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0acres)	+ 54.2 % (+1014.0acres)	+ 57.3 % (+1072.0acres)	+57.3 % (+1072.0acres)	+ 52.9 % (+989.0 acres)
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, Max increase in WSEL = 0.5 ft	Minor, Max increase in WSEL = 0.6 ft	Minor, Max increase in WSEL = 0.7 ft	Minor, Max Increase in WSEL= 0.8ft	Minor, Max increase in WSEL = 0.8 ft
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

V REPLACEMENT / COMPENSATION

The final major step in mitigation planning is replacement / compensation for impacts to resources. This step consists of ways to replace and/or compensate for the environmental functions that are adversely impacted by the project. The preferred means of mitigation at this point is through the following steps (from highest to least preferred):

Restoration → Enhancement → Creation → Preservation → Compensation

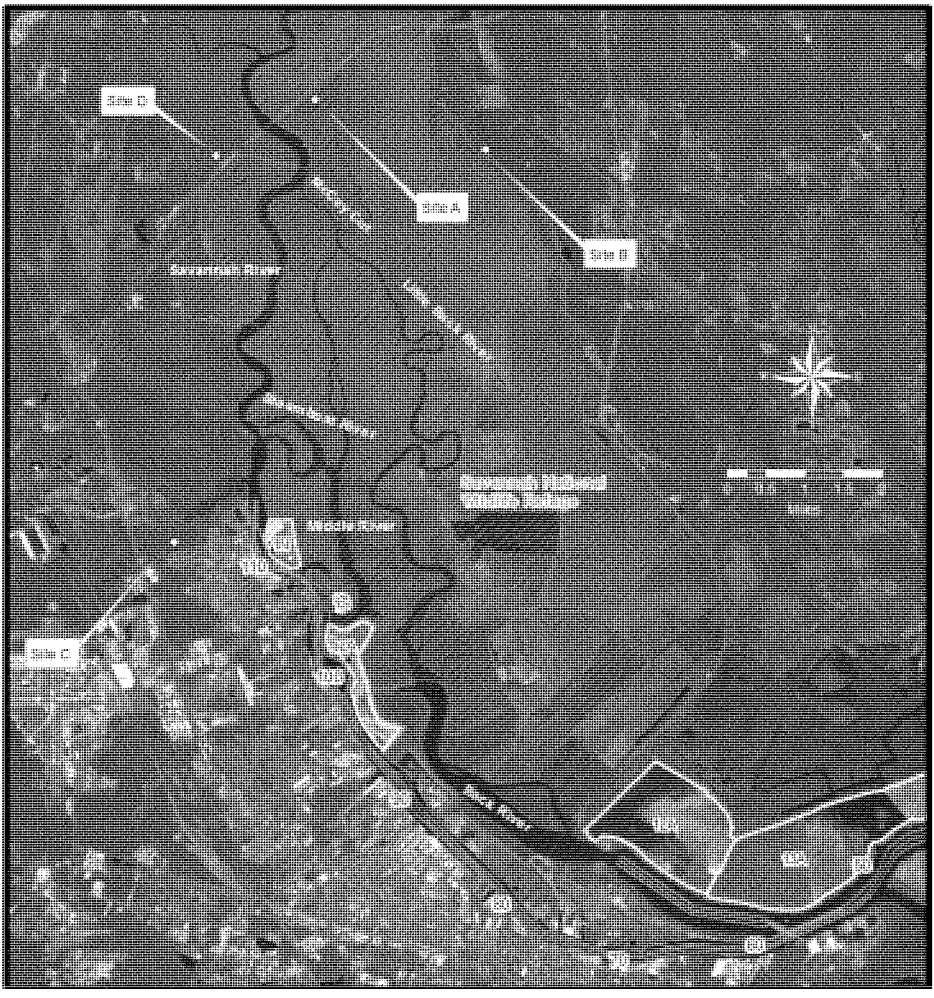
A. RESTORATION / ENHANCEMENT / CREATION

1. Wetlands

Once the extent of the impacts to wetlands was known, the Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs in an attempt to identify sites where freshwater wetlands could be restored, enhanced or created.

Four sites were identified and inspected by the Corps (Figure 18). These sites are within the Savannah estuary and near the impact area. The site labeled Site A is a borrow site that was used during construction of US Interstate 95. Soils were re-deposited at the site in the 1970s, and it has since revegetated. Although freshwater marshes no longer occur on the property, an inspection revealed the mixed site contains a considerable amount of wetland vegetation. Thus, a substantial increase in wetland functional values would not be obtained if the site was restored to a tidal freshwater marsh. Therefore, the site was deleted from further consideration.

The site labeled as Site B consists of forested lands along the SC boundary of the Savannah National Wildlife Refuge (SNWR). The Corps initially identified this as a potential site where tidal freshwater marsh could be created. The property is situated in the estuary where freshwater occurs both now and after a potential deepening project. The site is adjacent to existing freshwater marshes, and tidal creeks could be extended to provide the water necessary to flood the lands. The Corps developed preliminary designs to excavate the site to marsh elevation, move those soils to an adjacent property, and enlarge a creek to bring tidal flows to the site. Roughly 1,000 acres of freshwater wetlands could be created if lands exceeding a 10-foot MSL elevation were graded down to a 0 MSL elevation. The Corps and USFWS personnel inspected the site in September 2007. One portion of the site had been logged within the past 5 years, while two other portions were in the process of being logged. The Service questioned if the Corps could reliably convert the primarily upland site into a high quality tidal freshwater marsh. USFWS stated that they preferred the Corps not attempt to create wetlands on that site.


Site D
Site A
Site B
Site C
Savannah River
Augusta Canal
Augusta Canal
Discharge Canal
Augusta Regional
Airport (Bush Field)
Airport Runway
Spirit Creek
Spirit Creek
Spirit Creek

The USFWS did, however, acknowledge that the South Carolina lowcountry is rapidly developing, with residential developments seeming to sprout up nearly every month. Lands such as this tract, with its road access and marsh views, seem to be particularly highly desired. Developers had surveyed this site and others along the SNWR boundary and were actively marketing the properties. The Corps consulted with the natural resource agencies about the value of acquiring this site and preserving it to provide a buffer from development along one side of the Refuge. Before the Corps could complete its mitigation evaluation, the site sold for development and is no longer available to the non-Federal sponsor at a reasonable cost. Neither the Georgia Ports Authority nor the Georgia Department of Transportation has condemnation authority in South Carolina.

The site labeled as Site C is on the Georgia side of the river along St. Augustine Creek. The site had been identified by staff in Savannah District's Regulatory Division as having restoration potential. The site is a mixture of uplands and wetlands, with a breached dike bordering most of St. Augustine Creek. Planning Division staff inspected the site in September 2007. They found sections of dikes to still be present, but several openings allow tidal flows to cover portions of the area. It was not apparent the extent to which the dike segments are still reducing tidal flows to the site. A drainage ditch from GA Highway 21 crosses the site, likely reducing water levels on some of the tract. Active use of the ditch to drain the highway may limit the ability to block the ditch to raise adjacent water levels. The restoration potential may well be limited to removing the dike segments and restoring marsh vegetation within the footprint of the dikes. That seemed to present a limited opportunity and the site was dropped from further consideration for this project.

The site labeled as Site D is located approximately 1 mile NW of the I-95 bridge over the Savannah River and is approximately 1 mile WSW of the Savannah River at its closest approach. The tract encompasses approximately 260 acres at the head of Knoxboro Creek, a tributary of the Savannah River on the Georgia side. After conducting a site visit in November of 2010, Planning Division staff determined that the tract represents a very limited possibility for use as a wetland mitigation site for creation of tidal freshwater marsh. The site is surrounded on 3 sides by intact bottomland hardwood-cypress wetlands and the nearest existing freshwater tidal wetlands are 2.5 miles ESE of the site. It may be that tidal freshwater marsh would not normally exist on the tract and would likely require extensive management to prevent succession to the forested wetlands that would normally occur there. Furthermore, if tidal freshwater marsh were created on the tract, and Knoxboro Creek would not provide sufficient water ebb and flow, the next nearest water source is the Savannah River, approximately 1 mile away. Establishing and maintaining a constructed tidal freshwater marsh on the site would require expensive construction and maintenance costs, and once established, would and require constant intervention to prevent the site from reverting to forested wetlands. As such, the site was removed from consideration for this project.

Neither the Corps, the natural resources agencies, the Stakeholders Evaluation Group, nor the NGOs could identify other sites in the Savannah River estuary that could potentially be used for restoration or creation of tidal freshwater marsh.

The USFWS stated that mitigation actions must be performed within the basin for those actions to be acceptable to them and adequately compensate for wetland impacts within the Savannah

National Wildlife Refuge. The Service also confirmed that restoration, enhancement or creation of saltmarsh would not be acceptable as mitigation for losses to tidal freshwater marsh.

During the natural resource agencies' review of a preliminary version of the DEIS, the agencies requested "in kind" mitigation for direct impacts to brackish marsh. All the proposed harbor deepening alternatives would result in the loss of approximately 15.68 acres of brackish marsh. Preservation of freshwater wetlands adjacent to the Savannah National Wildlife Refuge was not considered appropriate mitigation for those impacts. USEPA recommended use of a salt marsh mitigation bank, the preferred choice of mitigation as specified in the USEPA/USACE Final Compensatory Mitigation Rule, which was published in the Federal Register on March 31, 2008. However, there are currently no salt marsh mitigation banks serving coastal Georgia (One salt marsh mitigation bank was approved by the Interagency Review Team (IRT) in 2007, but the owner declared bankruptcy before the bank was operational). Thus, the Corps was obligated to explore other mitigation opportunities. The Corps evaluated several sites within coastal Georgia, but the USFWS subsequently indicated a preference for mitigation of these impacts within the Savannah River Basin. Ultimately, a previously used sediment placement area (CDF 1S) within Savannah Harbor was identified as having the greatest opportunity to support the long term success of a restored brackish marsh system. CDF 1S is located adjacent to the confluence of Front River and Middle River, and it is located within the boundaries of the Savannah National Wildlife Refuge. Much of the site is currently "high ground" as a result of the previous sediment disposal actions, which were terminated at least 20 years ago. The Corps hosted a site visit on August 10, 2009, and the agencies approved the concept of grading down the site to restore it to a marsh. The proposed restoration area is approximately 42 acres. A portion (1.7 acres) of the site was graded down by GPA several years ago as mitigation for work at their facilities. The Corps would restore approximately 40.3 acres of marsh and include the GPA site to provide a contiguous 42.0 wetland restoration site.

The USACE used the Regulatory SOP to determine the exact number of acres that would be required for restoration (See Appendix A at the end of this Mitigation Plan). Figure 19 illustrates the restoration of the CDF 1S site would occur by grading it down to an elevation that would allow the growth of Spartina alterniflora (i.e., +7.6 to +7.7 MLLW). Appropriate elevations were identified based on the elevation of adjacent marsh. Once the new elevations have been established, the approximately 42-acre site would be allowed to naturally vegetate. If the site does not revegetate, the Corps would plant Spartina alterniflora to provide the basis for subsequent growth across the entire site.

At the request of USFWS, a "feeder" creek system would also be constructed toward the interior of the restored marsh. The creek would provide another mechanism of ensuring adequate exchange of brackish, surface water with pore waters that are located on the interior of the site (See figure below).

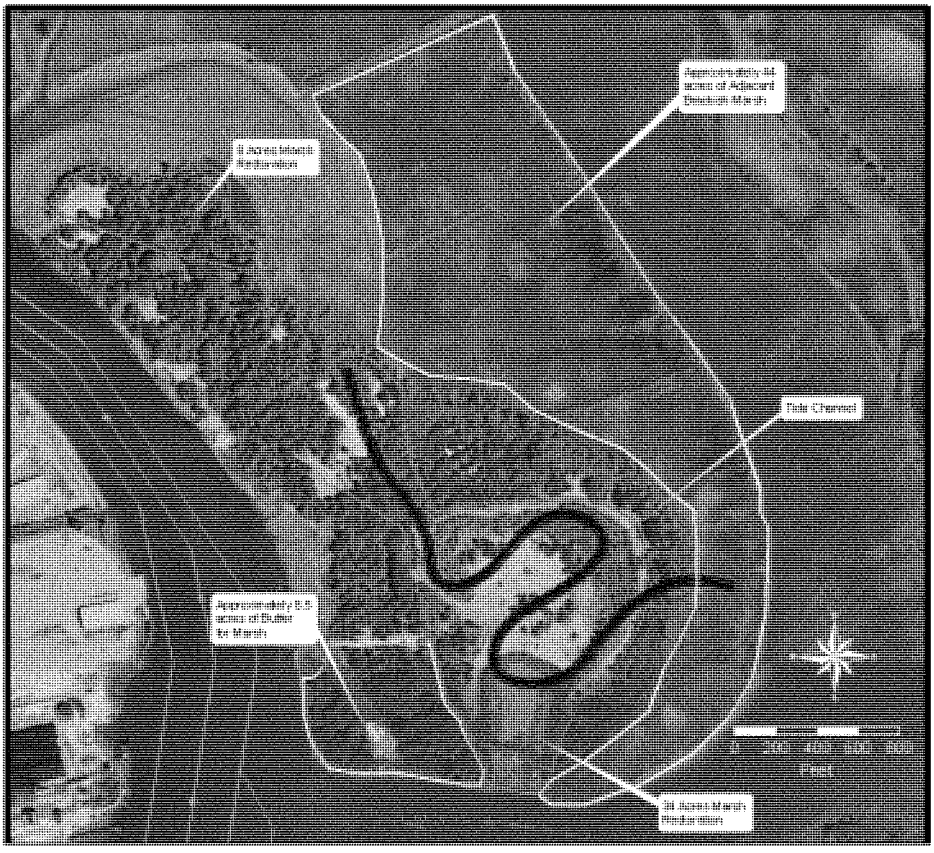


Figure 19. Proposed wetland restoration site at Disposal Area 1S.

The Corps is required to evaluate the cost effectiveness and perform an incremental cost analysis of its potential mitigation plans. Extensive wetland losses have occurred in the US, resulting in Congress establishing Federal laws (Section 404 of Clean Water Act (33 U.S.C. §1251 et seq.)) to limit those losses in the future and ensure that wetland impacts that occur are fully mitigated. Tidal marshes are important resources along the Georgia and South Carolina coasts. The natural resource agencies that comment on proposed Section 404 permits require losses of tidal marshes to be fully mitigated. The agencies that review Section 404 Regulatory permits in Georgia have agreed to a Standard Operating Procedure (SOP) that is used to quantify both the ecological effects of proposed wetland impacts and the mitigation required to compensate for those impacts. The SOP requires full compensation for the impacts that the project would produce.

Savannah District used its Regulatory SOP to identify the amount of restoration that would be required to compensate for the impacts of the various project alternatives on brackish marsh. In

this case, each depth alternative would result in the loss of 15.68 acres of brackish marsh. Using the guidelines set forth in the SOP, Savannah District identified the need to restore 28.8 acres of Area 1S to brackish marsh to fully compensate for those impacts. Area 1S was identified as the best location after a thorough search of potential sites in the Savannah River basin, along coastal Georgia, and in South Carolina. No other site was found that fully meets the project needs, which include location within the basin, sufficient size, and suitable salinity to allow the growth of the desired type of vegetation. The site would also support the goals of the Savannah National Wildlife Refuge by restoring developed lands within the Refuge to a more natural condition. Restoration of a larger footprint at the site is possible, but not required to address the impacts of this harbor deepening project. The District, however, plans to restore the entire site and use the additional 11.5 acres as "advance mitigation" for any additional wetland mitigation needs of the SHEP or operation and maintenance activities associated with the existing Savannah Harbor Navigation Project. The costs for those additional acres would be funded by the Corps O&M budget and would not be part of the costs of this harbor deepening project. Operation and maintenance of the existing Navigation Project periodically results in wetland mitigation needs to address impacts from small unforeseen O&M actions (new pipe ramps, etc). The Corps could have chosen to restore less than the acreage calculated by the SOP, but then it would not have followed the procedures it had previously agreed to with the natural resource agencies. The proposed restoration of 40.3 acres maximizes the restoration potential of the site, so additional restoration of the site would not be ecologically beneficial. Restoration of the full potential of the site at one time eliminates potential future construction impacts at the site and is more cost effective.

After selection of Disposal Area 1S as the site to restore, the District followed a rational design process to design the restoration work. The work would consist of grading down a previously-used sediment disposal site to restore the site to marsh vegetation. The rationale and major parameters are summarized below.

- Size of restoration area -- The required size was established by the calculation in the Regulatory SOP – 29 acres.
- Final elevation of site -- The elevation to which the site would be graded down was established by a field survey that identified the height of adjacent marsh -- +7.6 to 7.7 feet mean low water.
- Volume to be removed – The District calculated the volume by comparing a topographic survey of the existing elevations at the site with the desired final elevation – 425,000 cubic yards.

Additional acreages could be restored at the site, up to a maximum size of 45 acres, which is the amount that the USFWS (as landowner) agreed could be restored. Except for a narrow buffer around the marsh, 45-acres is the size of the site that now functions as an upland. The Corps could restore additional acreage beyond the required 29 acres, but they would not be a project cost. Those costs would be paid using Savannah Harbor Navigation Project O&M funds to create advance mitigation for its future activities that require brackish or saltmarsh mitigation. It would be better from an ecological perspective to perform all the construction/restoration work at the same time instead of performing the work several years apart. Combining the work would also save costs for mobilization/demobilization of equipment.

Since sediment would have to be transported from the site, the manner in which it is transported and the distance it is carried would affect the construction cost. There is no road access to the

site, so trucking is not a useable method to remove the sediment. The site has water access and dredges can move large volumes of material at a low unit cost, so the District first considered use of a small hydraulic cutterhead dredge for this work. Two potential deposition areas were identified – CDFs 2A and 12A. Area 2A is adjacent to the restoration area, but the District determined there was not sufficient capacity remaining to accommodate the roughly 425,000 cubic yards of material. CDF 12A is located further away and has no capacity constraints. A small hydraulic cutterhead dredge is not powerful enough to efficiently pump the sediments the long distance to CDF 12A. A large cutterhead dredge would be required to pump the heavy sands the long distance to CDF 12A. The District then evaluated use of a clamshell and barge to transport the excavated sediment to CDF 12A, and this method was determined to be a viable, efficient construction method. The District based its cost estimate on use of that equipment. Employing a clamshell and barge would eliminate the higher costs of a larger cutterhead dredge pumping the long distance to CDF 12A. The main factor that affects the unit dredging cost with a clamshell and barge is the volume of sediment to be removed. That number was established earlier in the design process, as described above.

The restricted site access, finite volumes, limited construction method alternatives, and placement options were all considered in the design process. As such, the process described above narrowed the scope of a Cost effectiveness/Incremental Cost Analysis and eliminated the need to develop and show cost estimates for various increments of project size, design alternatives, or construction methods. The rational process followed by the design team as described above ensured that the project identified the most cost effective design and construction method to meet the mitigation need.

The Corps clearly considered the cost effectiveness and evaluated incremental costs in its analysis and design of the restoration of brackish marsh at Disposal Area 1S. Based on information presented above, it is not necessary to develop and display the cost effectiveness of various increments of project size, design alternatives, or construction methods as is included in a typical CE/ICA.

2. Other Resources

Substantial impacts remain to other critical resources after the flow-altering and dissolved oxygen improvement components are included. Those resources include Shortnose sturgeon and Striped bass. The Corps consulted with the natural resource agencies, and we jointly could not identify any restoration, enhancement or creation measures in the Savannah River Basin that would compensate for the impact to those two fish species. However, the agencies did agree on measures to compensate for those impacts. Those measures will be discussed later in this document in a section titled "Compensation".

B. PRESERVATION

After pursuing ways to avoid and minimize project impacts, and then restore or enhance existing environmental functions, one looks to preservation as a means of addressing expected project impacts. For impacts to freshwater wetlands, the Corps used the Regulatory Standard Operating Procedures (SOP), which have been adopted by the natural resources agencies in Georgia to evaluate impacts and calculate compensatory mitigation on projects requiring Section 404 permits. Although the SOP was developed by the interagency Mitigation Banking Review Team

for actions permitted through the Corps' Regulatory Division, it can also serve as a framework to quantify impacts from civil works projects such as this. EPA Region 4 suggested the Corps consider use of the SOP for this project. In brief, the SOP uses several factors to quantify the ecological impacts and benefits expected from various project actions. For impacts, those factors include the type of impact, the duration of the impact, the type of vegetation being impacted, and the preventability of the impact. For restoration, the factors include: expected improvement in hydrology and vegetation, timing of the restoration, maintenance that is expected to be needed, monitoring which would be performed, and control over the land to reduce future impacts. For preservation, the factors include: degree of threat to the identified lands, type of vegetation occurring on the lands, and control over the land to prevent future impacts.

The Corps took the impact data produced by the approved hydrodynamic model as the starting point for the SOP. The output included acreage for wetlands at different levels of salinity. The Corps then evaluated the output both before and after the flow-altering features are included in the project. Wetland types that would experience a net loss in acreage were identified as ones that would experience an adverse impact. In a similar manner, wetlands that would experience an increase in net acreage would benefit from and be restored by the project. Finally, the model output was used to characterize and quantify 3 classifications of wetlands – Freshwater (<0.5 ppt), Brackish (0.5 to 4.0 ppt), and Saltmarsh (>4.0 ppt).

Using the previously described approach, adverse impacts were evaluated with respect to wetlands classified as Freshwater, Brackish and/or Saltmarsh. Model results documented that restoration could occur in both Freshwater and Brackish marsh. The flow-altering features were the primary means through which the net acreage in Freshwater and Brackish marsh would increase. In the 44-foot depth alternative, the flow-altering features of Plan 6B would result in net increases in both Freshwater and Brackish marsh acreage, with a corresponding decrease in Saltmarsh acreage. The natural resource agencies had previously determined Freshwater and Brackish marshes to be more valuable than Saltmarsh in the evaluation of this project. Since the 44-foot depth alternative with the Plan 6B flow-altering features would result in net increases in Freshwater and Brackish marsh acreage, the mitigation plan would fully mitigate that alternative depth's indirect adverse impacts to wetlands. Additional wetland mitigation would be needed for the other depth alternatives.

The SOP considers many factors in its calculations of the ecological extent of a project's impact, and the value of the restoration and/or preservation features. Those factors are summarized on the following page:

Table 18. Summary of SOP Factors

	FACTORS INCLUDED		
FACTORS	ADVERSE IMPACTS	RESTORATION	PRESERVATION
Type of Impact	X		
Duration of Impact	X		
Existing Condition	X		
Type of Habitat	X		
Preventability	X		
Rarity of Habitat	X		
Improvement in Vegetation		X	
Improvement in Hydrology		X	
Timing of Restoration		X	
In-Kind Vs Out-Of-Kind Mitigation		X	X
Maintenance Requirements		X	
Monitoring Plan		X	
Type of Control		X	X
Degree of Threat			X

One of the factors considered in the SOP is the degree of protection to be provided over the lands to be acquired and preserved. That is the issue addressed in the factor titled "Type of Control". Lands that are owned in fee or by a government agency are considered more protected from future adverse impacts than are lands protected only by a restrictive covenant or conservation easement. A conservation easement can sometimes be obtained from a private owner without the government needing to resort to condemnation. However, more lands under easement would be needed to provide the same SOP-derived value as would fewer lands under government ownership. The Corps consulted the natural resource agencies to determine the type of real estate interest that the agencies believed would be most appropriate in this situation. The USFWS stated that fee ownership would be required.

The Corps applied the SOP to this project using the acreage outputs from the hydrodynamic model at various salinity levels. The Corps also evaluated the extent of impact that would occur to existing marshes (i.e., conversion of one intertidal marsh type to another) and the benefit that would occur to marshes as a result of the flow-altering features. The Corps also considered development pressures that are on waterfront properties in this estuary. Using the SOP, the 47-foot alternative would result in 6,743 units of adverse impacts to wetlands. The impacts must be mitigated by at least an equal number of restoration and preservation units. In Georgia, the resource agencies' policy is that acceptable mitigation should consist of at least 50 percent restoration. For this project, restoration through the flow-altering features would comprise 58 percent of the total wetland mitigation for the 48-foot alternative, 60 percent for the 47-foot and 46-foot alternatives, and 65 percent for the 45-foot alternative. Using the SOP, the Corps

calculated the minimum number of acres that need to be acquired and preserved to acceptably mitigate for wetland impacts. For the project, those numbers are shown below.

Table 19. Preservation Needs as Determined by SOP Calculations for Wetland Impacts

DEPTH ALTERNATIVE	MINIMUM ACRES NEEDED
44-FOOT	0
45-FOOT	1,643
46-FOOT	2,188
47-FOOT	2,245
48-FOOT	2,683

The Corps shared its SOP calculations with the Wetlands Interagency Coordination Team (comprised of EPA, USFWS, NOAA Fisheries, SC DNR, SC DHEC, GA DNR-EPD, and GA DNR-CRD). In the Draft Fish and Wildlife Coordination Act Report, the USFWS recommended changes to certain factors the Corps proposed to use in the calculations. The Corps agreed with the Service's recommendations and the numbers shown above reflect the factor values supported by the USFWS in their Draft F&W Coordination Act Report, which was included in the DEIS. The Final F&W Coordination Act Report does not address specific factor values, but concurs in the numbers shown above.

Although Savannah District had coordinated use of the SOP with the Wetland Interagency Coordination Team during the analysis period, some natural resource agencies expressed questions about certain aspects of the SOP calculations and its overall application during their review of the DEIS. SC DNR and EPA questioned the use of "0" as the Dominant Effect for expected adverse impacts to saltmarsh. The Corps had selected that value in recognition of the views expressed by the Wetland ICT that (1) freshwater wetlands are presently the most ecologically valuable type of wetland in the estuary (because of losses they have experienced over time), and (2) the Corps should take measures where possible to restore freshwater and brackish marshes in the estuary. The Corps' 2011 detailed analysis of likely wetland effects of the project from salinity changes (contained in Section VII of this appendix) indicates that noticeable changes in existing saltmarsh are unlikely from the expected changes in salinity. This supports the Corps' assignment of a "0" Dominant Effect value for those changes.

SC DNR questioned the use of "1.4" for the Net Improvement in Vegetation for the additional acreage of brackish marsh that is calculated to occur. The Corps selected that value because it had divided the marshes into the three classifications identified by the Wetland Interagency Coordination Team – Freshwater, Brackish, and Saltmarsh. Using the guidelines recommended by the ICT for the wetland categories, the acreage of brackish marsh would increase as a result of the proposed flow rerouting features. Brackish marsh would exist where it otherwise would not. Those newly created brackish marshes would be fully functioning and thus should receive the highest Net Improvement in Vegetation factor available for that category of wetlands. The increase in brackish marsh would occur at the expense of some other wetland type, primarily saltmarsh. The accompanying reduction in acreage of saltmarsh is identified as an adverse impact in the SOP calculations, increasing the project's mitigation needs.

SC DNR questioned the use of the flow rerouting features as restoration in the SOP. The Corps does not intend to set a precedent by such an application, but the application reasonably reflects the extensive coordination that the Corps had over the years with the Wetland ICT (natural resource agencies) in the development of mitigation plans for this project. Potential adverse effects to saltmarsh predicted using the salinity criteria recommended by the Wetland ICT are included in the SOP calculations.

The following table summarizes the results of the SOP calculations for the 47-foot alternative. The details of the SOP application for each depth alternative are shown in an appendix at the end of this document.

Table 20. Summary of SOP Calculations 47-Foot Alternative

IMPACTED WETLANDS	**FRESHWATER**	**BRACKISH**	**SALTMARSH**	**TOTAL**
Acres	223		740	
Units	2007		4736	6743
RESTORATION				
Acres		964		
Units		4048		4048.8 (60.0%)
PRESERVATION				
Acres		2245		
Units		2694.2		2694.2 (40.0%)

This is a unique use of the Regulatory SOP that neither Savannah District nor EPA consider precedent-setting. Some mechanism was needed to quantify the amount of mitigation remaining after the flow rerouting was added to the deepening project. The SOP was not designed for such use, but it is a reasonable tool for that purpose. The Regulatory SOP was one of the tools that the Corps used in the development of the mitigation plans. The SOP was not the single mechanism that was used to identify how much mitigation should be performed or the suitability of a potential mitigation measure. Those decisions required consideration of many factors, as described in the previous and subsequent portions of this appendix.

Savannah District consulted the Corps' Center of Expertise for Ecosystem Restoration to confirm that the Regulatory SOP was a technically sufficient method of determining the amount of acres that the Project would need to acquire and preserve in order to compensate for adverse impacts to wetlands. The Center concurred that the SOP was a technically sound technique. Their review can be found in Appendix U. They noted that -- as with other techniques -- the results depend heavily on the values assigned to specific parameters in the analysis. They also noted that with the approach followed in this application, much of the mitigation requirement was being driven by conversion of saltmarsh to brackish marsh, an activity which was reportedly a goal of the natural resource agencies for this estuary.

Table 21. Proposed Land Acquisition

CHANNEL DEPTH ALTERNATIVE	FRESHWATER WETLAND IMPACTS (ACRES)	REQUIRED ACQUISITION ACREAGE
44-FOOT	+322*	N/A
45-FOOT	-32	1,643
46-FOOT	-201	2,188
47-FOOT	-223	2,245
48-FOOT	-337	2,683

* Denotes an increase in freshwater wetlands in conjunction with mitigation plan

The regional agency-coordinated preferred level of mitigation for the 47-foot depth alternative is based on a base year impact of 223 acres. Corps policy requires calculation of project impacts on an average annual basis throughout the period of analysis. A waiver would be required should the agency-coordinated level of mitigation be recommended. That waiver has been requested and approved.

Identification of lands to be acquired

The USFWS and the Savannah National Wildlife Refuge have identified properties within the estuary that they believe are ecologically valuable and provide positive contributions to the goals of the Refuge and enhance the area's fish and wildlife resources. The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge". The Corps proposes to acquire lands from the Refuge's Acquisition Plan and provide them to the USFWS to manage as additions to the Savannah National Wildlife Refuge, to mitigate for the remaining wetland impacts from this project. The USFWS previously identified the ecological value of those properties and believes they would be valuable additions to, and advance the goals of, the Savannah Refuge. The Refuge has the authority to accept these lands, since the lands are already included in the Refuge's approved Acquisition Plan. The USFWS would manage these properties using funds obtained through the Department of Interior's normal budget process. Although there are 45,836 acres in the Refuge's approved Acquisition Plan, not all of those properties would provide the type of habitat that is desired as mitigation for this project. The location of these tracts is shown in Figure 20 from the Refuge's Acquisition Plan. The project would acquire properties from the Refuge's Acquisition Plan that best meet the needs of the project. Those needs would be met by properties that are dominated by freshwater wetlands. The Corps has consulted with the Refuge and will lean heavily on the Refuge's identified priorities. A detailed analysis of the rationale for preservation of lands for mitigation to impacts to freshwater wetlands and identification of potential lands for purchase is in Section C (Compensation) below.

Uneconomic Remnants

The project would acquire properties from the USFWS list until the needed acreage is secured (Figure 20). The Corps would attempt to acquire lands from willing sellers. Since the owners are likely to want to sell their entire property, developing a package of exactly the required mitigation acreage is unlikely. In addition, an uneconomic remnant could remain if the Corps wants to acquire only a portion of the last tract to be acquired. It is the Corps' policy to acquire a property and not leave owners with a land tract that is an uneconomic remnant. Additional funds could be set aside to address the issue of uneconomic remnants, but Savannah District believes that since large suitable tracts of land exist that meet the environmental requirements, the required acreage can be acquired from a small number of landowners without leaving any uneconomic remnants.

Cost Effectiveness/Incremental Cost Analysis

As discussed previously with the proposed mitigation for brackish marsh, the Corps is required to evaluate the cost effectiveness and perform an incremental cost analysis of it potential mitigation plans. The Corps performed a Cost Effectiveness/Incremental Cost Analysis as part of the development of the flow rerouting plans. That work was described previously in Section IV.A of this document (HYDRODYNAMIC AND WATER QUALITY MODELING), pages 10 to 32.

The District also followed a Cost Effectiveness/Incremental Cost Analysis in the development of the mitigation for conversion of freshwater marsh. The District used the Regulatory SOP to identify the amount of restoration that would be required to compensate for the impacts the various project alternatives would produce on freshwater marsh. The SOP requires full compensation for impacts that a project would produce. For freshwater marsh, the various depth alternatives would result in different amounts of freshwater marsh that would be converted to brackish marsh. For each alternative, the District used the SOP to identify the number of acres needed for acquisition and preservation to fully compensate for the impacts to freshwater marsh. The Corps could have chosen to restore less than the acreage calculated by the SOP, but then it would not have followed the procedures it had previously agreed to with the natural resource agencies. HQUSACE provided policy guidance early in the process that stated that mitigation proposed in this project could only compensate for impacts of this project. Therefore, the alternatives could not provide more than the acreage identified through the SOP as being needed to address their specific impacts.

The Refuge's approved Acquisition Plan contains tracts with a wide variety of habitats, including saltmarsh, brackish marsh, and freshwater wetlands. Preservation of freshwater wetlands is proposed to compensate for the project's impacts to freshwater marsh. In coordination with the FWS, it was determined that the sites considered for acquisition in this project would be primarily forested freshwater wetlands (bottomland hardwoods) located adjacent to the Refuge. Those properties are at risk of ecological loss through development and/or logging. Their acquisition would also advance the goals of the Refuge.

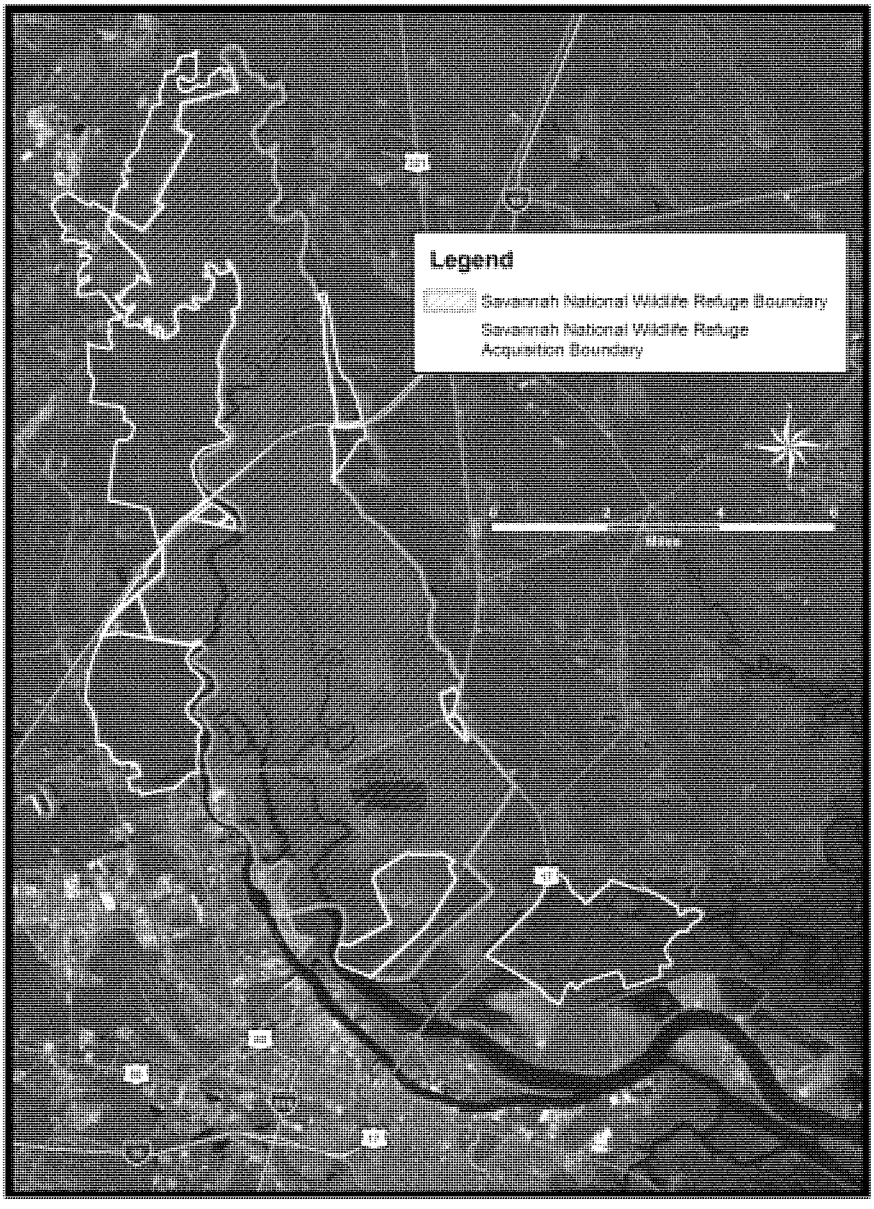


Figure 20. SNWR acquisition boundary.

The project would acquire properties from the Refuge's Acquisition Plan until the needed acreage is obtained. The Corps has consulted with the Refuge and will lean heavily on the Refuge's identified priorities for sites most suitable as mitigation for this project. The focus would be on large tracts of land to minimize acquisition costs. The Corps would seek to avoid uneconomic remnants, as described in the previous section. With the use of one initial large tract, the Corps believes the project could secure the remaining acreage in one or two other tracts. If the acreage of a given tract would exceed the mitigation acreage requirement, the project would acquire only the portion of the tract that is required to meet the total acquisition acreage identified in this document.

Sea Level Rise

A rise in sea level will adversely impact freshwater marshes and wetland in the Savannah River Estuary. Sites that presently support freshwater wetland vegetation would be converted to brackish or salt species. The Expansion Project assumes the historic rate of sea level rise will continue for the 50-year project life. If a higher rate of sea level rise actually occurs, some of the freshwater marshes would convert to more saline species, so they would not be available for impact by harbor deepening. The Corps evaluated project impacts under various scenarios of potential sea level rise. Information on the variation in impacts to freshwater wetlands can be seen in the following table and Figure 21:

Table 22. Variation in Impacts to Freshwater Wetlands Dne to Relative Sea Level Change (Acres)
(Base Year and 50-Year Project Life Projections)

Project Depth*	Relative Sea Level Rise**					
	Base Year Condition (2015)	Historic Rate (2065)	SHEP Cooperating Agencies Low Rate (2065)	EC 1165-2-211 Intermediate Rate (2065)	SHEP Cooperating Agencies High Rate (2065)	EC 1165-2-211 High Rate (2065)
	0 foot	0.5 feet	0.8 feet	0.9 feet	1.6 feet	2.3 feet
48 foot	-337	-130	29	73	488	903
47 foot	-223	-86	58	103	595	1181
46 foot	-201	-69	87	137	703	1398
45 foot	-32	96	233	275	745	1305
44 foot	322	140	152	173	653	1492

**All depth alternatives include mitigation features (depths are below MLLW).*
***Positive numbers indicate a projected net gain in freshwater wetlands after construction of deepening and flow-altering mitigation. Negative numbers indicate a projected net loss in freshwater wetlands after construction of deepening and flow-altering mitigation.*

The following table shows how the wetland impact acreage would vary over time using the Historic rate of sea level rise:

Table 23. Variation in Freshwater Wetland Impacts Due to Relative Sea Level Rise (Acres)

	Historic Rate**						
Project Depth*	**2015**	**2025**	**2035**	**2045**	**2055**	**2065**	**Average Acreage Impact**
	Base Year	10 yr	20 yr	30 yr	40 yr	50 yr	
	0.0 ft	0.1 ft	0.2 ft	0.3 ft	0.4 ft	0.5 ft	
	0 cm	3 cm	6 cm	9 cm	12 cm	15 cm	
48 ft	-337	-297	-256	-214	-170	-130	-234
47 ft	-223	-202	-178	-150	-118	-86	-161
46 ft	-201	-183	-161	-134	-102	-69	-143
45 ft	-32	-13	10	36	66	96	26
44 ft	322	265	219	182	155	140	210

**All depth alternatives include mitigation features (depths are below MLLW).*
***Positive numbers indicate a projected net gain in freshwater wetlands after construction of deepening and flow-altering mitigation. Negative numbers indicate a projected net loss in freshwater wetlands after construction of deepening and flow-altering mitigation.*

The regional agency-coordinated preferred level of mitigation for the 47-foot depth alternative is based on a base year impact of 223 acres. Corps policy requires calculation of project impacts on an average annual basis throughout the period of analysis. Savannah District requested and received a waiver from that policy for the Expansion Project. This allows the project to use the agency-coordinated level of mitigation based on the impacts expected at the first year after the project is constructed.

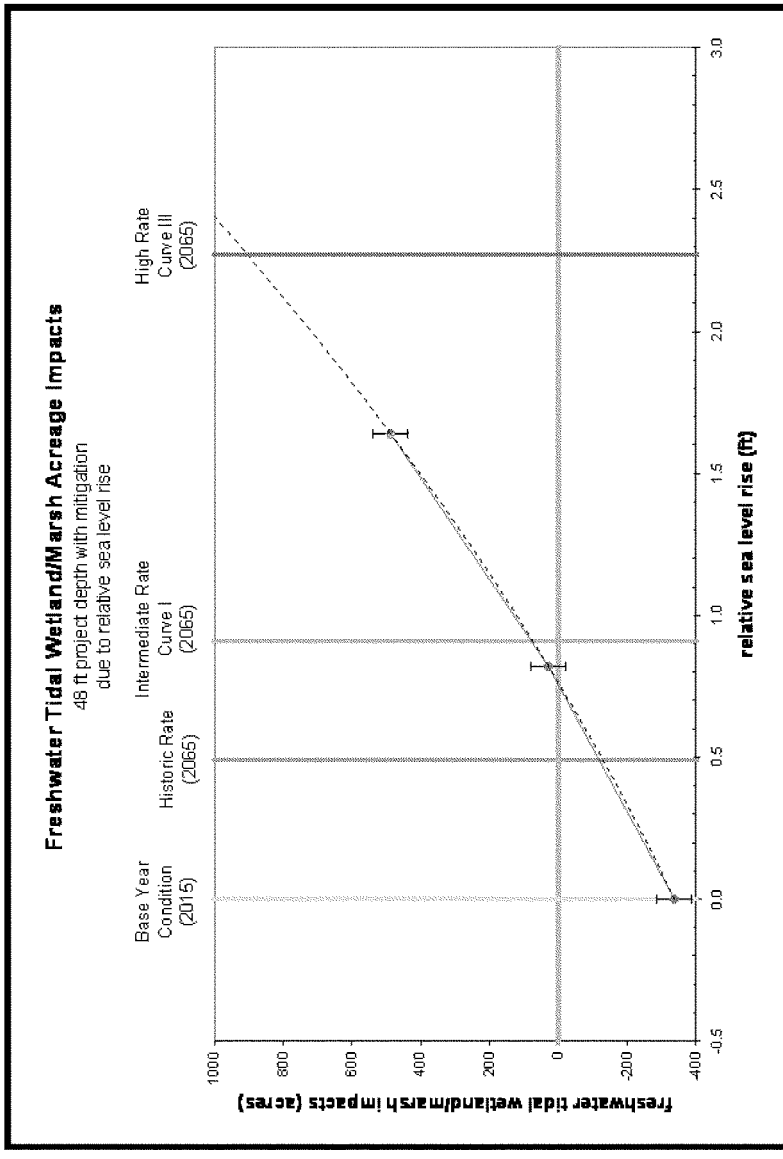


Figure 21. Freshwater tidal marsh impacts for the 48 foot channel.

C. COMPENSATION

1. Shortnose sturgeon

For Shortnose sturgeon, the expected reductions in habitat volume range from -11.0 to +19.0 percent, depending on channel depth, life stage, and season. The adverse effects are most pronounced in the juvenile life stage during January. When the hydrodynamic modeling results indicated that the impacts would not be substantially reduced by the initial mitigation plan components, the Corps consulted natural resource agencies about potential ways to address remaining impacts. Neither the Corps nor the agencies could identify any measures that could be implemented in the estuary that would restore sturgeon habitat or enhance existing habitats. The habitat suitability analysis indicated that the main issue determining the quantity of acceptable sturgeon habitat in the estuary is salinity. The reductions in volume of acceptable habitat result from unacceptable increases in salinity levels at sites that presently provide suitable habitat characteristics. The fish could move further upstream to areas possessing lower salinity levels. Those habitats may have excess carrying capacity, but that is unknown and those upstream sites may possess other factors that make them less suitable or unsuitable to sturgeon.

Since no means of increasing the volume of acceptable habitat within the estuary could be identified, the Corps began to assess other means to improve Shortnose sturgeon habitat including habitat improvements in upstream spawning habitat. The Corps acknowledged that removal of the lowest dam on the river, the New Savannah Bluff Lock and Dam (NSBL&D) at Augusta, Georgia, would be the preferred method to allow sturgeon and other anadromous fish to access historic upstream spawning habitat. The Corps also acknowledged that removal of the NSBL&D would benefit the ecosystem. The Corps had proposed such an action in 1999, but local governments opposed it, citing adverse impacts to recreational uses of the pool upstream of the dam. In response, the Corps proposed rehabilitating the structure and adding a fishway to allow fish to move pass the structure. In 2000, Congress authorized constructing and operating a fishway at NSBL&D as part of a lock and dam rehabilitation project. That project has not been funded. Coordination with local governments indicates they continue to oppose removal of the structure. At this time, removal of the NSBL&D is not a feasible mitigation alternative because:

1) The lock and dam is a Congressionally-authorized project; therefore, the Corps is obligated to maintain the project as long as Congress provides funding for such actions.
2) The current authorization language (WRDA 2000) as amended in Omnibus Act 2001 calls for repair and rehabilitation of the lock and dam structure, construction of a fish passage, and conveyance of the lock and dam structure to the City of North Augusta.
3) Removal of the structure would adversely impact the freshwater supply of eight major users.

Since removal of the NSBL&D is not feasible at this time, the Corps suggested fish passage at the NSBL&D be considered as a mitigation feature for SHEP impacts to Shortnose sturgeon habitat. A fishway around the structure would allow migrating fish to move past the dam. That would provide access to historic upriver spawning areas at the Augusta Shoals. The structure would also open up an additional 20 miles of river to American shad and other anadromous fish species, thereby helping those populations. The previously-approved horseshoe rock ramp

design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages.

In 2009, Savannah District conducted a survey of the bottom substrates in the Savannah River around Augusta to determine their suitability as spawning areas for sturgeon. In the 20-mile area upstream of the NSBL&D, substrate data were observed/collected at 57 sites in the Augusta Shoals/Savannah Rapids area. Using NOAA Fisheries (NMFS 2007) definitions for suitable sturgeon spawning substrate types, roughly 40 percent of the Shoals/Rapids area would be suitable for sturgeon spawning. An additional 37 percent of the area would be considered as marginally suitable for sturgeon spawning. As shown in the table below, approximately 33 percent of the area appeared to contain unsuitable substrates.

Table 24. Benthic Substrate Frequency in Augusta Shoals Study Area

Class	Benthic substrate	SI[1]	Number of Sites	Frequency (%)
1	Mud, soft clay/fines	0.0	0	0
2	Silt, sand (diameter < 2.0 mm)	0.0	7	12
3	Sand, gravel (diameter > 2.0 mm to < 64 mm)	0.5	0	0
4	Cobble/gravel (diameter > 64 mm to < 250 mm)	1.0	3	5
5	Boulder (diameter 250 mm to 4,000 mm)	0.8	20	35
6	Bedrock w/ fissures w/ gravel/cobble mixtures	0.6	21	37
7	Bedrock smooth w/ few fissures or gravel	0.2	6	11

[1] 1.0 indicates highest suitability; 0.0 the lowest.

The following link contains the full report of Shortnose sturgeon spawning habitat in the Savannah River, Georgia and South Carolina: http://www.sas.usace.army.mil/plnew.html

Lake sturgeon have been observed using constructed rapids that cover the entire river width and in natural rapids in the upper mid-west. Some of these observations have been when water depths were shallower than the proposed water depth (3.5 to 5.5 feet) for the fish passage at the New Savannah Bluff Lock and Dam (Aadland 2010). Lake sturgeon are larger than Shortnose sturgeon, so Shortnose should also be able to pass similar rapids.

The fishway would be located around the South Carolina abutment of the dam. This is the wooded area on the right side of Figure 22. The fishway would be designed to operate continuously and pass 600 CFS during low flow conditions (95% exceedance). The 600 CFS minimum attraction flow is 5 percent of the mean river flow during upstream spawning migration period of February through June. The fishway would pass higher flows when the river flows are higher. Flows in the fishway are designed to be self-regulating over a two-foot headwater variation, including a range of river flows from 3,600 to 20,000 CFS. The horseshoe rock ramp would have roughly a 75-foot width across the base and use boulder weirs at approximately a 25-foot spacing. There would be roughly a 9-inch drop per weir along the length of the fishway. The water depth would range between 3.5 and 5.5 feet in the fishway.

Figures 23 and 24 show the rock ramp fishway design. In June 2007, representatives of the resource agencies confirmed that the fishway appeared to be the best measure within the basin to effectively compensate for the predicted loss in Shortnose sturgeon habitats.

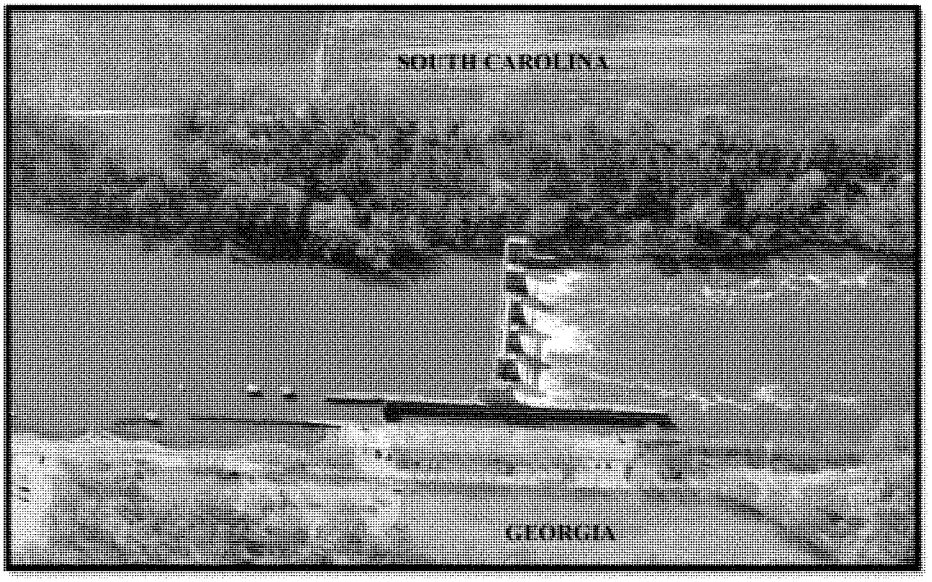


Figure 22. Aerial view of New Savannah Bluff Lock and Dam.

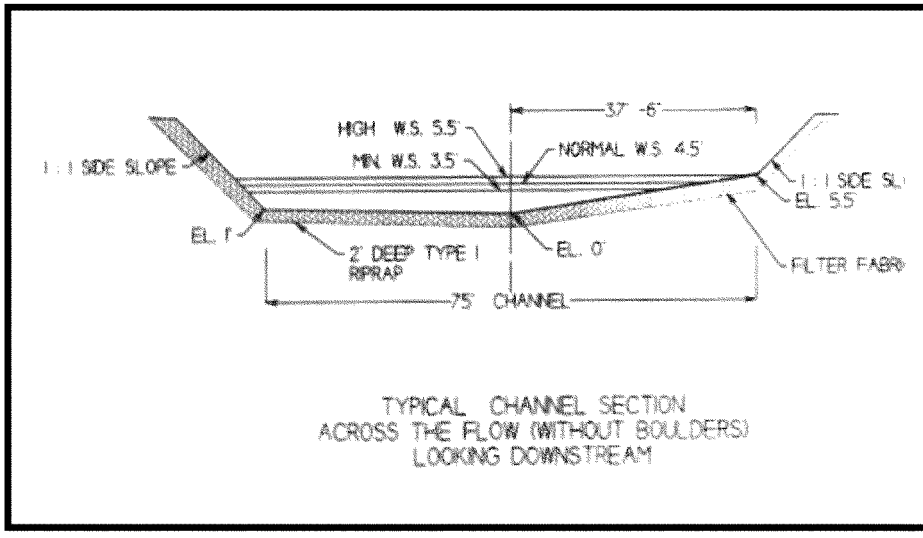


Figure 23. Typical cross-section of rock weir.

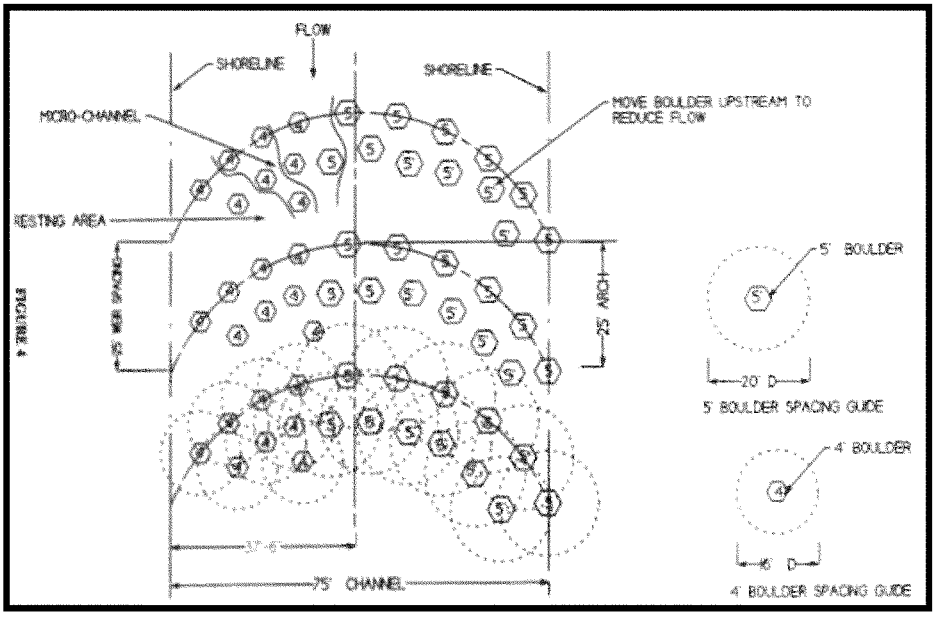


Figure 24. Plan view of boulder layout for rock weirs.

The Corps conducted a preliminary review of the 2001 fishway design and confirmed that conditions had not changed that would reduce its effectiveness or implementability. Also, in 2010, the Corps consulted the Federal and State regional natural resource agencies to determine if the state-of-the-art had advanced substantially since the design was completed for the fish passage structure at the NSBL&D. No fishery experts in the regional natural resource agencies identified any specific change to the proposed design that should be made as a result of recent documented fish passage research. That fishway was added as a feature of the mitigation plan at an estimated ROM cost (without contingencies) of $6.3 million (October 2010 price levels).

In the November 2010 General Reevaluation Report and Draft EIS, the Corps proposed a Horseshoe Rock Ramp Bypass around the South Carolina side of the NSBL&D to provide passage past that structure, which is the first dam fish encounter as they move up the Savannah River to spawn. No SNS passage has been documented at the site since the dam was constructed and providing passage would restore access to historic SNS spawning areas at the Augusta Shoals. The Horseshoe Bypass would capture 5 percent of the river flow. During review of the Draft EIS, the Corps received comments from natural resource agencies expressing a lack of confidence in the success of the proposed bypass design. Several stated that they believed the bypass would need to carry more of the river flow to successfully pass SNS.

The Department of Commerce (National Marine Fisheries Service) is one of the agencies that would need to approve SHEP for it to proceed to construction. They expressed concerns over the fish passage design the Corps proposed as mitigation for impacts to endangered SNS habitat and at the 1 April 2011 SHEP Principals Meeting. NOAA Fisheries reiterated its preference that the Lock & Dam be removed. The Corps agreed to hold an interagency workshop to review the fish passage design proposed for the NSBL&D. Savannah District hosted a meeting on 25-27 April 2011, which was attended by NOAA Fisheries, USFWS, SC DNR, GA DNR, UGA, TNC and USACE. The group reviewed the project's expected impacts to SNS, and evaluated the effectiveness of the mitigation options available. The natural resource agencies preferred removal of the Lock & Dam, followed in priority by a Full River Rock Ramp. Using a recently approved design for SNS passage on the Cape Fear River in NC, the attendees agreed on general design criteria for a successful rock ramp passage structure. CESAS then used those criteria to develop and evaluate several alternate designs.

The natural resource agencies considered the following potential SNS mitigation measures at the April 2011 interagency workshop:

- Removal of Dam
- Full River Rock Ramp and Floodway
- Nature-like Fish Bypass
- Horseshoe Fish Bypass
- Trap and Transport
- Ice Harbor Fish Ladder
- Modified Navigation Lock
- Hybrid Rock Ramp and Floodway
- Downstream Gravel Bars

The agencies had "Very High" confidence that removal of the L&D would provide satisfactory passage of SNS at that critical location in the basin. They had "High" confidence that a Full River Rock Ramp would satisfactory pass SNS and "Moderate" confidence that a Hybrid Rock Ramp would satisfactory pass SNS. They had "Low" or "Very Low" confidence in the ability of all other measures to satisfactory mitigate for project adverse impacts to SNS, including the Horseshoe design included in the DEIS. Those confidence levels represent the beliefs of the agency representatives who attended. The Corps did not express its beliefs during that discussion.

Savannah District continues to consider removal of the Lock & Dam to be unacceptable due to the development that now occurs upstream along the pool created by the dam. Local interests have stated that it would cost $30 million for them to modify their water intakes if the dam is removed and the river reverts to its natural depth and width. Additional costs would be incurred by the numerous dock owners and riverside landowners for modifications to existing bulkheads and docks. Those other costs would total another $15 million, in addition to the $8 million estimated to remove the structure.

The District used the natural resource agencies' evaluation to screen the potential SNS mitigation measures. CESAS used the design criteria provided by the agencies and prepared preliminary designs for three fish passage alternatives: (1) Full River Rock Ramp, (2) Off-Channel Rock Ramp, and (3) Hybrid Rock Ramp. Although not specifically considered at the interagency workshop, the District considers an Off-Channel Rock Ramp to be a variation of the Full River and Hybrid rock ramp designs since they would all transport roughly the same volume of water for SNS to use while moving through that location on the river. They differ by their location across the channel's cross-section. The performance of the alternatives is based on the beliefs expressed by the agencies at the April workshop on the likely success of the various measures in acceptable passing SNS in both upstream and downstream directions. For all three alternatives, a rock ramp would be constructed to allow SNS to swim up to the upstream pool. In each one, large boulders would be used to create pools with local areas of lower velocities. Once upstream passage occurs, successful downstream passage is critical to ensure the adult breeding SNS population can return to its traditional foraging habitats in the estuary. Each of these three designs would accommodate downstream passage of adult and fingerling SNS.

Because of the design criteria (such as velocity and depth) that the Corps used, all three designs would accommodate the larger Atlantic sturgeon (candidate species for listing), as well as SNS. The designs should also readily pass other anadromous species such as American shad and Striped bass.

Monitoring of the performance of the passage structure would be included in all three design proposals. This would include biological and physical monitoring both before and after construction. Funds would also be included for adaptive management, should adjustments be required to make the structure perform as expected.

The design team found maintaining the upstream pool elevation to be a challenge. The District maintains stable pool elevations (near EL 115 feet) during most river flows and raises the gates at the dam during high flows to reduce the backwater effects of the dam on the upstream pool and its adjacent development. Placing rock in the channel cross-section and/or making a gate inoperable reduces the ability of the water managers to lower water heights in North Augusta and

Augusta during high flow periods. As a result, the designers expended considerable effort to develop designs that would not increase upstream flood heights over the current condition.

The **Full River Rock Ramp** (Figure 25) would consist of a rock ramp constructed across the entire river, with the exception of the navigation lock and channel. All five gates would be removed from the existing dam, but the piers would remain in place. The rock ramp would be sloped up to a minimum crest of EL 109 at a 2% slope (1:50) on the downstream side and a 20% slope (1:5) on the upstream side. The crest would be 25-feet wide and there would be multiple crest elevations across the dam to maintain sufficient depth of flow at low river discharges. The ramp would provide water depths of at least 3.5 feet.

When the upper pool exceeds EL 115 feet, flood overflow would be collected by a concrete weir approximately one mile in length to be constructed along the South Carolina riverbank. This diversion during high river flows would be needed to reduce the backwater effects of the dam on upstream development to the same degree as the present operating procedures provides. A stilling basin behind the weir structure would feed a flood bypass channel that would be sited across the river meander, bypassing the dam structure. This design would require replacing approximately one mile of the natural riverbank with a concrete weir.

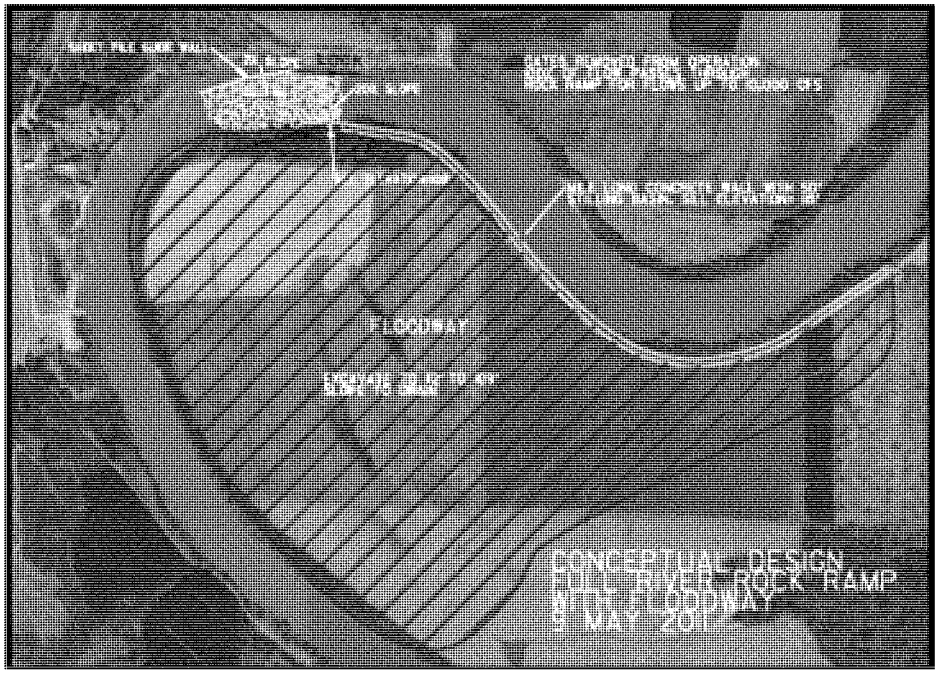


Figure 25. Conceptual design for full river rock ramp.

This design would allow 100% of the river flow to pass through ramp at flows up to 10,000 cfs. Flows over 10,000 cfs would flow through the flood bypass channel and the ramp. The range of river flows is shown in the following table:

Table 25. Full Rock Ramp with Floodway

Flow (cfs)	Upper Pool Elevation (feet)	Depth of Flow Over Rock Ramp (feet)	Percent of Flow	Velocity at Crest (fps)
3,100	112.55	3.55	100%	6.47
3,600	112.76	3.76	100%	6.82
4,300	113.04	4.04	100%	7.21
5,000	113.3	4.3	100%	7.6
6,000	113.65	4.65	100%	8.07
8,000	114.29	5.29	100%	8.87
10,000	114.88	5.88	100%	9.58
12,000	115.2*	6.2*	89%*	10*
15,000	115.4*	6.4*	78%*	11*
20,000	115.6*	6.6*	67%*	12*
25,000	115.8*	6.8*	56%*	13*
30,000	116*	7*	46%*	14*

*estimated values

The rock ramp uses a 2 percent upstream slope, well within the 4 percent slope design criteria provided by the agencies. The 1:5 slope on the small upstream ramp is flatter than one recently approved for use in the Cape Fear River, so it should acceptably pass SNS downstream. The maximum velocities on the ramp expected would vary depending on river flows. They would range from around 7 feet/second at flows of 3,100 cfs to around 10 feet/second at 10,000 cfs. Incorporating numerous rock boulders to form pools up the rock slope would reduce the typical velocity the SNS would have to navigate. With incorporation of the rock boulders to provide areas of low velocity, this design should readily pass SNS.

The design would accommodate 100 percent of the river flow for up to 73 percent of the days of February through June, which include the SNS spawning and hatching season. Flows greater than 10,000 cfs would pass over a weir and through the floodway. No SNS are expected to use the floodway for passage. SNS are bottom-oriented and tend to follow the main river channel rather than use small flows in tributaries. The alignment of the ramp in the main river channel and the large percentage of the river flow that would pass through the ramp would enhance its fish passage performance in both upstream and downstream directions. The natural resource agencies estimated that a Full River Rock Ramp that passes over 90 percent of the river flow would provide 90% performance of upstream SNS passage and 100 percent performance of downstream passage.

The ROM cost estimate for this design is roughly $100 million. Using an average SNS passage performance of 95 percent, the cost effectiveness of the design would be $1,050,000 for each percent of SNS passage effectiveness.

Upstream infrastructure in Augusta and North Augusta would be impacted during construction when the pool would be temporarily lowered. The design would not require any long term modifications of the upstream infrastructure.

This design would require the most modification to the existing dam of the three alternatives that the District considered. All five gates would be removed from the dam and replaced by a rock ramp. The dam itself would not require significant modifications. The lock and its operation would be unaffected. The present ability of the NSBL&D project to reduce flood levels in upstream areas would be retained through the construction of an overflow weir and flood bypass channel. The Full River Rock Ramp would substantially reduce the work that would need to be performed if funds become available to rehabilitate the Lock & Dam. The rock ramp would remove the requirement to construct a fish passage structure, since it would provide the same function. The rock ramp would also remove the requirement to rehabilitate the dam, as it would cover the dam and stabilize its structure and ensure its function continues to be provided in the future. The lock and its control house would still require the same amount of rehabilitation.

The **Off-Channel Rock Ramp** (Figure 26) would consist of a rock ramp constructed around the South Carolina side of the dam. All five gates would remain operational. Gates 1 and 5 would be structurally modified so they function as lift gates rather than overflow gates. That would allow 100% of the flow to pass through the fishway up to 8,000 cfs. The rock ramp would be sloped up to a minimum crest elevation of EL 109 at a 2% slope (1:50) on the downstream side and a 20% slope (1:5) on the upstream side. The crest would be 25-feet wide. The ramp would provide water depths of at least 3.5 feet.

When the upper pool exceeds EL 115 feet, all five gates would be opened as they are today to pass the high flows. A gate opening schedule would be developed to minimize velocity through the gates.

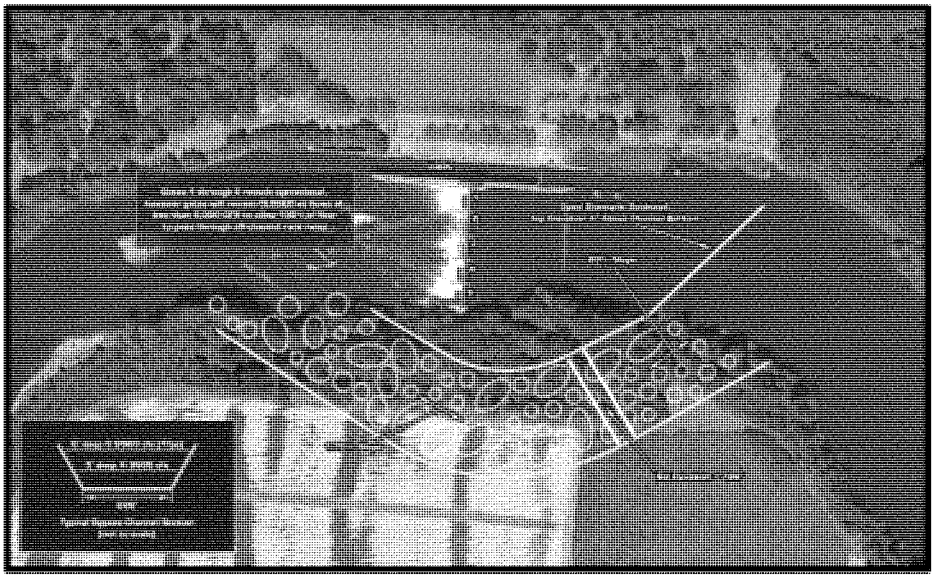


Figure 26. Conceptual design for off-channel rock ramp.

This design would allow 100 percent of the river flow to pass through ramp at flows up to 8,000 cfs. Flows over 8,000 cfs would flow through the gates on the dam. The design would accommodate 100 percent of the river flow for up to 64 percent of the days of February through June. In the late spring months of May and June, when downstream passage is more critical, the 100 percent flow capacity of the Off-Channel Rock Ramp increases to 78 percent of the time. The range of river flows is shown in the following table:

Table 26. Off-Channel Rock Ramp

Flow (cfs)	Upper Pool Elevation (feet)	Depth of Flow Over Rock Ramp (feet)	Percent of Flow	Velocity at Crest (fps)
3,100	112.57	3.57	100%	7.53
3,600	112.87	3.87	100%	7.92
4,300	113.27	4.27	100%	8.39
5,000	113.63	4.63	100%	8.82
6,000	114.13	5.13	100%	9.37
8,000	115.04	6.04	100%	10.29
10,000	115*	6*	80%*	10.29*
12,000	115*	6*	67%*	10.29*
15,000	115*	6*	53%*	10.29*
20,000	115*	6*	40%*	10.29*
25,000	115*	6*	32%*	10.29*
30,000	115*	6*	27%*	10.29*

*estimated values

A submerged sheet pile wall would be placed at a height of 3 to 4 feet above the river bottom or above the rock ramp. This wall would guide the bottom-oriented SNS out of the deep river channel and through the ramp in both upstream and downstream directions. With this feature, additional SNS should use the rock ramp to move past the L&D and the performance of the ramp would be higher than just the percent of river flow moving through it. A small amount of dredging would be performed to shape the channel bottom so that the thalweg flows to the rock ramp. This feature would also increase the design's expected SNS passage performance.

The rock ramp would use a 2 percent upstream slope, well within the 4 percent slope design criteria provided by the agencies. The 1:5 slope on the small upriver ramp is flatter than one recently approved for use in the Cape Fear River, so it should acceptably pass SNS downstream. The maximum velocities expected on the ramp would vary depending on river flows. They would range from around 7 feet/second at flows of 3,100 cfs to around 10 feet/second at 10,000 cfs. The velocity down the main slope would be 1-3 feet/second slower than that predicted for the Full River Rock Ramp. Incorporating numerous rock boulders to form pools up the rock slope would reduce the typical velocity the SNS would have to navigate. With incorporation of the rock boulders to provide areas of low velocity, this design should readily pass SNS.
The natural resource agencies stated that the fish passage performance generally matches the percent of river flow through the passage structure. This design would accommodate 100 percent of the river flow for 64 percent of the time during the months of February through June. Use of the submerged sheet pile guide walls across most of the channel width will increase the passage performance during those other days when some flow would pass through the spillway gates. Since vertical sills exist at both the downstream and upstream faces of the dam, no SNS are expected to move through the gates on the dam. No SNS passage has been documented at the site since the Lock & Dam was constructed. The primary concern would be fish that swim past the rock ramp and up to the dam. Until the river nears flood stage, the predominant flow

would still be though the rock ramp. Therefore, fish like SNS that follow the bottom contours and the predominant flow should use the Off-Channel Rock Ramp. As presently designed, CESAS expects this Off-Channel Rock Ramp to provide 75 percent performance of upstream SNS passage and 85 percent performance of downstream passage.

The ROM cost estimate for this design is roughly $26 million. Using an average SNS passage performance of 80 percent, the cost effectiveness of the design would be roughly $325,000 for each percent of SNS passage effectiveness.

Upstream infrastructure in Augusta and North Augusta should not be impacted since the pool would not need to be lowered, even during construction.

This design would require the least modification to the existing dam of the three alternatives that the District considered. None of the gates would need to be removed from the dam, however the two end gates would need to be modified from a 12-foot height to 15 feet. The present ability of the Lock & Dam project to reduce flood levels in upstream areas would be retained. The dam itself would not require modification. The lock and its operation would be unaffected. The Off-Channel Rock Ramp would reduce the work that would need to be performed if funds become available to rehabilitate the Lock & Dam. The rock ramp constructed as a SHEP feature would remove the requirement to construct a fish passage structure under the Lock & Dam rehabilitation project, since it would provide the same function. That would reduce the cost of the rehabilitation project. The dam would still need to be rehabilitated, to stabilize its structure and ensure its function continues to be provided in the future. The lock and its control house would still require the same amount of rehabilitation. Lands presently obtained for the Lock & Dam project would be needed to construct and operate the rock ramp around the SC end of the dam. Those lands are presently wooded and not used to operate the existing project. They provide structural stability to the dam and serve a limited security function. Those purposes would not be affected by construction and operation of the Off-Channel Rock Ramp. Additional lands would also need to be acquired to construct the rock ramp and for an access road to the site. Those lands would be acquired as part of the SHEP and not as part of the NSBL&D project.

The **Hybrid Rock Ramp** (Figure 27) would consist of a rock ramp constructed across a portion of the river and a portion of the riverbank on the South Carolina side of the dam. Gates 4 and 5 (along the SC side of the structure) would be removed, but the piers remain in place. A rock ramp would be placed in the location of Gates 4 and 5 and extend further landward. Gate 4 would be re-installed in place of overflow Gate 1 to enable 100% of river flow to pass through the fishway until its capacity is exceeded. The rock ramp would be sloped up to a minimum crest of EL 109 at a 2 percent slope (1:50) on the downstream side and a 20 percent slope (1:5) on the upstream side. To gain sufficient flow capacity for the entire river flow up to a 9,000 cfs discharge, the ramp would extend into the South Carolina bank an additional 170 feet at EL 111 feet. The crest would be 25-feet wide. The ramp would provide water depths of at least 3 feet.

When the upper pool exceeds EL 115 feet, the three remaining gates would be opened to pass the high flows. A gate opening schedule would be developed to minimize velocity through the gates.

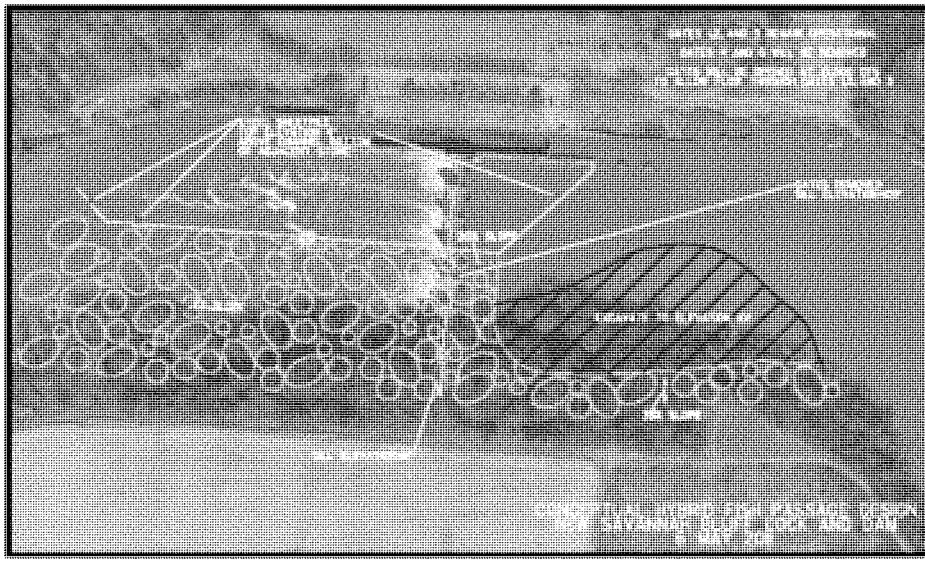


Figure 27. Conceptual design for hybrid rock ramp.

This design would allow 100 percent of the river flow to pass through ramp at flows up to 9,000 cfs. Flows over 9,000 cfs would flow through the gates on the dam. The design would accommodate 100 percent of the river flow for up to 70 percent of the days of February through June. The range of river flows is shown in the following table:

Table 27. Hybrid Rock Ramp

Flow (cfs)	Upper Pool Elevation (feet)	Depth of Flow Over Rock Ramp (feet)	Percent of Flow	Velocity at Crest (fps)
3,100	112.58	3.08	100%	6.73
3,600	112.8	3.3	100%	7.07
4,300	113.08	3.58	100%	7.47
5,000	113.34	3.84	100%	7.87
6,000	113.69	4.19	100%	8.35
8,000	114.31	4.81	100%	9.19
10,000	115.4	5.9	90%*	9.88
12,000	115*	5.5*	75%*	9.88*
15,000	115*	5.5*	60%*	9.88*
20,000	115*	5.5*	45%*	9.88*
25,000	115*	5.5*	36%*	9.88*
30,000	115*	5.5*	30%*	9.88*

*estimated values

A submerged sheet pile wall would be placed at a height of 3 to 4 feet above the river bottom or above the rock ramp. This wall would guide the bottom-oriented SNS out of the deep river channel and through the ramp, in both upstream and downstream directions. With this feature, additional SNS should use the rock ramp to move past the L&D and the performance of the ramp would be higher than just the percent of river flow moving through it. A small amount of dredging would be performed to shape the channel bottom so that the thalweg flows to the rock ramp. This feature would also increase the design's expected SNS passage performance.

The rock ramp would use a 2 percent upstream slope, well within the 4 percent slope design criteria provided by the agencies. The 1:5 slope on the small upriver ramp is flatter than one recently approved for use in the Cape Fear River, so it should acceptably pass SNS downstream. The maximum velocities expected on the ramp would vary depending on river flows. They would range from around 7 feet/second at flows of 3,100 cfs to around 10 feet/second at 9,000 cfs. The velocity down the main slope would be 3-5 feet/second slower than that predicted for the Full River Rock Ramp. Incorporating numerous rock boulders to form pools up the rock slope would reduce the typical velocity the SNS would have to navigate. With incorporation of the rock boulders to provide areas of low velocity, this design should readily pass SNS.

The natural resource agencies stated that the fish passage performance generally matches the percent of river flow through the passage structure. This design would accommodate 100 percent of the river flow for up to 70 percent of the days of February through June. Use of the submerged sheet pile guide walls across most of the channel width will increase the passage performance during those other days when some flow would pass through the spillway gates. Since vertical sills exist at both the downstream and upstream faces of the dam, no SNS are expected to move through the gates on the dam. No SNS passage has been documented at the site to date. The primary concern would be fish that swim past the rock ramp and up to the dam. Until the river nears flood stage, the predominant flow would still be though the rock ramp. Therefore, fish like SNS that follow the bottom contours and the predominant flow should use the Off-Channel Rock Ramp. As presently designed, CESAS expects this Hybrid Rock Ramp to provide 80 percent performance of upstream SNS passage and 90 percent performance of downstream passage.

The ROM cost estimate for this design is roughly $41 million. Using an average SNS passage performance of 85 percent, the cost effectiveness of the design would be roughly $480,000 for each percent of SNS passage effectiveness.

Upstream infrastructure in Augusta and North Augusta would be impacted during construction when the pool would be temporarily lowered. The design would not require any long term modifications of the upstream infrastructure.

Of the three alternatives that the District considered, this design (Hybrid Rock Ramp) would require an intermediate amount of modification to the existing dam. Two of the five gates would be removed from the dam and replaced by a rock ramp. The dam would be significantly modified at two of those gates. The dam would not be modified at the remaining three gates. The lock and its operation would be unaffected. The present ability of the Lock & Dam project to reduce flood levels in upstream areas would be retained through the construction of the rock ramp around the SC side of the dam. The Hybrid Rock Ramp would substantially reduce the work that would need to be performed if funds become available to rehabilitate the Lock & Dam.

The rock ramp would remove the requirement to construct a fish passage structure, since it would provide the same function. The Hybrid Rock Ramp would also remove the requirement to rehabilitate two bays of the dam, as the rock ramp would cover those bays and stabilize the dam's structure underneath. The other three bays of the dam would require the same amount of rehabilitation. The lock and its control house would still require the same amount of rehabilitation. Some additional lands would need to be acquired in SC for an access road to the rock ramp. Those lands would be acquired as part of the SHEP and not as part of the NSBL&D project.

Table 28. Comparisons of Potential Fishway Designs at NSBL&D

	Full River Rock Ramp	Off-Channel Rock Ramp	Hybrid Rock Ramp
100% of flow through ramp up to X cfs	10,000 cfs	8,000 cfs	9,000 cfs
Crest elevation of Rock Ramp	109 ft	109 ft	109.5 ft
Number of gates operational	0	5	3
Modification to existing Lock & Dam structure	Major	Minor	Moderate
Modification to existing Lock & Dam project	Major	Minor	Moderate
Percent of time ramp captures all of river flow (February - June)	73%	64%	70%
Effectiveness in fish passage (Upstream)	90%	75%	80%
Effectiveness in fish passage (Downstream)	100%	85%	90%
Effectiveness in fish passage (Overall)	Acceptable	Acceptable	Acceptable
ROM cost	$100 mil	$26 mil	$41 mil
Cost Effectiveness (Cost /% SNS passage effectiveness)	$1,050,000	$325,000	$480,000

Each of these alternatives would satisfactorily pass Shortnose sturgeon both upstream and downstream, thereby meeting the mitigation goals of the SHEP. The rock ramps would also allow other fish species to pass by the existing lock and dam, thereby improving the environment for those species.

The alternatives range in cost from $26 million for the Off-Channel Rock Ramp, $41 million for the Hybrid Rock Ramp, and $100 million for the Full River Rock Ramp. Using an average SNS passage performance, the cost effectiveness of the various designs would range from roughly $325,000 for each percent of SNS passage effectiveness with the Off-Channel Rock Ramp, to $480,000 for the Hybrid Rock Ramp, to $1,050,000 for the Full River Rock Ramp.

The design alternatives would have varying effects on the existing New Savannah Bluff Lock and Dam project, but those effects would not impede that project's ability to provide its authorized purpose – navigation, or impede future implementation of the Congressional direction given in the 2000/2001 Rehabilitation/Fish Passage authorizations.

Savannah District evaluated three rock ramps that should each satisfactorily pass Shortnose sturgeon in both upstream and downstream directions, allowing SNS access to historic spawning areas at the Augusta Shoals. Providing such access would meet the SNS mitigation goals of the SHEP. The Off-Channel Rock Ramp is the most cost effective of the three designs. Therefore, Savannah District included the Off-Channel Rock Ramp as its SNS mitigation in this Final EIS.

2. Striped bass

For Striped bass, the reductions in habitat volume range from -24 to +187 percent, depending on channel depth, life stage, and river flow. The adverse effects are most pronounced in the adult spawning habitat. Again, the hydrodynamic modeling indicates that those impacts would not be substantially reduced by the initial mitigation plan components.

The Corps evaluated what portion of the habitat suitability criteria was adversely impacted by the project alternatives. In general, salinity was the main factor in reducing the quantity of acceptable habitat. Some areas did fail the velocity criteria. The Corps evaluated methods of increasing velocity in those locations. Timber groins and rock vanes were considered. Similar timber structures exist along the mainstem of the Savannah River. The Corps consulted the natural resource agencies about their expectations of the effectiveness of such structures in increasing velocity in these areas. During the discussion, the agency representatives recognized that the location of the impacted area would vary with river flow (average vs. drought flows). Therefore, structures that are effective during one set of flow conditions would not be effective during other times. Since the flows vary each year, the agencies did not believe that structures at a given location could be counted on to provide consistent habitat improvements. Therefore, they recommended the Corps not pursue hard structures to improve flow velocities to increase Striped bass habitats.

The agencies could not identify any other measures that could be implemented in the estuary to restore or enhance Striped bass habitats. The loss of 10 percent of spawning, egg development or larvae habitats could limit the size of the Savannah River population of Striped bass. The agency representatives concluded that the only means of addressing that impact would be through a stocking program. Through such a program, the project would provide additional fish to the population to compensate for the limiting nature of the reduced spawning and early development habitats. The Wildlife Resources Division (WRD) of the Georgia Department of Natural Resources conducted a Striped bass stocking program in this river in the late 1990's. The Corps coordinated with GA DNR-WRD and confirmed that a stocking program could compensate for the impacts identified to Striped bass. The type of stocking program was then discussed that would be appropriate for the level of impacts identified.

Since the level of impacts varies by channel depth alternative, the Corps and the agencies jointly agreed that the following approach would be reasonable. GA DNR would define the requirements of a full-scale stocking program, assuming there is no natural recruitment in the system. In that case, all young would have to be introduced into the system through stocking. When the Fishery Interagency Coordination Team discussed the impact evaluation approach, they were most concerned about salinity in spawning and early life stage habitats before the fish could orient themselves and find rearing habitats with suitable salinities. Since the young are able to select their habitats within 2 months, stocking young-of-the-year (Phase II fish) would be

sufficient to get the population past the higher-salinity bottleneck caused by a harbor deepening. Development of a stocking program where young must be grown for a full year or more would not be needed to compensate for impacts from this project.

The costs for a full stocking program to replace 100 percent of the young would be appropriate mitigation if the project were expected to adversely impact 100 percent of the existing spawning or early life stage habitat in the estuary. However, since the alternatives being considered are not expected to result in impacts which are that severe, the extent of the stocking needed could be reduced to the amount of habitat predicted to be impacted by the project. Thus, the percentage of habitat loss could be multiplied by the cost for a full-scale stocking program to determine the amount that would be sufficient to compensate for the habitat loss that is expected.

Using that approach, the adverse impacts expected for each life stage of Striped bass were combined to generate the cumulative adverse impact shown in the following table.

Table 29. Striped Bass Impact Summary

CHANNEL DEPTH ALTERNATIVE	SPAWNING 50% Flows	EGGS 50% Flows	LARVAE 50% Flows	COMBINED ADVERSE IMPACT
44-FOOT	-2.9 %	-9.4 %	-5.6 %	17.0 %
45-FOOT	-9.2 %	5.2 %	1.7 %	2.9 %
46-FOOT	-10.0 %	-0.0 %	5.6 %	5.0 %
47-FOOT	-11.1 %	-5.0 %	-13.5 %	26.9 %
48-FOOT	-16.1 %	-10.8 %	-3.5 %	27.8 %

With that combined adverse impact value and the costs of a complete stocking program, one can calculate the compensation required to mitigate for each depth alternative. The GA DNR-WRD provided information on the costs to rehabilitate and operate some of GA DNR-WRD's facilities at their Richmond Hill hatchery to conduct a Striped bass stocking program capable of producing 40,000 Phase II fish each year. The costs included initial expenses of $3.1 million, annual expenses of $203,000 to operate the program, and recurring costs of between $30,000 and $50,000 for equipment replacement. The Corps used those values and calculated them to represent an annualized cost of roughly $466,700 for a complete Striped bass stocking program. Based on that average annual value, the following compensation would be required:

Table 30. Required Compensation Annualized

Channel Depth Alternative	Combined Adverse Impact	Annual Program Funding
44-FOOT	17.0 %	$79,335
45-FOOT	2.9 %	$13,534
46-FOOT	5.0 %	$23,334
47-FOOT	26.9 %	$125,536
48-FOOT	27.8 %	$129,737

The Corps proposes to fund that compensation as a lump sum. Using an interest rate of 4.125 percent over 50 years to obtain the present worth of that annual funding stream, the following lump sum payment would be required:

Table 31. Required Compensation Lump Sum

Channel Depth Alternative	Annual Program Funding	Lump Sum Payment
44-FOOT	$79,335	$1,668,000
45-FOOT	$13,534	$285,000
46-FOOT	$23,334	$491,000
47-FOOT	$125,536	$2,640,000
48-FOOT	$129,737	$2,728,000

Using the FY12 interest rate of 4.0 percent, the lump sum payment for the 47-foot depth alternative would be $2,672,000.

Using data collected during the Post-Construction monitoring period, the Corps would evaluate the impacts of the SHEP on Striped bass habitat. The field data collected would be used in conjunction with the updated hydrodynamic and water models to assess the impacts of channel deepening on Striped bass spawning, egg, and larvae habitat. This study would be conducted during years 2, 4, and 9 of the Post-Construction Monitoring.

3. Chloride Concentrations - Abercorn Creek

The City of Savannah has a water intake on Abercorn Creek to obtain surface water for its 62.5 million gallon per day (MGD) capacity Municipal and Industrial water treatment plant (Figure 28). The intake is located in Effingham County, Georgia about two miles from the confluence of Abercorn Creek and the Savannah River and about 11 miles upstream of the SHEP upstream limits. The City presently operates the plant at around 30 MGD. That rate has been increasing substantially over recent years as the western part of the County has grown rapidly.

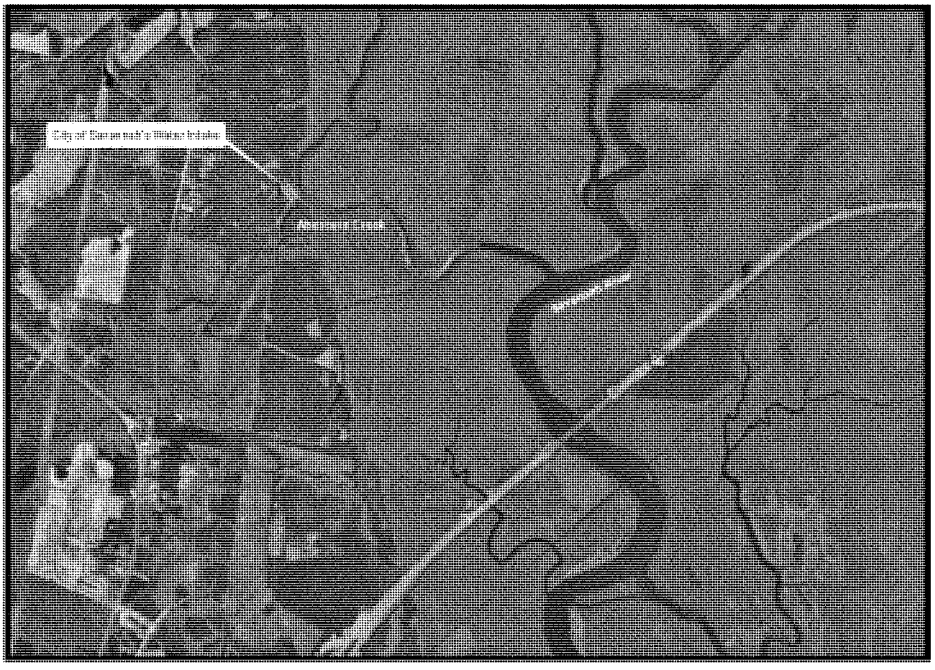


Figure 28. City of Savannah municipal and industrial water intake on Abercorn Creek.

The City withdraws water from Abercorn Creek for both municipal and industrial uses. In the past, the City's contracts with its industrial customers included a provision that the water provided must possess a chloride concentration not greater than 12 mg/L (or 12 ppm). That criterion is not included in the present contracts, but the industries still require water with very little chlorides.

Although most of the water supply from this intake is utilized primarily by industrial users, it also serves residences in west Savannah, Pooler and south Effingham County. In addition to this surface water supply, the City of Savannah operates a number of groundwater intakes at other locations. The City of Savannah is under directive from the State of Georgia to decrease

groundwater usage, which may increase demand for surface water from the Abercorn Creek intake.

Municipal water requires that chlorides be within the 250 mg/L (or 250 ppm) drinking-water standard established by the EPA. This level is specified as a threshold of taste and odor detection and not as a health hazard. Distribution pipeline corrosion, including lead and copper in residential plumbing, and certain industrial processes are sensitive to chloride concentrations much lower than the drinking water standard.

Chloride levels at the City's intake vary over time with changes in river flow and tidal conditions. Based on data collected by the City of Savannah, the level of chlorides at the water intake on Abercorn Creek has historically averaged 10 to 12 mg/l. However, the City presently experiences times when the chloride concentration at the raw water intake at Abercorn Creek exceeds the 12 ppm threshold. Drought conditions allow estuarine water to move further upstream, increasing the number of days that the City experiences chloride levels at or above their threshold. Field observations at I-95 show that upriver salinity intrusion occurs only at river flows less than 6,000 cfs. Flows greater than 6,000 cfs keep the higher saline waters lower in the estuary and do not allow them to move far upstream. During the extremely dry 2001-2010 period, the flow was below 6,000 cfs 42% of the time. The number of low flow occurrences (less than 6,000 cfs) was approximately doubled during 2001-2010, when compared to what would normally be expected. The lunar cycle also affects the extent to which tidal waters move up into the estuary, with larger incursions occurring during the week surrounding a new moon. It appears that those incursions sometimes affect chloride levels at the City's intake.

The City expressed concerns during the earlier phase of the project about whether additional harbor deepening would allow salinity to move upriver to the extent that chloride levels would increase to unacceptable levels at the City's water intake. Industrial uses need the water to be relatively free of chlorides (12 ppm is a general threshold of acceptability) or they experience additional corrosion of their industrial boilers and subsequent higher maintenance costs.

The City's Water Treatment Plant does not treat for chlorides and the industries bear the economic burden of increased maintenance costs at each of their facilities. The proposed harbor deepening could cause the City and/or its industrial customer's additional water treatment costs which would be considered an adverse project impact.

As part of the Savannah Harbor Expansion Project, Savannah District conducted a study to evaluate impacts to the City of Savannah's raw water intake on Abercorn Creek. An impact prediction tool was developed. The details of the development are outlined in the report titled *Savannah Harbor Expansion Project- Chloride Data Analysis and Model Development* dated November 15, 2006 which is included in the Engineering Investigations Supplemental Materials.

The objectives of this study were to:

- Provide a statistical correlation between chloride levels at the City's intake, chloride levels at a nearby downstream station, and upstream flows.
- Determine the likelihood of increased chloride levels at the City's intake.
- Identify potential point and non-point sources of chlorides within the watershed.
- Develop a chloride model to predict changes in concentrations at the City's intake.

Development of a statistical correlation was largely based on chloride data collected and analyzed by the City over the period 1988 to 2004. This is an extensive dataset with numerous chloride data points between 5 and 20 mg/l. The statistical correlation (equation) was developed to represent the data points. The correlation has a high level of accuracy predicting within the bounds of the data collected, however, for chlorides predicted outside of this range the equation is less representative and has a greater margin of uncertainty.

Projection of chloride impacts due to harbor deepening and wetland mitigation using this method are documented in two reports *Chloride Impact Evaluation Impacts of Harbor Deepening Only* dated February 2007 and *Savannah Harbor Expansion Project Evaluation of Chloride Impacts with Proposed Mitigation Plan* dated December 2007 which are both included in the Engineering Investigations Supplemental Materials.

Study findings projected only negligible changes to the chloride concentrations resulting from harbor deepening. The projected impacts were less than 1 mg/l and occurred only during low river flows (less than 6,000 cfs measured at Clyo, GA).

During the review process, concerns were expressed by the independent technical reviewer (USGS) and the City of Savannah about the methodology used to identify potential project impacts and the uncertainties due to lack of chloride data. The Corps reviewed the comments and confirmed that the statistical equation used to predict project impacts was the best that could be developed with the available data. The impact analysis concluded that the impacts to chlorides levels on Abercorn Creek from a harbor deepening would not be significant. That conclusion was reported in the November 2010 Draft GRR and EIS documents.

To address the concerns about the technical reliability of the impact prediction tool, the District and GPA began an intensive campaign to collect additional chloride data. The additional data would be used to improve the accuracy and reliability of the chloride predictive tool, thereby providing a more technically robust evaluation of potential chloride impacts on Abercorn Creek due to harbor deepening.

Recent Data Collection

Although initial studies determined that impacts to chloride levels at the City of Savannah's water intake on Abercorn Creek would be minimal, further concerns about the results of the study were expressed. Consequently, the Corps decided to conduct further studies involving collection of additional data which could be used to refine the predictive model. The Corps consulted with the City of Savannah to develop a scope of work for collection of additional chloride data that it could use to refine its tool to predict chloride levels with a harbor deepening. USGS and GPA also participated in development of the SOW. Data collection was performed from early 2009 through summer 2010. The SOW included collection of data using several techniques at multiple sources and locations, shown in Figure 29 including:

- Abercorn Creek (flows, water surface, chloride, temperature, and conductivity)
- Bear Creek (flow, water surface, flow splits for Abercorn and Little Collis Creeks)
- I-95 Bridge (water surface, chloride, temperature, and conductivity)
- Houlihan Bridge (flow, water surface, chloride, temperature, and conductivity)
- Plant McIntosh (water surface, chloride, temperature, and conductivity)
- City Intake on Abercorn Creek (chloride)

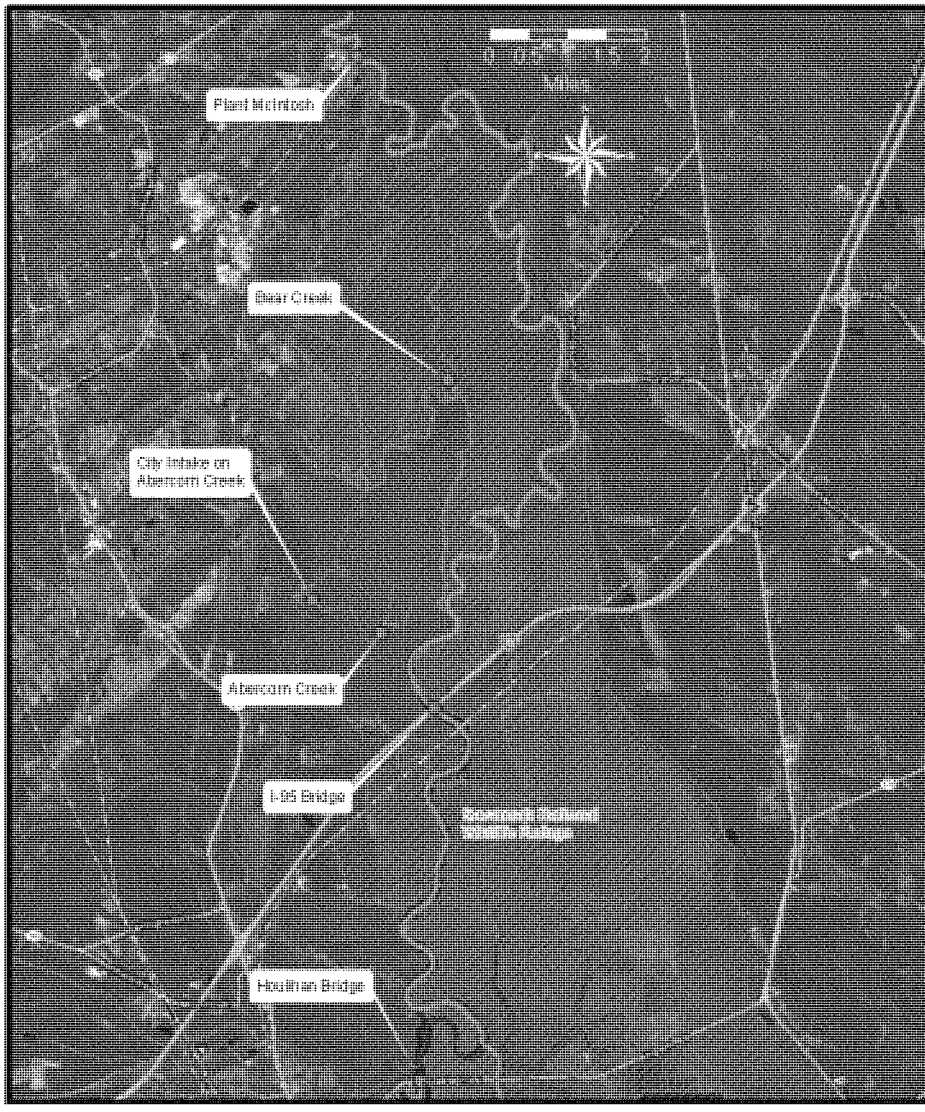


Figure 29. Chloride data collection 2009-2010.

Considerable effort was expended by Savannah District, USGS and ERDC to collect additional data. Automated collection of samples at various locations followed by laboratory analysis of the samples proved successful. Field instruments intended to record real-time chloride data were not successful and that data was not used in the analysis. In addition to chloride data, velocity measurements and flow data were collected at Three Mouths, which is the confluence of Abercorn, Bear and Little Collis Creeks, in order to better calibrate the flow split in the hydrodynamic model at that location.

The Corps used this new data, the City's original chloride data, and subsequent daily chloride measurements collected by the City of Savannah, to refine the modeling methodology.

Updated Modeling Methodology

The new modeling methodology, development and calibration, is outlined in the report titled *Chloride Modeling Savannah Harbor Expansion Project Savannah, Georgia* prepared by Tetra Tech and Advanced Data Mining Services dated December 31, 2010,and is included in the Engineering Investigations Supplemental Materials. The new model methodology has two parts: (1) an updated version of the EFDC model using an enhanced hydrodynamic grid to include the complicated distributary system of Abercorn Creek, and (2) an Artificial Neural Network (ANN) which uses data mining techniques. The two-pronged modeling approach provided both a mechanistic and empirical approach for predicting chloride concentrations at the City's intake and allows one to present the findings in "bands" to better represent the uncertainty associated with the data and the models. The two independent methodologies provided reasonably close agreement on chloride projections and is the best possible evidence of accuracy in the projections.

Technical Review

An Agency Technical Review (ATR) was performed on the updated model methodology and the report titled *Chloride Modeling Savannah Harbor Expansion Project Savannah, Georgia* prepared by Tetra Tech and Advanced Data Mining Services. A South Atlantic Division Regional Technical Expert for Water Resources Engineering performed an ATR of the EFDC component and ERDC staff experienced with neural networks performed an ATR of the ANN component of the chloride model.

The Independent External Peer Review (IEPR) was conducted by Battelle, Inc for chloride analysis. Comments from these rigorous reviews were incorporated into the modeling and analysis for SHEP impacts determination and the reviewers concluded that then models were applied appropriately for this purpose.

Analysis of Daily Average Chloride Concentrations

Table 32 summarizes the findings of the updated modeling effort. Results represent findings over two simulation periods. The first period is from 2003 to 2009 for both the EFDC and ANN models. This period was flood-free and included several prolonged drought periods, including the drought-of-record for the Savannah River Basin. This period represents impacts that could be expected during periods of extreme drought. The second period is from 1987-2009 which

was simulated with EFDC only to determine the magnitude and duration of impacts over a more representative period of time and river flow conditions.

Analysis of Table 32 shows that project effects vary depending on the parameter considered and the duration of the analysis. Average chloride concentrations at the City's water intake would increase with all deepening alternatives, but the increase would be small, ranging from 0.2 to 2.9 mg/l (from the existing 10.6/10.8 mg/l). Maximum daily average chloride concentrations would also increase with all deepening alternatives, ranging from 22 to 55 mg/l (from the existing 18 mg/l). All maximum values occurred during simulation of the drought of record (2008)..

Table 32. Daily Average and Maximum Daily Average Predicted Chloride Levels

	1987-2009 Typical River Flow	2003-2009 Drought Flow	2008 Drought of Record[4]
Project Depth Alternative	**Average Daily Chloride Level, mg/l**	**Average Daily Chloride[3] Level, mg/l**	**Maximum Daily Average Chloride Level, mg/l**
Existing[1]	10.6	10.8	18.3
44 ft Project	10.8	11.6	40.9
45 ft Project	11.1	12.0	48.6
46 ft Project	11.4	12.5	53.6
47 ft Project[2]	11.7	13.1	62.2
48 ft Project	12.2	13.7	73.6

[1]*Existing chloride value obtained from measurements observed by the City of Savannah.*
[2]*NED Plan*
[3]*Chloride values are averages of the ANN and EFDC approaches.*
[4]*All maximum values occurred during simulation of the drought of record. There are 80+ years of flow data in the record and the drought of record occurred in 2008.*

As the daily laboratory testing of chlorides is performed on a 24-composite schedule, so too are the daily chloride model projections presented above a composite of modeled hourly chloride values.

Analysis of Daily Chloride Durations

The maximum number of days that the chloride levels would be above a specified level for the 1987-2009 and 2003-2009 simulation periods are summarized in Table 33. Data shown for the existing channel condition is from daily sampling and laboratory analyses performed by the City of Savannah at their Port Wentworth water treatment plant. The high chloride spikes would be caused by a combination of low flow and spring high tides.

Table 33. Duration of Chloride Concentrations

Project Depth Alternative	Days Greater Than ... % of Days Greater Than...									
	2003-2009 Drought Flow					1987-2009 Typical River Flow				
	> 5 mg/l*	> 15 mg/l	> 25 mg/l	> 40 mg/l	> 50 mg/l	> 5 mg/l	> 15 mg/l	> 25 mg/l	> 40 mg/l	> 50 mg/l
Existing (Observed)	2483 100%	26 1.0%	0 -	0 -	0 -	6705 100%	111 1.7%	1 0.0%	0 -	0 -
44 ft Project	2483 100%	252 10.1%	39 1.6%	1 0.0%	0 -	8374 100%	457 5.5%	52 0.6%	1 0.0%	0 -
45 ft Project	2483 100%	331 13.3%	72 2.9%	11 0.4%	0 -	8374 100%	669 8.0%	91 1.1%	10 0.1%	0 -
46 ft Project	2483 100%	413 16.6%	112 4.5%	14 0.6%	4 0.2%	8374 100%	853 10.2%	142 1.7%	19 0.2%	4 0.0%
47 ft Project**	2483 100%	483 19.5%	156 6.3%	31 1.2%	10 0.4%	8374 100%	1051 12.6%	219 2.6%	41 0.5%	11 0.1%
48 ft Project	2483 100%	549 22.1%	206 8.3%	54 2.2%	18 0.7%	8374 100%	1301 15.5%	330 3.9%	68 0.8%	23 0.3%

**Background levels of chlorides are greater than 5 mg/l under all channel conditions.*
***NED Plan*

Table 34 shows the percentage of time that chloride levels are projected to be above 25 mg/l and 50 mg/l for the existing 42-foot channel depth and the proposed 47-foot depth for each year from 2001-2009. This period is not typical, as discussed previously and includes 2 prolonged droughts, including the drought of record occurring in 2008.

Table 34. Percentage of Days that Daily Average Chlorides are > 25 mg/l and 50 mg/l

Year	Chlorides > 25 mg/l		Chlorides > 50 mg/l	
	Existing 42 ft Depth	47 ft Project Depth	Existing 42 ft Depth	47 ft Project Depth
2001	0%	6%	0%	0.0%
2002	0%	5%	0%	0.0%
2003	0%	0%	0%	0.0%
2004	0%	2%	0%	0.0%
2005	0%	0%	0%	0.0%
2006	0%	0.2%	0%	0.0%
2007	0%	9%	0%	0.5%
2008	0%	17%	0%	2.2%
2009	0%	9%	0%	0.0%

Analysis of Hourly Chloride Concentrations and Durations

The City has indicated that it is necessary to adjust some of its treatment processes on an hourly basis, and as a result, is concerned about hourly fluctuations in the chloride concentration at their raw water intake. Because there is limited mixing of water as it moves through the Savannah I&D Water Plant process and the distribution pipelines, these hourly chloride projections are critical to the operation of the water plant.

The EFDC model used daily chloride concentrations in its calibration process, which used data from 2001-2009. Since 2003, the City has analyzed chloride content of its intake water on a daily basis using a composite of samples taken hourly. Therefore, the chloride values upon which the updated EFDC model was calibrated represent a daily composite/average of hourly samples.

The District consulted with Tetra Tech, the developer of the updated EFDC model for chlorides about the potential reliability of the EFDC calculations for hourly chloride values at the City's water intake. Tetra Tech stated that although the daily average chloride value projections were derived from the hourly computed values, the model was not calibrated with the intent of generating hourly data. They believe that the 90th percentile predicted chloride value is a more reasonable representation of maximum short-duration chloride level likely to be experienced with the proposed harbor deepening project.

As a result, the District used the EFDC model to predict hourly chloride values at the City's water intake. In Figure 30, the blue line indicates the hourly maximum predicted for the day, the green line is the daily average, and the red line is the minimum hourly value predicted for the day. The predicted hourly peak of 185 mg/l is substantially higher than the maximum daily average of 62 mg/l. However, the predicted daily minimum remains at about 15 mg/l on that peak day. The peak 90th percentile chloride value is about 150mg/l. The average being less than half the peak indicates that the lower chloride values have a longer duration than the higher chloride values. It also indicates that the high chloride levels are tidally dependent. When the tide ebbs, chloride levels are predicted to return to normal levels.

Model projections indicate for the period 1987-2009, there would be 41 days where the average daily chloride concentration exceeds a threshold of 40 mg/l; however, hourly exceedances of 40 mg/l are projected to occur 445 days during this same period. Hourly exceedances of 40mg/l typically occur 3 to 6 hours per day, with a maximum of 12 hours per day. Although there is little measured hourly chloride data for comparison, the model projects that the 40mg/l threshold has never been exceeded for even 1 hour under existing conditions.

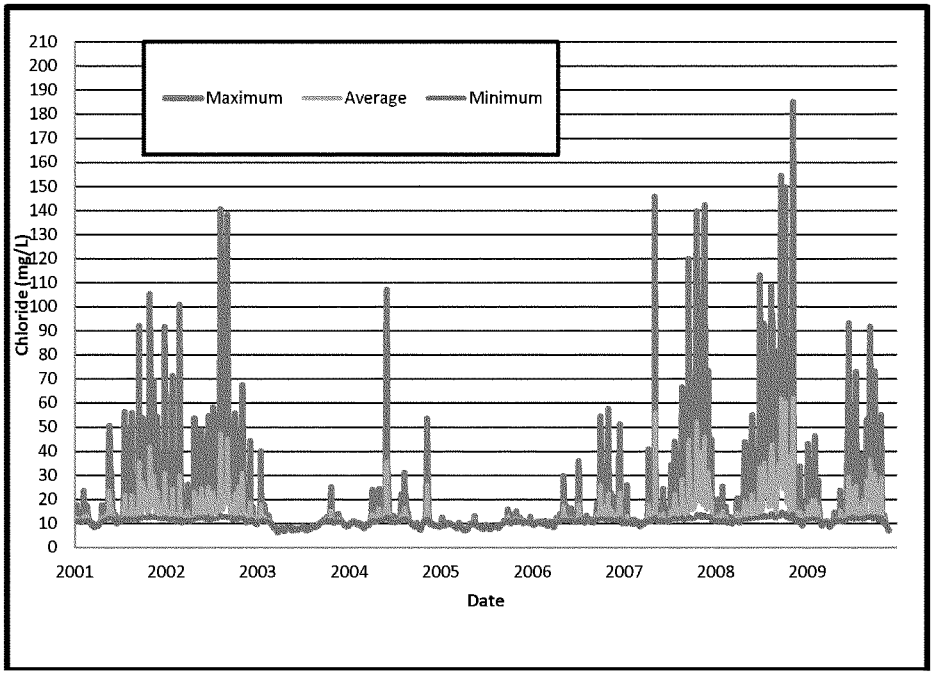


Figure 30. Hourly output from EFDC model, 47 ft. NED Plan with mitigation.

Drinking Water Concerns-Chloride Levels

The City of Savannah's M&I water intake on Abercorn Creek presently supplies its Port Wentworth treatment facility with about 30 MGD, although the plant's design capacity is 62.5 MGD and its withdrawal permit from GA DNR-EPD is for 55 MGD. The updated impact analysis indicates that the proposed harbor deepening would increase chloride levels at the water intake under drought conditions during high tide. Under those conditions, maximum daily average chloride levels are predicted to be 62mg/l with a maximum hourly chloride level projected as185 mg/l for the 47-foot project. However, the long-term average chloride level is only predicted to increase from 11 to 13 mg/l.

The drinking water standard for chloride is 250 mg/l as a Secondary Maximum Contaminant Level by EPA. This level is established as a threshold of taste and odor detection, not as a health hazard. The predicted chloride concentrations with harbor deepening do not approach that threshold, even under the worst-case drought conditions (drought-of-record).

Corrosion Concerns

The City also expressed concern with the impact increased chlorides could have on the corrosion of the steel water distribution pipes – resulting in increased life-cycle costs for the pipe distribution networks – and corrosion of lead and copper – which could lead to unsafe levels of copper and lead ions in the water. In their February 2011comment letter to the Corps, the City presented model results that show that corrosion rates of steel double for a chloride increase from 18 mg/l to 70 mg/l, on average, neglecting the influence of temperature. The City owns and maintains about 750 miles of water distribution pipeline, 60% of which is steel. They computed that a 12% decrease in life expectancy of pipelines, corresponded to an increased replacement cost of $22 million.

Consequently, an investigation and analysis of water system chloride concerns was conducted. . This report, completed April 29, 2011 is titled *Assessment of Chloride Impact from Savannah Harbor Deepening* and is included in the Engineering Supplemental Materials. Their initial investigation included computer simulations (WatSim), which indicated that raising pH was a potential remedy for increased corrosion rate, and laboratory testing to confirm the model study. The conclusion of the analysis was that copper and lead corrosion were likely not an issue, and that steel corrosion can be controlled by raising the pH of the treated water supplied to the distribution system. The study also recognized that increasing pH to reduce corrosivity can result in the formation of disinfection byproducts (DBPs), such as trihalomethanes and bromates, which are suspected carcinogens and regulated by the National Primary Drinking Water Standards.

The above report suggested additional laboratory analyses to confirm these conclusions. Consequently, more detailed laboratory analyses were performed on location at the water treatment plant that would replicate the City's current water treatment process and evaluate the impact of increasing chlorides on the plant water and treatment process including analysis of DBP formation. Their report titled *City of Savannah Seawater Effects Study* dated November 2011 which is included in the Engineering Investigations Supplemental Materials addressed concerns of the City's requirement for simultaneous compliance and presented evidence that there are two potential significant impacts to drinking water quality from increased chlorides – increased lead corrosion and formation of disinfectant byproducts (DBPs).

Lead Corrosion

Based on the laboratory analyses performed, lead corrosion is projected to increase considerably with increased chlorides, while copper and iron concentrations did not. While copper and iron concentrations were not shown to increase with increasing chlorides, lead concentrations in the water samples were shown to increase 2-4 times compared to the existing conditions as chloride concentrations increased from 10 mg/l to 50 mg/l.

Whether those increased levels would exceed regulatory action limits as defined by the USEPA's Safe Drinking Water Act (SDWA) Lead and Copper Rule, 40 CFR Part 141, as adopted in Georgia, cannot be determined with certainty due to the fact that regulatory sampling for lead is performed at the customer's tap, and is highly dependent upon the customer's piping and the residence time in that piping. Although the SDWA action level for lead is 0.015 mg/l, the ideal concentration of lead in drinking water is zero. The Corps has determined that for this project it

is not acceptable to increase lead concentration in drinking water even though the regulatory threshold is not exceeded. An increase in lead concentration is considered an increase in health risk.

Disinfection Byproduct Formation

The City of Savannah uses free chlorine as a disinfectant against pathogens in their water treatment process, as do many water suppliers. It is an effective disinfectant and is available at a relatively low cost. However, free chlorine can react with dissolved natural organic matter present in the water to form byproducts. These disinfection byproducts (DBPs) can be classified as trihalomethanes (THMs) and haloacetic acids (HAAs) which are regulated under the SDWA Disinfectants and Disinfection Byproducts Rule (D/DBPR). The D/DBPR is a Federal regulation adopted in Georgia that limits the concentration of DBPs water suppliers can allow in public drinking water. Stage 1 of the D/DBBR was issued by the USEPA in December 1998 and Stage 2 was issued in 2006. Potential cancer, reproductive and developmental health risks can result from exposure to DBPs. Through Stage 1 of the D/DBPR, the USEPA MCL for total trihalomethanes is 80 µg/l and the five haloacetic acids are 60 µg/l. Stage 2 of the D/DBPR requires compliance with the THM and HAA MCLs at all sample points in the water distribution system. These are Primary Drinking Water Standards, and violations require notifying the public and reporting to the State.

The lab analysis previously referenced showed that DBPs are affected by increasing chlorides in two ways.

- Increasing chloride concentrations due to SHEP causes an increase in chlorine required to treat the water. The additional disinfectant required to achieve treatment goals causes the formation of additional byproducts.
- As chlorides are pushed further upstream with harbor deepening, bromides, which are another component of seawater, are pushed further upstream as well. Brominated compounds can react with chlorine to form bromine-containing THMs, HAAs and other byproducts. The rate of DBP formation is also affected by the presence of bromide in the source water.

Under both of these circumstances expected to occur during low flow and high tide conditions with SHEP, total THMs are projected to increase above the permitted level when chlorides exceed about 60 mg/l. HAAs are not projected to increase above regulatory limits, however the regulated species may be expanded in the future to include brominated HAAs, at which time the chloride impacts could affect compliance.

Industrial Water Supply Concerns

The City of Savannah provided in a 2008 letter estimates of costs to the industrial users if chlorides were increased to 50 mg/l. The cost was very high but not considered to be representative since the increases to 50 mg/l are only projected to be occasional, not continuous.

Weyerhaeuser

Weyerhaeuser is the single largest user of the City's surface water supply; their demand is currently 12-13 MGD. Usage was higher, 15-16 MGD, before process water cooling towers

were installed. The plant does not operate any groundwater wells. They use water supplied by the City supplemented by an intake they operate on-site near the Houlihan Bridge that draws 12-15 MGD of estuary water into the plant.

The on-site intake water is used (1) in a large plant fire protection system and (2) to cool the black liquor surface condenser which operates with once-through cooling water. The intake is designed to draw water from near the surface, therefore, surface water model results most closely resemble the water used at the Weyerhaeuser intake. The EFDC modeling predicts that the increase in surface water chlorides at the Houlihan Bridge is about 50% (See Table 35). The principal concern for the Weyerhaeuser surface water intake is a reduction in the lifespan of the water distribution system. Their water distribution system for water purchased from the City is entirely separated from their surface water withdrawal system.

Table 35. Predicted Daily Average Chlorides at Houlihan Bridge

Model Projected Daily Average Chloride (mg/L)				
	Surface Layer		Bottom Layer	
	Existing	47' Plan	Existing	47' Plan
10th Percentile	287	569	1,444	7,203
50th Percentile	1,763	2,457	5,843	11,757
90th Percentile	2,965	3,887	10,174	15,456

Weyerhaeuser uses the water they purchase from the City of Savannah for boiler water, industrial process water, and cooling water. Boiler water must be demineralized before use. The demineralizer system is currently running at 50 to 60% of capacity. Additional chlorides, as well as any lime or phosphate introduced to reduce corrosion, will increase the load on the demineralizer and slow the output. Mill cooling water is cooled in cooling towers and returned to the mill circuit, however the amount of recycling is governed by the impurity concentration. An increase in chloride will result in fewer cycles of usage for the cooling water, thus requiring an increase in the supply from the City I&D plant. The major process use of City water is in the bleaching process. Chlorides interfere with the bleaching, so increases in chloride levels could create a serious problem. The plant has an on-site storage tank for about 11 hours usage of demineralized water. If the water supply quality does not meet their requirements for more than 11 hours, a plant shutdown would likely be needed. The hourly variation in chlorides indicates that the on-site storage of demineralized water may be sufficient if they are able to refill the storage tank between chloride spikes.

International Paper

International Paper (IP) uses water purchased from the City of Savannah and water from on-site wells that produce about 15 MGD. In the next 5 to 10 years, IP expects to be required by the GA DNR-EPD to replace their ground water supplies with surface water. The ground water has a high level of silica, which provides a natural corrosion protection in their process water distribution system, but which also must be removed by a demineralizer prior to being used in

the boilers. Since the surface water does not have high silica content, this would enable IP to have sufficient capacity to demineralize higher levels of chloride from the City water. However, IP is concerned about the integrity of their process water distribution system. Increased chlorides may result in an increased corrosion rate which could threaten the distribution system. Replacement of the piping system would likely be very costly due to the size of the system and the numerous facilities built above the pipelines since they were originally installed. Therefore the potential impact at IP is limited to a potentially reduced lifespan for the water distribution system.

Other Industrial Use

IP and Weyerhaeuser are the two largest water users that the City supplies. However, firms located in downtown Savannah, Garden City, Port Wentworth, Pooler and Effingham County are also fed by the Abercorn Creek Plant. No data is available on these other users, but their chloride concerns can be expected to be similar, but on a smaller scale.

Mitigation Techniques for Chloride Concentrations

Several mitigation options were identified early in the study process, in the event that mitigation due to harbor deepening would be warranted. These include:

- Increasing Freshwater Supply through Bear Creek. The Bear Creek diversion structure allows a portion of freshwater from the Savannah River to be diverted down Bear Creek to Abercorn Creek providing improved water quality at the raw water intake. Bear Creek flows through a heavily wooded area which is part of the Savannah National Wildlife Refuge. Flow in Bear Creek is currently impeded by numerous fallen trees. Clearing and snagging would remove these trees and improve freshwater flow from the river. This option was shown to be effective when the Corps constructed the diversion structure in 2002 as part of the Lower Savannah River Basin Environmental Restoration Project. Clearing and snagging more of Bear Creek (than was included in the authorized Environmental Restoration Project) would be required for this measure to work effectively. Since the creek flows through the Savannah National Wildlife Refuge, approval from US Fish and Wildlife Service would be required. This option would also require a high level of periodic maintenance (removal of fallen trees) to perform as intended.

- Construction of Freshwater Storage Ponds. Water could be stored for use as a supplement when chloride concentrations on Abercorn Creek are higher than usual. Implementation could be triggered by an early warning gaging system or the City's daily chloride monitoring program. However, constructing water storage ponds ranges in cost from $38 – $85 million for a full 7-day supply (210 MG). A smaller storage volume would be needed if the water is mixed to dilute water from Abercorn Creek during periods of higher chloride. There is also risk involved as to whether the volume of the supply will be sufficient for the duration the supplement is needed. Use of storage ponds for blending water during intrusion events was not examined but has potential should further analysis be required.

- Desalinization. A conceptual cost estimate for desalinization treatment at the location of the four largest industrial users was developed using the methodology published by the U.S.

Department of the Interior. That estimated cost was $135 million and was determined to be cost prohibitive.

- Groundwater supplementation. Increasing the amount of groundwater withdrawal during times of potential chloride intrusion on Abercorn Creek. This would have to be offset by greater use of surface water during higher flow periods. The Georgia Department of Natural Resources Environmental Protection Division limits the amounts of groundwater withdrawn by municipalities, complicating the use of an alternate source of water during times of drought with accompanying high chloride levels. Additionally, the City's current water supply distribution system does not have the capacity to move large quantities of water from the wells currently in place throughout its network. Construction would likely require locating and installing new wells and modifying the distribution network.
- Freshwater Flow Supplementation. Instituting a variable drought plan release from Thurmond Dam. This produces problems for water managers and water users such as the City Of Augusta Savannah River Site, and Plant Vogtle.

- A combination of increased groundwater withdrawal and greater releases from Thurmond Dam, as described above.

- Construction of a sill at the mouth of Abercorn Creek to prevent chloride intrusion. Modeling results have shown, and field sampling has confirmed, that the Savannah River is well mixed (not stratified) at the mouth of Abercorn Creek. Therefore, a partial sill would not be effective in halting chloride intrusion. A mechanical gated structure that fully blocks inflow from the Savannah River during chloride incursion events would be required. Environmental impacts to wetlands would be excessive, and access to the gate location would be an issue. This option was not recommended for detailed study.

- Replacement of individual plumbing fittings that are the source of lead contamination. It is very difficult to estimate the total number of home and businesses that would require modification. Costs would vary significantly, with much higher costs to repair slab foundation homes. Real estate easement administration would also be very costly. Costs are conservatively estimated at $100 million, and this would not address the DBP issue.

- Use of barges to store water for supplemental use. It would require approximately 160 water tanker barges to provide the necessary volume. The logistics of storing and maneuvering these barges on Abercorn Creek make this alternative unfeasible.

- Construction of a Supplemental Water Intake Pipeline. Constructing a new intake pipeline would take fresh water from the Savannah River more than 10 miles further upstream from the current location on Abercorn Creek where chloride levels remain relatively constant at around 8 mg/l. The proposed pipeline route is 8.7 miles long through Chatham and Effingham County to the intake site located near Plant McIntosh. This alternative is estimated to cost $35.9 million.

- Modified Water Treatment Process. Conceptual cost estimates for modified treatment process options were developed. The report (*Assessment of Chloride Impact from Savannah Harbor* Deepening) is included in the Engineering Appendix Supplemental Materials. Potential modifications include a lime storage and feed system ($2.8 million),a granular

activated carbon system ($47.2 million), and an ozonation system ($35.4 million), all at the city I&D plant. The analysis in this report was based on water quality modeling and preliminary lab analysis. While results of this study are useful, they are not definitive and as a result, the report recommended further analysis be conducted regarding the corrosion of copper and lead resembling a larger on-site pilot scale study.

A primary objective of the subsequent testing was to identify a chemical process that would reduce the increased seawater corrosivity to existing levels that would work well with the City of Savannah's existing treatment plant, their water supply demands and the site specific water chemistry of the source water in Abercorn Creek. Various treatment options were explored as well as additional options. The results of the bench-scale study indicate that neither the existing corrosion inhibitor nor pH adjustment will consistently control lead corrosion. While there are chemical treatments that could potentially address the issue of DBP formation, they would not fully mitigate for increasing chlorides as lead corrosion would remain a problem. The only treatment solution that would address both lead and DBP formation issues is advanced treatment. Under advanced treatment the conventional treatment process is amended to incorporate a range of sophisticated membrane technologies such as nanofiltration or reverse osmosis. Both of these options would remove the precursors relating to corrosion and DBP formation prior to treatment. However, either option would be very costly both in capital costs and operation and maintenance costs. Capital costs have been estimated to exceed $60 million.

Based on extensive updated modeling efforts to predict chloride increases by frequency, concentration and duration along with multi-variable bench-scale laboratory analysis on-site at the at the City's treatment plant, the solution to mitigate for the impacts due to chloride increases with harbor deepening is to remove the influence of the increased seawater intrusion. This can be accomplished by storage impoundments (construct an impoundment that will store acceptable raw water for use during chloride spikes predicted to occur during very low river flow and high tides) or construction of a supplemental intake and pipeline that could draw water above the area impacted by salinity and chloride intrusion predicted with harbor deepening.

While impact studies were underway, the Corps further studied these potential mitigation techniques, including constructing either a raw water storage pond or holding tanks for treated water. The City Water Department staff expressed disapproval of holding tanks for treated water, identifying potential problems with residual chlorine byproducts when treated water is held for long periods before distribution and use. Therefore, the Corps focused on designing a storage pond for raw water. The preliminary design was for a pond capable of holding 1 week's supply of raw water (7 x 30 MGD = 210 MGD). [NOTE: According to the City, the production volume of their plant is roughly 30 MGD and the plant's capacity has been 62.5 MGD since its expansion in 1998.] The Corps believes that a 1-week duration is sufficient to allow higher chloride levels associated with the new moon to recede, so that the City could resume withdrawing water directly from the river.

The Corps identified 6 potential locations between the City's water intake and its treatment plant for siting a raw water storage pond. Those sites are shown on Figures 31 and 32.. The District provided its initial assessment of the locations to the City for comment and inspected each site. As a result of those assessments, the Corps eliminated 4 of the sites. The City of Savannah expressed concerns about the future availability of specific tracts in this rapidly-developing portion of the County. The PDT identified a nearby property that is already owned by the

Georgia Ports Authority. It was Parcel 3 of the Savannah International Trade Park, located near Mulberry Grove, shown in Figure 33. Use of that parcel would ensure the site is available when needed. The Corps focused the final design and cost estimating work on that 7th potential location – the one owned by the GPA.

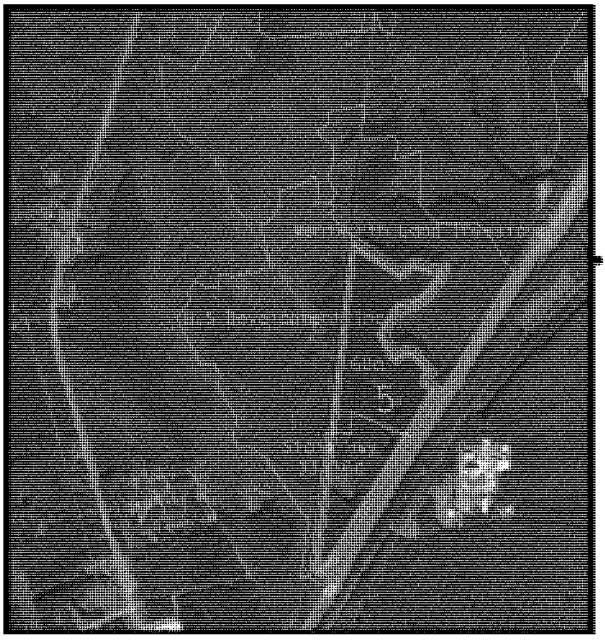
WATER STORAGE IMPOUNDMENT LOCATION OPTIONS

Proposed Storage for Approximately 210 Million Gallons of Raw River Water

- #1 North of Intake & Abercorn Road
- #2 Southwest of Hwy 21
- #3 North of Hwy 21 – East of Old Augusta Road
- #4 South of Intake – East of Old Augusta Road

Figure 31. Water storage impoundment location options

WATER STORAGE IMPOUNDMENT LOCATION OPTIONS (CONT)



- #5 Northwest of I-95 along Pipeline

- #6 Adjacent to and North of City's Water Treatment Plant

Figure 32. Water storage impoundment location options (continued)

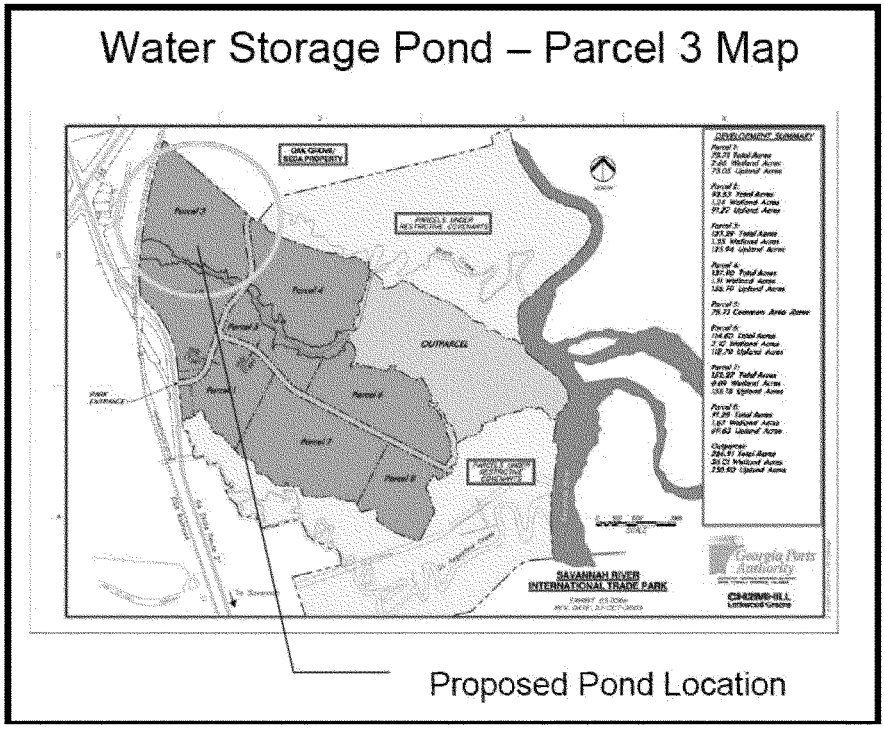


Figure 33. Water storage pond – parcel 3 map

The Corps also evaluated locating a secondary (supplemental) intake point for the City's M&I water supply further upriver. The USFWS had stated that it would not allow a new water line to cross the Savannah National Wildlife Refuge. That reduced the number of routes that a new line could take. The Corps developed two conceptual designs for a backup intake line. Both were intended to provide water for a short duration (1 month) during droughts when chloride levels would be high in Abercorn Creek.

The first conceptual design was to install a pipe down Abercorn Creek and then up the Savannah River above Interstate 95 to near Purrysburg Landing. The total distance for the pipe was estimated to be 6 miles. This would relocate the intake point further upstream and remove it from salinity influences from the harbor. The PDT determined that construction and maintenance difficulties would make this approach unacceptable.

The second design was for an 8.7-mile pipeline up a power line right-of-way to near Plant McIntosh (upstream on the Savannah River), an electrical generating facility operated by Georgia Power (Figure 34). An initial layout was provided to the City, who expressed concerns about the intake being located too close to the Plant's upstream discharge. The Corps developed a second layout, with the intake located slightly downstream. The second layout had a slightly shorter total length of 8.1 miles. Those layouts are shown below.

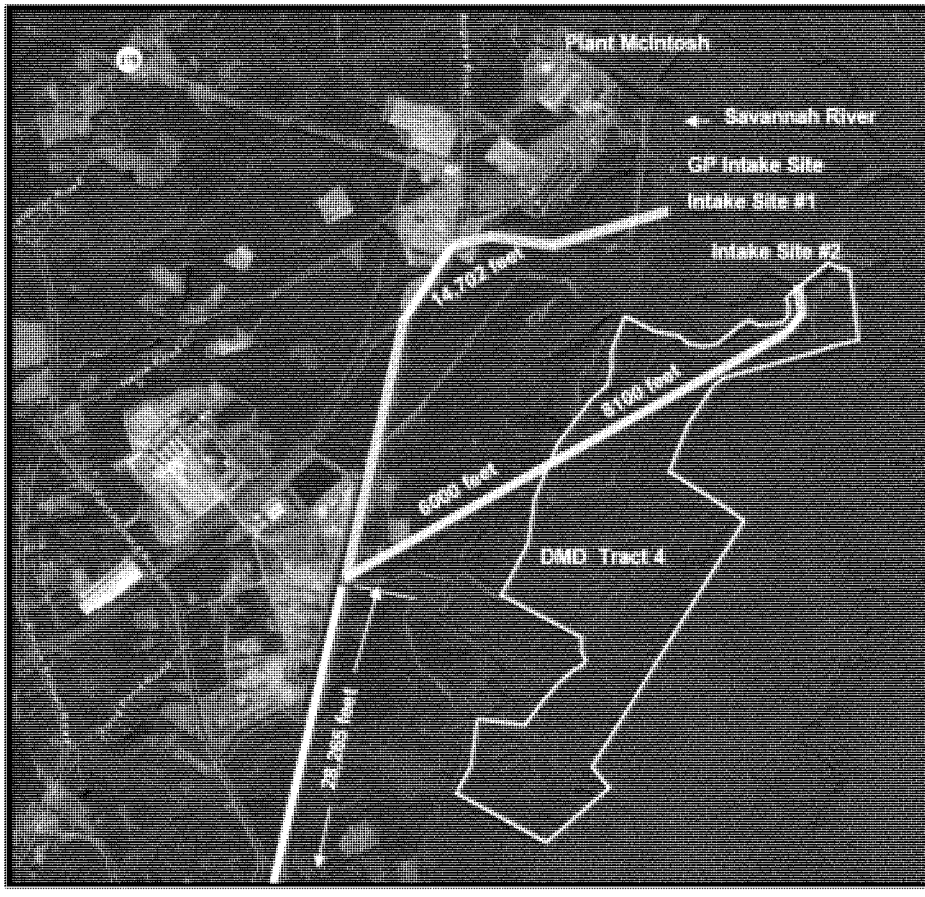


Figure 34. Potential pipeline locations.

Based on recent analyses, the storage alternative was determined to be the most cost-effective option that mitigates against both increasing lead corrosion as well as increasing DBP formation predicted with harbor deepening.

Design considerations for the raw water storage pond are:

- The GA DNR-EPD, in the Section 401 Water Quality Certification for Savannah Harbor Expansion, stated that any mitigation remedy selected shall be constructed in conjunction with the channel deepening. They also stated that mitigation shall be based on the maximum plant capacity of 62.5 mgd.
-
- A firm raw water pumping capacity of 75 mgd at the existing Abercorn Creek intake. Design constraints based on firm pumping capacity as opposed to the actual pumping capacity of 100 mgd is standard engineering practice and is required by the GA DNR-EPDs *Minimum Standards for Public Water Systems* published in May of 2000.

- 20% of the storage volume will be unusable due to access limitations and sedimentation.

- A performance goal of limiting the chlorides at the plant to 40 mg/l during the model predicted worst-case scenario and to 25 mg/l 99 percent of the time. As shown in the lab analysis, 40 mg/l is the chloride concentration at which THMs in the distribution system can be expected to reach the MCL and potentially trigger a regulatory violation. Also shown in the analysis is that chloride concentrations as low as 25 mg/l have an adverse impact on lead corrosion.

A series of statistical analyses were used to determine the appropriate size for a raw water impoundment for use at the City's drinking water supply plant for all project depths under the design considerations noted previously. Results of the analysis recommending an impoundment volume for each project depth are shown in Table 36.

Table 36. Proposed Raw Water Storage Impoundment Volumes Required for Each Project Depth Alternative

Project Depth	Recommended Usable Impoundment Volume, MG	Required Total Impoundment Volume, MG
44ft	22.5	28.0
45ft	30.0	38.0
46ft	46.5	58.0
47ft	77.5	97.0
48ft	120.0	150.0

A conceptual site layout for the 47 ft depth alternative is shown in Figure 35. The raw water storage impoundment would cover about 35 acres. The estimated cost of this mitigation feature is about $25.2 million. The preliminary layout and conceptual site plan includes the following. Details of the design can be found in the CDM report titled *City of Savannah Seawater Effects Study* included in the Supplemental Materials.

- Dual 36" influent and effluent pipes to connect the impoundment to the existing raw water pipeline (to provide redundancy at the tie in points and allow for maintenance to occur during times when the impoundment is in use).
- A pump station containing four vertical turbine pumps to convey flow out of the impoundment and back into the raw water lines.
- A mechanical mixer in the center of the impoundment to help maintain oxygen levels throughout the pond's depth reducing the likelihood of algae growth and the associated taste and odor issues.
- A powdered activated carbon silo and feed system to be used on an intermittent basis during severe taste and odor episodes.
- A 24" drain pipe to be used to empty the impoundment during periodic maintenance cleaning.
- One or more in-situ chloride meters to be installed in Abercorn Creek to provide data for operational decision making.

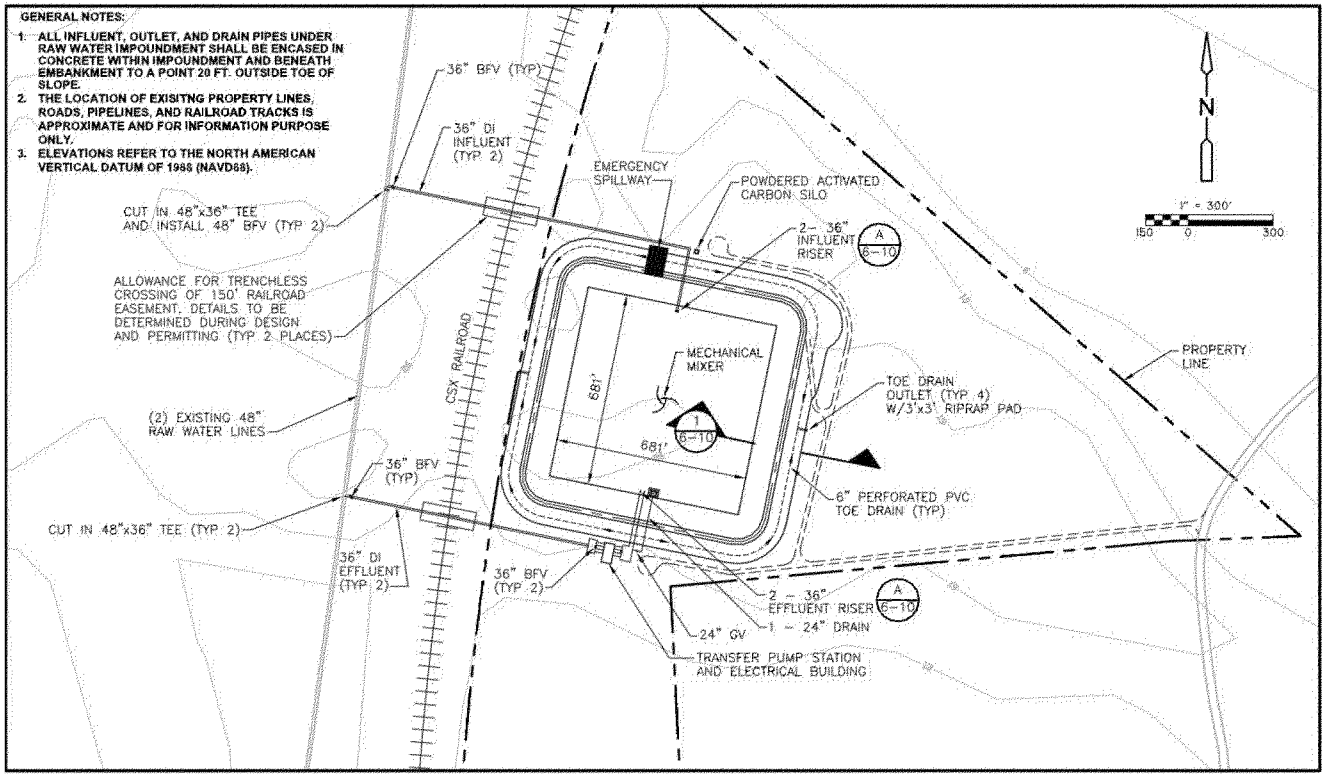


Figure 35. Raw water impoundment conceptual site layout

VI MITIGATION PLANS

The previous portions of this document described how the mitigation plans were developed for each of the channel depth alternatives. This section describes the final components of those mitigation plans.

A. Wetlands

Adverse impacts to wetlands would be mitigated through three types of actions: (1) flow-altering features, (2) acquisition and preservation of existing bottomland hardwoods, and (3) restoration of former Disposal Area 1S. The flow-altering features are summarized as follows:

Table 37. Mitigation Plan Summary

CHANNEL DEPTH	FLOW-ALTERING PLAN	FEATURES
44-FEET	PLAN 6B	Diversion Structure at McCoys Cut
		Close western arm at McCoys Cut
		Close Rifle Cut
		Remove Tidegate
		Sill and Broad Berm in Sediment Basin
45-, 46-, 47-, and 48-FEET	PLAN 6A	Plan 6B plus Deepen at McCoys Cut

The diversion at McCoys Cut would consist of two structures, one on each side of the river (see Figure 35). A rock Diversion Structure would extend about 465 feet from the Georgia side of the river. A sheetpile Diversion Wall would extend roughly 150 feet out from the South Carolina shoreline. Working together, they would divert flow down through McCoys Cut into the Back and Middle Rivers. The rock Diversion Structure would extend at a downstream angle from the inside of a bend in the Savannah River to move the thalweg toward the SC side of the river. It would have a crest elevation of 0 Mean Low Low Water (MLLW), so it would be submerged during most of the tide cycle. The structure would extend nearly half the width of the river, where the river is roughly 10 feet deep MLLW. The sheetpile Diversion Wall would redirect some of the flow down McCoys Cut while also limiting erosion of the outside of the bend from the additional flow. The sheetpile wall would have a top elevation of +11 feet MLLW and be exposed except during high spring flows. Rock may be placed along the sheetpile wall. This overall diversion design may be adjusted if detailed modeling is conducted during PED and that work suggests that the design would function better if revised. Most of the construction would take place from barges to minimize impacts to adjacent lands.

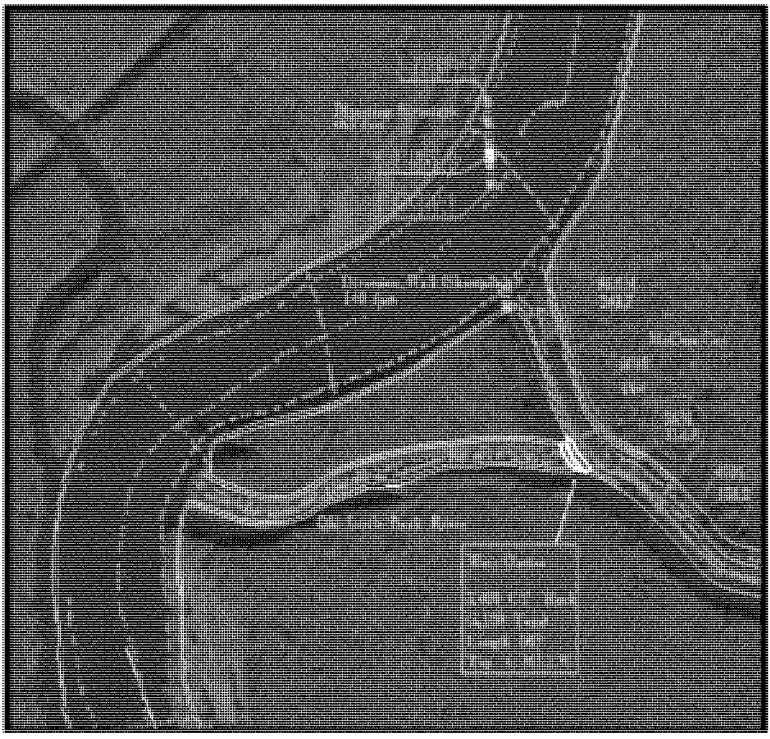


Figure 36. McCoys Cut diversion structures and weir

The western arm at McCoys Cut would be closed by constructing a plug at one end (see Figure 37). At present, the inner end – closest to McCoys Cut – appears to be the best location for the plug. The plug would be constructed of fill and rock and would extend to EL 10 (above the Mean Low Water line). At present, the design calls for a 185-foot long plug using 3,100 CY of rock. After the rock plug is placed, sediment excavated from McCoys Cut would be deposited mechanically to widen the plug to a top width of 30-feet when measured at the adjacent ground elevation. A clamshell is expected to be used to reach across the rock plug to deposit the sediments. Construction would take place from barges to minimize impacts to adjacent lands. Closing just one end would result in a small dead-end creek extending from the Savannah River. This creek would fill over time, but is expected to provide valuable fish habitat until the depths become too shallow.

Figure 37. Plug in Old Little Back River (western arm of McCoys Cut).

Rifle Cut would be closed by constructing a plug on the Middle River end. See Figure below. The plug would be constructed of roughly 3,300 CY of rock and would extend to EL +10 feet Mean Low Water (roughly 2 feet above Mean High Water). Construction would either take place from barges or use removable mats to minimize impacts to adjacent marshes. Filling the

cut at one end would result in the remainder of the cut functioning as a small dead-end creek, with its opening on Back River. This creek would fill over time, but would provide shallow fish habitats until that occurs.

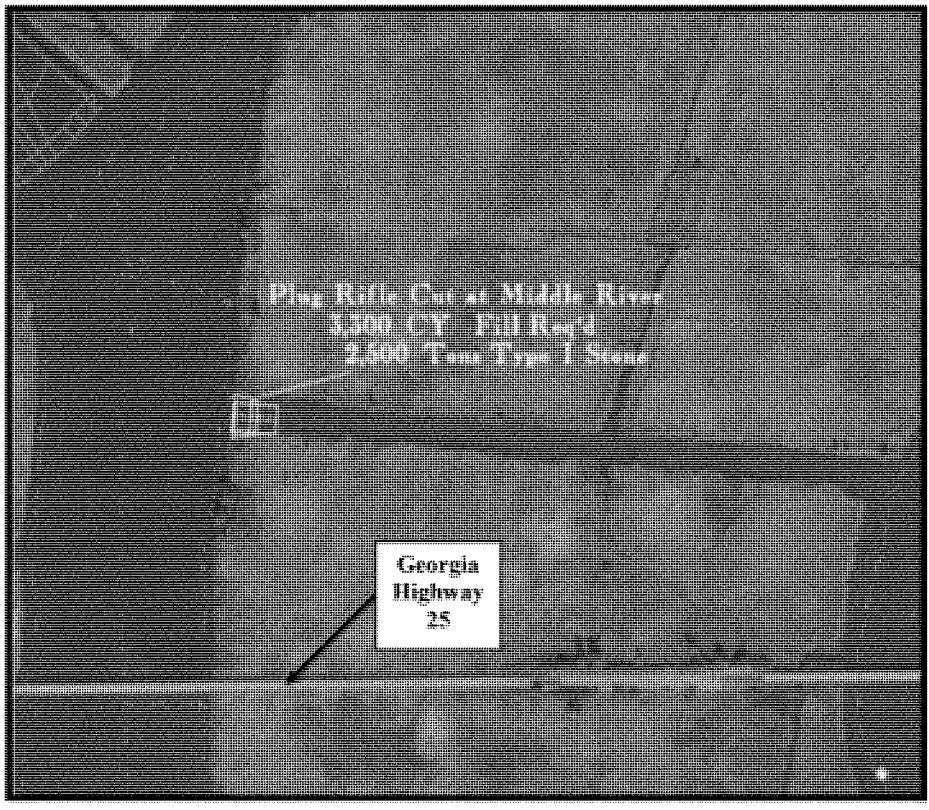


Figure 38. Plug in Rifle Cut at Middle River

The Tidegate and its abutments would be removed so that tidal flows are no longer restricted in Back River. See Figure 39 below. The concrete would be removed down to EL -14.6 feet NGVD, which is 2 feet below the river depth of approximately -12.6 feet (-3.85 meters MLLW). The concrete would be placed in the Sediment Basin, which will cease to be operated and allowed to fill naturally. Approximately 2.0 acres (240,000 CY) would be excavated from the north abutment and 15.8 acres (785,000 CY) would be removed from the south abutment to expand the width of the river past the site. A hydraulic cutterhead dredged is expected to perform that work. However, other equipment may be used. Abutment fill that consists of predominantly sands would be used to construct the submerged sill at the downstream end of the Sediment Basin. Sediments which are too fine-grained for such placement would be deposited in the project CDFs or other suitable upland sites. Removing the concrete may require blasting to remove the piers and/or submerged sill. If the Contractor decides that blasting is necessary, the contractor will implement a test blast program, from which he would prepare an Operational Blasting Plan and an Environmental Monitoring Plan. The details of that program and those plans were described earlier in this document.

Figure 39. Back River tidal flows

The Corps would cease to maintain the Sediment Basin and allow it to fill naturally. The Project would construct a submerged sill across Back River near Front River to speed the filling process. See the Figure on the following page. The sill would be constructed with a crest elevation of -12.6 feet (-3.85 meters) NGVD to match the depth of the river just upstream of the Tidegate. It

would fill the entire throat of the basin and extend up Back River a distance of 2,700 feet when measured at the top. The bottom of the sill would exceed 2,700 feet in length due to the sloping nature of the deposited sediments. The sill would be constructed in two phases. A rock weir would first be placed at the downstream end of the throat of the basin. The weir would extend across the width of the Back River to restrict both flow volumes and velocities moving through Back River. Roughly 65,000 CY of rock would be needed to construct this weir. The second phase consists of placing sandy sediments to widen the weir into a 2,700-foot long submerged sill (when measured at the top). Hydrodynamic modeling indicates that a wider sill would allow the basin to function closer to the long-term goal of restricting upstream salinity movement until the entire 13,000-foot long basin fills over time. The wider sill would fill the throat of the basin and extend roughly 20 percent of the length of the basin. Approximately 2.1 MCY of fill would be needed to expand the narrow rock weir into an effective submerged sill. Suitable new work sediments excavated during the channel deepening may be used to construct the sill. Those sediments would consist of at least 75 percent sands to be considered suitable. The sediment placement would occur during the fall and winter months to minimize impacts to water quality and spawning fish.

**CONSTRUCT SUBMERGED WEIR ACROSS BACK RIVER
TO ELEVATION -3.85 METERS MLLW**

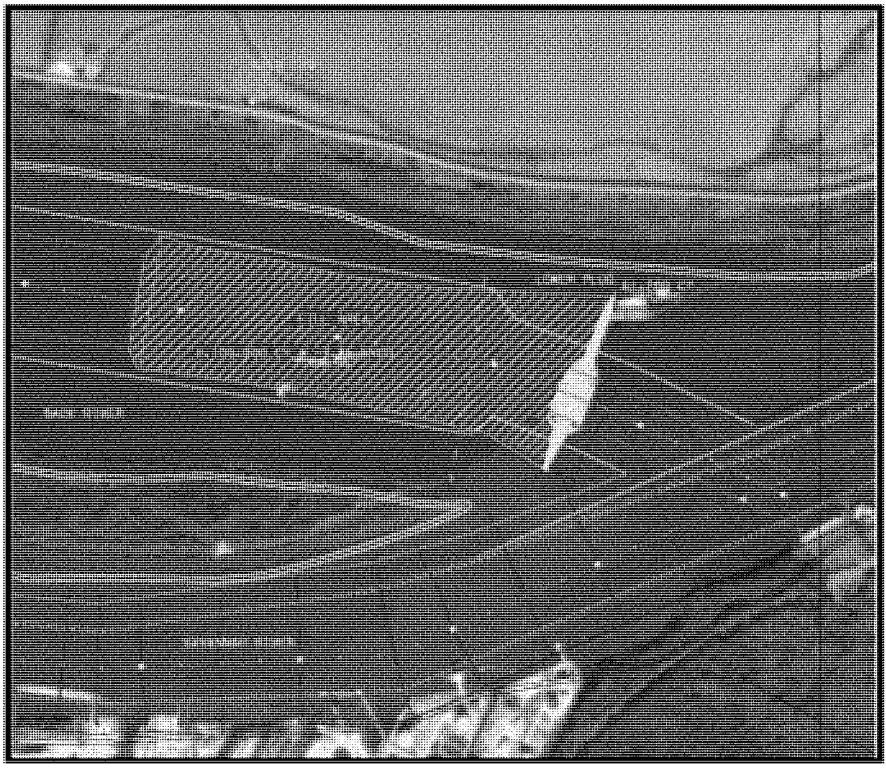


Figure 40. Construct submerged weir across Back River to elevation -3.85 meters MLLW.

Weir Elevation = -3.85 meters MLLW (-12.6 feet MLLW)

Rock sill = 61,200 CY of stone, 91,800 tons using GA Type I and Armor

Submerged berm = 2,100,000 CY of fill;
EL = -3.85 meters MLLW; Stations 1+500 to 4+200 then slope to bottom

The rivers would be deepened through McCoys Cut and down both Little Back and Middle Rivers to allow more freshwater to flow into Little Back and Middle Rivers (see Figures 41 to 43). The 5,250-foot long (1,600-meter) section through McCoys Cut would be deepened to a depth of -13.1 feet NGVD (-4 meters), while excavation would extend 5,565 feet (1,700 meters) down both Little Back and Middle Rivers, and occur to a depth of -9.8 feet MLLW (-3 meters). Three figures on the following pages show the location of this work. Roughly 105,000 CY of sediment is expected to be removed through McCoys Cut, 75,000 CY from Little Back River, and 185,000 CY from Middle River. The dredging would be performed from barges and all excavated sediments would be removed from the site. The dredging would not occur during the spring to minimize impacts to spawning fish. The excavated sediments would be placed in a project CDF or an upland disposal site. If the sediments are found to be suitable for such uses, they could also be placed in the Sediment Basin sill or in the nearshore area. A rock sill at the junction of Little Back and Middle Rivers is included as an adaptive management feature should it be found desirable to divert flow to increase fishery habitats in one of the rivers.

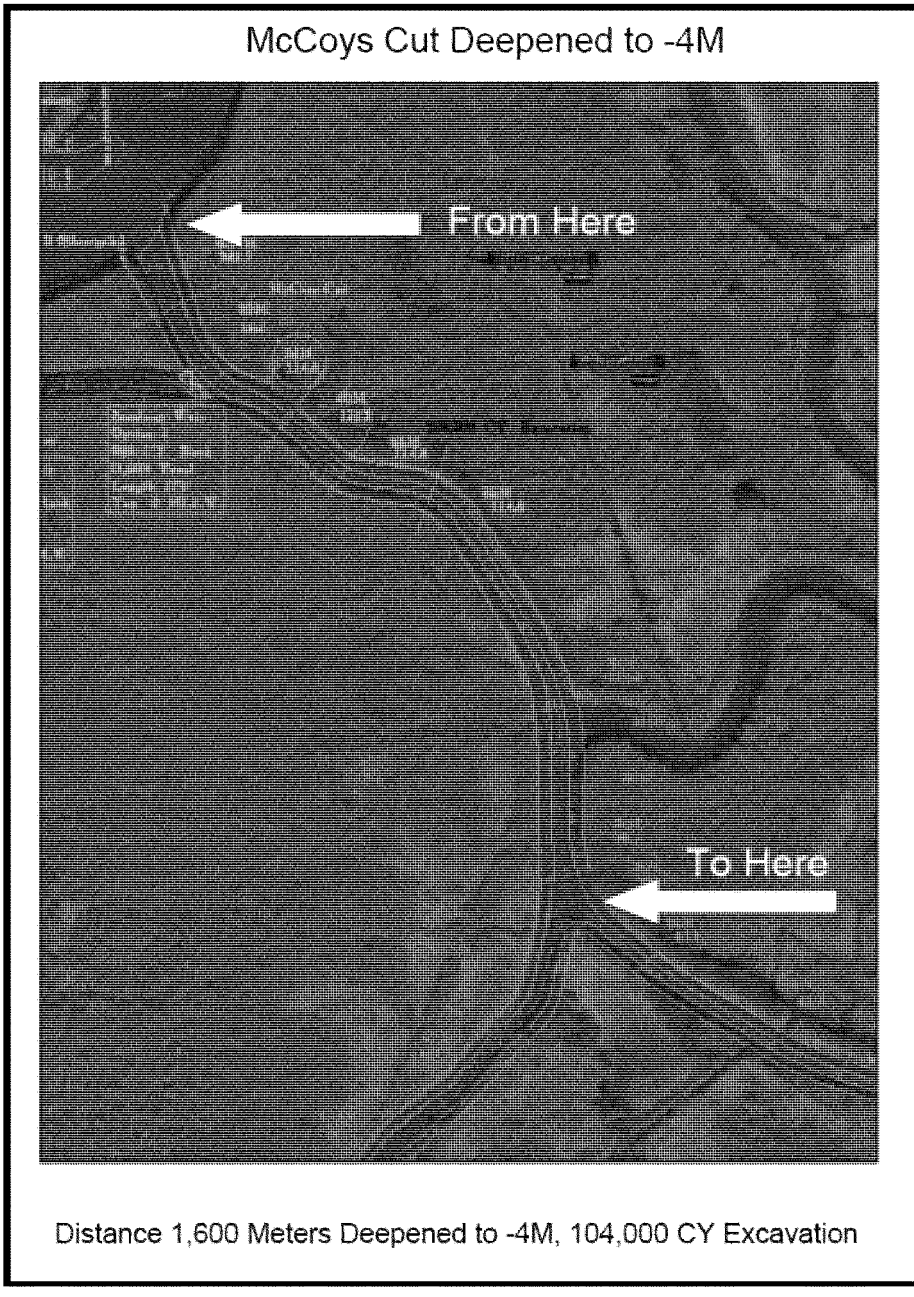

McCoys Cut Deepened to -4M
From Here
To Here
Distance 1,600 Meters Deepened to -4M, 104,000 CY Excavation

Figure 41

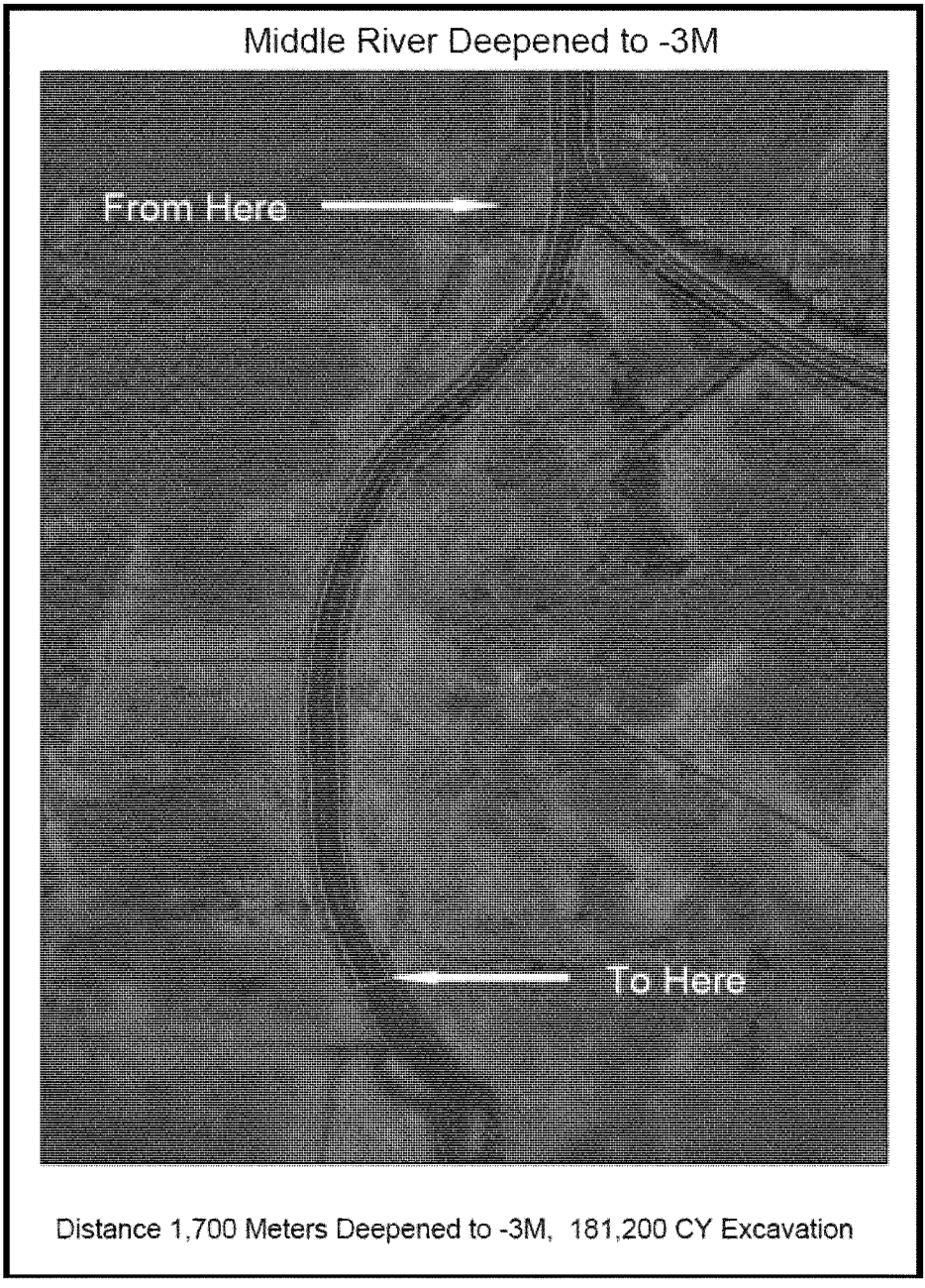

Middle River Deepened to -3M
From Here
To Here
Distance 1,700 Meters Deepened to -3M, 181,200 CY Excavation

Figure 42

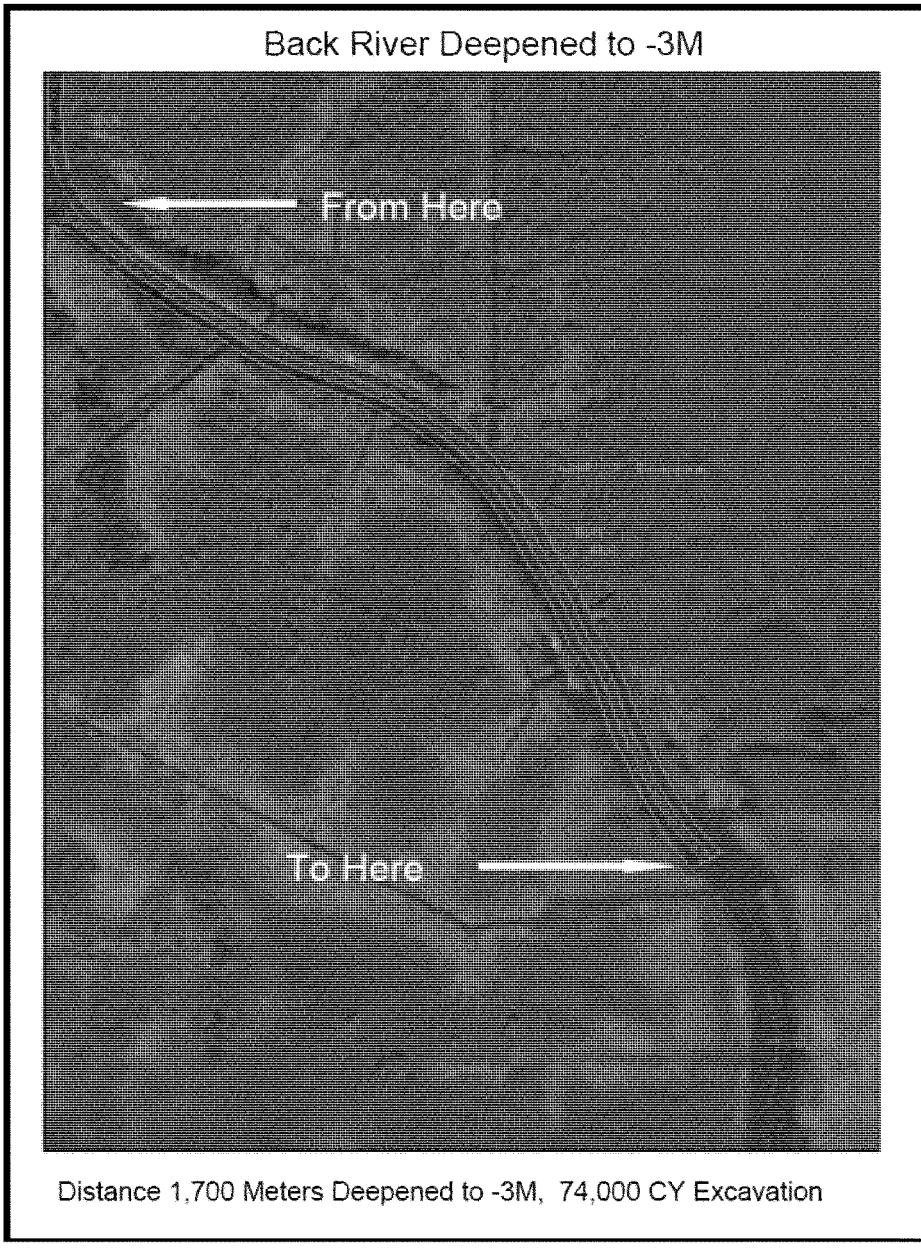

Back River Deepened to -3M
From Here
To Here
Distance 1,700 Meters Deepened to -3M, 74,000 CY Excavation

Figure 43

These flow-altering features would be constructed within the Savannah National Wildlife Refuge. The Refuge would approve these activities as part of their review of the EIS and in their Compatibility Determination. The Refuge would need to approve any minor changes that the Corps finds to be necessary when it prepares more detailed engineering and contract documents.

Acquisition of Lands

After implementing the flow-altering features described above, some impacts to wetlands would still remain. The Corps used the Savannah District Regulatory Standard Operating Procedures (SOP) to quantify the remaining mitigation requirements. That SOP had been developed by natural resources agencies in Georgia to evaluate impacts and mitigation on Regulatory projects requiring Section 404 permits. Using the SOP, the Corps calculated the following preservation requirements:

Table 38. Proposed Land Acquisition

CHANNEL DEPTH ALTERNATIVE	FRESHWATER WETLAND IMPACTS	REQUIRED ACQUISITION ACREAGE
44-FOOT	+322*	N/A
45-FOOT	-32	1,643
46-FOOT	-201	2,188
47-FOOT	-223	2,245
48-FOOT	-337	2,683

* Denotes an increase in freshwater wetlands in conjunction with mitigation plan

The USFWS and the Savannah National Wildlife Refuge have identified properties within the estuary that they believe are ecologically valuable and provide positive contributions to the goals of the Refuge and enhance the area's fish and wildlife resources. The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge". The Corps proposes to acquire lands from the Refuge's Acquisition Plan and provide them to the USFWS to manage as additions to the Savannah National Wildlife Refuge, to mitigate for the remaining wetland impacts from this project. The USFWS previously identified the ecological value of those properties and believes they would be valuable additions to, and advance the goals of, the Savannah Refuge. The Refuge has the authority to accept these lands, since the lands are already included in the Refuge's approved Acquisition Plan. The USFWS would manage these properties using funds obtained through the Department of Interior's normal budget process. Although there are 45,836 acres in the Refuge's approved Acquisition Plan, not all of those properties would provide the type of habitat that is desired as mitigation for this project. The location of these tracts is shown in Figure 44 from the Refuge's Acquisition Plan. The project would acquire properties from the Refuge's Acquisition Plan that best meet the needs of the project. Those needs would be met by properties that are dominated

by freshwater wetlands. The Corps has consulted with the Refuge and will lean heavily on the Refuge's identified priorities. The process of acquiring these preservation lands would begin the first year that Congress provides construction funds, with the goal to complete the acquisition in two years. As a result of the numerous actions that are required to complete all of the various associated real estate actions such as appraisals, Environmental Baseline Surveys, etc., the actual duration may be somewhat longer. However, all lands would be acquired before dredging is complete.

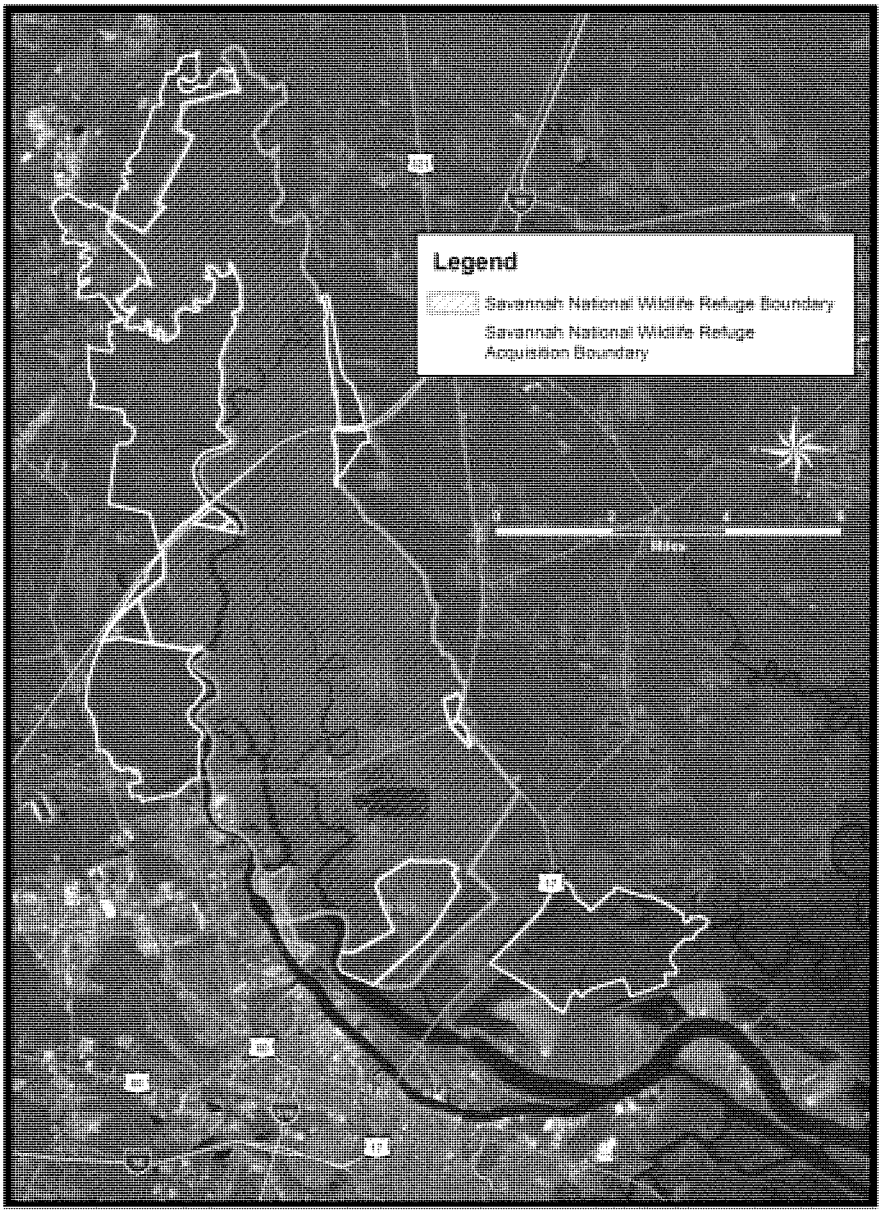


Figure 44. Savannah Wildlife Refuge

Restoration of Disposal Area 1S

Coordination with the natural resource agencies resulted in a request for "in kind/in basin" mitigation for direct impacts to brackish marsh. Specifically, the proposed harbor deepening would result in the excavation of approximately 15.68 acres of brackish marsh, and preservation of land adjacent to the Savannah National Wildlife Refuge was not considered appropriate mitigation. USEPA recommended use of a salt marsh mitigation bank, the preferred choice of mitigation as specified in the USEPA/USACE Final Compensatory Mitigation Rule, which was published in the Federal Register on March 31, 2008. However, there are currently no salt marsh mitigation banks serving coastal Georgia (One salt marsh mitigation was approved by the Interagency Review Team (IRT) in 2007, but the owner declared bankruptcy before the bank was operational). Thus, the USACE was obligated to explore other mitigation opportunities. The USACE evaluated several sites within coastal Georgia, but the resource agencies subsequently indicated a preference for mitigation of these impacts within the Lower Savannah River Basin. Ultimately, a previously used, sediment placement area (CDF 1S) within Savannah Harbor was identified as having the greatest opportunity to support the long term success of a restored brackish marsh system. CDF 1S is located adjacent to the confluence of Front River and Middle River, and it is located within the boundaries of the Savannah National Wildlife Refuge. Much of the site is currently "high ground" as a result of the previous sediment disposal actions, which were terminated at least 20 years ago. The proposed restoration area is approximately 40.3 acres. A small portion of the site was graded down by GPA several years ago as mitigation for work at their facilities. The Corps would expand the restoration acreage to include GPA's existing saltmarsh acreage (1.7 acres) to create a 42 acre wetland area. The USACE used the Regulatory SOP to determine the number of acres that would be required to restore to adequately compensate for the direct excavation impacts (See Appendix A at the end of this Mitigation Plan). The 15.68 acres of impact to salt and brackish marsh equates to approximately 138.0 mitigation credits. Calculations derived from the SOP indicate that approximately 28.8 acres of restored saltmarsh would be required to mitigate for the 15.68 acres of impact. The Corps intends to restore approximately 40.3 acres of brackish marsh at CDF 1S. The roughly 11.5 acres of excess restored saltmarsh would be used as "advance mitigation" for any additional SHEP wetland mitigation needs that are identified during construction of the project or approved Savannah Harbor Operations and Maintenance projects. The advance mitigation would not be available for use for the Savannah Harbor Navigation Project until the marsh restoration in Disposal Area 1S is successful.

Any restoration of the CDF 1S site would occur by grading it down to an elevation that would allow the growth of Spartina alterniflora (i.e., +7.6 to +7.8 MLLW) (Figure 44). The Corps selected that elevation range after inspection and surveying the elevations of natural marsh that is immediately adjacent to the proposed restoration site. Once the new elevations have been established, the approximately 42-acre site would be allowed to naturally vegetate. The Corps would let the site naturally revegetate. A reference marsh site would be established in the vicinity to provide a means of determining the success of the restoration. We expect the site to vegetate at the following rate:

Table 39. Revegetation Rate for Restored Marsh

Time Period	Percent Vegetative Cover
Construction	0
Year 1	15
Year 2	25
Year 3	40
Year 4	60
Year 5	80
Year 6	85
Year 7	90

Thus, site-specific mitigation represents the only course of action for mitigating impacts to 15.68 acres of brackish marsh. The development of the restored marsh also includes an adaptive management plan, which would require the planting of juvenile *Spartina alterniflora* plants if the site does not naturally revegetate at the rate of colonization indicated in previous table. Should the restored marsh not meet the success criteria illustrated in the previous table, the Corps would consult with the Wetland Interagency Coordination Team (ICT) to identify and/or recommend corrective actions, including planting requirements and associated sprig densities, to achieve compliance with the reported percentages in the previous table. The need for corrective action(s) would be determined annually with agency involvement and concurrence. Annual monitoring reports would be generated over a period of seven years and provided to the Wetland ICT. If at the end of seven years the plant density at the restored marsh is not within 10% of the reference site, then the Corps would consult with the Wetland ICT to determine what further actions should be taken..

As requested by the USFWS, a "feeder" creek system would also be constructed toward the interior of the restored marsh. The creek would provide another mechanism of ensuring adequate exchange of brackish, surface water with pore waters that are located on the interior of the site. Concern has also been expressed about the possibility of the marsh restoration site being overtaken by invasive species such as the Common reed (*Phragmites australis*). It is unlikely that invasive species would significantly colonize the restoration site given the density of *Spartina alterniflora* and associated seed stock in the immediate vicinity. Likewise, the site's salinity/tidal range are conducive to supporting a robust growth of *Spartina alterniflora*. However, the site would be monitored for invasive species. Removal of invasive plant species would be conducted if required.

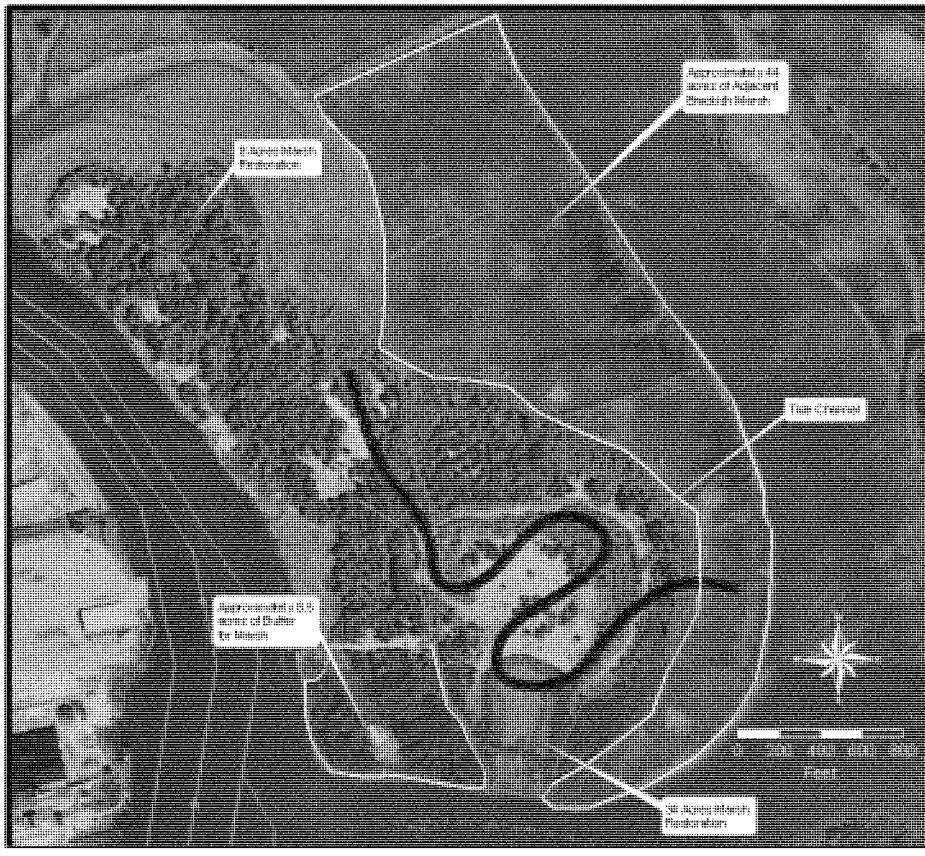


Figure 45. Wetland restoration at 1S

B. Dissolved Oxygen

Deepening the navigation channel would adversely impact dissolved oxygen levels in the harbor without mitigation. Since this is a critical resource in the harbor, the Corps has included a feature in the mitigation plan for each depth alternative that minimizes that adverse effect.

The Corps' studies indicate that oxygen injection is the most cost-effective method for raising D.O. levels in the harbor. Due to site-specific requirements, the Corps believes that a land-based injection system would be the most effective solution. It identified the use of Speece cones as the specific technique to inject oxygen into the water, although another land-based technique could be found to be more cost-effective. A different injection technique could be substituted at the time of construction without further NEPA coordination if impacts to wetlands, water quality or fisheries remain the same as with the Speece cones. The hydrodynamic and water quality modeling indicate that a system of injection locations would be needed, as summarized in the following table. These systems would remove the incremental effects of the channel deepening alternatives.

Table 40. Dissolved Oxygen Injection Summary

Depth Alternative	Number of Injection Locations	Number of Cones Operated	Number of Cones Installed	Capacity to Increase D.O. (lbs/day)
44-foot	3	9	11	36,000
45-foot	3	8	10	32,000
46-foot	3	9	11	36,000
47-foot	3	10	12	40,000
48-foot	3	11	13	44,000

The locations identified for these systems are shown in Figure 46. All three locations (Georgia Pacific, Hutchinson Island – west, Hutchinson Island –east) would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend out into the authorized navigation channel. Figure 47 shows a typical layout for the oxygen injection facility. The systems would be operated at full capacity during the months of July/August/September. The Corps would begin to operate the systems on 15 June to allow the dissolved oxygen to be fully distributed throughout the estuary by 1 July.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the site increases. Removing the incremental project effect at a great distance from injection site requires substantially greater amounts of oxygen. A tradeoff results between the amount of oxygen required and the distance from the injection site.

This becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity of maintaining numerous systems also increases. The D.O. system configuration is designed to remove the incremental effect of a deeper channel in 95 percent of the cells in the hydrodynamic model. The minor impact at distances away from the injection location is balanced by the higher dissolved oxygen levels that would occur close to where the oxygen is added. The District believes the 95 percent level of performance recognizes both the higher D.O. levels close to the injection sites and the limitations of the model at distinguishing small differences between different run conditions.

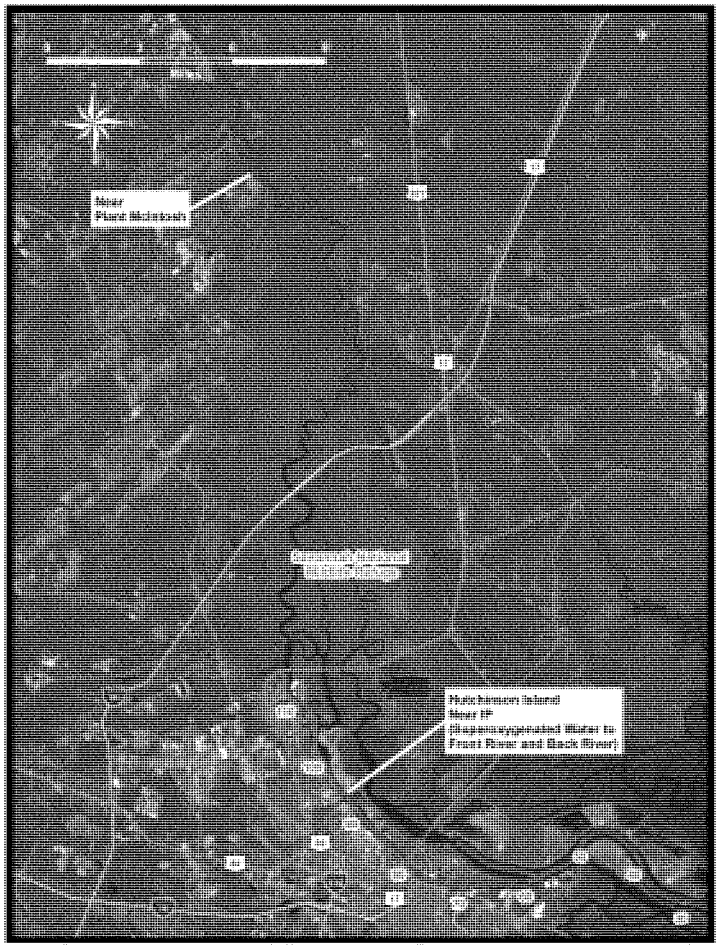


Figure 46. Locations for oxygen injection systems.

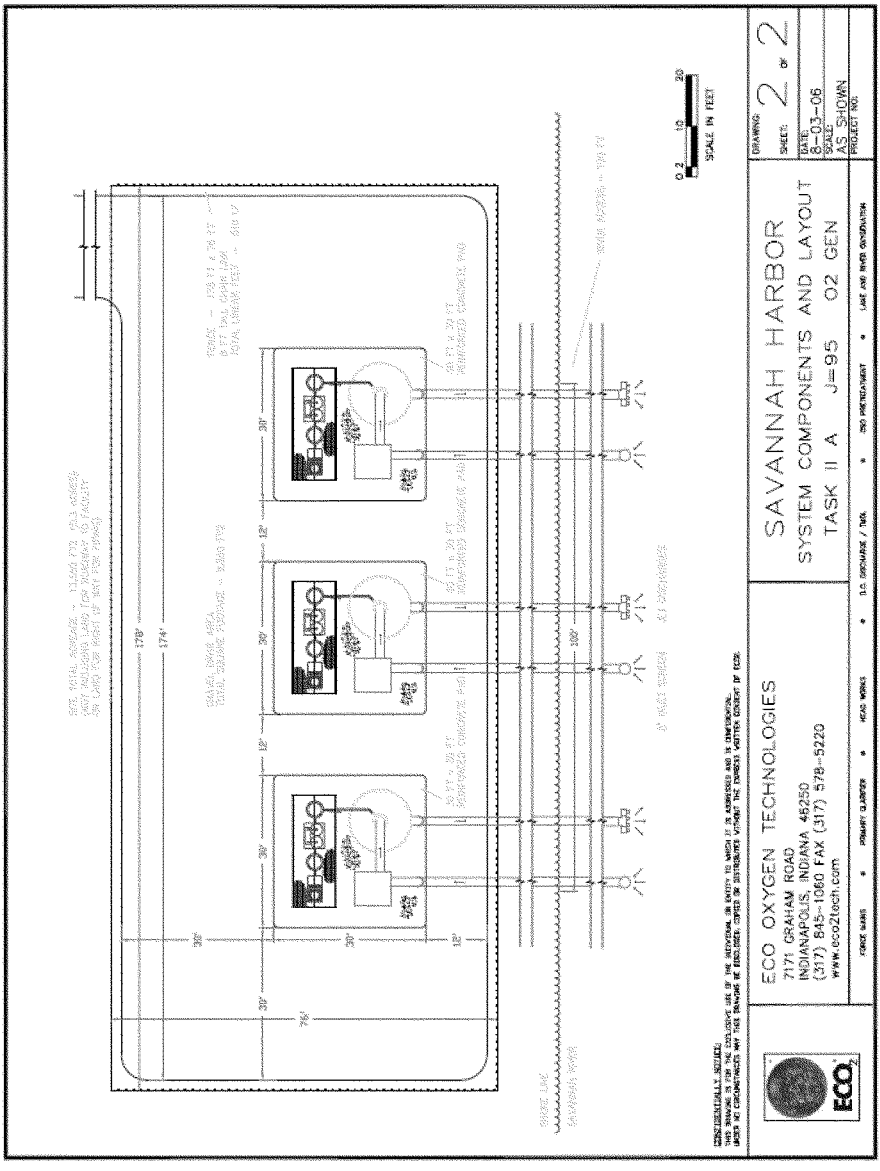

SAVANNAH HARBOR
SYSTEM COMPONENTS AND LAYOUT
TASK II A J=95 02 GEN
ECO OXYGEN TECHNOLOGIES
7171 GRAHAM ROAD
INDIANAPOLIS, INDIANA 46250
(317) 845-1060 FAX (317) 578-5220
www.eco2tech.com
SCALE IN FEET
DRAWING 2 OF 2
SHEET: 2
DATE: 8-03-06
SCALE: AS SHOWN
PROJECT NO:

Figure 47.

Since dissolved oxygen levels would be higher near the injection site and taper off away from the site, the Corps analyzed the model outputs and found that the systems would increase dissolved oxygen levels above their present levels over much of the harbor. Such improvements are a secondary benefit of a system that is designed to remove the incremental effect of a deeper channel in 97 percent of the bottom half of the water column. The following information shows the extent of the improvements that would occur:

Table 41. Percent of Cells with Improvement in D.O. Levels Over Existing Conditions With the D.O. Improvement Systems

	Vertical Layer	44 ft depth	45 ft depth	46 ft depth	47 ft depth	48 ft depth
5th percentile	Surface	99.9	99.7	99.9	99.9	99.9
	Mid-Depth	94.4	98.3	98.1	98.7	98.5
	Bottom	97.2	97.4	97.8	98.1	97.2
	Water Column	98.3	99.9	99.9	99.9	99.9
10th percentile	Surface	99.9	99.9	99.8	99.9	99.9
	Mid-Depth	95.3	99.2	99.1	99.0	99.1
	Bottom	97.5	97.5	97.9	98.4	97.1
	Water Column	98.4	99.9	99.9	99.9	99.9
25th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	95.5	99.4	99.3	99.1	99.2
	Bottom	97.9	97.7	98	98.1	97.7
	Water Column	98.7	99.9	99.9	99.9	99.9
50th percentile	Surface	99.9	99.9	99.9	99.9	99.9
	Mid-Depth	96.3	97.7	97.7	98.1	97.8
	Bottom	98.0	98.4	97.8	97.2	97.1
	Water Column	99.1	99.9	99.8	99.8	99.9

The proposed system designs provide the best balance of system spacing, size and effectiveness, when the issues of operating complexity, existing land uses, and over-compensation of impacts are considered. The systems are also scalable so that it could be expanded in the future if desired to produce net improvements in harbor D.O. levels.

C. Shortnose sturgeon

As previously discussed in this Appendix, the Corps consulted natural resource agencies about potential ways to address remaining adverse impacts to Shortnose sturgeon. Neither the Corps nor the agencies could identify any measures that could be implemented in the estuary that would restore sturgeon habitat or enhance existing habitats. Consequently, the Corps began to

assess ways to improve Shortnose sturgeon habitat in the upper Savannah River especially spawning habitat. This assessment focused on providing Shortnose sturgeon access to traditional spawning grounds above the NSBL&D. The biologically preferred alternative to achieve this would be to remove the NSBL&D. However, for reasons previously discussed, this is not feasible. The Corps then suggested an action that had previously been identified on the Savannah River that would increase the extent of sturgeon habitat – a method of allowing fish to move by the NSBL&D. A fishway around the structure would allow migrating fish to move past the dam. That would open up an additional 20 miles of habitat upstream of the dam to Shortnose sturgeon, reaches that they had used in the past. The structure would also open up the river to American shad and other anadromous fish species, thereby helping those populations. The previously approved horseshoe rock ramp design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages.

During review of the DEIS, the natural resource agencies expressed a lack of confidence in the success of the horseshoe rock ramp design. Most of the comments were based on the concern that the rock ramp design would not carry enough of the river flow to successfully pass Shortnose sturgeon. Based on these comments, the Corps convened a fish passage workshop which was attended by NOAA Fisheries, USFWS, SC DNR, GA DNR and other interested parties. The group reviewed the project's expected impacts to Shortnose sturgeon, and evaluated the effectiveness of the mitigation options available. Since removal of the NSBL&D is not feasible at this time, the group focused on design criteria for a successful rock ramp passage criteria. The Corps then used those criteria to develop and evaluate several alternate designs. The selected design is the Off-Channel Rock Ramp fish passage structure Figure 48). This structure would provide a substantial improvement in fish passage capability over the original rock ramp design which would have only captured 5% of the river flow. The Off-Channel Rock Ramp design would capture 100% of the river flow up to 8,000 cfs, and it would capture about 64% of the flow during the Shortnose sturgeon migratory season (February-June). This translates to about 75% effectiveness in fish passage for upstream movement and about an 85% effectiveness for downstream movement. The project's monitoring and adaptive management plan (See Appendix D) includes extensive monitoring of Shortnose sturgeon (as well as other species of anadromous fish) in the vicinity of the NSBL&D and monitoring of fish movement through the fish passage structure once it is constructed.

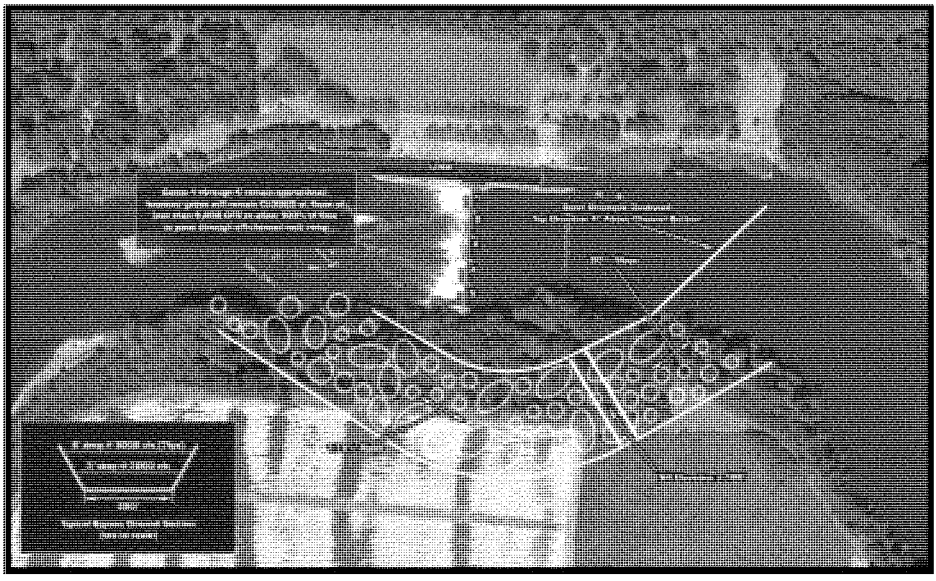


Figure 48.

D. Striped bass

The natural resource agencies could not identify any physical measures that could be implemented in the estuary to restore or enhance Striped bass habitats. The loss of 10 percent of spawning, egg development or larvae habitats could limit the size of the Savannah River population of Striped bass. The agency representatives concluded that the only means of addressing that impact would be through a stocking program. Through such a program, the project would provide additional fish to the population to compensate for the limiting nature of the reduced spawning and early development habitats. The Wildlife Resources Division (WRD) of the Georgia Department of Natural Resources conducted a Striped bass stocking program in this river in the late 1990's. The Corps coordinated with GA DNR-WRD and confirmed that a stocking program could compensate for the impacts identified to Striped bass. The type of stocking program was then discussed that would be appropriate for the level of impacts identified.

GA DNR defined the requirements of a full-scale stocking program, assuming there is no natural recruitment in the system. In that case, all young would have to be introduced into the system through stocking. When the Fishery Interagency Coordination Team discussed the impact evaluation approach, they were most concerned about salinity during spawning and early life-stage habitats before the fish could orient themselves and find nursery habitats with suitable salinities. Since the young are able to select their habitats within 2 months, stocking young-of-the-year (Phase II fish) would be sufficient to get the population past the higher-salinity bottleneck caused by a harbor deepening. Development of a stocking program where young must be grown for a full year or more would not be needed to compensate for impacts from this project.

The costs for a full stocking program to replace 100 percent of the young would be appropriate mitigation if the project were expected to adversely impact 100 percent of the existing spawning or early life stage habitat in the estuary. However, since the alternatives being considered are not expected to result in impacts which are that severe, the extent of the stocking needed could be reduced to the amount of habitat predicted to be impacted by the project. Thus, the percentage of habitat loss could be multiplied by the cost for a full-scale stocking program to determine the amount that would be sufficient to compensate for the habitat loss that is expected

Using that approach, the adverse impacts expected for each life stage of Striped bass were combined to generate the cumulative adverse impact shown in the following table.

Table 42. Striped Bass Impact Summary

CHANNEL DEPTH ALTERNATIVE	SPAWNING 50% Flows	EGGS 50% Flows	LARVAE 50% Flows	COMBINED ADVERSE IMPACT
44-FOOT	-2.9 %	-9.4 %	-5.6 %	17.0 %
45-FOOT	-9.2 %	5.2 %	1.7 %	2.9 %
46-FOOT	-10.0 %	-0.0 %	5.6 %	5.0 %
47-FOOT	-11.1 %	-5.0 %	-13.5 %	26.9 %
48-FOOT	-16.1 %	-10.8 %	-3.5 %	27.8 %

With that combined adverse impact value and the costs of a complete stocking program, one can calculate the compensation required to mitigate for each depth alternative. The GA DNR-WRD provided information on the costs to rehabilitate and operate some of GA DNR-WRD's facilities at their Richmond Hill hatchery to conduct a Striped bass stocking program capable of producing 40,000 Phase II fish each year. The costs included initial expenses of $3.1 million, annual expenses of $203,000 to operate the program, and recurring costs of between $30,000 and $50,000 for equipment replacement. The Corps used those values and calculated them to represent an annualized cost of roughly $466,700 for a complete Striped bass stocking program. Based on that average annual value, the following compensation would be required:

Table 43. Required Compensation Annualized

CHANNEL DEPTH ALTERNATIVE	COMBINED ADVERSE IMPACT	ANNUAL PROGRAM FUNDING
44-FOOT	17.0 %	$79,335
45-FOOT	2.9 %	$13,534
46-FOOT	5.0 %	$23,334
47-FOOT	26.9 %	$125,536
48-FOOT	27.8 %	$129,737

The Corps proposes to fund that compensation as a lump sum. Using an interest rate of 4.125 percent over 50 years to obtain the present worth of that annual funding stream, the following lump sum payment would be required:

Table 44. Required Compensation Lump Sum

CHANNEL DEPTH ALTERNATIVE	ANNUAL PROGRAM FUNDING	LUMP SUM PAYMENT
44-FOOT	$79,335	$1,668,000
45-FOOT	$13,534	$285,000
46-FOOT	$23,334	$491,000
47-FOOT	$125,536	$2,640,000
48-FOOT	$129,737	$2,728,000

Using the FY12 discount rate of 4.0 percent, the lump sum payment for the 47-foot depth alternative would be $2,672,000.

The Mitigation Plan and Adaptive Management Plan (Appendix D) also provide for evaluations to be performed after the project is constructed to quantify the impacts of the SHEP on Striped bass habitat. Field data from the post-construction monitoring would be used in conjunction with the updated hydrodynamic and water quality models to evaluate the project's impacts on Striped bass habitat. Those evaluations would be performed during years 2, 4, and 9 of the post-construction phase of the project.

E. Construction of Boat Ramp

Closing Rifle Cut would lengthen the transits of recreational boaters that use the existing boat ramp at the Houlihan Bridge as they travel to use Back River. The Corps would mitigate for these impacts by constructing a new boat ramp on Hutchinson Island, which would provide a ramp on Back River for those recreational boaters (Figure 49). The Corps would turn over the site to Chatham County, which would operate the facility in perpetuity.

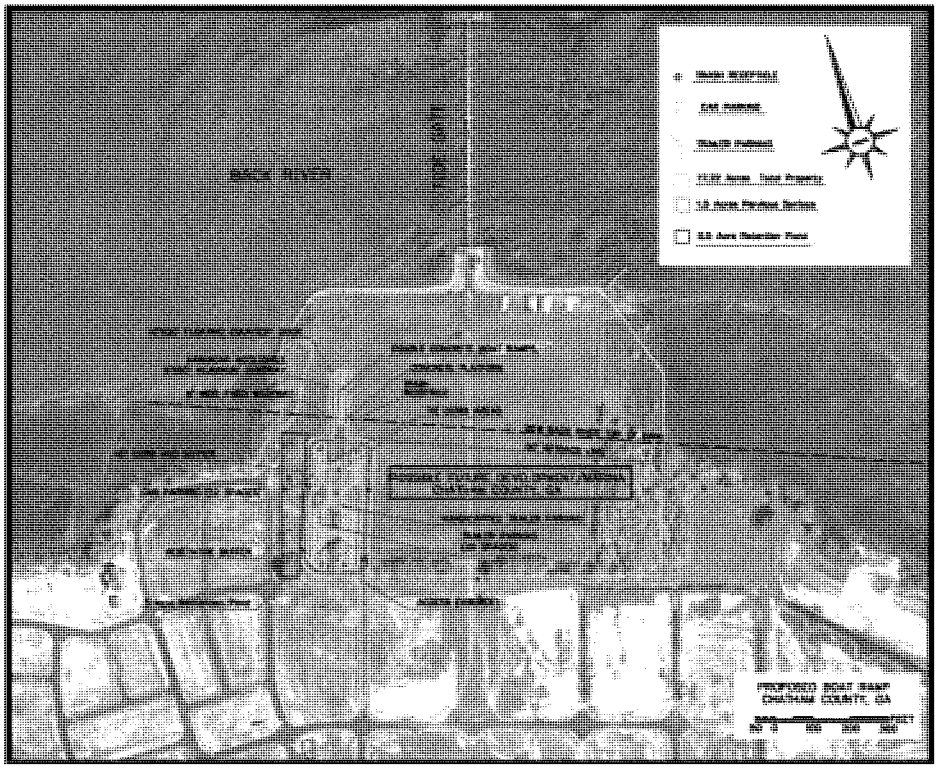


Figure 49

The proposed new boat ramp is located on Government-owned land at the Tidegate, which is located on Hutchinson Island adjacent to Back River. The proposed 2-lane concrete boat ramps would include the following: floating dock, 20 space trailer parking, handicap accessible and parking, and parking spaces for 12 single cars.

F. Construction of a Raw Water Storage Impoundment

The Corps has conducted extensive studies to evaluate the potential impacts of the SHEP on chloride levels at the City of Savannah's M&I water supply intake on Abercorn Creek. The latest studies indicate that construction of the SHEP would increase chloride levels at the intake during low flows and high tides. Two concerns are associated with this increase in chloride levels at the City's water intake.

The first concern is that increased chloride levels could increase lead corrosion in pipes. Based on the laboratory analyses performed, lead corrosion is expected to increase considerably with increased chlorides. Lead concentrations in the water samples were shown to increase 2-4 times compared to the existing conditions as chloride concentrations increase from 10 mg/l to 50 mg/l. Whether those increased levels would exceed regulatory action limits as defined by the USEPA's Safe Drinking Water Act (SDWA) Lead and Copper Rule, 40 CFR Part 141, as adopted in Georgia, cannot be determined with certainty due to the fact that regulatory sampling for lead is performed at the customer's tap, and is highly dependent upon the customer's piping and the residence time in that piping. Although the SDWA action level for lead is 0.015 mg/l, the ideal concentration of lead in drinking water is zero. The Corps has determined that for this project it is not acceptable to increase lead concentration in drinking water even though the regulatory threshold is not exceeded. An increase in lead concentration is considered an increase in health risk.

The second concern is the potential for an increase in the formation of DBPs. Increasing chloride concentrations due to SHEP causes an increase in the use of chlorine required to treat the water. The additional disinfectant required to achieve treatment goals causes the formation of additional byproducts. Also, as chlorides are pushed further upstream with harbor deepening, bromides, which are another component of seawater, are pushed further upstream as well. Brominated compounds can react with chlorine to form bromine-containing THMs, HAAs and other byproducts. The rate of DBP formation is also affected by the presence of bromide in the source water. Under both of these circumstances which are expected to occur during low flow and high tide conditions with SHEP, total THMs are expected to increase above the permitted level when chlorides exceed about 60 mg/l. HAAs are not expected to increase above regulatory limits. However, EPA may expand the regulated species in the future to include brominated HAAs, at which time the chloride impacts could affect compliance.

During SHEP studies, the Corps evaluated numerous mitigation alternatives to address elevated chloride levels at the City of Savannah's water supply intake on Abercorn Creek should mitigation be required. Based on the most recent studies, mitigation is required, and the most cost efficient method to provide this mitigation is construction of a raw water storage impoundment. This storage impoundment would provide the City with water during times of

high chloride spikes. Consequently, the project's mitigation plan includes the construction of a 97 MG raw water storage impoundment.

VII Consideration of the USEPA/USACE Mitigation Rule

The Corps has evaluated the proposed project mitigation with respect to the Mitigation Rule- entitled "Compensatory Mitigation for Losses of Aquatic Resources", 33 CFR Part 332 (and also 40 CFR Part 230) (jointly established by the USEPA and USACE and published in the Federal Register on April 10, 2008) (referred to herein as the Mitigation Rule).

The Mitigation Rule applies to Clean Water Act Section 404 permit applications, not Corps civil works projects such as SHEP. In addition, the Mitigation Rule does not apply to substantial work done before it was issued. The SHEP wetland mitigation study and planning began in 2002. The agencies devoted substantial time, effort, and expense to development of the wetland mitigation and associated flow rerouting plan before the Mitigation Rule was promulgated in 2008. The preamble to the Mitigation Rule states: "the new requirements should not be applied retroactively to permit applicants who have invested substantial effort in developing data and plans under the previous rules and guidance." 73 Fed. Reg. 19594, at 19608 (April 10, 2008). Nevertheless, the Corps has attempted in good faith to consider and follow the Mitigation Rule to the extent practicable.

As shown in the following sections, the Corps has determined that the proposed project mitigation conforms to the requirements and intent of the Mitigation Rule, 33 CFR Part 332.

A. Watershed Characterization

Characterization of the Lower Savannah River Watershed: The Lower Savannah Watershed is identified by Hydrologic Unit Code (HUC) 03060109. The watershed is approximately 377,000 acres in size and includes portions of Georgia and South Carolina. The Savannah River constitutes the primary drainage feature within the 8-digit HUC watershed, with limits that extend from southern Screven County, Georgia, and Allendale County, South Carolina, to the mouth of the river located between Chatham County, Georgia, and Jasper County, South Carolina. North of Interstate 95 (I-95), the watershed is primarily rural and dominated by agricultural entities. Similar land use trends are also located south of I-95 in South Carolina. However, Chatham and portions of Effingham Counties have experienced considerable urbanization over the last 20 years. A review of data reported by the University of Georgia suggests rates associated with high intensity urbanization within the Lower Savannah Watershed are approximately 260 acres/year (http://narsal.uga.edu/glut/watershed.php?watershed=27), and a predominant amount of these trends has been observed in Chatham and Effingham Counties. The Savannah Harbor and those areas in Georgia adjacent to harbor are primarily dominated by industrial and/or commercial activities. The Georgia Ports Authority (GPA) presently operates the Ocean City and Garden City Terminals within the harbor. In addition, approximately 13 other entities also maintain shipping terminals within the harbor. Please see Section 4 for an additional information concerning characterization of the project area and the Savannah Harbor.

Land use trends within the watershed have also been evaluated with respect to changes in wetland acreage. From 1985 to 2005, the quantity of wetlands found within the Lower Savannah

Watershed has continued to decrease. The table illustrated below was obtained from the University of Georgia's Natural Resources Spatial Analysis Lab (NARSAL) and illustrates the relative decline of wetlands located within the watershed (http://narsal.uga.edu).

Table 45. Land Use Trends

	Year				
Land Use Cover (Acres)	**1985**	**1991**	**1998**	**2001**	**2005**
Forested Wetland	126,480	125,398	112,996	106,818	99,290
Non-Forested Wetland (Salt)	3,751	2,954	2,873	2,334	2,235
Non-Forested Wetland (Fresh)	3,788	3,234	4,057	2,229	2,675

All three classifications of wetlands can be found adjacent to the Savannah Harbor. The harbor contains brackish marsh wetlands that are principally dominated by *Spartina alterniflora* and *Spartina cynosuroides* species. Additionally, tidal freshwater wetlands can be found north of the Savannah Harbor and in close proximity to the Savannah River National Wildlife Refuge. Please see Section 4 and Appendix C III and IV for greater detail concerning wetlands located within the project review area.

Non-point Source Discharges: Residential, commercial and industrial development result in an increase in impervious surfaces (roof tops, paved roads, parking lots, etc.), which affects storm water discharges. Development results in an increase in non-point source contaminant loading through associated increases in urban landscaping (pesticides and fertilizers), increased traffic (oil, grease and metals), and other associated activities. There would be an anticipated incremental increase in adverse impacts to water quality as impervious surfaces increase, independent of the proposed harbor deepening project. The following table is a summary of anticipated population growth and the associated increase in impervious surfaces in the Lower Savannah Watershed. The amount of impervious surface coverage is increasingly recognized as a valuable predictor of overall water quality within a watershed. In general, as population increases, so does impervious surface. As impervious surface area increases, water quality decreases. The table below illustrates population and impervious surface area growth over time for the Lower Savannah River Basin.

The impervious surface data was generated by the US Environmental Protection Agency and provided to the USACE via a table titled "Total Impervious Area Calculations by 12-Digit Hydrologic Unit Code Watershed (based upon National Land Cover Data, 1993). Using simple linear regression analysis, the USACE utilized county population projection data to estimate the percent increase in impervious surface, by county. The data contained in the table below indicates that as the population of each county continues to increase, there will be an associated increase in impervious surfaces. Two counties in the study area, Chatham and Effingham, would be anticipated to experience an increase of less than one in percent impervious surface by the year 2020. The other four counties in this area are expected to experience an increase of less than 0.5 in percent impervious surface. Each county is responsible for regulating non-point source storm water discharges pursuant to Section 402 of the Clean Water Act. These county storm water management programs should help to minimize the anticipated adverse impacts to water quality.

Table 46. Projected Population Growth and Projected Increases in Percent Impervious Surface Coverage

COUNTY		2000	2005	2010	2020
Chatham(GA)	Population	232,048	239,861	249,748	265,006
	% Impervious Surface	8.64	8.88	9.18	9.63
Effingham (GA)	Population	37,535	46,515	53,652	68,544
	% Impervious Surface	2.81	3.08	3.29	3.74
Screven (GA)	Population	15,374	15,172	15,639	16,387
	% Impervious Surface	2.14	2.14	2.15	2.17
Allendale (SC)	Population	11,211	10,727	10,237	9,304
	% Impervious Surface	2.02	2.02	2.02	2.02
Hampton (SC)	Population	21,386	20,982	22,116	23,613
	% Impervious Surface	2.32	2.31	2.35	2.39
Jasper (SC)	Population	20,678	21,122	23,559	27,362
	% Impervious Surface	2.30	2.32	2.39	2.50

Using best available data, the USACE identified a historical listing of Section 303(d) listed waters located within the Lower Savannah Watershed. A more detailed explanation of the results can be found at the following website: (http://cfpub.epa.gov/surf/huc.cfm?huc_code=03060109. The Table below illustrates the named water, pollutant and listed cause of impairment for those 303(d) listed waters located in the Lower Savannah Watershed.

Table 47. Section 303(d) Waters

Section 303(d) Listed Waters in the Lower Savannah Watershed (HUC 0306019)		
Named Water	**Pollutant**	**Listed Cause of Impairment**
Buck Creek	Cyanide, Zinc, and Toxicity	Cyanide, Zinc, and Toxics
Ebenezer Creek	BOD and pH	Organic Enrichment/Low Dissolved Oxygen, pH
Savannah Harbor	BOD, Oxygen Demand	Dissolved Oxygen
Savannah River	Mercury	Fish Consumption Guidance
Savannah River Basin	BOD, Oxygen Demand, Fecal Coliform	Dissolved Oxygen, Fecal Coliform

In October 2006, the EPA finalized a TMDL for Savannah Harbor to satisfy a consent decree obligation established in Sierra Club v. EPA, Civil Action No: 94-CV-2501-MHS (N.D.GA). In summary, the TMDL concluded that Savannah River cannot accept anthropogenic oxygen-demanding substances and still provide acceptable habitat for critical aquatic life that reside in those reaches of the river. This finding means that the States will have to revise their permits for point source discharges in those reaches as they expire and come up for renewal. As part of its analysis, EPA evaluated the dissolved oxygen requirements for several different fish species and the natural conditions for the river.

EPA published a Revised Draft TDML for dissolved oxygen in Savannah Harbor in April 2010. This TDML requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand (UOD) to about 130,000 lbs/day.

In 2009, the State of Georgia revised its DO standard for Savannah Harbor. The new standard calls for a daily average in the dissolved oxygen to be no less than 5.0 mg/L throughout the year, with an instantaneous minimum of 4.0 mg/L. These new standards apply throughout the water column and they match the South Carolina standard for waters of the same use classification.

The effects of the proposed expansion project on DO levels in the Savannah Harbor have been evaluated. Please see Section 4 and Appendix C IV and VI for more detailed information concerning impacts to DO and the associated mitigation.

B. Functional Assessment of Wetland Impact Areas

1.0 Indirect Impacts to Wetlands

Indirect impacts associated with the proposed deepening (47-foot channel) would result in a vegetative shift to 223 acres of freshwater marsh and 740 acres of saltmarsh. In brief, the EFDC model was used during the SHEP study to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where marsh salinity contour lines are extrapolated from the river into the adjacent marsh areas. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt (See Section 5, "Consequences of the Proposed Action" – Section 5.01.2 of the FEIS). In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.6-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh.

The results of our functional assessment concluded that the differentiation between salt marsh and brackish marsh recommended by the Wetland Interagency Coordination Team and used in the DEIS was overly constrained. The salinity range used in the SHEP model to differentiate between brackish marsh (0.6-4 ppt) and salt marsh (> 4ppt) was quite restrictive given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt), both of which occur within the area of potential effect, also supports those findings. Thus, the salinity range used to quantify salt marsh in the area of potential effect (i.e., > 4 ppt) over estimated the amount of saltmarsh in the system and under estimated the amount of brackish marsh. As such, the described conversion of salt marsh to brackish marsh, which would occur as a result of harbor deepening, would be negligible when taking into account vegetative characteristics for wetland environments with associated salinities commonly associated with a brackish marsh (i.e., range between 5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, we have concluded the 740-acre calculated conversion of saltmarsh to brackish marsh if the harbor is deepened to 47-feet, may be an exaggerated value, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah. That said, the Corps was inclusive in its assessment of the potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts.

The conversion of 223 acres of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 47-feet as proposed. Again, it is important to reiterate that the ecological values of the impacted 223 acres of freshwater wetlands would not be completely lost. Instead, those acres would be converted to brackish marsh. The Corps' calculation of the number of acres of freshwater wetland that have the potential to be converted to brackish marsh is based on a shift in the

location of 0.5 ppt salinity, a traditional rule-of-thumb for differentiating between freshwater marsh and brackish marsh. However, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994).

Deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined as brackish marsh (Latham et. al., 1994). Likewise, the 47-foot depth would result in a conversion of the dominant vegetative species typically observed in 740 acres of saltmarsh (saltmarsh to brackish marsh scenario) and dominant saltmarsh species like *Spartina alterniflora* would still be observed in areas which have salinities that define a brackish marsh. However, the overall basic wetland functions typically associated with these systems would not change. A comparison of potential changes in elements of wetland function for both conversion scenarios is provided in Table 50.

Table 48. Changes in Wetland Fnnction as a Result of Wetland Conversion

Elements of Wetland Function	Freshwater to Brackish Marsh (Approximately 223 acres)	Saltmarsh to Brackish Marsh (Approximately 740 acres)
Water Purification	Negligible	Negligible
Flood Protection	Negligible	Negligible
Shoreline Stabilization	Negligible	Negligible
Groundwater Recharge	Negligible	Negligible
Streamflow Maintenance	Negligible	Negligible
Retention of Particles	Negligible	Negligible
Surface Water Storage	Negligible	Negligible
Subsurface Storage	Negligible	Negligible
Nutrient Cycling	Negligible	Negligible
Values to Society	Negligible	Negligible
Fish and Wildlife Habitat	Minor Adverse	Negligible

Negligible Effect – the effect on the resource would be at the lowest levels of detection, barely measurable, with no perceptible consequences, either adverse or beneficial, to the resource.
Minor Adverse Effect – the effect on the resource is measurable or perceptible, but it is slight.
Adverse Effect - the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result

As illustrated in Table 50, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system.

Alternatively, the USACE recognizes that a comparison of fish and wildlife habitat between freshwater and brackish marsh systems yields fewer similarities. However, the conversion in fish and wildlife habitat will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation after deepening in wetland areas that would be classified as brackish marsh.

2.0 Direct Impacts to Wetlands

The harbor deepening project would also result in direct impacts to 15.68 acres of brackish marsh. It should be noted that these impacts would result after all possible avoidance and minimization measures have been used. In brief, these marsh areas are subject to periodic flooding as a result of daily tides and the vegetative communities in these areas generally consist of one plant species, which is a smooth coordgrass known as *Spartina alterniflora*. Approximately 7.3 acres (47%) of the total saltmarsh acreage that would be excavated is subject to the wave action of passing ships and the resulting perturbation. Thus, these areas exhibit vegetation densities which are significantly less than what is typically observed in a pristine marsh. Patches of bare, course-grain sand and mudflat are integrated throughout the patches of *Spartina alterniflora* in these locations. Given the sparse presence of vegetation, it would appear that these areas are challenged, somewhat degraded, and do not possess the same degree of primary productivity as observed in robust, densely-vegetated, saltmarsh systems located throughout coastal Georgia.

C. Functional Assessment of Mitigation Areas

1.0 Assessment of Preservation Area used to Mitigate for Indirect Impacts

The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge (SNWR)". The document characterizes the lands proposed for preservation in the areas identified as Mill Creek and Abercorn Island. The properties comprising the Mill Creek and Abercorn Island areas are characterized by wetlands and upland pockets. The Mill Creek Area is comprised of Ecosystem CES 203.066/Alliance A.292 and CES 203.66/Alliance A.345, which total 4,900 acres (Figure 50). Similarly, the Abercorn Island area is composed of Ecosystem CES 203.240/Alliance A.357 and CES 203.242/Alliance A.375, which total 1,989 acres (Figure 51).

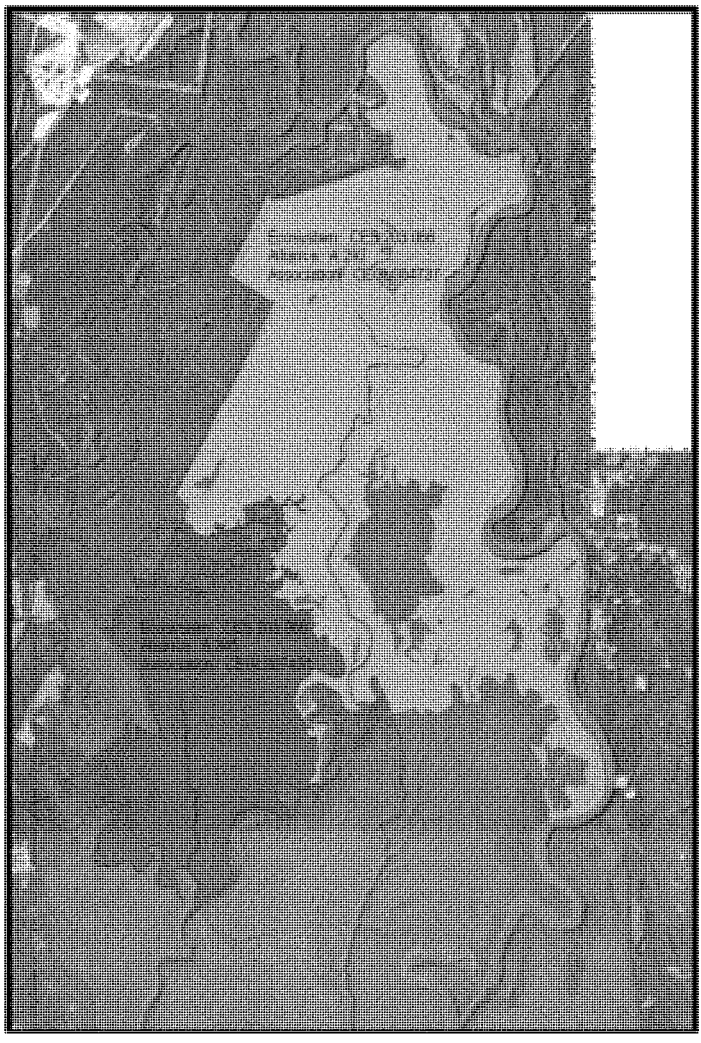


Figure 50.

1.1 Ecosystem CES203.066: Southern Atlantic Coastal Plain Large River Floodplain Forest

Summary: This system represents a geographic subset of Kuchler's (1964) Southern Floodplain Forest. Examples may be found along large rivers of the Atlantic Coastal Plain, especially the Roanoke, Great Pee Dee, Congaree/Santee, Savannah, and Altamaha rivers. Several distinct plant communities can be recognized within this system that may be related to the array of different geomorphologic features present within the floodplain. Some of the major geomorphic

features associated with different community types include natural levees, point bars, meander scrolls, oxbows, and sloughs (Sharitz and Mitsch 1993). Vegetation generally includes forests dominated by bottomland hardwood species and other trees tolerant of flooding. However, herbaceous and shrub vegetation may be present in certain areas as well.

1.1A Alliance: A. 292 Quercus (phellos, nigra, laurifolia) Temporarily Flooded Forest Alliance

Forests in this alliance are typically dominated by some combination of *Quercus phellos, Quercus nigra*, and/or *Quercus laurifolia*. They may be found throughout the Coastal Plain and adjacent areas of the lower Piedmont, Arkansas Valley, Interior Low Plateau, and the Ouachita Mountains in temporarily flooded environments. These forests may occur in large, relatively high-gradient floodplains (in which they tend to occur on topographically higher portions of the floodplain, such as ridges or terraces), or in small, relatively low-gradient floodplains (in which the landforms are too small and/or too poorly developed to create much consistent, local topographic relief). In the Atlantic and East Gulf coastal plains, these forests may occur more often in association with blackwater / low-sediment / low-nutrient rivers and streams than brownwater ones. They occur on very acidic to mildly alkaline soils, commonly on Portland, Tensas, and Hebert silt loams. Dominant and associated species vary with geographic location and landscape setting. Associated canopy species include *Quercus texana, Fraxinus pennsylvanica, Pinus taeda, Quercus similis, Quercus michauxii, Magnolia virginiana, Pinus glabra, Liquidambar styraciflua, Acer rubrum, Nyssa biflora, Ulmus alata, Carya aquatica, Carya alba, Carya glabra, Quercus pagoda, Taxodium distichum*, and *Celtis laevigata*. Subcanopy and shrub species include *Halesia diptera, Carpinus caroliniana, Ilex decidua, Sebastiania fruticosa, Ostrya virginiana, Viburnum rufidulum, Diospyros virginiana, Itea virginica, Symplocos tinctoria, Rhododendron canescens, Illicium floridanum, Cyrilla racemiflora, Ilex verticillata, Crataegus viridis, Vaccinium elliottii*, and *Ilex opaca*, among others. Woody vines are an important component of these forests; species include *Toxicodendron radicans, Bignonia capreolata, Smilax rotundifolia, Vitis rotundifolia, Parthenocissus quinquefolia, Trachelospermum difforme, Berchemia scandens, Smilax glauca, Campsis radicans, Cocculus carolinus, Ampelopsis arborea*, and others. This alliance also includes forests of large bottomlands dominated by *Quercus phellos* and *Ulmus crassifolia* that occur on flat ridges and grade up from forests dominated by *Quercus lyrata* and *Carya aquatica*. Characteristic canopy species include *Pinus taeda, Quercus similis, Liquidambar styraciflua, Gleditsia triacanthos*, and *Carya aquatica*, but the wettest sites likely will have only *Quercus phellos* and *Ulmus crassifolia*. Understory species include *Ilex decidua, Viburnum dentatum*, and *Crataegus* spp., with *Sabal minor* in drier sites.

Vegetation Summary: Stands of this alliance are typically dominated by some combination of *Quercus phellos, Quercus nigra*, and/or *Quercus laurifolia*. Dominant and associated species vary with geographic location and may include *Quercus texana, Fraxinus pennsylvanica, Pinus taeda, Quercus similis, Quercus michauxii, Magnolia virginiana, Pinus glabra, Liquidambar styraciflua, Acer rubrum, Nyssa biflora, Halesia diptera, Ulmus alata, Carya aquatica, Carya alba, Carya glabra, Quercus pagoda, Taxodium distichum*, and *Celtis laevigata*. Subcanopy and shrub species include *Carpinus caroliniana, Ilex decidua, Sebastiania fruticosa, Ostrya virginiana, Viburnum rufidulum, Diospyros virginiana, Itea virginica, Symplocos tinctoria, Rhododendron canescens, Illicium floridanum, Cyrilla racemiflora, Ilex verticillata, Crataegus viridis, Vaccinium elliottii*, and *Ilex opaca*, among others. Woody vines are an important

component of these forests; species include *Toxicodendron radicans, Bignonia capreolata, Smilax rotundifolia, Vitis rotundifolia, Parthenocissus quinquefolia, Trachelospermum difforme, Berchemia scandens, Smilax glauca, Campsis radicans, Cocculus carolinus, Ampelopsis arborea*, and others. This alliance also includes forests of large bottomlands dominated by *Quercus phellos* and *Ulmus crassifolia* that occur on flat ridges and grade up from forests dominated by *Quercus lyrata* and *Carya aquatica*. Characteristic canopy species include *Pinus taeda, Quercus similis, Liquidambar styraciflua, Gleditsia triacanthos*, and *Carya aquatica*, but the wettest sites likely will have only *Quercus phellos* and *Ulmus crassifolia*. Understory species include *Ilex decidua, Viburnum dentatum*, and *Crataegus* spp., with *Sabal minor* in drier sites.

Environmental Summary: Forests in this alliance occur primarily along blackwater or low-sediment / low-nutrient rivers and small streams in the Atlantic Coastal Plain, lower Piedmont, Arkansas Valley, East Gulf Coastal Plain, West Gulf Coastal Plain, Interior Low Plateau, and the Ouachita Mountains in temporarily flooded environments. These forests may occur in large, relatively high-gradient floodplains (in which they tend to occur on topographically higher portions of the floodplain, such as ridges or terraces), or in small, relatively low-gradient floodplains (in which the landforms are too small and/or too poorly developed to create much consistent, local topographic relief). They occur on very acidic to mildly alkaline soils, commonly on Portland, Tensas, and Hebert silt loams.

Association: CEGL004737 Quercus laurifolia - Quercus lyrata / Carpinus caroliniana - Persea palustris / Vaccinium elliottii Forest

Summary: This community type covers forests of low blackwater bottomland river terraces and ridges, in the Atlantic Coastal Plain of the Carolinas and possibly Virginia. This type may have a somewhat longer hydroperiod than other types in this or other temporarily flooded alliances, but it is not seasonally flooded. It is distinguished from some related types by lacking a significant component of levee species. The canopy is dominated by *Quercus laurifolia* and *Quercus lyrata*. The subcanopy characteristically contains *Carpinus caroliniana* and *Persea palustris*. One prominent shrub is *Vaccinium elliottii*. Additional floristic information is needed. Stands of this community have a significant component of *Quercus lyrata* and generally lack a significant component of *Pinus taeda*.

Vegetation Summary: The canopy of this association is dominated by *Quercus laurifolia* and *Quercus lyrata*. The subcanopy characteristically contains *Carpinus caroliniana* and *Persea palustris*. One prominent shrub is *Vaccinium elliottii*. Additional floristic information is needed. Stands of this community have a significant component of *Quercus lyrata* and generally lack a significant component of *Pinus taeda*.

Environmental Summary: This community occurs on low blackwater bottomland river terraces and ridges, in the Atlantic Coastal Plain of the Carolinas and possibly Virginia. This type may have a somewhat longer hydroperiod than other types in this or other temporarily flooded alliances, but it is not seasonally flooded.

1.1B Alliance: A.345 -Nyssa aquatica - (Taxodium distichum) Semipermanently Flooded Forest Alliance

Summary: This alliance encompasses semipermanently flooded forested riverine swamps dominated by *Nyssa aquatica*, with or without *Taxodium distichum* as a codominant. Stands of this alliance may vary in composition from ones largely dominated by *Nyssa* to ones dominated by a mix of *Taxodium, Nyssa*, and other hardwood species. Dominance of *Nyssa* may vary conceptually from 100-25%. Dominance of *Taxodium* may vary from less than 75% to absent. Other canopy and subcanopy species may include *Nyssa biflora, Quercus lyrata, Carya aquatica, Fraxinus profunda, Fraxinus caroliniana, Planera aquatica*, and *Populus heterophylla*. Shrubs and herbs are typically limited to tree bases, fallen logs, and other elevated places in the stand. *Itea virginica* is often the only shrub present. Herbaceous species may be absent and often are sparse. Species present can include *Phanopyrum gymnocarpon (= Panicum gymnocarpon), Pluchea camphorata, Boehmeria cylindrica, Rudbeckia laciniata, Sagittaria latifolia, Onoclea sensibilis, Triadenum walteri, Carex joorii, Carex glaucescens, Proserpinaca pectinata, Asclepias perennis, Saururus cernuus, Justicia ovata, Leersia lenticularis*, and others. Associations in this alliance occur in backwater sloughs, low wet flats, swales and backswamps, and along blackwater streams and other alluvial settings. Related vegetation associated with artificial lakes and millponds are accommodated in another alliance, *Taxodium distichum - (Taxodium ascendens)* Seasonally Flooded Lakeshore Woodland Alliance (A.652). Surface water is present throughout the growing season in most years. Forests in this alliance occur virtually throughout the Atlantic and Gulf coastal plains and the Mississippi River Alluvial Plain within the range of *Nyssa aquatica*, and in the Arkansas River Valley; also reported from the Mobile and Tensaw rivers in Alabama.

Vegetation Summary: This alliance occurs virtually throughout the Atlantic and Gulf coastal plains and the Mississippi River Alluvial Plain within the range of *Nyssa aquatica*. It includes forested riverine swamps dominated by *Nyssa aquatica*, with or without *Taxodium distichum* as a codominant. Other canopy and subcanopy species include *Nyssa biflora, Quercus lyrata, Carya aquatica, Fraxinus profunda, Fraxinus caroliniana, Planera aquatica*, and *Populus heterophylla*. Shrubs and herbs are limited to tree bases, fallen logs, and other elevated places in the stand. *Itea virginica* is often the only shrub present. Herbaceous species may be absent, and often are sparse. Species present can include *Phanopyrum gymnocarpon, Pluchea camphorata, Boehmeria cylindrica, Rudbeckia laciniata, Sagittaria latifolia, Onoclea sensibilis, Triadenum walteri, Carex joorii, Carex glaucescens, Asclepias perennis, Saururus cernuus, Justicia ovata, Leersia lenticularis*, and others.

Environmental Summary: Associations in this alliance occur in backwater sloughs, low, wet flats, swales and backswamps, along blackwater streams, and in artificial lakes and millponds and other situations with altered or enhanced hydrology. Surface water is present well into the growing season in the forests of this alliance.

Association: CEGL007431 Taxodium distichum - Nyssa aquatica / Fraxinus caroliniana Forest

Summary: This is a semipermanently flooded community of brownwater rivers which occurs primarily in the outer Atlantic Coastal Plain extending through the East Gulf Coastal Plain. Vegetation is characterized by a dense canopy composed almost exclusively of straight, tall individuals of *Taxodium distichum* and *Nyssa aquatica* with a sparse to moderate subcanopy and

depauperate shrub and herb layers. Occasional individuals of several species (e.g., *Populus heterophylla, Salix nigra, Nyssa biflora, Planera aquatica, Ulmus americana, Fraxinus profunda, Fraxinus caroliniana, Carya aquatica, Quercus lyrata*) are possible in the canopy or subcanopy. The herbaceous layer is very sparse, and typical species include *Saururus cernuus, Proserpinaca pectinata, Proserpinaca palustris, Asclepias perennis, Commelina virginica, Leersia lenticularis*, and *Phanopyrum gymnocarpon (= Panicum gymnocarpon)*. It is found on the lower Atlantic Coastal Plain from southeastern Virginia to southern Georgia, and possibly on the lower Gulf Coastal Plain west to southeastern Louisiana, excluding the Mississippi River Alluvial Plain. It can be found in oxbow lakes and ponds, along the banks of rivers and lakes, on low wet flats and sloughs, swales and backswamps. It occurs only on saturated or flooded soils. Forests dominated by *Taxodium distichum* and *Nyssa aquatica* are common throughout the southeastern Coastal Plain.

Vegetation Summary: Vegetation is characterized by a dense canopy composed almost exclusively of straight, tall individuals of *Taxodium distichum* and *Nyssa aquatica* (together contributing at least 75% of the canopy cover) with a sparse to moderate subcanopy and depauperate shrub and herb layers. Occasional individuals of several species (e.g., *Populus heterophylla, Salix nigra, Nyssa biflora, Planera aquatica, Ulmus americana, Fraxinus profunda, Fraxinus caroliniana, Carya aquatica, Quercus lyrata*) are possible in the canopy or subcanopy. The herbaceous layer is very sparse, and typical species include *Saururus cernuus, Proserpinaca pectinata, Proserpinaca palustris, Asclepias perennis, Commelina virginica, Leersia lenticularis*, and *Phanopyrum gymnocarpon (= Panicum gymnocarpon). Decumaria barbara, Toxicodendron radicans*, and *Bignonia capreolata* are commonly occurring vines but usually have <10% cover.

Environmental Summary: The community occurs on a variety of inundated topographic habitats, including oxbow ponds and lakes, backwater sloughs, along river edges and in various isolated depressions within the floodplain. It is more commonly associated with brownwater than blackwater rivers. Soil types on which it is found include very poorly drained phases of Entisols, Alfisols, Inceptisols, Ultisols, and Spodosols (Burns and Honkala 1990a). Hydrologic regime is the most important environmental determinant of the distribution of this community. Sites experience frequent flooding to near permanent ponding, with floodwater that may be 3 m deep during rainy seasons and may remain for extended periods (Burns and Honkala 1990a). Probability of annual flooding is 100% with soils nearly permanently saturated (Wharton et al. 1982).

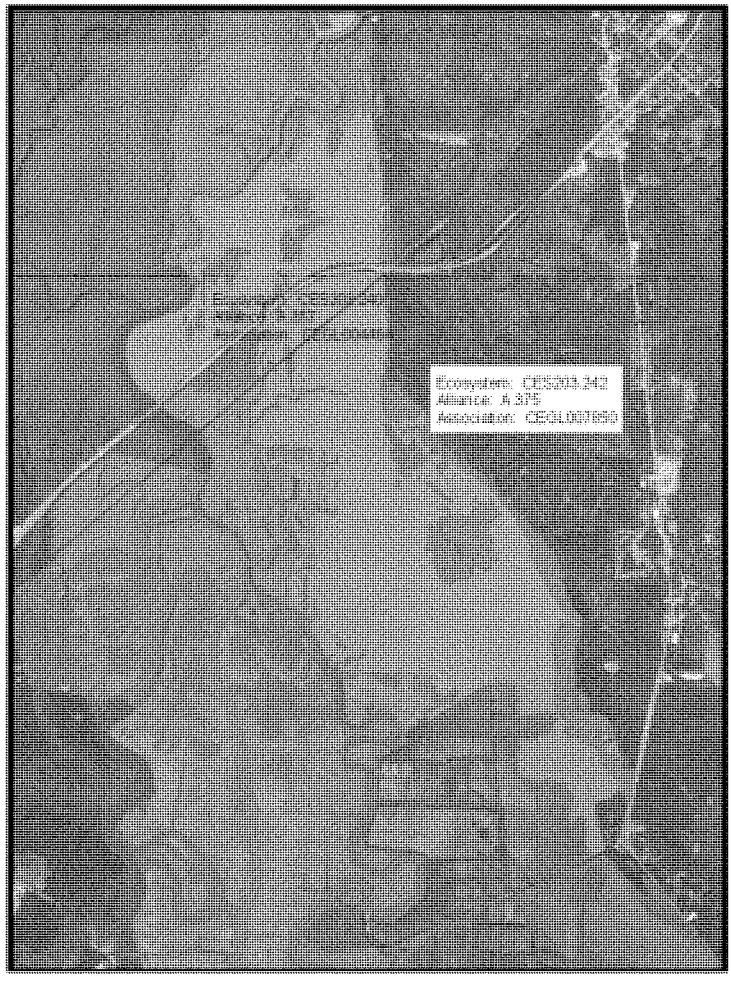


Figure 51

1.2 Ecosystem: CES 203.240 Southern Atlantic Coastal Plain Tidal Wooded Swamp

Summary: This system encompasses the tidally flooded areas in lower river floodplains and edges of estuaries of the Atlantic Coastal Plain from southeastern Virginia southward to northern Florida that have sufficiently fresh water and short enough flooding to be able to support tree canopies. *Taxodium, Nyssa,* or *Fraxinus* generally dominate. Swamps may be either regularly flooded by lunar tides or irregularly flooded by wind tides.

1.2A Alliance: A.357- Nyssa biflora - (Nyssa aquatica, Taxodium distichum) Tidal Forest Alliance

Summary: This alliance accommodates tidally flooded forests in lower, estuarine reaches of brownwater and blackwater rivers in the Outer Coastal Plain (tidewater) and also along estuarine shores. Flooding can be either lunar-tidal or wind-tidal and can be affected as well by riverine flooding events. The trees often have a stressed appearance, and the herbaceous layer usually is well-developed and more species-rich than in most non-tidal swamps, possibly as a result of the tidal nutrient input. Various combinations of *Nyssa biflora, Taxodium distichum*, and *Nyssa aquatica* usually dominate the canopy. One association is characterized by *Pinus taeda* along with *Nyssa biflora* and *Taxodium distichum* in the overstory. On blackwater rivers, *Nyssa aquatica* is often an indicator of a tidal condition, presumably because it requires the higher nutrients provided by tidal flooding. Other species common in tidal situations, such as *Morella cerifera (= Myrica cerifera), Lilaeopsis carolinensis, Peltandra virginica, Thelypteris palustris var. pubescens, Osmunda regalis var. spectabilis, Osmunda cinnamomea*, and *Rosa palustris*, are often common. Typical species of non-tidal swamps, such as *Quercus lyrata, Carya aquatica, Quercus phellos, Smilax laurifolia, Ilex glabra, Lyonia lucida, Woodwardia virginica, Sphagnum* spp., *Chamaecyparis thyoides, Cyrilla racemiflora*, and others, are absent.

Vegetation Summary: The canopy of stands of this alliance are usually dominated by various combinations of *Nyssa biflora, Taxodium distichum*, and *Nyssa aquatica*. On blackwater rivers, *Nyssa aquatica* is often an indicator of tidal condition, presumably because it requires the higher nutrients provided by tidal flooding. Other species common in tidal situations, such as *Morella cerifera (= Myrica cerifera), Lilaeopsis carolinensis, Peltandra virginica, Thelypteris palustris var. pubescens, Osmunda regalis var. spectabilis*, and *Rosa palustris*, are often common. Typical species of non-tidal swamps, such as *Quercus lyrata, Carya aquatica, Quercus phellos, Smilax laurifolia, Ilex glabra, Lyonia lucida, Woodwardia virginica, Sphagnum* spp., *Chamaecyparis thyoides, Cyrilla racemiflora*, and others, are absent.

Environmental Summary: These tidally flooded forests are found in lower, estuarine reaches of brownwater and blackwater rivers in the outer coastal plain (tidewater), and also along estuarine shores. Flooding can be either lunar-tidal or wind-tidal, and can be affected as well by riverine flooding events.

Dynamics: Flooding can be either lunar-tidal or wind-tidal, and can be affected as well by riverine flooding events.

Association: CEGL004484- Nyssa biflora - (Taxodium distichum, Nyssa aquatica) / Morella cerifera - Rosa palustris Tidal Forest

Summary: This broadly defined association accommodates tidally flooded forests in lower, estuarine reaches of brownwater and blackwater rivers in the Outer Coastal Plain (tidewater), and also along estuarine shores. It may require subdivision as more information becomes available. Flooding of these environments can be either lunar-tidal or wind-tidal, and can be affected as well by riverine flooding events. The trees often have a stressed appearance, and the herbaceous layer usually is well-developed and more species-rich than in most non-tidal swamps, possibly as a result of the tidal nutrient input. Various combinations of *Nyssa biflora, Taxodium distichum*,

and *Nyssa aquatica* usually dominate the canopy. In addition, *Liquidambar styraciflua* may be present. On blackwater rivers, *Nyssa aquatica* is often an indicator of tidal condition, presumably because it requires the higher nutrients provided by tidal flooding. Other species common in tidal situations, such as *Morella cerifera (= Myrica cerifera), Lilaeopsis carolinensis, Peltandra virginica, Thelypteris palustris var. pubescens, Osmunda regalis var. spectabilis*, and *Rosa palustris*, are often common. Typical species of non-tidal swamps, such as *Quercus lyrata, Carya aquatica, Quercus phellos, Smilax laurifolia, Ilex glabra, Lyonia lucida, Woodwardia virginica, Sphagnum* spp., *Chamaecyparis thyoides, Cyrilla racemiflora*, and others, are absent.

Vegetation Summary: The canopy of stands of this vegetation type are usually dominated by various combinations of *Nyssa biflora, Taxodium distichum*, and *Nyssa aquatica*. In addition, *Liquidambar styraciflua* may be present (Wharton 1978). On blackwater rivers, *Nyssa aquatica* is often an indicator of tidal condition, presumably because it requires the higher nutrients provided by tidal flooding. Wharton (1978) cites *Persea palustris, Forestiera acuminata, Sabal minor, Salix nigra, Cornus amomum, Planera aquatica, Alnus serrulata*, and *Viburnum obovatum* as additional woody components. Other species common in tidal situations, such as *Morella cerifera (= Myrica cerifera), Lilaeopsis carolinensis, Peltandra virginica, Thelypteris palustris var. pubescens, Osmunda regalis var. spectabilis*, and *Rosa palustris*, are often common (Schafale and Weakley 1990). Some additional low woody and herbaceous species cited by Wharton (1978) include *Aletris aurea, Decumaria barbara, Onoclea sensibilis, Arisaema dracontium, Justicia ovata, Clematis crispa, Ipomoea pandurata, Physostegia* sp., and *Leersia* sp. Typical species of non-tidal swamps, such as *Quercus lyrata, Carya aquatica, Quercus phellos, Smilax laurifolia, Ilex glabra, Lyonia lucida, Woodwardia virginica, Sphagnum* spp., *Chamaecyparis thyoides, Cyrilla racemiflora*, and others, are absent.

Environmental Summary: These tidally flooded forests are found in lower, estuarine reaches of brownwater and blackwater rivers in the Outer Coastal Plain (tidewater), and also along estuarine shores. Flooding can be either lunar-tidal or wind-tidal, and can be affected as well by riverine flooding events.

1.3 Ecosystem: 203.242 Southern Atlantic Coastal Plain Mesic Hardwood Forest

Summary: This upland system of the Atlantic Coastal Plain ranges from Delaware south to interior Georgia in a variety of moist but non-wetland sites that are naturally sheltered from frequent fire. Such sites include lower slopes and bluffs along streams and rivers in dissected terrain, mesic flats between drier pine-dominated uplands and floodplains, and local topographic high areas within bottomland terraces or nonriverine wet flats. Soil textures are variable in both texture and pH. The vegetation consists of forests dominated by combinations of trees that include a significant component of mesophytic deciduous hardwood species, such as *Fagus grandifolia* or *Acer barbatum*. Its southern limit is generally exclusive of the natural range of *Pinus glabra* as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* as mapped by Outcalt (1990). Upland and bottomland oaks at the mid range of moisture tolerance are usually also present, particularly *Quercus alba*, but sometimes also *Quercus pagoda, Quercus falcata, Quercus michauxii, Quercus shumardii*, or *Quercus nigra*. *Pinus taeda* is sometimes present, but it is unclear if it is a natural component or has entered only as a result of past cutting. Analogous systems on the Gulf Coastal Plain have pine as a natural component, and this may be true for some examples of this system. Understories are usually well-developed. Shrub and herb

layers may be sparse or moderately dense. Within its range, *Sabal minor* may be a prominent shrub. Species richness may be fairly high in basic sites but is fairly low otherwise.

Classification Comments: There remains some uncertainty how this system and other mesic hardwood systems should be divided. There is a broad gradient in climate and species composition from north to south and west. The boundaries at the northern edge of its range (the Chesapeake Bay Lowlands TNC ecoregion) and at the break between the South Atlantic Coastal Plain and East Gulf Coastal Plain ecoregions are boundaries of convenience to create breaks in this broad gradient. At the southern end, the boundary has been better determined (April 2006) to exclude areas within the combined ranges of *Pinus glabra* and *Magnolia grandiflora*, making this system deciduous rather than mixed evergreen-deciduous. Differences from mesic forests of the Piedmont are sometimes fairly subtle, and species that differentiate them in one part of the range many not work in other parts. In particular, some species that are excluded from the Coastal Plain farther south are common components farther north. In MD and DC, this system can extend into the Piedmont, straddling the fall zone where the Coastal Plain and Piedmont meet. Besides the variation across the range of this system, there are two sets of distinctions within it that may be worthy of consideration for defining separate systems. Acidic and basic substrates have substantial floristic differences. Variants on upland slopes, nonriverine swamp islands, and high ridges in bottomlands could be recognized as separate systems, or the latter two could be treated as part of the systems that surround them. However, the difference between ecological processes in uplands and wetlands separates those surrounded by wetland systems from the surrounding systems. This is especially true in the case of floodplains, which have flood-carried nutrient input as well as wetness as a difference. Floristic differences may exist between these variants, but they are subtle and do not appear to be definitive.

1.3A Alliance: A.375 Live Oak - Cherrybark Oak Forest Alliance

Summary: Wet-mesic forests of the Outer Coastal Plain of Louisiana, occurring on low ridges of the antecedent Mississippi River. Forests of related environments of South Carolina and possibly Georgia are included here as well. This alliance as presently defined is near the upland/wetland boundary; examples are constantly moist and sometimes have a high water table. The canopy is dominated by *Quercus virginiana, Magnolia grandiflora*, and *Quercus pagoda*, with lesser amounts of *Liquidambar styraciflua* and *Quercus nigra*. The open understory consists of *Cornus florida, Ilex opaca var. opaca*, and *Ilex decidua*. Woody vines are abundant, especially *Parthenocissus quinquefolia, Toxicodendron radicans*, and *Campsis radicans*. The herb layer is well-developed and includes species such as *Asplenium platyneuron, Sanicula* sp., *Elephantopus carolinianus*, and *Thelypteris kunthii*.

Vegetation Summary: The canopy is dominated by *Quercus virginiana, Magnolia grandiflora*, and *Quercus pagoda*, with lesser amounts of *Liquidambar styraciflua* and *Quercus nigra*. The open understory consists of *Cornus florida, Ilex opaca var. opaca*, and *Ilex decidua*. Woody vines are abundant, especially *Parthenocissus quinquefolia, Toxicodendron radicans*, and *Campsis radicans*. The herb layer is well-developed and includes species such as *Asplenium platyneuron, Sanicula* sp., *Elephantopus carolinianus*, and *Thelypteris kunthii*.

Environmental Summary: Wet-mesic forests of the Outer Coastal Plain of Louisiana, occurring on low ridges of the antecedent Mississippi River. Forests of related environments of South Carolina and possibly Georgia are included here as well. This alliance as presently defined

is near the upland/wetland boundary; examples are constantly moist and sometimes have a high water table.

Association: CEGL007850
Live Oak - Cherrybark Oak - Southern Magnolia - Pignut Hickory / American Holly Forest

Summary: This forest occurs on mesic to dry-mesic bluffs in the outer Coastal Plain of southeastern South Carolina. The canopy is dominated by *Carya glabra, Quercus virginiana, Quercus pagoda*, and *Magnolia grandiflora*, with lesser amounts of *Quercus nigra* and *Liquidambar styraciflua*. The subcanopy is open and is dominated by *Ilex opaca*, with lesser amounts of *Pinus glabra, Cornus florida*, and *Carpinus caroliniana ssp. caroliniana*. The shrub layer is open, with *Ilex vomitoria, Vaccinium elliottii, Arundinaria gigantea ssp. tecta, Morella cerifera (= Myrica cerifera var. cerifera), Symplocos tinctoria, Callicarpa americana, Juniperus virginiana, Sabal minor, Berchemia scandens*, and *Toxicodendron radicans ssp. radicans*. Herbs are few, though *Chasmanthium laxum* and *Chasmanthium sessiliflorum* may be patchily common.

Presently, the wetland systems located on these properties exhibit all traditional functions associated with bottom land hardwoods. The upland areas also exhibit relatively undisturbed maritime forest-type ecosystems. In the past 10 years, areas in the vicinity of the SNWR have experienced substantial changes in land use. The USACE and other entities anticipate that the Savannah Harbor, and areas surrounding the SNWR, will continue to experience population growth, industrial/commercial development, and changes in land use. In addition to the industrial developments that have been permitted by the USACE in recent years, the US Geological Survey, Water Science Center (GaWSC) commented on the large number of industrial facilities and associated impacts that are anticipated on lands in close proximity to the Georgia Ports Authority and the SNWR. There are also threats that subtle changes in adjacent land use will also have a detrimental impact on the SNWR. By way of example, a Public Notice published by the Charleston District, Corps of Engineers on September 28, 2009, requests comment on a proposal from a private landowner to divert tidal water flow onto an approximately 693-acre property to increase the hydrology on 485 acres of previously-existing rice impoundment. The 693-acre property, which would be used as a mitigation bank, presently provides benefits to migratory waterfowl during migratory stops similar to those provided by Refuge lands. Conversion of such acreage to saltmarsh could shorten their stay in the area and result in the birds that the Refuge serves resuming their migration with less rest. The expected effects of the proposed regulatory action on the SNWR have not been quantified at this time, but the proposed project is an example of the continued threat that manipulation of adjacent lands pose to the SNWR and the resources it protects.

2.0 Assessment of Restored Marsh Area used to Mitigate for Direct Impacts

Disposal Area 1S is approximately 45 acres in size and is located north of the Federal Navigation Channel. It is located in close proximity to Middle River and directly east of the Atlantic Wood Industries and Savannah Foods facilities within the Savannah Harbor. Disposal Area 1S was previously used for the disposal of dredged material but is now closed because the capacity of the disposal area had been achieved. Historical records indicate that the composition of the dredged material consisted of approximately 67% sand (#230 sieve), 14% silt, and 9% clay material. Presently, the existing dikes of CDF1S support both tree and shrub vegetation with

some marsh fringe areas dominated by *Spartina alterniflora* at the lower elevations. In addition, an existing 1.7 acre restoration site is also located in an area of the CDF that was graded to provide mitigation for a previous GPA project.

The 42 acres of contiguous, restored brackish marsh, which includes development of tidal creeks, will have more ecological value than 47% of marsh proposed for impact (i.e., 7.3 acres of marsh proposed for impact is degraded, poorly functioning brackish marsh along the navigation channel). As previously mentioned, the proposed mitigation site is north of the Federal Navigation Channel that would be operated at the 47-foot depth. Thus, the large, non-segmented size of the mitigation area, coupled with its "in basin" location and incorporation of a strip of trees to separate the restoration site from the harbor, makes it an ideal "in kind / in basin" mitigation option for replacing the brackish marsh acreage that would be impacted.

D. Use of Watershed Assessment to Identify Appropriate Wetland Mitigation

33 CFR 332.2- (b) provides information on the approach to identifying type and location of compensatory mitigation. It states, " *(1) When considering options for successfully providing the required compensatory mitigation, the district engineer shall consider the type and location options in the order presented in paragraphs(b)(2) through (b)(6) of this section. In general, the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services, taking into account such watershed scale features as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources (including the availability of water rights), trends in land use, ecological benefits, and compatibility with adjacent land uses. When compensating for impacts to marine resources, the location of the compensatory mitigation site should be chosen to replace lost functions and services within the same marine ecological system (e.g., reef complex, littoral drift cell).Compensation for impacts to aquatic resources in coastal watersheds(watersheds that include a tidal waterbody) should also be located in a coastal watershed where practicable."*

The Corps used the approach identified above to justify the selection of the mitigation for both direct and indirect impacts to wetlands. The following sections provide details that illustrate how the Corps wetland mitigation complies with the Mitigation Rule.

1.0 Identification and Justification of Wetland Mitigation for Indirect Impacts

As defined in the Functional Assessment section of this analysis, deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). Of the functions associated these emergent wetland systems, the one that would experience a minor impact as a result of the conversion would be fish and wildlife habitat value. Therefore, it was important to the Corps that the mitigation selected would offset impacts to this wetland function.

1.1 Evaluation of Mitigation Bank Credits

The Corps evaluated the Regional Internet Banking Information and Tracking System (RIBITS) for potential mitigation banks that possess tidal freshwater credits within the Lower Savannah River Watershed. As of March 2011, the following banks have primary service areas that overlap the harbor area, and these banks are not sold out of credits: Bath Branch, Brushy Creek, Margin Bay, Millhaven, Old Thorn Pond, and Phinizy Swamp. These banks do not contain tidal, freshwater systems and/or the associated credits. A review of secondary service areas overlapping the project area resulted in the following list of banks that exist and are not sold out of credits: Black Creek and Wilhelmina Morgan. Likewise, these banks do not contain tidal, freshwater systems and/or the associated credits. Thus, at this time mitigation banks with "in kind" mitigation do not exist within the Lower Savannah Watershed.

1.2 Evaluation of In Lieu Fee Program Credits

As of March 2011, the In-Lieu Fee Program in the State of Georgia has not been updated or approved by the Corps and Interagency Review Team (IRT) to provide compensatory mitigation credits that would offset impacts to aquatic resources.

1.3 Evaluation of Permittee-Responsible Mitigation under a Watershed Approach

The Georgia Environmental Protection Division (GAEPD) developed the Savannah River Basin Management Plan 2001, *"to provide relevant information on the Savannah River basin characteristics, describe the status of water quality and quantity in the Savannah River basin, identify present and future water resource demands, present and facilitate the implementation of water protection efforts, and enhance stakeholder understanding and involvement in basin planning."* Per guidance provided at 33 CFR 332.3(c)(1), *"Where a watershed plan is available, the district engineer will determine whether the plan is appropriate for use in the watershed approach for compensatory mitigation."*

With respect to the Savannah River Basin Management Plan 2001, the Corps reviewed the document in order to determine if priorities listed in the plan were compatible with the development of a mitigation plan specific to the indirect impacts associated with the conversion of freshwater marsh to brackish marsh. Although the plan focused on measures for improving water quality and reducing water consumption, the long-term priorities for the Lower Savannah River Basin were considered and are indicated below:

> *"• Protecting water quality in lakes, rivers, streams, estuaries and coastal waters through attainment of water quality standards and support for designated uses;*
>
> *• Providing adequate, high quality water supply for municipal, agricultural, industrial, and other human activities;*
>
> *• Preserving habitat suitable for the support of healthy aquatic and riparian ecosystems;*
>
> *• Protecting human health and welfare through prevention of water-borne disease; minimization of risk from contaminated fish tissue, and reduction of risks from*

flooding; and

• Ensuring opportunities for economic growth, development, and recreation in the region."

Of the priorities listed in the Savannah River Basin Management Plan, *"preserving habitat suitable for the support of healthy aquatic and riparian ecosystems"* is a priority within the plan that is consistent with the preservation of 2,683 acres of wetland and upland buffer adjacent to the SNWR.

The Mitigation Rule also provides guidance when no formal watershed plan is available. In situations where watershed plans do not exist, 33CFR 332.3(c) (1) also states, "*Where no such plan is available, the watershed approach should be based on information provided by the project sponsor or available from other sources."*

The Corps assembled and used a Wetland Interagency Coordination Team (ICT) consisting of technical expert representatives from the Corps, Federal natural resource agencies, and State natural resource agencies representatives to identify acceptable mitigation for the proposed project. At that time, USFWS stated that mitigation actions must be performed within the basin for impacts to wetlands residing within the SNWR. The Service recommended preservation of lands as a possible solution and recommended sites that are part of their long term lands acquisition strategy to compliment the SNWR. The Corps also consulted with the Stakeholder Evaluation Group, including its Non-governmental Organizations (NGOs) members, to identify any other suitable mitigation alternatives. Over the 10-year study period, no agency or organization could identify another feasible alternative as mitigation for impacts that would occur as a result of wetland conversion. Therefore, the Corps proceeded with the identification of preservation sites.

In summer 2003, the Corps assembled a Wetland Interagency Coordination Team (ICT) to assist in its analysis of potential wetland impacts from the SHEP. The team consisted of agency wetland experts from USEPA, USFWS, NMFS, GA DNR, SC DNR, and SC DHEC. The agencies identified an acceptable technical approach to determine wetland impacts. They also identified the information needs they would have when they reviewed the EIS. Since creation of the team, the Corps hosted 7 meetings of the ICT. During those meetings, methods for evaluating functional losses and mitigation alternatives for wetland impacts were proposed and discussed at length. After every meeting, the Corps prepared a Memorandum For Record (MFR), which was provided to all members of the ICT.

The Corps also conducted an Agency Technical Review (ATR) to assess the use of Savannah District's SOP as a tool in the development of a mitigation plan for SHEP. The ATR was lead by the National Deep-Draft Navigation Planning Center of Expertise and was performed by Corps experts in the Engineering Research and Development Center in Vicksburg, MS. The ATR was to determine if the SOP was an appropriate method to determine the preservation acreage needed to compensate for impacts resulting from the SHEP. The ATR was also conducted to comment on the reasonableness of the assumptions and calculations that Savannah District used in applying the SOP for the SHEP. The SOP was used only to determine the amount of preservation acreage necessary to offset the remaining acreage impacted after development of avoidance, minimization, and restoration features. The ATR concurred with use

of the SOP to determine the amount of preservation acreage needed and considered Savannah District's application of the SOP to be reasonable in quantifying impacts and the associated mitigation that would be required.

The USFWS provided a Fish and Wildlife Coordination Act Report, dated August 2010. In that report, the USFWS concurred with use of the SOP, which calculated a need to preserve 2,245 acres of land adjacent to the SNWR for the 47-foot alternative. The Service provided updates to the SOP calculations in Appendix A of the report. The USACE concurred with use of the updated SOP worksheets and adopted the results of those calculations for use in the DEIS.

When evaluating possible mitigation options, the Corps considered 33 CFR 332.2(c)(2) i-v. With respect to the Lower Savannah River Watershed, the following facts show compliance with this aspect of the Mitigation Rule.

- Deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined as brackish marsh (Latham et. al., 1994). Please see Functional Assessment. As illustrated in Table 50, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. When considering SHEP impacts, all other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. With respect to fish and wildlife habitat, many of the same species use both brackish marsh and saltmarsh habitats.

- The FEIS describes the rationale behind selection of the EFDC model in Section 5.1.2.1 of the FEIS (Pages 5-8 through 5-13). In brief, a comparison of models illustrated that wetland impacts identified by using the EFDC hydrodynamic model are higher (i.e., greater quantity) than those identified by the Marsh Succession Model at all proposed project depths. This indicates that the Corps' use of the EFDC-derived impacts is a more inclusive and conservative estimate. That is, the EFDC model is more likely to capture all impacts than other models presently available.

- River flows used in simulations to determine wetland impacts for the "Basic Evaluation" are average/typical flows for the evaluation period of 1 March to 1 November as specified by the Interagency Coordination Team. Average/typical river flows were determined using recorded gage data for Savannah River at Clyo, Georgia. The EFDC model has continuous input boundary conditions for a 7 year period (1997-2003) available for simulation. The year 1997 was found to have flow conditions representative for the long term average flows for the river. Low or drought river flows were also considered for determining wetland impacts. This flow condition was called "Sensitivity Analysis #1". Low or drought river flows were determined using recorded gage data and 2001 was found to have flow conditions representative for the long term low/drought flows for the river. *As illustrated in the results for drought flow conditions, deepening (47-foot depth) in conjunction with flow diversion plan 6A actually converts 520 acres of brackish marsh to freshwater wetlands.* However, the

Corps chose to be more inclusive of impacts and used the results of average/typical river flows that results in 223 acres of freshwater wetland conversion as shown in the table below.

Table 49. Marsh/Wetland Impact

Freshwater Tidal Marsh/Wetland Impacted Acreages Deepening WITH Flow Diversion Plan 6A					
Model Scenario	**44 ft depth**	**45 ft depth**	**46 ft depth**	**47 ft depth**	**48 ft depth**
Basic Evaluation Average/Typical Flow Conditions	**322**	-32	-201	-223	-337
Sensitivity Analysis #1 Low/Drought Flow Conditions	**920**	**903**	**678**	**520***	**362**

Acreages shown in red are freshwater tidal wetlands that are not mitigated for by flow altering plans (6a & 6b).
**Interpolated value.*

- The US Fish and Wildlife Service reports that more than 12,000 acres of tidal freshwater marsh existed in the Lower Savannah River Basin in the early 1800s. Colonization, rice cultivation, harbor deepening projects, and other land manipulations have reduced those numbers over the last 200+ years (See Appendix L- Cumulative Impact Analysis, Section 8-Wetlands, for detailed description of Lower Savannah River Basin wetland composition over time).

- Several studies were conducted during the SHEP to establish baseline conditions in regards to the amount of tidal freshwater marsh remaining in the estuary. Both Applied Technology and Management (March 2003) and USFWS (Welch and Kitchens 2006) conducted studies to classify the various wetland communities in the study area (I-95 Bridge to mouth of Back River). Using a marsh succession model, the USFWS identified the following marsh distribution (Welch and Kitchens 2006):

Table 50. Marsh Distribution

Marsh Type	Acreage
Freshwater	3,269
Brackish	3,082
Saltmarsh	2,506

- The Savannah Harbor is a very dynamic environment that is subject to continuous manmade and natural perturbations/disturbances. As a result, there are no

opportunities in the Lower Savannah River Watershed to provide some form of sustainable, *in situ* tidal freshwater wetland mitigation.

- Wetland creation, which would be derived from upland areas, has a very high risk of failure. For the duration of the project, a created freshwater system would require continuous maintenance. The USFWS determined construction of freshwater habitat in upland would be extremely risky, not self sustained, and therefore, not a practicable alternative. Ultimately, the Corps and the Wetlands Interagency Coordination Team concluded that the creation of freshwater, tidal wetlands was not a viable option.

- Without the Flow Diversion Structures included in the SHEP project, approximately 1,177 acres of freshwater marsh would be converted to brackish marsh. By implementing flow-altering measure 6A, there would be 223 acres of freshwater conversion to brackish marsh. Thus, the flow altering measure 6A satisfies both avoidance and minimization elements by maintaining 954 acres of freshwater marsh that would otherwise experience some degree of vegetative conversion. In 10 years, the Corps and other members of the Wetlands Interagency Coordination Team could not identify any other opportunities to provide restoration and/or enhancement of tidal freshwater marsh. Therefore, the acquisition and preservation of lands (i.e., wetlands and non-wetland riparian corridors) adjacent to the SNWR was identified and subsequently prioritized as a large-scale method for maintaining the ecological functions of the Lower Savannah River Watershed.

- The Savannah River National Wildlife Refuge (SNWR) is a conservation area of national importance with habitats that are important to many unique plant and animal species, including threatened and endangered species. It is also located in the vicinity of the SHEP project (i.e., "In Basin" mitigation), but it is sufficiently removed from the project area so as not to be directly impacted by the project.

- Presently, wetland and non-wetland riparian areas adjacent to the SNWR are being converted to commercial/industrial land uses with increased impervious surface coverage. Development adjacent to the boundaries of the SNWR has the potential to directly and indirectly impact fish/wildlife habitat function; decrease water quality in the vicinity of the wildlife refuge; and increase risk of wildfire probability. All of these impacts are associated with development and human encroachment.

- Preservation of wetlands and upland buffers adjacent to the existing SNWR is a sustainable approach to mitigation that results in the expansion of the refuge property; protection of wetlands and upland buffers, the expansion/protection of wildlife corridors; reduction in likelihood of future indirect impacts associated with stormwater runoff and septic systems; and decrease risk of wildfire probability that comes with development and human encroachment.

- Georgia Environmental Protection Division (GAEPD) developed the Savannah River Basin Management Plan 2001 that identified "*Preserving habitat suitable for the support of healthy aquatic and riparian ecosystems*" as a long term priority for the Lower Savannah River Watershed.

- The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge". As defined in the plan, *"the proposed acquisition would protect a biologically diverse complex of wetlands with high ecological values for numerous plants and animals."* and *"project lands acquired as part of the refuge would be managed in a manner that would protect and enhance the fish and wildlife habitat values they provide."* By acquiring lands adjacent to the SNWR, and thereby expanding the refuge, a primary initiative of the National Wildlife Refuge System Improvement Act of 1997 is also satisfied. It also satisfies major objectives of Georgia and South Carolina's Comprehensive Wildlife Conservation Strategies.

- Estuarine generalist fish species are found in all Savannah River Estuary (SRE) habitats (i.e., tidal freshwater marsh <1ppt; Oligohaline (1-5 ppt); Mesohaline (5-15 ppt); and Polyhaline (> 15ppt)), and variability in distribution is attributed to seasonal trends. As illustrated in the table below, spatial patterns in fish distribution are not discernable particularly in the <1 ppt to 15 ppt salinity range.

Table 51. Fish Distribution in the Savannah River Estuary

Polyhaline (>15 ppt)				Mesohaline (5-15 ppt)				Oligohaline (1-5 ppt)				Tidal Freshwater (<1 ppt)			
F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su
141	324	724	3731	1297	1165	9582	14147	2953	4616	5448	6264	1627	3401	7967	4071
TOTAL: 4,920				TOTAL: 26,191				TOTAL: 19,281				TOTAL: 17,066			

Estuarine generalist fish species including: Bay anchovy, Atlantic menhaden, Atlantic croaker, spot, other drum species, gobies, blueback herring, Southern flounder, and striped mullet dominated the fish densities in habitats and comprised over 90 % of the total number of fishes collected. Generally, most of the 91 fish species sampled from the SRE could be considered estuarine generalists that were present in most habitat types during most seasons. Jennings and Weyers (2003) report this finding was not surprising because the variability in salinity distribution in the SRE created a mosaic habitat pattern influenced by tidal fluctuation and river discharge. Many areas of the SRE had different salinity-based habitats in a 6-hour tidal period and from year 1 to year 2 when river discharge was different. The most abundant species seemed capable of using all of the habitats found in the SRE. Statistical comparisons of mean fish density and mean species richness gave variable results. Most variation in fish distributions was attributed to seasonal trends. Density and richness were lowest in fall when many species disappeared from sample reaches and abundances of other species decreased across the estuary (Jennings and Weyers, 2003).

When evaluating possible mitigation options, the Corps also considered 33 CFR 332.3 (c)(3) i-iii, *Information* Needs. The following facts show compliance with this aspect of the Mitigation Rule.

- With respect to overall development trends in the Lower Savannah River Watershed, estimates of increases in population and associated impervious surface coverage are provided in Section A titled, "Watershed Characterization" of this Appendix. Within the watershed, Chatham and Effingham counties (lower end of watershed) are expected to experience the greatest percent increase in percent impervious surface coverage from 2010 to 2020, which is estimated at 4.9% (Figure 52).

- The Corps has evaluated development trends within 5 miles of the Savannah National Wildlife Refuge for the last 15 years. In those 15 years, the Corps has authorized approximately 170 Corps permit actions (Savannah and Charleston Districts) that resulted in more than 230 acres of wetland impacts. Figure 53 illustrates the number of actions and acreage of wetland impacts authorized during the past 15 years. The reduced number of actions associated with the 2006-2010 period reflects a decrease in economic growth, and associated development, experienced during that time. This has also been reflected in the total number of regulatory actions processed throughout the state during this time period. However, those trends are expected to change in the future. It is also important to note that these Corps-permitted actions do not account for other projects in the area that would result in land use changes but did not require a Corps permit. The Figure 52, below, illustrates the rate at which the cumulative Corps actions have accrued. Although the magnitude of wetland impact cannot be assumed with each future action, the trends illustrated in Figure 53 suggest that by 2015 the Corps will have potentially authorized 230 wetland impact actions (cumulative since 1995) within 5 miles of the SNWR.

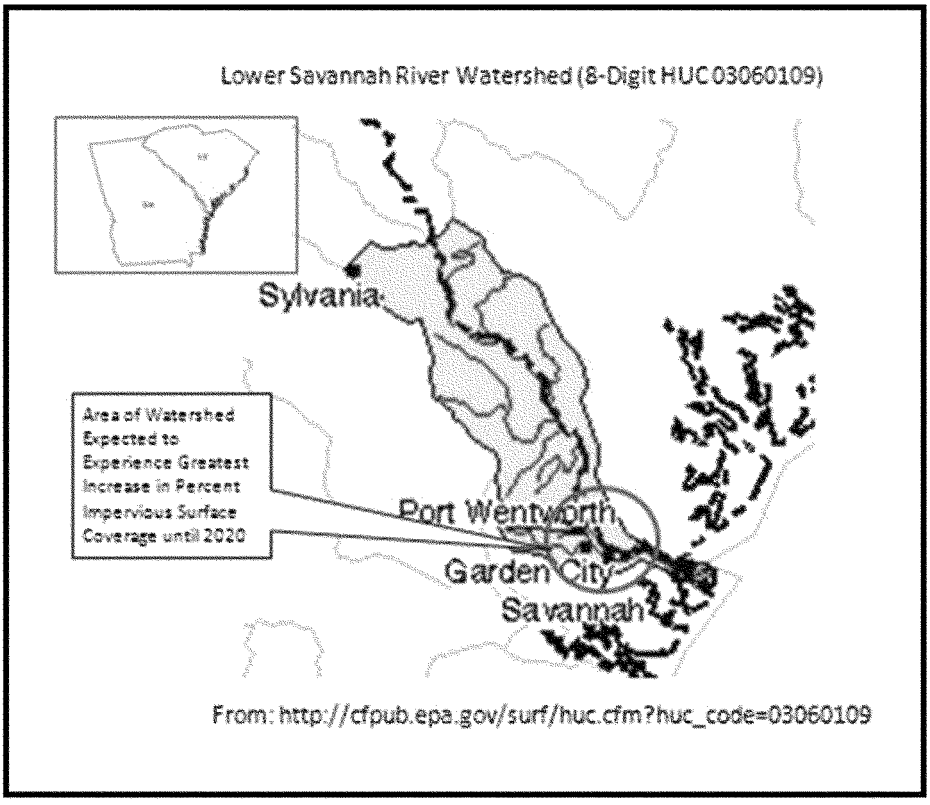


Figure 52. Lower Savannah Watershed identified with area of greatest percent increase in percent impervious surface coverage.

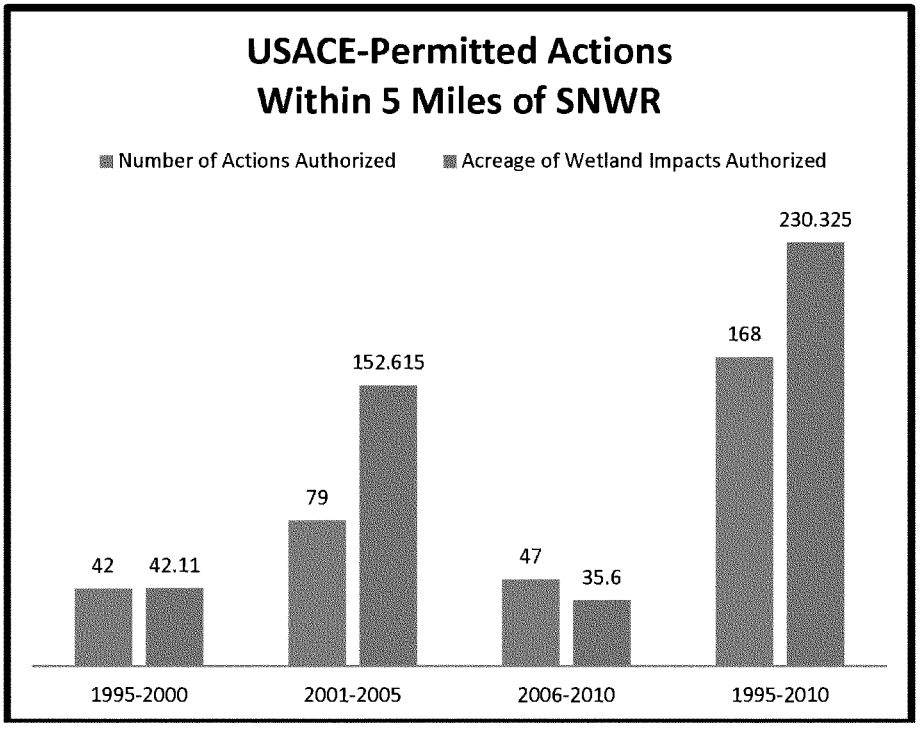


Figure 53. Number of USACE-permitted actions and acreage of wetland impacts authorized during the past 15 years within 5 miles of SNWR.

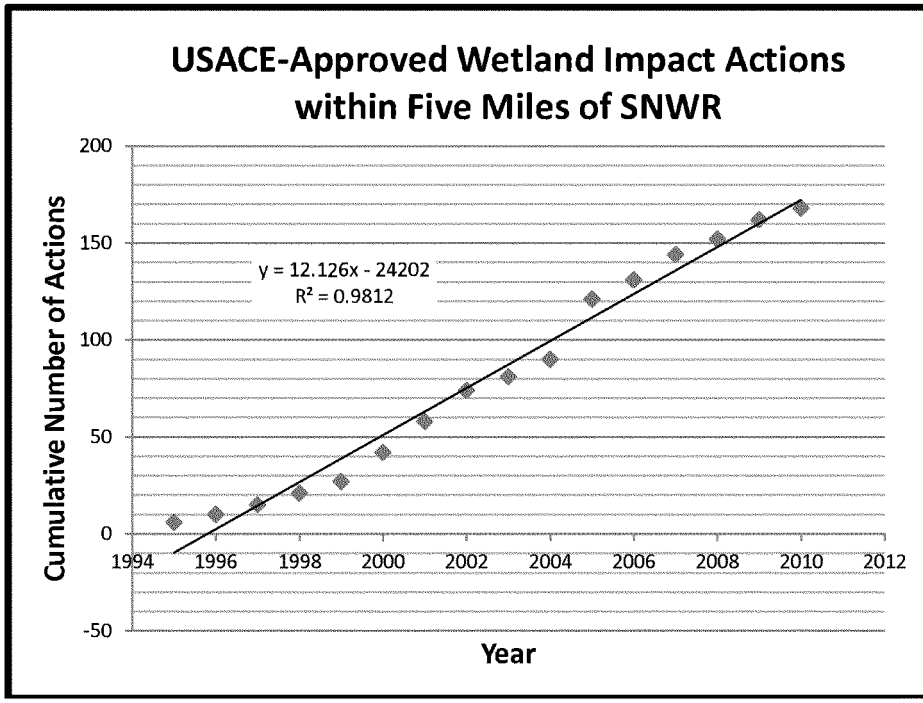


Figure 54. Cumulative number of USACE-permitted actions over time.

Figure 55 illustrates the type of Corps-permitted activity that has occurred within 5 miles of SNWR as a percentage of the total 168 actions.

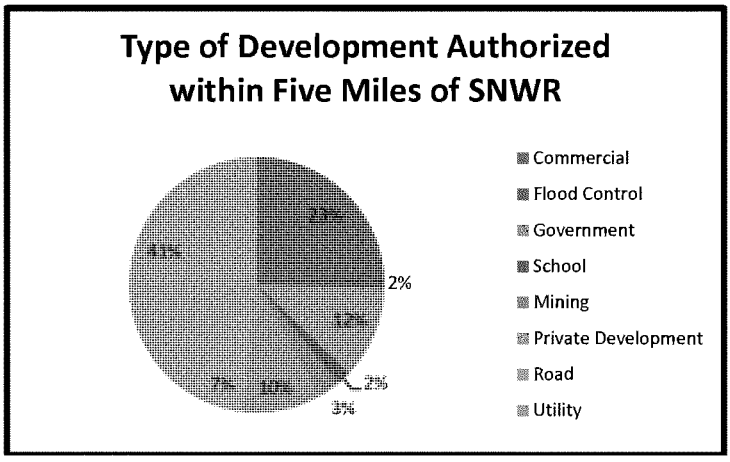


Figure 55

- The Corps also evaluated water quality impairments using USEPA's MyWATERS Mapper (www. watersgeo.epa.gov). This version of MyWATERS Mapper depicts the status of NPDES permits for each State; summary information from the Clean Watershed Needs Survey; and water quality assessments. A review of the Impaired Waters Layers identified three impaired water points on the Savannah River, from south of Savannah Electric's Plant McIntosh to the mouth of the Savannah River (Figure 56). These impaired water points have been identified relative to features located on the vicinity map as well as the approximated boundaries of the SNWR. Table 54 also provides information concerning the cause of impairment and designated use for the waters where samples have been collected. Data for these sites and the associated designation was acquired during the 2008 cycle.

Table 52. Impaired Water Points/Locations, Causes and Designated Use

Sample I.D.	Cause of Impairement	Impairment Group	Designated Use	State TMDL
244972	Mercury	Mercury	Fish Consumption	Needed
244965	Fecal Zinc	Pathogens Metals	Aquatic Life Support (Both)	Needed Needed
276597	Mercury	Mercury	Fish Consumption	Needed

As depicted in Figure 55, the Impaired Water Points are located in the Savannah River at locations that are adjacent to the SNWR. The impairments associated with these waters suggest that existing commercial, industrial and residential land use maybe contributing to the degradation in reported water quality. Previous Corps permitting data suggests that areas in the vicinity of the SNWR (< 5 miles away) will continue to urbanize in the future. Thus, it is reasonable to assume that these future-anticipated conversions in land use will have a negative effect on the water quality within the SNWR. However, the integration of land buffers adjacent to the SNWR would help to ameliorate any long-term direct and/or secondary impacts by preventing additional development in such close proximity.

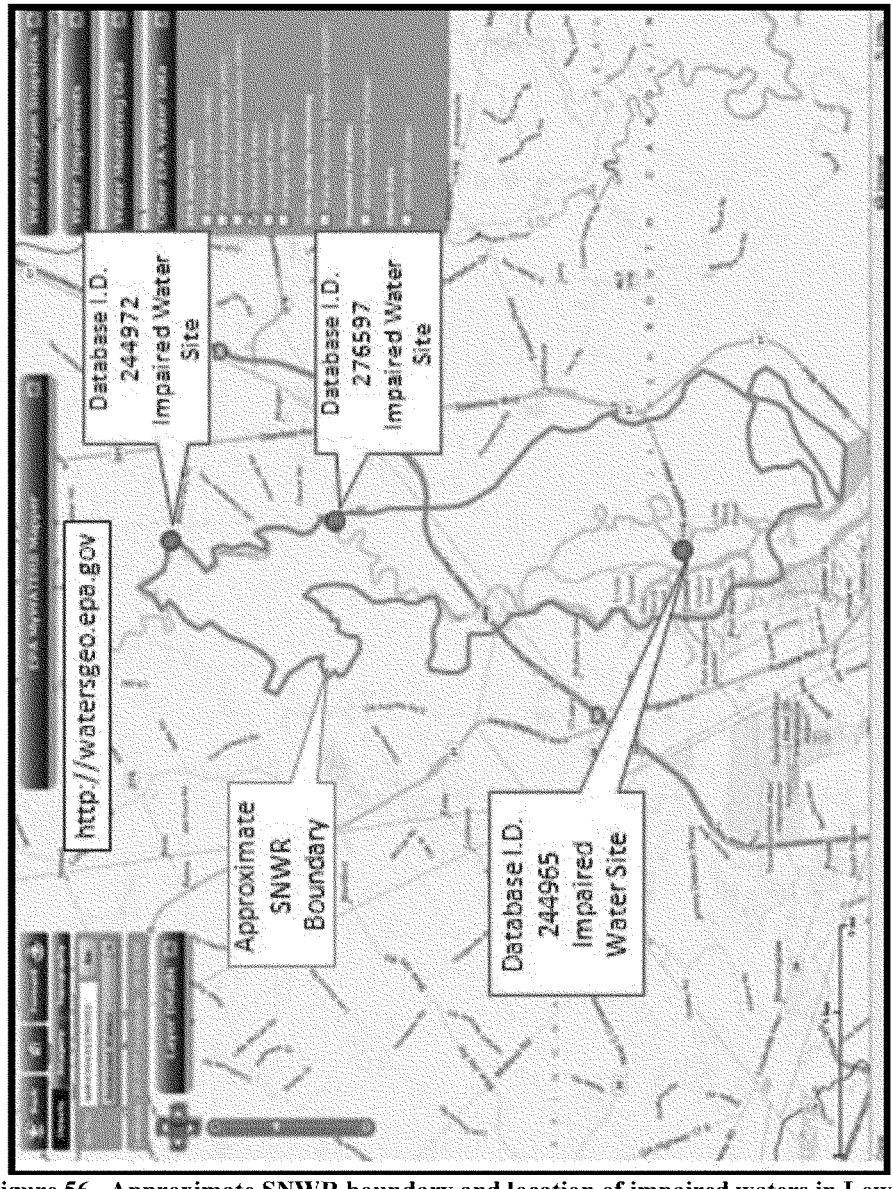


Figure 56. Approximate SNWR boundary and location of impaired waters in Lower Savannah River.

- The Corps assembled and used a Wetland Interagency Coordination Team (ICT) consisting of technical expert representatives from Corps, Federal natural resource agencies, and State natural resource agencies representatives to identify acceptable mitigation for the proposed project. At that time, USFWS stated that mitigation actions must be performed within the basin for impacts to wetlands residing within the SNWR. The Service recommended preservation of lands as a possible solution and recommended sites that are part of their long term lands acquisition strategy to compliment the SNWR. The Corps also consulted with the Stakeholder Evaluation Group, including its Non-governmental Organizations (NGOs) members, to identify any other suitable mitigation alternatives. Over the 10-year study period, no agency or organization could identify another feasible alternative as mitigation for impacts that would occur as a result of wetland conversion.

  As an information need, the Corps also determined the extent of project influence on freshwater marsh, brackish marsh and salt marsh. The functional assessment provided in previous sections described impacts to223 acres of freshwater marsh and the associated fish and wildlife habitat (See functional assessment). The approximate freshwater marsh contour (0.5 ppt salinity threshold) that would result with a 48-foot project is indicated in Figure 57. Following project construction, marsh systems immediately downstream of that contour line would be more closely aligned with brackish marsh. Also downstream of that contour line is an area of the harbor that is heavily industrialized and subject to continuous manmade perturbations via dredging, industry operation, or other port-related activities. These two circumstances preclude the identification of potential freshwater marsh mitigation sites downstream and in the vicinity of the 0.5ppt contour line. Although Figure 57 shows the freshwater marsh contour for the 48-foot project instead of the 47-foot project, the rationale in this paragraph would apply to the 47-foot project as well.

  When trying to identifying long-term and self-sustaining wetland mitigation, it is also important to recognize that coastal ecosystems are very dynamic and subject to natural variation. Regardless of the SHEP, marsh areas in the Lower Savannah River Watershed and other coastal areas are susceptible to natural transitions and vegetative shifts when environmental conditions change (North Carolina DENR Draft Report, 2010). The extent and duration of that change will dictate the magnitude of conversion within a marsh (White and Alber, 2009). Changes in marsh composition have been observed in a period of 1 year in association with drought periods (Davis, 2004). Drought conditions, storm events and sea level rise all have the potential to influence the vegetative composition of marsh habitats within the Lower Savannah River Watershed. The approximated marsh areas that could be subject to such future influences are identified within the dashed area in Figure 57. Although no opportunities were available to provide tidal freshwater marsh restoration in any area of the Lower Savannah River Watershed, the rationale presented in this section provides justification for why tidal freshwater wetland mitigation sites east of Interstate 95 would not be sustainable.

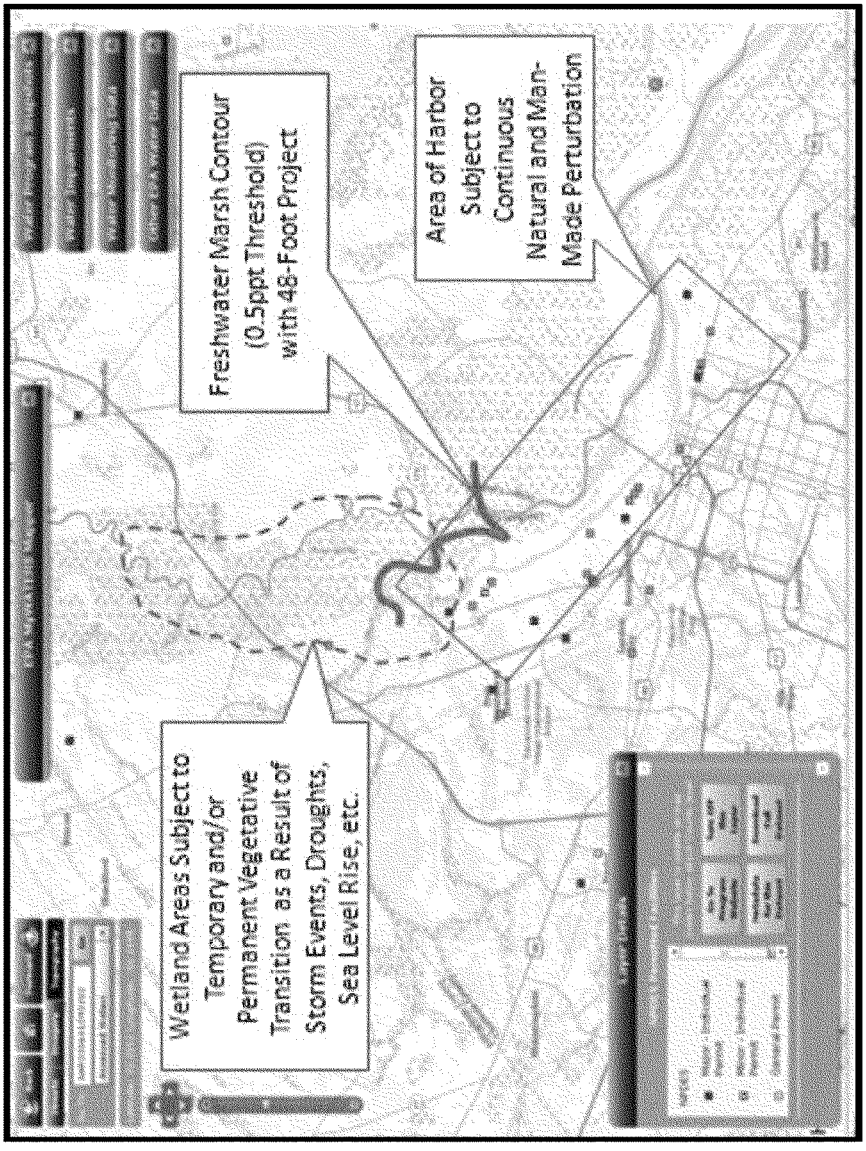


Figure 57. Project-related impacts, existing land use, and other influences on vegetative shifts in the Savannah Harbor.

- From a geographic standpoint, mitigation opportunities west of Interstate-95 and in close proximity to SNWR represents the next logical location for identifying wetland mitigation opportunities that would still provide "In Basin" mitigation. The SHEP project will result in the vegetative conversion of 223 acres of tidal freshwater marsh to brackish marsh. Consequently, the Corp's functional assessment concluded that fish and wildlife habitat would be the key wetland function impacted as a result of the conversion. However, similarities in wildlife composition would remain between habitats. For example, insect abundance and diversity have been reported as similar in salt and freshwater marsh systems(Brinson *et al.*, 1981). Muskrats are also known to be common in both tidal fresh and brackish marsh (Brinson *et al.*, 1981, Odum, 1984). Still others have observed reptiles such as black rat snakes (*Elaphe obsoleta*), brown water snakes (*Nerodia taxispilota*), and diamondback terrapins (*Malaclemys terrapin*) in both tidal freshwater marsh and brackish marsh systems located in the Chesapeake Bay National Estuarine Research Reserve (Perry, J.E. and R.B. Atkinson (1997).

- The Corp's functional assessment concluded that fish and wildlife habitat would be the key wetland function impacted as a result of the conversion. However, similarities in fish composition have also been established in the Savannah River Estuary (SRE) habitats (i.e., tidal freshwater marsh <1ppt; Oligohaline (1-5 ppt); Mesohaline (5-15 ppt); and Polyhaline (> 15ppt)), and variability in distribution has been attributed to seasonal trends. As illustrated in the table below, spatial patterns in fish distribution are not discernable particularly in the <1 ppt to 15 ppt salinity range.

Table 53. Fish Distribution in the Savannah River Estuary

Polyhaline (>15 ppt)				Mesohaline (5-15 ppt)				Oligohaline (1-5 ppt)				Tidal Freshwater (<1 ppt)			
F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su
141	324	724	3731	1297	1165	9582	14147	2953	4616	5448	6264	1627	3401	7967	4071
TOTAL: 4,920				TOTAL: 26,191				TOTAL: 19,281				TOTAL: 17,066			

Estuarine generalist fish species including: Bay anchovy, Atlantic menhaden, Atlantic croaker, spot, other drum species, gobies, blueback herring, Southern flounder, and striped mullet dominated the fish densities in habitats and comprised over 90 % of the total number of fishes collected. Generally, most of the 91 fish species sampled from the SRE could be considered estuarine generalists that were present in most habitat types during most seasons. Jennings and Weyers (2003) report this finding was not surprising because the variability in salinity distribution in the SRE created a mosaic habitat pattern influenced by tidal fluctuation and river discharge. Many areas of the SRE had different salinity-based habitats in a 6-hour tidal period and from year 1 to year 2 when river discharge was different. The most abundant species seemed capable of using all of the habitats found in the SRE. Statistical comparisons of mean fish density and mean species richness gave variable results. Most variation in fish distributions was attributed to seasonal trends. Density and richness were lowest in fall when many species disappeared from sample reaches and abundances of other species decreased across the estuary.

- In addition, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994). The Corp's salinity value that denotes a defined shift from freshwater to brackish marsh (i.e., 0.5 ppt) is approximately 5 times lower than what has traditionally been observed with 100% vegetative shifts *in situ* within the Lower Savannah Watershed (Latham et al., 1994) and other coastal marsh systems in the southeastern United States (NOAA, 2010). Thus, many of the existing freshwater emergent plant species, and associated ecological parameters, will likely be sustained in areas predicted to experience salinity concentrations in the range of 2.5 ppt.

  With respect to the SNWR, similarities in support of fish and wildlife habitat also overlap between bottomland hardwood wetlands and freshwater marsh wetlands. All of the previously identified species would be common within freshwater marsh and bottomland hardwoods. In addition, Threatened and Endangered Species such as American alligator, American bald eagle, and Wood stork are thought to inhabit and/or utilize both types of wetlands within the SNWR (SNWR 2011). Kirkland's warblers may also stop at the SNWR during their migration and utilize both freshwater and bottomland hardwood wetlands. Bottomland hardwoods also support freshwater fish and their associated habitat by capturing and filtering stormwater before the resulting surface water discharges into creeks and open water habitats.

- In summary, the Corps has considered the scope and scale of the proposed impacts as well as the functions that would be lost as a result of the impacts. The USACE is satisfied that the level of information provided in this section satisfies the watershed approach and analysis as outlined in the Mitigation Rule.

When evaluating possible mitigation options, the Corps also satisfied the criteria for evaluating mitigation options in 33CFR 332.3 (c)(4),*Watershed Scale*. For purposes of our analysis, we established the Lower Savannah River Watershed as the appropriate scale to assess impacts and mitigation opportunities. The Lower Savannah River Watershed is also defined by the 8-digit Hydrologic Unit Code (HUC) 03060109. Characteristic of this watershed maybe found in previous sections of this analysis. The selection of this watershed scale is supported by the historical review of projects requiring Corps permits and the associated cumulative impacts analysis that considers past, present and reasonably foreseeable future impacts within the same 8-digit HUC. Additionally, most state and Federal resource agencies have used a watershed approach that has typically been scoped using an 8-digit hydrologic unit code (NRCS, 1997).

1.4 Evaluation of Site Selection for Permittee-Responsible Mitigation

When evaluating possible mitigation options, the Corps considered 33 CFR 332.3 (d)(1-3), *Site Selection*. The following facts show compliance with this aspect of the Mitigation Rule.

- The Corps prepared a wetland comparative analysis when considering the SHEP-derived conversion of freshwater wetland, wetland threats reported for the Lower Savannah River Watershed, function of wetland systems, opportunities for mitigation, and long term sustainability (Table 56). The comparative analysis evaluated the three types of wetlands commonly observed within the Lower Savannah River Basin and assessed similarities/differences based on function and threat. The analysis was also structured toward an evaluation of freshwater wetlands functions that are most susceptible to impacts from the SHEP (See functional assessment section). A ranking system was then used to characterize each sub-element of threat or function being considered. In brief, the values "High", "Medium", and "Low" were assigned values of 30, 20, and 10, respectively. The basis for the rankings is supported in previous sections of this document. Once values were assigned, the sum total derived for overall Threats was subtracted from the value for overall Function, which resulted in a Total Comparability Score. The resulting scores for each wetland type were then compared. When taking into consideration: (1) predominant function (i.e., fish and wildlife habitat) impacted as a result of freshwater marsh conversion, (2) opportunities for mitigation, threats to wetlands in the watershed, and (3) long-term sustainability, the freshwater marsh and bottomland hardwood wetlands have the same resulting score. These same or similar scores suggest that bottomland hardwood wetlands would provide suitable mitigation for the replacement of freshwater marsh function that is impacted as a result of SHEP. This analysis also takes into consideration a watershed assessment that illustrates the overall threats internal to the Lower Savannah River Watershed. In contrast, the negative value derived for the brackish marsh is indicative of the expansion of brackish marsh acreage that would occur as a result of the SHEP and the lower assigned values for supporting freshwater biota. Thus, brackish marsh as a mitigation option would not be practicable.

Table 54.

Consideration of Wetland Mitigation Based on Watershed Analysis of Threats and Functional Assessment in Conjunction with SHEP-Derived Impacts to Wetlands			
THREATS	Freshwater Marsh (0-0.5 ppt)*	Bottomland Hardwood	Brackish Marsh (0.5-4 ppt)*
SHEP Impacts	Medium (conversion)	N/A	N/A (increase in acreage)
Threat from Direct Impacts Associated with Coastal Sprawl	Low	High	Low
Threat from Indirect Impacts Associated with Coastal Sprawl	Medium	High	Medium
Subject to Conversion as a Result of Storm, Drought, Sea Level Rise	High	Low	Medium
SUBTOTAL	60	70	50
FUNCTION	Freshwater (0-0.5 ppt)*	Bottomland Hardwood	Brackish Marsh (0.5-4 ppt)*
Support Freshwater Avian and Terrestrial T&E Species	High	High	Low
Support Freshwater Terrestrial Wildlife	High	High	Low
Support Freshwater Fish Species	High	Medium	Low*
Mitigation Opportunities in Lower Savannah Watershed	Low (non-existent)	High	N/A
SUBTOTAL	100	110	30
TOTAL COMPARABILITY SCORE (= Function-Threats)	40	40	-20

High = 30
Medium = 20
Low = 10

* Literature indicates that freshwater marsh charactistics can exist up to 2.5 ppt on salinity continuum. Therefore, overlap with brackish marsh salinity suggest support for freshwater fish species in the salinity range of 0-2.5 ppt.

- When considering mitigation options that take into account the previous analysis, mitigation with bottomland hardwoods would provide compensation for impacted functions associated with the conversion of 223 acres of freshwater marsh to brackish marsh. Additionally, our assessment of watershed needs concluded that the SNWR, and all of the associated wetland habitats, are currently subject to stressors associated with urbanization. Total current refuge acreage consists of 29,175 acres of freshwater marshes, tidal rivers and creeks, and bottom land hardwoods (USFWS, 2010). Table 55 from the USFWS's Draft Comprehensive Conservation Plan (2010) provides the acreage associated with each of the habitat types located on the SNWR. Figure 57 illustrates the general habitat types with respect to location on the SNWR (USFWS, 2010).

Table 55.

Acreages of Habitat Types on Savannah National Wildlife Refuge

Habitat Type	Acres
Bottomland hardwood	6,546
Harwood hammocks	437
Upland Pine	275
Cypress–Gum Swamp	10,398
Mixed Hardwoods	883
Grassland Field	155
Upland Hardwood	178
Managed Impoundments	3,000
Tidal Marsh	7,192
Right-of-ways	24
Administrative Areas	87
Total	29,175

The refuge is dominated by forested wetlands to the north with oak hammocks located toward the interior. The southern refuge boundary is comprised of tidal marsh, scrub/shrub, freshwater impoundments and freshwater marsh.

- Figure 59 obtained from the USFWS's Final Comprehensive Conservation Plan illustrates the areas proposed for long term acquisition (yellow line) and the existing boundaries of the SNWR (red line). The sites that would be acquired as mitigation for SHEP are generally located in/around the location of the green ellipses. The properties comprising Mill Creek and Abercorn Island are characterized by wetlands and upland. The wetlands are classified as bottomland hardwood forest, dominated by old-growth oaks, cypress, sycamore and sweetgum. The sites are both temporarily and seasonally flooded and/or forested wetland (USFWS, 2007) (See Functional Assessment for characteristics of preservation sites).

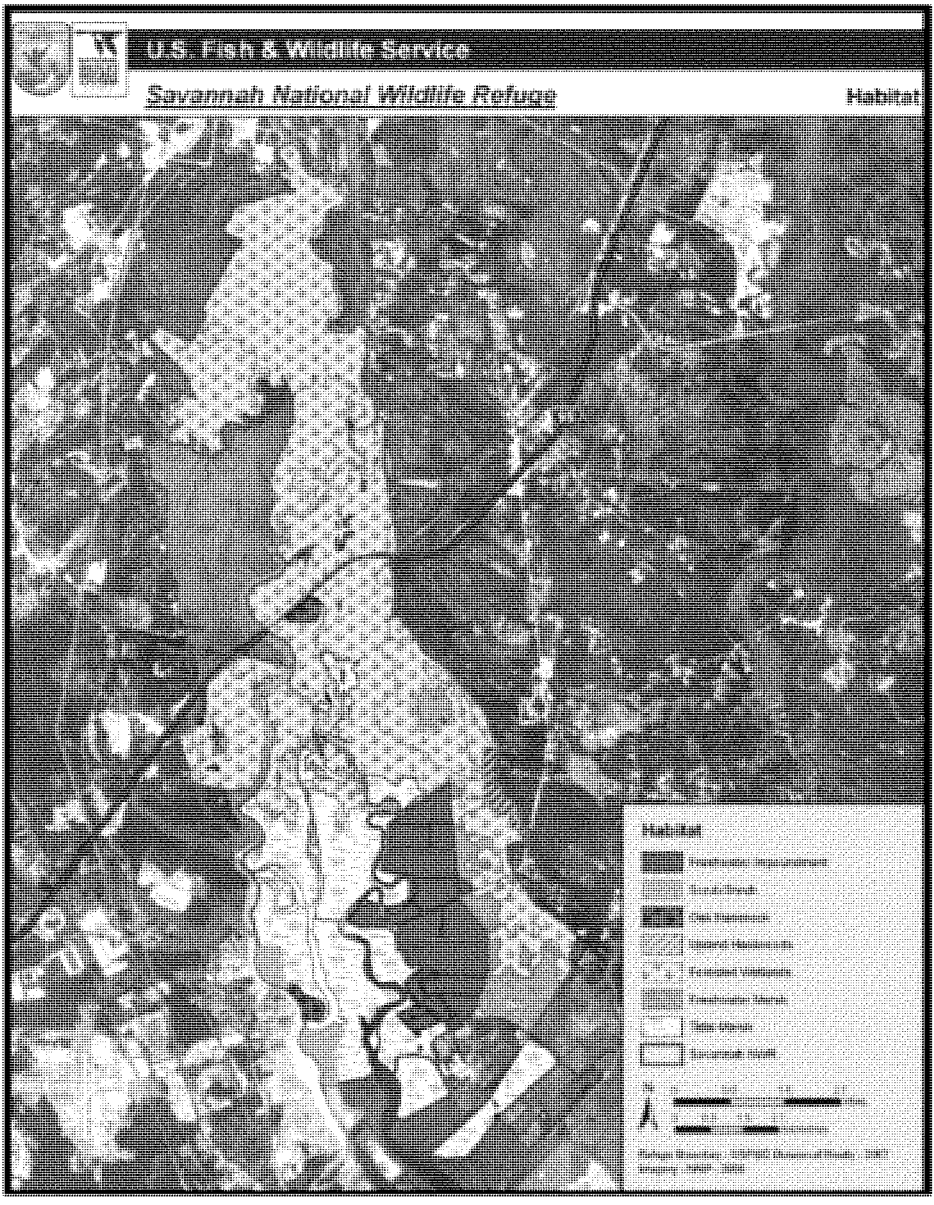


Figure 58. Habitat types within SNWR boundaries.

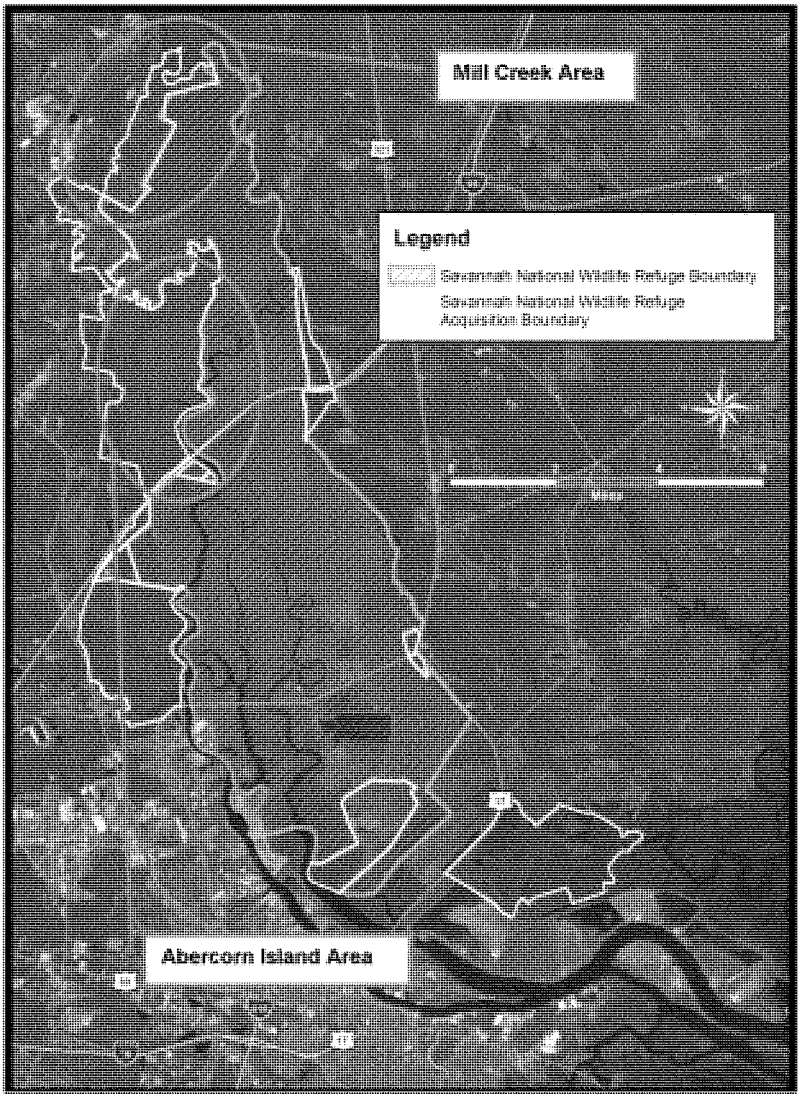


Figure 59. SNWR acquisition boundary.

- Preservation of wetlands and upland buffers adjacent to the existing SNWR is a sustainable approach to mitigation that results in the expansion of the refuge property; protection of wetlands and upland buffers, the expansion/protection of wildlife corridors;

reduction in likelihood of future indirect impacts associated with stormwater runoff and septic systems; and decrease risk of wildfire probability that comes with development and human encroachment.

- The Mill Creek and Abercorn Island areas are approximately 4,600 acres and 1,989 acres in size, respectively. Like the forested wetlands areas of the SNWR depicted in Figure 58, both the Mill Creek and Abercorn Island areas would provide similar resources with respect to aquatic habitat and connectivity with the existing wildlife habitat corridors within the SNWR. The lands proposed for preservation are completely compatible with the existing use of adjacent lands (i.e., SNWR) and acquisition of such lands would promote USFWS's Draft Comprehensive Conservation Plan. Integration of the 2,245 acres of wetland and upland buffer would be an approximate 7.7% increase in the total acreage of the SNWR. The additional lands would have a positive, net beneficial effect on wetlands and water quality as well as fish and wildlife habitat values within the SNWR and the surrounding area. Given the protective measures that would be afforded the 2,245 acres and the existing land use associated with the adjacent 29,175 acres, this compensatory mitigation project is anticipated to provide a substantial buffer for a very fragile, intact ecosystem. In the foreseeable future, this mitigation plan would also prevent any additional degradation of waters that comprise the SNWR and provide lasting protection to ecosystems that serve as habitat for several Threatened and Endangered species.

- Issues concerning development trends in the area of the mitigation sites were reported in previous sections of this analysis. Likewise, the local and regional goals for the restoration or protection of particular habitat types or functions have already been discussed. Finally, the 2,245 acres of wetland preservation that is being provided as compensatory mitigation is adjacent to arguably the most valuable, contiguous 29,175 acres of aquatic resources in the Lower Savannah River Watershed.

- The latest version of the Refuge's Acquisition Plan is dated July 2007 and is included in the document titled "Final Environmental Assessment and Land Protection Plan; Proposed Expansion of Savannah National Wildlife Refuge". As defined in the plan, *"the proposed acquisition would protect a biologically diverse complex of wetlands with high ecological values for numerous plants and animals."* and *"project lands acquired as part of the refuge would be managed in a manner that would protect and enhance the fish and wildlife habitat values they provide."* By acquiring lands adjacent to the SNWR, and thereby expanding the refuge, a primary initiative of the National Wildlife Refuge System Improvement Act of 1997 is also satisfied. It also satisfies major objectives of Georgia and South Carolina's Comprehensive Wildlife Conservation Strategies.

1.5 Evaluation of Permittee-Responsible Mitigation with Respect to Mitigation Type, Mitigation Amount, Mitigation Hierarchy and Preservation

When evaluating possible mitigation options, the Corps considered 33 CFR 332.3 (e-h), *(e) Mitigation Type, (f) Amount of Compensatory Mitigation,(g) Use of Mitigation Banks and In-Lieu Fee Programs,* and *(h) Preservation.* The following facts show compliance with this aspect of the Mitigation Rule.

- The proposed preservation of 2,245 acres consists of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer provides a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion (See previous sections).

- The Corps has conducted a watershed assessment in the Lower Savannah River Harbor to evaluate the mitigation opportunities that would compensate for the vegetative conversion of 223 acres of freshwater wetland. The Corps conducted this watershed assessment in conjunction with the results of the functional assessment that concluded the only element of wetland function that would be impacted as a result of the conversion was fish and wildlife habitat. The Corps has again reviewed the listing of approved mitigation banks in the Lower Savannah River Watershed. As of this response date, there are no mitigation banks established with tidal, freshwater wetland characteristics. Additionally, the In-Lieu Fee program has not been updated or approved by the Corps and Interagency Review Team (IRT) to provide compensation at this time. The Corps also looked for opportunities to provide "In Basin" restoration and/or enhancement of tidal, freshwater wetlands. However no sites where identified in a 10-year period of time. The Corps also considered the creation of freshwater, tidal wetlands. Wetland creation, which would be derived from upland areas, has a very high risk of failure. Ultimately, the Corps determined that the creation of freshwater, tidal wetlands was not a viable option, and for the duration of the project, a created freshwater system would not be sustainable.

- The Corps assembled and used a Wetland Interagency Coordination Team (ICT) consisting of technical expert representatives from the Corps, Federal natural resource agencies, and State natural resource agencies representatives to identify acceptable mitigation for the proposed project. At that time, USFWS stated that mitigation actions must be performed within the basin for impacts to wetlands residing within the SNWR. The Service recommended preservation of lands as a possible solution and recommended sites that are part of their long term lands acquisition strategy to compliment the SNWR. The Corps also consulted with the Stakeholder Evaluation Group, including its Non-governmental Organizations (NGOs) members, to identify any other suitable mitigation

alternatives. No restoration or enhancement sites (including tidal freshwater marsh or bottomland hardwood) were identified. Over the 10-year study period, no agency or organization could identify another feasible alternative as mitigation for impacts that would occur as a result of wetland conversion. Therefore, the Corps proceeded with the identification of preservation sites.

- In compliance with 33 CFR 332.3 (f)(1), the Savannah District's SOP was used as a tool to determine an acceptable amount of preservation acreage required to offset the vegetative conversion of wetlands. The approach for use of the SOP was approved by the ATR and other agency representatives. In summer 2003, the Corps assembled a Wetland Interagency Coordination Team (ICT) to assist in its analysis of potential wetland impacts from the SHEP. The team consisted of agency wetland experts from USEPA, USFWS, NMFS, GA DNR, SC DNR, and SC DHEC. The agencies identified an acceptable technical approach to determine wetland impacts. They also identified the information needs they would have when they reviewed the DEIS. Since creation of the team, the Corps hosted 7 meetings of the ICT. The Corps conducted an Agency Technical Review (ATR) to assess the use of Savannah District's SOP as a tool in the development of a mitigation plan for SHEP. The ATR was lead by the National Deep-Draft Navigation Planning Center of Expertise and was performed by Corps experts in the Engineering Research and Development Center in Vicksburg, MS. The ATR was to determine if the SOP was an appropriate method to determine the preservation acreage needed to compensate for impacts resulting from the SHEP. The ATR was also conducted to comment on the reasonableness of the assumptions and calculations that Savannah District used in applying the SOP for the SHEP. The SOP was used only to determine the amount of preservation acreage necessary to offset the remaining acreage impacted after development of avoidance, minimization, and restoration features. The ATR concurred with use of the SOP to determine the amount of preservation acreage needed and considered Savannah District's application of the SOP to be reasonable in quantifying impacts and the associated mitigation that would be required. The USFWS provided a Fish and Wildlife Coordination Act Report, dated August 2010. In that report, the USFWS concurred with use of the SOP, which calculated a need to preserve 2,245 acres of land adjacent to the SNWR for the 47-foot alternative. The Service provided updates to the SOP calculations in Appendix A of the report. The Corps concurred with use of the updated SOP worksheets and adopted the results of those calculations for use in the DEIS. In its Adaptive Management Program, the Corps also proposed acquisition of up to an additional five percent of wetlands if monitoring demonstrates that wetland impacts are under predicted.

- 33 CFR 332.3 (h) (1) (i-v) states, "*Preservation may be used to provide compensatory mitigation for activities authorized by DA [permits] when all the following criteria are met: (i) The resources to be preserved provide important physical, chemical or biological functions for the watershed; (ii) The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available; (iii) Preservation is determined by the district engineer to be appropriate and practicable; (iv) The resources are under threat of destruction or adverse modifications; and (v) The preserved site will*

be permanently protected through an appropriate real estate or other legal instrument (e.g., easement, title transfer to state resource agency or land trust)."

Based on our analysis and coordination with the natural resource agencies that participated in the Wetland ICT, the Corps has:

(i) concluded that the preserved lands provide important physical, chemical and biological functions for the SNWR , the Savannah Harbor, and the Lower Savannah Watershed (see response to request for Functional Assessment); and

(ii) the preserved lands will contribute to the sustainability of the watershed by ensuring the functions of bottomland hardwood wetlands on these properties are sustained in perpetuity, and the SNWR will be protected with a significant area of land that will function as a buffer in perpetuity. The preservation tracts will also enhance lands already within the SNWR by functioning as a buffer; and

(iii) for the reasons identified in (i) and (ii), the District Engineer has determined that preservation of these 2,245 acres is appropriate and practicable; and

(iv) the Corps and other entities anticipate that the Savannah Harbor, and areas surrounding the SNWR, will continue to experience population growth, industrial/commercial development, and changes in land use. In addition to the industrial developments that have been permitted by the Corps in recent years, the US Geological Survey, Water Science Center (GaWSC) commented on the large number of industrial facilities and associated impacts that are anticipated on lands in close proximity to the Georgia Ports Authority and the SNWR. Preservation of the 2,245 acres ensures aquatic resources on the associated properties will be protected in perpetuity. The preserved land will provide additional buffer so that any future development in the vicinity will not result in a secondary and/or indirect impact to existing Refuge lands. There is also a threat that changes in adjacent land use will also have a detrimental impact on the SNWR. By way of example, a Public Notice published by the Charleston District, Corps of Engineers on September 28, 2009 requests comment on a proposal from a private landowner to divert tidal water flow onto an approximately 693-acre property to increase the hydrology on 485 acres of previously-existing rice impoundment. The 693-acre property, which would be used as a mitigation bank, presently provides benefits to migratory waterfowl during migratory stops similar to those provided by Refuge lands. Conversion of such acreage to saltmarsh could shorten their stay in the area and result in the birds that the Refuge serves resuming their migration with less rest. The expected effects of the proposed Regulatory action on the SNWR have not been quantified at this time, but the proposed project is an example of the continued threat that manipulation of adjacent lands pose to the SNWR and the resources it protects. Acquisition and preservation of the proposed 2,245 acres as mitigation for the SHEP project would provide additional buffer and protection from these type of activities as well; and

(v) preservation of the 2,245 acres will include a restrictive covenant and the recording of a conservation easement with conveyance of the property to the USFWS. Collectively, the information provided in this response justifies the preservation of 2,245 acres

adjacent to the SNWR as satisfying the mitigation requirements for the conversion of freshwater and saltmarsh wetlands.

- 33 CFR 332.3(h) states, "*Where preservation is used to provide compensatory mitigation, to the extent appropriate and practicable the preservation shall be done in conjunction with aquatic resource restoration, establishment, and/or enhancement activities. This requirement may be waived by the district engineer where preservation has been identified as a high priority using a watershed approach described in paragraph (c) of this section, but compensation ratios shall be higher.*" The Corps has provided a watershed approach that was used to evaluate the selection and acceptability of the proposed preservation mitigation. The District's watershed assessment concluded that preservation of up to 2,245 acres of bottomland hardwood and upland adjacent to the SNWR was a high priority mitigation alternative for the Lower Savannah River watershed. Furthermore, our functional assessment of the impacts to tidal, freshwater wetlands and the benefits of the proposed mitigation sites concluded that the acreage proposed for preservation was an appropriate compensation ratio. Additional information on the appropriateness of Corp's compensation ratios maybe found in subsequent bullets.

- EPA's 2001 Region 4 Compensatory Mitigation Policy provides examples of preservation projects that were used to offset impacts to aquatic resources. USEPA describes these examples as, *"preservation projects that have accomplished the goals of the Clean Water Act while meeting the specific goal of the management agencies that accepted or will accept the preserved wetlands."* A project known as Walker Ranch in Osceola and Polk Counties, Florida, is included as an example project. In brief, Walker Ranch (8,500 acres) was purchased and preserved by the Disney Development Company as mitigation for filling approximately 600 acres of wetlands (Stutzman, 1992). The Orlando Sentinel newspaper reported this action as the "one of the largest wetlands losses ever requested in Florida at one time" (Regan, 1991). Although the mitigation-to-impacts ratio is 14:1, the preservation mitigation was provided in exchange for the irretrievable *and complete loss* of 600 acres of swamp and pristine wetland. All elements of wetland function were lost as a result of filling and/or draining of those 600 acres.

- Preservation of 2,245 acres (consisting of bottom land hardwoods and upland buffer) is more than sufficient to offset any conversion in freshwater wetland vegetation that might occur. Considering the vegetative conversion that is expected, the mitigation-to-impacts ratio of roughly10:1, which is consistent with ratios recommended in the 2001 EPA Region 4 Compensatory Mitigation Policy concerning wetland preservation. Using the DF analysis reported by Latham et al (1994) which aligned 37% of freshwater species with oligohaline sites, the 223 acres of freshwater to brackish marsh conversion is reduced further such that the mitigation-to-impacts ratio is increased to 16:1. It is important to reiterate that the SHEP impact would be a shift in vegetation, and that these wetlands would still provide the ecological functions associated with emergent wetland systems. This is significantly different from other example projects identified in EPA Region 4 Mitigation Policy where preservation was utilized for the irretrievable *and complete loss* of wetlands.

- The Corps has used a watershed approach when identifying and establishing the 2,245 acres of preservation as mitigation for the 223-acres of freshwater marsh conversion to

brackish marsh. Using a watershed approach, these areas of preservation have been identified as high priority mitigation (33 CFR 332.3(h)(2)). As such, the USACE has determined that acquisition of these lands shall satisfy the complete mitigation requirement in conjunction with the establishment of the resulting brackish marsh system. The information provided in the previous bullet illustrates that the mitigation preservation ratio would be 16:1. Given the impact to tidal freshwater marsh would result in a vegetative conversion with minor impacts to fish and wildlife habitat, the mitigation ration is satisfactory and also compliant with EPA Region 4's Mitigation Policy.

1.6 Evaluation of Permittee-Responsible Mitigation and Responsible Parties

33 CFR 332.3(l)(1) *Party responsible for compensatory mitigation* states. "*For permittee-responsible mitigation, the special conditions of the DA permit must clearly indicate the party or parties responsible for the implementation, performance, and longterm management of the compensatory mitigation project.*" To mitigate for the vegetative conversion of 223 acres of tidal freshwater wetland, the Corps proposes to acquire up to 2,245 acres of land identified in the SNWR's Comprehensive Conservation Plan. Once acquired, the land would be provided to the USFWS to manage as additions to the SNWR. As part of the SNWR, the lands would be subject to the same protections and use requirements as defined in National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). As defined in the SNWR's Comprehensive Conservation Plan,

"*All programs and uses must be evaluated based on mandates set forth in the Improvement Act. Those mandates are to:*

- *Contribute to ecosystem goals, as well as refuge purposes and goals;*
- *Conserve, manage, and restore fish, wildlife, and plant resources and their habitats;*
- *Monitor the trends of fish, wildlife, and plants;*
- *Manage and ensure appropriate visitor uses as those uses benefit the conservation of fish and wildlife resources and contribute to the enjoyment of the public; and*
- *Ensure that visitor activities are compatible with refuge purposes.*

The Improvement Act further identifies six priority wildlife-dependent recreational uses. These uses are: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. As priority public uses of the Refuge System, they receive priority consideration over other public uses in planning and management.

The Improvement Act directs the Service to ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans. The policy is an additional directive for refuge managers to follow while achieving refuge purpose(s) and the Refuge System mission. It provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems. When evaluating the appropriate management direction for refuges, refuge managers will use sound professional judgment to determine their refuges' contribution to biological integrity, diversity, and environmental health at multiple landscape scales. Sound professional judgment incorporates field experience, knowledge of refuge

resources, refuge role within an ecosystem, applicable laws, and best available science, including consultation with others both inside and outside the Service."

The Refuge has the authority to accept these lands, since the lands are already included in the Refuge's approved Acquisition Plan. The USFWS would manage these properties using funds obtained through the Department of Interior's normal budget process. Based on the information provided, the Corps has determined that the protective measures that would be afforded by the USFWS for the 2,245 acres of bottomland hardwoods and upland adequately satisfy the requirement of identifying the responsible party and defining implementation, performance and long-term management of the compensatory mitigation project.

1.7 Evaluation of Permittee-Responsible Mitigation and Timing

33 CFR 332.3(m) *Timing states, "Implementation of the compensatory mitigation project shall be, to the maximum extent practicable, in advance of or concurrent with the activity causing the authorized impacts. The district engineer shall require, to the extent appropriate and practicable, additional compensatory mitigation to offset temporal losses of aquatic functions that will result from the permitted activity."* As illustrated in Section VIII titled, "Timing of Construction" of Appendix C- Mitigation Planning, all of the properties comprising the 2,683 acres of preservation mitigation would be acquired in advance of the start of dredging within the Inner Harbor. Thus, the required mitigation would occur prior to the activity that results in the conversion of wetland.

1.8 Evaluation of Permittee-Responsible Mitigation and Financial Assurances

33 CFR 332.3(n) *Financial Assurances* states: *"The district engineer shall require sufficient financial assurances to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with applicable performance standards. In cases where an alternate mechanism is available to ensure a high level of confidence that the compensatory mitigation will be provided and maintained (e.g., a formal, documented commitment from a government agency or public authority) the district engineer may determine that financial assurances are not necessary for that compensatory mitigation project."* The need for Financial Assurances, as defined in the 2008 Final Mitigation Rule, and its application toward civil works projects like the SHEP, has not been justified. Regulation 33 CFR 332.3 (n)(1) of the 2008 Final Mitigation Rule states, *"In cases where an alternate mechanism is available to ensure a high level of confidence that the compensatory mitigation will be provided and maintained (e.g., a formal, documented commitment from a government agency or public authority) the district engineer may determine that financial assurances are not necessary for that compensatory mitigation project."* As this subsection recognizes, financial assurances are not required when a government agency would construct the project. The SHEP is a civil works project that will receive funding from the Federal government. The SHEP Record of Decision (ROD) will constitute a formal, binding commitment to implement the project mitigation, subject to Congressional appropriation of funds for the project. Mitigation features are required to be implemented before or concurrent with construction, so the project could not proceed if there were not sufficient funds to implement mitigation. After construction, mitigation operation and maintenance would be the Corps' highest budget priority. The Georgia Department of Transportation (another government agency within the State of Georgia) would be committed to

providing a cost-share for the project. There is little risk that mitigation features will not implemented as planned and be maintained for the life of the project.

1.9 Evaluation of Permittee-Responsible Mitigation and Ecological Performance Standards

33 CFR 332.5(a) *Ecological Performance Standards,* states: *"The approved mitigation plan must contain performance standards that will be used to assess whether the project is achieving its objectives. Performance standards should relate to the objectives of the compensatory mitigation project, so that the project can be objectively evaluated to determine if it is developing into the desired resource type, providing the expected functions, and attaining any other applicable metrics (e.g., acres).*" The conversion of 223 acres of tidal, freshwater marsh to brackish marsh would be mitigated through the preservation of 2,245 acres of bottomland hardwood wetland and upland adjacent to the SNWR. As such, there would be no need to establish ecological performance standards for the preservation mitigation sites.

1.10 Evaluation of Permittee-Responsible Mitigation and Monitoring

33 CFR 332.6(a)(1), *Monitoring,* states: *"Monitoring the compensatory mitigation project site is necessary to determine if the project is meeting its performance standards, and to determine if measures are necessary to ensure that the compensatory mitigation project is accomplishing its objectives. The submission of monitoring reports to assess the development and condition of the compensatory mitigation project is required, but the content and level of detail for those monitoring reports must be commensurate with the scale and scope of the compensatory mitigation project, as well as the compensatory mitigation project type. The mitigation plan must address the monitoring requirements for the compensatory mitigation project, including the parameters to be monitored, the length of the monitoring period, the party responsible for conducting the monitoring, the frequency for submitting monitoring reports to the district engineer, and the party responsible for submitting those monitoring reports to the district engineer.*" The conversion of 337 acres of tidal, freshwater marsh to brackish marsh will be mitigated through the preservation of 2,683 acres of bottomland hardwood wetland and upland adjacent to the SNWR. As such, there would be no need to establish monitoring protocols for the mitigation preservation sites. However, the unique nature of the impact area (i.e., vegetative conversion) does warrant monitoring in order to ascertain the magnitude of marsh conversion that does occur. To that end, the Corps has developed a monitoring plan (EIS Appendix D).

In brief, the Corps will establish 12 monitoring sites in these transitional areas that are predicted to most likely experience a vegetative shift as a result of the SHEP. Six of those sites have already been established as defined by model results and a 2000/2001 characterization by the USGS Florida Fish and Wildlife Cooperative Research Unit. The six new monitoring locations were chosen to expand monitoring in highly sensitive marshes, in other areas of marsh where significant salinity changes are possible under a variety of scenarios, and to monitor community shifts both vertically (up and down river) and laterally (interior vs. exterior). These data, coupled with the modeling results, were used to quantify indirect impacts to freshwater and saltmarsh. These areas will again be studied for 1 year as part of the pre-construction phase of the project. Monitoring of marsh vegetation will also occur during the 3-6 year period of construction and for an additional 7 year post-construction period. For this period of time (i.e., pre-, post-, and

construction phases of the project) the 12 marsh sites will be characterized with respect to vegetation composition and compared to a reference marsh site. Tidal sample stations installed at these marsh sites would also record water surface elevation, specific conductance of surface waters that flood the marsh, specific conductance of waters in the root zone, and water depth every 30 minutes. The recorded data would be downloaded monthly. The marsh transects would be sampled twice annually (June and October), and sampling protocols would follow those described in Kitchens (2003) and generally follow those performed when the USGS monitored in 2000/2001. The project would fund the USGS Florida Fish and Wildlife Cooperative Research Unit or similarly-qualified organization to perform this work. The USGS Cooperative Research Unit would prepare and provide annual reports of their findings to the Interagency Coordination Team (ICT) for review. In turn, the ICT would meet on an annual basis to discuss the result of those findings. The Corps believes this level of monitoring is acceptable and commensurate with the scale and scope of the anticipated impact.

1.11 Evaluation of Permittee-Responsible Mitigation and Site Protection

33 CFR 332.7(a)(1), *Site Protection, states:*
"The aquatic habitats, riparian areas, buffers, and uplands that comprise the overall compensatory mitigation project must be provided long-term protection through real estate instruments or other available mechanisms, as appropriate. Long-term protection may be provided through real estate instruments such as conservation easements held by entities such as federal, tribal, state, or local resource agencies, non-profit conservation organizations, or private land managers; the transfer of title to such entities; or by restrictive covenants. For government property, long-term protection may be provided through federal facility management plans or integrated natural resources management plans." To mitigate for the vegetative conversion of 223 acres of tidal freshwater wetland, the Corps proposes to acquire 2,245 acres of land identified in the SNWR's Comprehensive Conservation Plan. Once acquired, the land would be provided to the USFWS to manage as additions to the SNWR. As part of the SNWR, the lands would be subject to the same protections and use requirements as defined in National Wildlife Refuge System Improvement Act of 1997 (Improvement Act).

1.12 Evaluation of Permittee-Responsible Mitigation and Sustainability

33 CFR 332.7(b)(1) *Sustainability,* states: *"Compensatory mitigation projects shall be designed, to the maximum extent practicable, to be self-sustaining once performance standards have been achieved."* The conversion of 223 acres of tidal, freshwater marsh to brackish marsh will be mitigated through the preservation of 2,245 acres of bottomland hardwood wetland and upland adjacent to the SNWR. Once acquired by the Corps, the land would be provided to the USFWS to manage as additions to the SNWR. As part of the SNWR, the lands would be subject to the same protections and use requirements as defined in National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). The Corps determined that integration of these preserved lands into the SNWR is a self-sustaining form of mitigation.

1.13 Evaluation of Permittee-Responsible Mitigation and Adaptive Management

33 CFR 332.7(c)(2-3) *Adaptive Management,* states: *"If monitoring or other information indicates that the compensatory mitigation project is not progressing towards meeting its performance standards as anticipated, the responsible party must notify the district engineer as soon as possible. The district engineer will evaluate and pursue measures to address deficiencies in the compensatory mitigation project. The district engineer will consider whether the compensatory mitigation project is comparable to the original objectives of the compensatory mitigation project. (3) The district engineer, in consultation with the responsible party (and other federal, tribal, state, and local agencies, as appropriate), will determine the appropriate measures. The measures may include site modifications, design changes, revisions to maintenance requirements, and revised monitoring requirements. The measures must be designed to ensure that the modified compensatory mitigation project provides aquatic resource functions comparable to those described in the mitigation plan objectives."* The conversion of 223 acres of tidal, freshwater marsh to brackish marsh will be mitigated through the preservation of 2,245 acres of bottomland hardwood wetland and upland adjacent to the SNWR. As such, there would be no concern with performance standards and/or deficiencies on the actual preservation mitigation sites. However, the unique nature of the project impacts (i.e., vegetative conversion) does warrant an adaptive management plan should *in situ* monitoring of the impact site conclude additional tidal, freshwater acreage has converted to brackish marsh.

It is important to note that the FEIS describes the rationale behind selection of the EFDC model in Section 5.1.2.1 of the FEIS (Pages 5-8-5-13). In brief, a comparison of models illustrated that wetland impacts identified by using the EFDC hydrodynamic model are higher (i.e., greater quantity) than those identified by the Marsh Succession Model at all proposed project depths. This indicates that the Corps' use of the EFDC-derived impacts is a more inclusive and conservative estimate. That is, the EFDC model is more likely to capture all impacts than other models presently available.

Also, the Corps' salinity value that denotes a defined shift from freshwater to brackish marsh (i.e., 0.5 ppt) is approximately 5 times lower than what has traditionally been observed with 100% vegetative shifts *in situ* within the Lower Savannah Watershed (Latham et al., 1994) and other coastal marsh systems in the southeastern United States (NOAA, 2010). Thus, many of the existing freshwater emergent plant species, and associated ecological parameters, will likely be sustained in areas predicted to experience salinity concentrations in the range of 2.5 ppt. For those areas that do transition to more brackish characteristics, they would still continue to

provide the traditional ecological functions associated with all emergent wetland systems (please see functional assessment response).

To ensure the indirect impacts are well characterized, the Corps has also adopted a seven year, post-construction monitoring plan that would evaluate and quantify the degree of wetland conversion that does occur. In its Adaptive Management Program Plan (EIS Appendix D), the Corps also proposed acquisition preservation of up to an additional five percent of wetlands if monitoring demonstrates that wetland impacts are under predicted. The Corps is satisfied that the proposed Adaptive Management Plan is sufficient at this time. If monitoring results indicate additional mitigation is required, then the Corps shall coordinate with the ICT to develop an appropriate course of action.

1.14 Evaluation of Permittee-Responsible Mitigation and Long-Term Management

33 CFR 332.7(d)(1), *Long-term management* states: *"The permit conditions or instrument must identify the party responsible for ownership and all long-term management of the compensatory mitigation project. The permit conditions or instrument may contain provisions allowing the permittee or sponsor to transfer the long-term management responsibilities of the compensatory mitigation project site to a land stewardship entity, such as a public agency, non-governmental organization, or private land manager, after review and approval by the district engineer. The land stewardship entity need not be identified in the original permit or instrument, as long as the future transfer of long-term management responsibility is approved by the district engineer."* To mitigate for the vegetative conversion of 223 acres of tidal freshwater wetland, the Corps proposes to acquire 2,245 acres of land identified in the SNWR's Comprehensive Conservation Plan. Once acquired, the land would be provided to the USFWS to manage as additions to the SNWR. As part of the SNWR, the lands would be subject to the same protections and use requirements as defined in National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). Thus, the Corps has concluded that no additional long-term management requirements are necessary for the preserved land.

2.0 Identification and Justification of Wetland Mitigation for Direct Impacts

As defined in the Functional Assessment section of this analysis, deepening the harbor would result in direct impacts (i.e., excavation) to 15.68 acres of brackish marsh. It should be noted that these impacts would result after all possible avoidance and minimization measures have been used. In brief, these marsh areas are subject to periodic flooding as a result of daily tides and the vegetative communities in these areas generally consist of one plant species, which is a smooth cordgrass known as *Spartina alterniflora*. Approximately 7.3 acres (47%) of the total brackish marsh acreage that would be excavated is subject to the wave action of passing ships and the resulting perturbation. Thus, these areas exhibit vegetation densities which are significantly less than what is typically observed in a pristine marsh. Patches of bare, course-grain sand and mudflat are integrated throughout the patches of *Spartina alterniflora* in these locations. Given the sparse presence of vegetation, it would appear that these areas are challenged, somewhat degraded, and do not possess the same degree of primary productivity as observed in robust, densely-vegetated, brackish marsh systems located throughout coastal Georgia. The figure below illustrates the location and acreage of brackish marsh that will be excavated as a result of the SHEP.

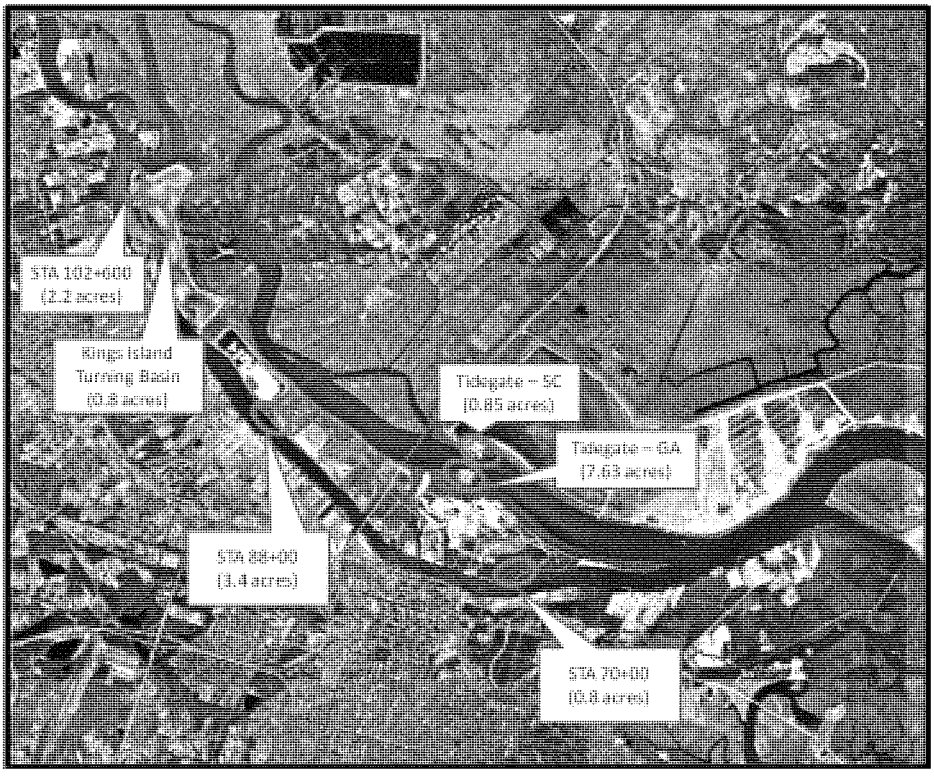


Figure 60. Location of direct impacts to brackish marsh within the Savannah Harbor

Based on the above determinations, the Corps is required to provide compensatory mitigation for the loss of 15.68 acres of estuarine emergent wetlands. The following sections of this analysis will illustrate how the Corps' proposed mitigation will result in no net loss of estuarine emergent wetlands as a result of the direct impacts. It should be noted that the term "saltmarsh" in the following mitigation discussion refers to both emergent brackish and saltwater marshes.

2.1 Evaluation of Mitigation Bank Credits

The Corps evaluated the Regional Internet Banking Information and Tracking System (RIBITS) for potential mitigation banks that possess saltmarsh mitigation credits within the Lower Savannah River Watershed. As of March 2011, no commercial saltmarsh mitigation banks were authorized within the Lower Savannah River Watershed. Other coastal watersheds immediately adjacent to the Lower Savannah were also evaluated. Again, no saltmarsh mitigation banks are currently authorized in the Ogeechee-Coastal Watershed (HUC 03060204) or the Broad-St Helena Watershed (HUC 03050208). The Savannah District, Regulatory Division is currently tracking three pending saltmarsh banks, and the Charleston District is currently tracking one (Table 56). Thus, at this time mitigation banks with "in kind" saltmarsh mitigation do not exist within the Lower Savannah Watershed or adjacent watersheds.

Table 56. Pending Saltmarsh Mitigation Banks

Bank Name	Watershed	Acreage of Bank*	Status	District
Salt Creek	Ogeechee-Coastal	98.9	Pending	Savannah
Tronox	Lower Savannah	88	Pending	Savannah
Vallambrosa	Ogeechee-Coastal	1,513	Pending	Savannah
Clydesdale Club	Lower Savannah	693	Pending	Charleston

* Acreage reflects total size of bank and may include additional habitat other than saltmarsh.

2.2 Evaluation of In Lieu Fee Program Credits

As of March 2011, the In-Lieu Fee Program in the State of Georgia has not been updated or approved by the Corps and Interagency Review Team (IRT) to provide compensatory mitigation credits that would offset impacts to aquatic resources.

2.3 Evaluation of Permitee-Responsible Mitigation under a Watershed Approach

As identified in Section 2.1 of this analysis, there are presently no salt marsh mitigation banks that could compensate for the loss of 15.68 acres of brackish marsh that will be directly impacted as a result of requiring bend wideners in the channel, enlarging the Kings Island Turning Basin and removing the Tidegate. Likewise, the In-lieu fee program is not presently structured to provide the necessary mitigation for the previously identified direct impacts to brackish marsh. The Georgia Department of Natural Resources Environmental Protection Division (GA DNR-EPD) developed the Savannah River Basin Management Plan 2001, *"to provide relevant information on the Savannah River basin characteristics, describe the status of water quality and quantity inthe Savannah River basin, identify present and future water resource demands, present and facilitate the implementation of water protection efforts, and enhance stakeholder understanding and involvement in basin planning."* Per 33 CFR 332.3(c)(1) of the Mitigation Rule, *"Where a watershed plan is available, the district engineer will determine whether the plan is appropriate for use in the watershed approach for compensatory mitigation."* A detailed assessment of GA DNR-EPD's 2001 Management Plan is provided in Section VII.D.1.3. As with the previous analysis of this plan, two long-term priorities "(1) *Preserving habitat suitable for the support of healthy aquatic and riparian ecosystems, and (2) Protecting water quality in*

lakes, rivers, streams, estuaries and coastal waters through attainment of water quality standards and support for designated uses," are of interest with respect to providing suitable mitigation for the 15.68 acres of unavoidable impacts to brackish marsh.

Presently, almost 50% of the brackish marsh acreage that will be excavated is subject to the wave action of passing ships and the resulting perturbation. These areas exhibit vegetation densities which are significantly less than what is typically observed in a pristine marsh. Patches of bare, course-grain sand and mudflat are integrated throughout the patches of *Spartina alterniflora* in these locations. Given the sparse presence of vegetation, it would appear that these areas are challenged, somewhat degraded, and do not possess the same degree of primary productivity as observed in robust, densely-vegetated, saltmarsh systems located throughout coastal Georgia. Obviously, it will be important that any of the identified mitigation options compensates for loss of excavated brackish marsh, but there is a strong likelihood that a watershed assessment for the Lower Savannah Watershed could identify "In kind/In basin" mitigation sites that actually allow for greater marsh productivity levels than the areas subject to direct impacts. Achieving this goal will support the two, long-term objectives of GA DNR-EPD's 2001 Mitigation Plan that were previously stated.

When evaluating possible mitigation options, the Corps also reflected on 33 CFR 332.2(c)(2) i-v of the Mitigation Rule. With respect to the Lower Savannah River Watershed, the following facts were considered with respect this aspect of the Mitigation Rule when developing a mitigation plan for the excavation of 15.68 of brackish marsh:

- The unavoidable excavation of 15.68 acres of brackish marsh will occur as a result of the harbor deepening project within the Lower Savannah Watershed (HUC 03060109). Excavation results in a complete loss of all wetland function (Table 59). Therefore, the best method for replacing all of the lost functions (or suite of functions) and ensuring "no net loss of aquatic resources" is to restore (or reestablish) a suitable brackish marsh ecosystem.

Table 57. Changes in Wetland Function as a Result of Brackish Marsh Excavation

Elements of Wetland Function	Effect of Excavation on Wetland Function (15.68 acres)
Water Purification	Major Adverse (lost)
Flood Protection	Major Adverse (lost)
Shoreline Stabilization	Major Adverse (lost)
Groundwater Recharge	Major Adverse (lost)
Streamflow Maintenance	Major Adverse (lost)
Retention of Particles	Major Adverse (lost)
Surface Water Storage	Major Adverse (lost)
Subsurface Storage	Major Adverse (lost)
Nutrient Cycling	Major Adverse (lost)
Values to Society	Major Adverse (lost)
Fish and Wildlife Habitat	Major Adverse (lost)

Major Effect – the effect on the resource is substantial, noticeable, and permanent. The action severely changes one or more characteristics of the resource.

Adverse Effect - the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result.

- Results of the previous Corps watershed assessment, which are reported in earlier sections of this analysis (Sections VII.A through VII.C), have merit when considering opportunities and threats for the mitigation of brackish marsh in the Lower Savannah River Watershed. Those results included inventories of historic and existing aquatic resources, identification of degreated aquatic resources, and identification of immediate and long-term needs with the watershed.

- Current and future-anticipated salinity concentrations that are observed well above the most active, industrialized areas of the harbor will support long-term reestablishment of brackish marsh.

- Approximately 7.3 of the 15.68 acres of brackish marsh that will be excavated occur in the most active areas of the Savannah Harbor. These areas are prone to disturbances caused by passing vessels as well as the overall maintenance needs of the harbor. These areas exhibit vegetation densities which are significantly less than what is typically observed in a pristine marsh. Patches of bare, course-grain sand and mudflat are integrated throughout the patches of *Spartina alterniflora* in these locations. Given the sparse presence of vegetation, it would appear that these areas are challenged, somewhat degraded, and do not possess the same degree of primary productivity as observed in robust, densely-vegetated, saltmarsh systems located throughout coastal Georgia.

- Given the ongoing perturbation within the area of the harbor with greatest vessel traffic and associated support activities, the search for "in kind/in basin" mitigation in the Lower Savannah River Watershed has focused on areas that are removed from these stressors.

- The Savannah National Wildlife Refuge (SNWR) is a conservation area of national importance with habitats that are important to many unique plant and animal species, including threatened and endangered species. It is located in the vicinity of the SHEP project (i.e., "In basin").

When evaluating possible mitigation options for impacts to brackish marsh, the Corps considered 33 CFR 332.3 (c)(3) i-ii, *Information needs*. The following facts show compliance with this aspect of the Mitigation Rule.

- Information concerning watershed conditions and needs has already been provided in Section VII.A of this analysis.

- Development activities, current developments, the presence and needs of sensitive species have already been provided in Section 1 of this analysis.

- Figure 2 illustrates the Savannah Harbor, the Federal Navigation Channel, and the upstream limits of the SHEP. The identification of an in kind/in basin mitigation site requires that the location be outside the primary "zone of influence" of large container vessels. This zone of influence would hinder success of a brackish marsh compensatory mitigation project. As indicated in previous sections, approximately 7.3 acres of brackish marsh proposed for impact is subject to the wave action of passing ships and the resulting perturbation. Thus, avoiding areas of increased wave action and hydrodynamic intensity will promote long-term, sustainable mitigation. Additionally, Figure 59 illustrates the boundaries of the SNWR. The Corps has detailed all of the advantageous (location, size, habitat quality and connectivity, wildlife and aquatic resources diversity, protections, etc.) that make the SNWR a priority in terms of sustainable ecosystems within the Lower Savannah River Watershed (See Section VII.D.1.4). Therefore, identifying a degraded site within the boundaries of the SNWR would favor the long-term success, health and productivity of a brackish marsh mitigation project.

When evaluating possible mitigation options, the Corps also satisfied criteria for evaluating mitigation options as reflected in the determination of a *Watershed Scale*, which is defined at 33 CFR 332.3 (c)(4). For purposes of our analysis, we established the Lower Savannah River Watershed as the appropriate scale to assess impacts and mitigation opportunities. The Lower Savannah River Watershed is also defined by the 8-digit Hydrologic Unit Code (HUC) 03060109. Characteristic of this watershed maybe found in previous sections of this analysis (Section VII.A). The selection of this watershed scale is supported by the historical review of projects requiring Corps permits and the associated cumulative impacts analysis that considers past, present and reasonably foreseeable future impacts within the same 8-digit HUC. Additionally, most state and Federal resource agencies have used a watershed approach that has typically been scoped using an 8-digit hydrologic unit code (NRCS, 1997). Additionally, the identification of potential brackish marsh mitigation sites was further constrained by the availability of salinity concentrations necessary to support the function and integrity of such sites. Information presented in the *Considerations* and *Information Needs* sections was also important when evaluating brackish marsh mitigation options within the Lower Savannah River Watershed. After consideration, the Corps proposed constructing wetlands adjacent to a site previously restored at Disposal Area 1S as shown in the figure below.

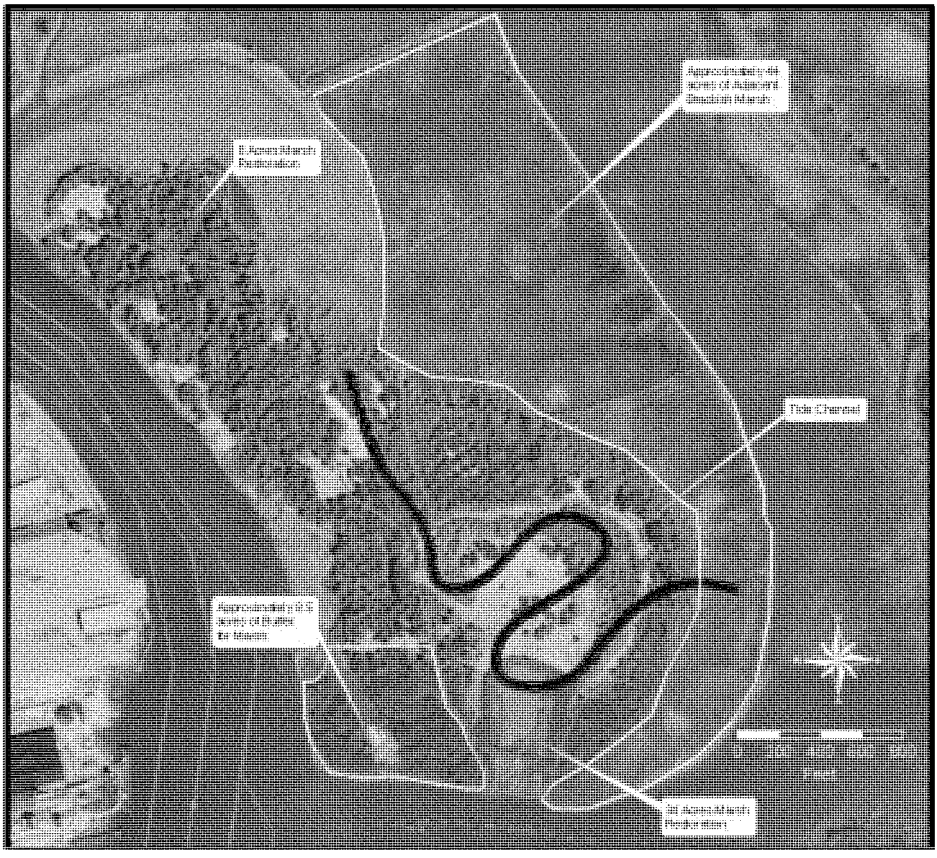


Figure 61. Location of restored brackish marsh in Lower Savannah River Watershed.

2.4 Evaluation of Site Selection for Permittee-Responsible Mitigation

When evaluating possible mitigation options, the Corps also satisfied criteria for evaluating mitigation options as reflected in 33 CFR 332.3 (d)(1-3), *Site Selection*. The following facts show compliance with this aspect of the Mitigation Rule.

- Figure 60 illustrates the proposed brackish marsh mitigation site. This site was operated as Disposal Area 1S that was used for many years to place maintenance dredged material from the upstream reaches of the Savannah Harbor.

- CDF 1S was used for the disposal of maintenance material collected from approximately STA 110+000 to 100+000. Historical records indicate that the composition of the dredged material consisted of approximately 67% sand (#230 sieve), 14% silt, and 9% clay. The high percentage of sand reduces the potential that contaminants would reside in the legacy dredge spoil material (Please Note: Prior to the start of any restoration activity, the site would be sampled and evaluated for the possibility of contaminants located within sediments proposed for removal. Results of those tests would be shared with the Wetland Interagency Coordination Team).

- Prior to construction of the Disposal Area, the site existed as a brackish marsh that had continuity with an approximately 44-acre marsh located immediately adjacent and east of the Disposal Area footprint (Figure 60). This abutting marsh area is dominated by *Spartina alterniflora* with *Spartina cynosuroides* located in areas that are relatively higher in elevation and distance from the tidally influenced surface water.

- The vicinity of Disposal Area 1S is subject to the flood and ebb of the tide. The salinity in this reach of the harbor can vary between 7 and 15 ppt. Following harbor deepening, the resulting salinity will still be capable of supporting a brackish marsh ecosystem at this site.

- Disposal Area 1S is located within the designated boundaries of the SNWR (Figure 58). As such, it is provided the same protections as other areas that comprise the refuge. The 42-acre restored marsh would abut approximately 44 acres of existing brackish marsh that is also located in the SNWR. When completed, the continuity of the restored marsh, coupled with the 44 acres of abutting marsh, will result in an expanded and improved estuarine ecosystem. Thus, the proposed restoration will be compatible with adjacent land uses and the plans/goals of the SNWR as defined in the Comprehensive Conservation Plan.

- The proposed mitigation site is north of the Federal Navigation Channel. Use of Disposal Area 1S would provide a site that is outside the primary "zone of influence" of large container vessels, and therefore, avoids areas of increased wave action and hydrodynamic intensity within the harbor. In addition, a remnant berm feature with protective trees would remain on the east side of the restored marsh. This berm feature would provide additional protection for the graded marsh area during the plant recruitment phase and growth of juvenile plant Spartina plants.

2.5 Evaluation of Permittee-Responsible Mitigation with Respect to Mitigation Type and Amount

When evaluating possible mitigation options, the Corps also satisfied criteria for evaluating mitigation options as reflected in the determination of *Mitigation Type* and *Amount of Compensatory Mitigation*, which is defined at 33 CFR 332.3 (e-f). The following facts show compliance with this aspect of the Mitigation Rule.

- 33 CFR 332.3 (e)(1) states: *"In general, in kind mitigation is preferable to out-of kind mitigation because it is most likely to compensate for the functions and services lost at the impact site. For example, tidal wetland compensatory mitigation projects are most likely to compensate for unavoidable impacts to tidal wetlands, while perennial stream compensatory mitigation projects are most likely to compensate for unavoidable impacts to perennial streams. Thus, except as provided in paragraph (e)(2) of this section, the required compensatory mitigation shall be of a similar type to the affected aquatic resource."* The proposed restoration of 42-acre brackish marsh would be considered "in kind" mitigation. Furthermore, the location of the mitigation site is within the Lower Savannah River Watershed. For the reasons previously identified in other sections of this evaluation, the restoration of the CDF 1S site would also constitute "in basin" mitigation as well.

- 33 CFR 332.3 (f)(1) states: *"If the district engineer determines that compensatory mitigation is necessary to offset unavoidable impacts to aquatic resources, the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions. In cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used."* The Corps used the Regulatory SOP to determine the exact number of acres that would be required for restoration (See Appendix A at the end of this Appendix). Historically, the Corps, Regulatory Division and members of the Interagency Review Team (IRT), which includes USEPA, USFWS, NMFS, and GADNR representatives, have authorized the creation of saltmarsh as mitigation to offset permitted projects, which authorize impacts and or loss of saltmarsh. Data obtained from the Savannah District, Regulatory Division identified 5 projects in Chatham County, which is located in the Lower Savannah Watershed, where saltmarsh was impacted, and the creation of saltmarsh was approved as mitigation typically on a ratio of 2 acres created to 1 acre impacted ratio (or less) (Table 58).

Table 58. Projects Impacting Saltmarsh and the Associated Brackish Marsh Mitigation

Project Name	USACE File Number	Brackish Marsh Impacts (Acres)	Brackish Marsh Creation (Acres)
Slip One- Hutchinson Island	200501453	0.28	0.56
Hardin Canal Drainage	200600393	0.27	0.54
Skidaway Narrows Emergency Access	200600909	0.56	0.56
Skidaway Road Drainage Improvements	200601249	0.52	0.75
SLNG-Slip Construction	200200640	3.24	7.5

The proposed restoration of 28.75 acres of brackish marsh as mitigation for impacts to 15.68 acres would be a ratio of 1.8:1 (acres restored to acres impacted). The ratio derived for the SHEP project provides roughly the same mitigation as other authorized projects that impacted brackish marsh. Savannah District's use of the SOP confirmed that the amount of proposed mitigation was appropriate given the area of marsh impact and the currently associated function/integrity. In support of site-specific mitigation, it is important to note that the 42 acres of contiguous, restored saltmarsh, which includes development of tidal creeks, will have more ecological value than 47% of marsh proposed for impact (i.e., 7.3 acres of marsh proposed for impact is degraded, poorly functioning saltmarsh along the navigation channel). Furthermore, the proposed mitigation site is north of the Federal Navigation Channel. Thus, the large, non-segmented size of the mitigation area, coupled with its "in basin" location and incorporation of a strip of trees to separate the restoration site from the harbor, makes it an ideal mitigation option for replacing the brackish marsh acreage that would be impacted.

The Savannah District SOP has been used, and will continue to be used, to evaluate Regulatory Division permit applications with wetland impacts that are greater than 10 acres. The Corps can document 15 permitted projects in the last 5 years with authorized wetland impacts greater than 10 acres (Table 59).

Table 59. Projects with Impacts Greater than 10 acres that Utilized SOP Calculations to Determine Mitigation Requirements

Project Name	USACE File Number	Wetland Impacts (Acres)
Northport/Oak Grove Plantation	200414950	33.2
Broadhurst Landfill	200501435	96.55
GDOT US441 / SR 89	200600828	64.04
Houston American Cement	200700577	21.21
Newton Tract	200701309	31.86
Robins Air Force Base	200701096	19.5
Fort Benning 69741	200900567	15.94
Fort Benning 69668	200900568	12.33
The Carter Group	200801428	11.3
GDOT I-95 Widening	200502310	14.47
Grady County	200500967	129.0
Fort Stewart	200900886	26.7
Fort Stewart Machine Gun Range	200900786	103.34
Fort Stewart Multipurpose Range	200901852	202.9
Fort Stewart Digital Multipurpose Range	200900885	43.6

For these projects, the SOP was used as the best available tool to quantify credits required for impacts to wetlands. With many of these projects, the SOP was also utilized to determine the credits generated in association with permittee-responsible mitigation (i.e., restoration, enhancement and preservation), if applicable. In every case where impacts were greater than 10 acres, the SOP was used as an assessment tool to ensure the credits required for mitigation were practicable given the magnitude of impact associated with the authorized project.

It is important to note that the SOP is a tool for calculating mitigation, but the Regulatory Division also uses sound, science-based judgment when evaluating an applicant's project that would impact waters of the United States. As defined in the Corps' General Regulatory Policies, 33 CFR 320.4 (r)(2) states, *"All compensatory mitigation will be for significant resource losses which are specifically identifiable, reasonably likely to occur, and of importance to the human or aquatic environment. Also, all mitigation will be directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable."* To that end, the Regulatory Division always ensures that calculated mitigation credits derived from the SOP pass the sensibility test and are consistent with actual, project-derived impacts.

It should be noted that the Regulatory Division is working to develop an updated Mitigation SOP that is based on a functional assessment. However, to date that tool is still being developed, and therefore, is unavailable for use at this time. The Regulatory

Division will continue to use the current SOP as a tool for assessing mitigation requirements for all projects (including projects with impacts greater than 10 acres) until such time that the updated Mitigation SOP has been completed, tested and validated.

2.6 Evaluation of Permittee-Responible Mitigation and Preservation

The Corps also satisfied criteria for evaluating mitigation options as reflected in 33 CFR 332.3 (h), *Preservation*. The following facts show compliance with this aspect of the Mitigation Rule.

- Disposal Area 1S is located within the borders of the SNWR. However, the Corps and GDOT still maintain and easement on the CDF that could allow for disposal and continued management of dredged material at a later date. As illustrated in Appendix A of this report, the Corps utilized a 0.5 value for the "Control" factor in the Savannah District's SOP calculation. The 0.5 value is the highest value that can be recorded for the "Control" factor. By using this control factor, the Corps and GDOT will agree to relinquish the easement that could allow for future use of Disposal Area 1S. Once the area has been restored to a functioning brackish marsh ecosystem, it will also be permanently protected through the State of Georgia's Coastal Marshlands Protection Act. Finally, the restoration area is already within the boundaries of the SNWR. The resulting marsh will be contiguous with existing marsh that abuts the restoration site. As such, the restored marsh will be permanently integrated into the same conservation and management plan that currently protects existing brackish marsh areas within the SNWR.

- The restored brackish marsh will replace the 15.68 acres of excavated brackish marsh. When compared to the excavated sites, the location and overall area of the restored marsh will provide greater physical, chemical and biological functions within the Lower Savannah River Watershed.

- Restoration and preservation of the brackish marsh site will contribute significantly to the ecological sustainability of the Lower Savannah River Watershed.

- Preservation is an element of the "Control" factor identified in the SOP calculation. Use of the Savannah District SOP to determine a credit requirement was accepted by the Wetland ICT. The ratios of mitigation to impact (i.e., 1.8:1) is comparable with other public projects that have directly impacted brackish marsh. Therefore, use of the preservation element in the SOP calculation is appropriate and practicable.

- The Preservation element identified through use of the SOP will be fulfilled in conjunction with restoration of brackish marsh at the Disposal Area 1S site.

2.7 Evaluation of Permittee-Responsible Mitigation and Responsible Parties

The Corps also satisfied criteria for evaluating mitigation options as reflected in 33 CFR 332.3 (l), *Party Responsible for Compensatory Mitigation*. The following facts show compliance with this aspect of the Mitigation Rule.

- The Corps will be responsible for the implementation, performance and long-term

management of the restored brackish marsh site.

- The Wetland ICT, which is comprised of representatives from USEPA, USFWS, NOAA, GA DNR-CRD, and SC DHEC-OCRM will receive biannual updates on the status of the compensatory mitigation project.

2.8 Evaluation of Permittee-Responsible Mitigation and Timing

When evaluating possible mitigation options, the Corps also satisfied criteria for evaluating mitigation options as reflected in the determination of *Timing*, which is defined at 33 CFR 332.3 (m) of the Final Mitigation Rule. The following facts are presented in compliance with regulation *m* that was previously cited.

- 33 CFR 332.3(*m*) states: *"Implementation of the compensatory mitigation project shall be, to the maximum extent practicable, in advance of or concurrent with the activity causing the authorized impacts. The district engineer shall require, to the extent appropriate and practicable, additional compensatory mitigation to offset temporal losses of aquatic functions that will result from the permitted activity."* The Corps has committed construction of the restored marsh concurrent with dredging in the Inner Harbor (See Timing of Construction Table). This would ensure that excavation of the 15.68 acres of brackish marsh happens at the same time (possibly before depending on positioning of hydraulic dredge and dredging window) as development of the 42-acre brackish marsh system.

2.9 Evaluation of Permittee-Responsible Mitigation and Financial Assurances

33 CFR 332.3(n), *Financial Assurances* states: *"The district engineer shall require sufficient financial assurances to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with applicable performance standards. In cases where an alternate mechanism is available to ensure a high level of confidence that the compensatory mitigation will be provided and maintained (e.g., a formal, documented commitment from a government agency or public authority) the district engineer may determine that financial assurances are not necessary for that compensatory mitigation project.* As this subsection recognizes, financial assurances are not required when a government agency would construct the project. The SHEP is a civil works project that will receive funding from the Federal government. The SHEP Record of Decision (ROD) will constitute a formal, binding commitment to implement the project mitigation, subject to Congressional appropriation of funds for the project. Mitigation features are required to be implemented before or concurrent with construction, so the project could not proceed if there were not sufficient funds to implement mitigation. After construction, mitigation operation and maintenance would be the Corps' highest budget priority. The Georgia Department of Transportation (another government agency within the State of Georgia) would be committed to providing a cost-share for the project. There is little risk that mitigation features will not be implemented as planned and maintained for the life of the project.

2.10 Evaluation of Permittee-Responsible Mitigation and Ecological Performance Standards

33 CFR 332.5(a) *Ecological Performance Standards*, states: *"The approved mitigation plan must contain performance standards that will be used to assess whether the project is achieving its objectives. Performance standards should relate to the objectives of the compensatory mitigation project, so that the project can be objectively evaluated to determine if it is developing into the desired resource type, providing the expected functions, and attaining any other applicable metrics (e.g., acres)."* The objective of this compensatory mitigation project is to restore the CDF 1S site to a fully functional, 42-acre brackish marsh ecosystem. As a result, compensatory mitigation for the excavation of 15.68 acres of brackish marsh, which is required for the SHEP, would be satisfied, and the remaining 63.6 mitigation credits (13.25 acres) associated with the restoration effort would be held in reserve for any future Corps Civil Works actions in the Savannah Harbor. Restoration of the CDF 1S site would occur by grading it down to an elevation that allows for the growth of Spartina alterniflora (i.e., +7.6 to +7.8 MLLW). The Corps selected that elevation range after inspection and surveying the elevations of natural marsh that is immediately adjacent to the proposed restoration site. Once the new elevations have been established, the approximately 42-acre site would be allowed to naturally vegetate. The abutting marsh, which is dominated by *Spartina alterniflora*, would provide the necessary seed stock to vegetate the restoration site. Given the prolific nature of the plant and its ability to outcompete other vegetative species within the salinity range observed in this reach of the harbor, we expect successful recruitment of the Spartina species with coverage of vegetation occurring at the following rate:

Table 60. Revegetation Rate for Restored Marsh

Time Period	Percent Vegetative Cover
Construction	0
Year 1	15
Year 2	25
Year 3	40
Year 4	60
Year 5	80
Year 6	85
Year 7	90

The density of Spartina plants and the resulting percent vegetative cover will be determined on an annual basis and reported to the Wetland ICT. In brief, ten 30-foot transects will be established on the restoration site. Additionally, one reference site transect will be established in the adjacent marsh. Vegetation counts and density measurements using $1ft^2$ quadrats will be collected along each of the transects, and all data will be compiled and reported on an annual basis. As requested by the USFWS, a "feeder" creek system would also be constructed toward the interior of the restored marsh. The creek would provide another mechanism of ensuring adequate exchange of brackish, surface water with pore waters that are located on the interior of the site.

The need for hydrology data is negligible since vegetative cover, and ultimate success of a brackish marsh system, is primarily dictated by the elevation of the marsh site in conjunction with two daily tidal cycles. Because elevation and the tides ultimately determine the health and function of the Spartina plants, which will subsequently dictate the primary productivity of the marsh, the Corps will not deploy instruments to measure hydrology nor propose any hydrologic indicators as a means of gauging ecological performance or success. Rather, the success of the marsh site will be determined based on the coverage of *Spartina alterniflora* as indicated by the revegetation rate depicted in the table above. See Section 2.12 "Evaluation of Permittee-Responsible Mitigation and Adaptive Management" for the identification of contingency plans should the mitigation site not progress toward meeting its performance standards.

2.11 Evaluation of Permittee-Responsible Mitigation and Monitoring

33 CFR 332.6(a)(1) *Monitoring,* states: *"Monitoring the compensatory mitigation project site is necessary to determine if the project is meeting its performance standards, and to determine if measures are necessary to ensure that the compensatory mitigation project is accomplishing its objectives. The submission of monitoring reports to assess the development and condition of the compensatory mitigation project is required, but the content and level of detail for those monitoring reports must be commensurate with the scale and scope of the compensatory mitigation project, as well as the compensatory mitigation project type. The mitigation plan must address the monitoring requirements for the compensatory mitigation project, including the parameters to be monitored, the length of the monitoring period, the party responsible for*

conducting the monitoring, the frequency for submitting monitoring reports to the district engineer, and the party responsible for submitting those monitoring reports to the district engineer." The excavation of 15.68 acres of brackish marsh will be mitigated through the restoration of a 42-acre brackish marsh site. Approximately 28.8 acres of the restored marsh will be used as mitigation for the impacts associated with excavation. The remaining mitigation credits/acreage would be used for approved Operations and Maintenance Projects associated with the Savannah Harbor Navigation Project. The Corps will monitor the restoration site for a period of seven years and success of the brackish marsh will be based on meeting or exceeding the annual values defined for the percent of vegetative coverage for *Spartina alterniflora* (See Table 62). The marsh transects would be sampled twice annually (June and October). The project would fund the USGS Florida Fish and Wildlife Cooperative Research Unit or similarly qualified organization to perform this work. The USGS Cooperative Research Unit would prepare and provide annual reports of their findings to the Interagency Coordination Team (ICT) for review. In turn, the ICT would meet on an annual basis to discuss the result of those findings. The Corps believes this level of monitoring is acceptable and commensurate with the scale and scope of the anticipated impact.

2.12 Evaluation of Permittee-Responsible Mitigation and Site Protection

33 CFR 332.7(a)(1) *Site Protection,* states:
"The aquatic habitats, riparian areas, buffers, and uplands that comprise the overall compensatory mitigation project must be provided long-term protection through real estate instruments or other available mechanisms, as appropriate. Long-term protection may be provided through real estate instruments such as conservation easements held by entities such as federal, tribal, state, or local resource agencies, non-profit conservation organizations, or private land managers; the transfer of title to such entities; or by restrictive covenants. For government property, long-term protection may be provided through federal facility management plans or integrated natural resources management plans." The excavation of 15.68 acres of brackish marsh will be mitigated through the restoration of a 42-acre brackish marsh site. Approximately 28.8 acres of the restored marsh will be used as mitigation for the impacts associated with excavation. The remaining mitigation credits/acreage would be used for any additional compensatory mitigation that might be needed in the Lower Savannah River Watershed at a future date. The restoration site (Disposal Area 1S) is located within the boundaries of the SNWR. However, the Corps and GDOT still maintain and easement on the Disposal Area that could allow for disposal and continued management of dredged material at a later date. As illustrated in Appendix A of this report, the Corps used a 0.5 value for the "Control" factor in the Savannah District's SOP calculation. The 0.5 value is the highest value that can be recorded for the "Control" factor. By using this control factor, the Corps and GDOT will agree to relinquish the easement that could allow for future use of Disposal Area 1S. Once the area has been restored to a functioning brackish marsh ecosystem, it will also be permanently protected through the State of Georgia's Coastal Marshlands Protection Act. Finally, the restoration area is already within the boundaries of the SNWR. The resulting marsh will be contiguous with existing marsh that abuts the restoration site. As such, the restored marsh will be permanently integrated into the same conservation and management plan that currently protects existing brackish marsh areas within the SNWR. Thus, the lands would be subject to the same protections and use requirements as defined in the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act).

2.13 Evaluation of Permittee-Responsible Mitigation and Sustainability

33 CFR 332.7(b)(1) *Sustainability,* states: *"Compensatory mitigation projects shall be designed, to the maximum extent practicable, to be self-sustaining once performance standards have been achieved."* The health and function of the restored Spartina marsh will ultimately be determined by achieving the appropriate elevation and the continued input of brackish water by the twice daily tides events. This critical step (i.e., setting the correct elevation) and resulting success will be known early in the restoration process as indicated by the recruitment of Spartina plants in the first few years. As requested by the USFWS, a "feeder" creek system would also be constructed toward the interior of the restored marsh. The creek would provide another mechanism of ensuring adequate exchange of brackish, surface water with pore waters that are located on the interior of the site. If 80% vegetative cover is achieved at the end of the five year monitoring period, then the self-sustaining nature of the site will be assured since selection of the appropriate "productive" elevation is relatively finite. In other words, there would be no need for pumps or other mechanical features to maintain the hydrologic input or vegetation of the established site. Thus, the restored site would be as likely to thrive in the future as any of the other adjacent brackish marsh sites in the vicinity.

2.14 Evaluation of Permittee-Responsible Mitigation and Adaptive Management

33 CFR 332.7(c)(2-3) *Adaptive Management,* states: *"If monitoring or other information indicates that the compensatory mitigation project is not progressing towards meeting its performance standards as anticipated, the responsible party must notify the district engineer as soon as possible. The district engineer will evaluate and pursue measures to address deficiencies in the compensatory mitigation project. The district engineer will consider whether the compensatory mitigation project is comparable to the original objectives of the compensatory mitigation project. (3) The district engineer, in consultation with the responsible party (and other federal, tribal, state, and local agencies, as appropriate), will determine the appropriate measures. The measures may include site modifications, design changes, revisions to maintenance requirements, and revised monitoring requirements. The measures must be designed to ensure that the modified compensatory mitigation project provides aquatic resource functions comparable to those described in the mitigation plan objectives."* The development of the restored marsh also includes an adaptive management plan, which would require the planting of juvenile *Spartina alterniflora* plants if the site does not begin to naturally revegetate with the rate of colonization indicated in Table 62. The site will be inspected twice annually (June and October). The presence of invasive species will be documented. If invasive species are identified, then they will be removed from the site via hand grubbing or another method approved by the Wetland Interagency Coordination Team (ICT). Should the restored marsh not meet the success criteria illustrated in the previous table, then the ICT would identify and/or recommend corrective actions, including planting requirements and associated sprig densities, which would achieve compliance with the reported percentages in the previous table. The need for corrective action(s) would be determined and/or implemented annually with agency involvement and concurrence. Annual monitoring reports would be generated over a period of seven years and provided to the ICT. If at the end of seven years the plant density at the restored marsh does not achieve 90 percent coverage, the ICT would be consulted for a determination on how to proceed (Please see updated Appendix C-Mitigation Planning). If monitoring results indicate additional mitigation is required, then the Corps shall coordinate with the Wetland ICT to develop an appropriate course of action.

2.15 Evaluation of Permittee-Responsible Mitigation and Long-Term Management

33 CFR 332.7(d)(1), *Long-term management,* states: *"The permit conditions or instrument must identify the party responsible for ownership and all long-term management of the compensatory mitigation project. The permit conditions or instrument may contain provisions allowing the permittee or sponsor to transfer the long-term management responsibilities of the compensatory mitigation project site to a land stewardship entity, such as a public agency, non-governmental organization, or private land manager, after review and approval by the district engineer. The land stewardship entity need not be identified in the original permit or instrument, as long as the future transfer of long-term management responsibility is approved by the district engineer."* If 80% vegetative cover is achieved at the end of the seven year monitoring period, then the self-sustaining nature of the site will be assured since selection of the appropriate "productive" elevation is relatively finite. The restored site would be as likely to thrive in the future as any of the other adjacent brackish marsh sites in the vicinity. The restoration area is already within the boundaries of the SNWR, and the resulting marsh will be contiguous with existing marsh that abuts the restoration site. As such, the restored marsh will be permanently integrated into the same conservation and long-term management plan that currently protects existing brackish marsh areas within the SNWR. Thus, the lands would be subject to the same protections and use requirements as defined in the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act).

33 CFR 332.7(d)(2) states, *"A long-term management plan should include a description of long-term management needs, annual cost estimates for these needs, and identify the funding mechanism that will be used to meet those needs."* With respect to restoration of the 42-acre marsh site, long-term management needs would be negligible. The methodology for restoring and sustaining a brackish marsh system is somewhat rudimentary with the greatest risk of success being identified within 1-2 years following the initial grading and/or establishment of the appropriate elevations (please see section 2.13 *Sustainability* for additional information). The *in situ* tidal flushing, protection of SNWR, and continuity with 44 acres of existing brackish marsh, all validate the Corps' position that there are no long-term needs required specific to the restored marsh. However, long-term management needs of the SNWR, which will include the restored salt marsh, are determined by annual budget authorizations from Congress. In 2005, the SNWR had an operating budget of $3,582,000. Although the monetary value cannot be ascertained from year to year, the same type of annual budget authorization from Congress is expected to continue well into the future for SNWR. As such, protection and long-term management of the SNWR as well as the restored marsh site are also anticipated.

33 CFR 332.7(d)(3) states: *"In cases where the long-term management entity is a public authority or government agency, that entity must provide a plan for the long-term financing of the site."* Once restored and the success of the site has been achieved at the end of five years, the brackish marsh would be managed like the other diverse habitats located within the SNWR. As part of the SNWR, the lands would be subject to the same protections and use requirements as defined in National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). Thus, the Corps has concluded that no additional long-term management requirements are necessary for the preserved land.

E. Conclusion

This section of Appendix C-Mitigation Planning, entitled "Consideration of 2008 USEPA/USACE Mitigation Rule," provides detailed analysis and justification for use of 2,245 acres of preservation mitigation to offset impacts associated with indirect impacts (i.e., vegetative conversion) to 223 acres of tidal freshwater wetland. Additionally, this section also justifies the restoration of brackish marsh at Disposal Area 1S as mitigation that offsets direct impacts to 15.68 acres of brackish marsh. As specified in the Mitigation Rule, the Corps used a sequential and systematic approach to reach a definitive conclusion regarding the validity of the respective mitigation plans for impacts to wetlands, and therefore, the Corps has complied with all elements of the Rule. By complying with the Mitigation Rule, the Corps is also satisfied that acceptable and appropriate compensatory mitigation for wetland impacts has been achieved, and implementation of the proposed mitigation plans will ensure that the national policy of "no net loss" of aquatic resources has been fulfilled.

VIII TIMING OF CONSTRUCTION

Harbor deepening would be a multi-year construction project. The duration of the work will substantially depend on the amount of funds available in a given year. The Corps estimates the project would take at least 4 years to construct.

Construction would begin with raising the dikes at the existing CDFs 14A and 14B and the dissolved oxygen systems. Dredging would begin on the entrance channel and extend over two winter seasons. Dredging in the inner harbor would begin the second year and continue through year four. The other mitigation features would be constructed in years two through four. The following figure shows a schedule for construction of the project and its various mitigation features. Monitoring would be performed before, during, and after the construction. The monitoring is summarized in the following section and described in detail in Appendix D.

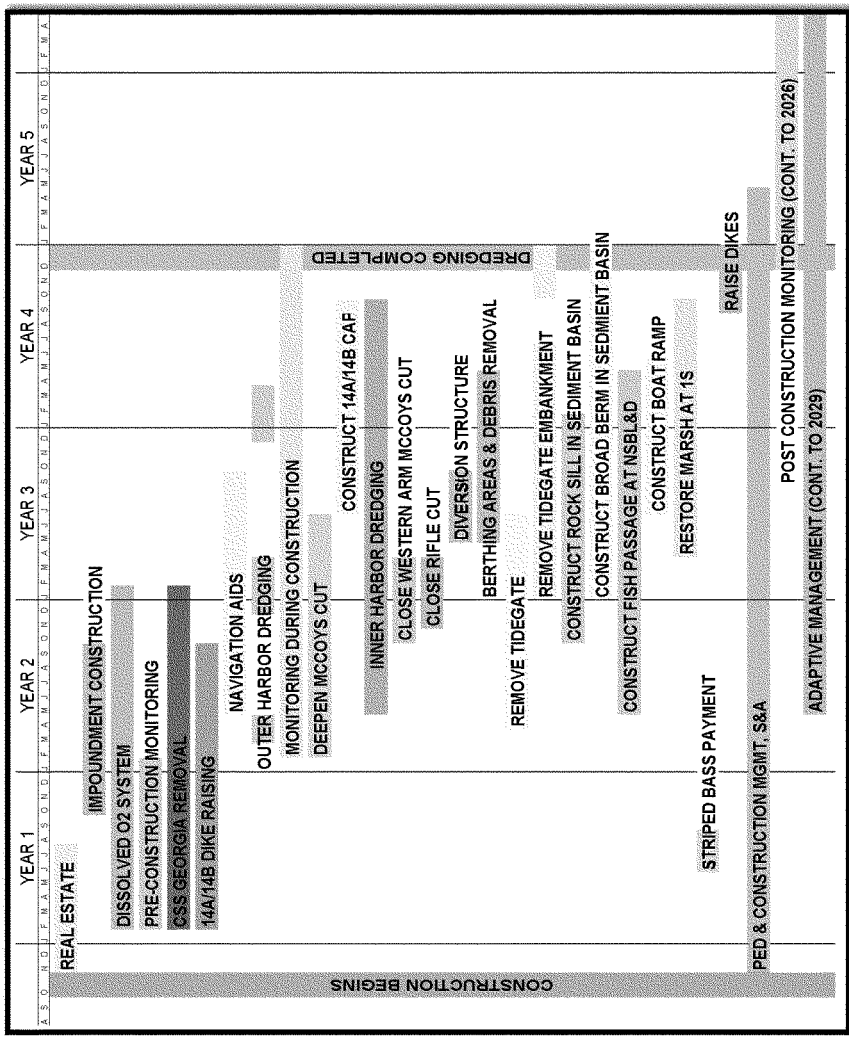


Figure 62. Timing of construction.

IX MONITORING

Monitoring would be conducted to ensure that (1) the impacts described in the EIS are not exceeded, and (2) the mitigation plans described in this document function as intended. The following provides an overview of the monitoring that would be performed:

- Multi-phase monitoring program (Pre-Construction, During Construction, and Post-Construction)
- Post-Construction monitoring of 10 years (Not all components of the plan would be conducted for 10 years)
- Monitoring of cadmium (sediments, effluent, birds) in CDFs 14A and 14B
- Geomorphic and Biologic components
- Continuous hydrodynamic and water quality monitors
- Intense 30-day periods of hydrodynamic and water quality monitoring
- Bathymetric monitoring
- Recalibration of the hydrodynamic and water quality models, if necessary
- Monitoring wetland vegetation
- Monitoring salinity levels in the marshes
- Monitoring Shortnose sturgeon distribution
- Monitoring fish passage at New Savannah Bluff Lock & Dam
- Monitoring chloride levels at the City of Savannah water intake on Abercorn Creek
- Adaptive Management approach to assess the monitoring results and make modifications of necessary
- Multi-agency approval of the Adaptive Management decisions
- Long Term monitoring of hydrodynamic and water quality parameters at select locations

A detailed description of the monitoring is included in Appendix D of the EIS and that document should be consulted for specifics of the program.

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APPENDIX A

APPLICATION OF SAVANNAH DISTRICT'S REGULATORY STANDARD OPERATING PROCEDURES (SOP) TO THE SAVANNAH HARBOR EXPANSION PROJECT

WETLANDS AND OPEN WATERS
Compensatory Mitigation
Definitions of Factors

Adverse effects as used in this section of the SOP means any adverse ecological effect on wetlands or areas of open water. Those effects, or impacts, include filling, excavating, flooding, draining, clearing, or similar changes affecting wetlands or open water areas. Other categories of effects such as aesthetic, cultural, historic, health, etc., are not addressed by this SOP.

Aquatic site means wetlands and other open water areas (streams not included in this section).

Control means the entity responsible for enforcing preservation requirements. Related terms are:
- Restrictive Covenant (RC). (0.1 credit factor)
- RC and Conservation Easement (CE) or Government/Public Protection (GPP). (0.1 credit factor)
- RC and CE and GPP. (0.5 credit factor)

Credit Schedule means the timing of mitigation in relation to adverse impacts to aquatic sites. Mitigation schedules are reviewed and approved on a case-by-case basis. Related terms include:
FOR NON-BANKS:
- Schedule 1. Mitigation is done prior to the adverse impacts. (0.4 credit factor)
- Schedule 2. The majority of the mitigation is done prior to the impacts and the remainder is done concurrent with, or after the impacts. (0.3 credit factor)
- Schedule 3. The mitigation is constructed concurrent with the impacts. (0.2 credit factor)
- Schedule 4. The majority of the mitigation is done concurrent with the impacts, and the remainder is done after the impacts. (0.1 credit factor)
- Schedule 5. The mitigation is done after the impacts. (0 credit factor)

FOR MITIGATION BANKS:
- Schedule 1. No credits may be withdrawn prior to final determination of success.
- Schedule 2. No more than 5% of the total credits are released upon recording a restrictive covenant over the bank site and at least 25% of the total credits are held until final determination of success.
- Schedule 3. No more than 10% of the total credits are released upon recording a restrictive covenant over the bank site and at least 20% of the total credits are held until final determination of success.
- Schedule 4. No more than 15% of the total credits are released upon recording a restrictive covenant over the bank site and at least 20% of the total credits are held until final determination of success.

Degree of Threat is an assessment of the level of imminent risk of loss or damage to a system. None (0 credit factor); Low (0.1 credit factor); Moderate (0.3 credit factor); High (0.5 credit factor).

Dominant Effect categories are defined as follows:
- Shading means to shelter or screen by intercepting radiated light or heat. (0.5 impact factor)
- Clear means to mechanically remove vegetation (mechanized landclearing). (1.0 impact factor)
- Flood means to periodically and temporarily cover an aquatic area with water. (1.2 impact factor)
- Draining means ditching, channelization, or excavation that results in the removal of water from an aquatic area causing the area, or a portion of the aquatic area, to change over time to a non-aquatic area or to a different type of aquatic area. (1.4 impact factor)
- Impound means to create a permanent lake or pond by obstructing the flow of a riverine system. (1.6 impact factor)
- Dredge means to dig, gather, pull out, or excavate from US waters. (1.8 impact factor)
- Fill material means any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a waterbody. (2.0 impact factor)

Duration means the length of time the adverse impacts are expected to last. Impact factors range from 0.1 (< 1 year) to 2.0 (7+ years).

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Effect is defined by Webster to mean something that inevitably follows an antecedent (as a cause or agent). The Council on Environmental Quality (CEQ) has defined at 40 CFR Part 1508.8 that the words impacts and effects are synonymous, and that effects includes ecological, aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Mitigation for other categories of effects (e.g., historic, cultural, aesthetic) is not addressed in this SOP. The CEQ stated that effects include: direct effects which are caused by the action and occur at the same time and place; and indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

Existing Conditions categories are defined as follows. This SOP is limited to evaluation of compensatory mitigation plans for adverse ecological effects.

- Class 1 means fully functional. For example: Mixed species hardwood forest with 40-year old or older dominant canopy trees, and no evidence of hydrologic alteration (2.0 impact factor).
- Class 2 means adverse impacts to aquatic function are minor and would fully recover without assistance. For example: Mixed species hardwood forest with 20 to 40-year old dominant canopy trees, and no evidence of hydrologic alteration (1.5 impact factor).
- Class 3 means adverse impacts to aquatic functions are minor and would not fully recover without some minor enhancement activity. For example: Mixed species 10 to 20-year old hardwoods with evidence of minor hydrologic alteration (i.e., few shallow ditches) (1.0 impact factor).
- Class 4 means major adverse impacts to aquatic function and substantial enhancement would be necessary to regain lost aquatic functions. For example: Clear-cut/cutover 0 to 10-year old stand dominated by early successional tree species (i.e., gums, maples, willows, etc.), and lacking many indigenous mast producing hardwood species. In addition, these areas may have extensive hydrologic alteration (i.e., network of drainage ditches and canals) (0.5 impact factor).
- Class 5 means most aquatic function has been lost. For example: Intensively managed pine plantations or farmed wetlands. (0.1 impact factor).

Hydrology, as used in this SOP, means the properties, distribution, and circulation of water on the surface of the land, in the soil, and underlying rocks. Related terms include:

- Mechanical hydrology means the employment of mechanical methods (e.g., pumps) to supply water to an area thereby causing an ecologically significant change in the hydrology of the area. (0 credit factor)
- Created hydrology means the permanent manipulation of the topography resulting in an ecologically significant change in the hydrology of the area. (0.1 credit factor)
- Natural hydrology means the area's hydrology, as it existed prior to the actions of modern man. Hydrology which has been restored to its natural state qualifies as natural hydrology. Examples of such restoration include effectively filling ditches that drain the area or removing berms that prevent inundation. (0.3 credit factor)

Kind is a factor used to compare the relative functions and values of the mitigation site to the impacted site. For Mitigation Banks the Kind Category will almost always be Category 1 (In Kind), because banks are encouraged to target restoration or enhancement of forested riverine systems, and these are the types of wetlands that receive the most impact. For Non-Banks, kind is as follows:

- Category 1 is In-kind. In-kind Mitigation means the replacement of the impacted aquatic site with one of the same hydrologic regime and plant community type (same species composition). (0.6 credit factor)
- Category 2 is Out-of-kind. Out-of-kind Mitigation means the replacement of an impacted aquatic site with one of a different hydrologic regime and plant community type (different species composition). For example, if a wooded swamp habitat is filled or altered and the mitigation consists of grading an area and planting it in freshwater emergent marsh species. (0.2 credit factor)

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Lost Kind categories are based on functional values. Habitat types that are not categorized below will be evaluated and assigned a category ranking by the Project Manager on a case-by-case basis.

- Kind A - Riverine forested wetlands; intertidal wetlands. (2.0 impact factor)
- Kind B - Non-riverine forested wetlands; freshwater areas adjacent to tidal areas. (1.5 impact factor)
- Kind C - Pine flatwood wetlands. (1.0 impact factor)
- Kind D - Lakes and impoundments. (0.5 impact factor)
- Kind E - Naturalized borrow pits. (0.1 impact factor)

Maintenance means any long term or perpetual manipulation or action after completion of the monitoring period that is necessary to achieve the mitigation goal. Remedial or planned work during the monitoring period is not considered maintenance, but is rather just a part of the mitigation work.

- None -- The mitigation area is expected to continue developing into the preferred habitat without any human intervention after the monitoring period is complete. (0.3 credit factor).
- Low -- Minimal level maintenance including removal of unwanted species. (0.2 credit factor).
- Moderate -- Maintenance including some replanting of the desired vegetation. (0.1 credit factor).
- High -- Maintenance includes significant replanting, addition of soils, hydrology manipulation, or other similar actions. (0 credit factor)

Monitoring and Contingencies (M and C Plans) means the actions which will be undertaken during the mitigation project to measure the level of success of the mitigation work and to correct problems or failures observed. Contingencies means the actions that will be employed to correct deficiencies or failures found during the monitoring period and to achieve the specified success criteria. Monitoring means the collection of field data to measure the success of a mitigation effort. It usually includes analysis of the data, and submittal of a comprehensive report containing the data, analyses, and a narrative discussion of the findings and conclusions. Proposals for Mitigation Banks and Establishment (Creation) sites must include an Excellent M and C Plan.

- Minimum Level Monitoring and Contingencies Plans: (0.1 credit factor)
  - At least 5 years of monitoring (unless approved otherwise)
  - Vegetation survival monitoring (including a commitment to replant if success is not achieved)
- Moderate Level Monitoring and Contingencies Plans: (0.2 credit factor)
  - At least 5 years of monitoring
  - Vegetation survival monitoring (including a commitment to replant if success is not achieved)
  - Basic hydrological monitoring
  - Collection of suitable baseline data
- Substantial Level Monitoring and Contingencies Plans: (0.3 credit factor)
  - At least 5 years of monitoring
  - Vegetation survival monitoring (including a commitment to replant if success is not achieved)
  - Extensive hydrological monitoring
  - Collection of suitable baseline data
  - Reference site comparison monitoring
- Excellent Level Monitoring and Contingencies Plans: (0.4 credit factor)
  - At least 7 years of monitoring
  - Vegetation survival monitoring (including a commitment to replant if success is not achieved)
  - Extensive hydrological monitoring
  - Collection of suitable baseline data
  - Reference site comparison monitoring
  - For mitigation banks, submission of an annual status report until all credits are sold

WETLANDS AND OPEN WATERS
Compensatory Mitigation
Definitions of Factors

Net Improvement is the level of enhancement and/or restoration of the functions of an aquatic site being used for mitigation. There are two Net Improvement credit factors. Vegetative Net Improvment can range from 0.1 1.4 and Hydrologic Net Improvement can range from 0.1 to 1.4. For larger mitigation sites and for mitigation banks, a functional assessment (i.e., HGM, RAP, etc.) will normally be required to provide justification in support of the selected Vegetative and Hydrologic Net Improvement factors. The USACE will make final decisions with regard to appropriate net improvements factors.

Preventability is an evaluation of the degree to which the adverse effects could be prevented. This factor is intended primarily for Nationwide Permit mitigation. Individual Permits must also satisfy the 404(b)(1) guidelines regarding avoidance, minimization, etc. Preventability levels are as follows:

- High means there may be practicable, less damaging alternatives that satisfy the purpose of the project. In the case of existing violations the presumption will be that there was high preventability unless demonstrate otherwise. (2.0 impact factor)
- Moderate means there may be alternatives but it is unclear if they satisfy the project purpose or if they are practicable. (1.0 impact factor)
- Low means there are no known alternatives which satisfy the purpose, are practicable, and are less damagin (0.5 impact factor)

Rarity Ranking categories are determined based on information furnished by the US Fish and Wildlife Service and/or the Georgia Department of Natural Resources or other available data. The USACE will assign a rarity ranking on a case-by-case basis with consideration of any comments provided by resource agencies. Categories are defined as follows.

- Rare means that the designated category is seldom occurring and is marked by some special quality. (2.0 impact factor)
- Uncommon means that the designated category is not ordinarily encountered or is of exceptional quality. (0.5 impact factor)
- Common means that the designated category is frequently occurring or widespread in distribution. (0.1 impact factor)

Upland Buffer Credit is based on the acreage of suitable upland buffer and the percentage of the total jurisdictional boundary on the mitigation area (interface between upland and aquatic site present, with upland present to serve as a buffer) that is protected by the buffer. Only the area (acres) of upland buffer in excess of th minimum 25' can be used to calculate upland buffer credit. Categories are:

- More than 95% of the total jurisdictional boundary of the aquatic site is protected by a suitable upland buffe (1.0 credit factor)
- From 68% to 95% of the jurisdictional boundary protected by upland buffer. (0.8 credit factor)
- From 50% to 67% of the jurisdictional boundary protected by upland buffer. (0.6 credit factor)
- From 33% to 49% of the jurisdictional boundary protected by upland buffer. (0.3 credit factor)
- Less than 33% of the jurisdictional boundary protected by upland buffer. (0.1)

Upland Buffer Enhancement Credit is based on the acreage of the buffered aquatic site and the percentage of the total jurisdictional boundary of the aquatic site (interface between upland and aquatic site present, with upland present to serve as a buffer) protected by a suitable upland buffer. Categories are:

- More than 95% of the jurisdictional boundary protected by upland buffer. (0.15 credit factor)
- From 50% to 95% of the jurisdictional boundary protected by upland buffer. (0.1 credit factor)
- Less than 50% of the jurisdictional boundary protected by upland buffer. (0.05 credit factor)

Vegetation means the plant material within a defined area. Related terms used in this SOP include:

- N.A.-- Not Applicable and vegetation adjustment is not part of the mitigation plan. (0 credit factor).
- Natural revegetation involves no planting. (0.1 credit factor).
- Planted means using transplanted, or nursery stock vegetation. (0.4 credit factor).

WETLANDS AND OPEN WATERS
Compensatory Mitigation
Definitions of Factors

Wetland Enhancement is the manipulation of the physical, chemical, or biological characteristics of a wetland (undisturbed or degraded) site to heighten, intensify, or improve specific function(s) or to change the growth stage or composition of the vegetation present. Enhancement is undertaken for specified purposes such as water quality improvement, flood water retention, or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland functions, but does not result in a gain in wetland acres. This term includes activities commonly associated with enhancement, management, manipulation, and directed alteration. Proposed enhancement mitigation plans must include an explanation of what values or functions are being enhanced and to what degree, and a narrative description of how the enhancement will be accomplished. The plan must also include a narrative description of how a functional assessment methodology (i.e., reference site, HGM, WRAP, etc.) would be used to document that identified values and/or functions are enhanced to the degree proposed.

Wetland Establishment (Creation) is the manipulation of the physical, chemical, or biological characteristics present to develop a wetland on an upland or deepwater site, where a wetland did not previously exist. Establishment results in a gain in wetland acres. In designing creation mitigation, the selection of high quality upland habitat for conversion will generally not be acceptable. For example, a cutover area or former agricultural field would be ecologically preferable to a mature forested area as a candidate for alteration. Mature forested areas will generally not be approved as suitable creation areas. Proposals for establishment mitigation must include an explanation of what values or functions are to be established and to what degree, and a narrative description of how the establishment will be accomplished. The plan must also include a narrative description of how a functional assessment methodology (i.e., reference site, HGM, WRAP, etc.) would be used to document that identified values and/or functions are established to the degree proposed.

Wetland Preservation is the permanent perpetual protection of existing wetlands, or other open water aquatic resources may be an acceptable form of mitigation when these areas are preserved in conjunction with establishment (creation), restoration, and enhancement activities. Preserved resources should augment the functions of newly established, restored, or enhanced aquatic resources. In **exceptional circumstances**, the preservation of existing wetlands or other aquatic resources may be authorized as the sole basis for generating credits as mitigation projects. Natural wetlands provide numerous ecological benefits that restored wetlands cannot provide immediately and may provide more practicable long-term ecological benefits. If preservation alone is proposed as mitigation, it must be demonstrated that the wetlands or other aquatic resources perform important physical, chemical or biological functions, the protection and maintenance of which is important to the region where those aquatic resources are located; and are under demonstrable threat of loss or substantial degradation from human activities that might not otherwise be avoided. The existence of a demonstrable threat will be based on clear evidence of destructive land use changes that are consistent with local and regional (i.e., watershed) land use trends, and that are not the consequence of actions under the control of the party proposing the preservation.

Wetland Restoration is the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former or degraded wetland. There are two categories of restoration as follows: (a) Re-establishment, which results in rebuilding a former wetland and results in a gain in wetland acres and (b) Rehabilitation, which results in a gain in wetland function but does not result in a gain in wetland acres. Proposals for restoration mitigation must include an explanation of what values or functions are being restored and to what degree, and a narrative description of how the restoration will be accomplished. The plan must also include a narrative description of how a functional assessment methodology (i.e., reference site, HGM, WRAP, etc.) would be used to document that identified values and/or functions are restored to the degree proposed.

RATIONALE FOR VALUES USED IN THE SOP CALCULATIONS

Adverse Impact Worksheet

The following table shows the different factors that are to be considered in the assessment of adverse impacts, the range of values allowed in the SOP for each parameter, and the value selected for this project:

		SALINITY ZONE		
		FRESHWATER MARSH	BRACKISH MARSH	SALTMARSH
	RANGE	0 to 0.5	0.6 to 4.0	> 4.0
Dominant Effect	2.0 to 0.5	0.5		0
Duration of Effects	2.0 to 0.1	2		2
Existing Condition	2.0 to 0.1	1		1.8
Lost Kind	2.0 to 0.1	2		2
Preventability	2.0 to 0	0.5		0.5
Rarity	2.0 to 0.1	2		0.1

Dominant Effect:

- Value of 0.5 selected for Freshwater Marsh based on its conversion to brackish or brackish to saltmarsh.
- Value of 0 selected for Saltmarsh based on its conversion to more valuable brackish marsh.

Duration of Effects: Value of 2.0 selected based on it being a permanent effect.

Existing Condition:

- Value of 1.0 selected for Freshwater Marsh based on there being minor adverse impacts to aquatic functions and minor hydrologic alteration. Numerous rice ditches are present in the FW marsh. Brackish plants periodically invade during periods of drought.
- Value of 1.8 selected for Saltmarsh based on the existing marsh being nearly fully functional with less hydrologic alteration.

Lost Kind: Value of 2.0 selected based on the sites being intertidal wetlands.

Preventability: Value of 0.5 selected based on there being no other alternatives which satisfy the project purpose.

Rarity:

- Value of 0.1 selected for Saltmarsh based on it being common and widespread in the area.
- Value of 0.5 selected for Brackish Marsh based on it being uncommon in the area.
- Value of 2.0 for tidal Freshwater Marsh based on it being rare and seldom occurring in the area.

Restoration / Enhancement Worksheet

The following table shows the different factors that are to be considered in the assessment of restoration or enhancement features, the range of values allowed in the SOP for each parameter, and the value selected for this project:

		FRESHWATER MARSH	BRACKISH MARSH	SALTMARSH
		----------	SALINITY ZONE	----------
	RANGE	0 to 0.5	0.6 to 4.0	> 4.0
Net Improvement - Vegetation	0.1 to 1.4		1.4	
Net Improvement - Hydrology	0.1 to 1.4		0.9	
Credit Schedule	0 to 0.4		0.4	
Kind	0.2 to 0.6		0.6	
Maintenance	0 to 0.3		0.2	
Monitoring	0 to 0.4		0.2	
Control	0.1 to 0.5		0.5	

Net Improvement – Vegetation: Value of 1.4 was selected based on a decrease in salinity, resulting in conversion of saltmarsh to brackish marsh with an increase in # of freshwater marsh species. The maximum value was claimed because in this use of the SOP, vegetation cannot be improved beyond that within a given category – in this case brackish vegetation.

Net Improvement - Hydrology: Value of 0.9 was selected based on increase in freshwater flow that decreases salinity in the area. A substantial improvement is expected, but not the maximum that is possible.

Credit Schedule: Value of 0.4 was selected since restoration would be conducted prior to all the impacts occurring.

Kind: Value of 0.6 was selected based on the same type of plant community (tidal brackish marsh) with the same functions and values on the site after the project. This would be considered an In-Kind mitigation.

Maintenance: Value of 0.2 was selected based on periodic dredging being performed to restore depth in tidal creeks.

Monitoring: Value of 0.2 was selected based on 5 years of monitoring with no reference site.

Control: Value of 0.5 was selected based on Government ownership.

Preservation Worksheet

The following table shows the different factors that are to be considered in the assessment of preservation features, the range of values allowed in the SOP for each parameter, and the value selected for this project:

	RANGE	VALUE SELECTED
Threat	0 to 0.5	0.3
Kind	0.2 to 0.6	0.4
Control	0.1 to 0.5	0.5

Threat: Value of 0.3 was selected based on their being a moderate threat of damage to the existing ecosystem. Adjacent lands are being logged and/or developed for residential use. Either of these would significantly lower the ecological value of the site. The sites that were identified are included on a USFWS list of lands of value to acquire and add to the National Wildlife Refuge.

Kind: Value of 0.4 was selected since the preserved lands would be a mixture of tidal wetlands and uplands.

Control: Value of 0.5 was elected based on Government ownership.

MITIGATION WORKSHEETS

45-FOOT DEPTH ALTERNATIVE

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
45 Foot Depth Alternative

ADVERSE IMPACT FACTORS

Factor	Options						
Dominant Effect	Fill 2.0	Dredge 1.8	Impound 1.6	Drain 1.4	Flood 1.2	Clear 1.0	Shade 0.5
Duration of Effects	7+ years 2.0	5-7 years 1.5	3-5 years 1.0	1-3 years 0.5	< 1 year 0.1		
Existing Condition	Class 1 2.0	Class 2 1.5	Class 3 1.0	Class 4 0.5	Class 5 0.1		
Lost Kind	Kind A 2.0	Kind B 1.5	Kind C 1.0	Kind D 0.5	Kind E 0.1		
Preventability	High 2.0	Moderate 1.0	Low 0.5	None 0			
Rarity Ranking	Rare 2.0	Uncommon 0.5	Common 0.1				

† These factors are determined on a case-by-case basis.

REQUIRED MITIGATION CREDITS WORKSHEET

Factor	Fresh marsh	Area 2	Salt marsh	Area 4	Area 5	Area 6
Dominant Effect	0.5		0			
Duration of Effect	2		2			
Existing Condition	2		1.8			
Lost Kind	2		2			
Preventability	0.5		0.5			
Rarity Ranking	2		0.1			
Sum of r Factors	$R_1 = 9$	$R_2 =$	$R_3 = 6.4$	$R_4 =$	$R_5 =$	$R_6 =$
Impacted Area	$AA_1 = 32$	$AA_2 =$	$AA_3 = 828$	$AA_4 =$	$AA_5 =$	$AA_6 =$
R × AA =	2007		4736			

Total Required Credits = Σ (R × AA) = **5587.2**

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
45 Foot Depth Alternative

ESTABLISHMENT (CREATION) MITIGATION FACTORS

Factor	Options				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Hydrology	N. A. 0	Mechanical 0	Created 0.1	Natural 0.4	
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		
Vegetation	N/A 0	Natural 0.1	Planted 0.4		

PROPOSED ESTABLISHMENT (CREATION) MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Credit Schedule					
Hydrology					
Kind					
Maintenance					
Monitoring and Contingencies Plan					
Control					
Vegetation					
Sum of m Factors	M_1 =	M_2 =	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 =	A_3 =	A_4 =	A_5 =
M x A =					

Total Creation Credits = $\sum$ (M x A) = ____

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
45 Foot Depth Alternative

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Net Improvement Hydrology	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		

PROPOSED RESTORATION/ENHANCEMENT MITIGATION WORKSHEET

Factor	Area 1	Brackish marsh	Area 3	Area 4	Area 5
Net Improvement Vegetation		1.4			
Net Improvement Hydrology		0.9			
Credit Schedule		0.4			
Kind		0.6			
Maintenance		0.2			
Monitoring and Contingencies Plan		0.2			
Control		0.5			
Sum of m Factors	M_1 =	M_2 = 4.2	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 = 861	A_3 =	A_4 =	A_5 =
M × A =		3616.2			

Total Restoration/Enhancement Credits = Σ (M × A) = **3616.2**

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
45 Foot Depth Alternative

PRESERVATION MITIGATION FACTORS

Factor	Options			
Degree of Threat	None 0	Low 0.1	Moderate 0.3	High 0.5
Kind	Category 2 0.2	Category 1 0.6		
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5	

PROPOSED PRESERVATION MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Degree of Threat	0.3				
Kind	0.4				
Control	0.5				
Sum of m Factors	M_1= 1.2	M_2=	M_3=	M_4=	M_5=
Mitigation Area	A_1= 1643	A_2=	A_3=	A_4=	A_5=
M x A =	1971.6				

Total Preservation Credits = $\sum$ (M x A) = 1971.6

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
45 Foot Depth Alternative

MINIMUM UPLAND BUFFER WIDTHS FOR MITIGATION CREDIT †

Adjacent Land Use Category	Minimum Width
Single Family Residential	50 feet
Multi-Family	75 feet
Commercial	75 feet
Industrial	100 feet
Landfill	100 feet
Other Categories	case-by-case

† widths are based on linear, constant elevation measurement

BUFFER MITIGATION FACTORS

Factors	Options				
Upland Buffer Factor (U1)	>95% 1.0	68% to 95% 0.8	50% to 67% 0.6	33% to 49% 0.3	<33% 0.1
Buffer Enhancement Factor (U2)	>95% 0.15	50% to 95% 0.1	<50% 0.05		

UPLAND BUFFER CREDIT WORKSHEET

	Area 1	Area 2	Area 3	Area 4	Area 5
Total Jurisdictional Boundary (B1)*					
Buffered Jurisdictional Boundary (B2)*					
(B2 ÷ B1) x 100 = % Buffered					
Acres of Upland Buffer (A1)					
Upland Buffer Factor (U1)					
A1 x U1 = C1					
Aquatic Mitigation Area Acres (A2)					
Buffer Enhancement Factor (U2)					
A2 x U2 = C2					
C1 + C2 = D	D_1=	D_2=	D_3=	D_4=	D_5=

Total Buffer Credit = $\sum D_{1\text{-}5}$= ____

* B1 = Total linear feet of jurisdictional boundary of each proposed restoration, enhancement, preservation and/or creation area.
* B2 = Total linear feet of jurisdictional boundary proposed to be buffered for each restoration, enhancement, preservation and/or creation area.

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
45 Foot Depth Alternative

Mitigation Summary Worksheet For Permit Application #__45__

I. Required Mitigation	
A. Total Required Mitigation Credits =	5587.2

II. Mitigation Credit Summary	Credits	Acres
B. Mitigation Bank		
C. Restoration and/or Enhancement	3616	861
D. Creation		
E. Functional Replacement Mitigation = B + C + D		
F. Upland Buffer		
G. Preservation	1971.6	1643
H. Total Proposed Non-Bank Mitigation = E + F + G	5587.6	2504

The following criteria must be satisfied for the mitigation proposal to meet minimum SOP requirements:

1. Total Proposed Mitigation (Row H) must be greater than or equal to Total Required Mitigation Credits (Row A).

2. Functional Replacement Mitigation (Row E) must be at least 50% of Row A.

3. Preservation Mitigation (Row G) can be up to, but not more than 50% of Row A, if no Upland Buffer Credits are proposed. If Upland Buffer Credits are proposed, then Preservation Mitigation may be reduced to 30% of the Total Required Mitigation Credits.

4. Upland Buffer (Row F) cannot exceed 20% of the Total Required Mitigation (Row A). The following table provides examples of how Preservation and Upland Buffer Mitigation can be used in combination:

Total Required Mitigation Credits	Functional Replacement Credits	Preservation Credits	Upland Buffer Credits
100	50	50	0
100	50	40	10
100	50	30	20

MITIGATION WORKSHEETS

46-FOOT DEPTH ALTERNATIVE

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
46 Foot Depth Alternative

ADVERSE IMPACT FACTORS

Factor	Options						
Dominant Effect	Fill 2.0	Dredge 1.8	Impound 1.6	Drain 1.4	Flood 1.2	Clear 1.0	Shade 0.5
Duration of Effects	7+ years 2.0	5-7 years 1.5	3-5 years 1.0	1-3 years 0.5	< 1 year 0.1		
Existing Condition	Class 1 2.0	Class 2 1.5	Class 3 1.0	Class 4 0.5	Class 5 0.1		
Lost Kind	Kind A 2.0	Kind B 1.5	Kind C 1.0	Kind D 0.5	Kind E 0.1		
Preventability	High 2.0	Moderate 1.0	Low 0.5	None 0			
Rarity Ranking	Rare 2.0	Uncommon 0.5	Common 0.1				

† These factors are determined on a case-by-case basis.

REQUIRED MITIGATION CREDITS WORKSHEET

Factor	Fresh marsh	Area 2	Salt marsh	Area 4	Area 5	Area 6
Dominant Effect	0.5		0			
Duration of Effect	2		2			
Existing Condition	2		1.8			
Lost Kind	2		2			
Preventability	0.5		0.5			
Rarity Ranking	2		0.1			
Sum of r Factors	$R_1 = 9$	$R_2 =$	$R_3 = 6.4$	$R_4 =$	$R_5 =$	$R_6 =$
Impacted Area	$AA_1 = 201$	$AA_2 =$	$AA_3 = 757$	$AA_4 =$	$AA_5 =$	$AA_6 =$
R × AA =	1809		4844.8			

Total Required Credits = Σ (R × AA) = **6653.8**

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
46 Foot Depth Alternative

ESTABLISHMENT (CREATION) MITIGATION FACTORS

Factor	Options				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Hydrology	N. A. 0	Mechanical 0	Created 0.1	Natural 0.4	
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		
Vegetation	N/A 0	Natural 0.1	Planted 0.4		

PROPOSED ESTABLISHMENT (CREATION) MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Credit Schedule					
Hydrology					
Kind					
Maintenance					
Monitoring and Contingencies Plan					
Control					
Vegetation					
Sum of m Factors	M_1 =	M_2 =	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 =	A_3 =	A_4 =	A_5 =
M x A =					

Total Creation Credits = Σ (M × A) = _____

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
46 Foot Depth Alternative

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Net Improvement Hydrology	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		

PROPOSED RESTORATION/ENHANCEMENT MITIGATION WORKSHEET

Factor	Area 1	Brackish marsh	Area 3	Area 4	Area 5
Net Improvement Vegetation		1.4			
Net Improvement Hydrology		0.9			
Credit Schedule		0.4			
Kind		0.6			
Maintenance		0.2			
Monitoring and Contingencies Plan		0.2			
Control		0.5			
Sum of m Factors	M_1 =	M_2 = 4.2	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 = 959	A_3 =	A_4 =	A_5 =
M × A =		4027.8			

Total Restoration/Enhancement Credits = Σ (M × A) = **4027.8**

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
46 Foot Depth Alternative

PRESERVATION MITIGATION FACTORS

Factor	Options			
Degree of Threat	None 0	Low 0.1	Moderate 0.3	High 0.5
Kind	Category 2 0.2	Category 1 0.6		
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5	

PROPOSED PRESERVATION MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Degree of Threat	0.3				
Kind	0.4				
Control	0.5				
Sum of m Factors	M_1= 1.2	M_2=	M_3=	M_4=	M_5=
Mitigation Area	A_1= 2188	A_2=	A_3=	A_4=	A_5=
M x A =	2625.6				

Total Preservation Credits = Σ (M x A) = 2625.6

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
46 Foot Depth Alternative

MINIMUM UPLAND BUFFER WIDTHS FOR MITIGATION CREDIT †

Adjacent Land Use Category	Minimum Width
Single Family Residential	50 feet
Multi-Family	75 feet
Commercial	75 feet
Industrial	100 feet
Landfill	100 feet
Other Categories	case-by-case

† widths are based on linear, constant elevation measurement

BUFFER MITIGATION FACTORS

Factors	Options				
Upland Buffer Factor (U1)	>95% 1.0	68% to 95% 0.8	50% to 67% 0.6	33% to 49% 0.3	<33% 0.1
Buffer Enhancement Factor (U2)	>95% 0.15	50% to 95% 0.1	<50% 0.05		

UPLAND BUFFER CREDIT WORKSHEET

	Area 1	Area 2	Area 3	Area 4	Area 5
Total Jurisdictional Boundary (B1)*					
Buffered Jurisdictional Boundary (B2)*					
(B2 ÷ B1) x 100 = % Buffered					
Acres of Upland Buffer (A1)					
Upland Buffer Factor (U1)					
A1 x U1 = C1					
Aquatic Mitigation Area Acres (A2)					
Buffer Enhancement Factor (U2)					
A2 x U2 = C2					
C1 + C2 = D	D_1=	D_2=	D_3=	D_4=	D_5=

Total Buffer Credit = $\sum D_{1\text{-}5}$= ____

* B1 = Total linear feet of jurisdictional boundary of each proposed restoration, enhancement, preservation and/or creation area.
* B2 = Total linear feet of jurisdictional boundary proposed to be buffered for each restoration, enhancement, preservation and/or creation area.

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
46 Foot Depth Alternative

Mitigation Summary Worksheet For Permit Application #__46__

I. Required Mitigation	
A. Total Required Mitigation Credits =	6653.8

II. Mitigation Credit Summary	Credits	Acres
B. Mitigation Bank		
C. Restoration and/or Enhancement	4027.8	959
D. Creation		
E. Functional Replacement Mitigation = B + C + D		
F. Upland Buffer		
G. Preservation	2625.6	2188
H. Total Proposed Non-Bank Mitigation = E + F + G	6653.4	3147

The following criteria must be satisfied for the mitigation proposal to meet minimum SOP requirements:

1. Total Proposed Mitigation (Row H) must be greater than or equal to Total Required Mitigation Credits (Row A).

2. Functional Replacement Mitigation (Row E) must be at least 50% of Row A.

3. Preservation Mitigation (Row G) can be up to, but not more than 50% of Row A, if no Upland Buffer Credits are proposed. If Upland Buffer Credits are proposed, then Preservation Mitigation may be reduced to 30% of the Total Required Mitigation Credits.

4. Upland Buffer (Row F) cannot exceed 20% of the Total Required Mitigation (Row A). The following table provides examples of how Preservation and Upland Buffer Mitigation can be used in combination:

Total Required Mitigation Credits	Functional Replacement Credits	Preservation Credits	Upland Buffer Credits
100	50	50	0
100	50	40	10
100	50	30	20

MITIGATION WORKSHEETS

47-FOOT DEPTH ALTERNATIVE

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
47 Foot Depth Alternative

ADVERSE IMPACT FACTORS

Factor	Options						
Dominant Effect	Fill 2.0	Dredge 1.8	Impound 1.6	Drain 1.4	Flood 1.2	Clear 1.0	Shade 0.5
Duration of Effects	7+ years 2.0	5-7 years 1.5	3-5 years 1.0	1-3 years 0.5	< 1 year 0.1		
Existing Condition	Class 1 2.0	Class 2 1.5	Class 3 1.0	Class 4 0.5	Class 5 0.1		
Lost Kind	Kind A 2.0	Kind B 1.5	Kind C 1.0	Kind D 0.5	Kind E 0.1		
Preventability	High 2.0	Moderate 1.0	Low 0.5	None 0			
Rarity Ranking	Rare 2.0	Uncommon 0.5	Common 0.1				

† These factors are determined on a case-by-case basis.

REQUIRED MITIGATION CREDITS WORKSHEET

Factor	Fresh marsh	Area 2	Salt marsh	Area 4	Area 5	Area 6
Dominant Effect	0.5		0			
Duration of Effect	2		2			
Existing Condition	2		1.8			
Lost Kind	2		2			
Preventability	0.5		0.5			
Rarity Ranking	2		0.1			
Sum of r Factors	$R_1 = 9$	$R_2 =$	$R_3 = 6.4$	$R_4 =$	$R_5 =$	$R_6 =$
Impacted Area	$AA_1 = 223$	$AA_2 =$	$AA_3 = 740$	$AA_4 =$	$AA_5 =$	$AA_6 =$
R × AA =	2007		4736			

Total Required Credits = Σ (R × AA) = **6743**

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
47 Foot Depth Alternative

ESTABLISHMENT (CREATION) MITIGATION FACTORS

Factor	Options				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Hydrology	N. A. 0	Mechanical 0	Created 0.1	Natural 0.4	
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		
Vegetation	N/A 0	Natural 0.1	Planted 0.4		

PROPOSED ESTABLISHMENT (CREATION) MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Credit Schedule					
Hydrology					
Kind					
Maintenance					
Monitoring and Contingencies Plan					
Control					
Vegetation					
Sum of m Factors	M_1 =	M_2 =	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 =	A_3 =	A_4 =	A_5 =
M x A =					

Total Creation Credits = $\sum$ (M x A) =

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
47 Foot Depth Alternative

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Net Improvement Hydrology	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		

PROPOSED RESTORATION/ENHANCEMENT MITIGATION WORKSHEET

Factor	Area 1	Brackish marsh	Area 3	Area 4	Area 5
Net Improvement Vegetation		1.4			
Net Improvement Hydrology		0.9			
Credit Schedule		0.4			
Kind		0.6			
Maintenance		0.2			
Monitoring and Contingencies Plan		0.2			
Control		0.5			
Sum of m Factors	M_1 =	M_2 = 4.2	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 = 964	A_3 =	A_4 =	A_5 =
M × A =		4048.8			

Total Restoration/Enhancement Credits = $\sum$ (M × A) = 4048.8

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
47 Foot Depth Alternative

PRESERVATION MITIGATION FACTORS

Factor	Options			
Degree of Threat	None 0	Low 0.1	Moderate 0.3	High 0.5
Kind	Category 2 0.2	Category 1 0.6		
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5	

PROPOSED PRESERVATION MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Degree of Threat	0.3				
Kind	0.4				
Control	0.5				
Sum of m Factors	M_1= 1.2	M_2=	M_3=	M_4=	M_5=
Mitigation Area	A_1= 2245	A_2=	A_3=	A_4=	A_5=
M x A =	2694.2				

Total Preservation Credits = $\sum$ (M x A) = 2694.2

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
47 Foot Depth Alternative

MINIMUM UPLAND BUFFER WIDTHS FOR MITIGATION CREDIT †

Adjacent Land Use Category	Minimum Width
Single Family Residential	50 feet
Multi-Family	75 feet
Commercial	75 feet
Industrial	100 feet
Landfill	100 feet
Other Categories	case-by-case

† widths are based on linear, constant elevation measurement

BUFFER MITIGATION FACTORS

Factors	Options				
Upland Buffer Factor (U1)	>95% 1.0	68% to 95% 0.8	50% to 67% 0.6	33% to 49% 0.3	<33% 0.1
Buffer Enhancement Factor (U2)	>95% 0.15	50% to 95% 0.1	<50% 0.05		

UPLAND BUFFER CREDIT WORKSHEET

	Area 1	Area 2	Area 3	Area 4	Area 5
Total Jurisdictional Boundary (B1)*					
Buffered Jurisdictional Boundary (B2)*					
(B2 ÷ B1) x 100 = % Buffered					
Acres of Upland Buffer (A1)					
Upland Buffer Factor (U1)					
A1 x U1 = C1					
Aquatic Mitigation Area Acres (A2)					
Buffer Enhancement Factor (U2)					
A2 x U2 = C2					
C1 + C2 = D	D_1=	D_2=	D_3=	D_4=	D_5=

Total Buffer Credit = $\sum D_{1\text{-}5}$= ____

* B1 = Total linear feet of jurisdictional boundary of each proposed restoration, enhancement, preservation and/or creation area.
* B2 = Total linear feet of jurisdictional boundary proposed to be buffered for each restoration, enhancement, preservation and/or creation area.

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
47 Foot Depth Alternative

Mitigation Summary Worksheet For Permit Application # 47

I. Required Mitigation	
A. Total Required Mitigation Credits =	6743

II. Mitigation Credit Summary	Credits	Acres
B. Mitigation Bank		
C. Restoration and/or Enhancement	4048.8	964
D. Creation		
E. Functional Replacement Mitigation = B + C + D		
F. Upland Buffer		
G. Preservation	2694.2	2245
H. Total Proposed Non-Bank Mitigation = E + F + G	6743	3209

The following criteria must be satisfied for the mitigation proposal to meet minimum SOP requirements:

1. Total Proposed Mitigation (Row H) must be greater than or equal to Total Required Mitigation Credits (Row A).

2. Functional Replacement Mitigation (Row E) must be at least 50% of Row A.

3. Preservation Mitigation (Row G) can be up to, but not more than 50% of Row A, if no Upland Buffer Credits are proposed. If Upland Buffer Credits are proposed, then Preservation Mitigation may be reduced to 30% of the Total Required Mitigation Credits.

4. Upland Buffer (Row F) cannot exceed 20% of the Total Required Mitigation (Row A). The following table provides examples of how Preservation and Upland Buffer Mitigation can be used in combination:

Total Required Mitigation Credits	Functional Replacement Credits	Preservation Credits	Upland Buffer Credits
100	50	50	0
100	50	40	10
100	50	30	20

MITIGATION WORKSHEETS

48-FOOT DEPTH ALTERNATIVE

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
48 Foot Depth Alternative

ADVERSE IMPACT FACTORS

Factor	Options						
Dominant Effect	Fill 2.0	Dredge 1.8	Impound 1.6	Drain 1.4	Flood 1.2	Clear 1.0	Shade 0.5
Duration of Effects	7+ years 2.0	5-7 years 1.5	3-5 years 1.0	1-3 years 0.5	< 1 year 0.1		
Existing Condition	Class 1 2.0	Class 2 1.5	Class 3 1.0	Class 4 0.5	Class 5 0.1		
Lost Kind	Kind A 2.0	Kind B 1.5	Kind C 1.0	Kind D 0.5	Kind E 0.1		
Preventability	High 2.0	Moderate 1.0	Low 0.5	None 0			
Rarity Ranking	Rare 2.0	Uncommon 0.5	Common 0.1				

† These factors are determined on a case-by-case basis.

REQUIRED MITIGATION CREDITS WORKSHEET

Factor	Fresh marsh	Area 2	Salt marsh	Area 4	Area 5	Area 6
Dominant Effect	0.5		0			
Duration of Effect	2		2			
Existing Condition	2		1.8			
Lost Kind	2		2			
Preventability	0.5		0.5			
Rarity Ranking	2		0.1			
Sum of r Factors	$R_1 = 9$	$R_2 =$	$R_3 = 6.4$	$R_4 =$	$R_5 =$	$R_6 =$
Impacted Area	$AA_1 = 337$	$AA_2 =$	$AA_3 = 730$	$AA_4 =$	$AA_5 =$	$AA_6 =$
R × AA =	3033		4672			

Total Required Credits = Σ (R × AA) = **7705**

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
48 Foot Depth Alternative

ESTABLISHMENT (CREATION) MITIGATION FACTORS

Factor	Options				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Hydrology	N. A. 0	Mechanical 0	Created 0.1	Natural 0.4	
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		
Vegetation	N/A 0	Natural 0.1	Planted 0.4		

PROPOSED ESTABLISHMENT (CREATION) MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Credit Schedule					
Hydrology					
Kind					
Maintenance					
Monitoring and Contingencies Plan					
Control					
Vegetation					
Sum of m Factors	M_1 =	M_2 =	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 =	A_3 =	A_4 =	A_5 =
M x A =					

Total Creation Credits = $\sum$ (M x A) = ____

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
48 Foot Depth Alternative

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Net Improvement Hydrology	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		

PROPOSED RESTORATION/ENHANCEMENT MITIGATION WORKSHEET

Factor	Area 1	Brackish marsh	Area 3	Area 4	Area 5
Net Improvement Vegetation		1.4			
Net Improvement Hydrology		0.9			
Credit Schedule		0.4			
Kind		0.6			
Maintenance		0.2			
Monitoring and Contingencies Plan		0.2			
Control		0.5			
Sum of m Factors	M_1 =	M_2 = 4.2	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 = 1068	A_3 =	A_4 =	A_5 =
M × A =		4485.6			

Total Restoration/Enhancement Credits = Σ (M × A) = 4485.6

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
48 Foot Depth Alternative

PRESERVATION MITIGATION FACTORS

Factor	Options			
Degree of Threat	None 0	Low 0.1	Moderate 0.3	High 0.5
Kind	Category 2 0.2	Category 1 0.6		
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5	

PROPOSED PRESERVATION MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Degree of Threat	0.3				
Kind	0.4				
Control	0.5				
Sum of m Factors	M_1= 1.2	M_2=	M_3=	M_4=	M_5=
Mitigation Area	A_1= 2683	A_2=	A_3=	A_4=	A_5=
M x A =	3219.6				

Total Preservation Credits = $\sum$ (M x A) = 3219.6

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS
48 Foot Depth Alternative

MINIMUM UPLAND BUFFER WIDTHS FOR MITIGATION CREDIT †

Adjacent Land Use Category	Minimum Width
Single Family Residential	50 feet
Multi-Family	75 feet
Commercial	75 feet
Industrial	100 feet
Landfill	100 feet
Other Categories	case-by-case

† widths are based on linear, constant elevation measurement

BUFFER MITIGATION FACTORS

Factors	Options				
Upland Buffer Factor (U1)	>95% 1.0	68% to 95% 0.8	50% to 67% 0.6	33% to 49% 0.3	<33% 0.1
Buffer Enhancement Factor (U2)	>95% 0.15	50% to 95% 0.1	<50% 0.05		

UPLAND BUFFER CREDIT WORKSHEET

	Area 1	Area 2	Area 3	Area 4	Area 5
Total Jurisdictional Boundary (B1)*					
Buffered Jurisdictional Boundary (B2)*					
(B2 ÷ B1) x 100 = % Buffered					
Acres of Upland Buffer (A1)					
Upland Buffer Factor (U1)					
A1 x U1 = C1					
Aquatic Mitigation Area Acres (A2)					
Buffer Enhancement Factor (U2)					
A2 x U2 = C2					
C1 + C2 = D	D_1=	D_2=	D_3=	D_4=	D_5=

Total Buffer Credit = $\sum D_{1\text{-}5}$= ____

* B1 – Total linear feet of jurisdictional boundary of each proposed restoration, enhancement, preservation and/or creation area.
* B2 = Total linear feet of jurisdictional boundary proposed to be buffered for each restoration, enhancement, preservation and/or creation area.

WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
48 Foot Depth Alternative

Mitigation Summary Worksheet For Permit Application #___48_____

I. Required Mitigation	
A. Total Required Mitigation Credits =	6653.8

II. Mitigation Credit Summary	Credits	Acres
B. Mitigation Bank		
C. Restoration and/or Enhancement	4485.6	1068
D. Creation		
E. Functional Replacement Mitigation = B + C + D		
F. Upland Buffer		
G. Preservation	3219.6	2683
H. Total Proposed Non-Bank Mitigation = E + F + G	7705.2	3751

The following criteria must be satisfied for the mitigation proposal to meet minimum SOP requirements:

1. Total Proposed Mitigation (Row H) must be greater than or equal to Total Required Mitigation Credits (Row A).

2. Functional Replacement Mitigation (Row E) must be at least 50% of Row A.

3. Preservation Mitigation (Row G) can be up to, but not more than 50% of Row A, if no Upland Buffer Credits are proposed. If Upland Buffer Credits are proposed, then Preservation Mitigation may be reduced to 30% of the Total Required Mitigation Credits.

4. Upland Buffer (Row F) cannot exceed 20% of the Total Required Mitigation (Row A). The following table provides examples of how Preservation and Upland Buffer Mitigation can be used in combination:

Total Required Mitigation Credits	Functional Replacement Credits	Preservation Credits	Upland Buffer Credits
100	50	50	0
100	50	40	10
100	50	30	20

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

ADVERSE IMPACT FACTORS

Factor	Options						
Dominant Effect	Fill 2.0	Dredge 1.8	Impound 1.6	Drain 1.4	Flood 1.2	Clear 1.0	Shade 0.5
Duration of Effects	7+ years 2.0	5-7 years 1.5	3-5 years 1.0	1-3 years 0.5	< 1 year 0.1		
Existing Condition	Class 1 2.0	Class 2 1.5	Class 3 1.0	Class 4 0.5	Class 5 0.1		
Lost Kind	Kind A 2.0	Kind B 1.5	Kind C 1.0	Kind D 0.5	Kind E 0.1		
Preventability	High 2.0	Moderate 1.0	Low 0.5	None 0			
Rarity Ranking	Rare 2.0	Uncommon 0.5	Common 0.1				

† These factors are determined on a case-by-case basis.

REQUIRED MITIGATION CREDITS WORKSHEET

Factor	Brackish	Area 2	Saltmarsh	Area 4	Area 5	Area 6
Dominant Effect	2					
Duration of Effect	2					
Existing Condition	1.8					
Lost Kind	2					
Preventability	0.5					
Rarity Ranking	0.5					
Sum of r Factors	$R_1 = 8.8$	$R_2 =$	$R_3 =$	$R_4 =$	$R_5 =$	$R_6 =$
Impacted Area	$AA_1 = 15.68$	$AA_2 =$	$AA_3 =$	$AA_4 =$	$AA_5 =$	$AA_6 =$
R × AA =	138.0					

Total Required Credits = Σ (R × AA) = **138.0**

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

ESTABLISHMENT (CREATION) MITIGATION FACTORS

Factor	Options				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Hydrology	N. A. 0	Mechanical 0	Created 0.1	Natural 0.4	
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		
Vegetation	N/A 0	Natural 0.1	Planted 0.4		

PROPOSED ESTABLISHMENT (CREATION) MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Credit Schedule					
Hydrology					
Kind					
Maintenance					
Monitoring and Contingencies Plan					
Control					
Vegetation					
Sum of m Factors	M_1 =	M_2 =	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 =	A_3 =	A_4 =	A_5 =
M x A =					

Total Creation Credits = $\sum$ (M × A) = ____

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Net Improvement Hydrology	Minimal Enhancement 0.1 ---------- to ---------- Complete Restoration 1.4				
Credit Schedule	Schedule 5 0	Schedule 4 0.1	Schedule 3 0.2	Schedule 2 0.3	Schedule 1 0.4
Kind	Category 2 0.2	Category 1 0.6			
Maintenance	High 0	Moderate 0.1	Low 0.2	None 0.3	
Monitoring and Contingencies Plan	N/A 0	Minimum 0.1	Moderate 0.2	Substantial 0.3	Excellent 0.4
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5		

PROPOSED RESTORATION/ENHANCEMENT MITIGATION WORKSHEET

Factor	Area 1	Brackish marsh	Area 3	Area 4	Area 5
Net Improvement Vegetation		1.4			
Net Improvement Hydrology		1.4			
Credit Schedule		0.4			
Kind		0.6			
Maintenance		0.3			
Monitoring and Contingencies Plan		0.2			
Control		0.5			
Sum of m Factors	M_1 =	M_2 = 4.8	M_3 =	M_4 =	M_5 =
Mitigation Area	A_1 =	A_2 = 28.75	A_3 =	A_4 =	A_5 =
M × A =		138.0			

Total Restoration/Enhancement Credits = Σ (M × A) = **138.0**

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

PRESERVATION MITIGATION FACTORS

Factor	Options			
Degree of Threat	None 0	Low 0.1	Moderate 0.3	High 0.5
Kind	Category 2 0.2	Category 1 0.6		
Control	RC 0.1	RC + CE or GPP 0.3	RC + CE + GPP 0.5	

PROPOSED PRESERVATION MITIGATION WORKSHEET

Factor	Area 1	Area 2	Area 3	Area 4	Area 5
Degree of Threat					
Kind					
Control					
Sum of m Factors	M_1=	M_2=	M_3=	M_4=	M_5=
Mitigation Area	A_1=	A_2=	A_3=	A_4=	A_5=
M x A =					

Total Preservation Credits = Σ (M x A) =

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

MINIMUM UPLAND BUFFER WIDTHS FOR MITIGATION CREDIT †

Adjacent Land Use Category	Minimum Width
Single Family Residential	50 feet
Multi-Family	75 feet
Commercial	75 feet
Industrial	100 feet
Landfill	100 feet
Other Categories	case-by-case

† widths are based on linear, constant elevation measurement

BUFFER MITIGATION FACTORS

Factors	Options				
Upland Buffer Factor (U1)	>95% 1.0	68% to 95% 0.8	50% to 67% 0.6	33% to 49% 0.3	<33% 0.1
Buffer Enhancement Factor (U2)	>95% 0.15	50% to 95% 0.1	<50% 0.05		

UPLAND BUFFER CREDIT WORKSHEET

	Area 1	Area 2	Area 3	Area 4	Area 5
Total Jurisdictional Boundary (B1)*					
Buffered Jurisdictional Boundary (B2)*					
(B2 ÷ B1) x 100 = % Buffered					
Acres of Upland Buffer (A1)					
Upland Buffer Factor (U1)					
A1 x U1 = C1					
Aquatic Mitigation Area Acres (A2)					
Buffer Enhancement Factor (U2)					
A2 x U2 = C2					
C1 + C2 = D	D_1=	D_2=	D_3=	D_4=	D_5=

Total Buffer Credit = $\Sigma D_{1\text{-}5}$= ____

* B1 = Total linear feet of jurisdictional boundary of each proposed restoration, enhancement, preservation and/or creation area.
* B2 = Total linear feet of jurisdictional boundary proposed to be buffered for each restoration, enhancement, preservation and/or creation area.

WETLANDS AND OPEN WATERS MITIGATION WORKSHEETS

Direct Impacts to Saltmarsh

Mitigation Summary Worksheet For Saltmarsh and Brackish Marsh Impacts

I. Required Mitigation	
A. Total Required Mitigation Credits =	138.0

II. Mitigation Credit Summary	Credits	Acres
B. Mitigation Bank		
C. Restoration and/or Enhancement	138.0	28.8
D. Creation		
E. Functional Replacement Mitigation = B + C + D	138.0	28.8
F. Upland Buffer		
G. Preservation		
H. Total Proposed Non-Bank Mitigation = E + F + G	138.0	28.8

The following criteria must be satisfied for the mitigation proposal to meet minimum SOP requirements:

1. Total Proposed Mitigation (Row H) must be greater than or equal to Total Required Mitigation Credits (Row A).

2. Functional Replacement Mitigation (Row E) must be at least 50% of Row A.

3. Preservation Mitigation (Row G) can be up to, but not more than 50% of Row A, if no Upland Buffer Credits are proposed. If Upland Buffer Credits are proposed, then Preservation Mitigation may be reduced to 30% of the Total Required Mitigation Credits.

4. Upland Buffer (Row F) cannot exceed 20% of the Total Required Mitigation (Row A). The following table provides examples of how Preservation and Upland Buffer Mitigation can be used in combination:

Total Required Mitigation Credits	Functional Replacement Credits	Preservation Credits	Upland Buffer Credits
100	50	50	0
100	50	40	10
100	50	30	20

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX D: Monitoring and Adaptive Management Plan

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

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US Army Corps of Engineers
Savannah District
South Atlantic Division

Monitoring and Adaptive Management Plan

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Monitoring and Adaptive Management Plan

1 BACKGROUND

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) state that agencies may perform monitoring "to assure that their decisions are carried out and should do so in important cases." The Savannah Harbor Expansion Project is an important one, as it has the potential to adversely affect nationally important resources. In addition, since predictions are made about future effects to biological resources, there is a degree of uncertainty about the impacts which the recommended action would actually produce. Those uncertainties include both the accuracy of the predictive impact tools, the changes to the environment, and the biological responses that will occur as a result of changes in the environment. A site map on the following page shows the upper portion of the harbor, where natural resources are most at risk.

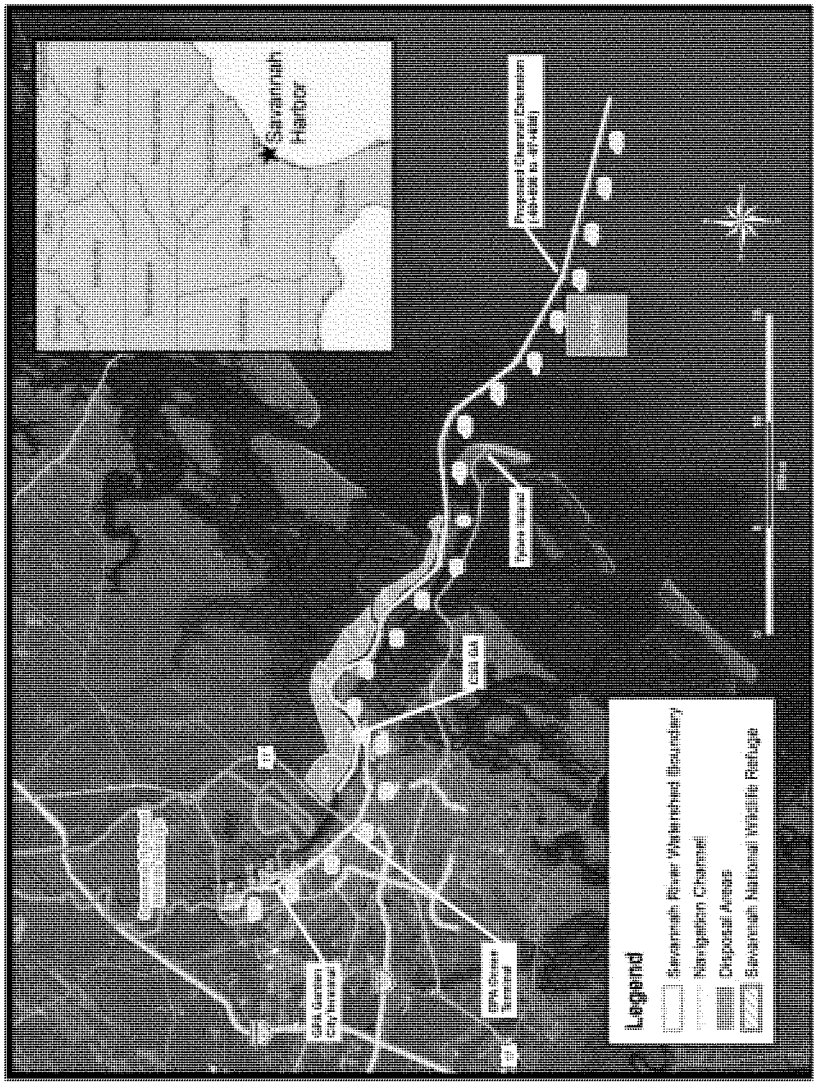
The approaches taken in this plan follow those described in the 2003 NEPA Task Force Report to the CEQ on Modernizing NEPA Implementation. This project will follow the following process, as described in that report:

Predict → Mitigate → Implement → Monitor → Adapt

Field investigations were conducted during the development of the EIS to identify important resources in the project area and obtain data from which to develop predictive tools for impact evaluation. Those correspond to the "Predict" step shown above. Field investigations will continue once a decision is reached on whether to implement the proposed harbor expansion. The studies will be conducted during two different phases of the "Implement" step shown above: both prior to and during construction. Other studies would be performed during the "Monitor" step. Long-term monitoring will be conducted over the life of the project. That phase is not shown in the process above. The various studies will vary by phase and may have a different purpose in each phase. These will be defined later in this document when the particular studies are discussed in detail. It should be noted that the Water Quality Monitoring Plan is included as an attachment to the Section 404(B)(1) Evaluation in Appendix H.

2 DEFINITION OF ADAPTIVE MANAGEMENT

For this project, adaptive management is defined as evaluating the accuracy of the predicted environmental impacts, assessing the effectiveness of the mitigation features, and modifying the project as needed to ensure the levels of environmental effects predicted in the Environmental Impact Statement (EIS) are not exceeded.


Savannah Harbor
Legend
Savannah River Watershed Boundary
Navigation Channel
Disposal Areas
Savannah National Wildlife Refuge
Proposed Channel Extension
(Jasper to Brunswick)
Jones Island
Elba Island
Fort Pulaski
National Monument
Fort Jackson
Savannah
City Hall
Talmadge
Memorial
Bridge
Hutchinson
Island
Port Wentworth
Garden City Terminal
Ocean Terminal
Kings Island
Turning Basin
Savannah
River
Back River
Wilmington
River
Little Back
River
Middle
River
Vernon
River
Wilmington
Island
Tybee
Island
Tybee
Roads
Tybee
Light
Fort
Pulaski
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Island
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3 GOALS OF AN ADAPTIVE MANAGEMENT PLAN

The definition of adaptive management as stated above has three components. There is a corresponding goal for the adaptive management program for each of those components.

The first component consists of evaluating the accuracy of the predicted environmental impacts. The corresponding goal is to improve the predictive capability of the models used to identify and quantify project-induced impacts. This includes both the hydrodynamic and water quality models. These models are explained in detail in other portions of this EIS, but they can be summarized as follows: The hydrodynamic model is a 3-dimensional computer model named the Environmental Fluid Dynamics Computer Code (EFDC) which was originally developed at the Virginia Institute of Marine Science and is now maintained by Tetra Tech under contract to the US Environmental Protection Agency (EPA). The model uses a finite difference solution scheme and a sigma-stretched vertical grid. The water quality model is the Water Quality Analysis Simulation Program (WASP), originally developed in 1983. The model includes the time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange. Both the water column and the underlying benthos can be included. These models are available to the public through the Total Maximum Daily Load (TMDL) Modeling Toolbox maintained by EPA Region 4. Tetra Tech applied the models to the Savannah River estuary and developed an enhanced grid which extends 61 miles upriver and 17 miles oceanward of the harbor entrance. The models' calibrations were approved by an interagency team including members of EPA Region 4, the USGS, the US Army Corps of Engineers' Engineering Research and Development Center (ERDC), the South Carolina Department of Health and Environmental Control (SC DHEC), and the Georgia Department of Natural Resources (GA DNR).

The second component consists of assessing the effectiveness of the mitigation features. Here the goal is to identify how effective the constructed mitigation feature is at reducing impacts. Physical parameters would be monitored within the estuary that describes how the system is functioning with the mitigation in place. Biota would also be monitored to determine the system's biological responses to those parameters. Natural variation will nearly guarantee that the conditions that actually occur in the first few years after construction will be different than the conditions under which the models were run during the feasibility phase. After post-construction monitoring data is available, the updated models would be rerun using the observed river flow conditions. This would provide the basis for the model's predictions for conditions under the observed conditions. Those predictions would be compared to the observed physical parameters to determine the accuracy of the models and the effectiveness of the mitigation features.

The final component is modifying the project as needed to ensure the levels of environmental effects predicted in the EIS are not exceeded. The goal for this component is to implement whatever modification is needed to the mitigation plan to keep the levels of observed environmental effects of the SHEP within the values predicted in the EIS. These modifications could occur any time during the construction or post-construction phases. If necessary, monitoring could continue beyond the length of the full post-construction monitoring program for the period needed to evaluate the effectiveness of a mitigation feature that was changed. All adaptive management project modifications would be monitored for a minimum of two years to

ensure that the modification was effective and that the observed environmental effects are then within the values predicted in the EIS.

4 IMPACT EVALUATION FRAMEWORK

The basic framework under which the project impacts are expected to occur is as follows:

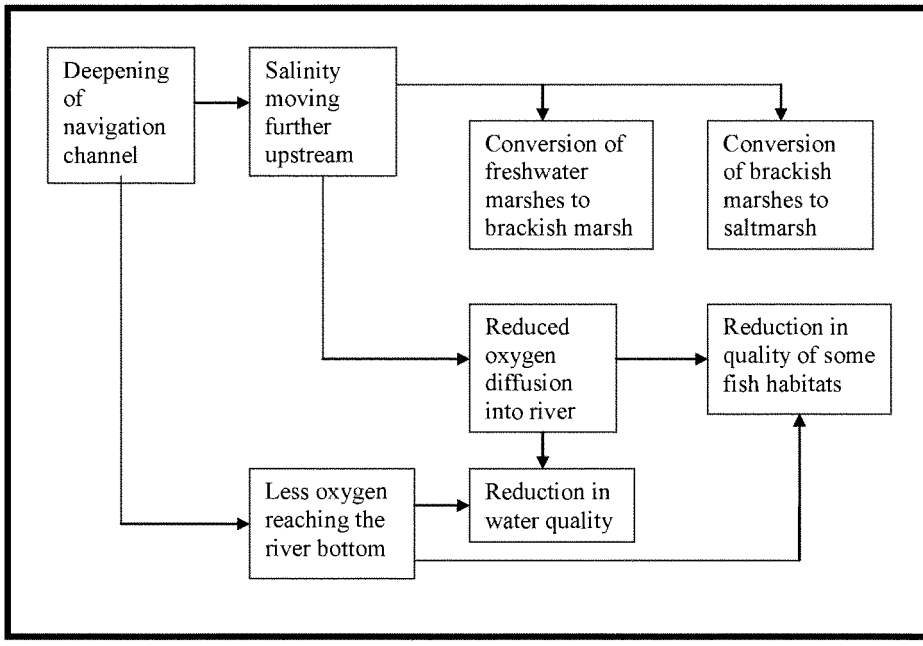

Figure 2. Impact evaluation framework.

5. PRE-CONSTRUCTION MONITORING

A. Goals. The first goal of the Pre-Construction Monitoring is to establish the baseline data bank for the Savannah Harbor estuary to assist with impact assessment during the Construction Monitoring and Post-Construction Monitoring phases of the project. Monitoring would be conducted for a period of one year before the construction begins which would affect aquatic resources in the inner harbor. This monitoring would be used to update the studies conducted during the feasibility phase and, thus, update the pre-project baseline from which impacts are measured. The Pre-Construction Monitoring would include eleven study efforts which are: (1) establishment of a baseline data bank; (2) monitoring of hydrologic and hydraulic data; (3) intense monitoring of hydrologic parameters within the lower estuary; (4) an assessment and recalibration (if required) of the hydrodynamic and water quality models; (5) groundwater monitoring; (6) monitoring of wetland sites; (7) bathymetric surveys to facilitate the assessment and recalibration of the hydrodynamic and water quality models; (8) monitoring of chloride levels within the vicinity of the City of Savannah's water intake on Abercorn Creeks; (9) Shortnose sturgeon distribution studies in the Savannah Harbor estuary; (10) Shortnose sturgeon study at the New Savannah Bluff Lock and Dam; and (11) establishment of ranges of predicted values. Prior to conducting the monitoring, the Corps would coordinate the sampling plans for the various monitoring study components with the natural resource agencies.

A second important goal will be to establish ranges of acceptable performance parameters for the Savannah Harbor estuary. While these may not be triggers for a specific action, they will indicate if the system is not performing as predicted so that the situation may be investigated. Performance will be established for specific conductance, salinity, flow, and concentration of dissolved oxygen (DO). An example for salinity is for specified flows at Clyo, ranges of modeled post project salinity values would be generated for each of the eight continuous water quality monitoring stations. From these data, graphs would be developed for each of the eight stations. A trendline and expected ranges of the modeled values would be developed. During construction and post-construction monitoring, data would be compared to these ranges to determine if the mitigation is performing as expected.

B. Major Components

1. Establishment of a Baseline Data Bank. In addition to the data that would be generated from the various Pre-construction monitoring studies, there is a wealth of existing data on resources in Savannah Harbor. The Corps would identify (with assistance from the Federal and state natural resources) existing data resources, reports, surveys, etc. that would provide useful data in regards to establishing the SHEP baseline. This information would include data on the resources of concern such as water quality, fisheries, groundwater, wetlands, etc. A baseline data bank would be established for use by the Corps, the Cooperating Agencies and the natural resource agencies. The cost to establish this data bank is estimated to be $100,000.

2. Collection of Hydrologic and Hydraulic Data. The relevant components of the Hydrologic Monitoring Plan that was developed in February 2006 by an interagency team and edited by the USGS SC Water Science Center for the Savannah River Estuary would be implemented. This monitoring would better define the complex interactions between the

estuarine ecosystem and the quantity and quality of water available. For this project, this would consist of installing and beginning to operate continuous recorders for hydrologic and hydraulic data. The project would fund USGS to perform this work for a period of one year.

The project would install and operate the following new continuous recording water quality stations:

- Middle River at GA 25, near Port Wentworth, GA
- Little Back River at GA 25, near Port Wentworth, GA
- Back River at US 17 at Savannah, GA
- Savannah River at I-95
- Lower Middle River in the fish hole

The project or project sponsor would fund operation of the following existing continuous recording water quality stations for this phase of the project:

- 02198920 Savannah River at GA25, at Port Wentworth, GA
- 021989773 Savannah River at USACE Dock at Savannah, GA
- 021989784 Little Back River above Lucknow Canal, near Limehouse, SC (independently funded by Georgia Ports Authority)

Continuous water level, streamflow, and water-quality data (water temperature, specific conductance, pH, dissolved oxygen and turbidity) would be collected on a 15-minute interval. All streamflow stations would use the new High-Data Rate (HDR) Geostationary Orbiting Earth Satellite (GOES) Data Collection Platforms (DCPs) to allow for hourly data transmissions, with one set of redundant data, during normal streamflow conditions. This would provide up to date hydrologic information. The streamflow stations would use thresholds to trigger random satellite transmissions during severe storms, and floods.

The Corps may not be able to install a piling in Middle River in the fish hole at a location that provides the information desired about that specific site, because the piling could be a hinderance to safe navigation. If further coordination reveals that a piling is not acceptable, then periodic manual sampling would be performed. The project would fund USGS or another qualified organization to perform this work.

The continuous real-time data would be available to resource managers and the general public through the USGS National Water Information System Web (NWISWeb) software or similar program. The USGS would also publish the collected data in the USGS Annual Data Report series. The PDF-report format would be available on the USGS publications web pages.

The estimated cost for this monitoring is $875,000, which is based on the following components:

Install new water quality stations	5 @ $50,000 = $250,000
Upgrade existing water quality stations	3 @ $35,000 = $105,000
Operate water quality stations for 1 year	8 @ $65,000 = $520,000
	Total = $875,000

The Corps would also include hydrologic and hydraulic data obtained by others during this pre-construction period.

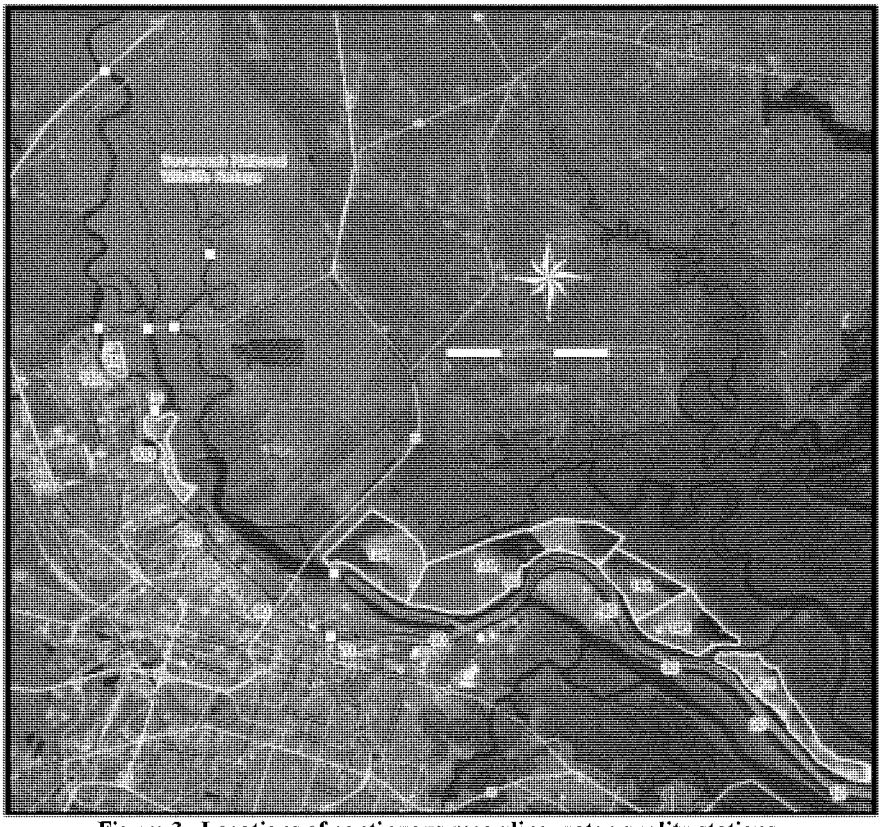

Figure 3. Locations of continuous recording water quality stations.

3. Intense Monitoring of Hydrologic Parameters within the Lower Estuary. Intense monitoring of hydrologic parameters within the lower estuary would be conducted for one lunar cycle (28-day period). This work would be conducted to provide information on the hourly, daily and weekly variations in the aquatic environment of the estuary. A report would be prepared and provided by the contractor performing the work. The information would be used to update the hydrodynamic and water quality models, if the data indicated that an update was warranted.

Intense sampling would be performed within the lower estuary over a lunar cycle during the summer. Sampling will be performed at multiple depths and at least twelve stations that will be

selected by the Corps in consultation with the resource agencies. This sampling would address those constituents considered important to evaluate the water quality regime in Savannah Harbor. It would also address how parameters change over a tidal cycle and over the course of a lunar cycle. It would be performed during the summer to monitor the estuarine system when the water quality is most stressed. The sampling would focus on the parameters that most affect water quality in the estuary. Those include river discharge, flow volumes, flow velocity, flow direction, water surface elevation, depth, salinity, dissolved oxygen, and water temperature. Some sampling would also be conducted for turbidity, suspended solids, pH, specific conductance, Biochemical Oxygen Demand (BOD) 5-day and chloride. Prior to conducting the event, a detailed monitoring plan will be coordinated with the Cooperating Agencies.

The estimated cost for the field monitoring is $350,000 and is based on the cost to perform a somewhat larger effort in Savannah Harbor in 1999. The cost would include a report of the data.

4. Update (If required) of the Hydrodynamic and Water Quality Models. The data gathered from the intense monitoring and the bathymetric surveys would be used to update the hydrodynamic and water quality models if the data indicate that an update is warranted, e.g. if the modeling performance guidelines are not being met, an update would be warranted. If the calibration of a model is revised, the model would be reviewed by the natural resource agencies. A report would be prepared addressing whether an update to the calibration of the models is warranted and if so, that update. Included in the report will be documentation of the changes in the resource impacts predictions by using the recalibrated model. The cost to assess and recalibrate the hydrodynamic and water quality models is estimated to be $120,000 and is based on recent similar efforts for the feasibility phase of the Savannah Harbor Expansion Project. The work would be performed by either the Corps or a modeling contractor.

5. Groundwater Monitoring. Monitoring of chloride in the Upper Floridan aquifer would be conducted along critical groundwater flow paths where chloride migrating downward through the confining unit beneath the Savannah River could move toward Savannah area production wells. Sentry wells would be installed along critical groundwater flow paths near the top of the aquifer to monitor downward migration of chloride through the confining unit and deeper in the aquifer to monitor how horizontal flow of freshwater within the aquifer mixes with and dilutes the chloride. The sentry wells would be located west of the locations of exploratory borings SHE-11 and SHE-13, and on Cockspur Island near Fort Pulaski. Monitoring wells would also be installed upgradient of critical groundwater flow paths to provide information on background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Background wells would be installed near the top of the aquifer and deeper in the aquifer. Six new groundwater monitoring wells would be installed. The Georgia DNR-EPD would approve the locations and depths of the background wells. Background chloride concentrations at sentry and background wells would be established. At least four background samples would be collected from each sentry and background well and statistical methods used to establish background chloride concentrations at each sentry and background well. The Georgia DNR-EPD would approve the collection of background samples and the statistical methods used to establish background chloride concentrations. The estimated cost to monitor the wells during the pre-construction monitoring is $30,000.

The Corps, in coordination with the Georgia DNR-EPD, would establish benchmark chloride concentrations for each sentry well. The Corps would determine what chloride concentrations caused by SHEP dredging activities would result in a measurable increase in chloride concentrations at Savannah area production wells. Savannah area production wells include industrial, commercial, municipal, agricultural, and other unpermitted wells. The benchmark chloride concentrations must be protective of the Savannah area production wells. The benchmarks would be established for each pair of sentry wells and for sentry wells near the top of the Upper Floridan aquifer and deeper in the aquifer. The benchmark concentrations established would require the approval of the Georgia DNR-EPD. The Corps would also develop a remediation and implementation plan which could be implemented if it is determined that the chloride entering the Upper Floridan aquifer due to deepening through the confining unit could affect Savannah area production wells. The plan would include adaptive management measures specific to accelerated chloride intrusion into the aquifer. This plan would be submitted to the Georgia DNR-EPD for review and approval.

6. Monitoring of Wetland Sites. Six of the seven marsh sites previously monitored by the USGS Florida Fish and Wildlife Cooperative Research Unit would be monitored again as part of this project. Figure 4 shows the location of both the old and new monitoring locations.

In this phase, the distribution and density of wetland vegetation would be would be monitored for one year. The marsh transects would be sampled twice annually (June and October), and sampling protocols would follow those described in Kitchens (2003) and generally follow those performed when the USGS monitored in 2000/2001. The Coop Unit would prepare and provide a report of their findings.

The project would install and operate new continuous recording stations at the twelve tidal marsh locations where wetland vegetation would be monitored. The six new monitoring locations were chosen to expand monitoring in highly sensitive marshes, in areas where significant salinity changes are possible under a variety of scenarios, and to monitor community shifts both vertically (up and down river) and laterally (interior vs. exterior). The preliminary locations are shown in Figure 4, although some adjustments may be made prior to commencement of the work; these adjustments would be made in close consultation with the resource agencies. These tidal marsh stations would record water surface elevation, specific conductance of surface waters that flood the marsh, and specific conductance of waters in the root zone, and water depth every 30 minutes. The recorded data would be downloaded monthly. Wetland vegetation would be monitored for one year. This would include sampling over two seasons. The project would fund the USGS Florida Fish and Wildlife Cooperative Research Unit to perform the work. They would monitor the same 6 sites as they did in 2000/2001 as well as the six additional marsh locations. They would prepare and provide a report of their findings.

The estimated cost for this initial monitoring is $336,000, which is based on the following components:

Install tidal marsh stations	12 @ $10,000	= $120,000
Operate tidal marsh stations for 1 year	12 @ $20,000	= $240,000
	Total	= $360,000

The cost for this initial monitoring is somewhat higher than would be needed for a repetitive operation due to the initial equipment purchases. These costs also include the twice-a-year vegetation sampling and analysis that the Florida Coop Unit would perform as part of their marsh monitoring.

Figure 4. Wetlands monitoring locations.

7. Bathymetry Monitoring. The Corps would conduct or fund bathymetric surveys of the riverine areas not normally surveyed to obtain up-to-date information on the depth and width of the tidal rivers that are included in the hydrodynamic model. Those surveys would typically consist of bank-to-bank cross-sectional surveys performed on 500-foot intervals. These surveys would cover the Front, Middle, and Back Rivers from I-95 to Old Fort Jackson. The estimated cost for this work is $158,000.

8. Chloride Monitoring. The Corps would conduct or fund monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek. This work would consist of two components. The first component consists of an automated sampler to be installed near the City's water intake to collect samples on at least a daily basis. These samples would be collected and analyzed in a laboratory to identify chloride levels at the intake. All of the collected samples may not be analyzed, dependent upon flow and tide variables. The second component is installation of two chloride meters; one at the City intake and one in Abercorn Creek near its confluence with Savannah River. The lab analyses will be used to verify the data collected by the meters and determine their level of accuracy and reliability with the low chloride levels that are generally encountered. The meter data will also be used to provide additional detail, including trends and timing, between the lab samples. One or both of the meters are expected to be a permanent installation, whose operation and maintenance would become a responsibility of the City of Savannah when the SHEP monitoring period ends. The estimated cost for this work is $250,000.

9. Shortnose Sturgeon Distribution Study in the Savannah Harbor Estuary. The distribution of Shortnose sturgeon in the harbor would be monitored for one year, possibly by the SC DNR Marine Resources Division in much the same manner as the study conducted in 1999/2000. This monitoring would include capturing, tagging and tracking both adult and juvenile sturgeon. Water quality would be measured and documented where sturgeon are captured and later found. Monitoring would be performed in each season. The study area would include Front, Middle, and Back Rivers. The bottom substrate would be identified when fish are found to intensively use a specific area. Water quality data will also be collected at receiver location. The work would not track fish over a 24-hour period, as had been conducted in 1999/2000. That information would not be needed for this project. The Corps would coordinate with NOAA Fisheries on the scope of work before the work began. The contractor will prepare and provide a report of their findings. The estimated cost for this monitoring is $200,000.

10. Shortnose Sturgeon at New Savannah Bluff Lock and Dam. The movement of fish at the New Savannah Bluff Lock and Dam (NSBL&D) would be monitored for one year. This monitoring would include capturing, tagging and tracking Shortnose sturgeon and possibly other representative species of the NSBL&D area fish community (Striped bass, Robust redhorse, and American shad). Based on availability, up to 25 Shortnose sturgeon (and a total of 75 fish) would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be captured within 1 km of the dam by electrofishing, hook and line, or gill net.

USGS would monitor fish continuously in the vicinity of NSBL&D using a fixed station radio receiver. In addition, during the migration season they would search the river weekly between NSBL&D and the Jackson, SC Landing and NSBL&D and the Augusta Water Supply Dam for

fish with transmitters. On a monthly basis, they would search the Savannah River from the Savannah Harbor Kings Island Turning Basin to the NSBL&D, and above to the Augusta Water Supply Dam. When located, species, identification number, and location would be recorded. Temperature would be recorded several times daily using temperature loggers established at fixed locations at NSBL&D, 1, 10, 50, 100 and 200 km below the dam, and 1 km above the dam. Dissolved oxygen concentration, turbidity, and river stage at NSBL&D would be recorded at least weekly. Dam discharge will be recorded daily.

The contractor will prepare and provide a report of their findings. The estimated cost for this initial monitoring is $300,000.

11. Establish Ranges of Predicted Values. The hydrodynamic and water quality models would be used to establish ranges of predicted values for performance parameters at specific points in the Savannah Harbor estuary. From these datasets, graphs for specific monitoring points in the estuary would be created. An example graph is shown below. The graph will include a trendline and expected ranges for existing conditions at the same monitoring points for comparison to conditions observed during the construction period. Inclusion of existing conditions trends will be important to the comparison because in some locations (i.e., Front River) salinity will be increasing while in other locations (i.e., Back River) salinity will be decreasing. An example of this follows:

For specific conductance, which is a model output parameter, trendlines and expected ranges of modeled specific conductance values would be prepared for specified freshwater flows at each of the eight continuous water quality monitoring stations for post-project and existing conditions. From this data, graphs would be developed for each monitoring station (see below). The y-axis would be specific conductance values and the x-axis would be freshwater flow values as measured at Clyo. The trendline and expected ranges of the modeled values could then be compared to water quality data collected during construction.

For dissolved oxygen, another model output parameter, trendlines and expected ranges of modeled DO values would be prepared for specified freshwater flows (or another parameter) at each of the eight continuous water quality monitoring stations. However, correlation of DO datasets to freshwater flows (or another parameter) would be useful for making only general comparisons. While salinity and conductivity variations in the harbor are largely dependent on tides and freshwater flows, DO in the harbor is influenced by several other factors, including temperature and waste discharge volumes to the river. Since the industries report their waste discharge volumes to the states on a monthly basis, detailed comparisons of expected (modeled) and observed data would not be available for DO on a real-time basis.

For flow, model data would show predicted flows at the three water quality stations along the Georgia Highway 25 / South Carolina Highway 170 Bridge for various river flows at Clyo.

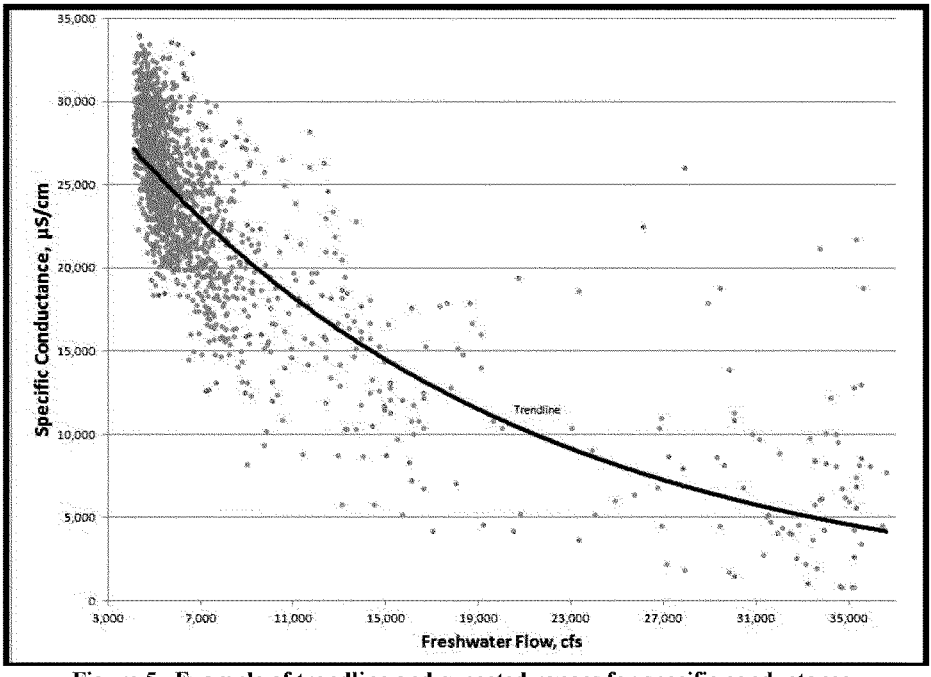

Figure 5. Example of trendline and expected ranges for specific conductance.

C. Reporting

The Corps would establish a website that is available to the public which will house data and reports that become available during the pre-construction period. Data obtained by USGS from the continuous water quality monitoring would be included in the annual reports that they post on their websites and make available to the public. A summary of reports to be provided by the Corps for the Pre-Construction Monitoring is as follows:

Report on Intensive Monitoring of Hydrologic Parameters

Report on Update of the Hydrodynamic Models

Annual Report on Groundwater Monitoring

Report on Monitoring of the 12 Wetland Sites

Report of the Monitoring of Shortnose sturgeon in the Savannah Harbor Estuary

Report on the Monitoring of Shortnose sturgeon at the NSBL&D

Report of ranges of predicted performance values for parameters at specific points in the Savannah Harbor estuary during construction

D. Cost Summary

The costs for the monitoring that would be performed during the pre-construction period are summarized as follows:

Baseline Data Bank	$100,000
Continuous Riverine Monitoring	$875,000
Intense Monitoring	$350,000
Assess & Recalibrate Models	$120,000
Bathymetry Monitoring	$158,000
Chloride Monitoring	$250,000
Groundwater Monitoring	$30,000
Wetlands	$360,000
Shortnose sturgeon-Savannah Harbor	$200,000
Shortnose Sturgeon-NSBL&D	$300,000
Reporting	$50,000
Oversight & Contracting	$100,000
Pre-Construction Total:	**$2,893,000**

6. MONITORING DURING CONSTRUCTION

A. Goals. Monitoring would be conducted during the construction period to ensure the construction is performed within the environmental constraints imposed by the EIS and the approvals of the natural resource agencies. Monitoring would also be performed to ensure that levels of impacts predicted in the EIS are not exceeded and that unexpected impacts do not present themselves. The length of the construction period will depend on the amount of funds that are received to perform the work. At present, the estimated construction period is about 4 years. The Corps would perform the monitoring described in this section for whatever length of time it takes to construct the project. The cost estimates shown below assume a 4-year construction estimate. If construction requires more than four years, monitoring during construction will be extended to ensure that levels of impacts predicted in the EIS are not exceeded and that unexpected impacts do not present themselves. Additional funding will be secured to accomplish this rather than reducing the planned post-construction monitoring and adaptive management.

B. Major Components. Monitoring during the Construction phase would include fifteen major study components. Some of these study components (five) would be a continuation of study efforts started during the Pre-construction phase, while others would be initiated to specifically address the potential impacts of the project that could occur during the construction phase.

The Corps would continue to operate the eight continuous recorders for hydrologic and hydraulic data that were established or funded as part of the Pre-Construction Monitoring. The monitoring of the 12 marsh sites would be continued (with the exception of during year 1 of construction), as would groundwater monitoring, monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek, and monitoring the distribution of Shortnose sturgeon in the Savannah Harbor estuary.

New monitoring efforts that would be conducted during the construction phase include:

- a bathymetric survey of the Sediment Basin to facilitate the model assessments
- an assessment of how well the models predict the salinity and dissolved oxygen levels during construction
- a Transfer Efficiency Study (oxygen injection systems)
- monitoring effluent from the seven CDFs that would be used for disposal of the dredged material
- monitoring dissolved oxygen concentrations in the vicinity of the dredge during the summer months
- monitoring cadmium in the inflow and effluent in CDFs 14A and 14B
- monitoring cadmium levels in the sediments placed in CDFs 14A and 14B
- wildlife use surveys in CDFs 14A and 14B
- biological monitoring of cadmium levels in birds (tissue or blood samples) that use CDFs 14A and 14B, both before and during placement of cadmium-laden sediments

On a regular basis (every four months), the Corps would assess how well the hydrodynamic and water quality models predict the salinity and D.O. levels that are occurring during the construction process. This process will serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after the project's construction is complete.

As part of the assessment of the hydrodynamic and water quality models predictions, the Corps would conduct bathymetric surveys of the Sediment Basin. This information would be needed to allow the hydrodynamic model to reflect the changing conditions that would occur during the construction period.

In addition to the specific construction monitoring components listed above, the Corps would perform its normal quality assurance inspections during construction. The Corps places the environmental compliance requirements that it receives from natural resource agencies for a proposed action in the contract documents that it prepares for the work. The contractor who performs the work is then responsible for performing the work in compliance with those requirements. The Corps' inspectors provide quality assurance by overseeing the work

performed by the dredging and civil engineering contractors. Those inspectors ensure the contractors perform the work within the environmental clearances obtained for the project.

C. Details of the Monitoring

1. Hydrologic and Hydraulic Data Collection. The Corps would fund operation of the continuous monitoring in the rivers. Operation of one station (Savannah River at USACE Dock) is being fully funded by another source and would not be an expense for this project. Similarly, some of the operating costs for three other existing stations are being funded by another source and would not be an expense for this project. This riverine monitoring would be performed by the USGS. The costs for this work are estimated as follows:

Operate water quality stations	4 years x 8 @ $65,000 = $2,080,000

2. Monitoring of Wetland Sites. The Corps would continue to fund monitoring of the 12 marsh sites during years 2, 3, and 4 of construction, when dredging occurs in the inner harbor. Monitoring of wetland sites would temporarily cease during year 1 when no inner harbor dredging is expected to occur. This monitoring would be performed by the USGS Florida Fish and Wildlife Cooperative Research Unit. The costs for this work are estimated as follows:

Monitor marsh sites	3 years x 12 @ $20,000 = $720,000

A report would be prepared at the end of the construction monitoring summarizing the results of this study.

3. Chloride Monitoring. Monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek would continue during the construction phase of the project. Monitoring would be performed to ensure unforeseen increases in chloride levels do not occur during the construction period. The Corps would fund or perform this work. The estimated cost for this work is as follows:

Chloride monitoring	4 years x $100,000 = $400,000

4. Groundwater Monitoring. The Corps would continue to conduct or fund monitoring of chloride levels in the Floridan aquifer. The project would use the sentry and background gradient wells that were installed during the pre-construction monitoring period for this purpose. Chloride levels would be recorded four times a year in each well. An annual monitoring report would be prepared and provided to the Georgia DNR-EPD by January 31st of each year following the initiation of dredging. The report would include the results of the previous year's monitoring. Additionally, differences in the long-term trends of chloride concentrations in the sentry and background wells would be used to evaluate the impacts of SHEP dredging activities from impacts of groundwater withdrawals on chloride concentrations in the Upper Floridan aquifer. The estimated cost for this work is as follows:

Groundwater monitoring	4 years x $7,500 = $30,000

5. Shortnose Sturgeon Distribution Study-Savannah Harbor. The Corps would fund monitoring of Shortnose sturgeon distribution in Savannah Harbor each year of the construction period. This monitoring would duplicate the work conducted in the Pre-Construction Monitoring. The costs for this work are estimated as follows:

Shortnose sturgeon monitoring	4 years x $200,000 = $800,000

A report would be prepared at the end of construction monitoring summarizing the findings of this study.

6. Bathymetric Surveys of the Sediment Basin. The Sediment Basin would be allowed to fill naturally after construction of the submerged sill at its lower end. The depths in the Sediment Basin affect water and salinity movement up Back River, and the Basin will likely be filling throughout the duration of the construction and some of the post-construction monitoring period. As a result, bathymetric surveys will be needed of the Basin on a periodic basis to perform a proper assessment of the hydrodynamic model's accuracy in predicting conditions that are being observed during the monitoring period. The Corps would perform or fund these surveys, which would be conducted every 4 months. The costs for these surveys are estimated as follows:

Bathymetric surveys of Sediment Basin	4 years x 3 x $25,000 = $300,000

7. Transfer Efficiency Study. The work would also include a Transfer Efficiency Study of the dissolved oxygen systems. That near-field study would identify the efficiency at which the systems add oxygen to the estuarine waters. The Corps would provide the resource agencies with an opportunity to review the study plan and propose methods of monitoring and data analysis. The Corps would use this efficiency rate to determine how it needs to operate the systems to add the amount of oxygen determined by the modeling to be needed to compensate for the impacts of the harbor deepening project. This Transfer Efficiency Study would be conducted when construction of the oxygen injection systems is complete. As presently scheduled, that would occur early in the schedule for construction of the overall project. The two downstream oxygen injection systems (Hutchinson Island) are scheduled to be installed and operational prior to commencement of dredging the inner harbor, and the upstream system (near Georgia Power's Plant McIntosh) is scheduled to be complete and operational within one year of that point. A report would be prepared describing the results of the study as well as prescribing the standard operating procedures for the oxygen injection systems. This study is estimated to cost $300,000.

8. Model Predictions of Dissolved Oxygen and Salinity during Construction. The Corps will regularly assess (every four months) how well the hydrodynamic and water quality models predict the salinity and D.O. levels that are occurring during the construction process. The Corps expects the dredging in the navigation channel upstream of Fields Cut to generally proceed at about 2,900 feet per month, so the hydrodynamics of the estuary would not be altered substantially on a monthly basis. The assessment would be performed by comparing the models' predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the new bathymetry and the actual river flows would

be used. Conducting this assessment every 4 months is believed to be sufficient to identify the emergence of any unexpected results. This process would serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after construction is complete. The costs for these assessments are estimated as follows:

Assess Hydrodynamic and WQ models 4 years x 3 x $60,000 = $720,000

9. Monitoring of Effluent from the CDFs. The effluent from all of the CDFs used for the SHEP would be monitored to ensure that no applicable water quality standards would be violated. At the beginning of deposition of new work material, into the CDFs, the contractor would construct a 500 mg/L Total Suspended Solids (TSS) standard and determine turbidity (in NTUs) associated with the standard. The contractor would then visually compare effluent turbidity at each of the discharging weirs to the standard on a daily basis. The contractor would measure (weekly) turbidity at each outfall pipe with a discharge. Measurements would include dissolved oxygen, salinity, conductivity, temperature and turbidity. Measurements would be made with a Hydrolab or similar instrument. A water sample would be obtained from each outfall pipe every two weeks and analyzed for NTUs, TSS in mg/L. Monitoring reports would include the results of the sampling and analyses (as well as the discharge point and dates of discharge) and be submitted to the Georgia DNR-EPD , SC DHEC, and USFWS on a monthly basis. The annual cost for this monitoring is about $143,000.

10. Monitoring of Dissolved Oxygen Levels in the Vicinity of the Dredge during the Summer Months. Dissolved oxygen levels in Savannah Harbor become stressed during the summer months. The Corps is required to monitor dissolved oxygen levels in the vicinity of hydraulic pipeline dredges performing dredging in the inner harbor during the summer months. This monitoring would also be implemented during the SHEP construction. The cost for this monitoring is about $75,000 per year. The Corps will coordinate a detailed monitoring plan with Georgia DNR-EPD prior to conducting these events. The standard for the monitoring agreed upon with NMFS and the GA DNR EPD is:

> "Dredging operations must maintain a daily average of 5.0 mg/L and an instantaneous average of 4.0 mg/L throughout the water column during those times of year when the ambient condition in the waterbody has a dissolved oxygen level above these values. If it is determined that the ambient condition in the waterbody is less than these values, the criteria will revert to the "ambient condition" and the water quality standard will allow for a 0.1 mg/L deficit from the "ambient" dissolved oxygen value. Since the available dissolved oxygen deficit has already been allocated, the USACE will only be able to conduct maintenance dredging when the dissolved oxygen, one meter from the bottom, is 3.0 mg/L or greater and the maintenance dredging does not affect the dissolved oxygen levels in the Savannah River Harbor. Exceptions for maintenance dredging when dissolved oxygen levels are less than 3.0 mg/L may be allowed if coordination occurs with NMFS and GA DNR-EPD and subsequent issuance of a waiver from GA DNR-EPD."

11. Monitoring of Inflow and Effluent in CDFs Containing Cadmium-Laden Sediments. All cadmium-laden sediments would be placed in CDFs 14A and/or 14B. Detailed design could result in the deposition of all cadmium-laden sediments in a single DMCA -- #14A. Monitoring of dredging and disposal operations in areas with cadmium-laden sediments would require monitoring of the inflow and effluent from CDFs 14A and/or 14B for cadmium.

Additional monitoring of the inflow and discharges from CDFs 14A and 14B where cadmium-laden sediments would be placed would be conducted. Samples would be taken from the inflow (head section of the discharge pipe) on a weekly basis. Sampling would be conducted weekly to determine the cadmium concentrations in the effluent discharged from CDFs 14A and 14B Should the effluent dissolved cadmium concentration be found to be higher than the State standard (8.8 ug/L for South Carolina), sampling would be repeated within two days and would include both the outfall pipe sample and a receiving water sample taken approximately 100 feet down current of the point at which the effluent enters the receiving water. Should the receiving water sample be found to violate State standards, corrective action would be undertaken to eliminate the violation. Monitoring of the effluent from CDFs 14A and 14B for cadmium would continue as long as a discharge occurs and until all sediments have been dewatered, stabilized and covered. Following the installation of a clean cover, cadmium would be monitored in the effluent for one year. The above effluent monitoring plan will include a quarterly metals analytical scan with the inclusion of ammonia. The results of the effluent monitoring plan would be reported to the Georgia DNR-EPD, SC DHEC, and USFWS on a quarterly basis. The estimated cost to conduct this monitoring in CDFs 14A and 14B is $380,000.

12. Analyses of Sediments Placed in CDFs 14A and/or 14B. Sampling of cadmium-laden sediments discharged into CDFs 14A and 14B would also be conducted during construction. Once placement of the cadmium-laden sediments has been completed in the CDF, grab samples would be collected to characterize the cadmium levels of the surface sediments. This would occur prior to the placement of the cover. Approximately 86 grab samples would be collected to a depth of 15 cm of the surface of the sediments in 14A and 14B and analyzed for cadmium. After the cover has been placed, approximately 86 grab samples would be collected and analyzed to characterize the cadmium levels in the exposed cover sediments. The samples will be evenly spaced across the CDFs. If the concentrations of cadmium in the sediments are less than 4 mg/kg, the sampling would be complete. If the distribution of sediments with a cadmium concentration of 4 mg/kg or greater extends over a cumulative area of 25 acres or greater, sediments from operation and maintenance dredging would be scheduled to be placed in the area at the earliest possible time to provide an additional cover. After placement of the cover of operation and maintenance material is placed into the CDF, sediment sampling and analyses would be conducted again as previously described, except samples will be collected to a depth of 30 cm. This process would be repeated until cadmium concentrations in the sediments were less than 4mg/kg. The estimated cost to conduct this monitoring in CDFs 14A and 14B is $416,000 per year for two years. Detailed design could result in the deposition of all cadmium-laden sediments in a single DMCA – CDF 14A.

13. Wildlife Use in CDFs 14A and 14B. The Corps would perform monthly wildlife use surveys in CDFs 14A and 14B. These one-day surveys would record all birds and other major vertebrates seen within each CDF. Monitoring would be performed during placement of sediment and for a minimum of three years after placement is complete and continue as long as other cadmium-related sampling is occurring. If there is a concern about the number of birds or other animals or a particular species using the CDF, some type of hazing may be appropriate. Any hazing decisions would be coordinated with the USFWS.

14. Avian Blood/Feather Monitoring in CDFs 14A and/or 14B. During Year 1 of construction and prior to commencement of dredging in the inner harbor, baseline avian blood/feather sampling would be conducted in CDFs 14A and/or 14B to determine background avian cadmium blood levels. Blood/feather monitoring would continue throughout the remainder of the construction period (estimated to be three additional years) during placement of cadmium-laden sediments and the cap/cover in CDFs 14A and 14B. Since the CDFs would reenter the rotation program after the covering sediments have been placed, the CDFs may be dry or wet, depending on the year. Their hydrologic condition will drastically alter their bird use, as different species use the CDFs in those two conditions. The season also drastically affects bird use of the CDFs. Sampling would be timed to correspond when the majority of each species arrives and mid-season which corresponds to approximately April and September. Sampling in April would maximize exposure time for wintering species (September through April), while sampling in about September should maximize exposure time for summer nesting species (April through September). All work will be closely coordinated with the USFWS prior to commencement, including potentially substituting reference site sampling or liver tissue sampling with a smaller target sample size for the baseline dataset if agreed to by the USFWS. The estimated cost to conduct this monitoring is $100,000 per year.

D. Reporting

The Corps would post the monitoring information on the public website as it becomes available. The USGS would include the hydrologic and hydraulic data collected from the continuous recorders in their annual report to the state.

A summary of reports that would be prepared to address the various monitoring efforts that would be conducted during the construction phase is as follows:

- A report summarizing the findings of the three years of monitoring of the 12 wetland sites.
- Annual reports of the groundwater monitoring data to be submitted to Georgia DNR-EPD by January 31st of the following year.
- A report summarizing the findings of the four years of monitoring of Shortnose sturgeon distribution in the Savannah Harbor estuary.
- A report on the results of the Transfer Efficiency Study
- Twelve reports summarizing the results of the hydrodynamic and water quality model assessments. The Corps would prepare a brief technical paper after each assessment of the hydrodynamic and water quality models documenting the findings of the comparison between observed water quality data and predicted levels. The Corps would provide this

report and hydrodynamic and water quality model output data to the natural resource agencies. After a 30-day review period, the Corps would revise the report as necessary and place it on the public website.

- Monthly reports containing the data from the monitoring of the effluent from CDFs used for dredged material from the SHEP. These reports would be sent to the Georgia DNR-EPD, SC DHEC, and USFWS as wells as being posted online.
- Quarterly reports containing the data from the monitoring of the effluents from CDFs 14A and 14B for cadmium and other analytes. These reports would be sent to the Georgia DNR-EPD, SC DHEC, and USFWS as well as being posted online.
- A summary report of the findings of the monitoring efforts for the construction phase of the project. At the end of the construction period, the Corps would prepare a report of the data obtained during this phase. For the hydrologic and hydraulic data, the report would include the Corps' conclusions about the comparisons between observed water quality data and predicted levels. The Corps would provide this report to natural resource agencies and make it available to the public.

E. Cost Summary

The costs for the monitoring that would be performed during a 4-year construction period are summarized as follows:

Continuous Riverine Monitoring	$2,080,000
Bathymetry Monitoring (Sediment Basin)	$300,000
Chloride Monitoring	$400,000
Groundwater Monitoring	$30,000
Transfer Efficiency Study	$300,000
Wetlands	$720,000
Shortnose sturgeon	$800,000
Assess Hydrodynamic and WQ models	$720,000
Monitoring of DO-Dredge	$300,000
Monitoring of Effluent from CDFs	$572,000
Cadmium Monitoring-Effluent	$380,000
Cadmium Monitoring-Sediments	$832,000
Wildlife Use Studies-CDFs	$300,000
Avian Blood/Feather Monitoring	$400,000
Reporting	$200,000
Oversight & Contracting	$400,000
During Construction Total:	**$8,734,000**

7. POST-CONSTRUCTION MONITORING

A. Goals. The main goal of the Post-Construction Monitoring is to verify that the project does not produce more impacts than predicted and that the mitigation features function as they were designed.

Monitoring conducted during the Post-Construction monitoring period would include many of the same study elements performed during the Pre-Construction and construction monitoring periods including operation of the continuous hydrologic and hydraulic data monitors, monitoring of the marsh sites, bathymetric surveys, updating and assessing the hydrodynamic and water quality models, chloride monitoring at the City of Savannah's water supply intake on Abercorn Creek, groundwater monitoring at the sentry and upgradient background wells, intense hydrologic and hydraulic monitoring events (as performed in the Pre-Construction Monitoring) and monitoring of Shortnose sturgeon.

Other study elements in the Post-Construction monitoring phase include fish, crab, and shrimp distribution and abundance studies in marsh areas, an assessment of the impacts of the project on Striped bass habitat, monitoring of the marsh restoration site in Disposal Area 1S, two intense surveys (1 week) to determine the location of the freshwater interface at high and low tides, and impact assessment studies using the field data collected and the hydrodynamic and water quality models.

Although construction of the project would be complete, some cadmium monitoring would still be occurring. This monitoring would include monitoring of effluent from the CDFs during dewatering of the disposal areas, sampling, wildlife use surveys in the CDFs 14A and 14B, monitoring of cadmium levels in birds in CDFs 14A and 14B, and analysis of channel sediments prior to maintenance dredging.

Post-construction monitoring would be conducted for a period of 10 years, however, not all study elements would be conducted for ten years as described below.

B. Major Components. This phase would begin after completion of the final construction activities that would alter salinity or river flow distribution in the estuary. This consists of the channel dredging, the flow-altering components of the mitigation plan, and the dissolved oxygen system.

1. Hydrologic and Hydraulic Data Monitoring. The Corps would continue to operate the eight continuous hydrologic and hydraulic data recorders for ten years. USGS staff would perform this work. They would include the data in their state annual reports. This monitoring would help the Corps document and assess the hydrodynamic and water quality changes that resulted from the harbor deepening.

2. Intense Hydrologic Data Monitoring. The Corps would conduct two intense hydrologic monitoring events. These events would monitor conditions over a lunar cycle (28 days). One of the events would be conducted in year 1 and the other in year 5. Sampling will be performed at multiple depths and at least twelve stations that will be selected by the Corps in

consultation with the resource agencies. The parameters included in these events would be the same as those in the Pre-construction monitoring intensive survey. Prior to conducting the events, a detailed monitoring plan will be coordinated with the cooperating agencies. A report would be prepared for each sampling event to summarize the results. The Corps would use the data to update (if required) the hydrodynamic and water quality models. The Corps may collect and use data at points established as being important to the agencies.

3. Bathymetric Surveys in Unique Areas. The Corps would conduct two bathymetric surveys of riverine areas not normally surveyed to obtain up-to-date information on the depth and width of the tidal rivers that are included in the hydrodynamic model. The surveys would extend from I-95 to Old Fort Jackson and include the Front, Middle, and Back Rivers. These surveys would be conducted at the same time as the intense hydrologic and hydraulic surveys. Data from these surveys would also be used to update (if required) the hydrodynamic and water quality models; if the modeling performance guidelines are not being met, an update would be warranted.

4. Hydrodynamic and Water Quality Model Assessments. The data gathered from the bathymetric surveys and the intense hydrologic surveys would be used to update (if required) the hydrodynamic and water quality models; if the modeling performance guidelines are not being met, an update would be warranted. These model assessments would occur twice during Post-Construction Monitoring. A report would be prepared summarizing both model assessments. The natural resource agencies would review these reports.

5. Identification of the Freshwater Interface. Two intense one-week studies would be conducted to identify the freshwater interface location during both high and low tides. This study would focus on salinity and dissolved oxygen. One use of the results would be to compare the locations indentified for the interface to those locations predicted by the hydrodynamic and water quality models. As flows and other environmental factors which influence the freshwater interface are variable, the exact timing of the study will be determined in consultation with all the resource agencies.

6. Chloride Levels-City of Savannah's Water Intake. The Corps would continue to monitor chloride levels at the City of Savannah's water intake on Abercorn Creek. Corps staff may perform this work. This monitoring would be conducted for a period of five years after completion of construction. The Corps would post the data on the public website. One or both of the meters are expected to be a permanent installation, whose operation and maintenance would become a responsibility of the City of Savannah when the SHEP monitoring period ends.

7. Chloride Levels-Groundwater. The Corps would continue to monitor chloride levels in groundwater at the sentry and upgradient background wells that the Corps installed to identify any unforeseen adverse impacts to the Floridan drinking water aquifer. Savannah District staff may perform this work. The Corps would post the data on the public website. These wells would be maintained and monitored throughout the Post-Construction Monitoring period and for the life of the project. Any changes to the monitoring protocol or adaptive management measures would be conducted in accordance with the GA DNR-EPD and SC DHEC water quality certifications, and the adaptive management procedures outlined below.

8. Monitoring of the Marsh Sites. The USGS Florida Fish and Wildlife Cooperative Research Unit or other qualified organization would monitor the twelve sites they monitored in the Pre-Construction and Construction monitoring in the same manner. They would perform this work for ten years. They would measure marsh salinities continuously and sample vegetation twice a year. They would prepare a report of their findings in year 5 that included data from years 1-4. They would prepare a comprehensive report at the conclusion of year 10 to include data from the entire monitoring period. The final report would also include a comparison to the Pre-Construction monitoring results, the predicted values, and their previous work at these sites. Each year, the contractor would provide a summary of data collected that year.

9. Monitoring of the Marsh Restoration Site in Disposal Area 1S. The marsh site in Disposal Area 1S would be monitored for a period of seven years. Monitoring would include identification of any invasive species, and a plan to control invasive species, if required. Annual reports would be prepared that summarize results of the monitoring. The report prepared for year 7 would summarize the results of the monitoring in years 1-7 and provide an overall assessment of the success of the marsh restoration efforts in Disposal Area 1S and any recommendations as to what further actions might be required at the site to complete the marsh restoration efforts. Release of any excess credits (only for use on the Savannah Harbor Federal Navigation Project) would occur after the long-term health/productivity of the restoration site is verified by the Federal Cooperating Agencies.

10. Shortnose Sturgeon Distribution-Savannah Harbor Estuary. SC DNR Marine Resources Division or another qualified organization would monitor the distribution of Shortnose sturgeon in the same manner as previously performed. The work would be performed for five years and a report prepared discussing each year's findings. An additional year of this monitoring would be conducted in the ninth year of the Post-Construction Monitoring. The final report which would be provided in year 10 would be a comprehensive one describing their findings both prior to and after construction.

11. Fish Distribution Study. The USGS Georgia Fish and Wildlife Cooperative Research Unit or another qualified organization would monitor fish, crab, and shrimp abundance and distribution along the edges of marshes using a drop survey method that was a component of the study performed in 2000-2001(Jennings and Weyers, 2003). They would perform this work in years 1, 3, 5, and 9 after construction and prepare a report of each year's findings. The report provided in year 10 would be a comprehensive one describing their findings both prior to and after construction.

12. Shortnose Sturgeon Passage Study-NSBL&D. The USGS Georgia Fish and Wildlife Cooperative Research Unit or another qualified organization would monitor fish movement through the New Savannah Bluff Lock & Dam off-channel rock ramp fish bypass structure and monitor Shortnose sturgeon distribution patterns in the vicinity of the dam. They would perform this work for five years and then again in year 9 of the Post-Construction Monitoring. In this phase of the project they would search the river weekly between NSBL&D and the Jackson, SC Landing and NSBL&D and the Augusta Water Diversion Dam would be searched weekly for fish with transmitters during the migration season. On a monthly basis, they would search the Savannah River from the Savannah Harbor Kings Island Turning Basin past the

NSBL&D to the Augusta Diversion Dam. This phase may include the installation and use of a series of active infrared video cameras to monitor fish movement within the fish bypass structure. The system would operate continuously and collect images of fish at the upper end of the passage facility. The recorded video would be reviewed to determine the species composition, fish orientation (upstream versus downstream) and abundance. The USGS would prepare a report of each year's findings. The report provided in year 10 would be a comprehensive one describing their findings both prior to and after construction. The findings of this effort will be used to judge the effectiveness of the fish passage facility, when compared to the goals of 75 percent upstream sturgeon passage, 85 percent downstream sturgeon passage, and causing no harm to passing sturgeon.

13. Shortnose Sturgeon and Striped Bass Habitat Assessments. Evaluations of the impacts of the SHEP on Shortnose sturgeon and Striped bass habitats would be conducted in years 2, 4, and 9 of the Post-Construction Monitoring. The field data collected in other tasks would be used in conjunction with the updated hydrodynamic and water quality models to conduct this assessment. A report would be prepared at the end of each year the evaluations are performed. The report would assess any further impacts to Shortnose sturgeon and Striped bass habitats beyond that described in the EIS.

14. Impact Assessment. Data collected from the bathymetric surveys and the intense hydrologic surveys described above would be used to assess impacts and to evaluate the effectiveness of the mitigation features. In addition, the data will be used to update the hydrodynamic and water models. The physical monitoring data would be included in the models and compared to what those models predict should have occurred under the observed conditions. If the models successfully predict salinity and dissolved oxygen levels (which will be known from field measurements) for the conditions observed during the monitoring, then they would be a reliable tool for impact assessments. This study effort would be conducted once a year for ten years. Reports for this element of the monitoring would include annual reports describing the results of the studies conducted each year during years 1-9 of Post-Construction Monitoring and a final report describing the results of the modeling performed in Year 10 as well as the overall result of all ten modeling efforts.

15. Monitoring of CDF effluents. The Corps would continue to monitor water quality discharges from the CDFs that were used for the construction. This work may extend for a year or two until the CDFs are dewatered from the new work placement. Savannah District staff would perform the work. The District would prepare an Annual Report. This monitoring would ensure the discharges comply with water quality standards.

Following the installation of a stable clean cover over the cadmium-laden sediments in CDFs 14A and 14B, cadmium would be monitored in the effluent from these CDFs weekly for a period of one year. In addition, a quarterly metals scan with the inclusion of ammonia would be conducted. All of the above information would be furnished to the GA DNR-EPD, SC DHEC, and USFWS.

After the CDFs enter the O&M phase, the Corps would monitor the CDF effluents for the life of the project following its normal procedures.

16. Wildlife Use Monitoring in CDFs 14A and/or 14B. Monitoring of wildlife use in CDFs 14A and 14B would be continued from the construction phase for a minimum of three years after placement of the cadmium-laden sediments and would continue as long as other cadmium-related monitoring events are being conducted. The monitoring would be conducted in the same manner as the monitoring conducted during the construction phase of the project.

17. Avian Blood/Feather Monitoring in CDFs 14A and/or 14B. Avian blood/feather monitoring would continue for a minimum of three years after the placement of the cadmium-laden sediments in CDFs 14A and/or 14B is complete. It would continue until cadmium concentrations are determined to not significantly differ from the baseline concentrations for three consecutive years. The monitoring would be conducted in the same manner as the monitoring conducted during the construction phase of the project. Should the proposed blood/feather sampling as described in the During and Post-Construction monitoring indicate there is a statistically significant change (95% confidence level) in the cadmium blood levels of birds in the CDFs before and after placement of cadmium-laden dredged material, then the Corps would conduct avian liver tissue sampling as outlined below in Section 8. The cost to perform this work is estimated at $100,000 per year for blood/feather sampling, plus an additional $50,000 to conduct liver tissue sampling should it be necessary.

18. Cadmium Monitoring-Channel Sediments. At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (including cadmium). Analysis of the river bottom would provide an assessment of cadmium concentrations (as well as other metals) in sediment at the sediment-water interface.

As a condition of the Section 401 Water Quality Certification, the Georgia DNR-EPD and SC DHEC have requested sediment analyses prior to any maintenance dredging in those reaches of the channel with cadmium-laden sediments. Samples are to be taken from two locations in the channel 45 days prior to dredging, analyzed for cadmium, and the results furnished to the Georgia DNR-EPD, SC DHEC, and USFWS prior to initiation of dredging. This protocol would remain in effect through two maintenance dredging cycles. The Georgia DNR-EPD would review the results of the cadmium analyses and determine if additional such monitoring was warranted.

C. Reporting

Savannah District would place the data that is collected during the Post-Construction Monitoring and the reports that are produced onto the public website that was established during the Pre-Construction period. The District would prepare an Annual Report of data collected. The report would be provided to natural resource agencies and then placed on the public website.

A summary of reports concerning the various monitoring efforts that would be conducted during the Post-Construction Monitoring is as follows:

1. Intense Hydrologic Surveys Reports. Surveys would be conducted during years 1 and 5 of the Post Construction Monitoring.

2. Bathymetric Survey Reports. Surveys would be conducted during years 1 and 5 of the Post-Construction Monitoring.

3. Hydrodynamic and Water Model Update Reports. Model updates would be conducted after data from intense hydrologic and hydraulic surveys and bathymetric surveys become available, i.e., years 2 and 4 of the Post-Construction Monitoring Program.

4. Freshwater Interface Study Reports. Survey would be conducted during years 3 and 8 of Post-Construction Monitoring.

5. Groundwater Monitoring Reports. Annual reports will be furnished to Georgia DNR-EPD by 31st of January following the year of data collection.

6. Transfer Efficiency Study Report. One-time study that would occur either very late in construction or first part of Post-Construction Monitoring. This study is not included in the Post-Construction Monitoring Cost Summary below because it was included in the Construction Monitoring Cost Summary.

7. Marsh monitoring (12 sites) reports. Two reports will be prepared to address the ten years of Post-Construction Monitoring and changes from Pre-Construction Monitoring. One report in year 5 to address the findings of the first four years of monitoring and a report at the end of year 10 of the monitoring which would address years 5-10 of the monitoring and the overall 10-year study effort.

8. Monitoring of Marsh Restoration Site (1S) Reports. Seven reports to address seven years of Post-Construction Monitoring. The report for year 7 would be a comprehensive report to address monitoring of the site in years 1-7 and the success of the marsh restoration in Disposal Area 1S.

9. Monitoring of Shortnose sturgeon distribution in the Savannah Harbor Estuary Reports. Two reports to address six years of monitoring. One report in year six to address the findings of the monitoring for years 1-5, and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the six years of monitoring.

10. Monitoring of Shortnose sturgeon from NSBL&D to Savannah Harbor Reports. Two reports to address six years of monitoring. One report in year 6 to address the findings of the monitoring for years 1-5, and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the six years of monitoring.

11. Fish, Crab, and Shrimp Distribution Study Reports. Four reports to address four years of monitoring. Three reports would be prepared to address the results of the monitoring that would occur in years 1, 3, and 5 and a comprehensive report in year 10 to address the results of the monitoring conducted in year 9 and the overall findings of the four years of monitoring for this

study element. Reports would be provided to NMFS within 12 months of completing each year of sampling.

12. Shortnose sturgeon and Striped bass habitat assessment reports. Three reports to address the six evaluations. A report would be prepared to address the results of the studies conducted in years 2 and 4, and a comprehensive report prepared in year 10 to address the impacts of the monitoring that would be conducted in year 9 and an the overall findings of the three years of study.

13. Impact Assessment Study Reports. Annual, reports to address the findings of this study would be prepared each year for ten years. These would include a comparison of ranges of predicted performance values for parameters at specific points in the post-construction Savannah Harbor estuary to measured values.

14. Monitoring of effluent from CDFs 14A and/or 14B Reports. Annual, with the exception that Georgia DNR-EPD, SC DHEC, and USFWS would be provided a quarterly synopsis.

D. Cost Summary

The costs for this Post-Construction monitoring are estimated as follows:

Operate water quality stations	10 years x 8 @ $65,000	=	$5,200,000
Bathymetric Surveys (Unique Areas)	2 @ $158,000	=	$316,000
Intensive Monitoring	2 @ $350,000	=	$700,000
Freshwater Interface	2@ $40,000	=	$80,000
Assess Hydrodynamic and WQ Models	2 @ $150,000	=	$300,000
Chloride monitoring	5 years x $80,000	=	$400,000
Groundwater monitoring	10 years x $7,500	=	$75,000
Wetlands	10 years x 12 @ $20,000	=	$2,400,000
Monitor Marsh Restoration Site 1S			$680,000
Shortnose sturgeon monitoring	6 years x $200,000	=	$1,200,000
Fish passage at NSBL&D	6 years x $250,000	=	$1,500,000
Shortnose Sturgeon and Striped Bass Habitat Assessments	3 years x $ 70,000	=	$210,000
Fish distribution along marshes	4 years x $125,000	=	$500,000
Impact Assessment (using data and models)			$938,000
Monitor CDF effluent			$286,000
Wildlife Use Studies-CDFs 14A and 14B			$415,000
Avian Blood/Feather Monitoring			$350,000
Sampling Exposed Miocene for Cadmium			$78,000
Reporting			$500,000
Oversight			$700,000
Post Construction Total:			**$16,828,000**

Table 1. Summary of Major Monitoring Events

Element	Pre	During	Post										
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Post Year 10
Establish Baseline Data Bank	X												
Installation of Continuous Water Quality Data Recorders (5 new, 3 upgrade)	X												
Update Hydrodynamic and WQ Models (If Necessary)	X												
Bathymetric Surveys of Sediment Basin		X											
D.O. Transfer Efficiency Study		X											
D.O. Levels near Dredge during Summer Months		X											
Cadmium Sediment Sampling in 14A/14B		X											
CDF Effluent		X	X	X									
Monitoring of 8 Continuous Water Quality Data Recorders	X	X	X	X	X	X	X	X	X	X	X	X	4 Recorders
2 Intensive Water Quality/Hydrologic Monitoring Events	X		X				X						
2 Bathymetric Surveys in Unique Areas	X		X				X						
Hydrodynamic/Water Quality Model Assessment		X		X				X					
Freshwater Interface Determination					X					X			
Chloride Monitoring at Abercorn Creek Intake	X	X	X	X	X	X	X						
Groundwater Chloride Monitoring	X	X	X	X	X	X	X	X	X	X	X	X	8 Wells
Monitoring of 12 Marsh Sites (Chloride/Hydrologic/Vegetation)	X	X	X	X	X	X	X	X	X	X	X	X	
Monitoring of Marsh Restoration Site (1S)			X	X	X	X	X	X	X				
Shortnose Sturgeon Distribution in Estuary	X	X	X	X	X	X	X				X		
Shortnose Sturgeon Distribution at NSBL&D	X		X	X	X	X	X				X		
Fish Distribution Along Marshes			X		X		X				X		
Impact Assessment Review (Comprehensive Physical Data/Model Comparison and Review)			X	X	X	X	X	X	X	X	X	X	
Wildlife Use in 14A/14B (Avian/Terrestrial Field Counts)		X	X	X	X								
14A/14B Inflow/Effluent (Georgia)		X	X										
14A/14B Bird Tissue Analysis		X	X	X	X								
Sampling Exposed Miocene for Cadmium			X	X									
Shortnose Sturgeon and Striped Bass Habitat Monitoring				X		X					X		

8 PERFORMANCE MEASURES

A. Goals. This section will define the manner in which the findings of the monitoring would be evaluated and used in decision-making.

B. Components. The monitoring that would be conducted can be placed in one of the following four categories:

- Pre-Construction monitoring to establish a baseline prior to implementation of the harbor deepening project. The field investigations performed for this study would be conducted early in the study process and be updated to ensure information is available that reflects conditions just prior to the deepening;
- Monitoring during construction to identify any impacts that occur that are beyond the range of those expected to occur;

- Post-Construction monitoring to ensure the impacts that occur do not exceed those that were predicted and evaluate the effectiveness of the mitigation features; and
- Post-Construction monitoring to document the effects on a specific resource.

As stated in the background section of this appendix, the two aspects of performance that need to be distinguished are the accuracy of the impact assessment tools (primarily models) and the biological responses that will occur as a result of changes in the environment. The manner in which the monitoring is evaluated, therefore, would depend on the original purpose of that particular monitoring effort.

Pre-Construction Monitoring

The Pre-Construction monitoring consists of Geomorphic and Biologic components that would provide information to establish a pre-project baseline. Pre-construction monitoring would also include the establishment of a baseline data base using existing data and reports available on Savannah Harbor. The Continuous Riverine Monitoring, the Bathymetric Surveys and the Intensive Monitoring would be used to assess whether the hydrodynamic and water quality models should be recalibrated to increase their accuracy and reliability. Models that can accurately simulate conditions within the Savannah Harbor estuary are essential to examining whether biological responses that occur as a result of the project are within expected ranges. The Corps would enter the new information into the models, assess the accuracy and reliability based on the previous calibration, and determine whether that accuracy and reliability could be increased substantially if the model is recalibrated with the more up-to-date information. The Corps would use generally the same performance goals for the models that the Federal Cooperating Agencies established when the models were initially applied to Savannah Harbor with one exception. The USFWS recommended that the goal for salinity should be changed from +/- 0.5 ppt to +/- 10% when salinity is within the range of 1 to 5 ppt. While the table below reflects that recommendation, it may not be achievable. The modelers would make every effort to make the models as accurate as possible. The performance goals for the various parameters are summarized on the following page:

Table 2. Modeling Performance Goals

Parameter		Percentiles					Timing of Maxima (Min)
		5 %	10 %	50 %	90 %	95 %	
Elevation (cm)		+/- 2	-	+/- 2	-	+/- 2	+/- 30
Salinity (ppt) *	1-5 ppt	-	-	+/- 10 %	+/- 10 %	-	+/- 30
	< 1 ppt	-	-	+/- 0.1	+/- 0.1	-	+/- 30
DO (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
DO Deficit (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
Temperature (°C) **		-	-	+/- 1	-	-	-
Surface Currents (m/s) ***		+/- 25%	-	-	-	+/- 25%	+/- 30
Volume Flows (m/s) ***		+/- 25%	-	-	-	+/- 25%	-

* The salinity goals have been refined for the post project-approval period
* 50% represent Absolute Mean Error for temperature
** 5% and 95% represent the max. ebb and flood conditions for current and flow

After the model has been reviewed and possibly recalibrated, model runs will be made to establish ranges of predicted data values on selected performance parameters for specific points in the Savannah Harbor estuary. The data will be used to create graphs with trendline and curves showing the expected ranges of modeled values as described in the pre-construction section of this appendix. Performance parameters will be established for specific conductance, salinity, and DO. During construction and post-construction monitoring, measured values would be compared to these predicted ranges to determine if the project is performing as expected.

Monitoring During Construction

Many variables need examination to determine whether the responses of the Savannah River Estuary that occur as a result of the project are within the expectations provided in the EIS and as monitored by the ranges described above. To make the assessment, the Corps would combine results from several monitoring efforts. All the data that is collected will be used in those evaluations. Data from the Continuous Riverine Monitoring are expected to be available on a 24-hour basis and reflect near real-time conditions. Therefore, they will be most useful in identifying whether any impacts are occurring beyond the range of those expected.

The Corps would regularly assess (every four months) how well the hydrodynamic and water quality models predict the salinity and dissolved oxygen levels that are occurring during the construction process. The assessment would be performed by comparing the model's predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the new bathymetry and the actual river flows. If the modeling performance guidelines are not being met, recalibration of the model may be warranted.

These regular assessments also will be useful in identifying whether any impacts are occurring beyond the range of those expected. Using DO concentration as an example, the locations of the Continuous Riverine Monitoring stations correspond to zones SR, FR8, MR3, LBR2, LBR3, MR1, BR1, and FR3 in reports that supplement the GRR, and those reports contain tables that predict the frequency of particular average DO concentrations within the bottom waters of each zone during the time of year when DO is expected to be at its lowest. Near real-time results from the Continuous Riverine Monitoring stations can show whether the expectations for these zones are being met and can serve as proxies for what might be occurring elsewhere in the harbor.

Salinity provides another example. During the pre-construction monitoring period, modeled salinity and flow data at the continuous gauging station locations will be used to establish thresholds of acceptable response of the system to the harbor deepening. During and after the construction, measured salinity and flow data would be compared to modeled salinity for the observed flows at the continuous gauging stations to evaluate the ecosystem's response to the construction project. Plots will be generated showing the model projected relations between maximum, minimum, and mean salinity and streamflow. From these plots, trendlines will be developed and curves of the expected ranges of values will be computed to represent the expected range of responses of the system. The curves will provide salinity values for a corresponding streamflow at a particular site. As the real-time data is collected, the plots could be updated in near real-time to evaluate how the system is responding with respect to projected deepening conditions.

Model data for flow will show the predicted flows, as well as pre-construction flow data, at the three water quality monitoring stations along Georgia Highway 25 / South Carolina Highway 170 Bridge. Using methods similar to those described above, flow data during construction would be compared to these ranges of predicted values to evaluate if the system is responding as predicted.

Modeled data for various river flows at Clyo would be used to assess DO at the eight water quality monitoring stations.

Conducting these assessments every four months should be sufficient to assess performance of the models and the emergence of any unexpected impacts. This process would serve as the mechanism to identify the emergence of any unexpected variances with the predictions about how the harbor would function after construction is complete.

If the monitoring identifies impacts that are outside the range of those expected, the Corps would consult with the Cooperating Agencies to identify what actions may be appropriate. This could include more detailed monitoring in certain locations to obtain a better understanding of what is occurring, or a delay, reordering, or cessation of construction activities. The Corps would re-evaluate the data if a Cooperating Agency believes that the impacts are going outside the expected range.

The Corps would prepare a brief technical paper after each assessment of the hydrodynamic and water quality models documenting the findings of the comparison between observed data and

predicted levels. The Corps would provide this report to the natural resource agencies for review and comment. The Corps would then make the report available to the public.

In addition to the data from the continuous water quality monitors, the graphs of ranges of predicted values, and the use of the hydrodynamic and water quality models to assess project impacts during construction, other "tools" would also be available to measure the performance of the project during the construction phase of the project. These assessment tools would include the monitoring of dissolved oxygen levels in the harbor in the summer months, monitoring of chloride levels at the City of Savannah's water intake on Abercorn Creek, groundwater monitoring, and monitoring of effluent from the CDFs to ensure there are no violations of applicable water quality standards, analyses of cadmium concentrations of sediments placed in CDFs 14A and 14B, and monitoring of dissolved oxygen levels in the vicinity of the dredge during the summer months.

Post-Construction Monitoring

The Corps would again combine several of the monitoring efforts to evaluate model performance and identify whether any impacts occur that are beyond the range of those expected. All the data would be used in these evaluations of how the Savannah Harbor estuary and tidal marshes responded to the harbor deepening. The physical monitoring data would be included in the hydrodynamic and water quality models and compared to what those models would have predicted would occur under those conditions. The Corps would use the range of variability shown in the model performance goals to help in its assessment of the models' accuracy in predicting the observed effects. The District would continue to refine the hydrodynamic and water quality models to improve their accuracy and reduce their range of variability. It would also use the range of +/- 50 acres to assess the acreages of tidal freshwater, brackish, and salt marsh when the wetland impact and mitigation evaluations were conducted. The following table shows the predicted acres of marsh using the salinity criteria developed by the Wetlands interagency coordination team.

Table 3. Predicted Acres of Marsh Types

	Tidal Freshwater	**Brackish**	**Salt**
	<0.5 ppt	**0.6 to 4.0 ppt**	**>4.0 ppt**
Current	4072 acres	2253 acres	2806 acres
Predicted	3849 acres	3217 acres	1766 acres

In addition, monitoring data from continuous water quality monitoring stations will be compared to modeled values for those same points. Post-construction conditions within the Savannah Harbor estuary that are outside the ranges predicted would not necessarily trigger corrective action but would trigger coordination among the agencies so that the Corps may determine what action, if any, would be appropriate as described below.

Acceptability Criteria

This document does not include specific acceptability criteria for all water quality or biologic parameters which would be monitored for this project. Although identification of specific values would establish points at which action would need to be taken, it would also limit the judgment of experts about potential cumulative effects of changes in several parameters which do not exceed a single threshold. The monitoring and adaptive management plan is based on a collaborative decision making process among experts in several natural resource agencies. Establishing thresholds at this time would limit the ability of those agencies to respond to situations in a manner that they determine would be best for this estuary. Exceptions are noted in the three paragraphs below.

The Georgia DNR-EPD and South Carolina DHEC (as a condition of their Section 401 Water Quality Certifications) requested that a benchmark chloride concentration be established for each sentry well. The chloride concentration in the groundwater determined from the monitoring of sentry wells and up-gradient wells will have specific triggers for corrective action. The Corps must also determine what chloride concentrations caused by SHEP dredging activities would result in a measurable increase in chloride concentrations at Savannah area production wells. The benchmark chloride concentrations must be protective of the Savannah area production wells. The Corps would establish benchmark chloride concentrations for each pair of sentry wells near the top of the Upper Floridian aquifer and deeper in the aquifer. The establishment of the benchmark chloride concentration would be accomplished prior to the commencement of the dredging and would serve as a trigger for corrective action.

Another example is the conditional requirements under which the Corps would conduct vegetation sampling in the CDFs where cadmium-laden sediments are deposited. Vegetation sampling would be conducted in the event that elevated concentrations of cadmium (4mg/kg or greater) in a cumulative total of 25 acres or more of the covering layer. This sampling would be conducted on a quarterly basis. Sampling of vegetation would be initiated in defined "hot spots" to determine cadmium uptake by plants. Specific details of the vegetation sampling procedures would be determined in coordination with the USFWS before implementation. Samples collected from CDFs 14A and 14B would be compared to control samples derived from other low cadmium environments found in adjacent CDFs. Where at all possible, vegetation comparisons to reference will be by species and sampling would include all dominant species growing in the cover cap. If vegetations samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place additional, low cadmium sediments over the original capping layer. These measures would eliminate wildlife exposure should vectors for uptake of cadmium be identified. When soil sampling indicates sustained cadmium concentrations are less than 4 mg/kg, the vegetation monitoring would be complete.

Similarly, there is a conditional requirement under which the Corps would conduct avian tissue analyses. Should the proposed blood sampling as described in the During and Post-Construction monitoring indicate there is a statistically significant change (95% confidence level) in the cadmium blood levels of birds in the CDFs before and after placement of cadmium-laden dredged material, then the Corps would conduct avian liver tissue sampling. Since the CDFs

would reenter the rotation program after the covering sediments have been placed, the CDFs may be dry or wet, depending on the year. Their hydrologic condition will drastically alter their bird use, as different species use the CDFs in those two conditions. Consequently, if/when the CDFs are dry, three individuals from two species (six total) would be sampled at the beginning and end of the nesting season (April and August) from species that use typically use the CDFs for nesting. Also, if/when the CDFs are dry, three individuals from two species (six total) would be sampled at the beginning and end of the wintering season (October/November and March/ April). Samples would be obtained from species that typically use the CDFs during the winter months as outlined in Appendix M. The Corps may also choose to collect baseline liver tissue data. Post-construction liver tissue data would be compared to baseline data (if available) and published avian liver cadmium toxicity levels (screening level). Project liver tissue data would have to significantly exceed baseline data and/or the screening levels to trigger additional management options.

The field data collected, ranges of predicted values at water quality monitoring stations determined during pre-construction, and the hydrodynamic and water quality models using observed river flows would be the main tools which would be used to determine how the project is performing and if the impacts are generally as expected. Even though the potential impacts of the project were evaluated under a likely range of conditions, the actual circumstances experienced after construction will be somewhat different from those used for evaluation in the project's feasibility phase. Consequently, the monitoring data will be used to evaluate the response of the system to the mitigation features. In addition, the hydrodynamic and water quality models would be used to examine post-project performance under actual conditions, e.g. high/low flows, drought, or some combination of these. The performance (accuracy) of the models would be assessed once during pre-construction monitoring and twice during post-construction monitoring and recalibrated, if necessary. This repetition in modeling assessment/ recalibration would improve their predictive accuracy by decreasing their range of uncertainty. The Corps and the resource agencies would use the modeling data (after any necessary post-construction recalibration of the models) and compare those data to actual field results to determine whether the Savannah Harbor estuary is responding to SHEP as expected. The hydrodynamic and water models would be used to evaluate project performance once a year for ten years as part of the post-construction monitoring. The Corps would prepare a report after each of the ten assessments of the hydrodynamic and water quality models documenting the findings of the comparison between observed data and predicted levels. The Corps would provide this report to the natural resource agencies for review and comment. The Corps would then make the report available to the public.

Other tools that would be available to assist with the post-construction assessment of the performance of the project would include the study of the 12 marsh sites, the monitoring of the marsh restoration site in Disposal Area 1S, data from the chloride monitoring at the City of Savannah's water intake, groundwater monitoring, the data from the Shortnose sturgeon distribution study in the Savannah Harbor estuary, the data from the Shortnose sturgeon passage study at NSBL&D, the fish distribution study, and the data from the assessment of project impacts on Striped bass habitat. These studies would be used to evaluate the performance of the project as described below.

The 12 marsh sites would be monitored for ten years after completion of the project. The data could then be compared to the predictions in the EIS, post-construction modeled impacts (using observed river flows), past reports, and data gathered during previous years (one year of pre-construction and four years of construction) to evaluate impacts of the project on marshes (especially tidal freshwater) in the project area.

The Corps would use the following revegetation rate as the acceptability criteria for restoration of brackish marsh at Area 1S. A reference marsh site would be identified in the vicinity of Disposal Site 1S to facilitate the evaluation of the marsh restoration progress.

Table 4. Revegetation Rate for Area 1S

Time Period	Percent Vegetative Cover
Construction	0
Year 1	15
Year 2	25
Year 3	40
Year 4	60
Year 5	80
Year 6	85
Year 7	90

Marsh restoration in Disposal Site 1S includes an adaptive management plan which would require continued efforts until the success criteria are achieved. These efforts may include adjusting the elevation of the site as many times as necessary to achieve success and the planting of juvenile *Spartina alterniflora* plants if the site does not naturally re-vegetate at the rate of colonization indicated in the above table. Should the restored marsh not meet the success criteria in the above table, then the ICT would identify and/or recommend corrective actions, including planting requirements and associated sprig densities, which would achieve compliance with the re-vegetation criteria in the above table. The need for corrective action(s) would be determined and/or implemented annually with agency involvement and concurrence. Annual monitoring reports would be generated over a period of seven years and provided to a Wetland ICT. If at the end of seven years the plant density at the restored marsh is not within 10 percent of the reference site, the Corps would implement further actions to achieve successful marsh regeneration on this site.

The wetland restoration in Disposal Area 1S would also include an adaptive management plan with respect to invasive species. The site would be monitored for invasive species, and an invasive species control plan would be developed and implemented, if required.

The water quality model and ten years of post-construction data from the eight continuous recorders would provide information on how the project affected the dissolved oxygen regime in the Savannah Harbor estuary.
Ten years of post-construction data from the eight continuous water quality recorders would provide information on how the project affected the salinity regime in the Savannah Harbor estuary. This data would be supplemented with data from two intense hydrologic monitoring events (years 1 and 5 of post-construction monitoring) and two studies to identify the location of the freshwater interface (years 3 and 8 of post-construction monitoring).

Five years (years 1-5 of post-construction monitoring) would be available to assess the impacts of the project on chloride levels in the vicinity of the City of Savannah's water supply intake on Abercorn Creek. This data would be used to determine if the observed values are within the range of accuracy of the predicted values and to aid the City of Savannah in their operational procedures for the raw water storage pond.

Ten years of data from the sentry and upgradient background wells would be available to assess the impacts of the project on chloride levels in the Upper Floridan aquifer. This data could be compared to the five years of groundwater monitoring data collected during the one-year of pre-construction monitoring and the four years of the construction period.

The study of the passage of Shortnose sturgeon at NSBL&D would be conducted in years 1-5, and 9 of the post-construction monitoring. This study would concentrate on fish passage at NSBL&D. The Corps would prepare a report describing the findings of the monitoring of fish passage at New Savannah Bluff Lock and Dam. That report would identify whether any modifications to the fish passage structure are recommended for the mitigation feature to function as intended. The findings of this effort will be used to judge the effectiveness of the fish passage facility, when compared to the goals of 75 percent upstream sturgeon passage, 85 percent downstream sturgeon passage, and causing no harm to passing sturgeon.

Monitoring of Shortnose sturgeon would provide information on the locations of the estuary used by the Savannah River population. Monitoring of Shortnose sturgeon distribution in the Savannah Harbor estuary would be conducted during years 1-5 and year 9 of post-construction. This data would then be compared to the five years of data collected during pre-construction and the construction period to determine if there are any trends in Shortnose sturgeon distribution that might be attributable to the project. Changes that are not explained by known habitat parameters (salinity and dissolved oxygen) may require additional investigation. If greater losses of sturgeon habitat occur than would be expected under the observed flow conditions, then additional mitigation may be warranted.

Fish, crab, and shrimp distribution studies in Savannah Harbor would be conducted in years 1, 3, 5 and 9 of post-construction monitoring. This survey would monitor fish, crab, and shrimp abundance and distribution along the edges of marshes using a drop survey. The results of this study would be compared to the data collected during a similar study in 2000-2001 to determine if there are any observable changes in fish distribution and abundance that might be attributable to the project.

The field data collected would be used with the updated hydrodynamic and water quality models to evaluate the impacts of the project on Striped bass habitat. This study would be conducted during years 2, 4, and 9 of the post-construction monitoring. Data from this study would be used to determine if impacts to Striped bass habitat exceed those predicted during feasibility, and if so, what additional mitigation may be warranted.

The Corps believes that the monitoring efforts outlined above would allow the Corps and the resource agencies to determine how the completed project is performing (including its mitigation features). Consequently, the Corps and the natural resource agencies would be able to evaluate the impacts of the project to ensure they do not exceed those that are predicted, the effectiveness of the project's mitigation features, and the project's effects on specific resources. Savannah District would prepare a final monitoring report that would summarize the results and findings from the various components of the monitoring program. It would initially provide that document to the Cooperating Agencies and then to the public.

9 ADAPTIVE MANAGEMENT - DECISION MAKING PROCESS

A. Goals. This section will define the process by which decisions are made concerning whether the mitigation features of the project – or the entire navigation project – needs to be modified. It will also describe the participants in the decision-making process, the timeline for making those decisions, any authorizations that are needed from higher authorities, and coordination that would occur with those not participating in making the decisions.

B. Decision Process. The decision process in regards to the implementation of any adaptive management measures would be ongoing throughout the Construction and Post-Construction phases of the project. The Corps would maintain close coordination with the Cooperating Agencies and the state natural resource agencies throughout the monitoring conducted during the Construction and Post-Construction Phases of the project. During the Construction phase of the project, the Corps would place monitoring data and reports as they become available on a public website. After the reports are available for a given year, the Corps would meet with the Cooperating Agencies and the state natural resource agencies to review the new information. Meetings between the Corps and the agencies would be held more frequently during the construction phase of the project if the data indicate the need to do so.

Adaptive management measures that might be implemented during the construction phase of the project would be focused on changes to how the project is being constructed or how the various monitoring efforts are being conducted. Actual data would be compared to pre-construction modeled predicted performance and the modeled performance using actual river flows. If the monitoring identifies impacts that are outside the range of those expected, the Corps would consult with the Cooperating Agencies and the natural resource agencies to identify what actions may be appropriate. This could include more detailed monitoring in certain locations to obtain a better understanding of what is occurring. The monitoring could also dictate changes in how the project is being constructed, such as modifying the operation of the CDFs to improve the water quality in the effluent or a delay in the dredging operations until a problem could be assessed and corrective measures implemented. Adaptive management measures that might be required

during construction of the project could be implemented in an expeditious manner since decisions regarding changes to the monitoring plan or the construction process are normally delegated to the District/Division level.

After construction of the project is complete, the adaptive management decision process would become more focused on the long-term mitigation features of the project. The coordination process between the Corps and the Cooperating Agencies and the state natural resource agencies during the Post-Construction Monitoring phase of the project would be much the same as in the Construction phase. Some of the post-construction monitoring efforts would be conducted over 10 years. Should one agency request it, a meeting would be held at the end of each year between the Corps, the Cooperating Agencies, and the state natural resource agencies to discuss the new data that would be available or the implementation of an adaptive management measure if the data indicates that to be required. Meetings between the Corps and the agencies could be held more frequently if the need arises. At the end of the Post-Construction monitoring period, the Corps would review and consolidate the reports of the various monitoring efforts. The consolidated report would contain pertinent information from the various reports, focusing on issues which the Corps believes are most critical to decisions on the need to modify the navigation project or the mitigation plan. The report would identify whether the Corps believes that any modifications are warranted and recommendations on what modifications should occur. That report should be available within six months of receipt of the last monitoring report and within one year of the end of the Post-Construction monitoring.

The Corps would coordinate that draft report with the Cooperating Agencies and the state natural resource agencies. The agencies would review the draft report for 30 days and provide their comments at a meeting that the Corps would host on this issue. The Corps would consider the comments and revise the report if necessary.

The Corps would then issue a final monitoring report for public comment. The Corps would review the public's comments and prepare a decision document. It would provide that document to the Cooperating Agencies (USFWS Region 4, EPA Region 4, NOAA-Southeast Regional Office, and GPA/GA DOT) for review prior to the Federal agencies (including the Corps) making a joint decision on whether any modifications are warranted. Each of the Federal agencies must concur that a specific modification is warranted for that measure to be implemented. After the agencies' joint decision, the Corps would notify the public of the agencies' final determination.

If an agreed-upon measure is included in this EIS and its implementation has thus been environmentally evaluated, no additional authorizations or environmental approvals would be required to implement the measure. If an agreed-upon measure is not included in this EIS and it has not been evaluated by the Corps in some other NEPA document, the District would prepare a NEPA document to obtain environmental approvals to implement that measure. The Corps would fund that effort using the adaptive management funds that were previously set aside. If the budgeted adaptive management funds have been expended, the Corps would request additional funds through the Construction Program budget process.

If agreement cannot be reached because one of the parties believes that additional data is needed to conclude a feature is needed, adaptive management funds could be used for an additional year of monitoring to obtain the needed information. The agencies would recognize that the additional monitoring reduces the amount of funds remaining to implement whatever measures are determined to be warranted. In this case, the group would hold the adaptive management funds for another year until the monitoring is conducted and a report made available with the additional information.

If after either the 10-year Post-Construction monitoring period is complete or after an additional year's worth of data is collected, it appears that the agencies will not be able to agree on whether a specific modification is warranted, upon the request of two of the four Federal agencies, the Corps would convene a meeting of the Federal agencies in Washington. At that meeting, Washington-level agency representatives would make a decision on the issue.

C. Decision Criteria. During the monitoring for the construction and post-construction phases, the Corps, the Cooperating Agencies, and the state Natural Resource Agencies will review the monitoring data and reports as they become available. The agencies will review the information to determine whether the impacts are generally as expected and whether changes to the project and its mitigation plan are warranted. An indicator of impacts within the expected ranges would be monitoring data for points in the estuary within the ranges determined by pre-construction modeling over a range of flow conditions. Even though the team examined the performance of the project alternatives under a range of conditions, the conditions that are experienced during and after the construction are still likely to be different from those that were examined during this feasibility phase. The team will use the post-construction monitoring data and the model predications for points in the estuary to evaluate the response of the ecosystem and the effectiveness of the mitigation features. The natural resource agencies recognized that models could not be developed to replicate conditions observed in this complex estuary with 100% accuracy. They established performance goals for the models (a portion of which is shown in the table below), which the developers were able to meet. However, there was still some inaccuracy in the models, which is discussed in the Engineering Appendix of the GRR. Predictions about the biological and physical responses of the estuary to SHEP appear in the EIS and this appendix.

As discussed previously, adaptive management measures that would be implemented during the construction phase of the project would be centered around changes to the monitoring plan or the various construction processes (dredging, disposal of the dredged material, etc.). The need to implement any adaptive management measure during the construction process would be determined through a review of the wealth of data that would be generated by the various field monitoring efforts conducted during the construction process. The decision to implement any adaptive management measure during the construction process would also be based on model predictions of dissolved oxygen and salinity that would be conducted during the construction phase of the project. The Corps would regularly assess (every four months, e.g., twelve times during the construction phase of the project) how well the hydrodynamic and water quality models predict the salinity and dissolved oxygen levels measured in the field. These assessments would be performed by comparing the model's predictions against what is being measured at the 8 continuous water quality monitoring stations. The model grid would be updated to reflect the

new bathymetry and the actual river flows. Section 8 of this appendix provides additional detail and examples of how this adaptive management process would work.

Obviously, the post-construction phase of the project would present the best opportunity to evaluate the performance of the project and its mitigation features with respect to the response of the ecosystem. Because the project would be completed, the models would be assessed and recalibrated, if required, and post-construction field data would be available. The Corps believes that the goals which the natural resource agencies (EPA, USFWS, USGS, SC DHEC, and Georgia DNR-EPD) established for the performance of the models can also serve in the post-construction phase as an effective tool for examining whether the constructed project performs as expected. If the observed results are within the expected ranges (taking into account the models' performance goals), then the project would be performing as expected. No modification to the project and its mitigation plan would be warranted.

The performance (accuracy) of the hydraulic and water quality models will be assessed and recalibrated, if necessary, both during and after construction. The present plan includes collecting detailed data (intense monitoring), assessing the models' performance, and recalibrating, if necessary, once during the pre-construction monitoring period and twice during the post-construction monitoring period. This repetition in modeling assessment/recalibration will improve their predictive accuracy by decreasing their range of uncertainty. The modeling performance goals shown below could be improved upon. (The model performance goal for salinity when salinity in the range of 1 to 5 ppt, which has been changed in the table below from +/- 0.5 ppt to +/- 10% at the request of the USFWS, may not be achievable.)

The natural resource agencies would use the accuracy and reliability of the models after the post-construction assessment/ calibration to review the performance of the project and its mitigation features. The modeling data and predictions in the EIS for the estuary's response to the project would be compared to actual field results to evaluate whether the project is performing as expected. The ranges for values predicted by the models described in Section 5 Pre-Construction Monitoring of this appendix will be compared to post-construction measured data to further assess the performance of the mitigation. An overall assessment of the project's performance would be conducted once per year for the 10 years of the Post-Construction monitoring period.

Table 5. Federal Modeling Performance Goals

Parameter		Percentiles					Timing of Maxima (Min)
		5 %	10 %	50 %	90 %	95 %	
Salinity (ppt)	1-5 ppt	-	-	+/- 10 %	+/- 10 %	-	+/- 30
	< 1 ppt	-	-	+/- 0.1	+/- 0.1	-	+/- 30
DO (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
DO Deficit (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
Surface Currents (m/s) **		+/- 25%	-	-	-	+/- 25%	+/- 30
Volume Flows (m/s) **		+/- 25%	-	-	-	+/- 25%	-

*Section 8 provides additional explanation of this table

** 5% and 95% represent the maximum ebb and flood conditions for current and flow

10 ADAPTIVE MANAGEMENT – IMPLEMENTING WARRANTED MODIFICATIONS

A. Goals. The Corps would obtain funding sufficient to implement the actions described in the following section during the project construction period. The project would remain in a construction status until all of the construction is complete, the Post-Construction Monitoring is complete, and any adaptive management measures implemented that were determined to be required. The District intends to obtain funds for adaptive management each year it obtains funds to perform regular construction activities. The Corps will develop a construction funding plan as well as a mitigation and adaptive management funding plan. The Corps will seek funding each year as identified in the funding plans. If the total adaptive management costs exceed the above estimates, the Corps would seek to obtain Corps approvals for any additional amounts needed through the normal (Construction Program) budget process. Funds for un-programmed adaptive management needs would be considered should excess construction funds become available during the year. Adaptive management funds currently estimated at $2 million per year will be sought for the entire duration of the monitoring period and for any action needed based on the monitoring results. Any project funds that are not used during the year due to unforeseen circumstances would be carried forward as needed and justified. In addition, the non-Federal sponsor, acting through the Georgia Ports Authority, has agreed to set aside, in advance, their cost-shared portion of the monitoring and adaptive management funds in an escrow account upon approval of the project. Those adaptive management funds would be expended if the modifications are deemed necessary by the Federal Lead and Cooperating Agencies.

If modifications are found to be warranted and they are contained in the group of actions described in the following section and the EIS, they could be implemented without further public coordination or environmental approvals. If then-existing programmed funding is not sufficient

to implement the above-mentioned warranted modifications, the Corps would seek to identify funds for reprogramming. Funds to be reprogrammed must first be identified as excess to another project's needs. If such funds are identified, the District will seek to obtain them to implement the needed adaptive management actions, thereby minimizing unanticipated adverse project effects.

If modifications are identified that are not in the following section, the Corps would prepare the documents needed to coordinate the proposed action with the public and the agencies to obtain the required environmental approvals.

If modifications are deemed warranted that are larger in scope than those described in the following section and require additional funding, the Corps would submit the appropriate documents to its Headquarters for approval. If additional Federal funding is required, Congressional action would likely be needed to obtain those funds.

B. Components of Approved Adaptive Management Plan. The following adaptive management features are included as part of the Savannah Harbor Expansion Project:

- Enlarging the diversion structure at the mouth of McCoys Cut;
- Enlarging the deepened area at McCoys Cut, Middle & Back Rivers;
- Constructing a diversion structure at the junction of Middle and Back Rivers;
- Removing the Tidegate sill;
- Raising or lowering the height of the submerged sill at the Sediment Basin;
- Improving fish passage at the New Savannah Bluff Lock & Dam;
- Acquisition of additional freshwater wetlands;
- Modifying the oxygen injection systems; Constructing and operating additional oxygen injection systems;
- Modifying the wetland restoration area at former Disposal Area 1S;
- Preferential placement of maintenance sediments into CDFs 14A and/or 14B as additional covering material.

Removing the Tidegate sill may increase tidal flows up Back River. This may be necessary to address water quality issues or improve fishery habitats. Enlarging the diversion structure at the mouth of McCoys Cut may be needed to draw more freshwater into the Middle and Back River portions of the estuary. Enlarging the deepened area at McCoys Cut, as well as Middle and Back Rivers would perform the same effect and could be needed in addition to enlarging the diversion structure. The additional freshwater flows down those two rivers would make freshwater vegetation more dominant in those portions of the estuary and improve some types of fish habitats in those locations. Constructing a diversion structure at the junction of Middle and Back Rivers would direct more freshwater down one of those two rivers. This additional freshwater flow down one arm may be needed to preferentially improve habitats along one of those two rivers. Fish passage at the NSBL&D could be improved by several methods, including (1) altering flows in the fish passage structure to enable that structure to attract and pass the Shortnose sturgeon, as intended, (2) modifying the fish passage rock ramp, or (3) enabling passage through the lock or gates on the dam. Acquisition of additional bottomland hardwoods/freshwater wetlands would compensate for additional impacts to freshwater marshes

beyond those that are predicted in the EIS. Additional dissolved oxygen may be needed under some flow conditions. The additional capacity would allow the systems to function as intended under all flow conditions. Modifications to the wetland restoration area at former Disposal Area 1S may be needed for brackish marsh to revegetate the site. This may include re-grading the site, depositing additional sediment, or sprigging. Additional maintenance sediments may be needed on CDFs 14A and/or 14B as additional covering material to adequately minimize the risk to wildlife using the sites. The project would pay the incremental cost of depositing O&M sediments in those sites instead of the regularly scheduled deposition site.

Any or all of these features would be implemented if post-construction monitoring finds them to be needed. Implementation of any or all of these specific features may not be needed. The adaptive management funding would be viewed programmatically. More could be spent on a given single item than is shown for the individual features identified below, but the total amount available for use in adaptive management would be the amount shown below. Which of these (or other) features would be implemented would depend on the monitoring results and the decisions of the Federal Cooperating Agencies.

C. Cost Summary. The cost to implement these features is estimated to be as follows:

Enlarging the McCoys Cut diversion structure	
Use 10% of initial cost of $2,324,082	$ 232,408
Enlarging the deepened area at McCoy's Cut, Middle, & Back Rivers	
Use 10% of initial cost of $7,287,980	$728,798
Diversion structure at Middle and Back Rivers	
Use 5% of initial cost of $1,800,688	$ 90,034
Removing the Tidegate sill	$2,908,990
Modifying the submerged berm at the Sediment Basin	
Use 10% of initial cost of $23,514,049	$2,351,405
Improving fish passage at the NSBL&D	$ 630,200
Acquiring additional freshwater wetlands	
Use 5% of initial acquisition	
$10,000/ acre x 0.05 x 2,683 acres	$1,341,500
Additional capacity in dissolved oxygen systems	
Use 10% of initial construction cost $56,643,000	$5,664,300
Modify the restoration site at Disposal Area 1S	
Use 10% of initial cost of $14,075,959	$1,407,596
Incremental cost to place O&M sediments in CDFs 14A/14B	
Use $1.00/CY x 782,500 CY x 2 CDFs	$1,565,000
Contingency Monitoring (3 x $1,000,000)	$3,000,000
Total	$19,920,231

The cost to acquire additional preservation lands shown above is based on a 48-foot depth alternative. Since the funds to be set aside for acquisition of additional lands depends on the

initial acreage to be acquired, the total adaptive management funding would be less for the other depth alternatives and would be as follows:

Table 6. Cost of Adaptive Management

CHANNEL DEPTH ALTERNATIVE	REQUIRED WETLAND ACQUISITION (ACRES)	COST OF ADDITIONAL WETLAND ACQUISITION	TOTAL ADAPTIVE MANAGEMENT COSTS*
44-FOOT	N/A	0	$ 18,579,000
45-FOOT	1,643	$821,500	$ 19,400,000
46-FOOT	2,188	$1,094,000	$ 19,673,000
47-FOOT	*2,245*	*$1,122,500*	*$ 19,701,000*
48-FOOT	2,683	$1,341,500	$ 19,920,000

*Total costs rounded to nearest $1,000

As a result of coordination with the natural resource agencies after release of DEIS, the Corps substantially increased the size of the fish bypass structure. The larger bypass would greatly increase the amount of flow passing through it (from 5% in the original design to 100% during the majority of the spawning season). The natural resource agencies now state that the percent of river flow passing through the structure roughly corresponds to the effectiveness they expect in passing SNS. Therefore, since the larger structure is more likely to pass SNS, the likelihood of needing to modify the structure after construction for it to function as intended is greatly reduced. The funds identified for adaptive management for the fish bypass should be sufficient to modify it if the post-construction monitoring indicates such action is warranted.

The adaptive management funds may be used to perform more work at a particular location than is shown above, as long as the total cost of the adaptive management stays within the total (plus contingencies) for the group of items shown above. Should other project features require adaptive management, then a portion of the funds outlined above may be used to modify those features, including performing vegetation sampling in CDFs with cadmium-laden sediments. Further, if the Cooperating Agencies believe that some other feature(s) would be more effective in addressing an identified problem, the Corps may use the funds authorized for adaptive management to implement that feature(s). The Corps may need to obtain additional environmental clearances to implement such a feature if it is not evaluated in this EIS or some other Corps NEPA document.

If the total adaptive management costs exceed the above estimates, the Corps would seek to obtain Corps approvals for those cost increases and request additional funds through the normal (Construction program) budget process and as described above.

D. Monitoring After Implementing an Adaptive Management Feature. Six of the eleven adaptive management features would alter flows in the estuary. To ensure a modification is performing as intended, additional Post-Construction monitoring would be conducted for two years after implementing the adaptive management feature. Longer focused monitoring could be necessary to demonstrate that the adaptive management feature performs as intended. The

monitoring would be focused to identify/confirm the type of effect intended by the feature. For instance, if the Tidegate sill is removed, the monitoring would focus on monitoring flows and water quality in Back River. The adaptive management funds identified in the previous section would be used to pay for this additional monitoring. Should the Cooperating Agencies determine additional monitoring is needed, then the monitoring period could be extended.

At the end of the monitoring period, the Corps would prepare a report on the effectiveness of the modification. The Corps would include a recommendation on whether further action is warranted. The Federal Cooperating Agencies (including Corps) would review the report and reach agreement on whether further action is needed.

11 LONG-TERM MONITORING

A. Goals. Monitoring would be conducted on a regular basis to ensure the project's recurring maintenance operations comply with environmental clearances and that the mitigation features continue to function as they are intended.

B. Major Components. For the project to reach this phase, the estuary would have reached its normal state of dynamic equilibrium and the Federal agencies determined that the mitigation features are effective. The Corps would inspect the mitigation features on at least an annual basis to determine if maintenance is required. Maintenance would be performed as a normal O&M activity.

Limited monitoring would be required to ensure the mitigation features continue to function as intended. Most of the mitigation features are designed to increase freshwater flows in Back and Middle Rivers. The other main physical feature located in the estuary would be the dissolved oxygen injection systems. The performance of all of these features could be assessed by monitoring salinity and water quality at specific critical points within the estuary. Therefore, the Long Term monitoring program is focused on providing that information.

The Corps would fund the USGS operation of continuous recorders for hydrologic and hydraulic data at four locations, as follows:

- 02198920 Savannah River at GA25, at Port Wentworth, GA
- 021989773 Savannah River at USACE Dock at Savannah, GA
- Back River at US 17 at Savannah, GA
- Savannah River at I-95

The Corps expects the Georgia Ports Authority to continue to fund (independent of SHEP) operation of a fifth station, 021989784 – Little Back River above Lucknow Canal, at the freshwater supply intake for the Savannah National Wildlife Refuge.

The estimated cost for this work is shown as follows:

Operate water quality stations	4 @ $69,250	= $277,000 per year

The Corps would perform a bathymetric survey every year at the following locations:

- McCoy's Cut
- Deepened area in Upper Middle River
- Deepened area in Little Back River

The estimated cost for these surveys is $60,000 per year.

The Georgia DNR-EPD and SC DHEC have mandated long-term monitoring of the sentry and background groundwater wells as a condition of their Section 401 Water Quality Certifications for the SHEP. These wells would be monitored for the life of the project, and an annual report would be prepared and submitted to the Georgia DNR-EPD summarizing the results of the monitoring. The cost to monitor the wells is estimated to be $7,500 per year.

The Corps would monitor water quality in effluent from CDFs as part of the annual O&M dredging program.

The costs to operate and maintain the dissolved oxygen systems are not included in this document. Those costs are shown elsewhere in the EIS.

C. Reporting. The USGS would include the hydrodynamic and water quality data collected at the continuous recorders in its annual state monitoring report. That report would be made available to the public. The Corps would furnish other data and internal reports to the agencies upon request.

D. Cost Summary. The annual costs for the long-term monitoring are summarized as follows:

Continuous Riverine Monitoring	$277,000
Annual Bathymetric Surveys	$ 60,000
Groundwater Wells	$ 7,500
Total	$344,500

These costs do not include the costs to operate and maintain the mitigation features. Periodic dredging may be needed to retain the flow capabilities of the flow-re-routing features. Adjustment of the rock used in these structures may be required after high river flows. Maintenance would also be needed to ensure the fish bypass at NSBL&D performs as intended. That maintenance would include periodic debris and sediment removal. The dissolved oxygen systems would need to be operated each year and maintained throughout their operating period. They would also need major rehabilitation when the equipment needs to be replaced. The annual cost to maintain the dissolved oxygen systems over the life of the project, including periodic replacement of equipment, is estimated to be $1,300,000.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX E: US Fish and Wildlife Service Final Fish and Wildlife Coordination Act Report

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps of Engineers
Savannah District
South Atlantic Division

United States Department of the Interior
Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

West Georgia Sub-Office
Post Office Box 52560
Fort Benning, Georgia 31995-2560

Coastal Georgia Sub Office
4980 Wildlife Drive, NE
Townsend, Georgia 31331

March 7, 2011

Colonel Jeffrey M. Hall
U.S. Army Corps of Engineers
Savannah District
100 West Oglethorpe Avenue
Savannah, Georgia 31401-3640
Attention: Mr. William G. Bailey, Chief, Planning Division

Dear Colonel Hall:

Enclosed you will find the Final Fish and Wildlife Coordination Act (FWCA) Report on the Savannah Harbor Expansion Project, in Chatham County, Georgia and Jasper County, South Carolina. This FWCA Report evaluates existing and future fish and wildlife resources within the Savannah Harbor area, provides the U.S. Fish and Wildlife Service (USFWS) analysis of project impacts and mitigation plans and provides the USFWS position and mitigation recommendations. The Endangered Species Act consultation is ongoing, awaiting information from the Savannah District U.S. Army Corps of Engineers (Corps). Based on the information currently available, this is the final detailed USFWS 2(b) report on the Savannah Harbor Expansion Project. However, because the Corps has not identified a recommended plan, we may provide additional 2(b) comments and recommendations after the recommended plan is identified. If you have any questions or need additional information please contact our Coastal Georgia Sub Office biologist, Bill Wikoff, at (912) 832-8739 extension 5.

Sincerely,

Sandra S. Tucker
Field Supervisor

cc: Robert D. Perry, Director, Office of Environmental Programs,
South Carolina Department of Natural Resources
Dan Forster, Director, Wildlife Resources Division,
Georgia Department of Natural Resources
Pace Wilber, Ph.D., Atlantic Branch Chief, Charleston, Southeast Regional Office,
NOAA Fisheries
Jack Arnold, Deputy Assistant Regional Director - Ecological Services, USFWS
USFWS, Townsend, Georgia

FISH AND WILDLIFE COORDINATION ACT REPORT
on the
SAVANNAH HARBOR EXPANSION PROJECT

Prepared by:
Edwin EuDaly
Palmetto Ecological Consulting

Under the Supervision of
Sandra Tucker, Field Supervisor
Division of Ecological Services
Athens, Georgia

March 2011

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

EXECUTIVE SUMMARY

Savannah National Wildlife Refuge (NWR) and the surrounding estuary support nationally important fish and wildlife resources. However, cumulative impacts of previous harbor modifications, primarily salinity intrusion, have severely impacted the resources that were present when the refuge was established. A freshwater supply system for managed wetlands, installed as mitigation for previous harbor deepening and a sediment control tide gate, has failed to function adequately. Tidal freshwater marsh has been reduced from about 12,000 acres historically to about 3,300 acres currently. Striped bass reproduction and recruitment were almost eliminated during tide gate operation but have recently begun to recover. Shortnose sturgeon habitat has been greatly impacted both by salinity increase and dissolved oxygen decrease.

The current inner harbor is 42 feet in depth. Impacts of project inner harbor depths of 44, 45, 46, 47 and 48 feet were evaluated using hydrodynamic and biological models. A number of mitigation measures have been proposed by the Corps. Most of these measures are based on channel and flow modifications in the estuary. In addition, a dissolved oxygen injection system, wetland acquisition, wetland restoration, striped bass stocking and a fish bypass channel at New Savannah Bluff have been proposed.

Impacts were assessed by comparing predicted with-project conditions immediately after construction to base year (current) conditions instead of comparing project-life average annual conditions to the base year. Impacts determined on an average annual basis would be less than those based on conditions immediately after construction because predicted sea level rise would impact the tidal freshwater wetlands and other habitat even without any harbor deepening. Without the cumulative impact of harbor deepening, it is unlikely that Savannah NWR would currently be impacted by salinity or would be substantially impacted by sea level rise during the project life, even with an expected increase in the rate of rise due to climate change. Therefore, it is appropriate to determine impact and formulate mitigation by comparing predicted with-project conditions immediately after construction to base year conditions.

The Corps proposes to reassess sea level rise effects in the future and assign "advance mitigation" credits to the project for use with future actions if the rate of sea level rise exceeds the historic rate. Sea level rise would have a negligible impact in the upper estuary if not for the cumulative impacts of previous harbor deepening. The rate of sea level rise is uncertain and substantial impacts resulting from sea level rise are not likely until well into the future. Conversely, the impacts of further harbor deepening will begin within a few years of project construction. In addition, due to the complexity of the system and limitations of the models, the models may underestimate wetland impacts. "Advance mitigation" is the functional equivalent of a mitigation bank, and U.S. Fish and Wildlife Service (USFWS) Mitigation Policy (64 FR 49229-49234) does not allow the use of NWR lands for mitigation banks. Therefore, the USFWS does not support the concept of advance mitigation based on a future evaluation of the relative impacts of sea level rise.

There is a great deal of risk and uncertainty regarding impacts and the channel and flow modification and dissolved oxygen mitigation plans. The mitigation plans are unlikely to perform exactly as predicted. There could be unintended adverse consequences resulting from the channel and flow mitigation measures. All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The Environmental Fluid Dynamics Code model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located there. Diversion of fresh water into the Back River allows salinity to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. The model may under predict the amount of salinity moving up Front and Middle River.

The 44- and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44- and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths.

The USFWS's preferred alternative for deepening Savannah Harbor is the 45-foot alternative because it minimizes impacts to Savannah NWR, tidal freshwater marsh and fish habitat. The Corps has proposed implementing either the national economic development plan (NED) (47-foot alternative) or the locally preferred plan (LPP) (48-foot alternative). Any additional economic benefits resulting from the LPP relative to the NED plan would represent local benefits. By contrast, the additional environmental impacts associated with the LPP, and in particular the loss of an additional 114 acres of already scarce and declining freshwater tidal wetlands, would occur on a national resource, the Savannah NWR. The additional 114 acres of impact to freshwater tidal wetlands associated with the LPP represents a 50% increase in impacts over the NED plan's depth. For this reason, the USFWS does not support the LPP.

For any project implemented, the USFWS supports a comprehensive monitoring program to document actual impacts and an adaptive management plan to rectify unanticipated impacts. This report makes a number of recommendations to improve both monitoring and adaptive management. As currently proposed, Corps funding for adaptive management activities that may be required will be dependent upon the Corps' annual appropriations process. Because these adaptive management actions may be essential to correct mitigation deficiencies and insure that impacts to fish and wildlife trust resources are offset, contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations.

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SAVANNAH HARBOR EXPANSION PROJECT

INTRODUCTION

Authority

A resolution adopted by the Senate Public Works Committee on July 10, 1972, authorized the Tier 1 Savannah Harbor deepening study which the Savannah District Corps of Engineers (Corps) initiated in 1995. After the Corps completed the Reconnaissance Report in 1996, the Georgia Ports Authority (GPA) funded feasibility studies under Section 203 of Water Resources Development Act (WRDA) of 1986. The 1999 WRDA included conditional authorization of the Savannah Harbor Project, which would deepen the harbor by up to six feet. Department of Interior, Department of Commerce and Environmental Protection Agency (EPA) concurrence is required before project implementation. The Savannah Harbor Expansion Study was initiated in 1999 to complete detailed impact evaluation, mitigation plan development and economics evaluation. The Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) (FWCA) authorized the U.S. Fish and Wildlife Service's (USFWS) involvement in this study. The USFWS participated in planning throughout the study and prepared this report with funds transferred from the Corps under the National Letter of Agreement between our agencies for funding of FWCA activities.

Purpose and scope

The purpose of the Tier One GPA/Corps study was to determine whether deepening of Savannah Harbor was needed to serve navigation interests. The purpose of the Tier Two study is to complete detailed impact evaluation, mitigation plan development and economics evaluation. This FWCA Report evaluates existing and future fish and wildlife resources within the Savannah Harbor area, provides the USFWS analysis of project impacts and mitigation plans and provides the USFWS position and mitigation recommendations. Based on the information currently available, this is the final detailed USFWS 2(b) report on the Savannah Harbor Expansion Project. However, because the Corps has not identified a recommended plan, we may provide additional 2(b) comments and recommendations after the recommended plan is identified.

Prior studies and reports

The Corps and other agencies have produced numerous reports dealing with Savannah Harbor. The following discussion focuses on prior USFWS reports most relevant to the current project and a few of the more relevant Corps studies. The Corps released the Stage I Report for the Savannah Harbor Comprehensive Study (SHCS) in April 1981 and a Preformulation Report in January 1983. In September 1987, the Corps released a Draft Feasibility Report and Draft Environmental Impact Statement (DEIS) on the project. These reports proposed a two-foot deepening project for the Harbor. Completion of the study was subsequently postponed because

of two general areas of concern. First, the Corps' hydrodynamic model, designed to predict salinity impacts of harbor deepening, was not adequately verified and could not be used with any confidence. Second, impacts of the tide gate on Savannah National Wildlife Refuge (Savannah NWR) were greater than predicted and needed to be addressed prior to further harbor modifications. To address these concerns, the Corps initiated a Savannah Harbor Environmental Study in early 1988.

The Corps released a revised SHCS Draft Feasibility Report and Environmental Impact Statement in April 1991. This report recommended a four-foot deepening of Savannah Harbor upstream to the Kings Island Turning Basin.

The USFWS provided SHCS Planning Aid letters to the Corps dated March 21, 1981; July 23, 1981; and September 18, 1981, expressing concerns related to dredged material disposal, Savannah NWR, harbor deepening, and harbor extension. The USFWS submitted a SHCS Planning Aid Report (PAR) on September 16, 1982, which provided: (1) an analysis of wetland resources in the study area; (2) an evaluation of the impacts of tide gate operation on Savannah NWR and striped bass habitat; and (3) a habitat evaluation procedures study of potential spoil areas. On December 1, 1983, the USFWS completed a second SHCS PAR which provided: (1) an evaluation of fish and wildlife resources on two new potential dredged material disposal areas; (2) resource categories and general mitigation goals and measures for all potential spoil areas; and (3) further analysis of freshwater supply problems on Savannah NWR.

The USFWS provided a reconnaissance level PAR on September 27, 1984, which analyzed impacts of harbor extension on fish, wildlife, and wetlands of Savannah NWR and adjacent areas. The PAR also identified information and studies needed to adequately assess impacts of harbor extension. In November 1986, the USFWS provided a Draft FWCA Report on the SHCS. This report evaluated existing and future fish and wildlife resources in the study area and identified problems, opportunities, and planning objectives for these resources. In addition, using information available at that time, the report evaluated fish and wildlife impacts of tide gate operation and harbor deepening. The report also questioned the reliability of the Corps' hydrodynamic model and recommended adequate verification before using the model for evaluation of harbor deepening.

In 1986, USFWS-funded studies were initiated to determine impacts of Savannah Harbor modifications, particularly the tide gate and New Cut, on Savannah NWR, and several reports on these studies were produced. In 1989, a report characterizing the hydrology of the lower Savannah River and impact of the tide gate on salinity levels was released (Pearlstine et al. 1989). In 1990 a report on effects of salinity on striped bass eggs and larvae was released (Winger and Lasier 1990) and a report on fishery resources, primarily striped bass, was published (Van Den Avyle et al. 1990). A report on the impacts of the tide gate on tidal freshwater marsh and development of a habitat successional model for the marsh was also published in 1990 (Pearlstine et al. 1990).

The USFWS provided a revised SHCS Draft FWCA Report in November 1990. This report concluded that deepening of Savannah Harbor in conjunction with continued operation of the tide gate project would exacerbate currently unacceptable fish and wildlife impacts. The USFWS opposed channel deepening until such time as the impacts of the tide gate project were completely offset and strongly recommended that the Corps remove the tide gate and fill New Cut. The USFWS provided a FWCA Report on Savannah Harbor - Closure of New Cut in June 1991. The USFWS supported the plan to close New Cut and take the tide gate out of operation.

The USFWS provided a Reconnaissance PAR on Port Wentworth Deepening Project in December 1993. The purpose of the Corps' study was to evaluate deepening of Savannah Harbor in the vicinity of Port Wentworth from Station 102 + 000 to Station 112 + 500.

In August 1996 the USFWS provided a Reconnaissance PAR on Savannah Harbor Expansion. The USFWS recommended that a reliable Savannah Harbor hydrodynamic model be developed to estimate impacts of the alternative plans on river system salinity patterns. The USFWS expressed concern that the project could increase salinity levels in the lower Savannah River system. An increased salinity level would adversely impact managed wetlands, tidal freshwater wetlands, and striped bass habitat on and near Savannah NWR. The USFWS also expressed concern that moderate incremental increases in the salinity level may become cumulatively significant if depth of the harbor is repetitively increased over time.

In June 1998 the USFWS provided a Planning Aid Letter on the proposed expansion project. Because of the lack of needed impact analysis model runs, the lack of an acceptable mitigation plan, and numerous concerns on potential impacts, we could not provide a FWCA report at that time. In July 1998 the Department of Interior provided comments on the Tier 1 DEIS for Savannah Harbor Expansion. The comments discussed a number of issues related to inadequate impact analysis, potential significant impacts on Savannah NWR and the lack of an adequate mitigation plan. In October 1998, the Department of Interior provided comments on the Chief of Engineers proposed report and Final Environmental Impact Statement. These comments reiterated the view that the documents were inadequate regarding impact analysis and proposed mitigation measures.

In June 2008, the USFWS provided a Plan Formulation PAR on the Savannah Harbor Expansion project. In November 2008, the USFWS provided a Draft FWCA Report on the Savannah Harbor Expansion project. Based on information available at that time, the 2008 report discussed existing fish and wildlife resources and evaluated project impacts. In addition the report evaluated the proposed mitigation options and provided USFWS recommendations to mitigate the predicted impacts.

DESCRIPTION OF THE STUDY AREA

The study area includes the Savannah Harbor and the surrounding land in Chatham County, Georgia, and Jasper County, South Carolina. The study area lies in the Coastal Plain Marine

Flatwoods region. The land surface is nearly level with broad depressions associated with drainage ways or wetlands. Elevation ranges from sea level to approximately 40 feet above sea level. Soils in the study area generally have a sandy surface layer, a high water table, and are underlain by marine sands, loams, and/or clays.

Rare natural upland forests in the study area are dominated by longleaf and slash pine. Most uplands have been converted to loblolly pine plantations or developed for residential or commercial purposes. Maritime forests, dominated by live oak with water oak and southern magnolia as associates, are found on less disturbed barrier islands and other uplands near the coastline. Estuarine emergent wetlands (salt marsh), estuarine sub-tidal wetlands, palustrine emergent wetlands (fresh marsh), palustrine forested wetlands (swamp) and riverine wetlands (freshwater rivers and creeks) are significant components of the study area.

Water flow in the Savannah River varies considerably both seasonally and annually. Discharge is typically high in winter and early spring and low in summer and fall, but regulation by upstream reservoirs has reduced natural flow variations. Average discharge (75 years) at the United States Geological Survey (USGS) Clyo gauge (Effingham County, Georgia) was 11,720 cubic feet per second (cfs) and the average for water year 2005 was 13,300 cfs with a range (daily mean) of 5,490 cfs to 30,300 cfs (Cooney et al. 2005). Tidal effects extend upstream to approximately river mile 45.

The existing authorized harbor navigation project provides for a channel 44 feet deep and 600 feet wide across the ocean bar; 42 feet deep and 500 to 600 feet wide to the vicinity of Kings Island Turning Basin; and 30 feet deep and 200 feet wide to a point 1,500 feet below the Houlihan Bridge (GA Highway 25). The terminus of the existing channel for Savannah Harbor is at approximately river mile 21. The project provides turning basins for vessels at various locations in the harbor (Figure 1).

From 1977 until 1992, the project also included sediment control works consisting of a tide gate structure across Back River; a sediment basin, 40 feet deep, 600 feet wide, and about 2 miles long, with an entrance channel, 38 to 40 feet deep and 300 feet wide; a drainage canal ("New Cut") across Argyle Island, 15 feet deep and 300 feet wide; control works and a diversion canal on Little Back River. The diversion canal, a mitigation feature to supply fresh water to the Savannah NWR and adjacent private lands, was designed to replace the traditional supply, from various points on Back River that had been used for agriculture and wetland management for hundreds of years. The tide gate, essentially a series of large flap gates, opened during flood (incoming) tides and closed at high water. Therefore, ebb tidal water was forced to flow out through New Cut into Front River, increasing water velocities in the developed harbor and reducing sedimentation in the Front River. In addition, much of the sediment in the harbor was deposited in the sediment basin which is adjacent to dredged material disposal areas.

Because of unacceptable environmental impacts, the tide gate was permanently removed from operation and New Cut was closed with a sand and riprap structure in 1992. The tide gate structure is still in place but the flap gates have been removed to allow water passage at all tides.

The sediment basin is dredged periodically and it continues to trap a large quantity of sediment but less than the amount trapped when the tide gate was in operation.

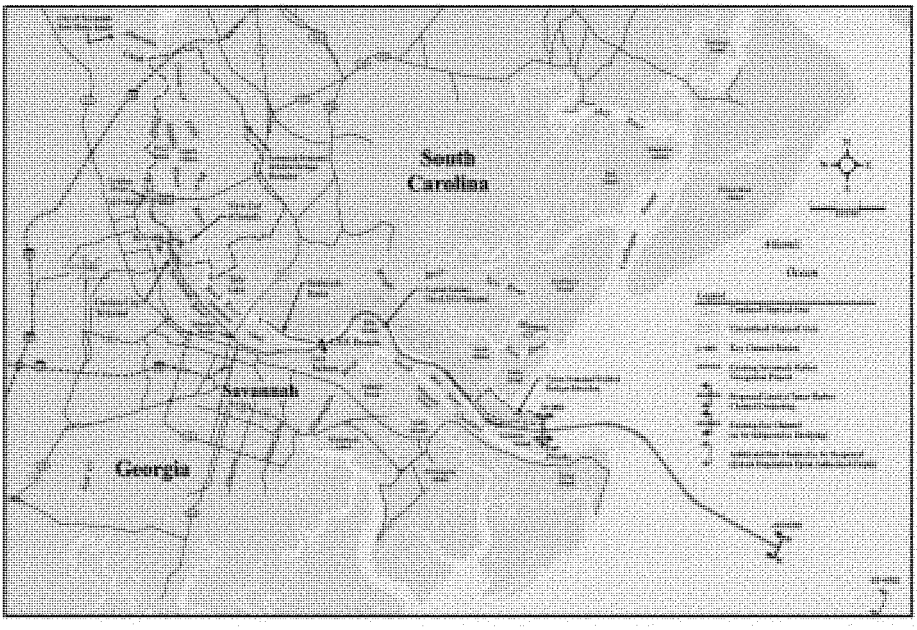

Figure 1. Existing and proposed Savannah Harbor navigation project, Georgia and South Carolina. Boundary of Savannah National Wildlife Refuge extends upstream and downstream further than shown on map. The bar channel would be extended to -98 + 600 (48-foot alternative).

Maintenance dredging in the harbor averages about 7.04 million cubic yards per year. Most of the material is placed in confined dredged material disposal areas (CDF's) north and east of the sediment basin in the Barnwell Island area of South Carolina. These disposal areas (12A, 12B, 13A, 13B, 14A, 14B) cover about 4,800 acres. Other disposal areas are located on Onslow Island (130 acres), Argyle/Hutchinson Island (185 acres), and Jones/Oysterbed Island (754 acres). All of these disposal areas were predominantly emergent wetlands (marsh) prior to being diked in the late 1950's. The material dredged to keep the bar channel at project depth is deposited in the EPA approved interim ocean disposal area, a 4.26 square mile area centered at 31°56'54"N, 80°45'34"W.

On March 12, 2007, Governor Sanford (South Carolina) and Governor Perdue (Georgia) signed an agreement (Term Sheet) to form a Bi-State Compact and jointly develop a new marine terminal in Jasper County, South Carolina at about Savannah River mile seven. The conceptual plan calls for a new 1,800-acre marine terminal to be located on Barnwell Island (disposal area

14A/B). The site is currently under a Corps dredged material disposal easement. Most of the existing container terminals are in Port Wentworth, Georgia between river miles 16 and 19. The Term Sheet directs Georgia Department of Transportation to transfer the land to the Bi-State Authority and requests that the Corps modify or release the disposal easements. The site currently has no infrastructure and a new rail and highway spur to the site would be required for terminal development. The proposed site is adjacent to the existing dredged channel so new channel dredging for a new terminal would be minimal.

FISH AND WILDLIFE RESOURCES

Savannah National Wildlife Refuge lies adjacent to, and upstream of, the Savannah Harbor project. Savannah NWR consists of 29,175 acres of palustrine forested wetlands, palustrine and estuarine emergent wetlands, palustrine scrub-shrub wetlands, riverine wetlands, diked waterfowl impoundments (managed wetlands) and uplands (Figure 2). About 3,000 acres of the Refuge lands are actively managed wetlands which provide excellent habitat for wintering waterfowl, shorebirds, wading birds, and wood ducks. Up to an additional 2,700 acres has some potential for water level control and may be actively managed in the future. The Refuge encompasses much of the high value fish and wildlife habitat that has been or is likely to be impacted by harbor development.

Tybee National Wildlife Refuge is located in Chatham County, Georgia, near the mouth of the Savannah River, adjacent to the navigation channel. The 400-acre migratory bird Refuge began as a one-acre oyster shoal. The Corps, while engaged in harbor deepening and maintenance, used the shoal as a dredged material disposal site and created Oyster Bed Island (the nucleus of the present Refuge).

Wassaw National Wildlife Refuge is located in Chatham County, Georgia about 13 miles south on the Savannah Harbor entrance channel. This 10,053-acre island consists of marine wetlands (ocean beach), maritime forest and estuarine wetlands. Loggerhead turtles (threatened) use the ocean beach for nesting and piping plovers (threatened) use the beach habitat for winter foraging and cover (John Robinette, USFWS, personal communication 2008).

Managed Wetlands

The managed wetlands were diked for purposes of rice culture, during the 18th and 19th centuries. Many of these areas remain impounded and are managed as migration and wintering habitat for waterfowl and other wetland-dependent migratory birds. Prescribed burning and water level control are two management tools used to promote desirable wetland plants of value to migratory birds. Moist soil management, which is used in most of the management units on Savannah NWR, produces the most productive waterfowl habitat. Fresh water is provided to the managed wetlands through the diversion canal on Little Back River. On Savannah NWR these managed wetlands provide the most heavily used habitat for wintering waterfowl and other

migratory birds. From 1990-2002, Savannah NWR supported an average of 23% of the South Carolina waterfowl observed in the mid-winter waterfowl counts (Berryman and Webb 2003).

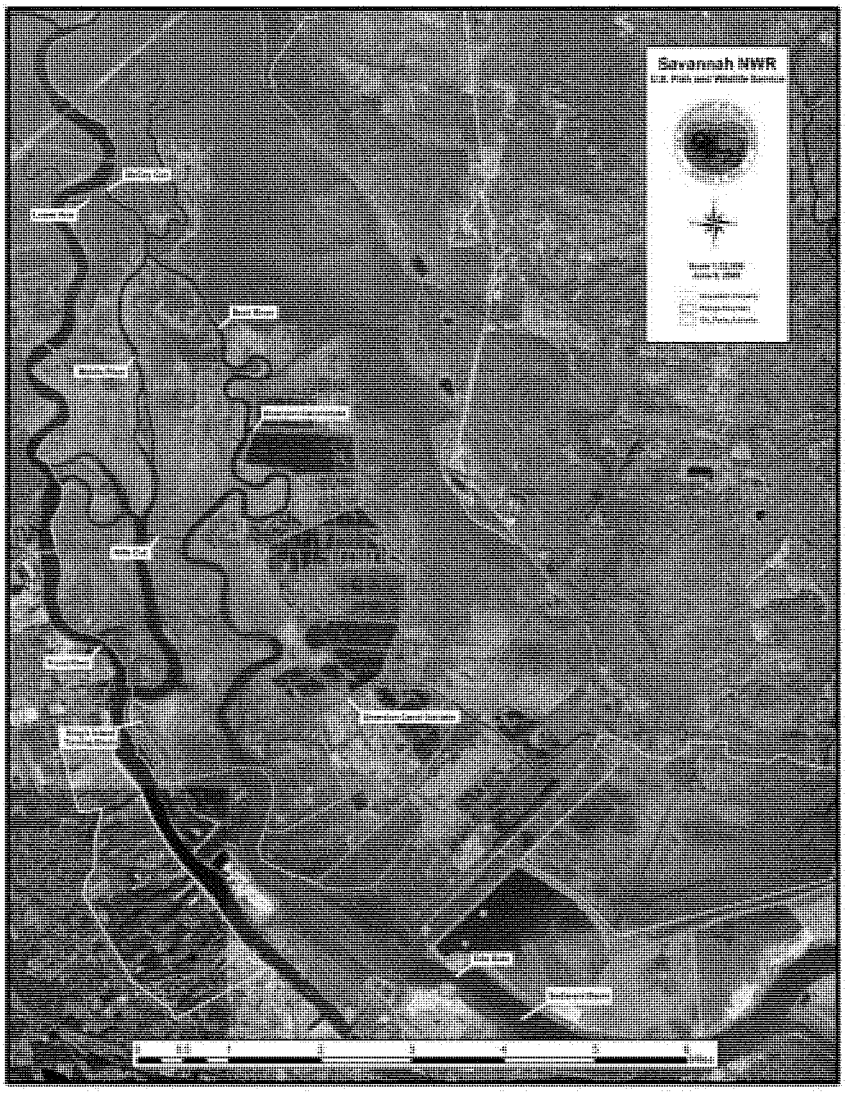

Figure 2. Savannah National Wildlife Refuge and prominent features of Savannah Harbor, May 2008. Refuge extends north along the Savannah River about 15 river miles beyond the extent of this map.

Freshwater management, with salinity less than 0.5 parts per thousand (ppt), is necessary to maintain maximum waterfowl use of the Refuge's managed wetlands. According to Tiner (1977), freshwater coastal impoundments in South Carolina produce a greater variety of marsh plants, many of which are desirable duck food, than brackish impoundments. Landers et al. (1976) in a study of South Carolina coastal impoundments found that: "Fifty-five percent of the area impounded in the general study area was freshwater marsh and 62 percent of the ducks were from freshwater impoundments. Ducks, except wigeons, gadwalls and scaups (*Anas americana, Aythya marila, A. affinis*) took foods that grew mostly in freshwater marsh in greater volume (about 87%) than foods from brackish and saline areas." They also found that: "Forty-five percent of the total impounded area was brackish marsh and 38 percent of the ducks were from brackish impoundments. Yet plants characteristically growing in brackish marsh composed only about 13 percent of food volumes." These studies indicate that freshwater management will produce a greater variety and quantity of desirable waterfowl food plants than brackish water management. Therefore, it is essential that the Refuge retain freshwater management to provide maximum benefits to the waterfowl resource.

Freshwater managed wetlands on Savannah NWR currently provide high quality feeding habitat for many species of wading birds, including the endangered wood stork. Several areas are managed each year specifically to provide optimum feeding opportunities for wading birds during and after the nesting season. Studies have revealed that wood storks, and many other wading bird species, select freshwater feeding sites (when available) over brackish or salt water sites. Gaines et al. (1998) found coastal nesting wood storks typically flew significantly longer distances to forage in palustrine habitats than in estuarine habitats and feeding site preference of storks from a colony on St. Simons Island was clearly skewed in favor of palustrine habitat over estuarine habitat despite lower overall availability of palustrine habitat. In addition, some species, such as white ibis (*Eudocimuns albus*), may require a fresh water food source for successful chick rearing (Johnston and Bildstein 1990). When nestling white ibis diets contain fiddler crabs (containing high salt content) nestlings experience depressed growth and increased mortality (De Santo 1992). De Santo et al. (1997) found that parental white ibis, in coastal South Carolina, concentrate their foraging efforts in freshwater swamps and impoundments at a considerable distance from the breeding colony site, despite the fact that it was more costly energetically and a greater travel time to these sites as compared to nearby salt marsh feeding sites. Freshwater impoundments are also managed to provide nesting and feeding habitat for shorebirds, and high quality feeding habitat for neotropical migrants such as the swallow-tailed kite.

Construction of the freshwater diversion canal, which provides fresh water to the Refuge and adjacent plantations, was completed as mitigation for the tide gate and harbor deepening in 1977. However, due to salinity levels much greater than predicted, the metal water control structures rusted and failed soon after construction was completed. The USFWS retrofitted the existing structures with stainless steel channels and solid stop-log structures, stainless bolts and flap-gates. This repair was the most effective and cost efficient for the USFWS to undertake at the time. The patch allowed the USFWS to provide for water needs of the Refuge and adjacent land owners for the next 27 years, but the system has never functioned as designed. The Refuge-

funded repair of the structures made the act of filling or draining the canal labor intensive and expensive. Compared to the original design, which required one person and minimal time to fill or drain, it now requires three persons, heavy equipment (for lifting the solid gates) and a full day to adjust the water within the canal. In addition, the structures are systematically failing due to the channels shearing off the structure walls. There are two structures controlling the water delivery system. Currently, the south water control structure cannot be operated; all four of the 48-inch openings have failed. The north structure originally had nine pipes but two of these were permanently closed in the past leaving seven openings. The remaining seven pipes are failing. Many of the interior water control structures which supply water to the individual management units are also failing.

If the USFWS loses the ability to control water levels, within the impoundment system, the Refuge would be subject to the ebb and flow of the tides. This would result in severe damage to Refuge infrastructure; i.e., roads, dikes and internal water control structures. Severe damage to Refuge roads and dikes would result in the loss of most public use, including hiking, birding and wildlife viewing. The USFWS would lose the ability to supply fresh water for wildlife habitat management to the adjacent Fife and Clydesdale plantations. The USFWS could not fulfill the congressional mandate that the Refuge was established under - to provide for the needs of the Nation's migratory bird resources. Migratory birds that utilize the Refuge for nesting, feeding, roosting and protection would be forced to find suitable habitat on other lands. On private lands this resource would be susceptible to disturbance and increased mortality, from hunting and poaching, and land management practices that focus on agricultural, developmental or industrial uses.

The USFWS has repaired, operated and maintained this system, at great expense and manpower for over 27 years. Now the system is in disrepair once again and is susceptible to imminent failure. During planning for the Savannah Harbor Expansion project, the USFWS documented the need to repair the system, prior to any additional harbor deepening, to fulfill previous mitigation commitments. In 2009, the Corps agreed to repair the system under existing authorities. The first phase of repair, south of South Carolina Highway 170 (SC 170), was initiated in June 2010. The second phase, north of SC170, is scheduled to begin in mid-2011.

Tidal freshwater wetlands

Tidal freshwater wetlands (palustrine emergent wetlands) cover much of Savannah NWR in the vicinity of the Harbor and, in contrast to the managed wetlands, are flooded twice daily by tidal action. These marshes were either never diked or the dikes constructed for rice culture have eroded to marsh elevation allowing tidal flooding. Based on vegetation, interstitial (marsh root zone) salinity and soils studies conducted in 1999-2001, the tidal freshwater marshes in the study area are composed of a highly diverse plant community and the community composition is highly dependent on the salinity gradient in the estuary (Dusek and Kitchens 2003). Using cluster analysis, Dusek and Kitchens (2003) identified eight vegetation classes in the study area and the number of species ranged from 11 in the most saline class to 99 in the most diverse freshwater class.

Welch and Kitchens (2006) used additional (1999-2005) vegetation, interstitial and soils data and additional ecological models to classify the plant community. Their classification generally resulted in five plant communities under both drought (2002) and non-drought (2005) conditions. The communities classified under drought and non-drought conditions were similar with minor shifts in the percentages of dominant species (Table 1). The authors developed decision trees that could be used to predict the plant community at a location in the estuary based on salinity, soils and distance to a channel.

A marsh succession model (MSM) consisting of a geographic information system that displays the plant communities based on the salinity, soils and distance to a channel was developed as a tool to evaluate channel deepening impact (Welch and Kitchens 2006). The first input into the MSM is the channel salinity as predicted by the Environmental Fluid Dynamics Code hydrodynamic model (EFDC). The EFDC is a three-dimensional physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. The channel salinity is translated to interstitial salinity using a model to marsh spreadsheet application developed by data mining techniques that used channel salinity data and interstitial salinity data at several locations in the estuary (Conrads et al. 2006). The decision trees (Welch and Kitchens 2006) were used in conjunction with the environmental data to predict the plant communities in the study area. Table 2 presents the area occupied, determined by the marsh succession model, by the plant communities under current conditions (42-foot channel).

Table 1. Marsh succession model (MSM) community names, interstitial salinity (Welch and Kitchens 2006) and mean channel salinity. Channel salinity is the 50% exceedance value for average flow conditions from Environmental Fluid Dynamics Code model (Bill Bailey, Corps, written communication 2006).

MSM Non-drought Community (2005)	MSM Drought Community (2002)	Non-drought Mean Interstitial Salinity (ppt)	Drought Mean Interstitial Salinity (ppt)	Channel salinity (ppt)
100% Elemo; Galti; Saglt*	91% Elemo	<0.83	<1.0	<0.5
80% Zizmi; Polsp*	100% Zizmi; Polsp	<0.83	<1.0	<0.5
45% Zizmi; Polsp; 29% Elemo; Galti; Saglt; 26% Sciva*	45% Elemo 31% Zizmi_Polsp 23% Sciva	<0.83	<1.0	<0.5
78% Sciva	86% Sciva	0.83-3.6	1-4.2	0.5-3
78% Spasp; Sciro; Astte*	78% Spasp_Sciro 22% Sciva	>3.6	>4.2	3-9

* Elemo=Eleocharis montevidensis, Galti=Galium tinctorium, Saglt=Saggataria lancifolia, Zizmi=Zizaniopsis miliaceae, Polsp=Polygonum sp., Sciva=Scirpus validus, Spasp=Spartina spp.,Sciro=Scirpus robustus, Astte=Aster tenuifolius

Table 2. Area occupied, determined by the marsh succession model (Welch and Kitchens 2006), by the plant communities under current depth (42-foot channel) for non-drought and drought conditions.

MSM Non-drought Community (2005)	No action acreage Non-drought	MSM Drought Community (2002)	No action acreage Drought
100% Elemo; Galti; Saglt*	2081	91% Elemo	868
80% Zizmi; Polsp*	761	100% Zizmi; Polsp	476
45% Zizmi; Polsp; 29% Elemo; Galti; Saglt; 26% Sciva*	427	45% Elemo 31% Zizmi_Polsp 23% Sciva	1069
78% Sciva	2427	86% Sciva	2485
78% Spasp; Sciro; Astte*	3151	78% Spasp_Sciro 22% Sciva	3949
Total	8847		8847

Commonly used marsh classifications are usually based on average channel salinity not interstitial salinity (Odum et al. 1984). The communities in the table with a channel salinity of <0.5 ppt are considered to be tidal freshwater marsh with differing species composition. Scirpus validus (78% Sciva) is considered to be oligohaline marsh. Oligohaline marsh is described by Odum et al. (1984) as having an average annual channel salinity of 0.5 ppt–5.0 ppt. The Spartina spp, Scirpus spp, Aster tenuifolius is considered to be mesohaline marsh. The location of the 50% exceedance (% of time a specified value is equaled or exceeded) 0.5 ppt salinity contour as predicted by the EFDC model is generally located downstream of the tidal freshwater marsh predicted by the MSM in the Front River and Middle River (Figure 3). This difference could be due to prediction errors in the EFDC model, the MSM model or both. The difference amounts to about one river mile on the Front River and on the Middle River. However, the predictions on the Back River from both models are at virtually the same location.

Cumulative salinity impacts due to previous harbor deepening projects have been significant and have substantially reduced the amount of freshwater marsh in the system. Table 3 presents the location of the freshwater limit, channel depth and amount of tidal freshwater marsh at the various times. Figure 4 shows the approximate location of the freshwater interface at various times in recent history. As the salinity interface has moved upriver, the diverse tidal freshwater marsh has been converted to lower diversity brackish marsh. In 1875, there was an estimated 12,000 acres of tidal freshwater marsh, compared to only 3,269 acres in 2005, a 73% reduction. As an alternative method, the Corps projected EFDC- predicted salinity in the river channels (Front, Middle and Back) across the marsh surface based on drainage patterns determined from aerial photos. This method resulted in an estimate of 4072 acres of tidal freshwater marsh in 2005 (Corps of Engineers 2010a).

During tide gate operation (1977-1992), salinity was increased by an additional increment in Back River and Little Back River, moving the freshwater-saltwater interface six miles upriver, and marshes in that area became more brackish and less diverse (Pearlstine et al. 1990).

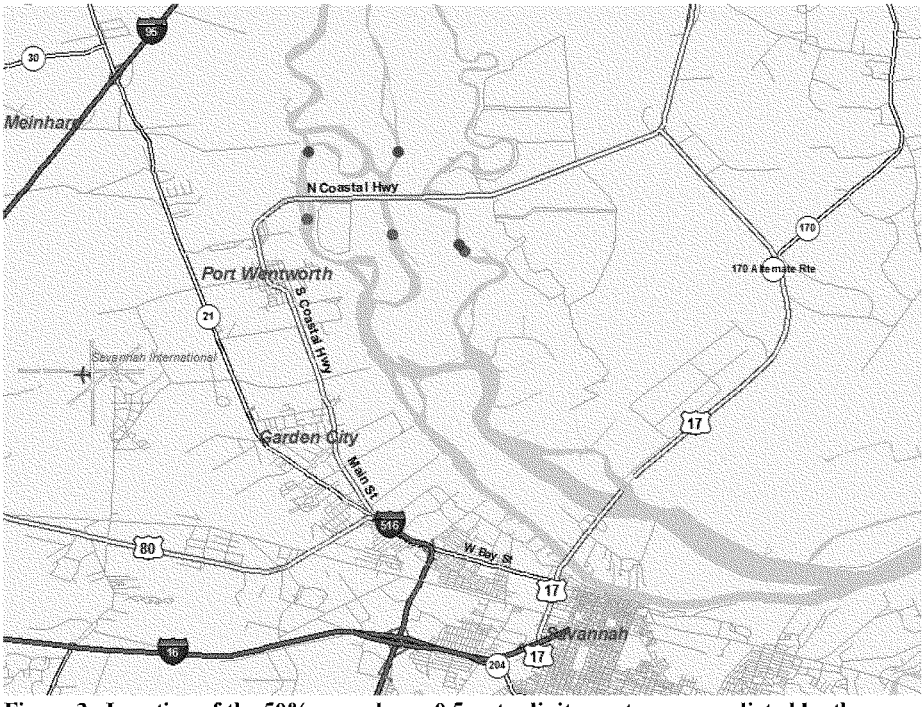

Figure 3. Location of the 50% exceedance 0.5 ppt salinity contour as predicted by the EFDC model (red points) and of the tidal freshwater marsh predicted by the MSM (blue points) in the Front River (left channel), Middle River (middle channel) and Back River (right channel).

Table 3. Location of the freshwater limit, channel depth and amount of tidal freshwater marsh in the Savannah estuary from 1875-2005.

Year	Channel depth	Freshwater limit (river mile)	Tidal freshwater marsh (acres)
1875	15	7 (Granger 1968)	12,000 (map estimate)
1940	28	13 (Lamar 1940)	8,000 (map estimate)
1974	34	17 (Corps of Engineers 1975)	6,007 (Tiner 1977)
2005	42	21 (EFDC prediction)	3,269 (Welch and Kitchens 2006)

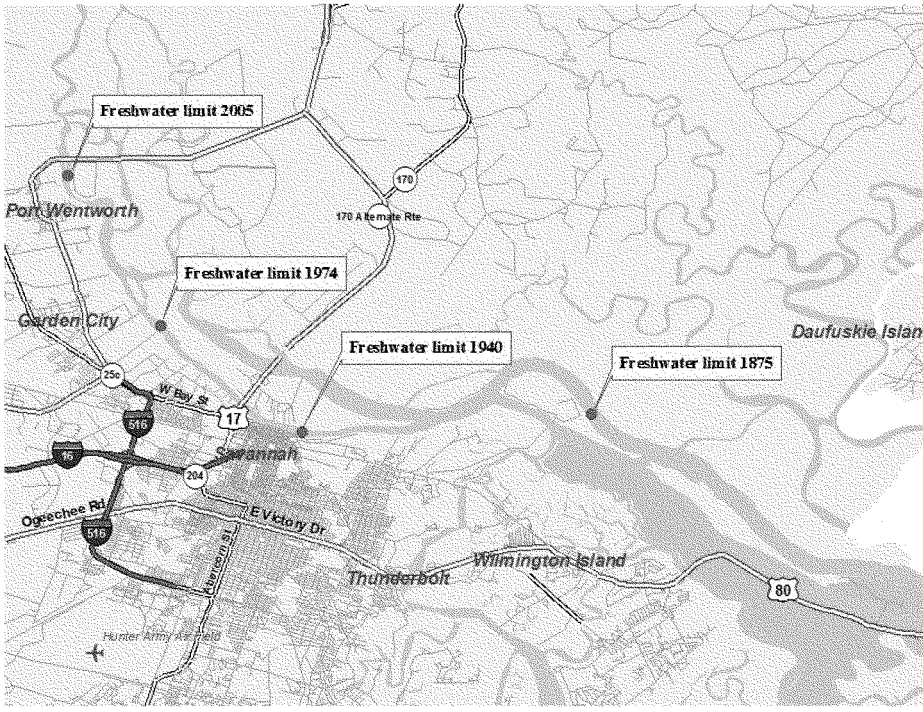

Figure 4. Location of the freshwater interface in the Savannah River from 1875-2005.

New Cut closure and termination of tide gate operation resulted in reversal of the previous adverse trends that were caused by the gate. Some studies have indicated a gradual return to freshwater wetland vegetation characteristic of the Back River before the construction of the tide gate (Latham and Kitchens 1996, Loftin et al. 2003). Another study, during 1999-2001 found fluctuations of plant species composition and the trend toward return of freshwater vegetation was not confirmed. However, this study occurred during a period of severe drought that increased salinity throughout the study area (Dusek and Kitchens 2003).

Fish

Jennings and Weyers (2003) conducted fish sampling in the Savannah River estuary during 2000-2002 and reported a diverse and abundant fish community that depended on the availability of specific salinity-defined habitats. A total of 91 fish species were collected with bay anchovy, Atlantic menhaden, Atlantic croaker and spot being the most abundant species. Most species were estuarine habitat generalists that could tolerate a wide range of salinities. A smaller number of species were marine species restricted to areas with higher salinity (>10 ppt) and these species moved further up the estuary as salinity moved inland during periods of low river discharge.

Obligate freshwater species that could not tolerate salinity above 5 ppt were the smallest component of the fish community. The authors stated that these freshwater species would probably be at the greatest risk of population declines or range reduction if salinity increased in the estuary.

The shortnose sturgeon (endangered) is the only fish in the project area listed under the Endangered Species Act. This species is almost always located near the river bottom where it feeds on invertebrates. The shortnose sturgeon is frequently located near the fresh water/salt water interface. A recent study (1999-2000) in the Savannah estuary used acoustic transmitters to track shortnose sturgeon location and determine habitat utilization (Collins et al. 2001). Juveniles were found in two different specific locations depending on water temperature. When water temperature was less that 22° C, they were found near the intersection of Front River and Middle River (river mile 19.7), moving between both rivers. When water temperature was greater than 22° C the juveniles moved upstream of the harbor area and concentrated around river mile 29.5, where the salinity was consistently 0.1 ppt. Adult movements were similar but more extensive than the juveniles, with some adult fish moving almost to the mouth of the river during low temperature periods. During the study several fish received transmitters that measured depth and these fish were always located on or near the bottom.

Sampling during the late 1980s found that juvenile shortnose sturgeon were concentrated in the Kings Island Turning Basin (river mile 18.7) (Hall et al. 1991) but no juveniles were collected that far downriver in 1999-2000 (Collins et al. 2001). Changes in the study area include harbor deepening from 38 to 42 feet, closing New Cut and taking the tide gate out of operation. The low catch rate of juveniles in 1999-2000 indicated that natural recruitment was quite low in the Savannah River. In the southeastern U.S. low recruitment is often thought to be caused by poor water quality in the nursery habitat located at the fresh water/salt water interface (Collins et al. 2001).

One of the most important species in the lower Savannah River, both as an important sport fish and as an indicator of environmental quality, is the striped bass. Studies in the 1960's and early 1970's indicated that the primary spawning area for striped bass in the Savannah River system was the tidal fresh water zone approximately 18-25 miles from the river mouth, specifically the Little Back River (McBay 1968; Smith 1970; Rees 1973, 1974). However, recent studies using egg surrogates (gellan beads) revealed striped bass egg sampling efficiency biases due to channel morphology and other hydraulic conditions. Sampling efficiency appeared to be higher, by an order of magnitude, in the narrower, shallower Back River than in the Front River (Reinert et al. 2004). Therefore, it is probable that the amount of spawning in the Front River has been underestimated in the past.

Production of striped bass eggs in the Savannah River estuary declined by about 95% between 1977, when the tide gate was put into routine operation and 1989 (Van Den Avyle et al. 1990). Tide gate operations increased the salinity on striped bass spawning grounds and altered current velocities and pathways of water movement in the middle and lower estuary (Van Den Avyle et al. 1990, Reinert et al. 2005). Adult spawners continued to use the same spawning grounds

reported prior to tide gate installation, but the amount of spawning was reduced. There was no evidence of an upstream shift of spawning as speculated by Dudley and Black (1978). These research results and Georgia Department of Natural Resources (GADNR) catch per effort for adult striped bass, indicated the reduction in spawning reflected reduced abundance of adults caused by lack of successful recruitment.

Salinities of 10 ppt or greater are toxic to striped bass larvae (Winger and Lasier 1990). Seaward of Hutchinson Island, salinity typically exceeds levels toxic to striped bass eggs and larvae. When the tide gate was operating, most striped bass eggs released in the Savannah River estuary during spawning were transported beyond Hutchinson Island in 30 to 48 hours. Striped bass eggs hatch within 40 to 60 hours post spawning, and the larvae, which are weak swimmers, are not able to avoid toxic conditions for at least 5 days post hatch.

Recovery of a viable, naturally-reproducing, Savannah River striped bass sport fishery following the 1992 tide gate project modification was expected to take many years. Because of the severe decline in brood stock, stocking of striped bass was required for population recovery. The stocking program, which was initiated in 1989 by GADNR, was continued through 2002 (Matt Thomas, GADNR, personal communication 2005). Male striped bass require three years to reach sexual maturity and females require five years (seven to eight years to become highly fecund). Assuming favorable environmental conditions, striped bass egg production was expected to increase about six years following New Cut closure, which occurred in 1992. Another five to six years was expected to be required for these naturally spawned fish to be recruited into the adult population and spawn. Studies indicated that striped bass egg production in the Savannah River remained very low from 1994-1996 (Reinert et al. 1996).

Recent studies indicate that successful striped bass natural reproduction had increased in the lower Savannah by 2001. Targeted striped bass egg sampling was conducted periodically from 1984 until 2000. By 1999-2000, there was some indication that egg abundance was increasing, from the very low levels of the mid-1990's (Reinart et al. 2005). Will et al. (2002) assessed the reproductive status of Savannah River striped bass using ultrasonography and histological samples. Oocyte development appeared to be normal and size to fecundity relationships were similar to other striped bass populations. Reproductive status in the Savannah River appeared to be equivalent to status found in healthy striped bass populations (Will et al. 2002). Jennings and Weyers (2003) reported that striped bass larvae were collected in 2001-2002 ichthyoplankton samples from freshwater and low salinity habitats, thus indicating successful reproduction in the estuary. Collins et al. (2002) reported collecting a high proportion of juvenile striped bass smaller than those stocked by GADNR in the Savannah estuary, indicating natural reproduction.

GADNR conducts regular striped bass sampling using electrofishing in the estuary and has collected striped bass spawned in 2003 and 2004. In addition, the number of striped bass age two years or more caught per hour of electrofishing has increased from 2 or less in the mid-1990's to more than 12 in the mid-2000's. The number of large striped bass (> 9 kilogram) caught per hour of electrofishing has increased from less than 0.1 in the early-1990's to more than 1.5 in 2003 (Reinert et al. 2005). Although no formal creel studies have been conducted, anecdotal

evidence indicates that sport fishing catch has greatly increased (Matt Thomas, GADNR, personal communication 2005). By closing New Cut and taking the tide gate out of operation, striped bass habitat has been improved and striped bass numbers, size and reproduction are increasing in the Savannah estuary.

Endangered Species

The Savannah Harbor study area supports a number of endangered and threatened species listed under the Endangered Species Act. Listed species known to regularly occur in the project area include West Indian manatee, right whale, wood stork, piping plover, loggerhead sea turtle and shortnose sturgeon (discussed above under "Fish"). Manatees have been observed in the waterways of Savannah NWR from 1987 to 2010 and in Savannah Harbor in recent years. Coastal waters of the project area provide important right whale wintering and calving habitat. Several other listed whale species can occur in coastal waters of the project area. Wood storks regularly feed in managed wetlands on Savannah NWR. A piping plover critical habitat unit is located on the north end of Tybee Island. A small number of loggerhead sea turtles nest on the beach at Tybee Island. Other sea turtles including leatherback, Kemp's ridley, hawksbill and green also occur in coastal waters of the project area.

PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

Based on the fish and wildlife resources in the project area the following fish and wildlife planning objectives have been formulated.

1. Restoration and maintenance of tidal freshwater marsh in the lower Savannah River.

Tidal freshwater marsh is one of the most diverse wetland types and provides excellent fish and wildlife habitat. Cumulative impacts of previous deepening projects have converted most of the tidal freshwater marsh to less diverse brackish marsh. Maintenance of normal tidal and salinity patterns is a major objective of coastal refuges and management areas to allow these areas to meet their wildlife objectives (Weller 1994). Therefore, the USFWS objective is to avoid or minimize loss of tidal freshwater marsh caused by salinity increase.

2. Restoration and maintenance of spawning and nursery habitat to support a self-sustaining striped bass population.

The striped bass is a nationally important fishery resource. Prior to tide gate installation, the Savannah River supported an important population of this species. Restoration of the habitat has been initiated by closing New Cut and removing the tide gate from operation. The USFWS objective is to avoid habitat impacts that would hinder recovery of this population.

3. Maintenance of the freshwater supply for management of approximately 3,000 acres of managed wetlands on Savannah NWR and for meeting agreements to supply freshwater to adjacent land owners.

Managed wetlands on Savannah NWR are managed for wintering waterfowl, wading birds and shore birds. Dabbling ducks are especially dependent on this habitat. Conversion of freshwater impounded wetland habitats on the Refuge to brackish wetland would severely impact management efforts, would be in direct opposition to the purpose for which the Refuge was established, and therefore must be avoided. The freshwater delivery system, which was installed mitigation for the tide gate and harbor deepening, failed soon after construction due to an inadequate design. The USFWS has repaired the system at great expense and management of the freshwater system has required significant staff time and resources. The USFWS objective is to repair the system prior to any additional harbor modifications.

4. Protection of riverine, palustrine, and estuarine wetlands in the lower Savannah River basin.

Palustrine, estuarine, and riverine wetlands provide the highest quality fish and wildlife habitat in the SHCS area. These wetlands also provide habitat for wildlife of high public significance, such as waterfowl and other migratory birds. Harbor development and maintenance have resulted in loss of approximately 6,000 acres of wetlands due to filling and dredged material disposal (see page 5). The USFWS objective is to avoid or minimize the loss of these highly valuable habitats.

ALTERNATIVES

The Savannah Harbor Expansion study evaluated deepening existing channels and selected turning basins by up to 6 feet. Total actual depths consist of nominal authorized project depths, plus advance maintenance and allowable overdepth, where applicable. Authorized project depth is the nominal channel depth provided for navigation. Advance maintenance (AM) is additional depth in the channel to provide storage for shoal material and currently adds two to four feet of depth in most of Savannah Harbor. Allowable overdepth (OD) is a dredging tolerance due to the inaccuracies of the dredging process and adds another two feet of depth. Therefore, immediately after maintenance dredging, depth of the channel in most of the harbor is four to six feet deeper than the nominal depth. As sedimentation occurs the actual depth approaches the nominal depth until the next dredging cycle. Table 4 presents the alternatives evaluated by the expansion project by nominal and maximum actual inner channel depth. The entrance channel is two feet deeper than the inner channel.

The Corps analysis shows that incremental net economic benefits are maximized on the Savannah Harbor Deepening Project at a depth of 45 feet, decrease from 45 to 47 feet, and are negative at 48 feet. However, because a depth of 47 feet provides the greatest total net benefits, it is the national economic development (NED) plan. The local sponsor has proposed a locally preferred plan (LPP) of 48 feet rather than the NED plan (47 feet) because the local sponsor has

stated that they believe the LPP will provide additional economic benefits justifying additional expenditures on their part.

Table 4. Authorized depths, maximum actual depths (feet below MLLW) and new dredged material quantity with the no action alternative and various depth alternatives.

Alternative	Authorized depth (AD)	Maximum depth (AD+AM+OD)	Dredged material (cubic yards)
No action (current conditions)	42	46-48	0
Alternative 1	44	48-50	10,300,000
Alternative 2	45	49-51	14,600,000
Alternative 3	46	50-52	19,000,000
Alternative 4	47	51-53	23,600,000
Alternative 5	48	52-54	28,300,000

PROJECT IMPACTS

Project impacts and mitigation alternatives were primarily assessed using a hydrodynamic and water quality model. The three-dimensional hydrodynamic model selected for this project is based on the EFDC, a physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. Water-quality impacts (dissolved oxygen, nutrients, temperature) are simulated using the water quality analysis simulation program (WASP) (Ambrose et al. 1993). The WASP model uses the hydrodynamic input from the EFDC model. The Savannah Harbor expansion version of the EFDC is based on the model originally developed by Tetra Tech for the EPA to determine the total maximum daily load for dissolved oxygen in the lower Savannah River. This model and the associated water quality model have been improved with an enhanced grid and other modifications. Extensive model development, coordination and peer review processes were conducted to ensure that the model was acceptable to evaluate project impacts (Corps of Engineers 2010b). The EFDC and WASP model output provide salinity and dissolved oxygen predictions in the river channels of the harbor and lower Savannah River. Salinity and dissolved oxygen predictions from the EFDC and WASP models were also applied to simple fish habitat models developed by an interagency group that included scientists from the Corps, USFWS, NOAA, South Carolina Department of Natural Resources and GADNR. Habitat models were developed for striped bass, shortnose sturgeon, southern flounder and American shad.

Impacts were assessed by comparing predicted with-project conditions immediately after construction to base year (current) conditions instead of comparing project-life average annual conditions to the base year. Impacts determined on an average annual basis would be less than those based on conditions immediately after construction because sea level rise would impact the

tidal freshwater wetlands and other habitat even without any harbor deepening. Corps policy recommends determining impact and mitigation using an average annual impact approach. Available information indicates that impacts of sea level rise on tidal freshwater marsh in Savannah NWR would be negligible except for the cumulative impact of harbor deepening. A study on the Altamaha River, Georgia found no marsh changes that indicated increasing salinity from 1953 to 1993, during a period of sea level rise, and freshwater marsh occurred downstream to about river mile 8 in 1993 (Higinbotham et al. 2004). In 2005, with Savannah Harbor at the current depth of 42 feet, freshwater marsh was found downstream only to about river mile 20 on the Savannah River (Figure 3, Table 3 this report). The Altamaha River has an average annual discharge about 15 % higher and is less regulated by reservoirs than the Savannah River. More importantly the Altamaha is a naturally shallow river, as was the Savannah, and is not dredged for navigation. Most of Savannah NWR lies upstream of Savannah river mile 19. Without the cumulative impact of harbor deepening, it is unlikely that Savannah NWR would currently be impacted by salinity or would be substantially impacted by sea level rise during the project life, even with an expected increase in the rate of rise due to climate change. Therefore, it is appropriate to determine impact and formulate mitigation by comparing predicted with-project conditions immediately after construction to base year conditions.

The most significant predicted impact of the deepening project is that salinity, in portions of the lower Savannah River, will be increased. Deepening of the Front River channel will increase tidal volume and increase salinity. Moderate incremental increases in the salinity level have become cumulatively significant as depth of the harbor has been repetitively increased over time. The potential impacts of the proposed deepening project must be considered in the context of these cumulative salinity impacts. Figure 4 presented the approximate location of the freshwater interface at various channel depths and times in recent history. As the salinity interface has moved upriver, tidal freshwater marsh has been converted to lower diversity brackish marsh. Habitat for striped bass and shortnose sturgeon has been modified and most of the original habitat for these fish has been rendered unsuitable.

Another highly significant impact is the predicted decrease in dissolved oxygen concentration due to increased salinity stratification. The numerous aquatic species that utilize wetlands in the Savannah estuary are dependent on suitable water quality to complete their life cycle. Dissolved oxygen is a key water quality component and adequate dissolved oxygen concentrations are essential to support fish and other aquatic life. Project impacts without mitigation, summarized briefly in the following sections, were presented in more detail in the November 2008 FWCA Report.

Managed Wetlands

Increased salinity levels in the lower Savannah River system have a number of adverse impacts to the managed wetlands of the Savannah NWR and adjacent private lands. During times of low flow, fresh water may not be available for the managed wetland system of Savannah NWR. The presence of brackish water would increase operation and maintenance costs due to increased

personnel requirements to monitor salinity levels and adjust operations to prevent frequent introduction of brackish water. Water control structures and other equipment would also require more frequent repair and/or replacement due to salinity levels. The freshwater delivery system is inadequate and water is leaking around the failing structures. The Refuge will not be able to prevent brackish water from entering the system unless repairs are completed. Evaporation tends to increase salinity levels in impoundment waters, and salt uptake by plants tends to increase soil salinity. Odum et al. (1977) state: "The floor of the freshwater marsh is composed of matted organic matter (mainly dead, non-decomposed roots and rhizomes) through which water flows. This mat will readily absorb sodium chloride and effectively increase the marsh salinity more than water level indicates." Soils frequently flooded with brackish water cannot have water removed for long periods of time because soil acidity increases beyond acceptable limits. These factors would change the plant community to less desirable plants for wildlife and preclude the ability to manage for freshwater plants. Freshwater management (salinity less than 0.5 ppt) is necessary to maintain maximum waterfowl use of the Refuge's managed wetlands.

Tidal freshwater wetlands

Increased salinity is predicted to cause conversion of tidal freshwater marsh to brackish marsh. Based on previous studies, as the marshes become more saline plant species composition becomes less diverse (Pearlstine et al. 1990, Dusek and Kitchens 2003, Welch and Kitchens 2006). In addition, tidal freshwater marsh primary productivity is high, generally falling in the range of 1,000 to 2,000 gm/m^2/yr (Odum et al. 1984). The quality of primary production of the fresh marsh community is also high. Major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife (Teal 1962). In contrast, the fleshy broad-leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and there is a high incidence of direct grazing or feeding on these plants (Odum et al. 1984).

Fresh marsh vegetation contributes to the food web base that supports the study area's estuarine fishery. Dominant macroinvertebrates are likely to be amphipods and polychaetes (Odum et al. 1984). Malloy (2003) found that members of the families Cyprinodontidae (pupfishes or killifish) and Palaemonidae (grass shrimp) were the most abundant nekton (aquatic organisms with the ability to swim) utilizing the marsh surface in the upper Savannah estuary. Estuarine dependent marine species were more prevalent in the tidal freshwater areas than freshwater species. Much of the prior research in other south Atlantic tidal freshwater marshes has indicated that freshwater species are dominant (Odum et al. 1984). Salinity intrusion due to prior Savannah Harbor deepening is a factor facilitating higher use by estuarine and marine species further upstream in the Savannah estuary. Water quality sampling has established the fact that Middle River periodically serves as a conduit for high salinity water far up that river. To a lesser extent Rifle Cut carries brackish water to Back River from Middle River. Such movements of saline water are likely to be favorable for marine species to move further up the estuary than they would under natural conditions. Harbor deepening would exacerbate these trends.

Tidal freshwater wetlands provide important habitat for many bird species, including neotropical migrants (birds that summer in North America and winter in tropical America). Resident and migrating birds utilize food and shelter found in this community; some species use freshwater marshes for nesting and breeding. Studies conducted in 2000-2002 reported that more species of neotropical migratory birds were stopping over in tidal freshwater marsh habitat than in tidal saltwater habitat on Savannah NWR (Berryman and Webb 2003). Higher plant species diversity and structural diversity in the freshwater marshes compared to brackish marshes may account for the higher use.

Graves (2001) found there were 26 species of birds exclusively associated with tidal freshwater marsh in the lower Savannah River and only four species exclusively associated with salt-dominated wetlands. Lower diversity of plant species combined with less structural diversity among plant communities in brackish marsh is most likely one basis for the differences among avian species richness and composition between freshwater and brackish marshes; brackish marshes might be more advantageous to generalist species, such as red-winged blackbirds (Peterson 1992). King rails are associated with freshwater and intermediate marshes and not found in salt-influenced marsh habitats within the Savannah River estuary (Graves 2001). King rail populations are declining and are listed as a species of concern by the USFWS. Graves (2001) concluded that an increase in salinity in tidal wetlands at Savannah NWR would lead to a significant loss of avian diversity and that many bird species could be extirpated from the estuary, resulting in the continued decline of some species of management concern such as the king rail.

Waterfowl feed directly upon tidal fresh marsh vegetation. Wild rice, sedges, spike rush, wild millet, bulrushes, and duckweeds serve as prime waterfowl food, and mollusks, insects, small crustaceans, and fish found in the fresh marsh community also are fed upon by waterfowl and other birds. Various species of ducks feed in the study area fresh marshes, along with wading birds such as the great blue heron, little blue heron, green heron, snowy egret, and great egret and many species of shorebirds.

Palustrine emergent wetlands also provide excellent habitat for fur-bearing mammals including the mink and river otter. Terrestrial species from surrounding forested areas often utilize the fresh marsh edge for shelter, food, and water; these include raccoon, opossum, rabbit, and bobcat. In summary, the tidal fresh marsh on Savannah NWR supports an extremely diverse plant community providing food, cover and nesting habitat for a wide variety of wildlife species throughout the year. Conversion to brackish marsh caused by harbor deepening would substantially reduce diversity and wildlife use of these marshes.

Other tidal wetlands

A total of 15.7 acres of brackish and salt marsh (estuarine emergent wetlands) would be excavated because of channel or turning basin widening and removal of the tide gate. Even though brackish and salt marsh supports less diversity and wildlife use than tidal fresh marsh, it is of high value in supporting the estuarine food web for invertebrates and fish, sediment trapping

and water quality improvement, and protecting shorelines from erosion and storm water detention. Excavation would result in a total loss of these functions.

Fish

The Savannah estuary supports a diverse fish community that utilizes the complex mosaic of tidal wetland habitat. However, only a few species of fish were selected to evaluate harbor deepening impacts. Species selected were based on their status as protected or trust resources, knowledge of habitat requirements and sensitivity to expected impacts. The shortnose sturgeon, striped bass, southern flounder, and American shad were the species chosen for evaluation.

The shortnose sturgeon is particularly vulnerable to water quality impacts, which will be most severe in deep water and will impact the fish directly as well as impacts to its invertebrate food source. In the past, shortnose sturgeon used the Kings Island Turning Basin and other locations in the Savannah estuary as nursery and foraging habitat. As the salinity increased in the estuary, due primarily to harbor deepening, these locations could no longer support shortnose sturgeon.

Current dissolved oxygen levels in much of project area are frequently marginal to support shortnose sturgeon. Shortnose sturgeon juveniles are extremely sensitive to dissolved oxygen concentrations. In a 6-hour test using 64-day-old fish and a dissolved oxygen concentration of 2.5 mg/l, a mortality rate of 86% was observed. While older juveniles appear to be more tolerant of this concentration, it has been shown that a concentration of 3.0 mg/l can alter sturgeon behavior possibly reducing the likelihood of survival in the environment (Jenkins et al. 1993).

In the Savannah River, the striped bass is dependent on habitat in the estuary for successful reproduction and recruitment into the adult population because almost no spawning has been documented upstream of the estuary. After spawning the egg and early larval stages are transported by tidal currents both upstream and downstream but the net movement is toward the ocean.

The habitat suitability model for striped bass indicates that a maximum salinity of 1.5 ppt or less is optimal for spawning (Bain and Bain 1982). Studies on the Savannah River indicate that striped bass almost exclusively spawn in areas where maximum salinity near the surface is less than one ppt (Van Den Avyle et al. 1990, Will et al. 2000). Winger and Lasier (1990) concluded that exposure to salinity greater than 15 ppt was toxic to Savannah River striped bass eggs. However, normally eggs will develop into larvae within about two days of spawning. Winger and Lasier (1990) concluded, using laboratory studies at a constant salinity, that Savannah River striped bass larvae survived well at 3-9 ppt salinity but survival decreased at higher salinity. Five-day-old larvae were able to tolerate higher salinity than two-day-old larvae. Therefore this important sport fish is very sensitive to salinity increases caused by harbor deepening.

The effects of low dissolved oxygen on egg, larval and juvenile striped bass can be dramatic. For example, dissolved oxygen concentrations between 2.0 and 3.5 mg/l were determined responsible

personnel requirements to monitor salinity levels and adjust operations to prevent frequent introduction of brackish water. Water control structures and other equipment would also require more frequent repair and/or replacement due to salinity levels. The freshwater delivery system is inadequate and water is leaking around the failing structures. The Refuge will not be able to prevent brackish water from entering the system unless repairs are completed. Evaporation tends to increase salinity levels in impoundment waters, and salt uptake by plants tends to increase soil salinity. Odum et al. (1977) state: "The floor of the freshwater marsh is composed of matted organic matter (mainly dead, non-decomposed roots and rhizomes) through which water flows. This mat will readily absorb sodium chloride and effectively increase the marsh salinity more than water level indicates." Soils frequently flooded with brackish water cannot have water removed for long periods of time because soil acidity increases beyond acceptable limits. These factors would change the plant community to less desirable plants for wildlife and preclude the ability to manage for freshwater plants. Freshwater management (salinity less than 0.5 ppt) is necessary to maintain maximum waterfowl use of the Refuge's managed wetlands.

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aquatic organisms to the biocidal properties of cadmium requiring higher doses to cause death. Sublethal effects in birds include growth inhibition, anemia and testicular damage (Eisler 1985).

The risk assessment prepared for the Corps concluded that cadmium concentrations in new work sediments have no potential to impact the ecology of the Savannah River and are unlikely to cause adverse impacts in placement site wetlands (EA Engineering, Science and Technology 2008). The Corps believes that sediments containing as much as 4 mg/kg cadmium would be adequate to protect birds utilizing the disposal areas (Corps of Engineers 2010a). The "Ecological Soil Screening Levels for Cadmium", concentrations that are assumed to be protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on the soil, are 0.77 mg/kg for upland insectivorous birds and 0.36 mg/kg for mammals (USEPA 2005). Based on detailed review of the risk assessment, the USFWS believes that short-term and long-term adverse impacts are possible on the Savannah River ecology as a result of dredging of sediments containing elevated cadmium concentrations and that adverse impacts on plants and wildlife in placement site wetlands/drainage areas and effluent-receiving waters may occur.

CORPS PROPOSED MITIGATION

Channel and flow modifications

To address salinity impacts a number of options to modify flows and channel depths in the different branches of the river were proposed for evaluation using the various models (Figure 5). Based on preliminary modeling, the options were either evaluated individually or combined to develop a number of mitigation plans. The major flow and channel options considered are as follows. A rock diversion structure in the Savannah River at McCoys Cut and dredging of small channels in the upstream portions of Little Back River and Middle River (h, Figure 5) are designed to divert water from Front River into Middle and Back River and thus reduce salinity in tidal freshwater wetlands. Filling of the sediment basin (to elevation -3.85 meters National Geodetic Vertical Datum), or allowing it to fill through sedimentation (a, Figure 5) would reduce salinity intrusion up Back River into important wetland areas. Closing of Rifle Cut (d, Figure 5) would reduce salinity intrusion into Back River because saline water flows up Middle River and through Rifle Cut. Removal of the tide gate structure and abutments (b, Figure 5) would remove restrictions to tidal flow in the Back River that may have resulted in sedimentation upstream of the gate. The tide gate has been out of operation since 1992; but, the gate structure and abutments have remained in place. Several other options were evaluated using the EFDC model but were eliminated because they were not effective, had potential adverse impacts or had too high a cost (USFWS 2008).

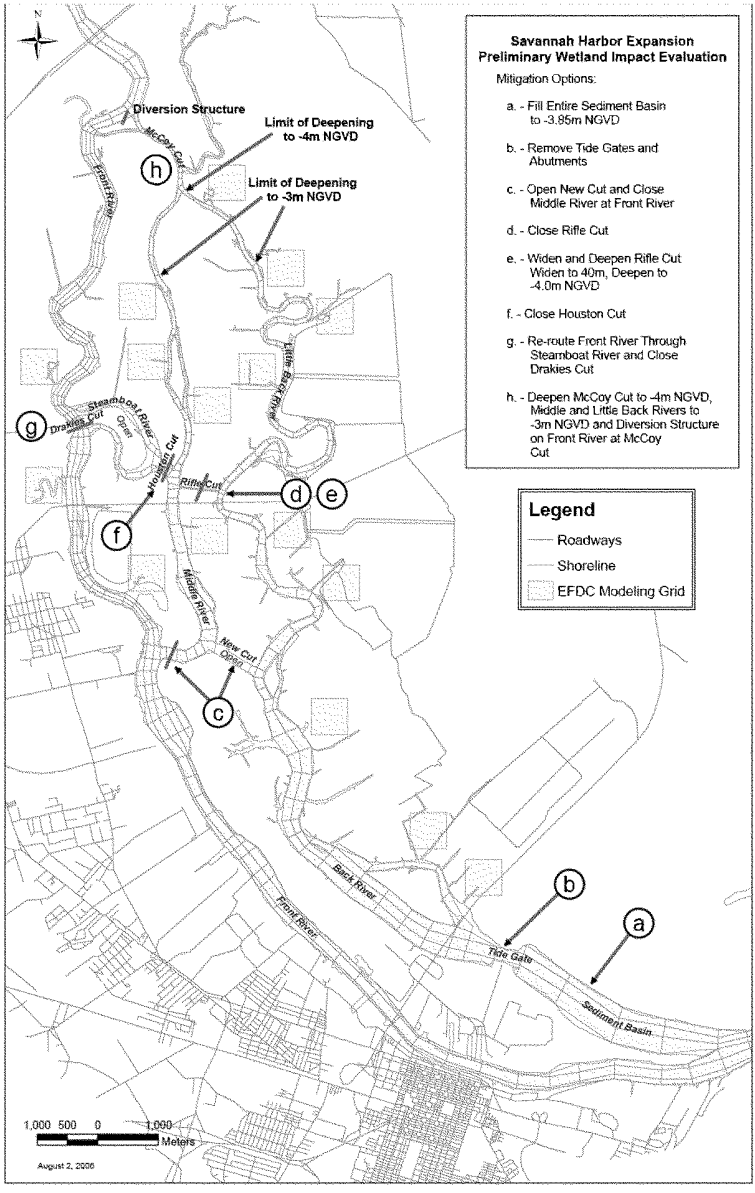

Figure 5. Flow and channel modifications evaluated as mitigation for the Savannah Harbor deepening project.

Two plans, designated 6A and 6B, were proposed by the Corps as the most effective in reducing impacts at an acceptable cost (Figures 6 and 7). Plan 6A would include the rock diversion structure in the Savannah River at McCoys Cut, dredging of small channels in the upstream portions of Little Back River and Middle River, filling of the sediment basin, closing of Rifle Cut and removal of the tide gate structure and abutments. Plan 6B would include the same features except for the dredging in Middle River and Little Back River, which would be eliminated. Both plans would close the downstream arm at McCoys Cut. Qualitative on-site observations indicate that much of the river flow entering the upstream arm of McCoys Cut enters the downstream arm and returns to the Front River. If return flow through the downstream arm were not prevented, the effectiveness of the McCoys Cut diversion structure would be reduced.

Land Acquisition

The Corps has also proposed land acquisition and management to offset tidal freshwater marsh impacts for the 45-foot and deeper alternatives. The Savannah District Standard Operating Procedures (SOP) for regulatory actions (http://www.sas.usace.army.mil/SOP.04.doc) were used by the Corps to determine loss of functional value and amount of lands needed to replace these values. After previous coordination, the Corps and USFWS agreed to acquisition amounts of 1,643 acres for the 45-foot alternative, 2,188 acres for the 46-foot alternative, 2,245 acres for the 47-foot alternative and 2,683 acres for the 48-foot alternative. The lands considered for acquisition are presented in Figure 8. The Corps has coordinated with USFWS regarding priority tracts for acquisition.

The Corps suggests that if the rate of sea level rise exceeds the historic rate, the proposed compensatory mitigation would overcompensate project impacts, because some of those acres would have converted to brackish or salt marsh without the project. The Corps proposes to reassess sea level rise effects in the future and assign "advance mitigation" credits to the project for use with future actions.

Wetland restoration

A previously used sediment placement area (CDF 1S) within Savannah Harbor was identified as having the potential to support a restored brackish marsh system. CDF 1S is located adjacent to the confluence of Front River and Middle River, and it is located within the boundaries of the Savannah NWR. Much of the site is currently upland as a result of the previous sediment disposal, which was terminated at least 20 years ago. The Corps utilized the Regulatory SOP to determine that about 29 acres that would be required for restoration to offset direct dredging impact. A portion of CDF 1S was graded down by GPA several years ago as mitigation for work at their facilities. The Corps would add the previous GPA restoration site (1.7 acres) to the currently proposed 29 acre restoration area. However, the Corps has proposed restoring a total area of approximately 42 acres and using the additional restoration area as "advance mitigation" for future harbor impacts.

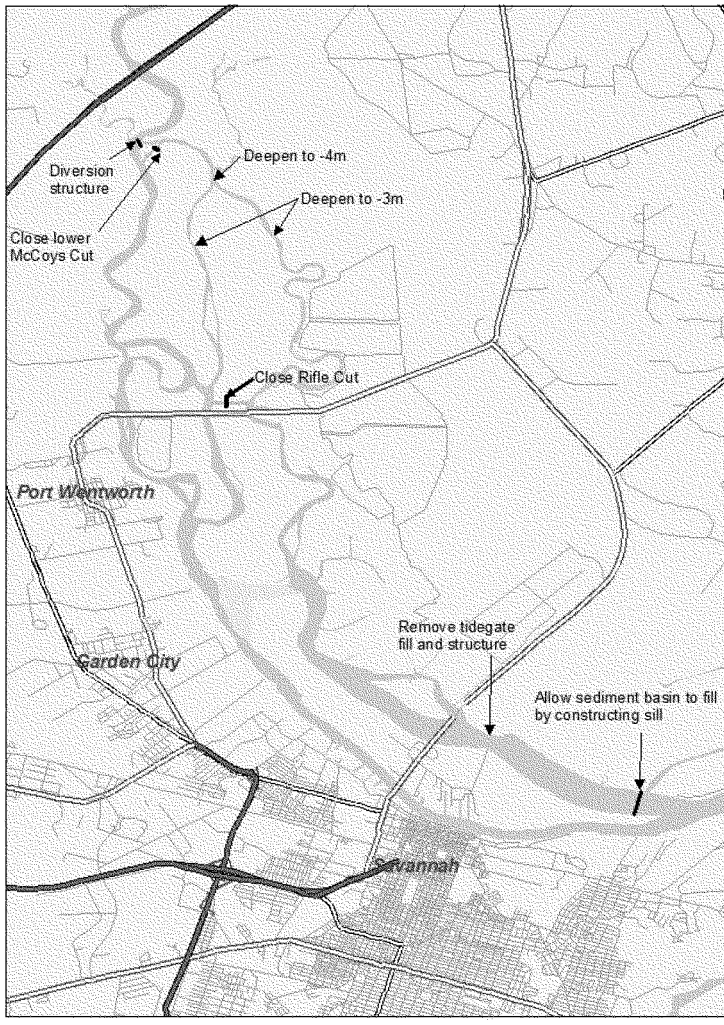

Figure 6. Savannah River estuary and mitigation plan 6A for Savannah Harbor deepening. Plan 6A includes a diversion structure at McCoys Cut, closing lower McCoys Cut, deepening of upper Back River and Middle River downstream to the points shown, closing Rifle Cut, allowing sediment basin to fill and removing tidegate.

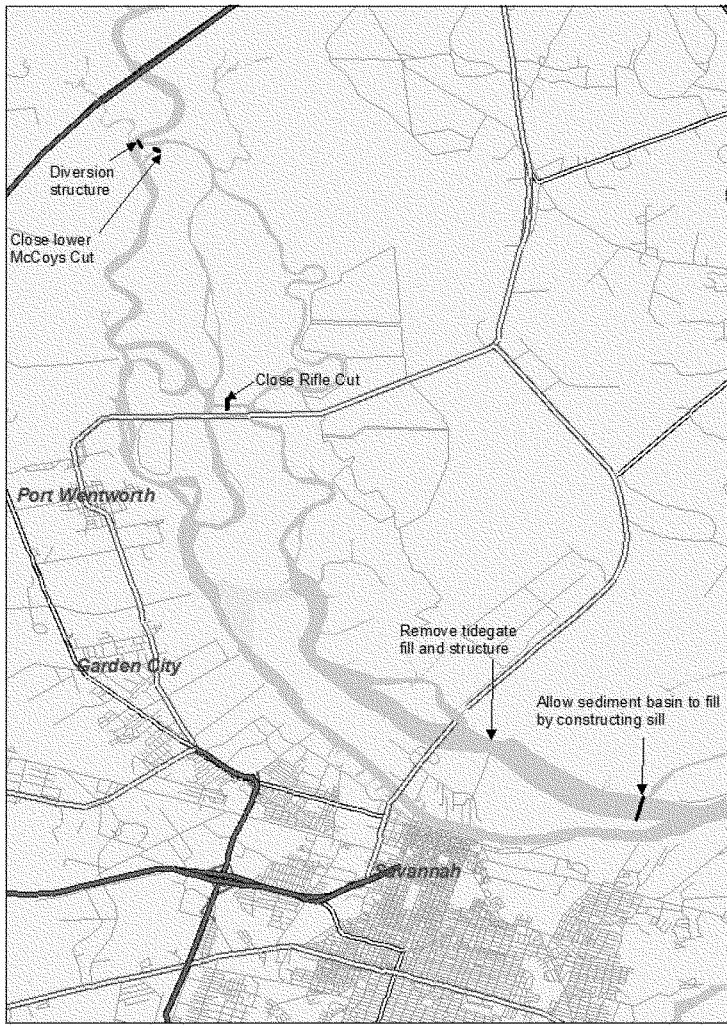

Figure 7. Savannah River estuary and mitigation plan 6B for Savannah Harbor deepening. Plan 6B includes a diversion structure at McCoys Cut, closing lower McCoys Cut, closing Rifle Cut, allowing sediment basin to fill and removing tidegate.

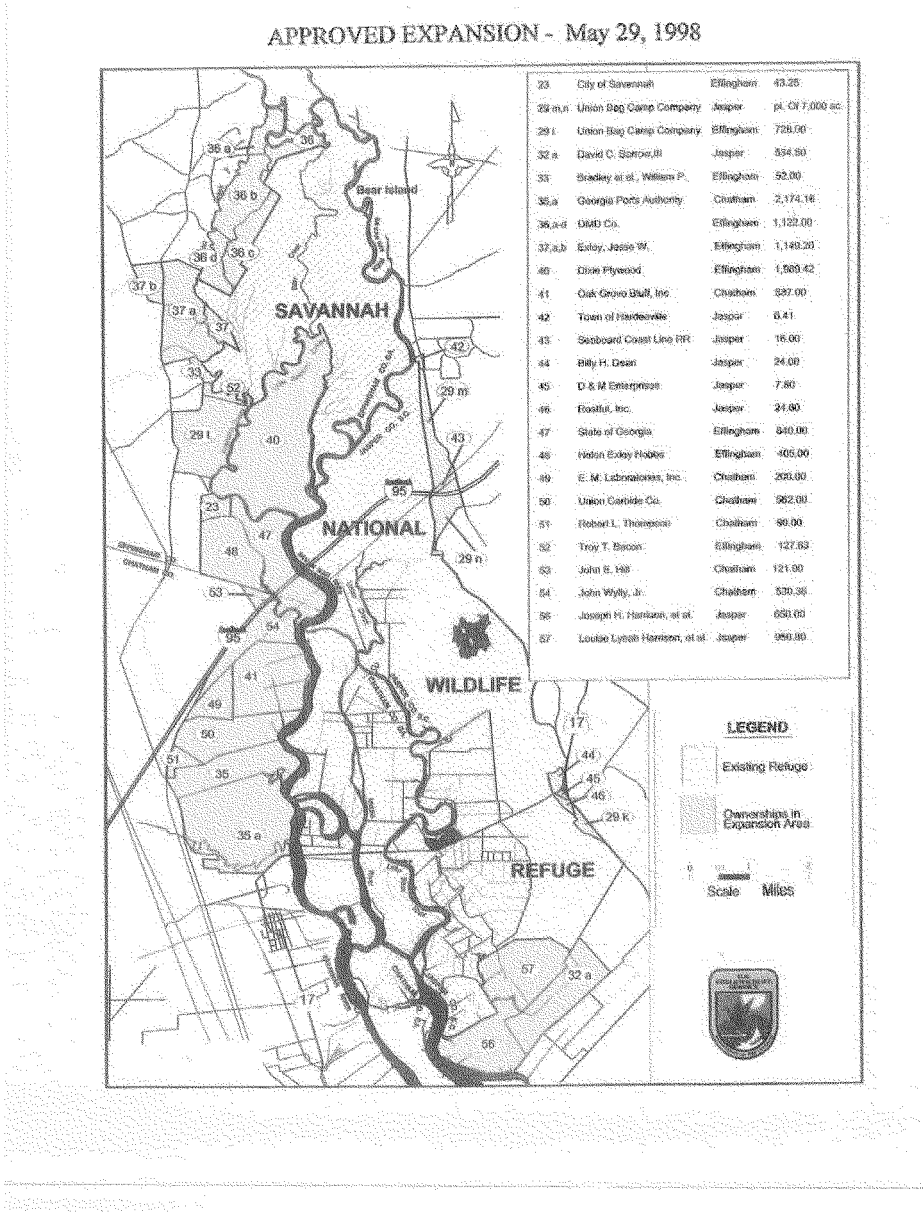

Figure 8. Lands that could be acquired and managed as compensation for Savannah Harbor deepening. All lands are within approved expansion area for Savannah NWR.

Restoration of the CDF 1S site would occur by grading it down to an elevation that would allow the growth of wetland vegetation. Appropriate elevations were identified based on the elevation of adjacent marsh. Once the new elevations have been established, the site would be allowed to naturally vegetate. If acceptable vegetation does not become established, the Corps proposes to plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site. A "feeder" creek system would also be constructed toward the interior from Middle River to support adequate tidal exchange to the interior of the restored wetland.

Dissolved oxygen

To address dissolved oxygen impacts the Corps has proposed to install and operate a re-oxygenation system using Speece cones (Tetra Tech, Inc. 2006). This system would inject oxygen near the river channel bottom at three locations. The oxygen injection locations and amounts would be selected to offset estimated dissolved oxygen reduction for each depth alternative.

Fish

Corps proposed fish mitigation measures would include constructing and operating a fish bypass channel (fishway) at the New Savannah Bluff Lock and Dam (NSBLD) near Augusta, Georgia to compensate for impacts to shortnose sturgeon habitats. This structure would be intended to allow passage of sturgeon and other migratory fish to access potential upstream spawning and nursery habitat. The Corps would also construct a 1,500-foot x 650-foot sill near the mouth of Middle River. Researchers have identified shortnose sturgeon occupying the bottom 1.5 meters of a deep hole in the Middle River approximately 2000 feet upstream from its mouth, and consider this area to be important habitat for juvenile shortnose sturgeon. The sill is intended to limit salinity movement into this habitat. In addition, funding would be provided for a striped bass stocking program to compensate for adverse impacts to striped bass spawning and nursery habitats within the estuary.

Cadmium

Sediments from cadmium-laden reaches would be placed in CDF's 14A and 14B and capped with two feet of clean sediment from other reaches. All sediment deposited in CDF's 14A and 14B as part of the harbor deepening project would not be used in the future for dike raising or borrow material. After sediment placement but before capping, 86 grab samples would be collected from the top 15 cm of each disposal area used to deposit sediments predicted to contain > 14 mg/kg cadmium. After capping, another 86 grab samples would be collected from the top 15 cm of these disposal areas. If the capping sediments within the disposal sites have more than 25 acres containing cadmium concentrations at or exceeding 4 mg/kg, the Corps will make covering those locations with maintenance-dredged sediments a priority. Maintenance sediments are low in cadmium and this covering would reduce potential for wildlife exposure to unacceptable

cadmium levels. After capping, the Corps would conduct tissue sampling of birds utilizing the confined disposal facilities.

Recreational boating and fishing

Closing Rifle Cut for mitigation will make small boat access to Back River and Little Back River more difficult. Boaters will still be able to access Little Back River from Middle River or McCoys Cut but a longer run (8-10 additional miles or more) will be required to reach parts of the Back River. The Corps is proposing to construct a public boat ramp on Hutchinson Island to provide Back River access.

Summary

Table 5 presents a summary of the proposed fish and wildlife mitigation measures. The Corps proposes to implement the mitigation measures concurrent with project construction. Channel and flow modification and wetland acquisition are intended to mitigate for tidal freshwater marsh impacts. Wetland restoration is intended to address direct dredging impacts on brackish and salt marsh. The dissolved oxygen system using Speece cones is intended to offset the dissolved oxygen reduction caused by increased salinity stratification. The fish bypass channel and striped bass stocking are intended to mitigate impacts to shortnose sturgeon and striped bass habitat, respectively.

Table 5. Summary of Corps proposed fish and wildlife mitigation measures for the Savannah Harbor project.

		CHANNEL DEPTH ALTERNATIVE			
	44-FOOT	**45-FOOT**	**46-FOOT**	**47-FOOT**	**48-FOOT**
Channel and flow modification	Plan 6B	Plan 6A	Plan 6A	Plan 6A	Plan 6A
Wetland acquisition	0	1,643 acres	2,188 acres	2,245 acres	2,683 acres
Wetland restoration	29 acres	29 acres	29 acres	29 acres	29 acres
Dissolved oxygen system	33,075 lbs/day	28,685 lbs/day	30,870 lbs/day	35,280 lbs/day	39,690 lbs/day
Fish bypass channel at NSBLD	Yes	Yes	Yes	Yes	Yes
Striped bass stocking funds	$1,654,000	$280,000	$485,000	$2,621,000	$2,710,000
Cadmium capping and monitoring	Yes	Yes	Yes	Yes	Yes
Construct boat ramp	Yes	Yes	Yes	Yes	Yes

USFWS EVALUATION WITH MITIGATION

Each channel and flow modification feature has positive and negative impacts (Table 6). A necessary result of salinity reduction in selected areas of the estuary is the increase in other areas. The goal of the flow diversion plan was to reduce the salinity in Back River to minimize impacts to tidal freshwater marsh and the freshwater supply system. Therefore, most of the mitigation measures would increase salinity in Front River. Filling of the sediment basin would reduce salinity intrusion up Back River but would require more frequent maintenance dredging in the navigation channel. These issues are discussed further in the risk and uncertainty section in this report.

Table 6. Summary of positive and negative impacts for channel and flow modifications (Figure 5) evaluated for mitigation of Savannah Harbor deepening.

Mitigation	Positive impact	Negative impact
Install diversion structure (h)	Reduces salinity in Little Back River and upper Middle River	Increases salinity in Front River
Dredge Little Back River/Middle River (h)	Reduces salinity in Little Back River and upper Middle River	Increases salinity in Front River; dredging impacts on habitat and water quality
Close Drakies Cut/reroute through Steamboat (g)	Decrease salinity in Front River	Increase salinity in Middle River
Close Houston Cut (f)	Reduces salinity in Middle River	Reduces tidal range in Back River and Middle River
Close Rifle Cut (d)	Reduces salinity in Little Back River	Increases salinity in lower Middle River; limits small boat access to Back River
Close Middle River/ open New Cut (c)	Reduces salinity in Back and Middle River	Reduces tidal range in Back River and Middle River
Remove tide gate (b)	Increases tidal exchange and sediment flushing in Back River; improves small boat access	Temporary blasting impacts
Fill sediment basin (a)	Reduces salinity in Back River	Increases salinity in Front River; Increases maintenance dredging in Front River

Channel and flow modifications - Managed wetlands

Table 7 presents model predicted salinity levels at the freshwater diversion canal entrance on Little Back River with the existing and alternative channel depths with Savannah River year 2001 flow and a mid-range sea level rise (25 cm). All depth alternatives except the 47-foot alternative were modeled for these conditions. The Corps modeled the 47-foot depth alternative under average freshwater flow conditions and existing sea level rise but did not model low flow and 25 cm sea level rise for the 47-foot depth alternative. However, they believe that the 47-foot interpolation between the modeled 46- and 48-foot alternatives is sufficient to reasonably predict salinity under the conditions because the data trends are obvious and the fact that the 47-foot estimate is bound by two modeled scenarios (Bill Bailey, Corps, written communication 2011).

Table 7. Predicted salinity (ppt) at the freshwater diversion canal entrance at current and alternative Savannah Harbor channel depths. Conditions modeled were low Savannah River flow (2001) and a 25 cm sea level rise.

Depth	Mitigation plan	Salinity ppt 50% exceedance	Salinity ppt 10% exceedance
42 (current)	None	0.31	0.95
44	6B	0.11	0.61
45	6A	0.12	0.65
46	6A	0.14	0.73
47	6A	0.16	0.82
48	6A	0.18	0.91

Predicted salinity at the entrance ranges from 0.11 to 0.95 ppt under these conditions. Of the information available, the salinity 10% exceedance (% of time a specified value is equaled or exceeded), which would occur under low river flows, provides the best comparison of the plans. The salinity 50% exceedance would occur during higher flows which are unlikely to occur during the fall when most water is needed in the managed wetlands.

The average salinity of water entering the diversion canal would likely be between the 10% exceedance and the 50% exceedance predictions. The model predicts that none of the depth alternatives, with proposed mitigation, increase the salinity at the diversion canal entrance. Therefore, the proposed flow diversion mitigation appears to avoid impacts to managed wetlands. Because of the cumulative impacts of repetitive harbor deepening, even at the current channel depth the average salinity of water entering the diversion canal is likely to exceed the freshwater limit (0.5 ppt) as sea level rises (Table 7). With the associated mitigation plans, the 44-foot, 45-foot and 46-foot alternatives would be most likely to maintain freshwater conditions at the entrance and in the managed wetlands.

Channel and flow modifications - Tidal freshwater wetlands

The model to marsh spreadsheet application (M2M) used for impact analysis was developed by data mining techniques that used channel salinity data and interstitial salinity data at several locations in the estuary (Conrads et al. 2006). However, this empirical model uses relations among marsh salinity and channel salinity based on existing channel morphology and flow patterns. All of the mitigation alternatives include substantial changes in channel morphology and flow patterns. Because the alteration of the channel configuration changes the relations used in the M2M, it could not be used with any confidence to evaluate mitigation plans. Use of the marsh succession model was dependent on the M2M; therefore, the MSM could not be used to evaluate the mitigation plans.

As an alternative method, EFDC- predicted salinity in the river channels (Front, Middle and Back) was projected across the marsh surface based on drainage patterns determined from aerial photos. Marsh acreage in each salinity category was calculated by the geographic information system used for project analysis (Corps of Engineers 2010a). As discussed earlier in this report and presented in Table 1, commonly used marsh classifications are usually based on average channel salinity not interstitial salinity (Odum et al. 1984). The communities with a channel salinity of <0.5 ppt are considered to be tidal freshwater marsh with differing species composition. We focused our analysis on minimizing conversion of tidal freshwater marsh (0-0.5 ppt) to higher salinity marsh. The magnitude of marsh change predicted by the EFDC with the various depth alternatives and mitigation plans is presented in Table 8.

Table 8. Area of existing tidal freshwater marsh, predicted tidal freshwater marsh and predicted impact due to salinity changes, at current sea level, in the Savannah estuary for the project with and without mitigation.

Depth	Existing acres	Project acres without mitigation	Impact without mitigation (acres)	Mitigation plan	Project acres with mitigation	Impact with mitigation (acres)
44	4072	3521	-551	6B	4394	**+322**
45	4072	3105	-967	6A	4040	**-32**
46	4072	3015	-1057	6A	3871	**-201**
47	4072	2895	-1177	6A	3849	**-223**
48	4072	2860	-1212	6A	3735	**-337**

Based on model-predicted salinity impacts, the 44-foot channel and plan 6B would result in an increase of tidal freshwater marsh. With the 45-foot channel, tidal freshwater marsh impacts would be almost offset by plan 6A; the predicted loss is 32 acres. The 46-foot channel with the Corps proposed plan 6A would result in a loss of 201 acres of tidal freshwater marsh. The 47-

foot channel with the Corps proposed plan 6A would result in a loss of 223 acres of tidal freshwater marsh. The 48-foot channel with the Corps proposed plan 6A would result in a loss of 337 acres of tidal freshwater marsh.

Land Acquisition

Resource agencies and the Corps attempted to identify areas where tidal freshwater marsh could be restored in the Savannah estuary but no suitable sites were located. Therefore land acquisition was proposed to compensate for impacts. Because the impacted lands are Federal property and are open for appropriate public use, fee title acquisition is the only way to ensure replacement of public use value. The most suitable tracts are near or adjacent to Savannah National Wildlife Refuge. Therefore, these lands would be provided to the Refuge for protection, wildlife management and appropriate public use. However, USFWS objects to the proposal for advance mitigation, because sea level rise would have a negligible impact in the upper estuary if not for the cumulative impacts of previous harbor deepening. The rate of sea level rise is uncertain and substantial impacts resulting from sea level rise are not likely until well into the future. Conversely, the impacts of further harbor deepening will begin within a few years of project construction. In addition, due to the complexity of the system and limitations of the models, the USFWS has concerns that the models may underestimate wetland impacts. The USFWS regards "advance mitigation" as the functional equivalent of a mitigation bank, and our Mitigation Policy (64 FR 49229-49234) does not allow the use of Refuge lands for mitigation banks to compensate for the effects of activities authorized by the Department of the Army under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Therefore, the USFWS does not support the concept of advance mitigation based on a future evaluation of the relative impacts of sea level rise.

Wetland restoration

Successful wetland restoration is dependent on three primary factors: soil, hydrology and vegetation. The proposed restoration site (1S) is located on an area that was predominantly wetland prior to use as a dredged material disposal area. When the dredged material is removed to initiate restoration, most of the exposed soil is likely to be similar to the original wetland soil. Therefore, it is likely that soil in the restoration will be suitable to support wetlands. Hydrology in the restoration area will be restored by removing the dredged material to match the elevation of adjacent marshes. In addition a "feeder" creek system would also be constructed toward the interior of the restoration site from Middle River to support tidal exchange to the interior of the restored wetland. Therefore, hydrology, as planned, in the restoration area is likely to be suitable to support wetlands if tidal sheet flow through adjacent marshes and flow through the feeder creek is sufficient. Conversely, if tidal flow is insufficient, less desirable vegetation may occupy the site. Also, depending on variables during construction, elevation of the site as constructed could vary from the planned elevation. A difference in elevation of only a few inches could result in the establishment of invasive vegetation (e.g. tallow tree) with almost no wildlife value

rather than desirable wetland vegetation with high wildlife value. The desired vegetation outcome is to establish a mixed brackish marsh, similar to adjacent marsh, on the site.

The monitoring and adaptive management plan includes monitoring vegetation coverage of the 1S restoration site and the Corps proposes to plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site if vegetation does not become established. The plan needs to be modified to specify that establishment of native wetland plants is necessary for successful restoration. In addition, the plan needs to include specific monitoring and management protocols to detect and control exotic and invasive species.

The "advance mitigation" proposed by the Corps is the functional equivalent of a mitigation bank, and USFWS Mitigation Policy (64 FR 49229-49234) prohibits the use of Refuge lands in mitigation banks. Therefore the USFWS cannot support credit for "advance mitigation". Restoration could be limited to the 29 acres needed to offset impacts of the proposed project. Coordination with USFWS and other interested agencies during continued planning, construction and monitoring would help insure successful restoration.

Dissolved Oxygen

Dissolved oxygen in the estuary will be reduced by harbor deepening and the Corps plans to mitigate this impact by using Speece cones to inject oxygen into the harbor and offset the incremental oxygen impact. In August-September 2007 a full scale test on two Speece cones was conducted in Savannah Harbor and oxygen was injected over a 39 day period. The contractor report on the test concluded that the system could improve dissolved oxygen deficit by 0.6-0.7 mg/l, enough to effectively mitigate the dissolved oxygen impact of harbor deepening (MACTEC 2008). An independent peer review by USGS found that this conclusion is not supported by monitoring data. It is important to note that the USGS review does not conclude that the Speece cone system could not be effective. However, the USGS review found that analysis of data in the report and other monitoring data did not convincingly quantify improvement of dissolved oxygen during the test period. The review indicated that the natural tidal cycle accounted for most of the variation in dissolved oxygen level during the demonstration (Paul Conrads, USGS written communication 2008). Another review of the test report and available data found that dissolved oxygen increased only at moderate temperatures at mid-depth at the point of injection and concluded that the Speece cones had a very limited effect on dissolved oxygen level (Civilized Engineering 2007). Therefore it is difficult to assess how effective the oxygen injection would be at reducing the dissolved oxygen impact.

Fish

The predicted impacts to shortnose sturgeon habitat for depth alternatives with associated mitigation plans are presented in Table 9. These predictions were formulated by comparing habitat criteria developed by an interagency team of biologists to results of the Corps water

quality model runs. The results of this analysis were presented in the Corps DEIS for the Savannah Harbor Expansion Project (Corps of Engineers 2010a).

After development of the original habitat criteria, NOAA recommended changing the salinity criterion for juvenile shortnose sturgeon and this change was accepted by the interagency team. The Corps has conducted additional analysis of juvenile impacts based on the revised criterion. However, NOAA has recommended additional modifications in the habitat analysis (Bill Bailey, Corps, personal communication 2011). Because there is currently no agreement on the revised juvenile habitat impact, the results presented in the Corps DEIS were considered appropriate for use in this report. Continued coordination between the Corps and NOAA is expected and may result in revised impact predictions for juvenile shortnose sturgeon.

Predicted impacts are caused by salinity changes in the various branches of the river system. Oxygen injection using Speece Cones is predicted by the models to offset impacts on dissolved oxygen. Winter habitat for juveniles is predicted to change 2% or less either positive or negative. Winter habitat for adults is predicted to decrease by 6% for the 44-foot/6b alternative and to decrease by 11% for the 48-foot/6a alternative. Adult summer habitat is expected to increase by 13% for the 44-foot/6b alternative and to decrease by 8% for the 48-foot/6a alternative. The cumulative impact on shortnose sturgeon was calculated by using a procedure for independent events (Sokol and Rohlf 1969, USFWS 2008). Impacts with the mitigation plan ranged from +7% for the 44-foot plan to -20% for the 48-foot plan. It is difficult to assess how effective the Corps proposed fishway would be as mitigation. This measure, if effective, would provide shortnose sturgeon access to the Augusta shoals and other riverine spawning areas. A much more effective measure would be removal of the NSBLD which would provide unrestricted spawning access as well as river restoration.

Table 9. Predicted impact to shortnose sturgeon juvenile winter (January) habitat, adult winter (January) habitat and adult summer (August) habitat and cumulative impact for depth alternatives with associated mitigation plan.

Channel depth/ Mitigation plan	Juvenile winter percent change	Adult winter percent change	Adult summer percent change	Cumulative impact
42 feet (baseline)	0	0	0	0
44 feet/6b	+1	-6	+13	+7
45 feet/6a	+2	-7	-1	-6
46 feet/6a	0	-9	-2	-11
47 feet/6a	-1	-9	-7	-16
48 feet/6a	-2	-11	-8	-20

The predicted impacts to striped bass spawning, egg and larval habitat for depth alternatives with associated mitigation plans are presented in Table 10. Predicted impacts are due to salinity changes in the various branches of the river system. For successful recruitment, all of these habitat components are needed.

Table 10. Striped bass spawning habitat, egg habitat, larval habitat and cumulative impact predicted for Savannah Harbor deepening at the 50%-tile flow.

Channel depth	Spawning habitat impact	Egg habitat Impact	Larval habitat Impact	Cumulative impact (%)
42 feet (baseline)	0	0	0	0
44 feet/6B	-3	-9	-6	-17
45 feet/6A	-9	+5	+2	-3
46 feet/6A	-10	0	+6	-5
47 feet	-14	-11	-5	-27
48 feet/6A	-16	-11	-4	-28

To assess overall impact to striped bass we used the mean flow (50^{th} percentile) as recommended by the GADNR. Cumulative impact was calculated by using a procedure for independent events (Sokol and Rohlf 1969, USFWS 2008). Table 10 summarizes the striped bass impacts for depth alternatives and associated mitigation plan. The 45-foot and 46-foot depths with plan 6A are predicted to have the least overall impact (-three and -five percent). The 47-foot and 48-foot alternatives have higher impacts, a 27% and 28% loss of habitat, respectively. GADNR believes the higher impacts (27-28% habitat loss at 47-48-foot depth) will have a significant effect on annual recruitment. The resulting permanent loss of critical spawning and nursery habitat will eventually lead to a collapse of the fishery due to the continued impacts on year class strength. They also believe that cumulative impacts would preclude the restoration of a naturally reproducing population of striped bass in the Savannah River. This complete failure of natural recruitment will require stocking striped bass in the Savannah River in perpetuity. GADNR concludes that to mitigate the impacts of the Savannah Harbor Expansion Project on striped bass habitat, a complete stocking and monitoring program should be fully funded for the life of the project. The Corps proposed to provide funding to GADNR for the striped bass stocking program in late 2015 or early 2016. To offset project impacts that begin when construction is complete, GADNR must have stocking capacity in place in the first spawning season following construction. The USFWS believes that the Corps should transfer funding for the striped bass stocking program when dredging is initiated, which should provide enough lead time to develop stocking capacity.

The models forecast an increase of between 52% and 74% in southern flounder habitat with mitigation, primarily because of predicted dissolved oxygen increase due to the Speece cone system. The American shad model predicted impacts of less than 2% for all depth alternatives and associated mitigation plans.

Cadmium

Although the USFWS maintains that the best available data does not support the Corps' determination that a cadmium concentration of >4mg/kg "is the lowest defensible estimate of a dry sediment cadmium level of potential concern," we recognize the uncertainty associated with the risk assessment model and the subsequent determination of a "protective" cadmium concentration. Due to the inherent uncertainties in ecological risk assessment, the USFWS is willing to accept the Corps' use of a cadmium concentration of >4mg/kg for monitoring purposes during dredging operations and following placement of the cover layer, to trigger priority in rotation for placement of maintenance sediments and to initiate vegetation monitoring. We recommend taking samples of the cap material to a depth of 30 cm instead of the 15 cm depth proposed.

However, as a condition of acceptance of the 4 mg/kg level, wildlife activity monitoring and bird tissue monitoring must be conducted to ensure that habitat within the CDFs is not harmful to wildlife. The USFWS believes the activity and tissue sampling are essential because of the uncertainties in risk assessment and because the CDFs will be managed to attract birds. Wildlife activity monitoring should begin with sediment placement and continue as long as all other monitoring of the CDFs. Tissue monitoring should occur: 1) prior to sediment placement to collect baseline data; 2) during sediment placement; and 3) post placement until 3 consecutive years of samples contain cadmium concentrations that are less than the potential adverse effect level, which is to be determined.

Summary plan evaluation

The 44-foot, 45-foot and 46-foot alternatives with associated mitigation plans would be most likely to maintain freshwater conditions at the diversion canal entrance and managed wetlands. Based on model predictions, tidal freshwater marsh impacts of the 44-foot channel would be eliminated by mitigation plan 6B and would result in an increase of tidal freshwater marsh. With the 45-foot channel, tidal freshwater marsh impacts would be almost offset by plan 6A; 32 acres would be impacted. The 46-foot channel and proposed plan 6A would result in a loss of 201 acres of tidal freshwater marsh. The 47-foot channel and proposed plan 6A would result in a loss of 223 acres of tidal freshwater marsh. The 48-foot channel with the Corps proposed plan 6A would result in a loss of 337 acres of tidal freshwater marsh. Because of the cumulative loss and high wildlife value of tidal freshwater marsh in the Savannah estuary, the USFWS places emphasis on avoiding or minimizing additional loss of this rare habitat. The only plans that accomplish this objective are the 44-foot and 45-foot depths with associated mitigation plans.

The American shad model predicted impacts of less than 2% for all depth alternatives and associated mitigation plans. Shortnose sturgeon habitat is expected to increase by 7% for the 44-foot/6B alternative, decrease by 6% for the 45-foot/6A alternative, 11% for the 46-foot/6A alternative, 16% for the 47-foot/6A alternative and 20% for the 48-foot/6a alternative. Striped bass habitat is expected to decrease by 17% for the 44-foot/6B alternative, 3% for the 45-foot/6A

alternative, 5% for the 46-foot/6A alternative, 27% for the 47-foot/6A alternative and 28% for the 48-foot/6A alternative.

Table 11 summarizes impacts of the various plans on important fish and wildlife resources. The 44 and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. The loss of freshwater marsh could be compensated by land acquisition as proposed by the Corps. However, land acquisition will not replace the wetland ecosystem function and diversity lost due to project impacts. Striped bass loss could be compensated to some degree by stocking. However this action does not address habitat degradation or meet the USFWS goal of restoration and maintenance of a self-sustaining striped bass population. In addition, it would not be practical to stock enough striped bass to equal the numbers of striped bass that could be produced by a healthy self-sustaining striped bass population. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44- and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths.

Table 11. Tidal freshwater marsh (0-0.5 ppt) predicted impact, striped bass habitat impact and shortnose sturgeon habitat impact for the Savannah Harbor project alternatives.

Alternative	Tidal freshwater marsh impact	Striped bass habitat impact	Shortnose sturgeon habitat impact
44-foot	+332 acres	-17%	+7%
45-foot	-32 acres	-3%	-6%
46-foot	-201 acres	-5%	-11%
47-foot	-223 acres	-27%	-16%
48-foot	-337 acres	-28%	-20%

UNCERTAINTY AND RISK

The EFDC model, the primary tool to evaluate project impacts and mitigation alternatives, is a mathematical representation of the Savannah River estuary, a highly complex system. The spatial, physical, chemical and biological complexity makes modeling of this system a significant challenge. The high tidal range, significant and variable freshwater inflow, salinity stratification and highly branched channel geometry with marsh storage result in a non-linear system that continuously varies over time and space. The EFDC/WASP model has known errors in its simulation of actual measured conditions and the simulation of the mitigation scenarios are an extrapolation of the model to an imagined system. It is unlikely that a model of this complexity will provide predictions that are accurate for all conditions and in all geographic areas. If there are errors in the model simulating the dynamics of the existing conditions, there will be greater

errors in simulating a completely different system as represented by the mitigation alternatives. Caution needs to be used in interpolating mitigation scenarios, especially ones that are substantially different than the existing system. The most responsible use of the model is for inference of the possible impacts to the system and not as an absolute prediction of the impacts. Although the EFDC/WASP model provides the best available estimate of mitigation effectiveness, the model salinity and dissolved oxygen predictions may be quite different from the post-project measured impacts in the estuary.

The EFDC model was extensively reviewed by scientists from a number of agencies including the USFWS, USGS, EPA, South Carolina Department of Health and Environmental Control (SCDEHEC) and GADNR. These agencies concluded that the EFDC model was adequate to evaluate the deepening project, but certain cautions were identified. The USFWS stated in letter of July 5, 2005: "Therefore, even if a model is judged to be acceptable for use there will always be some level of uncertainty in its performance. One important area of uncertainty will be in evaluating the predicted effects of mitigation plans involving flow diversions from the Front River to the Middle and Back River." The USGS stated in letter of June 28, 2005: "Modeling of the Middle, Little Back and Back Rivers is very difficult due to the complexity of this branched network of shallow tidal rivers and creeks...The flow predictions have improved from previous applications of the model but are only satisfactory. Possible mitigation scenarios include diverting a portion of the flow from the Savannah River to the Middle and Little Back Rivers. The inability of the model to capture the ebb-tide flow dynamics should be remembered while interpreting scenarios where increased flows in the vicinity of SNWR are significant." The SCDHEC, in letter of March 10, 2006, discussing the under prediction of ebb flows in the Middle River and Back River, stated: "...this issue is not considered significant ...for application to deepening impacts; however, application to mitigation scenarios that alter channel connections—and attempt to predict resulting changes to the flow regime and the effect on salinity—may require additional evaluation of model capability."

All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located in the Back River. In addition the diversion structure is modeled by constricting the Front River at McCoys Cut. Even though this constriction is essentially what a diversion structure would do, when the structure is actually constructed it may not alter flow distribution as predicted in the model. The design and construction of a diversion structure that would quantitatively alter flows exactly as predicted in the model is highly unlikely. Flow into the Little Back River will also be influenced by channel gradient and tidal progression in the river system (Wiley Kitchens, USGS, personal communication, 2005).

Another area of concern involves the potential for increased sedimentation in McCoys Cut, Middle River and Little Back River caused by the diversion structure at McCoys Cut. Several

studies indicate that increasing flow into river cutoff bends increases the siltation rate in the bend and decreases its duration as an aquatic system (Shields 1987). While the tributaries involved are not cutoff bends, sedimentation patterns are likely to be similar. Diversion structures divert most water when river flows and sediment loads are high. As sediment laden water reaches areas of lower velocity, sediment is deposited. The risk of sedimentation is high in the vicinity of McCoys Cut and Little Back River near Union Creek because of the presence of a tidal null point in this location. Large sediment bars are currently at this location and diversion of water from the Front River may accelerate sedimentation. If sedimentation increases, periodic maintenance dredging would be required to maintain the mitigation features. Maintenance dredging has impacts on benthic invertebrates and potential impacts on wetlands; depending on how dredging is performed and where dredged material is placed.

All of the mitigation features based on flow modification are intended to reduce salinity in the Back River because much of the tidal freshwater marsh and the freshwater diversion system are located in this branch. However, diversion of fresh water into the Back River allows salt water to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. Closing of Rifle Cut helps address the risk of salinity increase in Back River by preventing flow from Middle River to Back River. The model may under predict the amount of salinity moving up Front and Middle River. Even a slight error in the model could result in salinity moving into Little Back River from the Middle River near McCoys Cut or entering McCoys Cut from Front River. If either event occurred, impacts to tidal freshwater wetlands, the freshwater diversion system and striped bass would be higher than expected. Tree mortality in tidal forested wetlands along Front River would occur if salinity increases more than predicted. In addition, shortnose sturgeon, and striped bass which utilize the Front River and lower Middle River could be impacted more than expected. Salinity increases more with greater channel depth and the margin for error is reduced before impacts would occur to the Little Back River. Therefore, risk and uncertainty are highest with the 48-foot alternative.

As discussed earlier in this report, there is a high degree of uncertainty as to how effective oxygen injection would be. The fish habitat model results are based on predictions from the EFDC/WASP model. If the Speece cones are not as effective as previously assumed, the model predictions of harbor deepening impacts on fish would be underestimated. Because dissolved oxygen is a key component of all aquatic habitats, underestimation of harbor deepening impact would be important. In addition, if the number of Speece cones had to be increased, the cost of this mitigation feature could increase substantially.

Another area of uncertainty is how the planned Jasper County Terminal would impact fish and wildlife resources and the potential to avoid upstream impacts that would occur through development of this project. Deepening of the harbor only to river mile 7 would have much less impact on salinity intrusion into Savannah NWR and dissolved oxygen in the harbor compared to deepening the river an additional 12 miles to river mile 19. Mitigation cost of the project would be substantially reduced because it is likely that most of the mitigation features to address salinity intrusion and dissolved oxygen would be unnecessary. In addition dredging quantity would be

greatly decreased reducing initial cost and prolonging the life of dredged material disposal areas. However, because of the need to replace lost dredged material disposal capacity, there could be other mitigation costs associated with the Jasper County Terminal.

MONITORING AND ADAPTIVE MANAGEMENT

The Corps has proposed pre-construction monitoring (one year), monitoring during construction (three years) and post-construction monitoring (five years). The monitoring would include water quality, channel morphology, wetlands, shortnose sturgeon tagging and tracking in the estuary, and fish passage at the New Savannah Bluff fishway. The wetland monitoring would be similar to pre-project impact evaluation studies that were initiated in the late 1990's and were carried on for several years. The shortnose sturgeon estuary monitoring would be similar to pre-project impact evaluation studies that were initiated in the late 1990's and were carried on for two years. The monitoring plan is described in detail by the Corps (2010a).

The USFWS strongly supports the proposed comprehensive monitoring program. In addition to a post-construction monitoring plan, a post-construction monitoring data-analysis plan needs to be established. It will be difficult in a highly altered system, as represented by the mitigation plans, to analyze the post-construction monitoring data and to determine the efficacy of the mitigation measures. A recent example of the need for such a plan is the re-oxygenation demonstration project. Monitoring data was collected but there was not an effective data analysis approach in place to analyze the data and quantify the impact of the demonstration project on the highly variable dissolved oxygen dynamics of the system. There are a number of other concerns with the proposed monitoring plan.

Pre-construction monitoring for one year is intended to create or supplement a pre-project baseline. However, information based on only one year of data may not provide an adequate baseline. Use of available long-term salinity data sets, from the end of the last harbor deepening construction to the start of any new deepening construction, as baseline salinity conditions to supplement the one year of pre-construction water quality monitoring would help address this problem. Two existing water quality stations on Back River (021989784 and 021989791), and one on Front River (02198920), that have long-term salinity data should be included in the baseline. Similarly, wetland and fishery studies performed during project planning represent useful baseline information. The plan needs to describe in greater detail developing baseline conditions for the various monitoring parameters. If construction is delayed for more than one year after a decision for harbor expansion, pre-construction monitoring should be continued until construction begins.

A recent Savannah River drought with four years duration occurred during 1998-2002. Other droughts of two-three years duration are not uncommon. Periods of exceptionally high river flow also occur periodically and can last for several years. If the post-construction period coincides with a prolonged drought or high flow period, the monitoring data would be of limited value.

After a prolonged drought or high flow period, wetland vegetation will take some time to respond to the salinity change. Therefore, we believe that the post-construction wetland and continuous water quality monitoring needs to be increased from five years to ten years.

No monitoring is proposed for striped bass, but there is a great deal of uncertainty on the impact predictions. A post-project assessment of striped bass habitat using the water quality monitoring data and updated water quality simulations is needed. Model updates are already planned that would facilitate a low-cost assessment using the established striped bass habitat criteria. Habitat impact could be assessed during the fourth year of post-project monitoring. If the post-project impacts are higher than pre-construction predicted habitat impacts then funding for striped bass stocking should be increased in proportion to the impact.

The Corps proposes to fund four long-term water monitoring stations to determine whether the mitigation features are functioning as intended. A fifth station, Station 021989784, is located at the intake of the freshwater supply system for the 3,000 acres of managed wetlands on Savannah NWR and is therefore especially important for monitoring project impacts to the Refuge. Therefore this station should be added to the long-term stations.

The Corps (2008b) described the following potential adaptive management measures as part of the Savannah Harbor Expansion Project.

- Enlarging the diversion structure at the mouth of McCoys Cut;
- Enlarging the deepened area at McCoys Cut, Middle & Back Rivers;
- Constructing a diversion structure at the junction of Middle and Back Rivers;
- Removing the tidegate sill;
- Raising or lowering the height of the submerged sill at the Sediment Basin;
- Improving fish passage at the NSBLD fish bypass;
- Acquisition of additional freshwater wetlands;
- Constructing and operating additional dissolved oxygen systems;
- Modifying the submerged sill across Middle River
- Modifying the wetland restoration area at former disposal area 1S;
- Preferential placement of maintenance sediments into CDF's 14A and 14B

Many of these measures are proposed because of uncertainty regarding the channel and flow modifications. Post-construction monitoring and consultation with the Federal Cooperating Agencies would determine the need to implement these measures (Corps of Engineers 2010a). We support the proposed adaptive management plan but a number of improvements are needed.

The plan describes an informal inter-agency review process for monitoring data and reports during the five year post-construction monitoring period. Within one year after the five year post-construction monitoring period, the Corps would prepare a consolidated report of the various monitoring programs, followed by 30 days of agency review, an unspecified time period for further report revision, public review, and a potential elevation process. This time-line for making decisions on adaptive management actions would likely require a minimum of 1.5 years

after the five year post-construction monitoring period, and could take much longer. This process needs to be compressed so that final decisions on corrective actions are reached within one year after the monitoring period. In addition, because we are recommending extending the duration of post-construction monitoring from five years to ten years, a consolidated report of the various monitoring programs at the end of five years, and again at the end of ten years following project construction needs to be prepared and coordinated, to ensure that adaptive management decisions can be made when it becomes apparent that a problem exists, and in a timely manner.

The Federal modeling performance goals in the Corps plan are generally those provided by review agencies in 2001 during hydrodynamic model development. Because the agencies were aware of the complexity of the system and model limitations, we allowed considerable latitude in the performance of the models. We are concerned that adopting the same tolerances for the performance of the constructed project is inappropriate, because actual impacts could differ substantially from the predicted impacts without triggering remedial action. Based on earlier coordination, the Corps modified the tolerances for achieving a goal of <1 ppt salinity to +/- 0.1 ppt, and we support this change. The goal for salinity in the range of 1-5 ppt has not been modified, and would allow considerable impact without triggering action. As proposed, a range of 0.5 to 1.5 ppt is acceptable for a salinity goal of 1 ppt (+/- 50%), while a range of 0.89 to 1.09 ppt is acceptable for a salinity goal of 0.99 ppt (+/- 10%). Modifying the goal for salinity in the range 1-5 ppt to +/- 10 % (not +/- 0.5 ppt as the Corps proposed) to make it more consistent with other goals and triggers for adaptive management would be appropriate.

The Corps proposes to monitor the performance of corrective actions under the adaptive management program for one year. It is unlikely that one year of post-construction monitoring would be sufficient to determine the outcome of the action in a system as dynamic as the Savannah estuary. A minimum of three years of post-construction monitoring of adaptive management actions is needed to determine the success of implemented actions.

The plan states that the "Corps would seek and obtain its funds for this phase each year through the normal budget process". It is relatively certain that impacts to USFWS trust resources would occur following construction, but the effectiveness of the mitigation features is much less certain. Unless contingency funding for monitoring/adaptive management activities is assured the proposed mitigation plan may not adequately address project impacts.

SUMMARY AND CONCLUSIONS

Savannah NWR and the surrounding estuary support nationally important fish and wildlife resources. However, cumulative impacts of previous harbor modifications, primarily salinity intrusion, have severely impacted the resources that were present when the Refuge was established. A freshwater supply system for managed wetlands, installed as mitigation for the tidegate, has failed to function adequately. Tidal freshwater marsh has been reduced from about 12,000 acres to about 3,300 acres. Striped bass reproduction and recruitment were almost

eliminated during tide gate operation but have recently begun to recover. Shortnose sturgeon habitat has been greatly impacted both by salinity increase and dissolved oxygen decrease.

The current inner harbor is 42 feet in depth. Impacts of project depths of 44, 45, 46, 47 and 48 feet were evaluated using hydrodynamic, water quality and biological models. A number of mitigation measures have been proposed by the Corps. Many of these measures are based on channel and flow modifications in the estuary. In addition, a dissolved oxygen injection system, wetland restoration, wetland acquisition, striped bass stocking and a fish bypass channel at New Savannah Bluff have been proposed.

There is a great deal of risk and uncertainty regarding success of the channel and flow modification and dissolved oxygen mitigation plans. The mitigation plans are unlikely to perform exactly as predicted. There could be unintended adverse consequences resulting from the channel and flow mitigation measures. All of the proposed mitigation alternatives include flow diversion as a basic and highly important component. The predicted reduction of salinity in the Middle River and Back River is due in large part to the proposed flow diversion from Front River. The EFDC model uncertainty in this geographic area is of concern, particularly because most of the remaining freshwater tidal marsh and the entrance to the diversion canal are located there. Diversion of fresh water into the Back River allows salinity to move further up the Front River and into the Middle River. As a result, in the Front River and lower Middle River mean and maximum salinity would be higher with the mitigation plan than without it. The model may under predict the amount of salinity moving up Front and Middle River.

Based on the available information, there is a high degree of uncertainty as to how effective oxygen injection would be. The fish habitat model results are based on predictions from the EFDC/WASP model. If the Speece cones are not as effective as previously assumed, the model predictions of harbor deepening fish impacts would be underestimated. Because dissolved oxygen is a key component of all aquatic habitats, underestimation of this harbor deepening impact would be important. In addition, if the number of Speece cones had to be increased the cost of this mitigation feature could increase substantially.

The 44 and 45-foot plans (with mitigation) avoid or minimize impacts to tidal freshwater marsh and the freshwater supply system. The 45-foot depth minimizes impacts to striped bass habitat and the 44-foot depth minimizes impacts to shortnose sturgeon. Based on the information obtained for the specific purpose of evaluating this project, it is clear that the 44 and 45-foot alternatives would have much lower impacts on fish and wildlife resources. Impacts of the project increase substantially at the 46-, 47- and 48-foot depths. For any project implemented, the USFWS supports a comprehensive monitoring program to document actual impacts and an adaptive management plan to rectify unanticipated impacts.

RECOMMENDATIONS AND POSITION

The following recommendations and position are provided to the Corps pursuant to the FWCA, which requires the Corps to give full consideration to the report and recommendations of the Secretary of Interior and to any report of State Wildlife agencies. In addition, Department of Interior concurrence in the project is required before implementation, as provided for in the 1999 conditional Congressional authorization. Acceptance of the following recommendations and position would be the primary factor in determining USFWS and Departmental concurrence.

Recommendations

1. Determine project impact and formulate mitigation by comparing predicted with-project conditions immediately after construction (rather than average annual) to base year conditions.

2. Eliminate the "advance mitigation" proposed by the Corps for acquisition and additional restoration on site 1S. Restoration of site 1S could be limited to the amount needed to offset impacts of the proposed project.

3. Complete repair of the Savannah NWR freshwater supply system prior to harbor deepening construction.

4. Initiate mitigation land acquisition no later than initiation of harbor construction and complete acquisition in a timely manner (within two years of start).

5. Install a fish passage facility at New Savannah Bluff Lock and Dam or remove the dam to restore the river. Continue coordination with resource agencies to optimize design of any fish passage facility.

6. Transfer Corps striped bass stocking program funding to GADNR when harbor construction is initiated in order to provide enough lead time to develop stocking capacity.

7. Continue coordination with the USFWS to define the scope of vegetation, wildlife activity and bird tissue monitoring in the CDFs 14A and 14B.

8. Add Station 021989784, located at the intake of the freshwater supply system on Savannah NWR, as a long-term monitoring station.

9. Continue coordination with resource agencies to develop a data analysis and information delivery plan as part of the monitoring program.

10. Increase post-construction wetland and continuous water quality monitoring from five years to ten years and prepare a consolidated report of the various monitoring programs at the end of five years, and again at the end of ten years following project construction.

11. In the adaptive management plan, describe in greater detail how baseline conditions will be developed for the various monitoring parameters. Make maximum use of existing long-term water quality stations and all planning biological studies. If construction is delayed for more than one year after a decision for harbor expansion, continue pre-construction monitoring until construction begins.

12. Modify the monitoring and adaptive management plan to include a striped bass habitat impact assessment during the fourth year of post-project monitoring. If the post-project impacts are higher than pre-construction predicted habitat impacts then increase funding for striped bass stocking in proportion to the impact.

13. Modify the adaptive management plan to specify that establishment of native wetland plants is necessary for successful restoration. Include specific monitoring and management protocols to detect and control exotic and invasive species. Continue coordination with USFWS and other interested agencies during planning, construction and monitoring of wetland restoration site 1S.

14. Compress the adaptive management decision-making process so that final decisions on corrective actions are reached within one year after the monitoring period.

15. In the adaptive management plan, modify the performance goal for salinity in the range of 1-5 ppt to +/- 10 % (not +/- 0.5 ppt) to make it more consistent with other goals and triggers for adaptive management.

16. Perform three years of post-construction monitoring of any implemented adaptive management actions.

Position

The USFWS's preferred alternative for deepening Savannah Harbor is the 45-foot alternative. This alternative 1) minimizes the loss of already limited freshwater tidal wetlands; 2) minimizes impacts to Savannah NWR; and 3) minimizes risk and uncertainty of impacts on fish and wildlife resources.

Any additional economic benefits resulting from the LPP relative to the NED plan would represent local benefits. By contrast, the additional environmental impacts associated with the LPP, and in particular the loss of an additional 114 acres of already scarce and declining freshwater tidal wetlands, would occur on a national resource, the Savannah NWR. The

additional 114 acres of impact to freshwater tidal wetlands associated with the LPP represents a 50% increase in impacts over the NED plan's depth. For this reason, the USFWS does not support the LPP.

As currently proposed, Corps funding for adaptive management activities that may be required will be dependent upon the Corps' annual appropriations process. Because these adaptive management actions may be essential to correct mitigation deficiencies and insure that impacts to fish and wildlife trust resources are offset, contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations.

COORDINATION WITH STATE AND FEDERAL WILDLIFE AGENCIES

A draft of this FWCA report was provided to SCDNR, GADNR and NOAA for review and their responses are included in Appendix A. The Corps released the final version of the DEIS at the same time as this draft report was under review. The DEIS contained new or revised information on sea level rise, advance mitigation and adaptive management. Therefore, the final version of this FWCA report was revised to address the changes in the DEIS and a number of recommendations have been modified or added. The final version of this report added nine recommendations to the seven in the review draft. However, none of these changes affected the conclusions of the report or the Service position.

SCDNR generally concurred with the Service report and stated that the project should be limited to a maximum authorized depth of 44 or 45 feet in order to minimize environmental impacts. They also agreed that there was considerable uncertainty with the models used to predict impacts and with the proposed oxygen injection system. SCDNR concurred with what are recommendations 3, 4, 7, 10, 13 and 15 (modified) in the final version of the report. SCDNR did not concur with recommendation five in the final version of the report and they state that passage for shortnose stugeon is unproven and difficult to support. At the time of review, SCDNR did not support fish passage at NSBLD or removal of the dam.

GADNR commented on loss of spawning habitat that will likely preclude restoration of a naturally sustaining striped bass population in the Savannah River. They supported the proposed striped bass management program and requested that striped bass mitigation be made prior to project impacts. Recommendations 6 and 12 were added to address timely funding, monitoring and adaptive management of striped bass.

NOAA provided a number of detailed comments, many related to shortnose sturgeon. They did not make any recommendations about the acceptability of the proposed alternatives because they believe impacts to shortnose sturgeon and other resources need to be better understood. The Service revised this report to address several of their specific comments. NOAA and the Corps are continuing endangered species consultation and essential fish habitat consultation to address impacts and mitigation to resources under NOAA jurisdiction.

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APPENDIX A - AGENCY RESPONSE LETTERS

South Carolina Department of
Natural Resources

1000 Assembly Street Room 310A
PO Box 167
Columbia, SC 29202
803.734.3766 Office
803.734.9809 Fax
perryb@dnr.sc.gov

John E. Frampton
Director
Robert D. Perry
Director, Office of
Environmental Programs

December 17, 2010

Ms. Sandra S. Tucker
Field Supervisor
US Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

REFERENCE: USFWS Log Number 2011-0140 Savannah Harbor Expansion Project
Fish and Wildlife Coordination Act Report

Dear Ms. Tucker,

Personnel of the South Carolina Department of Natural Resources (DNR) have reviewed the Draft Fish and Wildlife Coordination Act (Draft FWCA) Report for the proposed Savannah Harbor Expansion Project (SHEP) and offer the following comments.

The Draft FWCA Report accurately characterizes the major environmental impacts of the proposed SHEP, as presented in the Draft Environmental Impact Statement (DEIS) for this project. Should SHEP be authorized, and contingent on the final DNR position on the DEIS for the project, DNR concurs with recommendations 1 and 2 and 4-7 included in the FWCA Report regarding the implementation, mitigation and long-term monitoring of this project. In addition, DNR reiterates support for grading down former disposal area 1S as compensatory mitigation for any direct loss of saltwater wetlands due to bend widening or other excavation related to SHEP. DNR also supports the construction of a public boat ramp on Hutchinson Island as compensatory mitigation for diminished recreational boating access to the Back River resulting from the proposed closure of Rifle Cut.

DNR agrees the project should be limited to a maximum authorized depth of 44 or 45 ft (MLW) in order to minimize impacts of increased salinity intrusion and decreased dissolved oxygen levels on fish, wildlife, freshwater wetlands, and water quality in the lower Savannah River and its tributaries. The 44 ft alternative (with mitigation) would minimize impacts to tidal freshwater wetlands and suitable habitat for the federally endangered shortnose sturgeon (*Acipenser brevirostrum)* (SNS); whereas, the 45 ft alternative, with mitigation, would minimize impacts to striped bass (*Morone saxatilis*) habitat, but result in some loss of tidal freshwater wetlands and SNS habitat. As stated in the report, the loss of tidal freshwater wetlands could be offset by the acquisition and transfer of suitable tracts of land to the Savannah National Wildlife Refuge for protection, wildlife management, and appropriate public use. The US Army Corps of Engineers

Ms. Sandra S. Tucker
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December 17, 2010

(USACE) proposes to partially offset the loss of SNS habitat by constructing and operating a fish bypass system at the New Savannah Bluff Lock and Dam (NSBLD), which theoretically would allow SNS and other anadromous fish to access upstream spawning and nursery habitat. Fish passage for SNS is unproven and difficult to support. The US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) believe a much more effective measure would be to remove the NSBLD entirely, which would provide access to upstream spawning and nursery habitat in this reach of the Savannah River. At this time and due to the substantial aquatic resource impacts associated with the proposed SHEP, DNR does not support either fish passage at NSBLD or removal of this dam.

DNR agrees that there is considerable uncertainty associated with the models used to predict environmental impacts of the proposed deepening project and other hydrological modifications proposed as mitigation for those impacts. Particularly there is considerable uncertainty associated with the effectiveness of the oxygen injection system that is proposed as compensation for projected decreases in dissolved oxygen resulting from the project. Therefore, DNR also agrees that adequate contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations to the USACE.

In conclusion, DNR commends the USFWS for its thorough review and analysis of all major environmental impacts of the proposed project, and supports most recommendations and positions as presented in the FWCA Report. DNR will provide additional comments on specific aspects of the SHEP directly to the USACE as part of the public review process for the DEIS, and nothing herein binds DNR relative to forthcoming comments on the DEIS. DNR anticipates continuing coordination with the USFWS, as well as NMFS, in formulating any additional recommendations or comments related to this proposed project. If your office will require any further information regarding this transmittal, please contact Priscilla Wendt at wendtp@dnr.sc.gov or 843-953-9305.

Sincerely,

Bob Perry
Director, Office of Environmental Programs

c: Jay Herrington – USFWS
Pace Wilber – NMFS
Bob Lord - USEPA
Barbara Neale – DHEC-OCRM
Heather Preston – DHEC-ECQ
Michael G. McShane – Chairman DNR Board
John Frampton
Don Winslow
Robert Boyles
Priscilla Wendt

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

JAN 0 3 2011

JAN 03 2010

MARK WILLIAMS
COMMISSIONER

DAN FORSTER
DIRECTOR

December 30, 2010

Sandra Tucker, Field Supervisor
Division of Ecological Services
US Fish and Wildlife Service
Coastal Georgia Sub-Office
4980 Wildlife Drive
Townsend, Georgia 31331

Subject: Comments on Draft Fish and Wildlife Coordination Act (FWCA) Report

Dear Ms. Tucker:

Thank you for the opportunity to review and provide comment on the Draft Fish and Wildlife Coordination Act (FWCA) Report for the proposed Savannah Harbor Expansion Project (SHEP). The Georgia Department of Natural Resources, Wildlife Resources Division (WRD) continues to work closely with Bill Wikoff and other Fish and Wildlife Service staff throughout this process and appreciate the level of cooperation and inclusion and data sharing that has occurred between our respective agencies. Much of our effort has been directed toward fishery resources, including the very popular striped bass fishery. This once thriving population nearly collapsed in the late 1980's due to changes in bathymetry and increased salinity levels in critical spawning grounds located in the Back River. WRD has made a long-term commitment to the recovery of the Savannah River striped bass population and has made tremendous strides towards recovering this fishery. Recovery efforts included closing new cut, removing the gates from the tide gate structure, closing the fishery to harvest, and an intense stocking program that continues to this day. The fishery was successfully re-opened to limited harvest in October 2005.

The FWCA Report does a thorough job identifying predicted impacts at project depths of 44, 45, 46, 47, and 48 feet and chronicling the predicted effectiveness of mitigation options at these depths. Methodologies used to assess cumulative impacts at the locally preferred plan of 48 feet predict significant impact to the remaining critical striped bass spawning habitat in the Savannah River estuary. Permanent loss of remaining spawning habitat will likely preclude restoration of a naturally sustaining striped bass population in the Savannah River. Furthermore, flow and channel modification mitigation options do not ameliorate predicted project impacts. To compensate for the predicted impacts to striped bass, we concur with the FWCA Report in that the Savannah River striped bass management program should be funded and request that striped bass mitigation be made prior to further degradation of critical habitat caused by river dredging. We agree with your assessment that an adaptive and comprehensive monitoring program will be necessary to document project impacts and address corrective measures.

Sincerely,

Dan Forster

Dan Forster

DF/tab

cc: John Biagi

2070 U.S. HIGHWAY 278 S.E. | SOCIAL CIRCLE, GEORGIA 30025-4711
770.918.6400 | FAX 706.557.3030 | WWW.GEORGIAWILDLIFE.COM

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
(727) 824-5317; FAX (727) 824-5300
http://sero.nmfs.noaa.gov/

February 16, 2011 F/SER4:PW/pw

(Sent via electronic mail)

Sandra Tucker
Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606

Attention: Bill Wikoff

Dear Ms. Tucker:

NOAA's National Marine Fisheries Service (NMFS) reviewed your letter dated November 15, 2010, requesting comments on the *Draft Fish and Wildlife Coordination Act Report on the Savannah Harbor Expansion Project* (FWCA Report) in Chatham County, Georgia, and Jasper County, South Carolina. On December 13, 2010, Kay Davy, from our Protected Resources Division, and Pace Wilber, from our Habitat Conservation Division, met with Ed Eudaly from your office. During this meeting we reviewed the report page-by-page, discussed our comments, and indicated NMFS's current position on the major points made by the Fish and Wildlife Service in the draft report. Several short, follow-up communications occurred after the meeting. The attached list provides a record of the comments that were provided during the meeting and follow-up communications. Also attached for easy reference is a copy of the letter NMFS provided the U.S. Army Corps of Engineers on January 25, 2011, that summarizes NMFS' position on several key questions raised in the FWCA Report.

NMFS greatly appreciates the effort the Fish and Wildlife Service has put into the FWCA Report and other facets of the planning for the Savannah Harbor expansion, and thank you for the opportunity to provide comments on the draft report. Related correspondence should be directed to the attention of Pace Wilber (843-762-8601 or Pace.Wilber@noaa.gov) or Kay Davy (954-356-6791 or Kay.Davy@noaa.gov).

Sincerely,

/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc:
Ed Eudaly, peconsulting@knology.net
FWS, Bill_Wikoff@fws.gov, Sandy_Tucker@fws.gov
SCDNR, WendtP@dnr.sc.gov, PerryB@dnr.sc.gov
SER3, SER4

NMFS comments and questions on the *FWCA Report for the Savannah Harbor Expansion Project,* dated January 2011

Preface: To avoid redundancy in our comments, we are not commenting on the *Executive Summary* and assume that any changes needed to the *Executive Summary* based on the comments below would be made. Also, citations provided below refer to citations provided in the FWCA Report unless otherwise specified.

Prior Studies and Reports (section begins page 1)

1. May want to add to this section a discussion of the continuous impacts of the navigation project on diadromous fish and estuarine fish and shellfish. For example, the dredged material disposal areas are a continuous impacts on estuarine and tidal freshwater ecosystems due to the fill and blockage of extensive tidal creek systems formerly connected to the river.

Fish and Wildlife Resources (section begins page 6)

2. In the absence of management, how would habitats described as "freshwater managed wetlands" be characterized; specifically the impounded areas shown in Figure 2 associated with the diversion canal, Fife Plantation, and Clydesdale Plantation? Recommend Figure 2 be modified to include a polygon and labels that identify the freshwater managed wetlands referenced. This would also increase the precision of acreage calculations.

Fish and Wildlife Resources, Tidal freshwater wetlands (section begins page 9)

3. In this section and elsewhere, brackish marshes are described as having "lower diversity" than tidal freshwater marshes. While we agree that brackish marshes have fewer plant species than tidal freshwater marshes, the FWCA Report should not suggest that this difference equates to a difference in value when all ecosystem components (e.g., nursery habitat for fish, crabs, and shrimp) are considered. Assessments of wetland value are made with respect to a purpose, and FWS' view of what the purpose of these wetlands is should not be viewed as determinative.
4. Page 11 includes acreage for tidal freshwater marsh as far back as 1875. The source of these acreages should be provided; polygons would be preferable to increase precision and use in the adaptive management program.
5. Page 11 references Bill Bailey for a personal communication in 2008 on a major point – the amount of tidal freshwater marsh present in 2005 using a method based on drainage patterns. Such an important point should have a source that is more available for others to review.

Fish and Wildlife Resources, Fish (sections begins page 13)

6. The reference to Collins et al. (2001) is incomplete. They say "During 1988-1992, juveniles were concentrated in Kings Island Turning Basin. It appears that harbor modifications (deepening; tide gate removed from service; New Cut closed) since then have changed the hydrographic conditions and caused the fish to move from that area. No juveniles were found as far downriver as the turning basin in this study." The FWCA Report should include this suggested explanation. We also are aware of a study by The Nature Conservancy that suggests shortnose sturgeon avoid large portions of Back River (*Draft Report on the Movements of Shortnose Sturgeon in the Savannah River, GA/SC: 2006-2009*. In prep. by Amanda Wrona Meadows, Bill Post, and Jason Moak. The final version of the FWCA Report should include the results from this study.
7. Also should note the study by Collins et al. (2001) refers to adults and larger juveniles, not post-larval and early juvenile life stages that may be in shallower small tidal freshwater sloughs and creeks.

Fish and Wildlife Resources, Endangered species (sections begins page 16) AND *Project Impacts, Endangered species* (sections begins page 23)

8. Reference to the section 7 consultation with NMFS should indicate the consultation <u>is</u> underway, as opposed to just indicating that NMFS is responsible for working with the COE on the consultation.

NMFS also is working with the COE on how to address impacts to Atlantic sturgeon, which has been proposed for listing under the Endangered Species Act (ESA).

9. The list of species subject to ESA jurisdiction for this project is incomplete. North Atlantic right whale, Atlantic sturgeon, smalltooth sawfish, and all five species of sea turtles (Kemp's ridley, leatherback, green, hawksbill, and loggerhead) should also be included in addition to shortnose sturgeon. The final report should indicate that section 7 consultation with NMFS is underway for these species and a Biological Opinion will be prepared.

Problems, Opportunities and Planning Objectives (section begins page 16)

10. Bullet 1 says "maintenance of normal tidal and salinity patterns is a major objective of coastal refuges and management areas." The managed freshwater wetlands referenced earlier in the report should be referenced as an exception.
11. Bullet 4 indicates 6,000 acres of wetlands have been lost due to filling and dredging. Recommend the basis of this determination be provided, preferably as a set of polygons with acreages that show this difference.

Alternatives (section begins page 17)

12. Recommend the table caption state the values provided do not include allowable overdepth since many references in the news media and elsewhere do. We also recommend the table caption explicitly indicate the volumes listed to include the dredging needed to extend the Ocean Bar Channel. The FWCA Report generally avoids discussion of the Ocean Bar Channel and the issues associated with its lengthening, so it should be clear when this aspect of the project is covered.

Project Impacts (section begins page 18)

13. After briefly describing the hydrodynamic and water quality models, the first paragraph of this section says "extensive model development, coordination and peer review processes were conducted to ensure that the model was acceptable to evaluate projects impacts." No citation for the model evaluation is provided. If FWS has determined that the models are suitable for evaluating the impacts from Savannah Harbor Expansion Project, the report should describe how FWS came to this conclusion.
14. The reference to the habitat suitability models should indicate these models were meant to focus on a few species that may be indicative of the impacts from salinity or dissolved oxygen to species guilds or to the broader ecosystem. The models do not address impacts from other causes nor do they focus on all habitats likely to be impacted by the channel deepening, for example tidal freshwater marsh or nearshore habitat. In short, the habitat suitability models are useful tools, but they only assess a small portion the impacts likely from the proposed project.
15. At the bottom of page 18, the paragraph begins by saying "the most significant predicted impact of the deepening project is that salinity . . . will be increased." While we agree that this impact is significant, its relationship to other impacts is complex and involves multiple environmental mandates. Accordingly, we do not support its designation as "the most significant" since the FWCA Report is limited to the impacts from the Savannah Harbor Expansion Project that will occur in the harbor and does not address the impacts expect to occur in nearshore and offshore areas.

Project Impacts, Tidal freshwater wetlands (section begins page 19)

16. The discussion of productivity at the top of page 20 is limited to primary production and does not include detritus-based food chains.
17. Middle of page 20 states "salinity intrusion due to prior Savannah Harbor deepening is a factor facilitating higher use by marine species . . . . [and that] harbor deepening would exacerbate these trends." These statements are not supported by the baselines studies done by the SC Department of Natural Resources and others that show the great majority of the species collected in tidal creeks were estuarine, not marine.

Project Impacts, Fish (section begins page 21)

18. What is the source of the information regarding historical use of the Kings Island Turning Basin by shortnose sturgeon as nursery and foraging habitat? Is it Hall et al. 1991 "*Movements and habitats of Shortnose sturgeon,* Acipenser brevirostrum *in the Savannah River.*"
19. The mortality figure is partially correct. What was actually stated in the paper was: Jenkins et al. (1994) observed 86 - 100% mortality for 25-64 day old fish in an acute 6 **hr** exposure to 2.5 mg/l at 22.5 C (30% saturation). Older juveniles 100-310 days old experienced 12-20 % mortality under the same conditions.
20. The comments on "safe temperature" is a little confusing. The temperatures quoted concern the identification of a "safe temperature" for gill netting (for sampling purposes). Ziegeweid et al. (2008b) found that shortnose sturgeon acclimated to higher temperatures are more tolerant of elevated temperatures and that tolerance to elevated temperatures and low dissolved oxygen concentrations also appears to increase with age (body size). Anecdotal field observations indicate possible latitudinal variation in thermal tolerance. Atlantic sturgeon from southern river systems have been safely captured in gill nets at temperatures exceeding 30°C (Doug Peterson, University of Georgia, pers. comm.).
21. Is the "oxygen squeeze" discussed in the FWCA Report similar to what has been reported for shortnose sturgeon in the hypoxic areas of Chesapeake Bay and Hudson River? Additional explanation is needed.

Projects Impacts, Cadmium (section begins page 23)

22. The risk assessment that was reviewed should be cited.

Mitigation, Acquisition (section begins page 25)

23. Recommend that lands adjacent to shortnose sturgeon concentrations in the river be given a high priority for acquisition. NMFS would be happy to work with FWS on specific locations that meet this criterion.

Mitigation, Wetland restoration (section begins page 29)

24. The proposed restoration area is 42 acres, but Table 5 shows only 29 acres would be restored. This should be clarified.
25. Including creeks in the restoration marsh was proposed by multiple agencies, not just FWS. The recommendations would be stronger if it were based on input from multiple agencies.

Mitigation, Dissolved oxygen (section begins page 29)

26. The report cited, Tetra Tech (2006), does not reflect the placements provided in Tetra Tech (2010), which are the locations for the DO injectors in the Draft environmental Impact Statement. The FWCA Report should be amended to indicate the most recent locations.
27. FWS should explicitly and precisely state what the goals of the DO injection are with respect to its trust resources. This clarity by FWS and other resource agencies is needed to judge the likely success of the injection and for the public to weigh the cost of this expensive mitigation feature with respect to its importance and likelihood of success.

Mitigation, Fish (section begins page 29)

28. On page 29, the hole within Middle River should not be characterized a "nursery habitat" but rather more generally as a place where shortnose sturgeon concentrate during certain times of the year and environmental conditions.

Mitigation, Cadmium (section begins page 31)

29. NOAA is deferring to FWS and SC Department of Natural Resources evaluations of the adequacy of the proposed monitoring plan.

Alternatives Evaluation With Mitigation (section begins page 32)

30. The description, in Table 6, of the effects from each mitigation option is limited to salinity and boating access. The COE's reports of the effects of the hydrologic mitigation without DO injection show the hydrologic mitigation also effects DO concentrations, particularly in upper portions of Middle River where DO concentrations are expected to decrease.
31. Table 6 describes open water disposal of dredged material in the sediment basin as a negative impact. Not clear why this action is described in this manner given that open water disposal would be used to construct the plug at the seaward end of the sediment basin.

Alternatives Evaluation With Mitigation, Managed wetlands (section begins page 32)

32. The source of the predictions referenced in Table 7 should be provided. Model predictions for the 47-foot alternative are listed as "estimated," as opposed to actual model runs. The source of these estimates should be provided along with a short description of how the estimation was done.

Alternatives Evaluation With Mitigation, Tidal freshwater wetlands (section begins page 34)

33. The alternative to M2M for evaluating mitigation plans is not well described, ultimately referring to personal communication from the COE. More substantive citations should be given if available.
34. The GIS layers used for calculating the acreages in Table 8 should be made publically available. FWS staff have told us these acreages do not include sea level rise, where as Table 7 says 25 cm is sea level rise is included. Table 8 should be equally explicit on this point.

Alternatives Evaluation With Mitigation, Fish (section begins page 35)

35. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.
36. NOAA agrees that removal of New Savannah Bluff Lock and Dam (NSBLD) is more likely to be a more effective measure than the fish passage currently proposed. As currently proposed the COE's fish passage is not likely to be successful in passing sturgeon to justify its use as mitigation against the much more certain impacts of the harbor deepening. If a fish passage structure is to be used as mitigation for impacts of the harbor deepening there will need to be extensive changes to the proposed design. Even if an effective design can be agreed upon, the fish passage structure would require maintenance and repair in perpetuity. The removal of the NSBLD is our preferred method to allow sturgeon access to upstream habitats. In comparison to the uncertain success and impermanence of the proposed passage structure, removal of the NSBLD would certainly restore access to upriver habitat in perpetuity.
37. Tables 8, 9, and 10 have predictions for a 47-foot alternative, but does not label these predictions as "estimates" as in Table 7. Please clarify.

Alternatives Evaluation With Mitigation, Summary plan evaluation (section begins page 37)

38. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.

Uncertainty and Risk (section begins page 38)

39. As noted before, NOAA and the COE are revising the habitat predictions for shortnose sturgeon, so FWS may want to revise the FWCA Report when those predictions are complete.
40. For the reasons cited in the report, NOAA agrees with FWS that there is a high degree of uncertainty as to how effective the oxygen injection system would be.

41. NOAA agrees with FWS that calculating the impacts to salinity and DO concentrations for the deepening the harbor only to river mile 7 would enhance the evaluations within the Environmental Impact Statement.

Monitoring and Adaptive Management (section begins page 41)

42. While NOAA generally supports the Monitoring and Adaptive Management Plan described in DEIS Appendix D, NOAA believes further elaboration is needed in two areas: (1) the plan should specify criteria for evaluating the success of mitigation measures and should clearly articulate triggers for implementing corrective action as indicated by monitoring results and determined necessary in coordination with the resource agencies and (2) the plan presently proposes to monitor wetlands and marshes for use by finfish but does not include monitoring of invertebrates such as shrimp and crab that are key components of the ecosystem and necessary for NOAA to understand the response of the estuary to the new dynamic equilibrium that will be established following construction.

Recommendations and Position (section begins page 45)

43. Until the impacts of the project to shortnose sturgeon and other resources are better understood, NOAA is unable to make any recommendations about the acceptability of any of the proposed deepening alternatives.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701-5505
(727) 824-5305; FAX (727) 824-5308
http://sero.nmfs.noaa.gov

JAN 25 2011 F/SER

Colonel Jeffrey M. Hall
District Commander
U.S. Army Engineer District, Savannah
ATTN: PD
Post Office Box 889
Savannah, Georgia 31402-0889

Dear Colonel Hall:

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), Southeast Region has received the *Draft Tier II Environmental Impact Statement for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina* (DEIS) and *Draft General Re-evaluation Report for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina* (DGRR). NMFS Southeast Region is a cooperating agency with the Corps of Engineers, Savannah District (COE), for this project under the National Environmental Policy Act, and NMFS is also engaged in consultation with the COE for the project's effects on essential fish habitat (EFH) and endangered and threatened species, under the Magnuson-Stevens Fishery Conservation and Management Act and the Endangered Species Act (ESA), respectively. Further, the Water Resources Development Act of 1999 authorizes the Secretary of Commerce to approve the selected plan and determine that the associated mitigation plan adequately addresses the potential environmental impacts of the project.

Over the last two years NMFS has provided comments on the proposed project, as well as requests for information needed to better understand the potential impacts of the project on NMFS' trust resources. Many of these issues have been addressed through ongoing discussions with the COE, but some key issues remain outstanding. Enclosed we provide comments on the project, based on the DEIS and DGRR, which address project concerns related to EFH and ESA trust resources. We believe these remaining issues need to be resolved, and the resulting revised information incorporated into the Final Environmental Impact Statement. We will continue to work with the COE to seek mutually acceptable resolution of remaining issues.

Of paramount importance to NMFS is assuring the impacts of the project do not threaten the continued existence of the shortnose sturgeon, an endangered species that still persists in the Savannah River. The sturgeon's remaining foraging and refuge habitat is largely

within the Harbor, and the dredging and hydrological changes of the project will degrade large portions of this habitat, rendering it unsuitable for shortnose sturgeon. The two deficiencies of the DEIS and mitigation plan relating to shortnose sturgeon highlighted here are preventing us from fully evaluating project impacts on this species and significantly affecting the adequacy of the proposed mitigation plan.

Habitat Suitability Assessment for Shortnose Sturgeon

The habitat suitability assessment provided in the DEIS for shortnose sturgeon contains inconsistencies and deficiencies, which we have identified in discussions with the COE on multiple occasions. Thank you for your personal involvement in proposing and participating in yesterday's video conference to clarify these issues. We look forward to receiving the information and analyses we requested as soon as possible so we can have a complete assessment of the project's impact to shortnose sturgeon habitat, which is necessary for us to be able to comment meaningfully on the different project alternatives. At this time, we are unable to make any recommendations about the acceptability of any of the proposed deepening alternatives. However, we may offer specific depth recommendations after receiving the information and analyses that we discussed on the call and highlighted in the enclosure.

These inconsistencies and deficiencies in the sturgeon habitat assessment are also preventing us from initiating consultation on the project under section 7 of the ESA. NMFS expects to issue a biological opinion on project impacts within 135 days of the date these issues are resolved.

Mitigation for Sturgeon Impacts at the New Savannah Bluff Lock and Dam

While the impacts of the proposed project on endangered shortnose sturgeon cannot be fully understood prior to completing section 7 consultation, proposed dredging and hydrological changes are expected to have substantial adverse effects on that species' foraging and refuge habitat. Adequately mitigating for this habitat loss will require re-establishing access to habitat above the New Savannah Bluff Lock and Dam (NSBLD). The NSBLD is the lowest dam on the Savannah River and impedes the sturgeon's movement upstream. Because the SHEP is expected to remove downstream habitat, without additional access upstream, overall habitat will be greatly reduced. Access to currently unavailable upstream habitat will mitigate this habitat constriction.

As currently proposed the COE's fish passage is not likely to be successful in passing sturgeon to justify its use as mitigation against the much more certain impacts of the harbor deepening. If a fish passage structure is to be used as mitigation for impacts of the harbor deepening there will need to be extensive changes to the proposed design. Even if an effective design can be agreed upon, the fish passage structure would require maintenance and repair in perpetuity. The removal of the NSBLD is our preferred method to allow sturgeon access to upstream habitats. In comparison to the uncertain success and impermanence of the proposed passage structure, removal of the NSBLD would certainly restore access to upriver habitat in perpetuity. Additionally, cost information we included in our enclosed comments indicates removal would be the less expensive option in the short- and long-term. Such action would be consistent with the

COE Savannah District's recommendation in the September 2000 report on the NSBLD disposition study.

We are aware that, as a Congressionally-authorized structure, the COE would be required to seek Congressional authorization to remove the NSBLD. However, the COE must also seek authorization for the increased costs of the Savannah Harbor Expansion Project. Combining these authorization requests presents an ideal opportunity to redress the environmental damage of the COE's legacy dam while advancing the modern economic benefits of the project.

With respect to the EFH consultation, NMFS believes three key topics of information require further attention, and we request this information be included in the FEIS.

- First, the Ocean Bar Channel Extension is a project feature added relatively late to the project design. One consequence of the feature is that hardbottom habitat may be adversely affected by dredging the channel extension. In addition, additional dredge material will need to be placed in the area of the potential hardbottom dredging impact. To date, the COE has assured NMFS that surveys will be completed of the bar channel extension and that this survey information will be adequate to describe potential impacts of dredging to hardbottom habitat. Further, the areas where the additional dredged material will be placed support important managed species including red snapper. The dredge material has been proposed to be placed and configured in a way that would provide suitable fishery habitat in the impacted hardbottom areas. To fully assess the likely success of this mitigative measure, NMFS requests plans be included in the FEIS for the dredge material placement and configuration as well as information on monitoring the effectiveness and durability of these features.
- Second, dredge material is proposed for placement at a feeder berm near Tybee Island. This material is intended to replenish the beaches of Tybee Island downstream of the feeder berm. To ensure this result is likely, NMFS requests modeling be conducted to demonstrate the likely fate and disposition of the material placed at the Tybee Island feeder berm.
- Third, although considerable progress has been made in developing the Monitoring and Adaptive Management Plan described in DEIS Appendix D, NMFS requests further elaboration in two areas:
  - The Plan should specify criteria for evaluating the success of mitigation measures and should clearly articulate triggers for implementing corrective action as indicated by monitoring results and determined necessary in coordination with the resource agencies.
  - The Plan presently proposes to monitor wetlands and marshes for use by finfish but does not include monitoring of invertebrates such as shrimp and crabs. As key components of the ecosystem and as managed stocks (in the case of white shrimp), NMFS believes it is very important to understand the response of these species to the altered dynamic equilibrium that will be established in the estuary following project construction.

We appreciate the COE's efforts to identify and resolve the many technical and conservation issues associated with this large, complex, and potentially very important project. We will continue to provide interagency coordination on this project under all our authorities and to work with the COE to bring the remaining issues to resolution. Our primary contact for endangered species issues is Ms. Kay Davy. She may be reached by phone at (954) 356-6791 or by e-mail at Kay.Davy@noaa.gov . Questions regarding EFH may be addressed to Pace Wilber at (843) 762-8601 or by e-mail at Pace.Wilber@noaa.gov .

Sincerely,

James E. Weaver

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure

National Marine Fisheries Service (NMFS) Comments on:
Draft Tier II Environmental Impact Statement for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina (DEIS) and Draft General Re-evaluation Report for the Savannah Harbor Expansion Project, Chatham County, Georgia and Jasper County, South Carolina (DGRR)

January 25, 2010

As indicated in our letter dated November 24, 2010, NMFS is conducting a joint consultation pursuant to the essential fish habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act and section 7 of the Endangered Species Act of 1973, as amended, on the Savannah Harbor Expansion Project (SHEP).

Section 7 of the Endangered Species Act (ESA)

NMFS Protected Resources Division has reviewed information included in the DEIS, the DGRR, and subsequent information that has been provided by the Savannah District Army Corps of Engineers (COE). The following comments on the protection of endangered species under NMFS' authority are based on the current information available. We will be providing additional comments with the issuance of the upcoming Biological Opinion.

Affected Species

Sea Turtles

Deepening of the Savannah Harbor Entrance Channel and construction of the Channel Extension will require dredging to be conducted over a long project period. The COE has proposed the use of hopper dredges for the offshore dredging in the project area. NMFS believes the use of hopper dredges over an extended time period greatly increases the chances of impact with sea turtles and may make it necessary to use relocation trawling as an aid in their protection. The revision of the new South Atlantic Regional Biological Opinion (SARBO) is underway and may contain additional measures to be implemented. Regardless of whether or not the SARBO is completed by the time the project dredging is to begin; the COE should be pro-active in its commitment to protect sea turtles. The Biological Opinion to be issued in conjunction with our review of SHEP is likely to provide additional recommendations and estimates on turtle take.

North Atlantic Right Whales

NMFS has strong concerns about the proposed use of hopper dredges and the adherence to speed limits in the project area. The COE provided project-specific information regarding their proposal to adhere to the 10-knot speed restriction and provided a statement that can be found in Appendix B, page 99 of the DEIS. The information states that the COE will adhere to the 10-knot speed restriction for hopper dredges during calving season and adhere to the new South Atlantic Regional Biological Opinion (which addresses vessel speeds), once it is finalized.

NMFS acknowledges the COE's commitment to adhere to the 10-knot speed restriction. However, we note that on page 181 of Appendix B of the DEIS it states: "...hopper dredges will be restricted to 10 knots when loaded with material transiting to disposal areas and to 12 knots when light-loaded returning from disposal areas during the calving season." Subsequent personal communication with staff within the COE's South Atlantic Division confirmed that the vessel speed when loaded and when light-loaded will be 10 knots. The information should be correctly stated in the FEIS to reflect the COE's commitment to adhere to the 10-knot speed restriction.

Recent Proposed Listing of Atlantic Sturgeon

The Atlantic sturgeon was recently proposed for listing. If the listing becomes final before section 7 consultation is concluded, a discussion of the project effects on the species will be included in the Biological Opinion. If a decision has not been reached, Atlantic sturgeon will be included by Conference under section 7 of the ESA.

Since so very little information is known about Atlantic sturgeon in the Savannah River, we will need to make some basic assumptions based on the best available data. It is known that adult Atlantic sturgeon can tolerate high salinities and are often found in the ocean, so we can assume that they would also be found utilizing the entire lengths of the Front, Middle, and Back Rivers. Project effects could impact Atlantic sturgeon. Low dissolved oxygen could limit the availability of acceptable habitat and the proposed hydrological modifications for flow re-routing (i.e., the closure of Rifle Cut and the filling of the Sediment Basin), may have additional impacts on this species as they may not be able to use the Back River for moving between their upriver spawning habitat and their downstream foraging habitat in the estuary. Some of the measures proposed for mitigating impacts to shortnose sturgeon would also be appropriate for Atlantic sturgeon.

Shortnose Sturgeon

Habitat Suitability Modeling

Through extensive prior coordination NMFS has been working with the COE to develop the best modeling of existing habitat of the shortnose sturgeon, use of the most appropriate habitat criteria, and to evaluate potential project effects associated with the different deepening scenarios. During meetings held in 2001 to discuss SHEP, the Fisheries Interagency Coordination Team provided guidance on fisheries issues and developed a conservative set of parameters for modeling habitat suitability for the shortnose sturgeon. The Fisheries Coordination Team determined the conditions (in Appendix P) which the water quality and hydrodynamic models would use to identify acceptable and unacceptable habitat. River flow rates and time of year were also specified. Average river flows were used to represent long term conditions, but additional models were run to represent drought years.

Overall, the habitat suitability maps produced using the habitat criteria indices for adult shortnose sturgeon showed reasonably good agreement with previous field data collected on shortnose sturgeon, however, the maps produced for juvenile sturgeon did not show good agreement between documented habitat, as determined by field research, and the modeled results. In using a conservative maximum salinity index of <= 4 ppt, as developed by the Fisheries Coordination Team, the output excluded documented habitat for the larger juvenile shortnose sturgeon. It is believed this occurred due to the ability of larger juveniles to tolerate salinities higher than 4 ppt, whereas higher salinities have been proven to be detrimental to small juveniles in lab experiments. In order to generate maps that would include available habitat of the large juveniles, NMFS proposed that the maximum salinity index should be increased to <= 14.9 ppt, which was the maximum salinity measured during research conducted by Collins et al. (2001), where large juveniles (measuring 32.3 cm to 47.6 cm fork length) were located. (It is important to note that sampling of smaller juveniles has not been conducted in the lower Savannah River, although they are presumed to occur there.) The COE acknowledged our request to revise the salinity criteria. Once the new criteria were used in the modeling of habitat, the mapped results showed a more accurate depiction of acceptable habitat, particularly in the area of the lower Middle River, which includes a deep hole (~7.9 meters depth) used by large juvenile and adult sturgeon during the winter, and also within the Front River at the confluence with the lower Middle River to above Steamboat Creek.

Ground-truthing of the habitat suitability maps was based on field research conducted in the lower Savannah River, which indicated that large juvenile shortnose sturgeon prefer the Front River from just above the deeper Kings Island Turning Basin to the mouth of Abercorn Creek (located near Interstate 95). During the winter, they also heavily utilize the deep hole located in the lower Middle River and adjacent portions of the Middle River. They have not been documented in the Back River. Within the project area, adult shortnose sturgeon have been found to utilize the entire length of the Front River, the entire length of the Middle River, the uppermost reaches of the Back River, and the Sediment Basin/Tide Gate area within the lower Back River. They migrate upriver to the base of the New Savannah Bluff Lock and Dam for spawning. They have not been shown to use the full length of the Back River and recent tracking data, conducted by The Nature Conservancy, indicates adult sturgeon may enter the Sediment Basin from the lower end of the Back River or access it by traveling through Rifle Cut, which connects the Middle and Back Rivers. According to personal accounts from biologists conducting research in the Back River and a bathymetry map of the project area produced by the COE, there are portions of the middle section of the Back River above Rifle Cut that have depths that may be too shallow for the passage of sturgeon during certain tide stages. Firsthand accounts by these same biologists also report that portions of the Sediment Basin have become too shallow to navigate.

The COE performed analyses using the habitat criteria for the existing conditions (-42 feet) and for the five deepening scenarios (-44, -45, -46, -47, and -48 feet). The models predicted outcomes with and without the proposed flow re-routing and dissolved oxygen injection. (Flow re-routing mitigation was proposed to offset potential impacts to the adjacent Savannah National Wildlife Refuge. It is important to note that over 160 different flow re-routing models were conducted to evaluate the effects of each mitigation plan. The proposed injection of dissolved oxygen as mitigation is addressed later in this document.)

In addition to the modeling runs shown in the DEIS, the COE performed other analyses that included parameters such as high dissolved oxygen loading superimposed on the habitat parameters for adult shortnose sturgeon during the summer and winter and also for large juvenile shortnose sturgeon during winter conditions. Other scenarios included project effects with the deepening only, deepening plus hydrological modifications, and deepening with the hydrological modifications and dissolved oxygen injection. While NMFS appreciates the time and effort by the COE to produce the modeled outputs, there is much uncertainty in the results and maps depicting suitable habitat have conflicting information. This is probably due to the highly complex nature of the modeling design. NMFS remains hopeful that the COE will be able to deliver model outputs that provide accurate predictions of the project effects, but at this time we do not have these products. A preliminary assessment based on information in the tables provided in the DEIS (although they may not be entirely accurate) show that the 47-foot (National Economic Development Plan)and 48-foot (Maximum Authorized Plan) deepening alternatives would result in significant habitat loss for adult shortnose sturgeon during January conditions (439 acres lost) and August conditions (113 acres lost). There would also be loss of juvenile shortnose sturgeon habitat during January conditions (21.6 acres lost). Specific measures to address the predicted loss of foraging habitat for shortnose sturgeon within the project area were not identified in the DEIS.

Some of the proposed flow re-routing modifications include closing Rifle Cut and allowing the Sediment Basin to fill-in. The COE's assessment of the habitat suitability models with the flow re-routing modifications indicate that areas above the Sediment Basin within the Back River will become "suitable habitat" for shortnose sturgeon. However, NMFS is concerned that this is an inaccurate assessment as the elimination of Rifle Cut, which connects the Middle and Back Rivers, coupled with the shallow depth of the Sediment Basin, could result in the Back River becoming a dead end for adult sturgeon trying to migrate between their upriver spawning habitat and downstream foraging habitat. Juvenile shortnose sturgeon already cannot enter through the lower end of the Back River due to the high salinities found there. We have concerns that what the COE is showing as habitat gained in some areas of the Back River (and we are still evaluating usage of the area) would produce an inaccurate assessment of the mitigation effects. While more habitat may be created, that could be classed as "suitable" when based on salinity and dissolved oxygen parameters, it may be located in areas not used by sturgeon or in areas that

will become inaccessible to sturgeon after the flow re-routing modifications have been completed. Therefore, the "gain" would have no value to sturgeon.

COE-Proposed Measures to Address Impacts to Shortnose Sturgeon

Dissolved Oxygen Injection

Measures to address impacts to water quality associated with the project deepening have been proposed. Project impacts include a decrease in dissolved oxygen (DO) levels associated with the increase in channel depth, the increase in the volume of water over the project area, and the decrease in average river velocity, which will reduce mixing of oxygen throughout the water column. With the decrease in DO, the ability of the river system to handle introduced point source and non-point source loads of pollutants will also be decreased. DO typically drops during the summer months in the Savannah River associated with a lower oxygen diffusion rate and a higher uptake from biological organisms.

The area the COE identified as of primary concern for low DO is located between Fort Pulaski and the Seaboard Coastline Railroad Bridge, a length of approximately 27 river miles. This also includes the primary areas identified as important foraging habitat for the shortnose sturgeon within the lower Savannah River. According to the DEIS, model predictions from the SHEP studies indicate that further deepening will have additional impacts on the dissolved oxygen regime in the Savannah Harbor. Using guidance provided by the Water Quality Interagency Coordination Team, the analyses conducted were based on average drought river flow conditions (August 1999). Other sensitivity analyses included average river flows (August 1997) and 2004 point source loads. Project impacts to DO were found to be higher during drought conditions than during average flow conditions. Supplemental model runs provided to NMFS after the publication of the DEIS have shown that when the 2004 point source loads are added to average river flows, there is an additional loss of acceptable habitat in the Front River adjacent to and upriver from the confluence with the lower Middle River. While this is a preliminary assessment and may not be completely based on accurate data, it may show that compounded effects of high point source loads and deepening of the harbor may result in additional loss of habitat for shortnose sturgeon. To offset the decrease in DO associated with the project, the injection of DO using Speece cones is proposed. The injection systems would be located along the banks of the Savannah River at three sites: the Georgia Pacific facility, located above the project area; and at International Paper within the project area on the West and East sides of Hutchinson Island along the Front River and Back River. The systems would be operated during July through September to provide the needed amount of oxygen. The cost to operate the systems would use a large portion of the mitigation budget. NMFS has previously expressed a concern to the COE about whether the on-going cost to operate the systems can be maintained in perpetuity. In its response, the COE stated that funding for any portion or feature of the project, whether

mitigation or navigation, is subject to the normal budgetary process and appropriation by the US Congress. The COE stated they cannot predict or speculate on the amount of appropriations that a future Administration or Congress may provide to operate the Savannah Harbor Navigation Project. Without funds to operate the Navigation Project, the COE said they would have no funds to operate the project's mitigation features. They further stated that failure to operate all aspects of the project as described in the EIS and the Record of Decision (including its mitigation features) would subject the COE to legal challenges that it is operating the project outside its NEPA clearances. NMFS is concerned that the environmental impacts will continue in perpetuity, while the mitigation measures will only be operational as long as funding is available. The COE's record of not providing adequate maintenance of the mitigation features within the Savannah National Wildlife Refuge partially substantiates this concern.

NMFS also questions the efficacy of the injection systems to actually increase DO in the areas of concern. It is critical for the continued existence of shortnose sturgeon that DO remains at levels acceptable to shortnose sturgeon, particularly for juveniles which cannot tolerate low DO, even for short duration. The DEIS states that the injection system has been designed to remove the incremental effect of a deeper channel in 97 percent of the bottom half of the water column. Using the bottom half instead of the deepest layer of the water column for the modeling design may not benefit shortnose sturgeon since they are bottom feeders and they would encounter the lowest DO along the deepest portions of the river. If the current design and placement of the injection system does not provide any benefit for the foraging shortnose sturgeon, its use as a measure to offset impacts to shortnose sturgeon is negated. **NMFS continues to be concerned that this is a very risky operation with a high degree of uncertainty.**

Proposed Sill at Lower Middle River

Recent discussion with the COE has raised concern about the proposed construction of a higher sill within the lower Middle River. A low sill currently exists, but as a measure to block the salt wedge from entering the lower Middle River after the deepening, construction of a higher sill is proposed. It is important to protect the deep hole, which is heavily utilized by shortnose sturgeon, and located just beyond the existing sill, from receiving the higher salinities that will occur with the deepening in the Front River. It was thought that by raising the height of the sill, the heavier, more saline water would be prevented from entering the area surrounding the deep hole. While NMFS believes that construction of the sill could benefit the shortnose sturgeon, **NMFS is also concerned that the maintenance requirements needed to keep the sill functioning properly have not been included in the COE's budget. Monitoring of the sill should also be included in the Monitoring and Adaptive Management Plan.**

Fish Passage at New Savannah Bluff Lock and Dam

While NMFS agrees with the COE that there are impacts to shortnose sturgeon associated with the inaccessibility to spawning habitat above the New Savannah Bluff Lock and Dam and that

providing access to this habitat would benefit sturgeon, we disagree with the proposal to construct a fish passage bypass around the dam, as currently designed. The construction of a bypass facility to pass shortnose (or Atlantic) sturgeon at this site may not be successful. Unlike shad and herring which swim high in the water column and orient to surface currents, sturgeon are primarily found on the bottom and have distinctly different swimming behavior. Shortnose sturgeon may not be able to adapt to the currently proposed facility. The construction of the proposed design for the purpose of passing sturgeon could be a failed venture that would require additional mitigation measures as a part of adaptive management.

According to the COE, the construction of a fish bypass at the New Savannah Bluff Lock & Dam would involve the least cost and would be the most environmentally acceptable method of providing a measure to offset impacts to the shortnose sturgeon. Information on page 65 of Appendix C of the DEIS states that the cost of removing the lock and dam would exceed the cost to construct a fishway. However, the COE did not include the total costs associated with providing fish passage at the New Savannah Bluff Lock and Dam in their estimates. The lock and dam also need extensive repairs and rehabilitation, which in 2001 was estimated to cost approximately $6.8 million. According to the Congressional authorization, fish passage construction and rehabilitation of the lock and dam are linked. The rehab cost ($6.8 M at 2001 prices) plus the estimated cost of fish passage construction ($6.3 M), well exceed the cost of dam removal ($7.5 M). Other costs to consider are the monitoring for detection of sturgeon, the monitoring and maintenance of the fishway, and the construction of a mixing tower to aid in temperature adjustment between the mixing bodies of water. Additionally, there is a need to have a greater flow than the proposed 5 percent attraction flow for shortnose sturgeon. Shortnose sturgeon may require an attraction flow of 10 percent of the available flow during all river conditions. Shortnose sturgeon would require a wider and deeper facility than is currently designed. Additionally, with the recent proposed listing of the Atlantic sturgeon, this species would also need to be accommodated and would require a wider and deeper fish passage facility. In addition to the costs associated with the rehabilitation of the lock and dam, and the upfront costs associated with the construction of a fish bypass and its infrastructure, there would be continual maintenance needed for the bypass and for the lock and dam. There are no proven results that indicate that the COE would maintain the lock and dam as it has not had maintenance provided for a long time. There is also no guarantee that funds would be available to provide needed maintenance of the fish passageway in perpetuity. NMFS recommends that the COE re-address the cost estimates to better reflect all of the associated costs involved in construction and maintenance of the fish bypass and lock and dam.

The regional resource agencies were recently contacted (on October 1, 2010) by the COE to provide input on the proposed fish passage design. The responses received from the agencies clearly indicated that there is concern about the design and that the best alternative would be removal of the lock and dam. Comments provided about the design emphasized the lack of its

proven effectiveness to pass sturgeon. Previous comments provided to the COE by NMFS explained how a single miscalculation or any combination of the various attributes of the design could cause it to fail. For example, a lack of adequate water flow, an inadequate attraction flow to direct sturgeon to the bypass, wrong placement of boulders or resting places within the bypass, the wrong slope of the rock ramp, or inadequate depth and width characteristics could contribute to the structure not being successful in passing sturgeon.

From a risk management perspective, NMFS continues to strongly support removal of the lock and dam and believes this is the best and most meaningful mitigation offered that will result in a benefit for the endangered shortnose sturgeon.

Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act

The NMFS Habitat Conservation Division has reviewed the DEIS, the DGRR, and information subsequently provided by the COE. With the exceptions noted below, these documents and information provide sufficient information to complete the EFH consultation and to develop appropriate EFH conservation recommendations.

Project Impacts

Entrance Channel (Ocean Bar Channel) Deepening and Extension
In November 2009, the Savannah District first advised NMFS of the need to extend the Ocean Bar Channel seaward of station -60+000B (this station marks the seaward limit of the existing channel). The length and dredging needed for this extension depend on the project depth (DEIS Table 3-1). Under the locally preferred plan (LPP), the channel would be lengthened 38,600 feet and require approximately 4,212,500 cubic yards of dredging (DEIS Table 3-9). This material would be disposed at two locations, referred to as "Site 11" and "Site 12" in the DEIS, and configured in a manner to serve as an artificial reef attractive to fish. Within the footprint of the existing Ocean Bar Channel (i.e., landward of station -60+000B), 9,113,013 cubic yards would be dredged. This material, along with some additional material from near the harbor entrance, would be placed in seven to nine nearshore areas (DEIS Section 3.07 and Section 5.13) near Tybee Island. Currents and waves would separate sandy material from silty material, remove the silty material from the area, and transport the sandy material onto the beach at Tybee Island.

As indicated in past correspondence with the COE (most recently September 9, 2010 and November 24, 2010) NMFS Habitat Conservation Division requests additional information to complete evaluation of this portion of the project as it is currently proposed, including:

- Surveys for hardbottom habitat within and near the Ocean Bar Channel extension, Site 11 and Site 12;
- Designs for the mounds that would be constructed at Sites 11 and 12;
- Projections of the design life of the mounds at Sites 11 and 12 along with descriptions of any maintenance that would occur;

- Monitoring plans for evaluating the success and durability of the mounds at Sites 11 and 12 and descriptions of how monitoring results would inform maintenance of the mounds and determine if corrective actions are needed, should the mounds not perform as designed;
- Clarification on the projected use of Sites 5 and 6, which are shown in figures (e.g., Figure 3-2) describing the nearshore placement areas but which are not discussed in the text;
- Verification that hardbottom habitat does not occur in or near the nearshore placement areas;
- Estimates of the amount of material expected to be transported to the beach from the nearshore mounds near Tybee Island and descriptions of the fate of the remaining material (e.g., will the eroded fine material affect borrow areas used for traditional beach nourishment projects);
- Discussion of the feasibility of placing material during winter months only into the nearshore mounds to avoid impacting benthic communities during periods of peak production and foraging by fishery resources;
- An element of the Adaptive Management Program that focuses on monitoring the nearshore placement of dredge material to evaluate the success of nearshore placement, assesses the impacts from the placement, and describes how monitoring results would inform maintenance and guide corrective actions, should the mounds not perform as designed.

While this additional information is needed for the NMFS Habitat Conservation Division to complete its evaluation, we offer below some general comments. Given the past and previous detrimental effects of the navigation channel on the beaches of Tybee Island, the NMFS Habitat Conservation Division supports plans to ameliorate those impacts. Assuming the dredged material from the extension of the Ocean Bar Channel is beach quality, the surest manner to address the impacts at Tybee Island would be to place the material from the channel extension directly onto the beach at Tybee Island. Dredged material from more landward areas that is not of sufficient quality for direct beach placement could be placed into the offshore dredge material disposal site. If the upcoming surveys of the Ocean Bar Channel extension show hardbottom habitat would be impacted by the project, these impacts could be addressed via options such as the State of Georgia's artificial reef program. However, if the COE is committed to disposing material at Sites 11 and 12 in manners that may provide suitable fish habitat, NMFS will work with the COE on the design of the mounds and the monitoring that will gauge effectiveness and inform maintenance decisions.

Monitoring and Adaptive Management

By letter dated July 31, 2009, NMFS provided the COE with a detailed review of the adaptive management program and the monitoring needed to implement the program. DEIS Appendix D provides a revised plan for the adaptive management program. While the revised plan provides some additional detail on the monitoring and includes an updated budget, principal omissions from the last review remain in the current version of Appendix D:

- The plan does not provide explicit criteria for evaluating the success of mitigation measures or triggers for initiating corrective actions. The plan should include a mechanism that ensures results from monitoring feed into operation of the dredges and the oxygen injection system. Also, the success criteria and triggers would need to take into account expected rates of sea level rise and the new hydrodynamic regime that would be established in the estuary as a result of project construction.

- The plan does not include monitoring of the marshes for use by crabs, shrimp, and other invertebrates that provide the forage base for fishery species. We do note, however, that since our letter from July 2009, the COE has added fish monitoring of the marshes, but only for the post-construction phase of SHEP. Monitoring for fish and invertebrates should be conducted in synchronization with the marsh vegetation monitoring.

USACE Responses
Final Fish and Wildlife Coordination Act Report
March 2011

Recommendations:

Recommendation #1: Determine project impact and formulate mitigation by comparing predicted with-project conditions immediately after construction (rather than an average annual) to base year conditions.

USACE Response: Concur. ER 1105-2-100 states "Ecosystem outputs are not discounted, but should be computed on an average annual basis taking into account the outputs achieved are likely to vary over time". The District has requested a waiver of the requirements of ER 1105-2-100, and approval is expected. Mitigation would then be based on the impacts that would occur at the time of construction.

Recommendation #2: Eliminate the "advance mitigation" proposal by the Corps for acquisition and additional restoration on site 1S. Restoration of Site 1S could be limited to the amount needed to offset construction.

USACE Response: Restoration of 40.3 acres of marsh within Disposal Area 1S exceeds the construction project's mitigation requirements (28.75 acres). Periodically, operation of the existing Savannah Harbor Federal Navigation Project adversely impacts small amounts of brackish and saltmarsh wetlands through activities conducted at the project's confined disposal facilities. When such instances are anticipated, the District develops mitigation to compensate for the impacts. Coordination with the USFWS and the Wetland Interagency Coordination Team have identified the potential for restoration of roughly 40.3 acres of brackish marsh at Disposal Site 1S. Such restoration agrees with the goals of the USFWS and the Savannah National Wildlife Refuge to restore Refuge lands to more ecologically valuable conditions, when possible. Restoration of Disposal Site 1S is the best potential brackish marsh restoration activity in the estuary. In the future, the Corps would likely request approval from the Service to complete the remaining restoration of the site if it does not complete that work if/when harbor deepening occurs. Restoration of the entire site at one time would be better for the environment (and the Refuge) than would construction in that area on multiple occasions. The Corps proposes to restore the entire site at one time and considers the acreage that it restores beyond the project's initial mitigation requirement as advance mitigation solely for the Savannah Harbor Federal Navigation Project. Performing mitigation in advance of an impact is generally preferred by natural resource agencies. The Corps is required to perform its mitigation prior to, or at the same time as the activity that causes the impact. Since the Corps would use the advance mitigation to compensate for future impacts resulting from the same overall project - the Savannah Harbor Navigation Project - this would not be a mitigation bank. The advance mitigation acreage would not be available for use by others or for other projects. Instead, it would be reserved for Federal Government use as wetland mitigation solely for the Savannah Harbor Navigation Project. Outside interests could not purchase the advance mitigation. As a result, the 11.55 acres to be restored at Disposal Area 1S that exceed the requirements of the Savannah Harbor Expansion Project are not a mitigation bank.

Recommendation #3: Complete repair of the Savannah NWR freshwater supply system prior to harbor deepening construction.

USACE Response: Concur. The repairs on the Federal lands are underway and are scheduled to be complete in 2012, well before harbor deepening would occur.

Recommendation #4: Initiate mitigation land acquisition no later than initiation of harbor construction in a timely manner (within two years of start).

USACE Response: Concur. The project would begin acquiring the preservation lands the first year that Congress provides construction funds. It is the Corps' and GPA's intent to complete the acquisition within the first two years, but that may not be possible because of a number of actions that would need to be completed. The acquisition requirements include completing various real estate actions such as appraisals, Environmental Baseline Surveys, etc. Discussion to this effect has been added to the Mitigation Plan (EIS-Appendix C).

Recommendation #5: Install a fish passage facility at the New Savannah Bluff Lock and Dam or remove the dam to restore the river. Continue coordination with resource agencies to optimize design of any fish passage facility.

USACE Response: Concur. Removal of the New Savannah Bluff Lock and Dam cannot be recommended at this time. Although the Lock and Dam is no longer used to support navigation on the Savannah River, most recent direction from Congress was for the Corps to rehabilitate the structure and convey it to local interests. As a result of additional coordination with the natural resource agencies, the Corps has revised its proposal for passage of Shortnose sturgeon at the New Savannah Bluff Lock and Dam. The mitigation identified in the FEIS is the construction and operation of an Off-Chanel Rock Ramp that would provide access around the dam to historic spawning areas upriver at the Augusta Shoals.

Recommendation #6: Transfer Corps striped bass stocking program funding to GADNR when harbor construction is initiated in order to provide enough lead time to develop stocking capacity.

USACE Response: The schedule has been revised to reflect that funding for Striped bass stocking would be made available to the Georgia DNR before dredging occurs in the inner harbor. The Corps believes this meets the intent of the recommendation by providing time for GA DNR to expand its stocking capacity before the impacts would occur and the additional stocking is needed.

Recommendation #7: Continue coordination with the USFWS to define the scope of vegetation, wildlife activity and bird tissue monitoring in the CDFs 14 A and 14B.

USACE Response: Concur. The Corps has coordinated extensively with the USFWS after the DEIS to refine the monitoring that the Corps would perform at CDFs 14 A and 14B. The plan included in the FEIS reflects the agreements made between the Corps and the Service.

As an overview, the District would perform the following actions:

All cadmium-laden sediment from Stations 6+375 to 45+000, 51+000 to 57+000, and 80+125 to 90+000 would be placed in CDF's 14A and 14B. Material would be placed so that it remains covered with water until after placement of the cover is complete. This material would not be allowed to dewater and/or desiccate until after the cover has been placed and cadmium levels in the surface sediments of the CDF are less than 4 mg/kg. Samples would be taken of the inflow (head section of dredge discharge pipe) during placement and analyzed for cadmium. The Corps would perform monthly biological sampling (wildlife and avian use abundance surveys) in CDFs 14A and 14 B. This monitoring would be performed during and after (for 3 years) sediment placement to provide a record of wildlife and bird use of these CDFs.

Following placement of all the cadmium-laden sediments within a CDF, grab samples would be collected to characterize the cadmium levels of the surface sediments. This would occur prior to placement of the sediment cover. Eighty-six (86 grab) samples would be collected from a depth of 15 cm. Samples would be evenly spaced across the CDF and analyzed for cadmium concentration on a dry weight basis.

A cap/cover of sediments obtained from areas of the channel where concentrations of cadmium are believed to be 4 mg/kg or less would be placed on the sediments in the CDFs. Following placement of the cover, eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If the analysis of the sediment samples taken from the cover indicates that concentrations of cadmium are less that 4 mg/kg, monitoring of the cover would be complete.

If the analysis of the sediment samples taken from the cover indicates that concentrations of cadmium are equal to or exceed 4 mg/kg in a cumulative area of 25 acres or more of the capping/covering layer, then three actions would be initiated. **First**, the CDF would be kept flooded to keep the sediments wet/moist. Second, the CDF would receive a cover of O&M sediments at the earliest possible time. The **second** action is the sampling (86 grab samples) of the CDF surface sediments (to depth of 30 cm) and their analysis for cadmium. The process of placing O&M sediments into the CDF and testing for cadmium would be repeated until cadmium concentrations in the surface sediments are less than 4 mg/kg.

Third, biological monitoring would be conducted (monthly) to determine which avian and wildlife species are frequenting the CDFs. If there is concern about the number of birds or animals or a particular species using the CDFs, then some type of hazing may be appropriate. Vegetation sampling would be conducted on a quarterly basis. Vegetation sampling would be conducted in defined "hot spots" to determine the potential for cadmium uptake by plants. Samples collected from CDFs 14A and 14B would be compared to control samples from other, cadmium-free environments found in adjacent CDFs. If

vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation.

Independent of the concentrations of cadmium on the cap/cover, the Corps would perform monthly biological monitoring of birds that use CDFs 14A and 14B during and after sediment placement. Cadmium levels in tissue samples would be evaluated. Blood or feather samples may be used as an alternate procedure if this procedure appears practicable and the Corps and the USFWS both agree. Appendix M describes the plan for bird sampling protocols which take into account the hydrologic condition of the CDFs (wet or dry) and the season (since these conditions greatly influence the avian species that use the CDFs). A reference CDF would also be sampled as background. This sampling would continue during dredged material placement activities and for 3 years after placement is complete.

The effluent from all CDFs would be monitored during dredging operations. The effluent from CDFs 14A and 14B would be specifically monitored for cadmium. Sampling (weekly) would be conducted to determine the cadmium concentrations in the effluent discharged from CDFs 14A and 14B. Monitoring of the effluent from CDFs 14A and 14B would continue as long as a discharge occurs and until all sediments have been covered, dewatered, and stabilized. Following the installation of a clean cover, cadmium would be monitored in the effluent on a monthly basis for one year.

Recommendation #8: Add station 021989784, located at the intake of the freshwater supply system on Savannah NWR, as a long-term monitoring station.

USACE Response: Operation of the continuous water quality monitoring station at the intake to the SNWR is already funded by the Georgia Ports Authority.

Recommendation #9: Continue coordination with resource agencies to develop a data analysis and information system delivery plan as part of the monitoring program.

USACE Response: Concur.

Recommendation #10: Increase post-construction wetland and continuous water quality monitoring from five years to ten years and prepare a consolidated report of the various monitoring programs at the end of five years, and again at the end of ten years following project construction.

USACE Response: Concur. The post-construction monitoring period has been extended to ten years, with a focus on critical natural resources. The wetland monitoring aspects of the post-construction monitoring plan have been extended from five years to ten years. Monitoring of the wetland aspects of the project (12 marsh sites) would be extended to ten years, although sampling would not occur every year. Reports would be prepared on the monitoring of the 12 marsh sites at the end of the fifth year and again at the end of ten years. The final report would be a comprehensive report that discusses the entire monitoring period. Annual reports would be prepared to discuss the results of the marsh restoration effort in Disposal Site 1S. A comprehensive report would be prepared at the end of monitoring year 7 to

discuss the overalls success of the marsh restoration efforts in Disposal Area 1S, including any measures recommended to complete the project.

The post-construction monitoring plan has also been revised to provide for operation of the continuous hydrologic and hydraulic data recorders for ten years. This monitoring data would be used along with the hydrodynamic and water quality models to assess how the project and its mitigation features are performing. The performance (accuracy) of the models would be assessed during pre-construction monitoring and post-construction monitoring and recalibrated, as necessary. This repetition in modeling assessment/recalibration would improve their predictive accuracy by decreasing their range of uncertainty. The Corps and the natural resource agencies would use the modeling data (after the post-construction assessment/calibration) and compare it to actual field results to evaluate whether the project is performing as expected. This assessment would be conducted once per year during the ten years of post-construction monitoring.

Recommendation #11: In the adaptive management plan, describe in greater detail how baseline conditions will be developed for the various monitoring parameters. Make maximum use of existing long-term water quality stations and all planning biological studies. If construction is delayed for more than 1 year after a decision for harbor expansion, continue pre-construction monitoring until construction begins.

USACE Response: Concur. The Corps would use all available data in establishing the pre-construction database. The compilation of a Savannah Harbor data base has been added as an element of the pre-construction monitoring. One year of monitoring would be conducted before dredging starts in the inner harbor.

Recommendation #12: Modify the monitoring and adaptive management plan to include a striped bass habitat assessment during the fourth year of post-project monitoring. If the post-project impacts are higher than pre-construction predicted habitat impacts then increase funding for striped bass stocking in proportion to the impact.

USACE Response: Concur. The Corps agrees that a post-project assessment of Striped bass habitat using the most recent water quality monitoring data and updated water quality simulations would be appropriate. This assessment would be conducted during years 2, 4 and 9 of post-construction monitoring.

Recommendation #13: Modify the adaptive management plan to specify that establishment of native wetland plants is necessary for successful restoration. Include specific monitoring and management protocols to detect and control exotic and invasive species. Continue coordination with USFWS and other interested agencies during planning, construction and monitoring of restoration site 1S.

USACE Response: Concur. The wetland mitigation plan has been revised to include monitoring of invasive species at the restoration site on Disposal Site 1S and an invasive species control program that could be implemented, if required. The details of these plans would be developed (in coordination with the USFWS) during the preparation of plans and specifications for the project. The Cooperating Agencies and the natural resource agencies would all have access to the monitoring reports for this site.

Recommendation #14: Compress the adaptive management decision making process so that final decisions on corrective actions are reached within 1 year after the monitoring period.

USACE Response: The Corps concurs that decisions on the need to implement adaptive management measures should be made in a timely manner. As proposed, the Corps would have one year from the end of the post-construction monitoring period to prepare a report that summarizes the results of all of the monitoring reports, analyzes and discusses what the results of the monitoring data mean, assesses the need for the implementation of any adaptive management measures, and identifies the exact modifications that should be made to the mitigation features, if required. While the Corps will make every effort to prepare this report as expeditiously as possible, it is doubtful that a report of this nature and scope can be prepared in a much shorter timeframe.

Recommendation #15: In the adaptive plan, modify the performance goal for salinity in the range of 1-5 ppt to +/-10% (not =/-0.5ppt) to make it more consistent with other goals and triggers for adaptive management.

USACE Response: Appendix D was revised to include the suggested goal for salinity predictions. While this goal may not be achievable, modelers would strive to achieve this objective.

Recommendation #16: Perform three years of post-construction monitoring of any implemented adaptive management actions.

USACE Response: The document has been revised to indicate that two years (versus one) of monitoring would be conducted for any adaptive management action. The Corps believes that two years of monitoring would generate sufficient data to determine the performance of the adaptive management measure.

Positions:

Position #1: The USFWS's preferred alternative for deepening Savannah Harbor is the 45-foot alternative. This alternative 1) minimizes the loss of already limited freshwater tidal wetlands; 2) minimizes impacts to Savannah NWR; and 3) minimizes risk and uncertainty of impacts on fish and wildlife resources.

USACE Response: The Corps recognizes the USFWS's preference for the 45-foot project alternative because it would result in fewer adverse environmental impacts.

Position #2: Any additional economic benefits resulting from the LPP relative to the NED Plan would represent local benefits. By contrast, the additional environmental impacts associated with the LPP, and in particular the loss of an additional 114 acres of already scarce and declining freshwater tidal wetlands, would occur on a national resource, the Savannah NWR. The additional 114 acre of impact to freshwater tidal wetlands associated with the LPP represents a 50% increase in impacts over the NEDs plan's depth. For this reason, the USFWS does not support the LPP.

USACE Response: Additional Federal economic benefits would be gained with the 48-foot alternative over what would be gained with the 47-foot alternative. The Corps recognizes the USFWS's opposition to the 48-foot project based on the additional impacts to tidal freshwater marsh and the SNWR.

Position #3: As currently proposed, Corps funding for adaptive management activities that may be required will be dependent upon the Corp' annual appropriations process. Because these adaptive management actions may be essential to correct mitigation deficiencies and insure that impacts to fish and wildlife trust resources are offset, contingency funding for any required adaptive management activities needs to be assured, and not dependent upon annual appropriations.

USACE Response: The Corps' budget process does not permit requesting funds for contingencies. Construction funds (including monitoring and adaptive management activities) would be appropriated by Congress as the need is identified and the funds can be spent. The Corps would obtain funds for the SHEP through its established budget process. The Corps considers monitoring and adaptive management to be mitigation features, so they would be treated as "general navigation features" and budgeted along with the funds for channel deepening. The Corps would consider the project to still be in "Construction" until the end of the monitoring and adaptive management period. The Corps expects the Record of Decision to state that approval of the project is conditioned on performance of the monitoring and adaptive management aspects of the project. That procedure is a method identified by CEQ in their 14 January 2011 guidance titled "Appropriate Use of Mitigation Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact" as being sufficient for a Federal agency to ensure that the monitoring and adaptive management would be performed.

The State of Georgia has indicated that it would place its share of the Adaptive Management costs in an escrow account so they would be available if/when needed. The District intends to obtain its share of the Adaptive Management costs at the same time as the funds for the dredging work are obtained. By obtaining the funds as the construction progresses, they would be available to make adjustments to the project's mitigation if/when needed. In this way, all the funds identified in the final project documents for Adaptive Management would be obtained by the time the dredging is complete.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX F: Cultural Resources

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

(Revised July 2012)

US Army Corps
of Engineers
Savannah District
South Atlantic Division

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EDITOR'S NOTE: The underlined portions of the document that have been updated since the January 2012 version.

CSS *Georgia* Mitigation

1. INTRODUCTION

The CSS *Georgia* was a Confederate ironclad built in Savannah in 1862. The vessel spent the war anchored in the Savannah River and served as a floating battery that guarded the channel (Figure 1). The vessel was a major reason why the city was not taken by sea. Confederate forces scuttled the vessel in December 1864 to avoid capture by Union forces. Some salvage was conducted in 1868. The vessel was listed in the National Register of Historic Places in 1987 at the national level of significance for its architecture, association with significant events, association with significant individuals, and archaeological research potential.

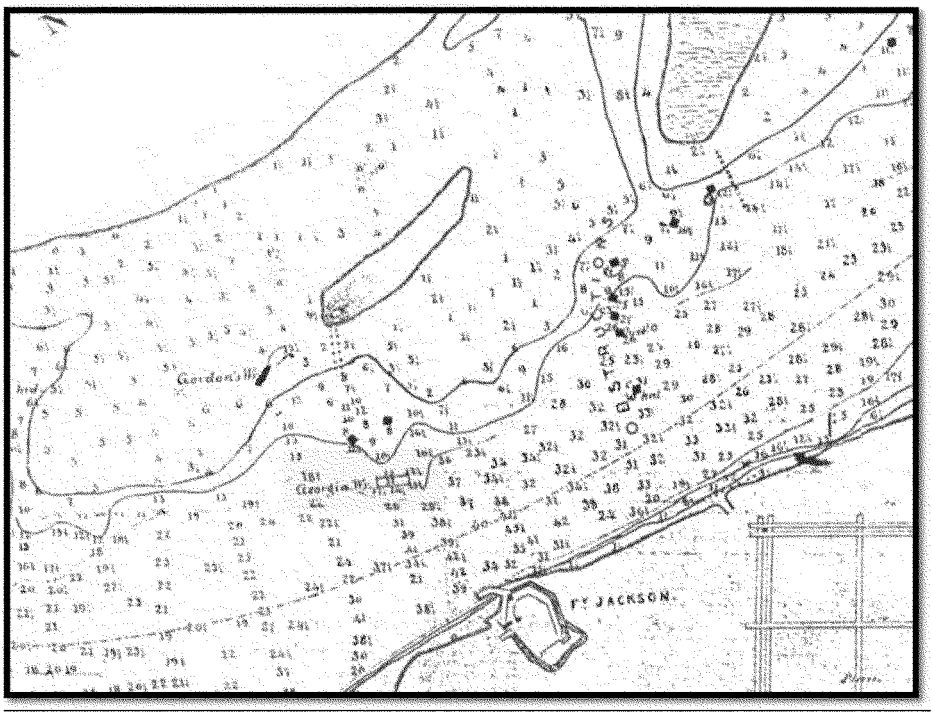

Figure 1. 1971 Gillmore and Ludlow map showing the wreck site located on the edge of the channel, opposite Fort Jackson, in approximately 20 feet of water (as presented in Swanson & Holcombe 2003:96).

2. PREVIOUS IMPACTS AND INVESTIGATIONS

2.1. Late 19th Century

From 1862 until December of 1864, considerable efforts were made to secure the eastern approaches to Savannah using river obstructions as well as shore batteries. The CSS *Georgia* was just one of many types of obstructions placed in the river during the Civil War. After the war ended, cribs and other obvious obstructions were removed from the River. Conversely, the CSS *Georgia*, resting in an unmarked location on the river bottom, remained, and was forgotten until struck in 1866 by the ship *Lizzie Baker* (Swanson and Holcombe 2003).

Recognizing the vessel and other hidden obstructions as potential threats to navigation, the Treasury Department issued two contracts to remove the *Georgia* and sunken properties downstream, as well as any remaining cribs. It was reported that dynamite was used at the wreck site in 1868 to remove portions of the vessel, apparently unsuccessfully. The 1872 Report of the Chief of Engineers noted that the wreck site had already created a sand bar and that the site was covered by 11 feet of water at low tide. As a result of the salvage work, at least 80 tons of the railroad iron were removed, but not the engines and other machinery (Garrison et al 1980). The Office of the Chief of Engineers determined the wreck was not a hazard to navigation and it remained in place and was soon forgotten.

2.2. Mid 20th Century

From roughly 1930 to 1960, annual cross sections of the navigation channel documented an obstruction at the wreck site protruding from the surrounding sediments. The top of the obstruction was at elevation –19 feet. The surrounding sediments were at about elevation –29 feet. When the channel was being widened by 100 feet in 1968, a contract dredge encountered the remains of the CSS *Georgia*. Railroad iron that made up the *Georgia*'s casemate became entangled in the cutterhead and portions of the vessel were impacted and strewn along the channel bottom. The wreck was left on the side slope and marked with a buoy. In the early 1970s, the design for a proposed sediment basin entrance channel was realigned to avoid cutting through the center of the wreck site. The revised design impacted one end of the vessel slightly. This action predated the establishment of the Georgia State Historic Preservation Office and passage of Public Law 93-291, which granted Federal Agencies the authority to expend funds for investigations and mitigation of cultural resources.

2.3. Late 20th Century

In 1979-1980, Savannah District contracted with Texas A&M University to perform historical and archaeological investigations to determine the significance and character of the site and identify potential mitigation alternatives (Garrison et al, 1980). Their studies found that the vessel was located in the side slope and was being impacted by Operations and Maintenance (O&M) dredging. The investigators found the vessel to be still largely intact, with the hull buried in sediments (Figure 2). The contractor recommended a five-phase recovery plan which included the construction of a cofferdam. The highest elevation of the wreckage was –29 feet.

The navigation channel bottom was at –38 feet. The design of the recommended cofferdam was completed in 1982, but no further work was performed due to the expected cost of the cofferdam.

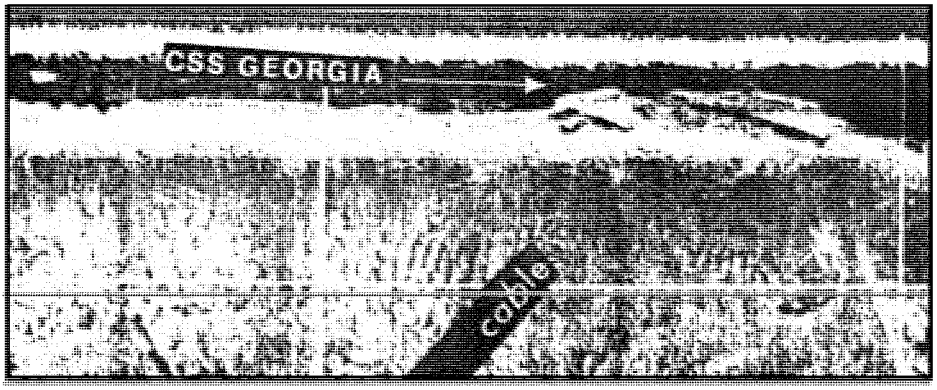

Figure 2. Acoustic image showing large sections of wreckage thought to be the West and East Casemate sections (as presented in Garrison et al. 1980: Figure 39).

In 1983, the District initiated advance maintenance dredging in Savannah Harbor in the vicinity of the CSS *Georgia*. Because this was determined to be a minor alteration to harbor maintenance activities, no environmental document was prepared and no historic preservation coordination was conducted. Dredging at the site included maintenance of the full channel width, 4 feet of advance maintenance, and box cutting 20 horizontal feet into the side slope. The dredge again encountered the wreck, and ordnance and other artifacts were recovered from the disposal area. There was a major change at that time in the wreck topography, with sonar showing dredge scars within the wreck site. In 1984, District divers recovered live ordnance and two cannons from the bottom of the navigation channel.

During the period 1984-1993, no maintenance dredging was conducted in the navigation channel bottom within 100 feet of the wreck site, but the throat of the sediment basin continued to be dredged. Although that operation impacted some of the wreckage, it was determined that not dredging the throat caused water exiting Back River to cut a channel behind the wreck. The District continued monitoring the wreck site using side scan sonar and hydrographic surveys and found that the elevation of the wreck site was becoming lower and the soft sediments that covered the center of the site were disappearing (Figure 3). During the period 1991-1993 the District locked open the Tide Gate and closed New Cut, thereby altering flows in the Back River, across the CSS *Georgia*, and in the navigation channel in Savannah River. It was at this time that the District entered into a Programmatic Agreement with the states of Georgia and South Carolina and the Advisory Council on Historic Preservation which included the requirement to determine past, present, and future impacts to the wreck site resulting from O&M activities and to mitigate such impacts.

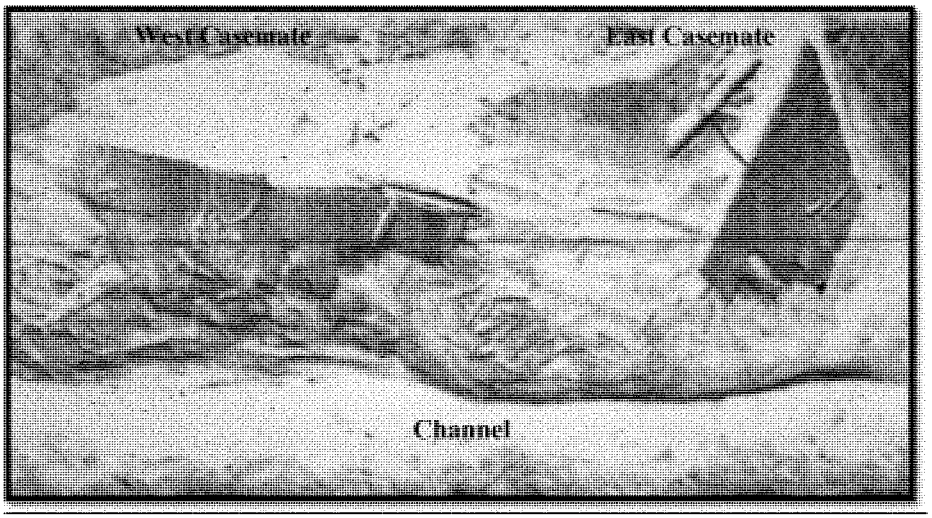

Figure 3. 1986 sidescan image of the *Georgia* wreck site (US Army Corps of Engineers, Savannah District).

During the period 1991-2003, no O&M funding was available to implement the studies required by the 1991 Programmatic Agreement. No maintenance dredging was conducted in this channel segment; however, hydrographic and sonar surveys showed continued deflation of the site.

During 1993 and 1994, the District deepened Savannah Harbor from 38 feet to 42 feet MLW. Since the navigation channel depth in the area of the site was already below 42 feet, and no new work dredging or O&M dredging would be required in that location, it was determined that harbor deepening would have no effect upon the wreck site. The District discontinued dredging the entire 500-foot channel width in the wreck site vicinity, implementing a 100-foot offset in the immediate vicinity of the CSS *Georgia*. The DMMP includes this prohibition of dredging in the immediate vicinity of the CSS *Georgia* as long as the vessel remains in place on the channel side slope.

2.4. Synopsis of Impacts

Past harbor activities have severely impacted the wreck site. The greatest recent impact came from the 1983 dredging, which consisted of 4-feet of advance maintenance and box cutting into the side slopes. Locking open the gates of the Tide Gate altered flow patterns in the vicinity of the CSS *Georgia*, scouring protective sediments from the wreck site. All sediments have been removed and the remaining wreck portions lie exposed on the impermeable Miocene clay layer. Dredge scars from the 1983 dredging event are carved into the Miocene clay on portions of the site. The top of the wreckage was at elevation –28 feet in 1980 and it is now at –38 feet. Loss of the covering sediments allowed marine borers to destroy the wooden portions of the vessel. All

that remains are the larger metal artifacts including portions of the broken up steam plant, a propeller, cannons, ordnance, etc. While severely impacted, the site still meets National Register listing requirements. With the exception of the Sediment Basin throat, no dredging has recently been conducted within 100 feet of the wreck site and normal maintenance dredging occurs within this immediate area.

3. EFFORTS TO MITIGATE EFFECTS TO CSS *GEORGIA*

Section 106 of the National Historic Preservation Act of 1966 (P.L. 89-655, as amended) states that Federal Agencies will take into account the impacts of their actions on historically significant resources. To do this, Savannah District has executed various agreement documents. The paragraphs below describe those agreements.

3.1. 1991 Programmatic Agreement

In 1991, Savannah District entered into a Programmatic Agreement (PA) to identify, evaluate, and mitigate impacts to Historic Properties as a result of the New Cut Closure Project. That agreement also required Savannah District to determine past, present, and future impacts of the existing Savannah Harbor Project upon the CSS *Georgia*. As part of this agreement, the District was to comply with the following stipulations:

a. The CSS *Georgia* is listed in the National Register of Historic Places (1987) at the national level of significance; therefore, the Savannah District shall identify and evaluate alternatives to avoid and/or mitigate adverse effects to such properties in accordance with 36 CDR 800.5(e).

b. The Savannah District shall also ensure that data recovery plans are developed in consultation with the GASHPO and SCSHPO for the recovery of archaeological data from properties determined eligible for inclusion in the National Register of Historic Places.

c. Further, as part of the Programmatic Agreement, and in consultation with the Council, the GASHPO, and the SCSHPO, Savannah District will prepare a Memorandum of Agreement (MOA) to outline procedures for identifying, evaluating, and mitigating and or removing adverse effects of the Savannah Harbor Navigation Project upon the CSS *Georgia*, a property listed in the National Register of Historic Places.

The MOA was prepared in 1996 (see following section). The required studies were initiated in 2003 and finalized in 2007 (Watts and James).

3.2. 1996 Memorandum of Agreement

In 1996, the District prepared a MOA for the CSS *Georgia*. In that document, the District committed to develop a mitigation plan to minimize the adverse effects on the CSS *Georgia* resulting from construction or maintenance of the Savannah Harbor Navigation Project. This

MOA was part of the Long Term Management Strategy (LTMS), August 1996, for which a Record of Decision was signed by the Division Commander in February 1997. There were two specific requirements stated in this document, which when completed, would satisfy Savannah District's Section 106 responsibilities for identifying, evaluating, and mitigating effects of the Savannah Harbor Navigation Project upon the CSS *Georgia*.

a. The first requirement in the MOA was to identify the present condition of the vessel.

b. The second requirement was to look at the contributing effect of the construction and/or maintenance of the Savannah Harbor Navigation Project on the CSS *Georgia*.

Once the above two requirements were carried out, the MOA states that Savannah District would implement the following:

- The Savannah District would identify and evaluate alternatives to eliminate, minimize, and retard the Savannah Harbor Navigation Project's contribution to factors which may threaten the vessel's present condition or stability.
- Savannah District would develop a mitigation plan to minimize the adverse effects on the CSS *Georgia* resulting from the construction or maintenance of the Savannah Harbor Navigation Project, in accordance with 36 CFR Part 800.5.
- The District's studies, study results, evaluations and determinations would be documented in a report. The report would include a discussion of the present condition of the vessel, factors which may threaten the vessel's present condition, adverse effects which construction and/or maintenance of the Project has had on the vessel, and restrictions which the vessel has on present harbor operations, the merits, efficacy, and projected costs of each alternative, and make recommendations as to the optimal alternative(s). The results and recommendations are found in the Watts and James 2007 report.
- Savannah District would implement the recommended plan, subject to the availability of funds.

The 2003 investigation fulfilled the stipulation of the MOA to identify the present condition of the vessel and assess the adverse effects of construction and/or maintenance of the Savannah Harbor Navigation Project on the wreck. Based on that report and other information, the District concluded that construction and/or maintenance of the Savannah Harbor Navigation Project has contributed to the degradation of the CSS *Georgia*. Since the Savannah Harbor Expansion Project was under evaluation when the studies were finalized, the District did not implement the recommended mitigation plan for the CSS *Georgia*.

4. 2003 INVESTIGATIONS OF THE CSS *GEORGIA* FOR THE SAVANNAH HARBOR EXPANSION PROJECT

4.1. Site Assessment

Savannah District contracted with Gulf Engineers and Consultants, Inc. to conduct in-situ archaeological investigations of the wreck site (Watts and James 2007). A separate archival

research project was contracted to New South Associates (Swanson and Holcombe 2007). The work was jointly funded by the Savannah Harbor Expansion Project and the Savannah Harbor Navigation Project (O&M). The objectives of the in-situ investigation were to characterize and delineate CSS *Georgia* wreck site using remote sensing data, ascertain the current (i.e., 2003) state of preservation, compare present (i.e., 2003) and past site conditions, provide an interpretation of site features using historical documents, identify current (i.e., 2003) and future impacts from the existing navigation project, vessel traffic, natural process and the potential deepening project and review alternatives and recommend a course of action and methodology for mitigating impacts from existing navigation and the potential deepening project. Studies found that the wreck site had become exposed and largely destroyed by a combination of factors, including different river flow patterns, dredging and marine organisms. The archival research project provided a historical context of CSS *Georgia*, which was useful for interpreting the site features.

The work consisted primarily of remote sensing, mapping of the wreck site, and dive investigations. Whenever possible, a video camera was used to enhance documentation; however, poor visibility often precluded its use.

The 2003 survey/investigation established that the surviving remains of the Civil War ironclad are limited, and that the lower hull of the vessel no longer exists. Two large sections of iron casemate and a third smaller section are present, along with the vessel's propulsion machinery including steam cylinders and at least one propeller and shaft, three cannon, a possible boiler, and miscellaneous, small, as of yet identified components and artifacts (i.e., debris field). Dredging impacts can be clearly seen in many of the sidescan sonar images in the report (Watts and James 2007). Dredging scars can be seen on the southern or main channel side of the site, with no evidence of dredging to the north. An acoustic image of the wreck site looking downriver or east shows the linear dredge scars that cut into the Miocene clays run just up to the West and East casemate sections. The easternmost section of the wreck and an "unknown," item possibly a boiler, lie in deep scars within the channel. Yet another image shows the depth and height of the dredge cuts, and the face that the cuts left in the clay bottom. An acoustic image of the wreck site looking down on the West Casemate, shows the linear dredge scars running in multiple directions. Known as the "Debris Field," the dredged area to the left and below (south) the Casemate contains propulsion system components, and cannon. While it is unknown if the multiple scars indicate different episodes of dredging, this portion of the wreck, including the West Casemate, has been heavily and adversely impacted by dredging operations.

4.2. Report Conclusions

Based on the 1979 Texas A&M investigations of the wreck site, it had been assumed that a significant portion of the hull of the vessel survived underneath the sections of armored casemate that is exposed on the river bottom. However, the investigation carried out in 2003 clearly established that this is not the case, that the surviving remains of the Civil War ironclad are limited, and that the lower hull of the vessel no longer exists. Two large sections and a smaller third section of iron casemate are present along with the vessel's propulsion machinery including steam cylinders and at least one propeller and shaft, three cannon, a possible boiler, and miscellaneous, small, as yet identified components and artifacts.

The absence of a lower hull and the impacts to the existing components are a direct result of historic salvage and to a much greater degree operation and maintenance dredging operations associated with the Savannah Harbor Navigation Project. Dredging impacts were discussed previously in detail.

The surviving sections of armored casemate lie on a base of Miocene clay. This dense clay that forms the riverbed has and would prevent downward migration of virtually any material associated with the CSS *Georgia*. Each section of the casemate was found to be resting on top of a pedestal created by erosion and/or dredging of the adjacent clay deposit. Examination of the Savannah District annual survey bathymetry indicates that opening of the Back River channel in 1978 contributed to the erosion of the sand and mud that once protected the wreck, leaving the surviving vessel structure and associated material exposed on the bottom surface. Hydraulic probing to a depth of seven feet around and in between casemate sections confirmed that no evidence of the hull is present below the bottom surface.

Based on the data collected during the 2003 investigation of the wreck, it is apparent that the surviving remains of CSS *Georgia* are limited. Although the archaeological record has been severely compromised by the salvage in the 19th century and dredging and erosion in the 20th century, the dearth of information about the ironclad's design and construction makes every surviving element of the structure valuable.

4.3. Report Recommendations

A National Register of Historic Places listed property, the *Georgia* site has been adversely affected over time, most recently through impacts from repeated dredging operations associated with operations and maintenance of the harbor. This has been clearly documented in the report of the 2003 investigation. Therefore, because of past adverse project effects, and prior to any future activities that may also impact the site, mitigation of these adverse effects is necessary, and it is recommended that measures take the form of a comprehensive investigation and recovery of extant remains.

Because of the limited amount of structural remains and the level of disturbance of the archaeological record, it is recommended that data and material recovery be designed to include systematic site testing, and partial and full excavation and data recovery that build cumulatively on the results of the 2003 in-situ archaeological investigation. The archaeological recovery of data and material from the CSS *Georgia* wreck site will mitigate past impacts and the continued deterioration of the surviving structural remains and the loss of valuable historical and archaeological data preserved in the wreckage and associated artifacts. In addition, the Savannah River navigational channel will be cleared of obstructions to navigation, including explosive ordinance that constitute a threat to both navigation and dredging in the vicinity of the wreck site. Use of a cofferdam is not recommended for any future work at this site. Rather, the site environment is such that it is both feasible and cost effective to conduct the data and material recovery operation with archaeological divers working from a fixed platform.

4.4. District Conclusions of the Existing Condition

The 2003 investigations revealed that the impacts from the 1983 dredging were more catastrophic than previously thought. In addition to the direct dredging impacts, the secondary impacts were site deflation and resultant destruction by marine organisms.

4.5. Expected Impacts of Savannah Harbor Expansion Project

Existing O&M dredging activities near the *Georgia* have an exclusion zone 250 feet from the wreck, resulting in dredging of only the southern half of the channel. If the proposed SHEP alternative is implemented, the north side of the channel will require dredging in areas previously off-limits, resulting in collapse of sidewalls. Additionally the selected alternative includes a 100 foot-wide meeting lane, which will also impact the site.

With the exception of the No Action Alternative, the same impacts would occur regardless of the depth alternative selected.

4.6. 2012 Programmatic Agreement

To mitigate adverse effects to the CSS *Georgia* caused by implementation of the proposed Savannah Harbor Expansion Project, the District entered into a PA with the Georgia and South Carolina State Historic Preservation Offices and the Naval History and Heritage Command. A copy of the PA is in Appendix G of the EIS.

5. Proposed Mitigation Methods and Costs

Mitigation methods and associated costs for CSS *Georgia* were developed based on the results and recommendations in the 2007 report of investigations and consultation with the 2012 PA signatories – the Georgia and South Carolina State Historic Preservation Offices, the Naval History and Heritage Command, and the US Army Corps of Engineers, Savannah District. Mitigation of the vessel would consist of (1) surveys and mapping to identify the present condition of the site and items that remain of the wreck, (2) removal of the wreck from the site, (3) conservation of items with cultural or historical value, and (4) long term curation of the conserved items.

This work is estimated to cost approximately $9.5 million and extend over 7 years, although the archaeological portion will be completed in approximately 1.5 years. The conservation of the large metal artifacts is a lengthy process and will require several years of electrolysis to remove salts that have permeated the artifacts. Stopping and restarting this process is detrimental to the artifacts. As a result, the conservation process would continue on a given artifact once it is begun until the process is complete. Large-volume conservation space is not commonly available and if funds were not available throughout the conservation process, a facility could commit the space to another project and be unavailable for the half-conserved artifacts. To address this potential issue, the Corps would enter into a multi-year funding agreement to ensure the conservation facility receives sufficient funds to complete its work on the CSS *Georgia* artifacts.

Once the artifacts are conserved, O&M funding would be used to fund curation in perpetuity. Curation involves the long-term preservation and storage of the artifacts and documents associated with the wreck investigation. Criteria for curation of Federal archaeological collections are outlined in 36 CFR, Part 79. Curation costs include the costs of moving the documents and conserved artifacts to the facility and an initial fee for their incorporation in the facility. Yearly fees for collection, care, and maintenance continue in perpetuity.

5.1. Mitigation Methods

Based on the results of the 2003 in-situ investigations of the CSS *Georgia* and the recommendations (Watts and James 2007), the District developed a data recovery strategy to mitigate adverse impacts to the vessel. The excavation and data recovery will enable archaeologists to address research questions regarding the design and construction of the CSS *Georgia*, as no drawings or plans of the vessel are known to exist. The project will entail systematic identification, mapping and recovery of material associated with the wreck. A team of archaeologists, unexploded ordnance (UXO) specialists and marine salvage specialists will be required to complete the field work portion of the project. Once the vessel and associated artifacts have been recovered, long term conservation and curation will be required. More detail about the various stages of the mitigation project is presented below.

5.1.1. Archaeological Data Recovery and Mitigation

The data recovery and mitigation effort is estimated to cost about $5 million and will entail three major components: 1) archaeological data recovery, 2) UXO clearance, and 3) vessel recovery (i.e., marine salvage). The archaeological data recovery will be accomplished in phases by a single underwater archaeological contractor. Information developed in each phase will define the scope of work for the following phase. The Corps would work with the Consulting Parties to develop the research plan that describes the work to be conducted, and the research questions that are to be answered. The contractor will conduct remote sensing to accurately identify site conditions and establish a grid to accurately map the site. The site environment is such that it is both feasible and cost effective to conduct the data recovery operation with archaeological divers working from a fixed platform (e.g., barge) rather than using a cofferdam. In 2003, it was determined that the majority of the wreck site sits just outside the navigation channel. Commercial vessel traffic, while transiting close, should not be an issue with respect to setting mooring and anchors at the wreck site, or with respect to diver safety (Figure 4). The District will coordinate with the US Coast Guard and the Harbor Pilots to ensure commercial vessels are aware of the diving to ensure safety. The results of the fieldwork and analysis will be presented in a technical report which would undergo peer review before being accepted by the federal government and the state historic preservation offices. It is estimated that all archaeological work, with the exception of acceptance of the final report, will be completed approximately 1.5 years after the first task order has been issued.

Due to the historical significance of the wreck, several studies have been conducted to determine the extent of artifacts and ordnance present (Garrison et al. 1980; Kozak 1984; Swanson and Holcombe 2003; Watts and James 2007). A discussion of previous investigations is found in Chapter 2 of this document. The most recent effort was conducted in 2003 and included side-scanning sonar as well as diver investigations of the vessel and associated remains (Watts and James 2007). These surveys collectively identified locations of anomalies and permitted visual confirmation of the types and sizes of items, including heavy guns and ordnance. Diving operations conducted in 1986 by the District resulted in the clearance of numerous munitions and two cannon. A single iron round shot was observed in the wreck site during the 2003 investigation. Historical research suggests the remaining three cannon are a 6–pounder, an 8.5-inch shell gun, and a 32-pounder Model 1846. The services of a UXO team working with a marine salvage company will be required to ensure all ordnance is properly cleared from the vessel and the channel in the vicinity of the vessel.

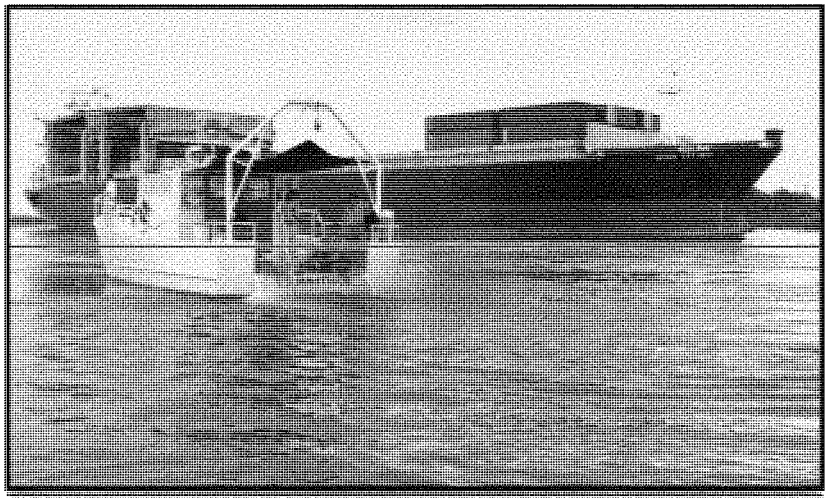

Figure 4. View of 2003 survey vessel with upbound freighter in navigation channel in background. Note Old Fort Jackson to the right of the freighter's bow. (Watts and James 2007:Figure 20).

The services of a marine salvage company will also be necessary to recover the vessel and associated large artifacts. Investigations conducted in 2003 indicated the surviving remains of the ironclad to be composed predominately of two major intact sections of vessel structure, disarticulated railroad iron, and items from the 'Debris Field' which are primarily vessel propulsion machinery as well as other unmapped and unidentified objects. The largest piece of casemate was observed to have an overall length of 68 feet with a width of approximately 24 feet at its widest point.

5.1.2. Conservation

Artifacts will be recovered in three phases of fieldwork over a 9- to 12-month period. Artifact conservation must begin while the artifacts are being recovered. Waiting until all artifacts are recovered, inventorying them, and then scoping, negotiating, and awarding a contract is detrimental to the artifacts and is not ethical. It is likely the District will issue an IDIQ for this work. If an IDIQ is not in place when the artifacts are recovered, a temporary conservation facility/triage facility will be established until such time as the artifacts can be transferred for long-term conservation.

By setting up an IDIQ contract, an existing state-of-the-art conservation facility can be selected and artifacts can be transferred and conserved in lots using task orders. In 2003, the District requested the assistance of the US Army Corps of Engineers, St. Louis District Mandatory Center of Expertise for the Curation and Management of Archaeological Collections (MCX-CMAC) to identify conservation facilities that could accommodate the remains of the *Georgia*. The study indicated that there are only a handful of large, quality conservation facilities, and only the *Hunley* facility was prepared and willing to take on a project of this size. Since that time, the East Carolina University facility has been enhanced and the *Monitor* facility at the Mariners Museum has been developed. East Carolina University has indicated that it would be willing to take on this project. The status of the facility at Mariners Museum is also being investigated. The Conservation Research Laboratory at Texas A&M University has also expressed interest in conserving the wreck.

It is unknown at this time exactly how much of the vessel structure or how many of the artifacts will be recovered and conserved. Until remote sensing and initial dives have been completed, it will not be possible to ascertain the present condition of the vessel. Discussions between the 2012 PA consulting parties will be conducted to determine which pieces have the greatest research potential, can be logistically removed without creating extensive damage to the artifact and can ultimately be exhibited to the public in a facility that meets federal curation standards. It is estimated that it may take as long as 5-7 years to conserve some of the larger artifacts. Conservation costs for the vessel and artifacts are estimated to cost approximately $3.5 million. This figure assumes that one hundred percent recovery and conservation of artifacts is not probable.

5.1.3. Curation

The District must comply with federal regulations "Curation of Federally-Owned and Administered Archeological Collections (36 CFR Part 79)." Part 79 contains the definitions, standards, procedures and guidelines to preserve collections of prehistoric and historic material remains, and associated records. A collection as defined in 36 CFR Part 79 is "material remains that are excavated or removed during a survey, excavation or other study of a prehistoric or historic resource, and associated records that are prepared or assembled in connection with the survey, excavation or other study." It is estimated that curation costs will be approximately $300,000.

According to 36 CFR Part 79, curation involves "managing and preserving a collection according to professional museum and archival practices." There is no existing curation facility in Georgia or South Carolina capable of handling the massive, special-needs collection that will be generated by this project. The preferred curation alternative is to keep the collection in the same complex with the interpretation facility in Savannah, the city with which the vessel was associated. The Coastal Heritage Society (CHS) wishes to be the curation and major interpretive/display center. CHS interprets Savannah's Civil War naval history at two of its National Historic Landmark sites. Old Fort Jackson, the former headquarters of Savannah's Confederate Naval Squadron, is located across the river from the wreck and may serve as a staging and interpretive area during excavation. Savannah History Museum, in downtown Savannah, has an existing exhibit on Savannah's Confederate Navy and efforts to obstruct and defend the river. CHS has amassed over $22 million in Federal, state, county, and city funds for the rehabilitation and restoration of their third landmark property, the Central of Georgia Railroad Shops located next to the Savannah History Museum. Large exhibit spaces and a major, state-of-the-art curation facility are planned for this facility. The facility also has a historic connection to CSS *Georgia*. Workers from the Central of Georgia Railroad were contracted to assist in the vessel's construction and the railroad iron used in the vessel's armored casemate was purchased from the Central of Georgia Railroad. St. Louis District's CMX-CMAC will provide technical recommendations to CHS and will assist in preparation and execution of the curation agreement document.

While Savannah District will be conducting the mitigation effort, the CSS *Georgia* is actually the responsibility of the US Navy. A formal transfer of property from the General Services Administration to the US Navy was made in 2003. Therefore, the Navy will have approval authority over the curation facility that is chosen and the US Navy will enter into long-term curation agreements with the facility. The US Navy would also approve the temporary loan of artifacts to other museums or facilities wishing to exhibit the artifacts.

5.2. Associated Tasks and Coordination

Once the District has awarded contracts for the archaeological data recovery and mitigation, conservation and curation, District personnel will continue to spend a considerable amount of time coordinating with other agencies to ensure the work is completed safely, in conformance with the terms of the contracts, in ways that protect the resource as much as possible, and without adverse impacts to the overall Savannah Harbor Expansion Project schedule.

5.2.1. US Coast Guard and Savannah Pilots

As the work site is on the edge and partially within the Savannah Harbor Navigation Channel, the District will need to coordinate the dive operations with the US Coast Guard and Savannah Pilots to ensure diver safety. It is anticipated that at least one large barge will be anchored continuously on the edge of the channel for up to 1 year. Smaller barges and small craft will be working in the area during dive operations. US Coast Guard regulations and US Army Corps of Engineers Safety Manual will be reviewed to identify safe anchoring procedures, lighting, other markings, etc. During the 2003 dive operations, large vessel traffic was restricted to one way navigation while diving was conducted and a Notice to Mariners was issued requiring other harbor traffic to reduce speed during dive operations. With the exception of large vessel traffic

associated with Savannah Harbor pilots, this notice was NOT effective. A more effective method needs to be identified and implemented. Since the work barge will be anchored in the harbor during the hurricane season, a hurricane evacuation plan will be required. Department of Homeland Security requirements and notifications will also need to be addressed.

5.2.2. Ordnance and Explosives Safety Specialists

Live and inert ordnance is present and must be addressed during recovery, conservation, and curation phases. The contractor's UXO specialist, in consultation with the District's Explosive Ordnance Specialist and the Corps' Ordnance and Explosives Center of Expertise, will develop a UXO plan to include a description of each type of ordnance known to be on the vessel, as well as descriptions of other types of ordnance of the period that may have been stored aboard the vessel. The descriptions will include photographs and scale drawings showing diagnostic features for the type and, if of an explosive type, detailed descriptions and drawings of fuse mechanisms, powder chambers, powder, etc. The UXO plan will identify contractor procedures should ordnance be encountered. It will also include the identities, contact information, and notification procedures for the designated Explosive Ordnance Disposal dive team that will recover the ordnance and how the ordnance will be treated once recovered. While there is very little sediment on the site that could conceal ordnance, some pieces may be located under the two large pieces of casemate. Ordnance may also be located in the barrels of the cannon that are believed to still be within the wreck.

5.2.3. Public Involvement

There is substantial public interest in the CSS *Georgia*. The 1998 Draft Environmental Impact Statement elicited 1,588 responses from individuals supporting archaeological recovery of the CSS *Georgia* and stabilization of Fort James Jackson. The work on Fort Jackson has since been completed.

When the latest studies (2003) were conducted of the CSS *Georgia*, Savannah District held a media day and created public information brochures. A local television station ran a series of stories on the progress of the investigations and one of its former employees created a documentary about the vessel. District archaeologists made presentations to a large number of groups. Among them are the Society for Georgia Archaeology, local chapters of the Sons of Confederate Veterans and the United Daughters of the Confederacy, the Coastal Georgia Archaeological Society, an honors sorority, and other groups.

Public involvement will be a major component of the mitigation project. While all media events, educational interpretation, etc., will be subject to guidance, review, and approval of the District's Corporate Communications Office (i.e., Public Affairs), much of the material such as web site info, short-term exhibits, etc., will be generated by the archaeological excavation and conservation contractors and, possibly, the Coastal Heritage Society. The plan will need to identify media and interpretive goals, as well as coordination and approval procedures. It will also identify major media event opportunities (project start up, project milestones, etc.) and develop a potential list of interpretive themes and methods to be investigated at various sites (Old Fort Jackson, Savannah History Museum, web, schools, etc.).

5.2.4. Summary of Mitigation Phase and Task Descriptions

As stated previously, data recovery and mitigation of the CSS *Georgia* will entail multiple phases of work that will be conducted by both contractors outside of the District and District personnel. Below is a summary of the tasks that will be required for this effort.

Phase—Set-up—In-House

I. Tasks

A. Scope, negotiate, and award IDIQ contract for data recovery
B. Scope, negotiate, and award IDIQ contract for conservation
C. Select curation facility
D. Coordinate with US Coast Guard
E. Coordinate with Savannah Pilots
F. Prepare scope of work, negotiate, and award first task orders on IDIQ for data recovery
G. Prepare scope of work, negotiate, and award first task order on IDIQ for conservation
H. Prepare and execute real estate agreement for contractor staging area, conservation triage facility, and interpretive facilities
I. Prepare UXO plan
J. Prepare public involvement plan

II. Task Descriptions

A. Scope, negotiate, and award IDIQ contract for data recovery.

Tasks: Prepare scope of work, CBD notice, evaluation criteria and estimate, review proposals and estimates, and award contract.

Lead(s): SAS archaeologist, SAS CT

Contributing Personnel: Other designated proposal reviewers, SAS administrative assistant, SAS supervisor, SASOC

Discussion: This mitigation effort will total about $5 million. It will be accomplished in phases by a single contractor. Information developed in each phase will define the scope of work for the following phase. The best method for accomplishing this is through use of a separate IDIQ contract. Each project phase, up to and including report preparation, will be accomplished as a task order under the IDIQ.

B. Scope, negotiate, and award IDIQ contract for conservation.

Tasks: Prepare scope of work, CBD notice, evaluation criteria, and estimate, review proposals and estimates, and award contract.

Lead(s): SAS archaeologist and SAS Contracting personnel.

Contributing Personnel: Other designated proposal reviewers, SAS administrative assistant, SAS supervisor, SAS OC

Discussion:

Artifacts will be recovered in three phases of fieldwork over a 9- to 12-month period. Artifact conservation must begin while the artifacts are being recovered. Waiting until all artifacts are recovered, inventorying them, and then scoping, negotiating, and awarding a contract is detrimental to the artifacts and is not ethical.

This IDIQ will not be a small business set aside. By setting up an IDIQ contract, a top-flight facility can be selected and artifacts can be transferred and conserved in lots using task orders. The 2003 St. Louis District study indicated that there are only a handful of large, quality conservation facilities, and only the *Hunley* facility was prepared and willing to take on a project of this size. Since that time, the East Carolina University facility has been enhanced and the *Monitor* facility at the Mariners Museum has been developed. East Carolina University has indicated that it would be willing to take on this project. The status of the facility at Mariners Museum is also being investigated.

C. Select curation facility.

Tasks: Identify curation facility, negotiate long-term agreement

Leads: SAS archaeologist, St. Louis District Center of Expertise for Curation

Contributing Personnel: SAS administrative staff

Discussion: There is no existing curation facility in Georgia or South Carolina capable of handling the massive, special-needs collection that will be generated by this project. The preferred curation alternative is to keep the collection in the same complex with the interpretation facility in Savannah, the city with which the vessel was associated. The Coastal Heritage Society (CHS) wishes to be the curation and major interpretive/display center. CHS interprets Savannah's Civil War naval history at two of its National Historic Landmark sites. Old Fort Jackson, the former headquarters of Savannah's Confederate Naval Squadron, is located across the river from the wreck and will probably serve as a staging and interpretive area during excavation. Savannah History Museum, in downtown Savannah, has an existing exhibit on Savannah's Confederate Navy and efforts to obstruct and defend the river. CHS has amassed over $22 million in Federal, state, county, and city funds for the rehabilitation and restoration of

their third landmark property, the Central of Georgia Railroad Shops located next to the Savannah History Museum. Large exhibit spaces and a major, state-of-the-art curation facility are planned for this facility. The facility also has a historic connection to CSS *Georgia*. Workers from the Central of Georgia Railroad were contracted to assist in the vessel's construction and the railroad iron used in the vessel's armored casemate was purchased from the Central of Georgia Railroad. St. Louis District's Center of Expertise for archaeological curation will provide technical recommendations to CHS and will assist in preparation and execution of the curation agreement document.

D. Coordinate with US Coast Guard.

Tasks: Identify navigation and security needs and methods and procedures to address them.

Leads: SAS archaeologist

Contributing Personnel: SAS OP-N, Savannah Pilots, Georgia Ports Authority, other interested harbor users

Discussion: The work site is on the edge and partially within the Savannah Harbor Navigation Channel. At least one large barge will be anchored continuously on the edge of the channel for up to 1 year. Smaller barges and small craft will be working in the area during dive operations. US Coast Guard regulations and US Army Corps of Engineers Safety Manual will be reviewed to identify safe anchoring procedures, lighting, other markings, etc. During the 2003 dive operations, large vessel traffic was restricted to one way navigation while diving was conducted and a Notice to Mariners was issued requiring other harbor traffic to reduce speed during dive operations. With the exception of large vessel traffic associated with Savannah Harbor pilots, this notice was NOT effective. A more effective method needs to be identified. Since the work barge will be anchored in the harbor during the hurricane season, a hurricane evacuation plan will be required. Homeland security needs will also need to be addressed.

E. Coordinate with Savannah Pilots.

Tasks: Identify contact and coordination procedures and safe navigation procedures.

Leads: SAS archaeologist

Contributing Personnel: SAS OP-N, Georgia Ports Authority, US Coast Guard

Discussion: The work site is on the edge and partially within the navigation channel. During 2003 diver investigations, the dive boat was only anchored in the work area during actual dive operations and pilots were able to maintain a no passing zone in the project vicinity during these times. A plan will be developed for safe navigation for the anchored barge during dive and non-dive periods.

F. Prepare scope of work, negotiate, and award first task orders on IDIQ for data recovery.

Tasks: In consultation with the consulting and concurring parties, develop, negotiate, and award first task order.

Leads: SAS archaeologist

Contributing Personnel: GA SHPO, SC SHPO, GA State Archaeologist/Underwater Archaeologist, SC State Underwater Archaeologist, US Naval Historical Center, NPS Submerged Cultural Resources Unit, SAS geologist, SAS OP-N

Discussion: This will be Task Order 1 under the data recovery IDIQ contract and will require the development of the base plan for wreck recovery and a detailed scope of work for Task Order 2, the first excavation phase (site mapping, small finds recovery, identification of large finds and development of rigging/recovery plans).

G. Prepare scope of work, negotiate, and award first task order on IDIQ for conservation.

Tasks: Prepare scope of work, negotiate, and award first task order on IDIQ for conservation

Leads: SAS archaeologist

Contributing Personnel: Excavation IDIQ contractor, GA SHPO, SC SHPO, GA State Archaeologist/Underwater Archaeologist, SC State Underwater Archaeologist, US Naval Historical Center, NPS Submerged Cultural Resources Unit

Discussion: Task Order 1 will set up working and coordination procedures between the excavation contractor and conservation facility staff and direct the facility to create and maintain a local temporary facility where recovered materials can be stabilized and packaged for transport to the conservation facility. It will also initiate conservation at the main facility.

H. Execute real estate agreement for contractor's staging area, conservation triage facility, and interpretive facilities.

Tasks: Execute any real estate agreement with Coastal Heritage Society for property for contractor access, administrative office, storage facilities, and use of dock at Old Fort Jackson.

Leads: SAS RE and Georgia Department of Transportation

Contributing Personnel: SAS archaeologist

Discussion: Old Fort Jackson is located 600 feet from the wreck site. It is owned by the State of Georgia, but is under a long-term lease to the Coastal Heritage Society (CHS) which preserves and interprets it for the public benefit. The property has a dock, as well as an area that will

accommodate the contractors' field office, temporary storage buildings, and a temporary conservation facility. The contractor and Government will need to use the dock for both routine and emergency access to the wreck site. CHS is amenable to sub-leasing this area with a right of access for this project. If for some reason, the fort site is not available, alternate facilities to be considered may include the Corps of Engineers Depot on Hutchinson Island, a second barge anchored near the wreck site, or using a larger barge for excavation work.

I. Prepare UXO plan.

Tasks: Prepare UXO plan for identification, recovery, and disposal/inerting

Leads: SAS Safety Office, SAS EN-GH (Explosive Ordnance Specialist)

Contributing Personnel: SAS archaeologist, SAS OP-N (District Diver Coordinator)

Discussion: Live and inert ordnance is present and must be addressed during recovery, conservation, and curation phases. The UXO plan will include a description of each type of ordnance known to be on the vessel, as well as descriptions of other types of ordnance of the period that may have been stored aboard the vessel. The descriptions will include photographs and scale drawings showing diagnostic features for the type and, if of an explosive type, detailed descriptions and drawings of fuse mechanisms, powder chambers, powder, etc. The UXO plan will identify contractor procedures should ordnance be encountered. It will also include the identities, contact information, and notification procedures for the designated EOD dive team that will recover the ordnance and how the ordnance will be treated once recovered. While there is very little sediment on the site that could conceal ordnance, some pieces may be located under the two large pieces of casemate. Ordnance may also be located in the cannon barrels.

J. Prepare public involvement plan.

Tasks: Prepare public involvement plan identifying lead and supporting organizations, coordination procedures, timing of large media events, and types of media to be used.

Leads: SAS CCO, SAS archaeologist

Contributing Personnel: Coastal Heritage Society, Excavation Contractor, Conservation Contractor

Discussion: Public involvement will be a major component of the mitigation project. While all media events, educational interpretation, etc., will be subject to guidance, review, and approval of SAS CCO, much of the material (web site info, short-term exhibits, etc.) will be generated by the excavation and conservation contractors and, possibly, the Coastal Heritage Society. The plan will need to identify media and interpretive goals, as well as coordination and approval procedures. It will also identify major media event opportunities (project start up, large lifts,

etc.) and develop a potential list of interpretive themes and methods to be investigated at various sites (OFJ, Savannah History Museum, web, schools, etc.).

6. PROJECT CHALLENGES AND OPPORTUNITIES

The National Register listed ironclad CSS *Georgia* was built in Savannah in 1862 with funds raised by a Ladies Gunboat Association (Figure 5). She guarded the channel below Savannah and was a major reason why the city was not taken by sea. Confederate forces scuttled her in 1864 as Sherman's Union forces arrived at the end of their "March to the Sea." After a few minor salvage attempts, she was forgotten until she was relocated during a 1968 widening project.

Because the site is located in a 40-foot-deep, near-zero-visibility, high-current navigation area, diving is restricted to about 4-hours around low or high tide and presents many challenges. During the 2003 diving operations, tidal variation was approximately 9 feet. Due to the extreme tides, substantial currents existed over the site and the velocities at ebb flow were recorded in excess of 5 feet per second. On several occasions dives were aborted or shortened due to excessively strong or increasing currents.

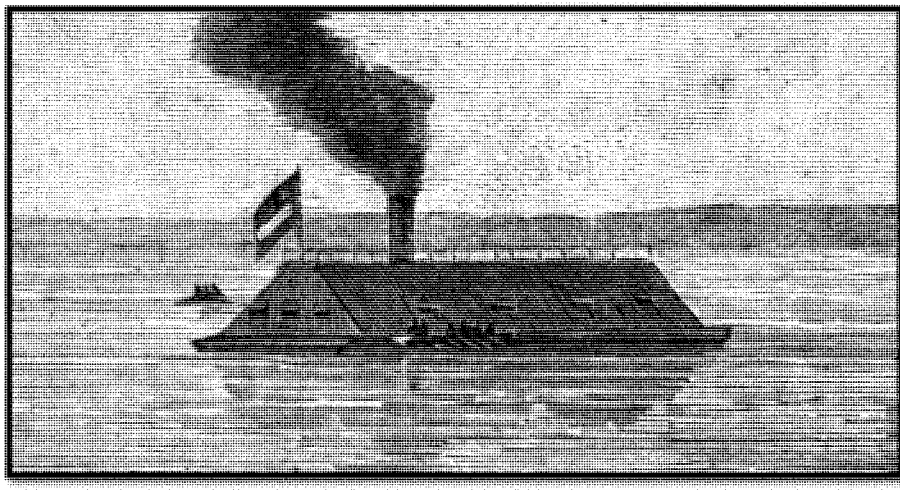

Figure 5. 1863 lithograph of CSS *Georgia* (as presented in *Frank Leslie's Illustrated Newspaper* February 21, 1863).

Work on the site is also constrained by visibility. During the 2003 investigations, divers noted that visibility ranged between 0 and 3 feet with a helmet or wrist-mounted light. Visibility was generally best on slack current or beginning incoming tides. Visibility often changed dramatically during a single dive, going from good to nonexistent in several minutes or vice versa.

Mapping in a near zero-visibility environment is a challenge. It is difficult to read a tape measure. In the past, divers have resorted to counting knots on a rope and other low-tech methods that produced maps of questionable accuracy. During the 2003 investigations divers attempted to use a short-baseline sonic positioning system in which a transponder sends locational data electronically to the surface to accurately plot on the site map. Unfortunately a number of problems were encountered with the system and more traditional methods of mapping were employed. Since that time, advances in technology may have occurred that should make mapping of the site easier and more accurate.

Very little information on the design and construction of CSS *Georgia* survives in either the historical or archaeological record, making accurate reconstruction of the vessel nearly impossible. Significant clues, however, are preserved in the surviving remains of the wreck. By using the data that will be gathered from the mitigation effort it will be possible to develop a reasonable reconstruction of the vessel, including the hull design. Previous investigations have already determined that while the condition of the site is a disappointment, it still has a major story to tell.

7. REFERENCES CITED

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ENVIRONMENTAL IMPACT STATEMENT
APPENDIX G: Programmatic Agreement for Cultural Resources

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps
of Engineers
Savannah District
South Atlantic Division

PROGRAMMATIC AGREEMENT

AMONG THE US ARMY CORPS OF ENGINEERS, SAVANNAH DISTRICT, THE GEORGIA STATE HISTORIC PRESERVATION OFFICER, THE SOUTH CAROLINA STATE HISTORIC PRESERVATION OFFICER, AND THE US NAVY NAVAL HISTORY AND HERITAGE COMMAND

WHEREAS, the US Army Corps of Engineers, Savannah District (Savannah District), proposes to expand the Savannah Harbor Navigation Project by deepening the existing navigation channel between station 103+000 and -60+000 by up to 6 feet, extending the bar channel seaward, constructing bend wideners in selected areas along the existing channel, deepening the existing Kings Island Turning Basin, constructing passing lanes, disposing of dredged material in existing disposal areas and possible new sites, and creating fish and wildlife mitigation lands, as described in the attached letter report, and

WHEREAS, the Savannah Harbor Expansion Project lies within the States of South Carolina and Georgia, and

WHEREAS, the Savannah District recognizes that the proposed Savannah Harbor Expansion Project may have an effect upon properties included in or eligible for inclusion in the National Register of Historic Places (National Register)and has consulted with the Advisory Council on Historic Preservation (Council), the Georgia State Historic Preservation Officer (Georgia SHPO), and the South Carolina State Historic Preservation Officer (South Carolina SHPO) pursuant to regulation 36 CFR, Part 800 implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470h-2(f), and

WHEREAS, the Naval History and Heritage Command of the US Navy (US Navy) owns the National Register listed property CSS *Georgia* and has requested to be a Consulting Party for actions associated with this resource, and

WHEREAS, the definitions given in Appendix A are applicable throughout this Programmatic Agreement;

NOW THEREFORE, the Savannah District, the Consulting Parties composed of the Council, Georgia SHPO, the South Carolina SHPO, and US Navy agree that the project shall be administered in accordance with the following stipulations to satisfy Savannah District's Section 106 responsibilities for all individual aspects of the project.

Site Specific Stipulations

The Savannah District, subject to receiving funds appropriated by the Congress of the United States, shall ensure that the following measures are carried out:

In consultation with the consulting parties, the Savannah District shall prepare and implement a data recovery plan to mitigate impacts of the Savannah Harbor Expansion Project upon the CSS *Georgia*. The plan shall meet all requirements contained in the General Stipulations section of this Programmatic Agreement.

General Stipulations

The Savannah District, subject to receiving funds appropriated by the Congress of the United States, will ensure that the following measures are carried out:

1. The Savannah District shall ensure that archeological surveys of areas that may be affected by the proposed Savannah Harbor Expansion Project are conducted in a manner consistent with the Secretary of Interior's Standards and Guidelines for Identification (48 F.R. 44720-23) and any standards and guidelines developed by the Georgia SHPO and the South Carolina SHPO. The surveys shall be conducted in consultation with the Georgia SHPO and the South Carolina SHPO, and reports of the survey shall be submitted to the Georgia SHPO and the South Carolina SHPO for review and comment.

2. The Savannah District shall evaluate properties identified through the surveys in accordance with 36 CFR, Part 800.4. If the survey results in the identification of properties that are eligible for, or included in, the National Register of Historic Places, Savannah District shall determine the effect of the proposed project upon those resources in accordance with 36 CFR, Part 800.5.

3. The Savannah District shall identify and evaluate alternatives to avoid and/or mitigate adverse effects to properties determined eligible for inclusion, or included in, the National Register of Historic Places in accordance with 36 C.F.R. Part 800.6.

4. The Savannah District shall insure that data recovery plans are developed in consultation with the Georgia SHPO or South Carolina SHPO (as appropriate), and US Navy (as appropriate) for the recovery of archaeological data from properties determined eligible for inclusion in the National Register of Historic Places. The plans shall be consistent with the Secretary of the Interior's Standards and Guidelines for Archeological Documentation (48 F.R. 44734-37) and take into account the Council's publication, *Treatment of Archeological Properties* (Advisory Council on Historic Preservation 1980), and any standards and guidelines set forth by the Georgia SHPO, South Carolina SHPO, and US Navy (as appropriate). The plans shall specify, at a minimum:

a. the property, properties, or portions of properties where data recovery is to be carried out;

b. any property, properties, or portions of properties that will be destroyed without data recovery;

c. the research questions to be addressed through the data recovery, with an explanation of their relevance and importance;

d. the methods to be used, with an explanation of their relevance to the research questions;

e. the methods to be used in analysis, data management, and dissemination of data, including a schedule;

f. the proposed disposition of recovered materials and records;

g. proposed methods for involving the interested public in the data recovery;

h. proposed methods for disseminating results of the work to the interested public;

i. proposed methods by which local historic sites and historic preservation agencies and individuals will be kept informed of the work and afforded the opportunity to participate; and,

j. a proposed schedule for the submission of progress reports to the Savannah District, the Georgia SHPO, South Carolina SHPO, US Navy (as appropriate), and the Council.

5. The data recovery plans shall be submitted by the Savannah District to the Georgia SHPO and/or South Carolina SHPO (as appropriate), the US Navy (as appropriate),and the Council for 45 days review. Unless the Georgia SHPO, South Carolina SHPO, the US Navy (as appropriate), or the Council objects within 45 days after receipt of a data recovery plan, the Savannah District shall ensure that it is implemented.

6. The Savannah District shall ensure that all archeological survey, testing, and data recovery work carried out pursuant to this Programmatic Agreement is carried out by or under the direct supervision of a person or persons meeting at a minimum the standards for archeologist set forth in the Secretary of the Interior's Standards and Guidelines for Archeological Documentation (48 F.R. 44716-42).

7. The Savannah District shall ensure that all materials and records resulting from survey, testing, and data recovery are curated in accordance with 36 CFR, Part 79.

8. The Savannah District shall ensure that all final archeological reports resulting from actions pursuant to this agreement will be provided to the Georgia SHPO, the South Carolina SHPO, the US Navy (as appropriate), and the Council. The Savannah District shall ensure that all such reports are responsive to the contemporary professional standards, and to the Department of Interior's Format Standards for Final Reports of Data Recovery Programs (42 F.R. 5377-79).

9. Any party to this Programmatic Agreement may request that it be amended, whereupon the parties will consult in accordance with 36 CFR, Part 800.6(c)(7) to consider amendment.

10. The Council, the Georgia SHPO, the South Carolina SHPO, and US Navy (as appropriate) may monitor activities carried out pursuant to this Programmatic Agreement, and the Council will review such activities if so requested. The Savannah District will cooperate with the Council, the Georgia SHPO, the South Carolina SHPO, and the US Navy (as appropriate) in carrying out their monitoring and review responsibilities.

11. The parties to this agreement shall consult to review implementation of the terms of this agreement and determine whether revisions are needed. If revisions are needed, the parties to this agreement will consult in accordance with 36 CFR, Part 800 to make such revisions.

12. Any party to this agreement may terminate it by providing 30 days notice to the other parties, provided that the parties will consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the event of termination, the Savannah District will comply with 36 CFR, Parts 800.4 through 800.6 with regard to individual undertakings covered by this Programmatic Agreement.

13. Should the Georgia SHPO, South Carolina SHPO, the US Navy (as appropriate), or the Council object within 45 days to any actions proposed pursuant to the agreement, the Savannah District shall consult with the objecting party to resolve the objection. If the Savannah District determines that the objection cannot be resolved, the Savannah District shall request further comments of the Council pursuant to 36 CFR, Part 800.7. Any Council comment provided in response to such a request will be taken into account by the Savannah District in accordance with 36 CFR, Part 800.7 with reference only to the subject of the dispute; the Savannah District's responsibility to carry out all actions under this agreement that are not the subjects of the dispute will remain unchanged.

14. At any time during implementation to the measures stipulated in this agreement, should an objection to any such measure be raised by a member of the public, the Savannah District shall take the objection into account and consult as needed with the objecting party, the Georgia SHPO, the South Carolina SHPO, the US Navy (as appropriate), or the Council to resolve the objection.

15. In the event the Savannah District does not carry out the terms of the Programmatic Agreement, the Savannah District will comply with 36 CFR, Parts 800.4 through 800.6 with regard to individual undertakings covered by this Programmatic Agreement.

Execution and implementation of this Programmatic Agreement evidences that the Savannah District has satisfied its Section 106 responsibilities for all individual undertakings of the program.

16. Nothing herein shall constitute, or be deemed to constitute, an obligation of future appropriations by the United States.

US ARMY CORPS OF ENGINEERS, SAVANNAH DISTRICT:

Jeffrey M. Hall DATE: 4 Nov 2011
Jeffrey M. Hall
Colonel, US Army
Commanding

GEORGIA STATE HISTORIC PRESERVATION OFFICER:

Dave Crass DATE: 22 NOV. '11
David Crass, Ph.D., Division Director and Deputy State Historic Preservation Officer

SOUTH CAROLINA STATE HISTORIC PRESERVATION OFFICER:

Elizabeth M. Johnson DATE: 11/30/2011
Elizabeth M. Johnson, Deputy State Historic Preservation Officer

US NAVY, NAVAL HISTORY AND HERITAGE COMMAND:

J.A. DeLoach DATE: 2/23/12
J.A. DeLoach, Rear Admiral, U.S. Navy (RET.)
Director, Naval History and Heritage Command

APPENDIX A
DEFINITIONS

Consulting Parties. The consulting parties for the entire project include the US Army Corps of Engineers, Savannah District, the Georgia State Historic Preservation Officer, the South Carolina State Historic Preservation Officer, and the Advisory Council on Historic Preservation. The Naval History and Heritage Command of the US Navy is a Consulting Party for any actions regarding the National Register listed property CSS *Georgia*.

CSS *Georgia*. The CSS *Georgia* was a Confederate ironclad that was constructed in Savannah in 1862, served in the harbor during the Civil War, and was scuttled on December 21, 1864, to prevent capture. The wreck site is located on the Savannah Harbor navigation channel bottom and side slope within Chatham County, Georgia, and Jasper County, South Carolina. The site was listed in the National Register of Historic Places in 1982 at the national level of significance for its architecture, association with important historical personages and events, and for its ability to provide information important in history. The vessel is owned by the US Government and is administered by the US Navy. The Naval History and Heritage Command of the US Navy will act as a Consulting Party for actions affecting this resource.

Savannah Harbor Expansion Project
Historic Properties

I. Previous and Proposed Agreement Documents for the Savannah Harbor Navigation Project

In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts of the then existing Savannah Harbor Navigation Project and the then proposed harbor deepening project. This deepening project was completed in 1994. All stipulations of the agreement have been carried out.

In 1992, Savannah District, the South Carolina and Georgia State Historic Preservation Offices, and the Advisory Council on Historic Preservation entered into a Programmatic Agreement to address impacts associated with the closing of New Cut and removing the tide gate from operation in Savannah Harbor. Compliance with Stipulation 12 is continuing. All other stipulations have been carried out.

Stipulation 12 states: "In consultation with the Council, the GASHPO, and the SCSHPO, Savannah District will prepare a Memorandum of Agreement to outline procedures for identifying, evaluating, and mitigating and/or removing adverse effects of the Savannah Harbor Navigation Project upon the CSS *Georgia*, a property listed in the National Register of Historic Places."

In 2002, Savannah District and the Georgia Ports Authority initiated studies of the CSS *Georgia* to determine the effects of past and future harbor operation and maintenance activities and the effect of the proposed Savannah Harbor Expansion Project upon this property and to identify mitigation alternatives. The reports have been coordinated with the South Carolina and Georgia State Historic Preservation Officers.

Savannah District prepared a Programmatic Agreement to address Section 106 compliance for the proposed Savannah Harbor Expansion Project. Consulting Parties include the Georgia and South Carolina State Historic Preservation Offices, the Naval History and Heritage Command of the US Navy, and Savannah District. The Advisory Council on Historic Preservation decided not to participate. All parties reviewed and commented upon the draft agreement. All issues and concerns were resolved in the revised final version. The agreement document is currently being circulated for signatures.

II. Project Description

A. Deepen the existing 42-foot-deep inner harbor navigation channel by up to 6 feet between stations 0+000 and +103+000 and to a width that will not disturb existing side slopes. The present project features include an additional 2 feet of allowable over depth and up to 4 feet of advance maintenance dredging. These project features will be retained.

B. Deepen the existing 44-foot-deep bar channel by up to 6 feet from station 0+000 to station –60+000 and to a width that will not disturb existing side slopes. The present project features include an additional 2 feet of allowable over depth and up to 4 feet of advance maintenance dredging. These project features will be retained.

C. Construct bend wideners and perform full-channel-width dredging in isolated areas as necessary to facilitate ship movement.

D. Construct an approximately 38,600-foot-long extension to the 600-foot-wide bar channel to a depth of up to 50 feet plus 2 feet of allowable over depth and up to 4 feet of advance maintenance dredging.

E. Deepen the existing 42-foot-deep Kings Island Turning Basin by 6 feet. The present project features include an additional 2 feet of allowable over depth and up to 4 feet of advance maintenance dredging. These project features will be retained.

F. Construct a passing lane 100 feet wide on the north side of the channel from stations +55+000 to +60+000 and a passing lane 100 feet wide on the south side of the channel from stations +16+000 to +20+000.

G. Dispose of dredged material in existing Savannah Harbor operation and maintenance dredged material disposal areas.

H. Construct mitigation features for project impacts to environmental resources.

III. Alternatives Considered During Project Design in Order to Reduce the Area of Potential Effect.

The initial project design was to deepen the full channel bottom width for the entire 165,000-foot-long navigation channel by up to 10 feet. This design would have resulted in side slope sloughing that would have impacted an area up to 50 to 80 feet wide on either side of the navigation channel. The design was subsequently modified to deepen the channel by no more than 6 feet and to dredge to a width that would not affect existing side slopes.

The initial project design also included a series of 16 bend wideners varying from 76 to 156 feet in width and with a total length of over 56,000 linear feet. The results of a ship simulation study resulted in a new design with four bend wideners with widths from 76 to 156 feet and a total length of less than 15,250 linear feet and nine areas to be dredged to the full existing channel width with a total length of less than 49,000 feet.

IV. Area of Potential Effect

A. Channel bottom and side slopes of bar channel extension.

B. Channel bottom and side slopes of existing navigation channel.

C. Channel bottom and side slopes of bend wideners and channel side slopes where full-channel-width dredging will occur.

D. Channel bottom and side slopes of the Kings Island Turning Basin.

E. Channel bottom and side slopes in proposed passing lane areas.

F. Existing disposal sites.

G. Environmental mitigation features.

V. Previously Disturbed Areas Located within the Area of Potential Effect for which No Historic Property Investigations are Proposed

A. The existing navigation channel bottom between stations +103+000 and -52+000 has been dredged to a depth well below historic harbor depths. Historically, the deepest place in the inner harbor was a 30-foot-deep hole located near station +57+000 and the average channel depth was less than 15 feet. Any historic properties that were once located in the dredged channel bottom were removed by previous harbor deepening projects

B. That portion of the existing bar channel bottom located between stations -52+000 and -60+000 was surveyed prior to construction during the last harbor deepening project. No historic properties were located.

C. The side slopes and adjacent tops of slopes of the existing navigation channel between stations +103+000 and -60+000 were surveyed prior to construction of the last harbor deepening project. Historic properties that would be affected by construction of that project were identified and mitigated. Since much of the proposed project is to be constructed in a manner that will not alter existing channel side slopes and tops of slopes, these areas will not be investigated for historic properties, except in places where previous surveys have identified historic properties located immediately adjacent to the existing project.

D. Those portions of proposed bend wideners and the proposed passing lane that overlap existing harbor turning basins and channels that have been dredged to a depth of 38 or more feet, well below historic channel depths, will not be surveyed. Historic properties located in these areas would have been removed as part of previous dredging projects.

E. The bottom of the Kings Island Turning Basin has been dredged to a depth well below that which could have contained historic properties. This area will not be surveyed.

F. The existing Savannah Harbor dredged material disposal sites have been used for a number of years. Original land surfaces that may contain historic properties are buried under 30 or more feet of dredged material. Existing offshore disposal areas were designed to avoid impacts to any sonar targets or magnetic anomalies identified during the planning process.

VI. Areas Investigated or to be Investigated for Historic Properties

A. Channel bottom and side slopes of bar channel extension.

B. Sides slopes of the existing navigation channel between stations +103+000 and -60+000 in areas where the full channel width must be dredged to facilitate ship movements and in areas where historic properties abut the existing navigation channel.

C. Bottoms and side slopes of bend wideners where they do not overlap existing turning basins.

D. Sides slopes of the Kings Island Turning Basin.

E. Bottom and side slopes of proposed passing lanes.

F. Lands and water bottoms proposed for enhancement for project-related impacts to environmental resources.

VII. Investigations Completed or in Progress.

A. The portion of the existing navigation project that was deepened in 1994 (stations 103+000 to –60+000 plus the Kings Island Turning Basin) was surveyed at that time and historic properties were investigated and mitigated.

B. Remote sensing surveys were conducted of the Back River sediment basin area and portions on upper Back River were surveyed as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the tide gate from operation. The survey area included the Back River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to Hog Island.

C. Investigations of the CSS *Georgia* to identify past, present, and future impacts from the existing navigation project and the effects of the proposed expansion project have been conducted. The reports of these investigations have been coordinated with the Georgia and South Carolina State Historic Preservation Offices.

D. In 2003, Savannah District contractor Panamerican Consultants, Inc., completed a survey of the first channel design.

E. In 2005, Savannah District contractor Panamerican Consultants, Inc., conducted a survey of new design elements and conducted diver investigations of a 10 magnetic anomalies and/or sonar targets located within the area of potential effect.

F. Savannah and Wilmington Districts conducted a study to determine the incremental effect of the proposed expansion project upon Ft. Pulaski National Monument.

G. In 1992, as part of the New Cut Closure Project studies, Savannah District contractor Tidewater Atlantic Resources, Inc., conducted low water shoreline and remote sensing surveys of the Back River from its mouth to the lower end of Hog Island in Little Back River. Thirty-one archaeological sites and 26 magnetic anomalies and/or sonar targets were recorded.

H. In 1993 and 1994, Savannah District archaeologists conducted archival research, archaeological survey, site documentation and monitoring, and diver investigations of the sites and anomalies/targets identified in Back River above the tide gate during the 1992 survey. A number of the sites were determined eligible for inclusion in the National Register of Historic Places. The report concluded that the New Cut Closure Project had caused erosion at some of the resources, but, these sites had since stabilized and the detailed research and documentation conducted by Savannah District was adequate to mitigate this effect.

I. Savannah District recovered core samples from an area of the proposed off-shore bend widener that analysis of sub-bottom profiler data indicated the presence of a Pleistocene stream channel. The cores were analyzed in and results reported by New South Associates, Inc., in 2005.

VIII. Resource Potential and Status of Investigations:

A. *Bar Channel Extension (Outside State Waters) –Stations –60+000 to –98,600--Bottom and Side Slopes.*

The project, as originally proposed, included a 25,000-foot long channel extension, Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and cesium magnetometer surveys of the proposed channel extension area. The survey area was 700 feet wide, sufficient to include the 600-foot proposed channel width and side slopes. In 2005, Savannah District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of potentially significant anomalies and/or targets. The contractor has completed the analyses and has investigated one magnetic anomaly/sonar target. The anomaly/target was identified as modern debris.

As part of studies to identify potential impacts to the Floridan Aquifer, Savannah District conducted sub-bottom profiler surveys of the existing bar channel area, as well as areas on the bar considered for bend wideners and channel extension. The purpose of the survey was to identify the depth and character of the aquifer's Miocene-age cap and to locate former Pleistocene stream channels that cut into the cap. Since stream banks have a higher potential for containing prehistoric archaeological sites, the results of these surveys were also examined by District archaeologists. No Pleistocene streams were found in the extension area.

Due to changes in shoals, in 2009, the bar channel extension was redesigned to be a 38,600- foot-long by 600-foot-wide channel located on a different alignment. Savannah District is contracting for a side scan sonar, magnetometer, and sub-bottom profiler, and diver investigation of the new location. In order to ensure that avoidance of impacts to potentially significant cultural resources is a viable alternative, the area being surveyed is 1100 feet wide. The survey is designed to locate shipwrecks and landforms likely to contain prehistoric sites.

B. Bend Wideners and Full-width Dredging Areas.

Bend Widener (SC waters)—Stations –21+000 to –14+000, 76-foot bottom width plus side slope of 20 feet. Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and magnetometer surveys of this area. The survey area was 300 feet wide. In 2005, the District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of the anomalies. The contractor completed the analyses and recommended no anomalies and/or targets for evaluation.

Sub-bottom profiler surveys conducted as part of the aquifer impact studies identified a Pleistocene stream channel that bisected this area. Savannah District geologists and a contract geoarchaeologist with Brockington and Associates selected four areas from which to take core samples—three located along the banks of the stream and one located on a terrace that formed within the stream channel as sea level rose. Analysis of the cores revealed that the sediments within and adjacent to the stream channel date to the mid-Pleistocene Era and are not associated with human activity.

Full-channel-width Dredging Area (SC waters)—Stations +9+000 to +12+750—side slope impact area of ca. 20 feet. The easterly 1000 feet has been previously impacted by construction of a 36-foot-deep turning basin. The remaining area was surveyed in 2003 by Savannah District contractor Panamerican Consultants for a then-planned 76-foot-wide bend widener plus side slopes. Eight anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 200 feet from the revised area of potential effect. No further investigations are recommended.

Full-channel-width Dredging Area (GA waters)—Stations +9+500 to +11+500—side slope impact area of ca. 20 feet. This area was surveyed for a previous deepening project. No magnetic anomalies and/or targets were located. No further investigations are recommended.

Full-channel width Dredging Area (SC waters)—Stations +27+250 to +31+750—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Ten magnetic anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 100 feet from the revised area of potential effect.

Full-channel-width Dredging Area (SC waters)—Stations +41+500 to +49+500—side slope impact area of ca. 20 feet. This area was surveyed as part of a previous deepening project. The survey identified four anomalies and/or targets for further evaluation. Two of the targets, SH-R15 and SH-R19N-1 were located within that project's area of potential of effect and were investigated. Both targets were found to be generated by modern debris. The remaining two anomalies/targets, SH-R16-2 and SH-R17N-1, have not been investigated. These targets will be relocated and assessed.

Full-channel-width Dredging Area (GA waters)—Stations +31+000 to +49+500—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Seven individual or clusters of anomalies and/or targets recommended as potentially significant are located within or near to the side slope impact area. Two anomalies and/or targets clusters (cluster 7C-1, 7C-9, 7C-10 and cluster 7E-6, 7E-14, 7E-18, 7E-34, 7E-53, 7E-55) were investigated by Panamerican Consultants, Inc., in 2005 and were found to be generated by modern debris. The remaining three potentially significant individual anomalies and one cluster are recommended for evaluation. Anomaly 7B-4 and anomaly cluster 7C-5, 7C-14 appear to extend into the area of potential effect and will be investigated.

Bend Widener (GA waters)—Stations +49+500 to +53+000—156-foot bottom width plus side slope of less than 75 feet. In 2003, an area 450 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. In 2005, Panamerican Consultants considered diving on anomalies 7A-1 and 7A-8, but, further analysis of the fathometer data and additional remote sensing data gathered as part of that investigation found that the anomalies were located in the dredged channel bottom and were generated by modern debris. Anomaly 7A-9 would be located within the side slope of the proposed bend widener and, based on limited dated, anomalies 7A-26, 7A-28, 7A-31, and 7A-32 are located sufficiently near to the area of potential effect to warrant further investigation.

Bend Widener (SC waters)—Stations +52+250 to +55+000—76-foot bottom width plus side slope of less than 100 feet. In 2003, an area 350 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. No anomalies and/or targets were recommended for further investigation. No further investigations are proposed for this bend widener.

Full-channel-width Dredging (GA waters)—Stations +63+250 to +69+000—side slope impact area of ca. 20 feet. The westernmost 1,750 feet of this area overlaps the Fig Island Turning Basin that has been previously dredged to 38 feet. The eastern portion of this area was surveyed as part of a previous deepening project. Five anomalies and/or targets were identified, none of which were recommended for additional investigation. No further investigations are recommended for this area.

Full-channel-width Dredging (GA waters)—Stations +69+000 to +71+000—side slope impact area of ca. 20 feet. In 2003, an area 500 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Four anomalies located within the existing channel side slope (4-22, 4-24, 4-26, and 4-27) are recommended for further investigation.

Full-channel-width Dredging (GA waters)—Stations +76+000 to +77+500—side slope impact area of ca. 20 feet. In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. One anomaly (3-1) was recommended for additional investigation based on the characteristics of its magnetic signature, however, this anomaly is located at the toe of the side slope of the existing navigation channel in an area that has been dredged to 36 feet for commercial wharves. Based on the history of bottom disturbance in this area, no further investigations are recommended for this anomaly.

Full-channel-width Dredging (GA waters)—Stations +87+750 to +89+500—side slope impact area of ca. 20 feet. In 2003, an area 400 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. No anomalies and/or targets located within the side slope impact area were recommended for further investigation. No further investigations are proposed for this area.

Bend Widener (GA waters)—Stations +101+000 to +103+000—128.6 feet plus side slope of less than 100 feet. This area was investigated by a Georgia Ports Authority archaeological contractor as part of studies conducted for proposed channel modifications associated with the construction of Container Berth 8. Section 106 compliance was completed as required by a Department of the Army Permit issued under the authority of Section 404 of the Clean Water Act of 1972. It has since been dredged. No further investigations are recommended for this area.

C. *Kings Island Turning Basin Side Slopes (GA waters)—Stations 98+500 to 100+500—side slope impact area of ca. 20 feet.*

In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with side slope changes. No anomalies and/or targets were recommended for additional investigation. Two shoreline sites that had been identified by a previous survey and determined not to be eligible for inclusion in the National Register of Historic Places were relocated. No further investigations are recommended for this area.

D. *Passing Lanes*

GA and SC waters—Stations +55+000 to +68+500—100 feet wide plus side slope of less than 100 feet.

In 2005, Savannah District contractor Panamerican Consultants, Inc., surveyed an area 400 feet wide to identify potential impacts associated with this passing lane. One previously identified resource, CSS *Georgia*, is located within this area and is discussed in the following section. The survey also identified a number of magnetic anomalies and sonar targets, six of which were selected for diver investigation. Three were found to be generated by modern harbor debris, one (GA waters) was generated by the remains of a steel-hulled sailing vessel dating to the late nineteenth or early twentieth century, and two (SC waters) were generated by the remains of Confederate crib obstructions.

The sailing vessel has been tentatively identified as the pilot boat *Eclipse*, which burned in this general area in 1918. The vessel is potentially eligible for inclusion in the National Register of Historic Places. It is located behind (north of) the submerged remains of the original Fig Island jetty where historical documentation indicates that the bark *Undine* was also abandoned in 1893. *Undine* was built in 1867 as a clipper ship by William Pyle of Sunderland, England. Attempts were made to redesign the passing lane to avoid impacts to these resources, however, it was found that a shorter lane would not meet the needs of the larger vessels transiting the channel.

The Confederate crib obstructions, although severely degraded, are sufficiently intact for the site to be recommended as eligible for inclusion in the National Register of Historic Places at the local level for their archaeological research potential and association with significant events.

GA waters—Stations +16+000 to +20+000—100 feet wide plus side slopes of less than 100 feet.

An area 100 feet wide was surveyed in 1994 for the previous channel deepening project. No potentially significant sonar targets or magnetic anomalies were located in this area. The remaining 100-foot-wide impact area associated with the construction of the proposed passing lane will be surveyed. Archival research has shown that this area of the harbor has the lowest potential for containing shipwreck remains.

E. *Fish and Wildlife Mitigation Lands (GA and SC)*

In compliance with requirements of the Clean Water Act, Savannah District is working with the US Fish and Wildlife Service, US Environmental Protection Agency, the Georgia Department of Natural Resources, and the South Carolina Department of Health and Environment identified properties to be used, and actions to be taken, for mitigation of wetland impacts. Lands being considered include wetlands, submerged river bottoms, and high ground.

Plan 6a. This plan includes the following features, McCoy Cut diversion structure, channel deepening on McCoy Cut to -4m NGVD and Upper Middle and Little Back Rivers to -3m NGVD, fill entire sediment basin to -3.85M NGVD by constructing a submerged sill, close Rifle Cut, remove tide gate abutments and piers, close lower (western) arm of McCoy Cut. Because the proposed features are designed to change the hydraulics of the Middle, Little Back, and Back Rivers, the area of effect includes the construction areas as well as any areas that will be subjected to increased erosion or deposition. In order to determine the effect of the proposed plan upon historic properties, the construction areas, as well as the entire lengths of Middle, Little Back, and Back River channels and shorelines will need to be archaeologically surveyed. These surveys will include archival research, shoreline low water survey and testing, remote sensing (magnetometer and side scan sonar) surveys of submerged areas, and diver investigation of anomalies and/or targets.

One portion of Back River has been surveyed previously. In 1992, Tidewater Atlantic Research, Inc., conducted remote sensing and low water surveys of the Back River area as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the tide gate from operation. The survey area included the Back River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to lower end of Hog Island in Little Back River. The survey identified 31 archaeological sites. Sixteen were wrecked or abandoned vessels. One was a prehistoric archaeological site. The remaining sites were related to historic rice plantations (e.g. wharves, dikes, dams, bulkheads, canals, trunks, mills, etc.). The 1992 survey also identified 26 magnetic anomalies and/or sonar targets.

In 1993 and 1994 Savannah District archaeologists conducted archival research, archaeological survey, site monitoring, and diver investigations of sites, magnetic anomalies, and/or sonar targets in the portion of the 1992 survey area located above the tide gate. The purpose of the work was to determine the historical significance of the previously recorded resources and to assess the effect of the New Cut Closure Project upon these resources. A number of sites were determined eligible for inclusion in the National Register of Historic Places. The research concluded that the project had caused some erosion, the areas had stabilized and the extensive documentation conducted during the survey was sufficient to document the portions of the resources that were impacted. The potential impact of Plan 6a upon these resources will be evaluated.

Seven of the magnetic anomalies and/or sonar targets were located in the sediment basin area below the tide gate. More detailed evaluations of these anomalies/targets are needed to determine if they are located within the area of potential effect and their potential significance.

The remaining portions of the area of effect for Plan 6a are located within the Savannah National Wildlife Refuge. None of these areas have been previously surveyed for cultural resources.

Oxygenation Systems. Two areas have been proposed for construction of oxygenation systems. The area of effect for these systems includes the construction areas, as well as the submerged areas near the outlet pipes that would be subjected to larger increases in oxygen levels. Increases in oxygen result in increased degradation of submerged resources (e.g. wrecks, wharves, artifacts, etc.),

One system would be located on the South Carolina side of Back River at the tide gate. The terrestrial and submerged areas have been severely disturbed by tide gate construction and disposal of dredged material. The second system would be above the harbor located on Drakies Bluff in Georgia. The terrestrial portions of the area of effect will be surveyed for historic properties. The submerged portion of the area of effect includes a channel known as Drakies Cut. Historically, this was a small creek known as Canoe Cut. The creek was enlarged (drag lines and dredging) in the early 20th century and became the main navigation channel.

Other Environmental Mitigation Features. Other proposed environmental features include: constructing a boat ramp on Hutchinson Island, construct a fish passage at New Savannah Bluff Lock and Dam, stocking of striped bass, and restoring brackish marsh in existing Disposal Area 1S. Fish stocking will have no effect upon historic properties. The Hutchinson Island boat ramp would be located in Georgia within the area that was heavily disturbed during Tide Gate Construction and that has previously been determined to not contain historic properties. The fish ladder would be located in South Carolina in an area believed to have been disturbed during original lock and dam construction. Savannah District will conduct archival research and an archaeological survey during the design process to verify that the entire area has been disturbed. Disposal Area 1S (Georgia) was not surveyed prior to its use as a Savannah Harbor disposal area. While it is unlikely that any historic properties buried beneath the disposal sediments would retain sufficient integrity to be determined eligible for inclusion in the National Register of Historic Places, Savannah District will conduct archival research and coring investigations to investigate this possibility.

IX. Previously Identified Significant Properties Located in the Vicinity of the Area of Potential Effect Warranting Special Consideration.

A. *National Monuments.*

Fort Pulaski National Monument (GA)--Station -2+000 to 8+000. Constructed during the 1830s and 1840s, Fort Pulaski is operated and maintained as an historic site by the National Park Service. It is included in the National Register of Historic Places at the national level of significance for its architecture, association with significant events, association with significant people, and archaeological research potential. Erosion is an on-going problem on the channel ward side of monument property. While the fort itself is not endangered by the erosion, associated archaeological deposits may be. The shoreline is well outside the channel side slope and the erosion is unassociated with channel maintenance dredging.

The Monument has expressed concern about the incremental effect of wakes from deeper draft ships that would transit a deeper navigation channel. Savannah and Wilmington Districts conducted an engineering study to determine the nature and scope of this incremental effect. This study concluded that the proposed expansion project would result in a negligible increase in erosion. No further studies are recommended.

B. *National Historic Landmarks.*

Savannah National Historic Landmark District (GA)--stations +72+000 to +79+000. The Savannah National Historic Landmark District is located along the south shore of the Savannah Harbor navigation channel. The district is listed in the National Register of Historic Places at the national level for its architecture. All but one small area is protected by modern bulkheads, wharves, or rip rap. The exception is located near station +75+500 where a brick-faced wharf constructed during the last quarter of the nineteenth century forms an alcove in the modern bulkhead. This area is used for small boat mooring. Proposed channel improvements will have no effect upon the landmark district.

Fort James Jackson National Historic Landmark (GA)--station +58+000 and +59+000. Fort Jackson is located at the top of the channel side slope on the south shore of the Savannah Harbor navigation channel. It is owned by the State of Georgia and is operated and maintained as a historic site by the Coastal Heritage Society. It is listed in the National Register at the national level of significance for its architecture and association with significant events and historic figures. In 2003, in accordance with a Memorandum of Agreement between Savannah District and the Georgia State Historic Preservation Office, the District completed a bank stabilization project to protect this property from harbor operation and maintenance activities. The potential for future harbor deepening was considered in the design process. No further protection is required for this property.

C. *National Register Listed Sites.*

CSS *Georgia* (SC & GA waters)--station 58+500 to 59+000. The wreck of CSS *Georgia* is included in the National Register of Historic Places at the national level of significance for architecture, association with significant events, association with significant people, and archaeological research potential. The National Register boundary includes the channel side slope, the top of slope, and an area extending 50 feet into the authorized navigation channel. The boundary between South Carolina and Georgia runs through the wreck site. Since 1984, Savannah District has had an agreement with both states to avoid the site area during dredging by 50 horizontal feet for a distance of 1000 feet along the channel. No dredging has been conducted of any portion of the existing navigation channel located between stations +58+000 and +59+000 since 1992.

A 1992 Programmatic Agreement required Savannah District to determine past, present, and future effects of the existing Savannah Harbor Navigation Project upon this resource and to identify and evaluate alternatives to mitigate these effects. This evaluation study was conducted in 2003 in conjunction with studies to determine the incremental effect of

the proposed expansion project. The studies demonstrated that past, present, and future operation and maintenance activities have, and will continue to have, an adverse effect upon the wreck site. In addition, the proposed passing lane that would be constructed as part of the expansion project would adversely affect the site. The draft report of these investigations has been coordinated with the Georgia and South Carolina State Historic Preservation Offices. The Savannah Harbor operation and maintenance project will conduct archaeological data recovery prior to construction of the expansion project. The expansion project will be responsible for final clearance of explosive ordnance prior to deepening the channel and constructing the passing lane.

The Savannah and Ogeechee Canal (GA)--station +79+000. The river lock and northern terminus of the Savannah and Ogeechee Canal is located on the south shore adjacent to the Highway 17 Bridge. The canal was constructed during the 1830s. It is listed in the National Register of Historic Places at the state level for architecture and archaeological research potential. The proposed project will have no effect upon the canal.

D. *Properties Pending Formal Nomination to the National Register of Historic Places.*

Pennyworth Island (Back River, GA). During 1993 and 1994, Savannah District archaeologists conducted archival research, shoreline inspection, and documentation of sites along the shoreline of Pennyworth Island, in support of the New Cut Closure Project. As a result of these investigations, Savannah District recommended that Pennyworth Island was eligible for inclusion in the National Register of Historic Places at the local level for its ability to provide information on 19th century rice culture along the Savannah River. The island had a diverse history spanning the period from 1825 to the early 20th century and was one of the last active rice plantations on the river. The investigations documented all historic shoreline features, noted that shoreline erosion had been on-going for many years, and recommended that no further work be conducted for the New Cut Closure Project.

The island was in private ownership during the 1993/1994 fieldwork. Recently, it was purchased by Chatham County. The County used the 1993/1994 research to prepare a nomination to the National Register of Historic Places. The nomination is pending approval. The island may be affected by the proposed environmental mitigation measures included in the Savannah Harbor Expansion Project. Affects may include increased shoreline erosion or accretion and will be addressed in accordance with the Programmatic Agreement for the project.

E. *Properties Formally Determined Eligible for Inclusion in the National Register of Historic Places.*

Fig Island Channel Site (GA)--station +72+000 to +73+500. The Fig Island Channel Site is located on the north side slope and shore of the existing navigation channel. The site has been determined eligible for inclusion in the National Register of Historic Places at the state level for its archaeological research potential. The site area was once a channel

between Fig and Hutchinson Islands. The channel was used for disposal of wrecked and derelict vessels during the eighteenth and nineteenth centuries.

The eastern third of the site has been bulk headed and lies beneath the US Army Corps of Engineers Depot. The western two-thirds of the site has been the subject of a number of archaeological investigations. The District excavated and documented three vessels as mitigation for the effects of a 1980s channel widening project. During the 1993/94 deepening project, the District excavated and documented parts of 20 vessels. The vessels spanned the period ca. 1770 to 1900 and were located within the area of potential effect for that deepening project.

In 2000, portions of the site's 1854 pile dam wall were illegally removed. In 2003, the extreme western portion of the site was investigated as part of planning for a Chatham County project that included bulk heading the adjacent slip. One eighteenth century hull was located within the project's potential area of effect. This project requires a Department of the Army Permit that would be issued under the authority of Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972. Federal permitting and consultation under Section 106 is proceeding as part of that project. A Memorandum of Agreement has been completed identifying mitigation procedures for effects to this resource.

The remaining non-bulk headed portions of the site have been purchased by a developer who intends to bulkhead the shoreline and construct residential and commercial buildings on the site. The bulkhead would require a Department of the Army permit. The project is in an early planning stage and the owner has not applied for a permit.

The Fig Island Channel Site area will not be affected by bend widener construction or full- channel-width dredging, however, since the channel side slope has been determined eligible for inclusion in the National Register of Places, the District has conducted a slope stability analysis study to determine if incremental erosion would occur at the site. The analysis indicated that there would be no impact to the side slope.

Mansfield/Shaftsbury Plantation—09CH685 (Back River, GA). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Poplar Grove Plantation—38JA203 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register at the local level of significance for its ability to

provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

Shubra Plantation—38JA204 (Back River, SC). Savannah District archaeologists conducted archival research and field documentation for this plantation as part of the 1993/1994 New Cut Closure Project studies. The plantation was recommended eligible for inclusion in the National Register at the local level of significance for its ability to provide information on historic rice culture along the Savannah River. No further investigations were recommended for this resource as part of the New Cut Closure Project. The site may be affected by increased shoreline erosion or accretion as part of the Savannah Harbor Expansion Project. Impacts to the site will be identified and addressed in accordance with the Programmatic Agreement.

X. Consultation with Native American Tribes

The notice of availability for the 1998 draft Environmental Impact Statement for the expansion project was provided to a number of Native American Tribes. In March 2006 and November 2010, coordination letters were sent to the nineteen Federally recognized Native American Tribes who have an interest in the proposed project area informing them of the status of the project and inviting their comments. Several Tribes responded and requested that they be notified should sites with Native American components be encountered.

XI. Consultation with the Georgia and South Carolina Historic Preservation Offices

The draft Programmatic Agreement (PA) and preliminary project description were coordinated with the Georgia and South Carolina Historic Preservation Offices in March 2006. Shortly after both offices reviewed and approved the agreement, it was determined that project planning would proceed for an extended period and it was likely that large, new features would be added. It was decided to hold the document until more of the new features and their potential effect on historic properties could be identified. While the agreement document itself has not been changed, the attached supporting documentation report (this document) has been updated to reflect the final proposed project. The PA and supporting documentation are being re-coordinated with the state offices.

XII. Consultation with the Advisory Council on Historic Preservation

The Advisory Council on Historic Preservation was contacted in May 2006 and asked if they wished to participate in the Programmatic Agreement. They indicated that they would not participate at that time. They are being contacted to reconfirm that position.

XIII. Public Involvement

A number of public involvement meetings have been held as part of the National Environmental Policy Act compliance activities. Two of these events included manned cultural resources information booths which informed the public about the cultural resources studies and potential impacts to these resources.

Savannah District conducted a media day and created brochures during studies of the CSS *Georgia*. A local television station ran a series of stories on the progress of the investigations and one former reporter is creating a documentary about the vessel. District archaeologists made presentations to a large number of groups. Among them were the Society for Georgia Archaeology, local chapters of the Sons of Confederate Veterans and the United Daughters of the Confederacy, the Coastal Georgia Archaeological Society, an honors sorority, and other groups.

The 1998 draft environmental impact statement elicited 1,588 responses from individuals supporting archaeological recovery of the CSS *Georgia* and stabilization of Fort James Jackson (since completed).

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX H: Section 404(b)(1) Evaluation

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

Revised July 2012

US Army Corps of Engineers
Savannah District
South Atlantic Division

SECTION 404(b)(1) EVALUATION

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SECTION 404 (b)(1) EVALUATION
SAVANNAH HARBOR EXPANSION PROJECT

1.0 INTRODUCTION.

Section 404 (b)(1) of the Clean Water Act of 1972 requires that any proposed discharge of dredged or fill material into waters of the United States must be evaluated using the guidelines developed by the Administrator of the U.S. Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. These guidelines are located in Title 40, Part 230 of the Code of Federal Regulations. The following Section 404 (b)(1) evaluation is prepared in accordance with those guidelines. This Section 404 (b)(1) evaluation analyzes all activities associated with the Savannah Harbor Expansion Project that involve the discharge of dredged or fill material into waters of the United States, including both construction and mitigation features and long-term maintenance requirements.

This Section 404 (b)(1) Evaluation focuses on aspects of the Savannah Harbor Expansion Project that would involve the discharge of dredged or fill material into waters of the United States An Environmental Impact Statement has been prepared which provides a comprehensive analysis of the other environmental issues associated with the project.

2.0 PROJECT DESCRIPTION.

2.1 Project Location. Savannah Harbor is a deep draft harbor on the South Atlantic coast 75 statute miles south of Charleston, South Carolina and 120 miles north of Jacksonville, Florida. Savannah Harbor includes an inner harbor that comprises the last 21.3 miles of the Savannah River and an entrance channel that presently extends about 11.4 miles into the Atlantic Ocean.

2.2 General Description-Existing Project. The Savannah Harbor Navigation Project has an authorized project depth of 30-feet MLW in the inner harbor from Stations 112+000 to 105+000, 36-feet MLW from Stations 105+000 to 103+000 and 42-feet MLW from Stations 103+000 to 000+000. The width of the inner harbor channel is 200 feet from the upstream end of the project to the Argyle Island Turning Basin, 400 feet to the Kings Island Turning Basin and 500 wide (except 400-feet wide from Stations 59+000 to 58+000) from the Kings island Turning Basin to the harbor entrance. The entrance channel is 600-feet wide and 42-feet deep from Stations 000+000 to -14+000B and 44-feet deep from Station -14+000B to the present end of the entrance channel (Station -60+000B).

2.3 General Description-Proposed Project. The Savannah Harbor Expansion Project would involve various construction efforts that would require the discharge of dredged or fill material into waters of the United States. The project would include extending the entrance channel, deepening the existing entrance channel, deepening of the inner harbor to the Garden City Terminal of the Georgia Ports Authority, annual maintenance dredging of the entrance and inner harbor channels to maintain authorized project depths (including advance maintenance), expanding the Kings Island Turning Basin across from the Garden City Terminal, deepening eight container vessel berths at the Garden City Terminal, construction of three bend wideners, two meeting areas, and construction of six mitigation features.

The District developed and evaluated five channel deepening alternatives, in addition to the No Action Alternative. Each channel deepening alternative contains mitigation features to address adverse environmental impacts that they would otherwise produce. With inclusion of the mitigation features, each depth alternative is environmentally acceptable. The 47-foot depth alternative is the National Economic Development (NED) Plan, the plan that maximizes net economic benefits to the Nation (See GRR). Under current Federal planning policy, the NED plan would be recommended for implementation unless there are overriding considerations that favor recommendation of another plan. Benefits that would accrue from the deepening of Savannah Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The economic benefits increase with each additional increment of channel deepening. Environmental impacts associated with a shallower depth would be less than those associated with the NED plan, but the lesser impacts of the 44-foot depth, 45-foot depth, and 46-foot depth alternatives are not considered sufficient to justify recommendation of these alternatives instead of the NED Plan. The 47-foot depth alternative is the selected plan.

The State of Georgia has asked the Corps to consider the 48-foot depth alternative as the Locally Preferred Plan. After review of the comments received on the Draft GRR and DEIS, and discussions with the non-Federal sponsor, the Corps has elected to select the NED 47-foot depth alternative for implementation.

The details of the proposed action are as follows:

A) The existing entrance channel would be extended 37,680 feet from its current end at Station -60+000B to Station -97+680B. When completed, the entrance channel would be -49 feet MLW deep and 600-feet wide from Station -97+680B to the jetties (Station -14+000B) and then -47 feet MLW deep and 500-foot wide from the jetties to the harbor entrance (Station 0+000). Construction of the extension to the entrance channel also includes a bend widener located between Stations -14+000B and -23+000B. The entrance channel would be dredged annually to maintain project depths.

B) The inner harbor would be deepened to -47 feet MLW from the harbor entrance (Station 0+000) to the Garden City Terminal of the Georgia Ports Authority (Station 103+000). Deepening the channel to -487feet MLW includes the construction of two

bend wideners located between Stations 27+500 and 31+500 and Stations 52+250 and 55+000 Inner harbor improvements also include the construction of two meeting areas between Stations 14+000 and 22+000 and Stations 55+000 and 59+000, respectively. The Kings Island Turning Basin, located between Stations 98+000 and 101+000, would also be deepened and expanded. The inner harbor would be dredged annually to maintain project depths, and authorized advanced maintenance.

C) Container Vessel Berths 2,3,4,5,6,7,8 and 9 at the Garden City Terminal of the Georgia Ports Authority would be deepened to -47 feet MLW. Maintenance of these berths after initial project construction would be the responsibility of the project sponsor.

D) Some components of the Mitigation Plan would be constructed to minimize an increase in upstream salinity levels caused by harbor deepening. These aspects of the mitigation were developed to minimize the anticipated increase in upstream salinity levels in the area of the Savannah National Wildlife Refuge. The plan includes a diversion structure at the entrance to McCoys Cut, closing the western arm of McCoys Cut, deepening a portion of McCoys Cut to -12 feet MLW, deepening a portion of Little Back River to -10 feet MLW, deepening a portion of Middle River to -10 feet MLW, and closing Rifle Cut. The plan also includes constructing a rock sill where Back River joins Front River downstream of the Tidegate structure, placing earthen fill upstream of the rock sill to construct a broad berm that would result in subsequent natural filling of the entire Sediment Basin, and removing the Tidegate structure. While removing the Tidegate structure does not directly constitute a discharge of fill material into waters of the United States, some concrete will be temporarily discharged into Back River as a result of the demolition. Concrete from the Tidegate structure will be recycled and beneficially used by either placing it in tidal waters within the estuary to create fish habitat or in the lower portion of the Sediment Basin as fill.

E) The Mitigation Plan also includes constructing a boat ramp in Back River near the Tidegate structure. The boat ramp would be constructed to replace access lost as a result of blocking Rifle Cut. Constructing this facility would also require placing riprap along the embankment of the river.

F) Studies indicate that construction of the SHEP would result in an increase in chloride levels at the intake of the City of Savannah's Municipal and Industrial Water Treatment Facility on Abercorn Creek. These conditions would occur during very low river flow and high tides. Consequently, a storage impoundment would be constructed that would be used to store raw water for use during chloride spike events predicted to occur during these events. The storage impoundment would be approximately 28 acres. The storage pond would be located on high ground in an existing industrial park. However, in view of its size and the need to construct a pumping station, inflow and outflow pipes, etc., adverse effects to a small amount of wetlands (non-tidal) could occur. The Corps will conduct detailed surveys during final design to identify and quantify any wetland areas that would be affected. If wetlands must be impacted to construct the storage impoundment, the Corps would follow the interagency-approved Savannah District Regulatory SOP to quantify the extent of mitigation that would be needed. The

Corps would coordinate the results of the SOP calculations with the Federal and Georgia natural resource agencies.

G) Site preparation would be required in Disposal Area 1S to allow restoration of estuarine emergent wetlands. Approximately 4.2 acres of brackish marsh would be lost as a result of excavation requirements for the project, and approximately 30 acres of brackish marsh would be lost as a result of the Kings Island Turning Basin expansion. In addition, removal of the Tidegate structure would result in a loss of approximately 8.48 acres of brackish marsh. To provide in-kind mitigation, about 40.3 acres of uplands in Disposal Area 1S (formerly wetlands) would be excavated down to the adjacent marsh elevation to allow the re-establishment of estuarine emergent wetlands. Approximately 28.8 acres of the restored site would serve as the required wetland mitigation for the excavation requirements of the SHEP. The remaining 11.5 acres of marsh restoration could be used to satisfy any additional wetland mitigation requirements of the SHEP or for approved Operation and Maintenance projects associated with Savannah Harbor. Although excavation of uplands in Disposal Area 1S does not constitute a discharge of dredged material into waters of the United States, some of the soil would inadvertently be discharged into the adjacent waterways during the construction process.

H) A fish passage structure would be constructed at New Savannah Bluff Lock and Dam. Deepening of the harbor would adversely affect Shortnose sturgeon habitat in Savannah Harbor. As part of the mitigation plan for the loss of Shortnose sturgeon habitat, an off-channel rock ramp fish passage structure would be constructed at the New Savannah Bluff Lock and Dam. The New Bluff Lock and Dam is located at Mile 188 of the Savannah River. It is the first structure on the Savannah River that blocks passage of Shortnose sturgeon (and other anadromous species of fish) from traditional upstream spawning grounds. Construction of this facility would provide access for spawning fish to about 20 miles of traditional spawning habitat in the Savannah River located between the New Savannah Bluff Lock and Dam and the Augusta Diversion Dam.

I) Without mitigation, construction of the SHEP would lower dissolved oxygen levels in Savannah Harbor. The project's mitigation plan includes installation of oxygen injection systems which would be operated during the summer months to remove the incremental effects of the project on dissolved oxygen. Construction the inflow and discharge pipes for the oxygen injection systems would require excavation of material along the banks at two locations on Hutchinson Island and another site upriver near Georgia Power's Plant McIntosh. Clean fill material (sand, concrete) would be discharged into these areas to provide the necessary support structures for the oxygen injection systems.

J) The maintenance requirements of the completed project are not expected to substantially differ from the existing 42-foot project. Approximately 6 million cubic yards of dredged material would be removed from the inner harbor on an annual basis. The Base Plan (least cost and environmentally acceptable plan) for maintenance of the harbor would remain the same. Maintenance material dredged from the inner harbor would be placed in the existing seven CDFs while material removed from the entrance

channel would be place into the ODMDS or at Site 2 and Site 3 which are located just south of the entrance channel. The LTMS study completed in 1996 also authorized placement of suitable maintenance material from the first part of the inner harbor and suitable material from the entrance channel to be placed into the nearshore area off Tybee Island to create a feeder berm system as well as directly on Tybee Beach. An EIS, including a Section 404 (b)(1) Evaluation, was prepared for the LTMS study. This EIS and accompanying Section 404 (b)(1) evaluation assessed the impacts of placing maintenance material from the Savannah Harbor Navigation Project into the existing CDFs, the ODMDS, Sites 2 and 3 adjacent to the entrance channel, the nearshore sites off Tybee Island, and on the beach at Tybee Island. Construction of the 47-foot project is not expected to result in a substantial change to the quantity or the quality of maintenance sediments that would have to be removed from the completed project. Consequently, this Section 404 (b)(1) Evaluation focuses on the impacts associated with the discharge of dredged or fill material that would occur during construction of the 47-foot project.

2.4 Authority and Purpose. The Savannah Harbor Expansion Project was authorized in the Water Resources Development Act of 1999 (Public Law 106-53, Section 102 (b) (9)). The legislation required the US Army Corps of Engineers to evaluate project depth alternatives ranging from 42 feet to 48 feet and develop acceptable mitigation plans.

3.0 GENERAL DESCRIPTION OF DREDGED OR FILL MATERIAL

3.1 General Characteristics of Sediments (Grain size, soil type). Dredged sediments from Savannah Harbor are a mixture of sands, silts, and clays. Sand is defined as grain size between 0.07 and 5.0 mm while silt and clay measures less than 0.07 mm in diameter. Fill material that would be used to construct the various mitigation features of the project would include clean sand, rock and riprap. The following is a description of the dredged and fill material that would be discharged into waters of the United States as a result of construction of the Savannah Harbor Expansion Project:

A) Savannah Harbor Entrance Channel (New Work Sediments). In the entrance channel, the reach from 0+000 to -30+750 averages about 79 percent sand. Very sandy sediments (at least 90 percent sand) occur from Stations -30+750 to -37+000, -41+250 to -47+500, and in the upper layer (down to -50 ft MLLW) from Station -47+500 to -60+000. The outermost reach for which data exists is from -60+000 to -63+000 which averages 88.4 percent sand.

B) Inner Harbor (New Work Sediments). Sandy sediments (at least 82 percent sand) occur in the upper harbor from Stations +47+000 to +45+000, +33+000 to 31+000, and 17+600 to 0+000. Reaches with the least amount of sand (no more than 37 percent sand) occur from Stations +103+000 to +76+500 and +45+000 to +33+000.

C) Sediments removed from Container Berths 2, 3, 4, 5, 6, 7, 8, and 9 would contain a high percentage of silts and clays.

D) Construction of the various features associated with the Mitigation Plan would involve placing structures in McCoys Cut, Rifle Cut, and Back River to divert, impede or stop the flow of water. Materials required to construct these structures include stone, armor stone, riprap, sheet pile and sand. Sediment dredged to deepen the channels in McCoys Cut, Little Back and Middle Rivers would be mostly sand. Sediment used to construct the broad berm in the Sediment Basin would come from the navigation channel during deepening construction or from the CDFs along Savannah Harbor and would consist of predominantly sand (> 75%).

E) Demolition of the Tidegate structure would result in the discharge of concrete into Back River and placement of the rubble at other estuarine sites. Construction of the boat ramp facility in Back River would require the placement of concrete for the boat ramp, as well as riprap for bank protection.

F) A storage impoundment would be constructed to serve the City Of Savannah's Municipal and Industrial water treatment plant on Abercorn Creek. This impoundment would provide a source of acceptable raw water during times (very low flows and high tides) when chloride levels increase at their intake on Abercorn Creek. Although the impoundment would be constructed on high ground, some fill might have to be placed in wetlands or construction could occur in wetlands to build the facility. The discharge of fill material to support this action would include concrete, stone and clean sand.

G) Establishment of a marsh restoration area in Disposal Area 1S would involve grading down about forty acres of high ground (former wetlands) to marsh elevation and constructing finger streams to allow tidal interchange. This high ground is mostly sand.

H) Material required to construct the fish passage facility at New Savannah Bluff Lock and Dam would be concrete and stone.

I) Fill Material-Oxygen Injection Systems. Some excavation along the river shoreline would likely be required. A discharge of clean sand and concrete would be required to provide support structures for the oxygen injection systems.

J) Entrance Channel Maintenance Sediments. Entrance channel maintenance sediments are primarily sand, except for sediments between the jetties (Station -5+000B) and at Station -45+000B which have high silt and clay components. Table 1 shows the characteristics of maintenance sediments in the entrance channel.

Table 1. Composition of Maintenance Sediments in Entrance Channel

Stations	Percent Sand	Percent Silt
0+000 to -10+000B	86	14
-10+000B to -20+000B	81	19
-20+000B to -30+000B	79	21
-30+000B to -40+000B	77	23
-40+000B to -50+000B	74	26
-50+000B to -60+000B	93	7

K) Inner Harbor Maintenance Sediments. The upper harbor from Stations 100+000 to 110+000 (including the Kings Island Turning Basin) has areas of high sand content (up to 88.7 percent sand) and areas with low sand content (3 percent sand). The ENSR toxicity test sample composite (KI, T110, T100) contained 66.9 percent sand. From Station 50+000 to 100+000 and the sediment basin, sand measurements range from 8 to 78 percent sand, with the area generally characterized by low sand content. The ENSR toxicity test sample for the channel composite (T60, T70, T80, T90) was 20.5 percent sand. The ENSR toxicity test sample for the sediment basin composite contained 8.6 percent sand. The area from Stations 27+500 to 50+000 is mostly sand, with sample measurements ranging from 0 (one sample) and 65 to 85 percent sand. The ENSR toxicity test sample composite (T30, T40, T50) contained 70.6 percent sand. The area from Stations 27+500 (Field's Cut) to 0+000 (at harbor entrance) is mostly sand with area samples ranging from 17 to 100 percent sand, with the average for all samples showing > 86 percent sand. The inner harbor maintenance sediments are primarily silts and clays from the upper end of the proposed project (Station 103+000) to Station 56+000. The reach from Station 56+000 to 25+000 has a higher percentage of sand in the sediments with the exception of the area in the vicinity of Station 36+000, which contains almost no sand. Sediments found between Station 25+000 and the mouth of the harbor are primarily sand. Sediments found in the Sediment Basin are almost totally silt.

Table 2 shows the maintenance sediment characterization by reach.

Table 2. Inner Harbor Sediments Composition

STATIONS	SAND (%)		FINES (%)
112+500 to 105+000	80		20
105+000 to 79+000	68		32
79+000 to 63+000	10		90
63+000 to 40+000	20		80
40+000 to 0+000	60		40
Sediment Basin	10		90

3.2 Quantity of Sediments (Cubic Yards). The following estimates indicate the amount of dredged or fill sediments that would be discharged for each action described above:

A. Project design estimates indicate that about 10.6 MCY of sediments will have to be removed to deepen the existing entrance channel to -49 feet MLLW, construct a bend widener, and extend the bar channel from Station -60+000B to -97+680B. Annual maintenance dredging requirements would increase only slightly for the improved entrance channel to about 1.12 MCY per year.

B. Deepening of the inner harbor from Stations 4+000 to 103+000 to -47 feet MLLW, construction of two bend wideners and two meeting areas, and deepening and expanding the Kings Island Turning Basin would require dredging approximately 13.0 MCY of sediments. Annual maintenance dredging requirements would change only slightly for the deepened channel versus the existing 42-foot channel. Estimates indicate that the annual maintenance dredging requirements for the 47-foot channel would be approximately 7.0 MCY per year.

C. Deepening the eight container berths at the Garden City Terminal of the Georgia Ports Authority would require the removal of about 170,000 cubic yards of sediments.

D. Constructing various features of the Mitigation Plan would require the discharge of both fill and dredged sediments. The present design to construct the diversion structure at McCoys Cut would require placing 8,400 tons of stone, 168 tons of sheetpile, and 266 tons of riprap. Closing the western end of McCoys Cut would require placing 5,100 tons of armor stone and 266 tons of riprap. Closing Rifle Cut would require discharging 3,300 cubic yards of sand and placing 2,500 tons of stone and 160 tons of riprap. Dredging to deepen the channel in McCoys Cut would involve removing about 208,000 cubic yards of sediments along 1.5 miles of the waterway. Dredging to deepen a portion of Little Back River would involve removing approximately 161,000 cubic yards of sediments in 1.7 miles of the stream. Dredging to improve the channel along 1.5 miles of Middle River would require removing about 74,000 cubic yards of sediments. Constructing the sill across Back River in the Sediment Basin would require placing 158,200 tons of stone. Approximately 2,100,000 cubic yards of sediment would be discharged behind the sill to create a broad berm to effectively reduce the upstream movement of saline tidal waters. Maintenance dredging of McCoys Cut, Little Back River, and Middle River is expected to occur approximately every 10 years for the duration of the project.

E. Detailed plans for construction of the boat ramp in Back River have not been developed. However, construction of a two-lane boat ramp would only involve placing a small amount of concrete into Back River and placing some riprap along the bank for stabilization.

F. Plans for the storage impoundment that would be constructed at the City of Savannah's water treatment facility on Abercorn Creek provide for it to be constructed on high ground in an existing industrial park. However, there is a possibility that some fringe non-tidal wetlands could be impacted by this construction. Fill material that would be used to construct this impoundment would consist of clean fill material as well as rock and stone.

G. The marsh restoration site in Disposal Area 1S would require the removal of approximately 437,000 cubic yards of sediment to grade the site to marsh elevation and to construct the necessary finger streams to insure the area receives sufficient tidal flow. Every effort would be made to prevent any of this material from entering adjacent water bodies. However, a small amount of this material may inadvertently enter adjacent streams during the grading and excavation processes.

H. Conceptual plans have been developed for the fish passage structure at New Savannah Bluff Lock and Dam. An off channel rock ramp design around the South Carolina end of the dam would be used. Consequently, concrete and rock would have to be placed in the Savannah River to build the structure.

I. As discussed previously, approximately 6 million cubic yards of maintenance material would be removed from the inner harbor on an annual basis.

3.3 Source of Material. Most of the dredged material that would be discharged into waters of the United States will emanate from the bottom of the Savannah River. The exceptions are the sediments that would be removed during deepening of the channels in McCoys Cut, Little Back River and Middle River. Most of the fill material (armor stone, riprap, concrete) that would be discharged into waters of the United States would be purchased from a commercial source. Sediments removed from the channel improvement dredging in McCoys Cut, Little Back River and Middle Rivers may be used to construct the broad berm in Back River. Sediments used to construct that broad berm may also be taken from Confined Disposal Facilities 12A, 13A, 13B, 14A, 14B, and Jones/ Oysterbed Island, or the material from the removal of the Tidegate structure earthen embankments.

4.0 DESCRIPTION OF THE PROPOSED DREDGED MATERIAL DISPOSAL SITES

4.1 Sites for Placement of Dredged Sediments from the Entrance Channel. Material dredged to deepen the existing entrance, extend the entrance channel from Stations -60+000B to -97+680B, and to construct the entrance channel bend widener would be discharged into the Savannah Harbor Offshore Dredged Material Disposal Site (ODMDS). Material removed from the first portion of the inner harbor (Stations 0+000 to 4+000) may also be placed in the ODMDS or an existing CDF. This work would normally be performed by a hopper dredge which would remove the material from the channel and carry it to the ODMDS. The environmental considerations and requirements for use of the ODMDS during the SHEP are addressed in Appendix R (ODMDS

Placement Evaluation). Maintenance sediments could also be deposited in Sites 2 and 3 or other approved nearshore placement areas.

Although material removed by a hopper dredge would be discharged into the ODMDS, pumping to overflow is a common practice when the sediments to be dredged are mostly sand and free of contaminants. Pumping to overflow allows the hopper dredge to take on the maximum load of material before it takes the material to the ODMDS. When the hopper dredge is inside of the 3-mile line, this overflow of dredged material from the hopper is considered a discharge of dredged material into waters of the United States. Consequently, the discharge of dredged material associated with hopper dredge overflow must be addressed using the Section 404 (b)(1) Guidelines.

On occasion, a hydraulic pipeline dredge may be used to remove material from the entrance channel. On those occasions, the new work dredged material is discharged into an existing CDF or the ODMDS. Maintenance sediments could also be deposited in Sites 2 and 3 or other approved nearshore placement areas.

The Savannah Harbor Ocean Dredged Material Disposal Site (ODMDS) is a 4.26 (2,726 acres) square mile site located south of the entrance channel. The site has been designated (December 1993) by the U.S. Environmental Protection Agency as an approved disposal site for sediments removed from the entrance channel during annual maintenance dredging operations. While this site has been cleared to receive maintenance sediments from the entrance channel, it has not been designated to receive new work sediments from the Savannah Harbor Expansion Project. Previous testing of sediments from the entrance channel revealed that maintenance sediments met the criteria of the EPA Ocean Dumping Regulations and are therefore acceptable for transportation for ocean disposal. The EIS contains an evaluation (Appendix R) of the excavation of new work entrance channel sediments, transportation to the ODMDS, and deposition into the ODMDS. At the request of EPA Region 4, the District is conducting biological testing of the new work sediments. When the results or those confirmatory tests are available, the District will prepare a Section 103 Evaluation and provide it to EPA for review and approval, before the ODMDS could be used.

4.2 <u>Disposal Sites for Dredged Sediments from the Inner Harbor.</u> New work sediments dredged from the inner harbor (Station 0+000 to Station 103+000), the two bend wideners, the two meeting areas, and the Kings Island Turning Basin would be deposited into the existing confined disposal facilities (CDFs) along Savannah Harbor. Figure 1 shows these CDFs. CDFs that would be used for the Savannah Harbor Expansion Project include 2A, 12A, 13A, 13B, 14A, 14B and Jones/Oysterbed Island. These same disposal sites would be used to maintain the completed project (Station 0+000 to Station 112+500).

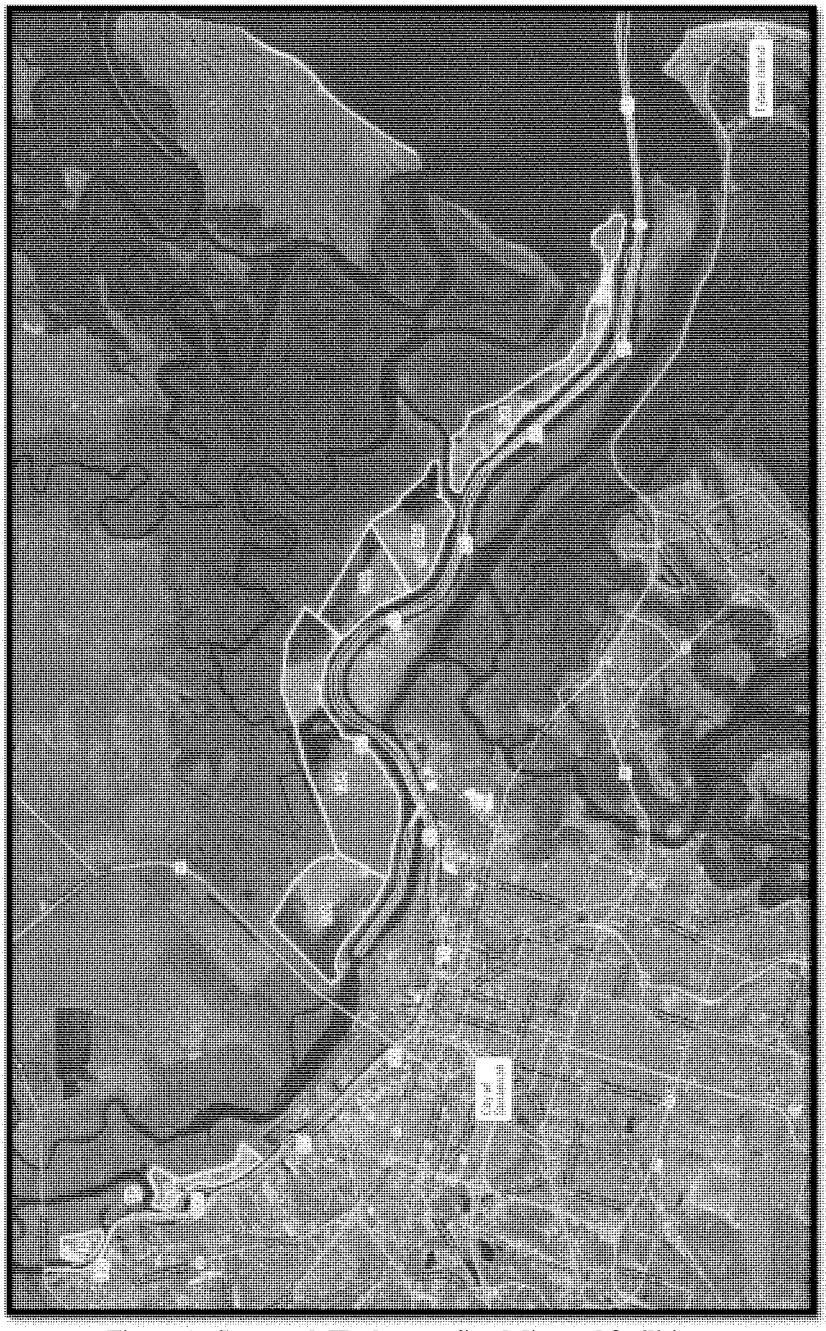

Figure 1. Savannah Harbor confined disposal facilities.

4.3 Disposal Site for Sediments Dredged from the Container Berths. Sediments dredged from the 8 container vessel berths at the Georgia Ports Authority Garden City Terminal would be discharged into existing CDFs for the Savannah Harbor Navigation Project, which include 2A, 12A, 13A, 13B, 14A, 14B and Jones/Oysterbed Island.

4.4 Sites for Dredged and Fill Material Associated with the Mitigation Plan. Figure 2 shows the major features of the Mitigation Plan, including the locations of the diversion structure at McCoys Cut, the structure that would close the western end of McCoys Cut, the one plug that would close Rifle Cut, and the location of the berm in Back River below the Tidegate. Concrete debris resulting from demolition of the Tidegate structure would be removed and placed along the banks in various locations in Back River and other portions of the estuary for fish habitat, or used to construct the berm in Back River. The boat ramp site is located in Back River at the present location of the Tidegate.

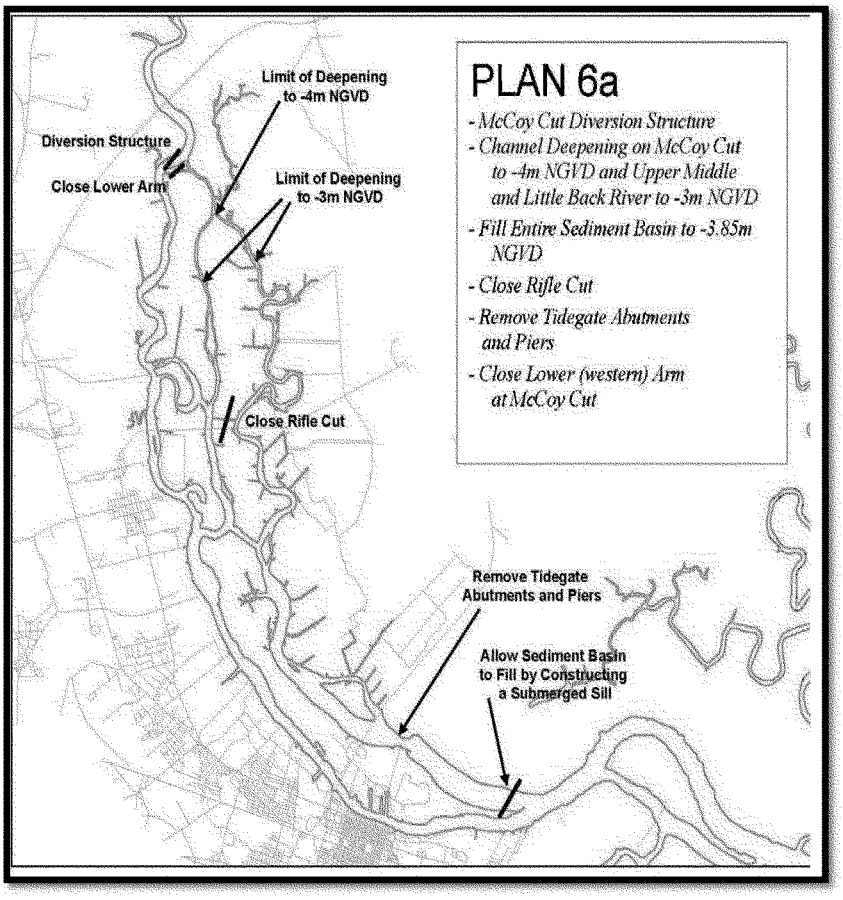

Figure 2. Mitigation flow re-routing plan.

4.5 Storage Impoundment for City of Savannah Water Treatment Plant. The discharge site for the storage impoundment at the City of Savannah's water treatment plant on Abercorn Creek would be in non-tidal wetlands (if required). The storage impoundment would be located in close proximity to the city's water treatment plant in Chatham County, Georgia. The site presently identified for this impoundment is in Parcel 3 in the Savannah River International Trade Park.

4.6 Re-establishing Wetlands at Disposal Area 1S. Some of the sediment excavated from Disposal Area 1S to permit re-establishment of estuarine emergent wetlands would be discharged into the Back River to construct the broad berm at the lower end of the basin, or into CDFs 2A or 12A. Some of the material may inadvertently be discharged into Middle River during the grading down of the dredged material deposits in Disposal Area 1S.

4.7 The New Savannah Bluff Lock and Dam. Located at about Mile 194 of the Savannah River, the discharge site for the fish passage facility would be located in the Savannah River around the South Carolina abutment of the dam.

4.8 Construction of the Pipes and Support Structures for the Oxygen Injection Systems. Fill material would be placed to facilitate construction of the inflow and discharge pipes and support structures for the three oxygen injection systems. Two systems would be located on Hutchinson Island (one in Back River and one in Front River) and one would be located near Georgia Power's Plant McIntosh upriver on the Savannah River (upstream of I-95).

4.9 Timing and Duration of Discharge. The estimated time to complete the entire Savannah Harbor Expansion Project is three to six years. The current schedule provides for a 4-year construction period. The individual construction components of the project will be of much shorter duration. Discharges of dredged sediments or fill material will be subject to restrictions which will limit when this type of work can be performed.

Use of hopper dredges in the entrance channel and subsequent disposal of the dredged sediments into the ODMDS would be restricted to the period December 15-March 31 to avoid the nesting season for endangered sea turtles, consistent with the Section 401 water quality certifications. Hydraulic pipeline dredges can be used in the entrance channel during the sea turtle nesting season since it has been demonstrated that they do not adversely affect sea turtles.

Hydraulic dredging in Savannah Harbor is not conducted above Station 63+000 during the spawning season for the Striped bass which is April 1-May 15. This restriction would also be applicable to the channel improvements proposed at McCoys Cut, Little Back River and Middle River. To minimize project impacts to sturgeon, the NMFS has stipulated in the BO that construction of the diversion structure at McCoys Cut be restricted to the period May 15-November 1 while most sturgeon are not expected to be in that portion of the estuary.

To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam will occur during the late winter/spring spawning period and early summer larval period between February 1 and May 31.

Dissolved oxygen concentrations in Savannah Harbor generally deteriorate in the summer months to where concentrations are at or below State standards. The Corps monitors dissolved oxygen levels in the vicinity of its operating dredges during the summer months. Dredging and disposal operations are stopped during these periods of low dissolved oxygen, if required. The oxygen injection systems may facilitate dredging conducted during the summer once they become operational.

4.10 Description of Proposed Dredging Methods. Hopper dredges would be used to remove sediments from Station 4+000 to -97+680B at the end of the extended entrance channel. Hydraulic pipeline dredges may also be used to remove and place dredged sediments removed from Stations 4+000 to -97+680.

The vast majority of the work in the inner harbor will be performed by hydraulic pipeline dredge. However, other types of equipment will be used as required such as barge mounted cranes, clamshells, and other mechanical dredges.

5.0 SUBPART B - COMPLIANCE WITH THE GUIDELINES

The following objectives should be considered in making a determination of any proposed discharge of dredged or fill material into waters of the United States.

5.1 Restrictions on Discharge (Section 230.10)

5.1.1 Practicable Alternatives.

"(a) . . . [N]o discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. (1) For the purpose of this requirement, practicable alternatives include, but are not limited to: (i) Activities which do not involve a discharge of dredged or fill material into the waters of the United States or ocean waters; (ii) Discharges of dredged or fill material at other locations in waters of the United States or ocean waters."

Introduction. The NEPA alternatives analysis will typically provide the information for evaluation of practicable alternatives under 40 CFR Part 230, known as the Section 404(b)(1) guidelines. 40 CFR 230.10(a)(4). The following summary describes and consolidates the comprehensive and iterative NEPA alternatives analysis for the project, and provides supplemental discussion regarding practicable alternatives.

Summary of SHEP NEPA Alternatives Analysis. The SHEP NEPA alternatives analysis ranged from considering other potential options or sites for the project, including other South Atlantic ports, to evaluating potential specific locations for disposal of dredged or fill material along Savannah Harbor and in the Atlantic Ocean along the entrance channel. The SHEP NEPA alternatives analysis is found in various places in the Environmental Impact Statement (EIS) and General Re-Evaluation Report (GRR) including EIS Section 2.0, Purpose and Need for Action; EIS Section 3.0, Alternatives; EIS Appendix O, Formulation of Alternatives; GRR Section 6, Formulation of Alternatives; various other sections in the GRR; GRR Appendix A, Economics; GRR Appendix A, Attachment 6 (Regional Port Analysis); GRR Appendix A, Attachment 4 (Multiport Analysis); and GRR Appendix D, Plan Formulation Appendix.

The SHEP NEPA alternatives analysis includes the following key elements: (1) the statement of project purpose and need (EIS Section 2.0); (2) a Regional Port Analysis (GRR, Appendix A, Attachment 6); (3) a Multiport Analysis (GRR, Appendix A, Attachment 4); (4) analysis of various structural and non-structural alternatives (EIS, Section 3.0; GRR, Appendix D); (5) analysis of eight alternative locations or sites for a port/terminal along the Savannah River (EIS, Section 3.0 and Appendix O; GRR Section 6 and Appendix D) (6) analysis of six different depths of harbor deepening along the Savannah River (EIS, Section 3.0 and Appendix O; GRR, various sections); (7) analysis of alternative disposal sites, methods, or beneficial use of dredged sediments (EIS, Section 3.01.1 and 3.07); (8) analysis of related maintenance dredging requirements (EIS, Section 3.08-3.10); and (9) analysis of the no-action alternative (EIS, Section 3.01.1 and Appendix O; GRR Section 6.12.1). For purposes of this Section 404(b)(1) guidelines discussion, these documents are incorporated herein by reference to avoid duplication.

Regional Port Analysis. The Regional Port Analysis specifically evaluated current and projected port capacity, demand, and growth, and environmental impacts and constraints for other South Atlantic ports (Norfolk, VA; Wilmington, NC; Charleston, SC; Savannah, GA; and Jacksonville, FL) and a proposed Jasper County Marine Terminal. GRR, Appendix A, Attachment 3, Final Report, pp. 1-20, and Interim Reports. In addition, the information regarding a Jasper County Marine Terminal from the Regional Port Analysis was further analyzed in a study of the potential costs and environmental impacts of locating the project at one of eight different sites along the Savannah River (four on the South Carolina side, four on the Georgia side). EIS Sec. 3.0 and Appendix O; GRR Section 6.8 and Appendix D.

Conclusions Regarding Alternative Project Sites. Among the conclusions reached as a result of the Regional Port Analysis, the Multiport Analysis, and the analysis of eight alternative sites for the project along the Savannah River were the following: (1) no one port could accommodate all the growth in container volume expected in the region, (2) there is no feasible alternative to improving Savannah Harbor because the major South Atlantic ports will experience so much cargo growth from 2005 to 2050 they will all need deepening or improvement, (3) the proposed deepening of Savannah Harbor would not take business from another port because the shipping cost efficiencies would not outweigh the additional landside transportation costs (largely due to the longer distances

from each port to and from population centers that are outside its primary service area), and (4) a Jasper County Marine Terminal would not be cost effective when compared to improving Savannah Harbor based on the high cost involved (now estimated by the Jasper Ocean Terminal Joint Project Office at more than $4 billion including the cost of constructing the new transportation infrastructure that would have to be built), and the timing (Jasper does not exist at present and cannot be constructed in time to meet the growth in demand occurring through Savannah Harbor).

Water Dependency. One of the issues to be considered during evaluation of practicable alternatives is whether a particular project is water dependent. In general, if a project is not water dependent, practicable alternatives are presumed to be available unless clearly demonstrated otherwise. A project is water dependent if the activity associated with a discharge which is proposed for a special aquatic site requires access or proximity to or siting within a special aquatic site to fulfill its basic purpose. 40 CFR 230.10(a)(3).

The special aquatic sites with regard to the SHEP are the Savannah National Wildlife Refuge and the various types of wetlands in the project area as described in EIS Section 5.1. The project generally will not involve any discharge of dredged or fill material in the Savannah National Wildlife Refuge nor into wetlands. (In a few locations, some fill material will be placed to mitigate other environmental impacts through constructing flow modifications to restore and protect freshwater and brackish marshes). The primary direct impacts to wetlands will occur as the result of excavating 15.68 acres but the excavated material would be disposed in a confined disposal facility (CDF). Although there would be no disposal of dredged or fill material in a special aquatic site (except as noted above), SHEP would clearly be considered a water dependent project, because the deepening of a harbor to allow ships to reach an upriver terminal obviously requires work to be performed in the water. Consequently, there is no presumption that practicable alternatives are available and no requirement to clearly demonstrate otherwise. Nevertheless, the following analysis clearly demonstrates no practicable alternatives are available.

Practicable Alternatives – Other Project Sites. "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 CFR 230.10(a)(2). As discussed above, the GRR/EIS contains a comprehensive analysis of alternatives to meet the project purpose of improving navigation efficiency to accommodate deeper draft container vessels. Due to the iterative nature of the analysis, several different parts of the GRR/EIS address alternatives. When read together they provide a thorough examination of environmental and economic issues for the full range of alternative projects. Importantly, the GRR/EIS carefully analyzed the feasibility of the No Action alternative, which would result in large deep-draft ships calling at alternative ports in the South Atlantic region and increasing the land transportation costs of their goods, and would not meet the project purpose and need.

Alternative management and structural measures were considered for reducing transportation costs by accommodating more efficient, deep-draft vessels. At least 10 structural measures other than deepening the channel to the Garden City Terminal were considered, including (a) other South Atlantic ports, (b), terminal development or improvements along the Savannah River at four sites in Georgia, four sites in South Carolina, (c) an Offshore Transshipment Terminal, (d) a Southeast Regional Port operating as a hub for other container ports and (e) navigation improvements. The implications of shifting traffic to other existing ports were considered in the Regional Port Analysis.

After initial evaluation, several alternatives were not carried forward for more detailed study. For example, the regional hub-and-spoke port concept was not carried forward for further review. There are several reasons supporting that decision, including the practical impossibility of meeting the need for new container capacity by concentrating traffic at a single load center. The forecasts of growth for the region are too large for any one port to handle current and projected traffic. GRR, pp. 118-19. Also, there is no precedent for construction of a US port of the size required to address southeastern US shipping traffic, or on the accelerated schedule required to have port capacity in place as container traffic grows. Moreover, double handling of containers from larger vessels to smaller ships costs time and money and increased distances to and from population centers would increase land transportation costs.

The Regional Port Analysis also includes a survey of environmental constraints facing port improvement plans on the South Atlantic coast. The survey demonstrates that development of a super-sized regional port at any of the locations considered would cause substantial environmental impacts to develop the channel improvements and land side infrastructure.

Evaluation of the feasibility of alternatives requires consideration of economic information developed for the National Economic Development study. As discussed in the main text, SHEP benefits exceed costs by a ratio of over 5 to 1. Information developed as part of the analysis confirms that shipping fleets are responding to expansion in world trade by shifting to lager more efficient deep-draft vessels, and that cargo volumes predicted for container traffic through South Atlantic ports will increase steadily from the current collective volume of less than 10 million TEUs to more than 23 million TEUs within 25 years of expansion of the Panama Canal in 2014, and reach 33 million TEUs by 2050. GRR, Regional Port Analysis, Tables 4 and 5. Handling cargo volumes of 33 million TEUs through southeastern ports will require all of the current and all of the planned capacity of ports in Norfolk, Wilmington, Charleston, Savannah and Jacksonville. GRR, Regional Port Analysis, Table 5.

If the region and nation are to enjoy the full cost savings that can be provided by accommodating deep-draft vessels, there are no feasible alternatives to SHEP for handling Savannah's 6.5 million TEU share (year 2030 projection based on demand and GPA's capital improvement program) of the total 33 million TEU demand. Expansion of Savannah and Charleston Harbors will be needed to meet projected trade demand and

to accommodate the shift in the composition of shipping fleets to larger vessels. Further, expansion at other southeastern ports and development of new container terminals such as a Jasper County Marine Terminal will also be needed to meet trade demand over the 50-year period of analysis. Expansion of Savannah Harbor will not divert traffic from other ports because each enjoys surface transportation advantages in its service area, and projected traffic volumes require the total planned capacity in the region. Therefore, there is no practicable alternative to deepening Savannah Harbor taking into account cost, existing technology, and logistics.

Practicable Alternatives – Other Locations for Disposal of Dredged or Fill Material. There are three basic issues regarding specific alternatives for disposal sites: (1) where to dispose of sediment dredged during construction and maintenance of the inner harbor, (2) where to dispose of sediment dredged during construction and maintenance of the harbor entrance channel, and (3) where to dispose of dredged or fill material during construction and maintenance of certain mitigation features. In addition to the discussion in EIS Sections 3.07, Alternative Disposal Methods or Beneficial Use of Dredged Sediments, 3.08 – 3.10, and elsewhere in this Appendix H, the following comments are provided.

Disposal of Harbor Material. Sediments dredged to deepen the inner harbor channel and construct the various improvements, as well as sediments dredged to deepen container vessel berths would be discharged into the existing CDFs along Savannah Harbor. All sediments dredged to deepen Savannah Harbor would be discharged into existing disposal areas.

Placement of sediment into existing CDFs would not constitute a discharge of dredged or fill material into waters of the United States because the CDFs are diked upland features. However, the extensive deposition will result in discharge of effluent from the CDFs, so evaluation as a Section 404 discharge is appropriate. Sediments suspended in the effluent would be of small volumes as a result of the settling that occurs within the CDF and the suspended solids limitation the Corps uses for the CDF discharges. Any naturally-occurring cadmium-laden sediment would be placed in CDFs 14A and/or 14B. Management of discharges from CDFs 14A and 14B is addressed in EIS Sec. 5.04, Appendix M, and elsewhere in this Appendix. Monitoring of the effluent from CDFs 14A and 14B would continue as long as a discharge is present and until all sediments had been covered and dewatered. Following deposition of the covering sediments, cadmium would be monitored in the effluent on a monthly basis for one year.

The practicable alternatives analysis regarding use of existing CDFs along Savannah Harbor is very simple: First, using existing CDFs along Savannah Harbor avoids the environmental impacts that would be associated with developing one or more new CDFs, if any sites were available. Second, using existing CDFs along the harbor and allows the most cost-efficient transportation of dredged material (pumping to CDFs located along the river close to the dredging location). Third, there is only one other existing CDF available along Savannah River – the one owned by Southern LNG on Elba Island, and that one does not have any present or future storage capacity available for use for this project. Therefore, taking into account cost, existing technology, and logistics, there is

no practicable alternative to using the existing CDFs of the Savannah Harbor Navigation Project.

Disposal of Harbor Entrance Material. The plan for disposal of sediment dredged from the harbor entrance (and possibly the first portion of the inner harbor) is to place it in the Savannah ODMDS, as described in EIS Section 3.07. An earlier plan to place some of the harbor entrance sediments in nearshore sites that would nourish Tybee Island was eliminated because of objections from Georgia DNR-CRD and the City of Tybee Island (EIS Section 3.07). Because these nearshore sites are no longer considered acceptable for deposition of sediments from this project, they are not practicable alternatives. An earlier plan (See Figure 3-2 in the EIS) also provided for some of the material to be placed in five sites (Sites 2-6) south of the entrance channel to construct submerged feeder berms and in two sites (Sites 11 and Site 12) south of the entrance channel to provide additional fish habitat. These sites were also eliminated based on objections from Georgia DNR-CRD and the City of Tybee Island. Consequently, these seven sites are not practicable alternatives. No other approved ocean disposal sites than the Savannah ODMDS exist in reasonable proximity to where the harbor entrance channel dredging work would occur, and therefore no other practicable alternatives have been identified. Furthermore, use of the existing Savannah ODMDS would have minor environmental impacts as described in the EIS and this Appendix.

Disposal of Mitigation Feature-Related Dredged or Fill Material. The remaining discharges of dredged and fill material included in the Savannah Harbor Expansion Project are associated with the various mitigation features of the project. Most of these discharges are associated with the implementation of the Mitigation Plan, which is designed to minimize the effects of increasing upstream salinity levels by increasing freshwater flow into the Back River, while shifting salinity increases largely to the Front River The discharge of dredged sediments associated with the Mitigation Plan includes sediments from the channel improvements in McCoys Cut, Middle River and Back River which would be discharged into existing CDFs, the sediments used to construct the plug in Rifle Cut, and the sediments used to construct the broad berm in the Sediment Basin. Discharges of fill material associated with the Mitigation Plan include construction of the diversion structure at McCoys Cut, construction of the submerged berm in Back River, and construction of the boat ramp with riprap in Back River. Other discharges of fill material associated with the mitigation features of the project include the construction of a fish passage structure on the Savannah River at the New Savannah Bluff Lock and Dam, the placement of concrete rubble from the Tidegate structure along the river shores to create fish habitat, the construction of support structures for the oxygen injection systems, and possibly some placement of fill in non-tidal wetlands to construct the storage impoundment near the City of Savannah's water treatment plant on Abercorn Creek.

Consequently, all discharges of dredged and fill material associated with the mitigation aspects of the Savannah Harbor Expansion Project would be into existing disposal areas or into sites specified in the project's Mitigation Plan. The discharges of dredged and fill material to construct the plug in Rifle Cut, the berm in the Sediment Basin, the diversion

structure at McCoys Cut, the boat ramp in Back River, and the fishway at New Savannah Bluff Lock and Dam would occur in open water on unconsolidated water bottoms. There would be no discharge of dredged material into emergent wetlands associated with the construction of these mitigation features. Construction of the support structures for the oxygen injection systems would require excavation of areas along the bank of the Savannah River and Back River. Fill material in the form of clean sand or concrete may be required to construct the support structures. The sites for these support structures would be selected to avoid emergent wetlands if at all possible. If the construction of these sites requires the excavation or filling of emergent wetlands, mitigation would be required.

The activity described above must be performed to implement the project's Mitigation Plan, which in general terms is designed to avoid, minimize, and compensate for increased salinity upriver. During development of the project mitigation plan, a series of flow re-routing options and plans (alternatives) was developed and analyzed based on effectiveness of these measures in reducing project impacts and their cost. EIS Section 5.1.2.3 and Appendix C, Mitigation Planning, pp. 15-37. Taking into account cost, existing technology, and logistics in light of overall project purposes, there is no practicable alternative to the selected Mitigation Plan. Further, as noted, the discharge of dredged material during this activity would be to existing CDFs, with relatively minimal discharges from these CDFs into waters of the United States. The discharge of fill material during this activity would be of clean fill required to accomplish the goals of the Mitigation Plan, and therefore could not take place at any other location (*i.e.*, there is no practicable alternative to the discharge of fill material involved).

Conclusion. The alternatives analysis contained in the GRR and EIS, as supplemented by the above discussion of practicable alternatives, fully satisfies NEPA and the Section 404 (b)(1) Guidelines. The proposed discharges of dredged and fill material associated with the Savannah Harbor Expansion Project have been evaluated and there are no known practicable alternatives with less adverse impacts on the aquatic ecosystem.

5.1.2 State Water Quality Standard or Toxic Effluent Standards.

"(b) Discharged of dredged material shall not be permitted if it;"

"(Causes or contributes, after consideration of disposal dilution and dispersions, to violations of any applicable state water quality standard;"

"(2) Violates any applicable toxic effluent standard or prohibition under Section 370 of the Clean Water Act."

Samples were taken in 1997 and 2005 from the entire Savannah Harbor Expansion Project area from the entrance channel to the upstream limit (Station 103+000) of the project. Analysis of the samples included investigations for metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients. Sample analysis results indicated there was only one main concern relating to

the dredging and subsequent disposal of the sediments from the Savannah Harbor Expansion Project. Some of the sediments in the Miocene clay that would be encountered during construction contain elevated levels (naturally occurring) of cadmium. All cadmium-laden sediments would be placed in CDFs 14A and/or 14B and capped/covered with cleaner new work sediments. Those sites would subsequently receive placement of Operation and Maintenance sediments to further cover the cadmium-laden sediments deposited in the disposal area. The effluent from CDFs 14A and 14B would be carefully monitored to ensure water quality standards are met. See Section 6.4 below for a complete discussion concerning the proposed dredging and disposal of cadmium-laden sediments.

The effluent from all CDFs is monitored for physical parameters (dissolved oxygen, suspended solids, pH, etc.) to ensure the CDFs are operating as designed. As a requirement of the Section 401 Water Quality Certification for the SHEP, weekly monitoring of the effluent from the CDFs would be conducted. Parameters to be monitored include total suspended solids, dissolved oxygen, pH, temperature, salinity, turbidity and conductivity. Corrective measures are taken when sample results indicate that discharges are not meeting state standards.

Hopper dredge overflow would also result in the discharge of dredged material into waters of the United States. However, no significant water quality degradation would be expected from allowing the practice of dredging to overflow when dredging in the open ocean. The material would be mostly silts with some clays. The increase in suspended solids and turbidity would be temporary in nature and occur in the open ocean. Based on previous sediment sampling, there are no contaminants of concern in the sediments where the hopper dredges would be working.

Based on the above determinations, there is no indication that the dredging and subsequent disposal of the inner harbor sediments from the Savannah Harbor Expansion Project will violate any state water quality standard or any applicable toxic effluent standard established under Section 370 of the Clean Water Act.

5.1.3 Threatened and Endangered Species.

"(3) Jeopardizes the continued existence of species listed as endangered and threatened under the Endangered Species Act of 1973, as amended."

A Biological Assessment of Threatened and Endangered Species (BATES) was prepared for the SHEP (See Appendix B). The BATES concluded that the SHEP may affect but is not likely to adversely affect North American right whale, humpback whale, sperm whale, leatherback turtle, loggerhead turtle, kemp's ridley turtle, hawksbill turtle, green sea turtles, Piping plover, Shortnose sturgeon and Atlantic sturgeon or their critical habitat. The BATES was submitted to the USFWS and the NMFS for their review and Biological Opinion. The report of the USFWS and the BO submitted by the NMFS are included in Appendix Z of this document.

The majority of the dredged material that would emanate from the SHEP would be discharged into existing CDFs. Some of the dredged material as well as clean fill material would be used to construct the various mitigation features of the project. Material used to construct these mitigation features would be discharged into unconsolidated river bottoms. These discharges of dredged or fill material would not adversely affect any critical endangered species habitat in the Savannah Harbor estuary.

Deepening Savannah Harbor would adversely affect Shortnose sturgeon habitat by increasing upstream salinity levels and causing a decrease in dissolved oxygen levels. The discharge of dredged and fill sediments associated with the Savannah Harbor Expansion Project will actually be an integral part of minimizing these impacts. The diversion structure at McCoys Cut, the structures to close the western end of McCoys Cut and Rifle Cut, the submerged sill in the Sediment Basin and the fill behind it, and the submerged sill in Middle River are all designed to minimize the anticipated increase in upstream salinity levels that would be caused by harbor deepening. Also, the fish passage structure at New Savannah Bluff Lock and Dam would allow Shortnose sturgeon access to about 20 miles of traditional spawning habitat between New Savannah Bluff Lock and Dam and the Augusta Diversion Dam. The discharge of fill material to facilitate construction of the support structures for the oxygen injection systems would allow these systems to be constructed and operated. The oxygen injection systems are designed to remove the incremental effects of the SHEP on the dissolved oxygen regime in Savannah Harbor. Consequently, construction and operation of the oxygen injection systems would minimize the adverse effects of the project on dissolved oxygen and thus minimize impacts on Shortnose sturgeon habitat.

The NMFS' BO included stipulations relating to the discharge of dredge and fill material to protect sturgeon.

1. To protect spawning sturgeon and their offspring, no-inwater fish passage construction downstream of the New Savannah Bluff Lock and Dam shall occur during the late winter/spring spawning period and early summer larval period between February 1 and May 31 of any year. In-water construction of the fish passage may be performed upstream of the dam throughout the year.
2. The construction of the diversion structure associated with the flow re-routing modifications has the potential to cause injury to sturgeon. The impact to sturgeon shall be minimized by constructing the diversion structure while most sturgeon are congregated upstream of the construction area between May 15 and November 1.
3. Appropriate erosion and turbidity controls shall be utilized wherever necessary to limit sediments from entering the water.

Project plans would include these stipulations.

5.1.4 Marine Sanctuaries.

"Violates any requirements imposed by the Secretary of Commerce to protect any marine sanctuary designated under Title III of the Marine Protection Research and Sanctuaries Act of 1972."

The discharge of dredged or fill material associated with the Savannah Harbor Expansion Project will not affect any marine sanctuary or other items addressed under the Act.

5.1.5 Human Health or Welfare.

"(c) Except as provided under Section 404(b)(2), no discharge of dredged or fill material which will cause or contribute to significant degradation of the waters of the United States. Findings of significant degradation related to the proposed discharge shall be based upon appropriate factual determinations, evaluations, and tests required by Subparts B and G of the consideration of Subparts C-F with special emphasis on the persistence and permanence of the effects contributing to significant degradation considered individually or collectively include:"

"(1) Significant adverse effects of the discharge of pollutants on human health, or welfare including, but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites."

The discharge of dredged or fill material associated with the SHEP would not result in the discharge of pollutants that would have adverse effects on municipal water supplies, plankton, fish, shellfish, wildlife or special aquatic sites. There would be no discharge of dredged or fill material in the vicinity of a municipal water supply intake, designated shellfish harvesting area or special aquatic site.

Sediment testing has been conducted along the entire stretch of inner channel that would be deepened. The only contaminant of concern detected at elevated levels was cadmium which was detected in sediments along some portions of the inner harbor channel. Dredged sediments with elevated levels of cadmium would be discharged into CDFs 14A and/or 14B and kept in a wet environment until they could be covered with other sediments from the harbor until concentrations of cadmium in surficial sediments are at an acceptable level (<4 mg/kg). The effluent from CDFs would be monitored to ensure that no applicable water quality standards were violated.

5.1.6 Aquatic Life and Wildlife Dependent on Aquatic Ecosystems.

"(2) Significant adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent upon aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their by-products outside the disposal site through biological, physical, and chemical processes."

The dredged material containing naturally-occurring cadmium at elevated levels would be placed in CDFs 14A and/or 14B. Studies indicate that this material can be dredged

and placed in the CDFs without a significant release of cadmium to the environment. Fill material (i.e., sand and rock) would be good, clean material. Therefore, provisions of the above paragraph would not be violated.

5.1.7 Aquatic Ecosystem Diversity, Productivity and Stability.

"(3) Significant adverse effects of the discharge of pollutants on aquatic ecosystems diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or

(4) Significant adverse effects of the discharge of pollutants on recreational, aesthetic, and economic values."

The discharge of dredged material associated with the Savannah Harbor Expansion Project would not adversely affect any emergent wetlands or wildlife habitat. Some of the dredged material as well as fill material would be discharged into unconsolidated water bottoms to construct the various mitigation features of the project. The dredged material to be used to construct the mitigation features does not contain any contaminants at levels of concern that would prohibit it from being used for this purpose. The fill material would be clean sand and rock,

Essential Fish Habitat (See Appendix S) in the project area includes estuarine emergent wetlands (includes palustrine, emergent, and forested wetlands), submerged aquatic vegetation, oyster reefs and shellbanks, intertidal flats, aquatic beds, estuarine water column (during construction) and estuarine water column (dissolved oxygen). Most of the dredged material emanating from the SHEP would be discharged into existing CDFs. Some dredged material would be discharged into open water areas to construct the mitigation features of the project. This dredged material does not contain contaminants at levels of concern. The dredged material to be discharged into open water sites to construct some of the mitigation features would not be discharged into any estuarine emergent wetlands. Adverse effects to other essential fish habitat (water column, etc.) would be avoided by not discharging any dredged material into open water areas above Station 63 during the Striped bass spawning season (April 1-May 15). As directed by the NMFS in the BO, construction of the diversion structure at McCoys Cut would only be conducted during the period May-15-November 1 to avoid possible impacts to surgeon that use the area.

The BO also contains a provision to protect fish habitat in the vicinity of the New Savannah Bluff Lock and Dam during construction of the fish passage facility. To protect spawning sturgeon and their offspring, no in- water construction downstream of the New Savannah Bluff Lock and Dam would occur between February 1 and May 31.

Some of the fill material that would be used to construct some of the mitigation features could impact estuarine emergent wetlands. Construction of the inflow and discharge pipes and support structures for the oxygen injection systems would require excavation of bank areas in Front River and Back River. Every effort would be made to avoid any

areas with estuarine emergent wetlands. If estuarine emergent wetlands cannot be avoided, mitigation would be required. Restoration of wetlands in Disposal Area 1S would provide 11.5 acres of wetland restoration beyond what is currently needed to offset wetland losses associated with SHEP. The 11.5 acres of excess wetland restoration would provide more than enough wetland mitigation credits to offset any wetland losses associated with constructing the oxygen injection system support facilities.

The closure of the western end of McCoys Cut (connects Front River to Middle River) and Rifle Cut (connects Middle River to Little Back River) will have a minor impact on recreational boating. Boaters will still have access to all waterways in the project area. A boat ramp would be constructed at the Tidegate location to provide easier access to the lower ends of Middle River and Little Back River as mitigation for the closure of Rifle Cut.

5.1.8 Steps Taken to Minimize Adverse Effects.

"(d) Except as provided under Section 404(b)(2), no discharge or dredged or fill material shall be permitted unless appropriate and practical steps have been taken which will minimize the potential adverse effects of the discharge on the aquatic ecosystem."

Most of the dredged material emanating from the SHEP would be discharged into existing CDFs, which would greatly minimize adverse impacts to the aquatic environment.

As previously discussed, sediments dredged from the inner harbor that have elevated cadmium levels will be discharged into CDFs 14A and/or 14B and capped/covered with clean sediments. The effluent that is discharged from these CDFs will be monitored for various parameters including cadmium to ensure that no applicable water quality standards are violated.

The dredged sediments discharged into Back River to partially fill in the Sediment Basin would be placed behind a submerged broad berm to prevent the sediments from moving into other areas of Back River. Hydraulic dredging in the inner harbor channel and the subsequent disposal of the dredged sediments would not be permitted above Station 63+000 from April 1 through May 15 to avoid the striped bass spawning season. The construction restrictions of the NMFS in the BO with respect to surgeon both in the Savannah Harbor estuary and in the vicinity of the New Savannah Bluff Lock and Dam would be adhered to.

6.0 FACTUAL DETERMINATION (SECTION 230.11)

6.1 Physical Substrate Determination.

Consideration shall be given to the similarity in particle size, shape, and degree of compaction of the material proposed for discharge and the material constituting the substrate at the disposal site and any potential changes in substrate elevation and bottom contours.

The discharge of dredged sediments associated with the Savannah Harbor Expansion Project would mostly involve deposition of sediments into areas with similar substrate. Sediments dredged from the inner harbor would be discharged into existing CDFs along Savannah Harbor which routinely receive maintenance sediments.

Sediments dredged from the eight container vessel berths would be discharged into CDFs 2A, 12A, 12B, 13A, 13B, 14A, 14B, or Jones/Oysterbed Island, which are used regularly for deposition of maintenance material.

The discharge of dredged sediments to partially fill in the Sediment Basin would involve the use of sediments dredged from the inner harbor or from within the existing CDFs. Discharge of these sandy sediments into the Sediment Basin would change the bottom substrate in the basin, which is presently about 100 percent silt.

Sediments used to construct the various features of the Mitigation Plan, the boat ramp, the supplemental water supply line for the City of Savannah Water Treatment Plant, and the fish passage structure at New Savannah Bluff Lock and Dam would be clean, commercial-grade sand, stone, riprap, etc. These types of materials are not uncommon along the Savannah River.

Sediments dredged from the inner harbor channel and the eight container vessel berths would be discharged into existing CDFs so there would be no change to aquatic substrate elevation. Changes to the aquatic substrate elevation would be realized in the Sediment Basin. A submerged broad berm and sill would be constructed in the Sediment Basin downstream of the Tidegate, and approximately 2,100,000 cubic yards of dredged sediments would be discharged upstream of the sill. The sill and dredged sediments placed behind the berm would serve as a barrier to impede the movement of saltwater up Back River to valuable marsh areas.

There would be some change in aquatic substrate elevations where the various mitigation features are constructed including the channels in Middle and Back River and McCoy's Cut, Rifle Cut, western arm of McCoy's Cut, the new boat ramp in Back River, the new water intake structure and supplemental supply line for the City of Savannah Water Treatment Plant, and the fish passage structure at New Savannah Bluff Lock and Dam.

Possible loss of environmental values

Net loss of environmental value is expected to be minimal. Most of the dredged material from the SHEP would be placed into existing CDFs. The discharge of dredged and fill material into open water areas to construct the mitigation features of the project would be conducted in a manner to minimize impacts to the aquatic environment as previously described.

Actions to Minimize Impacts

Dredged sediments discharged to construct the broad berm in the Sediment Basin would be placed behind a rock sill to prevent the sediments from migrating downstream into Front River.

Sediments dredged from the inner harbor channel deepening and construction of the various other improvements, as well as the sediments removed from the eight container vessel berths at the Garden City terminal would be discharged into existing CDFs. Effluent from these CDFs would be monitored for physical parameters such as dissolved oxygen and suspended solids as well as other parameters of concern to ensure that these facilities are managed and functioning properly.

6.2 Water Circulation, Fluctuations, and Salinity Determinations.

Consideration shall be given to water chemistry, salinity, clarity, color, odor, taste, dissolved gas levels, temperature, nutrients, and eutrophication plus other appropriate characteristics. Also to be considered are the potential diversion or obstruction of flow, alterations of bottom contours, or other significant changes in the hydrologic regime. Changing the velocity of water flow can result in adverse changes in location, structure, and dynamics of aquatic communities, shoreline erosion and deposition, mixing rates and stratification, and normal water-level fluctuation patterns. These affects can alter or destroy aquatic communities.

Many of the components of the Mitigation Plan are designed to change water circulation patterns and salinity gradients. The discharge of dredged and/or fill material required to construct the diversion structure at McCoys Cut and the closure structures at the western end of McCoys Cut are designed to increase the flow of fresh water from the Savannah River into Little Back River and Middle River. The closure of Rifle Cut is designed to reduce the flow of water from Front River (which has a higher salt concentration) into Little Back River and Middle River. The submerged broad berm in Back River below the Tidegate and the dredged sediments placed behind it are designed to impede the flow of water from Front River (which has a higher salt content) into Back River. These changes in flows are primarily designed to help maintain a freshwater environment which is required to provide a dependable source of freshwater at the SNWR intake, maintain freshwater tidal marsh in the area, as well as protect several important fisheries including Striped bass and Shortnose sturgeon.

Loss of Environmental Value

No net loss of environmental value from a change in water circulation patterns or a change in substrate elevation is envisioned based on the above determinations.

Actions to Minimize Impacts

The discharge of dredged and fill material required to construct the mitigation features of the SHEP in McCoys Cut, Middle River, Back River and Rifle Cut would be conducted in a manner to minimize impacts to the aquatic environment. Measures to reduce impacts to the aquatic environment include confining the material that is discharged into open water and avoiding discharges of dredged material into these open water areas during the Striped bass spawning season (April 1-May 15). Construction activities required to construct the diversion structure at McCoys Cut would be restricted to the period May 15-November 1 to minimize potential impacts to sturgeon. The construction of these various flow diversion structures would actually help maintain freshwater conditions in the upper reaches of Little Back River and Middle River that would be impacted by deepening of the Savannah Harbor Navigation Channel.

6.3 Suspended Particulate/Turbidity Determinations.

Effects due to potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site. Factors to be considered include grain size, shape and size of any plume generated, duration of the discharge and resulting plume, and whether or not the potential changes will cause violations of applicable water quality standards. Consideration shall include the proposed method, volume, location, and rate of discharge, as well as the individual and combined effects of current patterns, water circulation and fluctuations, wind and wave action, and other physical factors on the movement of suspended particulates.

Sediments dredged from the inner harbor channel and the eight container vessel berths would be discharged into the existing CDFs. The CDFs allow most of the suspended particulates to settle out in the disposal area before the effluent is discharged from the CDF via a weir. Normal effluent turbidity is expected to be less than river turbidity during rain events. A test of one Savannah CDF found a solids retention rate of over 99.93 percent (Palermo, 1988). According to data collected from 1988 to March 1994, the average suspended solid level in the effluent from Disposal Area 2A was about 200 mg/L. In the remainder of the O&M CDFs, the average suspended solid level was about 100 mg/l. Background levels within the vastly larger Savannah River range from 20 to 50 mg/l during non-rain events. Discharges from the CDFs are expected to meet water quality standards or meet them with a minimal mixing zone. The discharge of effluent from the CDFs is routinely monitored for suspended solids, dissolved oxygen, pH, etc.

Sediments discharged into Back River to construct the broad berm in the Sediment Basin would be placed behind a submerged rock sill. Placing the dredged sediments behind the sill should localize areas that would experience an increase in suspended solids and

turbidity. Material used to construct the various mitigation features of the project would consist of clean sand and rock, which would cause only minor increases in suspended particulates when discharged into the affected waterway.

Allowing the hopper dredges to dredge to overflow would result in increases in suspended solids and turbidity in the area of the dredging. These impacts would be expected to be temporary and localized.

Loss of Environmental Values

Due to reduction in light transmission, reduction in photosynthesis, reduced feeding and growth of sight dependent species, direct destructive effects to nektonic and planktonic species, reduced DO, increased levels of dissolved contaminants, aesthetics.

There would be no loss of environmental values associated with the discharge of dredged or fill material for the SHEP. Most of the material from inner harbor improvements would be discharged into existing CDFs. Open water disposal of dredged or fill material would be required to construct the various mitigation features of the project including the flow diversion structure at McCoys Cut, the closure plugs in the western end of McCoys Cut and Rifle Cut and the submerged berm in the Sediment Basin. The dredged and fill material used to construct these project features would consist of rock, and material with a high sand content. Consequently, discharge of this type of material into the open water environment would be expected to have only minor impacts on light transmission and nektonic and planktonic species of aquatic life.

Actions to Minimize Impacts

The effluent discharged from the confined disposal areas is tested for suspended solids content on a routine basis. Material discharged for the mitigation structures would be carried out in a manner to minimize effects to aquatic life. This work would be scheduled to avoid the Striped bass spawning season (April 1-May 15)

Dissolved oxygen concentrations are routinely monitored in the effluent from the CDFs and in the vicinity of the dredges during the summer months when dissolved oxygen concentrations in Savannah Harbor are low. The Georgia DNR-EPD has provided guidelines for maintenance dredging activities in the Section 401 Water Certification for the SHEP which state:

> "Dredging operations must maintain a daily average of 5.0 mg/l and an instantaneous average of 4.0 mg/l throughout the water column during those times of year when the natural condition in the waterbody has a dissolved oxygen concentration level above these values. If it is determined that the natural condition in the waterbody is less than these values, the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/l deficit from the "natural" dissolved oxygen value. Up to a 10% deficit will be allowed if

it is demonstrated that resident aquatic species shall not be adversely affected. Since the available dissolved oxygen deficit has already been allocated, the USACE will only be able to conduct maintenance dredging when the dissolved oxygen, one meter from the bottom, is 3.0 mg/l or greater and the maintenance dredging does not affect the dissolved oxygen levels in the Savannah River Harbor. Variances for maintenance dredging when dissolved oxygen levels are less than 3.0 mg/l may be granted if the additional oxygen is effectively injected into the Savannah River Harbor as appropriate".

6.4 Contamination Determination.

Consider the degree to which the proposed discharge will introduce, relocate, or increase contaminants. This determination shall consider the material to be discharged, the aquatic environment at the proposed disposal site, and the availability of contaminants. Consideration of Evaluation and Testing (parts 230.60 and 230.61).

Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built upon the results of the previous work. Detailed information on the sampling and analysis can be found in Appendix M of the Draft EIS. In 1997, sediment core samples were collected and examined for sediment physical and chemical properties. The sampling area covered the entire area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients. The evaluation found that most of the sediments provided no reason for concern over potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. One potential issue identified involved sediments near the old RACON Tower site. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed in the inner harbor during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 and 94+000 (River Mile 8.5 to 17.8).

Additional studies were conducted in 2007 to assess the potential pathways by which cadmium could enter the environment during the dredging and disposal process. The additional studies included the following activities:

- Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
- Side scan sonar survey to identify and map bottom characteristics in the channel;
- Benthic community assessment;

- Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);
- Collecting dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
- Compositing and processing sediment cores to create "high cadmium" and "low cadmium" composite samples for further testing;
- Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
- Analytical testing of porewater and SLRP samples at the high cadmium locations only;
- Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and
- Risk evaluation and report preparation.

Benthic community sampling was conducted in each of the four prevalent bottom types (coarse-grained sands, medium-to–fine-grained sands, silty sands, and clay substrates) both inside and outside of the navigation channel. Results of this sampling and subsequent sample analysis indicate a substantial benthic population both within and outside of the navigation channel. Polychaetes and oligochates were the numerically dominant taxonomic groups in the coarse sand, medium sand, and silt –sand substrates. The benthic community in the clay/sand veneer (the exposed Miocene clays with the high cadmium concentrations) was the most diverse community of the four sampled substrates and included annelids, bivalves, and crustaceans as dominant taxic groups. Based on these results, the existing bottom habitat types within the Savannah Harbor navigation channel support benthic communities that are diverse and provide an available food resource. Of the area sampled, the clay/sand veneer substrates comprised approximately 28.4% of the channel bottom.

Although substantial benthic communities reside in the clay/sand veneer substrates which have naturally-occurring elevated levels of cadmium, studies indicate that the cadmium is not freely soluble or readily bioavailable to aquatic organisms. Sediment sampling was conducted in the navigation channel to determine the physical and chemical properties of the sediments proposed for dredging, to verify cadmium concentrations in the Miocene clays, and to create a high cadmium composite sample (average concentration of 30 mg/kg) and a low cadmium composite sample (average concentration of 15 mg/kg). These samples were used for physical and chemical analyses, standard and effluent elutriate creation, simplified laboratory runoff procedure (SLRP), aquatic bioaccumulation testing, and plant uptake studies.

Sediments from the navigation channel were analyzed for aluminum, arsenic, cadmium, chromium, copper, manganese, nickel, and zinc concentrations, and detected concentrations were compared to Sediment Quality Guidelines [Effects Range-Low (ERL) and Effects Range-Medium (ERM) for marine sediments to assess the quality of sediments that would be dredged. A total of five metals -- cadmium, arsenic, chromium, nickel, and zinc -- each had concentrations that exceeded ERL values, but cadmium was

the only metal that had concentrations that exceeded the ERM value. The cadmium concentration in both the high cadmium composite and the low cadmium composite exceeded the ERM value of 9.6 mg/kg.

To evaluate the bioavailability of cadmium in both the high cadmium and low cadmium composites, sequential extraction procedures (SEP) were used. SEP uses a series of progressively more aggressive chemical extractions to determine the amount of metal bound in different fractions of the sediment or soil. SEP results can be used to predict the metal concentrations that would most likely be available to aquatic organisms, plants, and wildlife. Results of the SEP for the high cadmium composite and the low cadmium composites indicated that no cadmium was detected in the exchangeable fraction, and that about 98 percent of the cadmium in the Miocene sediments was bound in relatively insoluble forms. Therefore, these results suggest that the majority of the cadmium is not freely soluble or readily bioavailable.

Water quality sampling was conducted to determine background concentrations in the receiving water in proximity to the CDF and to collect site water (dredging water) for standard and effluent elutriate creation. Chemical analysis of site water, receiving water, standard elutriates, effluent elutriates, and porewater were each evaluated to assess the potential for chemical constituents, mainly cadmium, to be mobilized through water pathways during the dredging process and after placement in the CDF. Also, the SLRP was conducted for the dry, oxidized high cadmium composite sample to evaluate the water quality of precipitation runoff in the CDF.

Analysis of the site water, receiving water, standard elutriate, and effluent elutriate results included both the total and dissolved fractions and comparisons of detected chemical constituents to Federal and state (South Carolina) saltwater acute and chronic water criteria for the protection of aquatic life. In the dredging water and the receiving water, nutrient and metal concentrations in both the total and dissolved fractions were low, and generally below the USEPA/South Carolina saltwater quality criteria for the protection of aquatic life. Cadmium was not detected in either the total or dissolved fraction of the dredging water sample or the receiving water sample.

Porewater analysis of two core samples collected from the high cadmium locations indicated that concentrations of dissolved cadmium in the porewater were low and below the laboratory reporting limit and applicable water quality criteria.

For both the standard and the effluent elutriates, there was a substantial difference in the concentrations of detected constituents in the total and dissolved fractions which can be attributed to high Total Suspended Solids concentrations. Since the high cadmium and low cadmium composite samples were comprised of consolidated, fine-grained silts and clays, a significant portion of solids remained in suspension in solution after the elutriates were created. Consequently, concentrations of metals detected in the total fraction of the standard elutriates created using the high cadmium composite and the low cadmium composite were high, exceeding State of South Carolina water quality criteria for the protection of aquatic life. However, in the dissolved fraction of both the standard and the

effluent elutriate samples, cadmium concentrations did not exceed USEPA chronic saltwater quality criteria. Therefore, the cadmium detected in the total fraction is most likely bound to the fine-grained particulates that were present in the water column.

Aquatic bioaccumulation tests were designed to evaluate the potential of benthic organisms to bioaccumulate contaminants of concern from the dredged sediments. Aquatic bioaccumulation studies were conducted using the high cadmium and low cadmium composite created from samples collected in the navigation channel. Reference sediment samples were taken from New River. Sediments were evaluated in 28-day bioaccumulation studies using *Nereis virens* (sand worm) and *Macoma nasuta* (blunt-nose clam). Survival results from the bioaccumulation tests indicated that after 28 days of exposure, none of the test sediments had significantly lower survival than the reference sediment.

After completion of the bioaccumulation testing, the organism tissues were submitted for selected chemical analyses of cadmium, copper, lead, mercury, nickel, lipids, and moisture content. In the worm tissue, cadmium and nickel concentrations statistically exceeded the reference site tissue concentrations for tissue exposed to sediment from both the high and low cadmium composite samples. In the clam tissue, cadmium and other metal tissue concentrations from the high and low cadmium composites were not statistically different from the reference.

Plant uptake testing was conducted because plants may uptake metals from sediments/soils in the aquatic and terrestrial environments at the CDF, creating a pathway of exposure form organisms that feed on the plants. Plant uptake studies (45-day) using *Cyperus esculentus* (yellow nutsedge) were conducted using the high cadmium composite and low cadmium composite soils. Reference soil for the plant uptake study was collected from a location on the dikes in the CDF.

Plant tissues exposed to the prepared soils from the navigation channel were analyzed for cadmium, copper, lead, nickel, zinc, and moisture content. Concentrations of metals in plant tissues were compared to plant tissue metal concentrations exposed to soil taken from the reference site. The mean concentrations of cadmium, nickel, and zinc in plant tissue exposed to the samples taken from the navigation channel statistically exceeded concentrations in reference tissue for both the high and low cadmium composite samples, indicating that uptake from the soil to the plants occurred for each of these concentrations.

A risk assessment was conducted to identify the potential for impacts on human health or the environment from elevated cadmium concentrations in new work sediments that would be dredged. The risk assessment evaluated potential exposures and impacts of cadmium on aquatic and benthic organisms, wildlife, and fishermen in the Savannah River and on plants, aquatic and benthic organisms, and wildlife in the CDF. A conceptual model was developed to identify potential pathways for ecological and human receptors to cadmium in new work sediments during and after dredging. The conceptual model identified exposure pathways for two environments, which are the Savannah River where sediments would be mixed with surface water and where new sediment surfaces

would be exposed, and wetland and upland habitats in the CDF where dredged sediments are discharged, forming upland soil, wetland sediments, and effluent and runoff that could enter adjacent waterways.

To evaluate the potential for adverse impacts to aquatic and benthic organisms, multiple lines of evidence (measurement endpoints) were considered. Results of the testing and analysis were compared to various benchmarks, which are standards of comparison that correspond to a known level of ecological effect (usually no effect or low effect). For sediments, total cadmium concentrations in the composite samples were compared to sediment benchmarks protective of benthic organisms. The estimated bioavailable cadmium concentrations in sediment, determined from the SEP analysis, were compared to sediment benchmarks protective of benthic organisms. For surface water, cadmium concentrations in overlying water from the bioassays, in sediment porewater, and in elutriates prepared to mimic worse-case surface water conditions during dredging were compared to surface water benchmarks protective of aquatic and benthic organisms. For aquatic organism tissue, worm tissue concentrations from laboratory bioaccumulation exposures using sediment composite samples were compared to tissue benchmarks protective of benthic organisms. Worm tissue concentrations were used to estimate fish tissue concentrations which were also compared to benchmarks.
Based on risk assessment analyses, the following conclusions were reached:

Cadmium in new work sediments is not likely to cause adverse impacts to aquatic and benthic organisms in the Savannah River. While total concentrations of cadmium and in sediment and water are elevated above benchmarks, the bioavailability of cadmium is limited. Dissolved concentrations of cadmium in porewater, standard elutriates and overlying water from bioaccumulation tests were lower than benchmark concentrations protective of aquatic and benthic organisms. SEP data indicated that more than 98 percent of the cadmium in the sediment is not likely to be available to aquatic and benthic organisms. This is also reflected in bioaccumulation test results, which demonstrated that tissue concentrations of cadmium were either similar to reference concentrations or below no-effects tissue residue benchmarks.

While cadmium concentrations are likely to be elevated in sediment and water during and after dredging in Savannah Harbor, the limited bioavailability and bioaccumulation potential of cadmium results in relatively low doses to wildlife and no potential for adverse effects. Food web ingestion models were used to quantify exposures to evaluate potential adverse impacts to wildlife from cadmium in new work sediments. The assessment evaluated exposures for birds and mammals that consume fish and benthos that included blue heron, spotted sandpiper, osprey, and river otter. When considered in conjunction with life history and feeding habitat information, the modeled doses of cadmium were below benchmarks for each species. Risks to wildlife were further evaluated using limited dose benchmarks, which were developed based on the wildlife food web models as a protective standard of comparison for cadmium concentrations expected after dredging. The average cadmium concentrations expected for channel bottom sediments after dredging were below sediment limiting dose

benchmarks, indicating that wildlife are not likely to be at risk from cadmium in sediments expose by the dredging process.

The predicted concentration in game fish tissue was below the thresholds protective of human health, indicating there are no adverse impacts to humans. The projected concentration in a representative game fish species (flounder) was compared to fish tissue benchmarks protective for human consumption and found to be within acceptable limits.

Cadmium in dredged material and held at the CDF in a wet condition and in effluent, runoff, sediment discharged from the CDF are not likely to cause adverse impacts to plants in drainage areas and wetlands. The measurement endpoints evaluated for plants in upland CDF drainage areas and wetlands indicated that while total concentrations of cadmium in sediment and water were elevated, the bioavailable concentrations in sediment and the dissolved concentrations of cadmium in effluent elutriates and simulated runoff were below benchmarks protective of plants. Cadmium concentrations in the overlying water from the bioaccumulation tests were also below benchmarks.

Cadmium in sediments placed in the CDF is not likely to cause adverse impacts to aquatic and benthic organisms in drainage areas, impoundments, and wetland areas of the CDF. While total concentrations of cadmium in sediment and water were elevated above benchmarks, the bioavailability of cadmium is limited and unlikely to cause adverse impacts. Dissolved concentrations of cadmium in porewater, effluent elutriates, and overlying water from bioaccumulation tests were lower than benchmark concentrations protective of aquatic and benthic organisms. SEP analysis of the sediments demonstrated that more than 98 percent of the cadmium in sediments is not likely to be bioavailable to aquatic and benthic organisms. Bioaccumulation tests indicate that test tissue concentrations of cadmium were either similar to reference concentrations or below no-effects residue benchmarks or estimated tissue concentrations for higher trophic level fish were also below on-effects residue benchmarks.

There is a strong indication that cadmium is not likely to cause adverse effects to wildlife using drainage areas, impoundments, and wetlands at the CDF. Risks to wildlife from cadmium in wetland environments at the CDF were evaluated using food web ingestion models to quantify exposures. The assessment evaluated exposures for birds and mammals that consume plants, fish, and benthic organisms, and modeled doses were compared to no-effects and lowest observable effects benchmarks. Great blue heron, spotted sandpiper, osprey, Canada goose, muskrat, and river otter were used as representative or surrogate receptor species. Food web ingestion models based on concentrations in sediment composites and effluent or runoff indicated that for all species, except sandpiper, the doses of cadmium were below benchmarks. For sandpiper, the cadmium concentration in the high cadmium composite exceeded the no-effect benchmark, but did not exceed the lowest observable effects benchmark. Limiting dose benchmarks were developed based on the wildlife food web models as a protective standard of comparison for concentrations expected at the CDF. The concentrations of

cadmium expected in sediment and water at the CDF were all below limiting dose benchmarks.

Evidence from measurement endpoints indicates that there may be a limited potential for adverse impacts to plant growth from cadmium in new work sediments placed in the CDF.

Risks were evaluated for exposures in the CDF to upland soils composed of dredged sediments, to effluent discharged from the CDF, and to runoff discharged from the CDF. Dredged sediments placed in uplands is expected to undergo changes in soil chemistry that may make cadmium more bioavailable. The SEP indicates that a small but significant fraction of the total cadmium becomes more bioavailable as sediments dry. Plants may be exposed to cadmium through direct contact with soil. To evaluate the potential for adverse impacts to plants, multiple measurement endpoints were considered. Total cadmium concentrations from sediment composite samples were compared to soil benchmarks protective of plants. Estimated bioavailable cadmium concentrations based on SEP analysis of sediment composite samples were compared to soil benchmarks protective of plants. Plant biomass generated in bioassays was considered as a measure of growth and was compared to reference and control sample biomass. The total concentrations of cadmium in sediment exceeded benchmarks. However, SEP data indicated that more than 80 percent of cadmium is bound in the soils in forms not available to plants, and bioavailable concentrations in sediment did not exceed benchmarks. Bioaccumulation test results indicated that plant tissue concentrations for high and low cadmium composites were higher than reference concentration, but the plant tissue concentrations were below tissue residue benchmarks. Plant growth in the bioassays was statistically significantly lower for plants grown in high and low cadmium composites than for control and reference treatments. This reduced plant growth may be related to cadmium concentrations and/or the fine-grained size of the dredged sediments.

Cadmium concentrations in dredged sediments to be discharged into CDFs 14A and 14B could cause adverse effects to wildlife using uplands if not managed properly. Some of the dredged sediments that would be removed from the inner harbor are cadmium-laden. Project plans call for these sediments to be placed in CDFs 14A and/or 14B and held in a wet state until they can be covered with new material that is expected to have cadmium concentrations of 4 mg/kg or less. If necessary, an additional cap of sediment from operation and maintenance dredging would also be placed on the cadmium- laden sediments. Capping/covering material would be expected to produce tissue levels in target vertebrates below lowest observable effects limiting dose benchmarks. Risks to wildlife from cadmium in upland habitats were evaluated using food web ingestion models to quantify exposures. Models included site-specific bioavailability factors developed based on SEP analyses of the sediments and site-specific bioaccumulation factors developed based on sediment bioassays using plants. Modeled doses were compared to no-effects and lowest observable effects benchmarks. The assessment evaluated impacts for birds and mammals that consume plants, invertebrates, and small mammals which included the song sparrow, marsh wren, red-tailed hawk, meadow vole short-tailed shrew and red fox. Using concentrations in

sediment composites and effluent or runoff, modeled doses for song sparrow, marsh wren, and shrew for both low and high cadmium scenarios exceeded both no-effects and low-effects benchmarks. This indicates a definite for potential adverse effects to these receptors.

SHEP Cadmium Placement and Monitoring Plan. Based on the findings of the various studies relating to the dredging and disposal of cadmium contaminated sediments, a disposal and monitoring plan was developed for the Savannah Harbor Expansion Project. All of the cadmium- laden sediments that would be dredged from the inner harbor would be deposited into existing CDFs 14A and 14B. These sediments would be kept in a wet environment until a covering layer could placed on the material and sediment samples taken from that cover indicate that cadmium concentrations in the surface sediments are less than 4 mg/kg. Studies indicate that allowing the sediments in the CDF to dry changed the behavior of the cadmium in the sediments. Sequential extraction procedures on washed and dried sediment showed that cadmium becomes more available in the dried sediment. Plant uptake studies showed that plants can accumulate cadmium from dried sediments. An exposure model found that both birds and mammals exposed to the dried cadmium sediments are likely to accumulate cadmium at levels shown to have impacts. Following placement of cadmium-laden sediments, eighty-six (86) grab samples would be collected from a depth of 15 cm to characterize the cadmium levels of surface sediments. The sediments would then be covered with at least two feet of material consisting of sediments that are expected to have cadmium concentrations of 4 mg/kg or less. After this cover has been applied, sediment samples from the cover would be obtained and analyzed. Eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If cadmium levels in the cover are less than 4 mg/kg, the sampling would be considered complete. If cadmium levels in the cover are equal to or exceed 4 mg/kg in a cumulative area of 25 acres or greater, an additional cover of material from operation and maintenance dredging would be applied a soon as possible. Sediment sampling would then be conducted as previously performed. This process would be repeated until the concentration of cadmium in the samples was less than 4 mg/kg. The cadmium-laden sediments would remain in CDFs 14A and 14B and not used for other purposes (dike construction, etc.).

Monitoring would also include evaluation of the inflow and the effluent discharged from the disposal areas. Samples would be taken from the head section of the discharge pipe from the dredge and analyzed for cadmium. Samples of the effluent leaving the disposal area would be taken and analyzed to ensure that state water quality standards are being met. The Section 401 Water Quality Certification issued by the Georgia DNR-EPD requires cadmium concentrations be monitored on a weekly basis at the point of discharge from the CDFs where cadmium-laden sediments are placed. Monitoring shall continue at these CDFs for as long as the discharge of effluent is present, and until all dredged sediments have been dewatered, stabilized and capped. Following the installation of a stable, clean cover, cadmium must be monitored for one year.

If analytical results indicate standards are not being met, corrective actions include reducing the pumping rate of the dredge and/or boarding up the weir to decrease the amount of effluent being discharged from the CDF.

Other monitoring efforts associated with cadmium-laden sediments include wildlife use surveys in CDFs 14A and 14B, vegetation sampling and removal (if required), and biological monitoring.

The Corps would perform monthly wildlife surveys of the CDFs. These one-day surveys would record all birds and other major vertebrates seen within CDFs 14A and 14B. Monitoring would be performed during placement of sediment (including any placement of required cover) and for 3 years after placement is completed. If there is a concern about the number of birds or other animals or a particular species using the CDFs, some type of hazing may be appropriate (with concurrence of the USFWS).

If analyses of the sediment samples from the cover show that concentrations of cadmium equal or exceed 4 mg/kg, vegetation sampling would be required. This sampling would be conducted on a quarterly basis in "hot spots" to determine cadmium uptake by plants. Samples collected from the CDFs would be compared to control samples taken from other, cadmium-free environments in adjacent CDFs. If vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place additional, low-cadmium sediments over the capping layer. These contingency measures would eliminate wildlife exposure should vectors for cadmium uptake be identified. Vegetation sampling would be considered complete once sustained cadmium concentrations in the surface sediments of the cover are less than 4 mg/kg.

Blood sample monitoring of birds would be conducted prior to construction (baseline) and during placement of cadmium-laden sediments and its cover, and for 3 years after placement. The sampling protocols take into account the hydrologic conditions of the CDF (wet/ dry) and the season since these factors greatly influence which birds are using the CDFs at a given time. Tissue analysis would also be required if cadmium concentrations in the blood samples obtained during and after construction show a significant increase in levels observed in the pre-construction samples.

At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc). Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediments at the sediment/water interface.

The Section 401 Water Quality Certification also requires monitoring of maintenance dredging activities that would occur in areas of the channel with known high cadmium concentrations. Sediments to be dredged would require testing for cadmium from two locations that are representative of average sediment accumulation in that reach. This

protocol would remain in effect for at least two maintenance dredging cycles and would continue if the sampling indicates cadmium levels of concern.

Details of cadmium monitoring are fully discussed in Appendix M.

Disposal Areas 12A, 12B and 13 A contain underdrains. Underdrains are used to help dewater the dredged sediments. A 1994 NMFS study found that effluent released to the Wright River through those underdrains contained arsenic at levels that violated water quality criteria. Arsenic levels in the Disposal Area 12B weir 1 underdrain effluent ranged from 117 to 147 micrograms/liter and in the Disposal Area 13A weir 2 effluent (which included both underdrain and overflow effluent) ranged from 14.9 to 298 micrograms/liter. The underdrain effluent was found to be toxic to test organisms. This toxicity was attributed primarily to arsenic, although other factors were also implicated (elevated manganese, low salinity, low dissolved oxygen and high turbidity). In agreement with the South Carolina Office of Ocean and Coastal Resource Management, the District has closed the underdrains to the Wright River. As of October 1994, the underdrains in Disposal Area 12B were sealed. The other underdrains were closed later in 1994.

New underdrains were subsequently constructed and drained to Savannah River or Back River. The district has temporarily closed those underdrains and is conducting a study to ensure they can be operated in a manner that allows the effluent to meet water quality standards. A 100-foot mixing zone would be allowed to bring the effluent levels within water quality criteria.

Loss of Environmental Value. Based on the results of the analysis discussed above, the sediments in the inner harbor that have elevated natural cadmium concentrations can be dredged and discharged into the CDFs without any loss of environmental values.

Actions to Minimize Impacts. Cadmium-laden sediments would be managed in Disposal Areas 14A and 14B to minimize their exposure to the environment. Sediments with elevated concentrations of cadmium would be capped/covered by cleaner sediments. These sediments would be covered with sediments removed during maintenance dredging, if required.

The project would include monitoring of cadmium both during construction and after placement of the sediments into CDFs 14A and 14B. Monitoring during construction would include monitoring of cadmium concentrations in the sediment slurry leaving the dredge discharge pipe as it enters the CDF. The monitoring would also include sampling and analysis of the weir effluent to ensure it meets water quality standards.

The project would also include monitoring sediments in the CDFs after placement and drying. Actions for elevated cadmium concentrations, if required, include placing a maintenance material sediment cover on the cadmium-laden sediments, sampling of vegetation and removal of vegetation if required, wildlife use studies in CDFs 14A and 14B, and analysis of blood samples from birds for cadmium.

6.5 Aquatic Ecosystem and Organism Determinations.

Effect on the structure and function of the aquatic ecosystem and organisms and effect on the re-colonization and existence of indigenous aquatic organisms or communities.

Most of the dredged material emanating from the SHEP would be discharged into existing CDFs and thus would not adversely affect any aquatic organisms or communities. There would be some loss of bottom habitat where dredged material and fill material are placed to construct various mitigation features of the project. While there would be some loss of bottom habitat to certain aquatic organisms, the mitigation structures would provide potential habitat for other species.

Threatened and Endangered Species. Listed species most likely to be affected by the discharge of dredged or fill sediments include the Shortnose sturgeon. All discharges of dredged sediments associated with construction of the project would occur well below Shortnose sturgeon spawning habitat. Placement of fill sediments associated with the Mitigation Plan is designed to benefit Shortnose sturgeon by reducing salinity levels in Middle, Back and Little Back Rivers that would result from deepening the channel. The discharge of fill material into the Savannah River at the New Savannah Bluff Lock and Dam to construct a fish passage facility would benefit Shortnose sturgeon by allowing them to access additional spawning grounds between New Savannah Bluff Lock and Dam and the Augusta Diversion Dam.

A Biological Assessment of Threatened and Endangered Species (BATES) was prepared and can be found in Appendix B of the EIS. The BATES determined that the Project as currently proposed "may affect but is not likely to adversely affect" piping plover, wood stork, West Indian manatee, right whale and humpback whales, sea turtles, and Shortnose sturgeon. This determination is contingent upon the conditions outlined in the BATES and the Mitigation and Monitoring Plan (found in Appendices B and D in the EIS). The NMFS submitted their Biological Opinion (Appendix Z) which provides further guidance and construction restrictions to minimize the effects of the project on protected species. The NMFS included three stipulations in the BO relating to the discharge of dredged and fill material.

1. Construction of the flow diversion structure at McCoys Cut should be restricted to the period May 15-Novmeber 1 to avoid adverse impacts to sturgeon.

2. To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam should occur during the late winter/spring spawning period and early summer larval period between February 1 and May 31.

3. Appropriate erosion and turbidity controls shall be utilized wherever necessary to limit sediments from entering the water.

Fish, Crustaceans, Mollusks and Other Aquatic Organisms in Food Web

As indicated within Section 3.06 of the EIS, about 10.6 MCY of sediment excavated to deepen the ocean bar channel would be placed within the Savannah Harbor ODMDS. This would not interfere with recreational or commercial fishing operations.

A boat ramp would be constructed on Hutchinson Island to mitigate for the closing at Rifle Cut. Concrete rubble from the Tidegate would be deposited in intertidal areas along the estuarine riverbanks to produce fish habitat.

No significant adverse impacts to either recreational or commercial fishing are anticipated by the proposed action.

The project would not involve any discharge of dredged or fill material into areas with high concentrations of shellfish. Most impacts to benthos resulting from the discharge of dredged or fill material would be realized for those aspects of the project involving open water discharge. The ODMDS is used on a routine basis for the maintenance of the Savannah Harbor entrance channel. The environmental impacts from that placement are described in the ODMDS Placement Evaluation (Appendix R).

Other Wildlife

The discharges of dredged and fill material associated with the Savannah Harbor Expansion Project would not have any significant adverse effect on wildlife. Numerous species of wildlife including various mammals and birds use the CDFs. As part of the Long Term Management Strategy for the operation and maintenance of Savannah Harbor, some of the disposal areas are managed for wading and shorebird habitat. This practice would continue.

Special Aquatic Sites

The discharge of dredged and fill material associated with the Savannah Harbor Expansion Project would not directly affect any estuarine emergent wetlands. Dike raising would be required in the existing CDFs to accommodate the dredged sediments from the project. Dike raising would require footprint expansion to provide a suitable base for the dike. Footprint expansion is accomplished on the inside of the dike to prevent filling of adjacent wetlands. Sediments used to raise the dikes are usually obtained from within the CDF or from another CDF. Erosion control plans would be implemented during these construction events to ensure maintenance of water quality. "Best Management Practices," as defined in the Manual for Erosion and Sediment Control in Georgia or the South Carolina Stormwater Management and Sediment Control Handbook for Land Disturbance Activities, are used to determine the appropriate erosion control measures to implement during the dike raising process.

The discharge of dredged and fill material required to conduct the SHEP would not adversely impact any special aquatic sites. Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes. The flow diversion structures at McCoys Cut and Rifle Cut and the submerged berm in Middle River are within the boundaries of the SNWR. Material used to construct these flow diversion structures would consist of dredged material (sand) and rock. The purpose of these structures is to help maintain freshwater conditions in the vicinity of the SNWR by reducing the increase in upstream salinity levels that would result from the SHEP. Minimizing the increase in upstream salinity levels that would result from channel deepening is essential to maintain a reliable source of freshwater at the SNWR intake located off Little Back River and to reduce impacts to Striped bass and Shortnose sturgeon habitat in these streams.

The discharge of dredged and fill material associated with the Savannah Harbor Expansion Project would impact various types of estuarine, and riverine bottom habitat as previously described. Estuarine habitat would be affected by implementation of the Mitigation Plan, which includes diversion/closure structures in McCoys Cut and Rifle Cut, construction of a submerged sill and broad berm in Back River below the Tidegate. The Mitigation Plan was designed to minimize the predicted increase in upstream salinity levels in Middle River and Little Back River that would result from deepening the navigation channel, and thus reduce adverse impacts to tidal freshwater marsh. Implementation of the Mitigation Plan would also affect some bottom habitat in Back River where the boat ramp would be constructed to provide access for local fishermen.

Most of the impacts to riverine habitat would result from construction of the fish passage structure at New Savannah Bluff Lock and Dam. A small area of the Savannah River would be impacted by the construction of the fish passage structure at the New Savannah Bluff Lock and Dam.

Potential Effects on Human Use Characteristics

The discharge of dredged and fill material associated with the SHEP would affect human use of the affected waterways where the western end of McCoys Cut and Rifle Cut are closed since it would remove "short cuts" between Front River and Middle River and Middle River and Little Back River. Access to these streams would still be available to recreational boaters.

7.0 PROPOSED DISPOSAL SITE DETERMINATIONS

Each disposal site shall be specified through application of the guidelines. The mixing zone shall be confined to the smallest practicable zone within each specified disposal site that is consistent with the type of dispersion determined to be appropriate by the application of the guidelines.

The various disposal sites that would be used for the Savannah Harbor Expansion Project are in agreement with the intent of the guidelines. The placement of dredged and fill sediments involves using existing disposal areas or sites required to implement mitigation features of the project.

8.0 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

Cumulative Effects attributable to the discharge of dredged or fill material in Waters of the United States should be predicted to the extent reasonable and practical.

A cumulative impact analysis has been prepared for the Savannah Harbor Expansion Project and can be found in Appendix L. This analysis focused on the potential cumulative impacts to various resources in the estuary including wetlands, fisheries, groundwater, Shortnose sturgeon, the dissolved oxygen regime in Savannah Harbor, and the Tybee Island Beach and nearshore area. There are no known adverse cumulative impacts associated with any of the placement sites designated to be used for dredged or fill material.

9.0 DETERMINATION OF SECONDARY IMPACTS ON THE AQUATIC ECOSYSTEM

Most of the secondary impacts associated with the dredged and fill material placement sites for the Savannah Harbor Expansion Project are positive, since they are part of the project's mitigation plan.

10.0 FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH RESTRICTIONS ON DISCHARGE (SECTION 230.12)

10.1 Determinations.

a. An ecological evaluation of the discharge of dredged and fill material associated with the construction and operation of the proposed Savannah Harbor Expansion Project has been made following the evaluation guidance in 40 CFR 230.6, in conjunction with the evaluation considerations in 40 CFR 230.5 .

b. Potential short-term and long-term effects of the proposed work on the physical, chemical, and biological components of the aquatic ecosystem have been evaluated and it has been found that the proposed discharge will not result in significant degradation of the environmental values of the aquatic ecosystem.

c. There are no less environmentally damaging practicable alternatives to the proposed work that would accomplish the project goals and objectives.

(1) The proposed work will not cause or contribute to violations of any applicable State water quality standards, will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act, will not jeopardize the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, and will not violate any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.

(2) The proposed work will not cause or contribute to significant degradation of the waters of the United States.

(3) The discharge includes all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem.

10.2 Findings.

On the basis of the guidelines, the proposed disposal sites for the discharge of dredged or fill material are specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

ATTACHMENT

WATER QUALITY MONITORING PLAN

Savannah Harbor Navigation Project
Water Quality Monitoring
U. S. Army Corps of Engineers, Savannah District

1. Purpose:

To establish the duties of the Savannah District in performing water quality monitoring services for the activities associated with maintenance of Savannah Harbor. These activities include weir and potential underdrain discharges from project Dredged Material Containment Areas (DMCA's), and monitoring the performance of the oxygen injection systems which would be installed as part of the SHEP.

2. Responsibilities:

The Project Manager for the Savannah Harbor Navigation Project resides in Operations Division. Therefore, Operations Division is responsible for funding the monitoring that the District performs. Planning Division is responsible for the environmental compliance of the Savannah Harbor Navigation Project. Therefore, Planning Division is responsible for ensuring that the District conducts and coordinates the water quality monitoring that is required. Additional monitoring may be requested to obtain data to better document the effects of the District's operations on the environment. Engineering Division is responsible for the field performance of the monitoring and the quality of the data that are obtained.

3. Sampling Plan:

The District will perform water quality monitoring at the following locations, according to the following schedules or on an as needed basis as appropriate. Any alteration in schedules would need prior approval by Planning Division to ensure the Project continues to meet its environmental commitments. All field collection of samples will be taken in a manner such that the water in the sample bottle is truly representative of the water at the monitoring location.

A. Savannah Harbor Dredged Material Containment Areas (DMCA's) Overflow Weirs: Monitoring of all overflow weirs at the listed DMCA's will occur on a monthly basis as close to the beginning of the month as practicable. Total discharge from each weir outfall pipe will be determined, to include seepage through and flow over the weir boards. Where water is ponded at the weir but there is no discharge occurring, the water quality of the impounded water will be measured.

Each weir that is discharging greater than 0.1 cubic feet per second (cfs) through seepage and/or weir overflow (at least 1/2 inch of flow over 3 feet of weir board) will be checked weekly during the month for overboard weir flow and water quality parameters.

Seepage estimates will be updated on a monthly basis. Weekly measurements will be made at all DMCA weirs discharging greater than 0.1 cfs at the beginning of the month, at any additional weirs for which EN has been notified that boards have been pulled, and at the weirs of any DMCA that, during the month, begins to receive sediment deposition from a dredging operation. Where water is ponded at a weir in an area where deposition has just begun but there is no discharge occurring, the water quality of the impounded water will be measured. If the discharge is less than 0.1 cfs from a weir with ponded water, no additional sampling will occur until the following monthly check of all DMCA weirs. Where it is practicable, water quality parameters from weirs discharging greater than 0.1 cfs should be obtained at the weir from overflow or seepage water. Where that is not possible, measurement of ponded water is acceptable.

If the measured water is not compliant with standards and the discharge (weir flow and/or seepage) is greater than 0.1 cfs, water quality will be measured additionally at the outfall pipe. If non-compliant values are measured at the outfall pipe, monitoring will then occur at the receiving water or a representative intermediate point (see Section 6, below) at the earliest opportunity. The intention is to sample the receiving water within 24-hours of discovering the outfall discharge may be non-compliant. If the receiving water cannot be sampled within 48-hours of discovering the outfall discharge is non-compliant, PD and the OP Project Manager must be notified before that time has elapsed Receiving waters include the river or natural creeks. Intermediate points include the pool of water at the outfall pipe (where the pool is separated from the river), and ditches flowing through the marsh to the river. Monitoring should be performed near the beginning of each week so that any required retesting or sample collection may be performed the same day or the following day.

DMCAs 2A, 12A, 13A, 13B, 14A and 14B are located along Savannah Harbor near Port Wentworth, GA to the Atlantic Intracoastal Waterway (AIWW). All areas are accessible by road in a four-wheel-drive vehicle. The Jones-Oysterbed Island Disposal Area is located between the AIWW and the mouth of the Savannah River and is only accessible by boat. The locations of the weirs and disposal areas are shown in Figure 1.

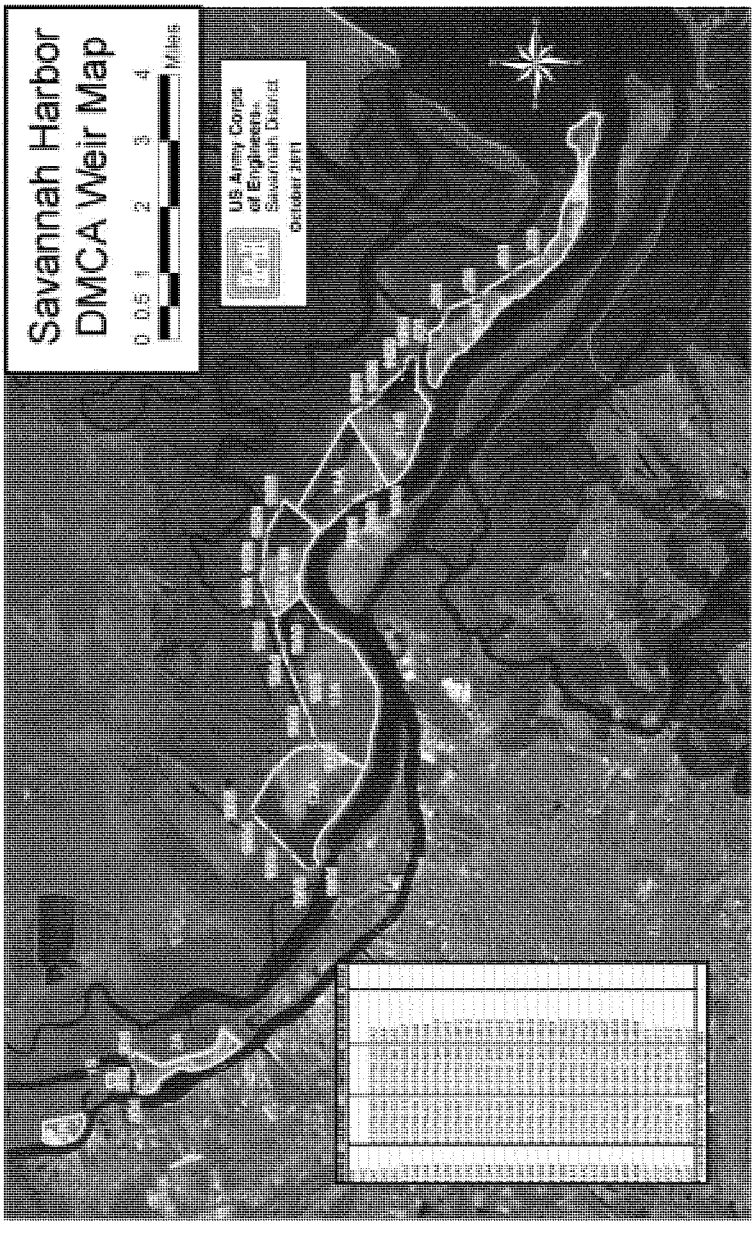

Figure 1. Locations of DMCAs and Weirs-Savannah Harbor

B. Savannah Harbor DMCA Underdrains: Underdrains exist at DMCAs 12A, 12B, 13A, and 13B. The underdrain in DMCA 12A discharges into Back River. One of the underdrains in DMCA 12B discharges into Back River while the other two discharge into the Savannah River. Disposal Areas 13A and 13B both contain three underdrains all of which discharge into the Savannah River. The underdrains are presently closed for an indeterminate period of time (no discharge is occurring) and are not being monitored.

If underdrains are used again, the following monitoring plan will be implemented. Monitoring of underdrain discharge pipes at the listed disposal areas will generally be performed every six months, where discharges are occurring. Monitoring should be performed at the beginning of a week so that any required retesting or sample collection may be performed the same day or the following day. Since the underdrains are allowed to discharge only on a moving tide, sampling will be performed at roughly mid-tide down-current from the discharge station. If the District determines metal analysis is appropriate, two samples should be collected for metals analysis at each discharge location. The first sample would be collected either within the pipe before the discharge occurs or outside the pipe before the discharge mixes with the receiving water. The second sample would be taken within the receiving body at the down-current edge of a 100-foot mixing zone from the discharge point (see Section 3, below). Water quality probe measurements should also be taken at the down-current sampling point to determine compliance with State Standards.

C. Savannah Harbor Oxygen Injection Systems: Monitoring will be performed on a daily basis to ensure the dissolved oxygen systems are performing satisfactorily. Monitoring will occur of the water entering and discharged from the Oxygen Injection Systems, as well as at specific fixed locations in the estuary. This monitoring will be performed remotely, by reviewing the values being recorded on continuous monitors that measure dissolved oxygen levels and report that information on a real time basis. If the monitoring indicates that the dissolved oxygen systems are not performing satisfactorily (adding the agreed upon amount of oxygen), the District will adjust the systems so that they do add the required amount of oxygen at that location.

After the Oxygen Injection Systems are found to be performing satisfactorily (expected to be the end of the 10-year post-construction monitoring program), the Corps would fund USGS to operate and maintain continuous recorders for hydrologic and hydraulic data at the following four locations:

- 02198920 Savannah River at GA25, at Port Wentworth, GA
- 021989773 Savannah River at USACE Dock at Savannah, GA
- Back River at US 17 at Savannah, GA
- Savannah River at I-95

USGS would service the dissolved oxygen monitors (and other needed parameters) on at least a monthly basis to ensure the monitors are making accurate measurements and reporting the data properly.

The District would fund USGS operation of continuous recorders for hydrologic and hydraulic data at four additional sites during the pre-construction and during-construction periods. The Corps would use that more detailed information to observe water quality in the estuary during the construction and ensure the Oxygen Injection Systems perform as designed.

4. Field Water Quality Parameters:

The District will record the following data at each weir and channel monitoring location:

- Location (identify DMCA, discharge pipe, receiving water for weirs, channel station number and location in channel -- middle, left side facing upstream, right side). When monitoring near a dredge, record sampling depth. For weir sampling, indicate if sampling is from ponded water, weir overflow, seepage at the boards, outfall pipe, outfall ditch, or receiving water.
- Date
- Time
- Tide (estimate of high slack, near high falling, mid-tide falling, near low falling, low slack,
  near low rising, mid-tide rising, near high rising)
- Depth of water flowing over the weir boards (also width of flow if it is less than the full width of the weir boards)
- Total discharge at weir outfall pipe on a monthly basis (to include seepage and weir overflow)
- Air Temperature (degrees Centigrade, °C)
- Water Temperature (degrees Centigrade, °C)
- Dissolved Oxygen (DO, in milligrams per liter, mg/l). Winkler analyses will be conducted as needed.
- pH
- Conductivity (in micromhos/centimeter, umho/cm)
- Salinity (in parts per thousand, ppt)
- Turbidity (in nephalometric turbidity units, NTU)
- Total Suspended Solids (reported as milligrams per liter (mg/l), developed through conversion of turbidity measurements). Actual TSS measurements would be taken only on an as needed basis.
- Comments (color of discharge waters, etc)

The District will record the following data at each underdrain monitoring location:

- Location (identify DMCA, discharge pipe number, discharge point (DP) vs. receiving waters (DS))
- Diameter of discharge pipe
- Amount of flow in pipe (full, three-quarters full, half-full, one-quarter full, trickle, and approximate discharge rate in cfs)

- Date
- Time
- Tidal stage
- Current direction

At each discharging underdrain location, the District will collect sufficient sample volume to allow subsequent laboratory testing. A second sample will be taken at the down-current edge of the 100-foot mixing zone in the receiving water.

If metal testing is conducted, each underdrain sample will be analyzed as total recoverable for the following parameters:

Arsenic
Beryllium
Cadmium
Chromium
Copper
Cyanide
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Total Suspended Solids (TSS)
Zinc

A duplicate sample will be taken from one underdrain outfall pipe and the results will be compared by the District to those of the matching sampling location.

The District will complete a chain of custody form that includes a listing of all analytes and the collection time for each sample. When laboratory analysis has been completed, the District will provide a reproducible data sheet with the results of each sampling event to the natural resource agencies.

Engineering Division will maintain a database of the reported data for DMCA and channel water quality. Planning Division will coordinate the results and any District analysis with the natural resource agencies, as required by their project approval documents.

5. Instrumentation and Calibration:

A Hydrolab Datasonde, similar YSI sonde, or other comparable equipment will be used to measure water temperature, DO, pH, conductivity/salinity and turbidity.

Air temperature should be determined using a calibrated mercury-filled centigrade thermometer or the nearest available weather station data.

The District (Engineering Division) will be responsible for calibration of all water quality monitoring instruments to ensure accuracy of the field data.

- Dissolved Oxygen (DO, in milligrams per liter, mg/l) sensors will be calibrated to air saturation or by collecting and "fixing" a sample in the field, followed by laboratory calibration of the results using the Azide/"Winkler" Method.
- pH sensors will be calibrated using buffered standards of pH 4.0, pH 7.0 and pH 10.0 as appropriate.
- Turbidity sensors will be calibrated using tap water and formazine standards.
- Conductivity sensor will be calibrated to air and standards.

Water quality instruments will be calibrated at the beginning of each sampling day. Daily data sheets will show the instrument results from calibration and will be archived by Engineering. During DMCA water quality sampling, weekly calibration will be sufficient to ensure accurate sampling results.

All laboratory procedures will be performed in accordance with the most recent edition of *Standard Methods for the Examination of Water and Wastewater*.

6. Water Quality Discharge Requirements:

Dissolved Oxygen requirement

State	Standard	Months
South Carolina	daily average of 5.0 mg/L	All Year
	daily minimum of 4.0 mg/L	All Year
Georgia	daily average of 5.0 mg/L	All Year
	daily minimum of 4.0 mg/L*	All Year
	minimum instantaneous throughout the water column	

pH requirement

State	Standard	Months
South Carolina	6.0 - 8.5	All year
Georgia	6.0 - 8.5	All year

Metals requirement

Parameter	Standard for Saltwater Chronic Criterion*		Months
Arsenic	36 ug/L		All Year
Cadmium	9.3 ug/L		All Year
Copper	3.7 ug/L		All Year
Cyanide	1.0 ug/L		All Year
Lead	8.5 ug/L		All Year
Mercury	1.1 ug/L		All Year
Nickel	8.3 ug/L		All Year
Selenium	71 ug/L		All Year
Silver	2.3 ug/L	***	All Year
Zinc	86 ug/L		All Year

*Standards are based on SCDHEC R.61-68, *Water Classifications and Standards*, April 25, 2008 and expressed in terms of total recoverable metals
*** Only Acute Criteria available

Turbidity requirement

State	Standard	Months
South Carolina	Does not change the receiving waters to such a degree as to create a nuisance, or interfere with classified or existing water uses.	All Year
Georgia	Does not interfere with legitimate water uses. Does not result in a substantial visual contrast in the receiving water body.	All year
Savannah District	500mg/L or 250 NTU's	All Year

7. **Retesting Procedures and Immediate Reporting:**

A. Weekly DMCA Overflow Weir Monitoring: A confirmed violation of a discharge requirement at a weir and discharge pipe will require monitoring to be

conducted where the discharge enters the receiving water body if the discharge is not reduced below 0.1 cfs. Retesting the same or following day at the weir, discharge pipe, and/or in the receiving water body will be necessary.

The District will determine the required location(s) for sampling in the receiving water body. A boat will be required for that sampling. Ready access will likely not be available to the receiving water body sampling location(s). Depending on which weir does not meet the discharge requirements, transit by boat for several miles may be necessary to reach the sampling location(s) specified in the receiving water body.

Sampling of the receiving water will be performed on the last half of an ebb tide where practicable. Samples will be taken at the surface, mid-depth, and one meter above the bottom. The samples shall be at least one meter apart in depth. Where shallow depths preclude three separate measurements, a mid-depth reading will be taken.

In general, sampling will occur in the receiving water near the discharge pipe, at the confluence point of an effluent ditch/canal and the receiving water, and 100 feet down-current in the receiving water. For discharges from Disposal Area 12A, monitoring will occur in the Back River approximately 100 feet down-current from the mouth of the ditch that carries effluent from the weirs. If the readings 100feet down-current in the receiving water indicates non-compliance, an additional set of readings will be taken 100 feet up-current. If those readings show the effluent discharge has no effect on the receiving water, then discharges from that weir/DMCA may continue. For DMCAs discharging to the Wright River (Disposal Areas 12B, 13A, 13B and 14A), monitoring will occur at the following locations: (a) the mouth of the ditch leading from the discharge pipe to the Wright River, and (b) in the Wright River 100 feet down-current from the mouth of the ditch that carries effluent from the weirs. If the readings 100-feet down-current in the receiving water indicates non-compliance, an additional set of readings will be taken 100 feet up-current. If that reading shows effluent discharge has no effect on the receiving water, then discharges from that weir/DMCA may continue.

If 100 foot up-current reading shows the discharge is non-compliant and has a measurable effect on the receiving water, then an additional set of readings will be taken at 50-foot intervals (up to 400 feet down-current from the edge of the 100-foot mixing zone) to determine where the discharge has no measurable effect on the receiving waters. If this second set of readings shows that the discharge continues to fail water quality requirements, (1) Planning Division will coordinate with the appropriate natural resource agencies and reach agreement on a resolution to the situation, or (2) Operations Division will stop the release of effluent from that discharge pipe.

B. CDF Underdrain Monitoring: If the readings do not meet the discharge requirements, the District will verify the results by taking a second reading, and, if necessary, taking a sample for laboratory analysis. If consistent measurements confirm potential violation of a standard, the investigator will immediately perform additional testing to (1) determine the ambient conditions in the receiving water near the discharge point, and (2) determine the distance of the mixing zone at which the discharge requirement is met.

The monitoring would be repeated the next day. If the discharge meets the water quality requirements no further action will be taken. If the discharge fails to meet water quality requirements, (1) Planning Division will coordinate with the appropriate resource agencies and reach agreement on a resolution to the situation, or (2) Operations Division will stop the release of effluent from that discharge pipe. Ready access will likely not be available to the receiving water body sampling location. A boat will be required for sampling the receiving water body at the edge of the mixing zone. Depending on which underdrain pipe does not meet the discharge requirements, transit by boat for several miles may be necessary to reach the required sampling location.

8. Equipment and Supplies:

The following equipment and supplies would generally be needed to perform the monitoring in the Plan:

- Four-wheel drive vehicle
- Boat and motor (with safety equipment)
- Multi-probe water quality monitoring instrument
- Cellular telephone
- Field equipment for collection of samples
- Laboratory equipment and supplies for calibration of the instrument
- Laboratory equipment and supplies for DO titrations and measuring total suspended solids
- Forms to ensure chain of custody on samples to be sent to commercial laboratories for analysis

9. Annual Reports:

Planning Division will be responsible for developing a written report of the water quality data that the District collects during a given fiscal year. Since Engineering Division will be storing the data, it will format the data in a useable manner and provide the data and any analysis it deems appropriate data to Planning. Environmental staff within Planning will then conduct its own analysis and highlight any significant items as it completes the report. After review by the Project Manager and Engineering staff, Planning will provide the report to the South Carolina and Georgia natural resource agencies. The intent is to provide this report of data collected over a fiscal year by the end of that calendar year.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX I: Federal Consistency Determination for the Georgia Coastal Management Program

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps of Engineers
Savannah District
South Atlantic Division

Federal Consistency Determination for the Georgia Coastal Management Program

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Federal Consistency Determination for the Georgia Coastal Zone Management Program

1.0 SUMMARY DETERMINATION

The Federal Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 et seq., as amended, requires each Federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved state management programs. A direct Federal activity is defined as any function, including the planning and/or construction of facilities, which is performed by or on behalf of a Federal agency in the exercise of its statutory responsibilities. A Federal development project is a Federal activity involving the planning, construction, modification or removal of public works, facilities or other structures, and the acquisition, use or disposal of land or water resources.

To implement the CZMA and to establish procedures for compliance with its Federal consistency provisions, the US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), has promulgated regulations which are contained in 15 C.F.R. Part 930. This Consistency Determination is being submitted in compliance with Part 930.30 through 930.44 of those regulations.

This evaluation was prepared to determine if the proposed Savannah Harbor Expansion Project (SHEP) is consistent with the Georgia Coastal Management Program (GCMP).

The information contained within this Consistency Determination is derived primarily from the EIS prepared for the proposed action. References to that document are included in some of the discussions on the Project's compliance with certain individual state policies. Should further information concerning the proposed project be desired, please refer to the EIS, of which this Determination is a component.

In accordance with the CZMA, Savannah District has determined that the proposed SHEP would be carried out in a manner which is fully consistent with the enforceable policies of the Georgia Coastal Management Program to the maximum extent practicable. The evaluations supporting that determination are presented in Sections 6.00 through 9.00 of this document. In addition, this determination is supported by information and analysis in the EIS which is incorporated by reference to the extent relevant to Georgia coastal zone consistency issues.

This Determination has been updated since the November 2010 Draft EIS which Georgia reviewed concerning the project's consistency with the State's Coastal Management Program. The update is primarily the result of new information that was developed or became available since the Draft EIS. Substantive information that Savannah District provided to GA DNR-CRD since the Draft EIS can be found in Appendix N, Agency Coordination.

2.0 BACKGROUND

2.1 Purpose

This Consistency Determination addresses the consistency of proposed deepening of the existing Savannah Harbor Navigation Project with the Georgia Coastal Management Program, as required by the CZMA. For purposes of the CZMA, the enforceable policies of the Georgia Coastal Management Plan constitute the approved state program.

2.2 Existing Savannah Harbor Federal Navigation Project

This document is an attachment to the Environmental Impact Statement (EIS) for the proposed work. See Section 3.2 of this document and Section 3.01 of the EIS for a description of the current navigation project.

2.3 GCMP Jurisdiction

Savannah Harbor is located within and near Savannah, Georgia. The navigation channel for Savannah Harbor extends from just below the Georgia Highway 25 Bridge to approximately 11 miles off-shore, a distance of about 32 miles. Savannah Harbor is bounded on the north by Jasper County, South Carolina, and on the south by Chatham County, Georgia. For the lower half of the inner harbor (Stations 0+000 – Back River Goes off), the state boundary follows the north toe of the channel. The state boundary then shifts to the middle of Back River until it rejoins the Savannah River at McCoys Cut. Chatham County is one of the six Georgia counties lying adjacent to the coast and is included in the Georgia Coastal Management Plan as one of the eleven counties that are within the coastal area. The Georgia CMP lists dredging, channel improvements, and other navigational works conducted by the US Army Corps of Engineers as being direct Federal activities that are subject to Federal Consistency.

2.4 Authority

The Federal Coastal Zone Management Act (CZMA), 16 U.S.C. SS 1451 et seq., as amended, is the legislative authority regarding the consistency of Federal actions with state coastal policies. Section 1456(c)(1)(A) of the CZMA states: "Each Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved state management programs." A Federal activity is defined as any function, including the planning and/or construction of facilities that is performed on behalf of a Federal agency in the exercise of its statutory responsibilities.

To implement the CZMA and to establish procedures for compliance with its federal consistency provisions, the US Department of Commerce, National Oceanographic and Atmospheric Administration, has promulgated regulations, 15 C.F.R. Part 930. This Consistency Determination was prepared in compliance with SS 930.30 through 930.44 of those regulations.

3.0 PROJECT DESCRIPTION

3.1 Identification of Alternatives

The Savannah Harbor Expansion Project involves various investigations relating to the feasibility and need to deepen the Savannah Harbor Navigation Project. The six detailed alternative plans evaluated include the No Action Alternative (maintaining the existing inner harbor depth of -42 feet MLW between Stations 000+000 and 103+000) as well as deepening the inner harbor channel to -44, -45, -46, -47 or -48 feet MLW. All five of the alternative plans consist of deepening the existing -42 foot channel, as well as deepening and expanding the existing Kings Island Turning Basin, deepening eight berths at the Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), constructing two meeting areas, constructing two bend wideners along the inner harbor, deepening and extending the existing entrance channel and constructing a bend widener in the entrance channel.

All of the proposed deepening alternatives are designed to maintain the existing side slopes of the channel. Although maintaining the existing side slopes would result in a narrower channel, this design would reduce the environmental impacts associated with deepening the harbor by confining the dredging impacts to the existing channel. Consequently, the adjacent marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, sedimentation and shoaling within the new deeper channel would be minimized. The navigation channel side slopes will be 5H:1V in the entrance channel area (Stations 0+000 to -97+680B) and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V means for every 5 and 3 feet of horizontal distance there would be a change of 1 foot of vertical distance. Although maintaining the existing side slopes of the channel would greatly reduce the adverse environmental impacts of the project, some channel widening would be necessary in those areas where the construction of meeting areas and bend wideners are required.

For all dredging alternatives, dredging depths will include 2 feet of allowable over depth and advanced maintenance. The practice of allowing 2 feet of over depth during dredging accounts for the inaccuracies of the dredging process. The practice of advance maintenance dredging (used in heavy shoaling areas) allows the project to remain at the authorized project depth between maintenance dredging cycles.

The environmental impacts and effects of the No Action Alternative and the five deepening plans are found in Chapters 4 and 5 of the EIS, respectively and in Table 5 below. The following is a brief summary of these alternatives that have been evaluated in the EIS:

3.2 Alternatives

Six harbor deepening plans (i.e., No Action Alternative or the Without Project Condition, which is the existing project depth of -42 feet MLW, -44 feet MLW, -45 feet MLW, -46 feet MLW, -47 feet MLW, and -48 feet MLW) were considered in detail for Savannah Harbor. Please see Figure 1 below for a review of the project vicinity. All of the harbor deepening alternatives would include the existing Kings Island Turning Basin (see Table 1), the eight berths at Garden City Terminal (Berths

2, 3, 4, 5, 6, 7, 8, and 9), two proposed meeting areas (see Table 2), three proposed bend wideners (see Table 3). However, the length of the bar channel extension varies with the proposed depth alternative (Table 4).

All of the proposed deepening alternatives would produce a narrower channel at the project depth than currently exists by maintaining the existing side slopes. By slightly decreasing the channel width (by maintaining the existing side slopes at different depths), the adjacent marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, the effects on sedimentation and shoaling within the new deeper channel would be minimized.

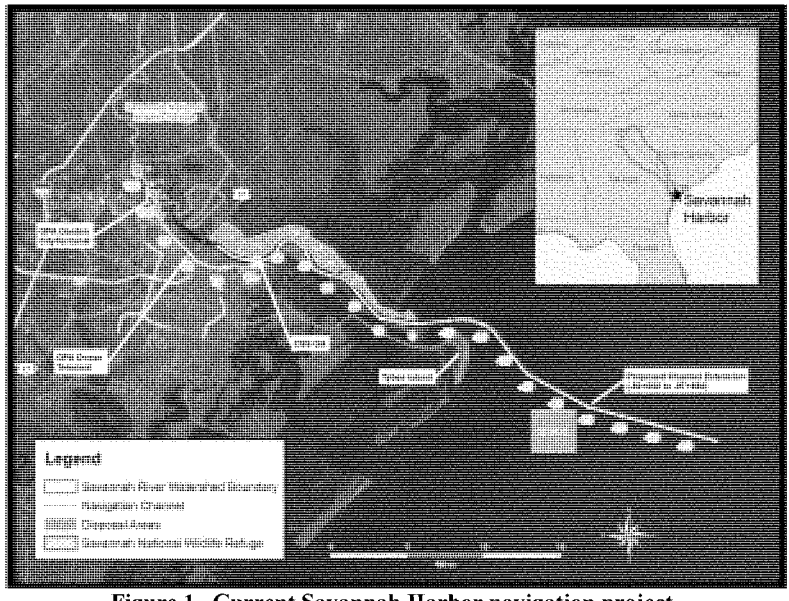

Figure 1. Current Savannah Harbor navigation project.

The navigation channel side slopes will be 5H:1V in the ocean bar area (Stations 0+000 to -98+600B) and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V means for every 5 and 3 feet of horizontal distance there would be a change of 1 foot of vertical distance.

For all dredging alternatives, dredging depths will include 2 feet of allowable overdepth and advanced maintenance. The allowable overdepths and advance maintenance allow for dredging inaccuracies and help the project remain at project depth between maintenance events (see detailed description of these terms, below).

3.3 Alternative A: No Action Alternative (-42 feet depth MLW) and Without Project Condition

Savannah Harbor is an approximately 32 mile Federal navigation project located along the Savannah River in southeastern Georgia. The current Savannah Harbor Navigation Project (Figure 3-1) has an authorized project depth of 30 feet Mean Low Water (MLW) in the inner harbor (Stations112+000 to 105+000), 36 feet MLW (Stations 105+000 to 103+000), 42 feet MLW (Stations 103+000 to 0+000), 42 feet MLW in the entrance channel (Stations 0+000 to –14+000B), and 44 feet MLW in the remainder of the entrance channel (Stations –14+000B to –60+000B). The current channel width is 600 feet across the ocean bar to the entrance channel (Stations -14+000B to -60+000B), 500 feet from the entrance channel to Kings Island Turning Basin (Stations -14+000B to 103+000, with the exception of 400 feet wide from stations 58+000 to 59+000), 400 feet from the Kings Island Turning Basin to the Argyle Island Turning Basin, and 200 feet from the Argyle Turning Basin to the upstream limit of the authorized project.

Annual maintenance dredging requires the removal of about 6 million cubic yards of material from the inner harbor and about 1 million cubic yards of material from the entrance channel. Material removed from the inner harbor is placed in Confined Disposal Facilities (CDFs) located along Savannah Harbor. Material removed from the entrance channel is placed in the Savannah Harbor Offshore Dredged Material Disposal Site (ODMDS), upland CDFs, or Site 2 submerged berm.

3.4 Alternative B: -44-FOOT ALTERNATIVE (2 FEET DEEPER). This plan would involve dredging the inner harbor to -44 feet (2 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the proposed project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2 below), and two bend wideners (see Table 3 below). Improvements in the entrance channel would involve deepening of the existing channel to -46 feet MLW from Stations -14+000B to -60+000B. The depth of -46 feet MLW would extend an additional 35,680 feet for the ocean bar channel extension (from Stations -60+000B to -95+680B). A bend widener would be constructed between Stations -14+000B to -23+000B. The total volume of excavated sediment associated with this project is about 10.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.5 Alternative C: -45-FOOT ALTERNATIVE (3 FEET DEEPER). This plan would involve dredging the inner harbor to -45 feet MLW (3 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the proposed project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2), and two bend wideners (see Table 3). Improvements in the entrance channel would involve deepening of the existing channel to -47 MLW from Stations -14+000B to -60+000B. The depth of -47 feet MLW would extend an additional 36,880 feet for the ocean bar channel extension (from Stations -60+000B to -96+800B) (Table 4). A bend widener would be

constructed between Stations -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 14.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

Table 1. Present Advance Maintenance Sections

Begin Station	End Station	Authorized Advanced Maintenance (feet)	Required Contract Depth (feet MLLW)
Inner Harbor			
112+500	105+500	2.0	32.0
105+500	103+000	2.0	38.0
103+000	102+000	0.0	42.0
102+000	100+000	2.0	44.0
100+000	79+600	2.0	44.0
79+600	70+000	2.0	44.0
70+000	50+000	4.0	46.0
50+000	37+000	4.0	46.0
37+000	35+000	6.0	48.0
35+000	24+000	4.0	46.0
24+000	0+000	2.0	44.0
Port Wentworth TB		0.0	30.0
Argyle Island TB		0.0	30.0
Kings Island TB		8.0	50.0
Marsh Island TB		0	34.0
Fig Island TB		4.0	38.0
Entrance Channel			
0+000	-14+000(B)	2	44.0
-14+000(B)	-60+000(B)	0	44.0

No advance maintenance is presently performed between Stations 58+000 and 59+000 to reduce potential impacts to the CSS GEORGIA, which is located along that reach.

Table 2. Proposed Two New Meeting Areas (see Figure 3-1)

Location	Description
GA waters: Station 14+000 to 22+000	The existing 400 foot wide channel would be widened 100 feet on the south to provide an average width of 500 feet. Side slopes would be 3H:1V.
GA and SC waters: Station 55+000 to 59+000	The existing 400 foot wide channel would be widened 100 feet to the north to provide an average width of 500 feet. Side slopes would be 3H:1V.

Table 3. Proposed New Channel Bend Wideners (see Figure 3-1)

Widener N	Location	Description
1	SC waters: Stations -23+000 to -14+000	76-foot bottom width plus side slope of ~20 feet. North side of channel.
2	GA waters: Stations 27+500 to 31+500	156-foot bottom width plus slide slope of less than 100 feet. North side of channel
3	SC waters: Stations 52+250 to 55+000	76-foot width plus slope of less than 100 feet. North side of channel.

Table 4. Length of Bar Channel Extension Required for Depth Alternatives

Length of Bar Channel Extension Required for Depth Alternatives		
Depth (Feet)	**Bar Channel Extension (Stations)**	**Length of Extension (Feet)**
44	-60+000B to -95+680B	35,680
45	-60+000B to -96+880B	36,880
46	-60+000B to -97+510B	37,510
47	-60+000B to -97+680B	37,680
48	-60+000B to -98+600B	38,600

3.6 Alternative D: -46-FOOT ALTERNATIVE (4 FEET DEEPER). This plan would involve dredging the inner harbor to -46 feet MLW (4 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the proposed project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, above), and two bend wideners (see Table 3, above). Improvements in the entrance channel would involve deepening of the existing channel to -48 feet MLW from Stations -14+000B to -60+000B. The depth of -48 feet MLW would extend an additional 37,510 feet for the ocean bar channel extension (from Stations -60+000B to -97+510B) (Table 4). A bend widener would be constructed between Stations -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 19.0 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.7 Alternative E: -47-FOOT ALTERNATIVE (5 FEET DEEPER). This plan would involve dredging the inner harbor to -47 feet MLW (5 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the proposed project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, above), and two bend wideners (see Table 3 above). Improvements in the entrance channel would involve deepening of the existing channel to -49 feet MLW from Stations -14++000B to -60+000B. The depth of -49 feet MLW would extend an additional 37,680 feet for the ocean bar channel extension (from Stations -60+000B to -97+680B) (Table 4). A bend widener would be constructed between Stations -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 23.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.8 Alternative F: -48-FOOT ALTERNATIVE (6 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.01.1, above) to -48 feet MLW (6 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the proposed project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, above), and two bend wideners (see Table 3 above). Improvements in the entrance channel would involve deepening of the existing channel to -50 feet MLW from Stations -14+000B to -60+000B. The depth of -50 feet MLW would extend an additional 38,600 feet for the ocean bar channel extension (from Stations -60+000B to -98+600B) (Table 4). A bend widener would be constructed between Stations -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 28.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.9 SELECTED PLAN:

The District developed and evaluated five channel deepening alternatives, in addition to the No Action Alternative. Each channel deepening alternative contains mitigation features to address adverse environmental impacts that they would otherwise produce. With inclusion of the mitigation features, each depth alternative is environmentally acceptable. The 47-foot depth alternative is the National Economic Development (NED) Plan, the plan that maximizes net economic benefits to the Nation (See GRR). Under current Federal planning policy, the NED plan would be recommended for implementation unless there are overriding considerations that favor recommendation of another plan. Benefits that would accrue from the deepening of Savannah Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The economic benefits increase with each additional increment of channel deepening. Environmental impacts associated with a shallower depth would be less than those associated with the NED plan, but the lesser impacts of the 44-foot depth, 45-foot depth, and 46-foot depth alternatives are not considered sufficient to justify recommendation of these alternatives instead of the NED Plan.

The State of Georgia has asked the Corps to consider the 48-foot depth alternative as the Locally Preferred Plan. After reviewing the comments received on the Draft GRR and DEIS and having further discussions with the non-Federal sponsor, the Corps has elected to select the NED 47-foot depth alternative for implementation.

The selected plan is the 47-foot depth alternative. The following paragraphs describe the features of the selected plan.

4.0 EFFECTS OF PROPOSED PROJECT

State-of-the-art hydrodynamic and water quality models were used to assess potential impacts of the project in the inner harbor. State-of-the-art models were also used to assess potential impacts in the nearshore area. The development of the various models was accomplished through coordination with the various Cooperating Agencies and state resource agencies. Development and approval of the inner harbor models occurred between 1999 and 2005. After the agencies approved use of the models on this project, the tools were applied and the modeling was performed (2006 and 2007). The project-related impacts (without mitigation) predicted by the various models for the deepening alternatives are summarized in Table 5.

Table 5. Summary of Project-Related Impacts Without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres
Brackish Marsh (Loss)	-7.2 acres	Same	Same	Same	Same
Dissolved Oxygen	Reductions at mid-depth and bottom	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater amount	Same effect, but greater amount
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (185.0)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 77 mg/L	Max hourly increase of 105 mg/L	Max hourly increase of 121 mg/L	Max honrly increase of 149 mg/L	Max honrly increase of 170 mg/L
Drinking Water Aqnifer	Same type of effect, bnt less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, bnt less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow throngh confining unit by 3-4%
Hnrricane Surge	Minor, max increase in WSE of 0.3 feet	Minor, max increase in WSE of 0.5 feet	Minor, max increase in WSE of 0.6 feet	Minor, max Increase in WSE of 0.8 feet	Minor, max increase in WSE of 0.9 feet
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measnrable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Mininal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

After the expected impacts to these resources were identified, the hydrodynamic and water quality models were used to evaluate ways to reduce those impacts. Major impacts of concern that were evaluated included a predicted increase in upstream salinity levels and a decrease in dissolved oxygen levels that would be caused by harbor deepening. A flow diversion plan was developed for each depth alternative that decreases the amount of salt water entering Middle River and Little Back River and increases the amount of freshwater entering these streams. Consequently, these mitigation plans would minimize the adverse affects to tidal freshwater marsh, striped bass habitat, and Shortnose sturgeon habitat that would result from increased salinity levels.

Previous studies identified oxygen injection as being the best method to improve dissolved oxygen levels in the harbor. Mitigation of low dissolved oxygen levels caused by harbor deepening would require the injection of oxygen at various locations in the Savannah estuary. Studies indicate that construction of three oxygen injection systems would be required to remove the effects of the proposed harbor deepening alternatives. Two of these systems would be constructed on Hutchinson Island and one would be located upstream near Georgia Power's Plant McIntosh. Oxygen would be injected during the summer months (July-September) when dissolved oxygen levels are low in Savannah Harbor.

Even with the flow modification plan and oxygen injection in place, impacts to Striped bass habitat, Shortnose sturgeon habitat, and tidal freshwater marsh were not completely eliminated. The effects of the proposed work are described in detail in Section 5.0 of the Environmental Consequences of the EIS. The Mitigation Plan can be found in Appendix C of the EIS. Table 6 shows the impacts of the deepening alternatives with the flow diversion and oxygen injection plans in place.

The project's mitigation plan (Appendix C) includes funding for the Georgia Department of Natural Resources to stock Striped bass fingerlings in the lower Savannah River to compensate for the loss of spawning, egg, and larvae habitat. The project's monitoring and adaptive management plan (Appendix D) includes a study during the post-construction monitoring to further evaluate the impacts of channel deepening on Striped bass habitat in the lower Savannah River. The hydrodynamic and water quality models would be used along with the field data collected to assess project impacts on Striped bass habitat. Further mitigation could be provided should the results of this study indicate that to be appropriate.

A horseshoe rock ramp fish passage structure at New Savannah Bluff Lock and Dam was proposed in the DEIS as additional mitigation for the loss of Shortnose sturgeon habitat in the lower Savannah River that would be caused by channel deepening. This fish passage facility would permit Shortnose sturgeon (and other species of anadromous fish to move above the dam to traditional upstream spawning areas. Comments expressed during the review of the DEIS indicated that some of the resource agencies had concerns about the fish passage efficiency of the horseshoe rock ramp design (mainly based on flow through the structure). Consequently, the Corps convened a fish passage workshop in April 2011. As a result of this workshop, the Corps revised the design for fish passage at the New Savannah Bluff Lock and Dam. An off-channel rock ramp structure would capture much more of the river flow and is expected to be much more effective in passing fish past that dam (See Appendix C).

As shown in Table 5, the project would affect both tidal freshwater and brackish wetlands. Approximately 15.68 acres of brackish marsh would be lost as a result of various excavation requirements of the project. The excavation requirements (in regards to the amount of wetlands that would be affected) for all five channel depth alternatives are the same. Approximately 2.2 acres would be removed at Station 102+600 and 0.8 acres would be removed as part of the Kings Island Turning Basin expansion. The project would remove brackish marsh from two locations on Hutchinson Island where approximately 3.4 acres would be excavated at Station 88+000 and 0.8 acres at Station 70+00. The project also includes removal of the Tidegate Structure abutments on both the Georgia and South Carolina sides of the river. Removal of the Tidegate Structure abutment on the Georgia side would result in the loss of about 7.63 acres of brackish marsh while about 0.85 acres would be lost on the South Carolina side of the River.

The project's mitigation plan provides for restoration 0f 40.3 acres of brackish marsh in Disposal Area 1S to compensate for the loss of 15.68 acres of brackish marsh from project excavation requirements. Restoration of wetlands on this site would provide the required 138 wetland credits (28.8 acres using Savannah District Regulatory SOP) in-kind mitigation for the impacts of the project. The wetland credits for the additional 11.5 acres of wetland restoration would be used for any additional SHEP wetland mitigation needs and mitigation needs associated with operation and maintenance activities for the Savannah Harbor Navigation Project.

Table 6. Summary of Project-Related Impacts With Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary up Front River	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater Amount	Same effect, but greater amount
Freshwater Wetlands (Conversion)	+ 322 acres	- 32 acres	- 201 acres	-223 acres	- 337 acres
Brackish Marsh (Conversion)	+ 488 acres	+ 861 acres	+959 acres	+964 acres	+1068 acres
Salt Marsh (Conversion)	- 808 acres	-828 acres	-757 acres	-740 acres	-730 acres
Brackish Marsh (Loss)	-15.68 acres	Same	Same	Same	Same
Dissolved Oxygen	Minimal Net improvement	Same	Same	Same	Same
Fisheries	**Loss (-) or Gain (+) of Acceptable Habitat**				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	-4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	- 6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+19.0 % (+260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	-+6.5 % (+89.0)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	- 6.7% (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6% (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0acres)	+ 54.2 % (+1014.0acres)	+ 57.3 % (+1072.0acres)	+57.3 % (+1072.0acres)	+ 52.9 % (+989.0 acres)
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, Max increase in WSEL = 0.5 ft	Minor, Max increase in WSEL = 0.6 ft	Minor, Max increase in WSEL = 0.7 ft	Minor, Max Increase in WSEL= 0.8ft	Minor, Max increase in WSEL = 0.8 ft
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reductiou, but not measurable	Same	Same	Same	Same

As discussed in the previous paragraphs, indirect impacts associated with the proposed deepening would result in a vegetative shift in 223 acres of tidal freshwater marsh to brackish marsh with implementation of the selected plan (47-foot channel depth alternative) even with the flow routing. Approximately 740 acres of saltmarsh would also be impacted by the flow routing since more freshwater would be introduced into Little Back and Middle Rivers, which could cause some areas of saltmarsh to shift to more brackish species. As previously discussed, the Corps used the EFDC model to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary, as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where riverine surface salinity levels are extrapolated across the adjacent marshes. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.5-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh.

The results of the functional assessment concluded that the differentiation between salt marsh and brackish marsh recommended by the Wetland Interagency Coordination Team and used in the DEIS was somewhat constrained. The salinity range used in the SHEP to differentiate between brackish marsh (0.6-4 ppt) and salt marsh (> 4ppt) was quite restrictive, given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt) which occur within the area of potential effect, also supports those findings. The EFDC value for saltmarsh (> 4.0 ppt) is approximately 2.5 times less than that reported by NOAA (2010). Additionally, the NOAA (2010) range for brackish marsh includes areas determined by the EFDC model to be saltmarsh. When considering values reported in the literature, the acreage of saltmarsh conversion (740 acres) which was calculated using the EFDC model is a very inclusive value and includes existing vegetative areas that would not transition to brackish marsh flowing deepening because these areas currently exist within the salinity range of a brackish marsh (0.5-10 ppt). Thus, the salinity range used to quantify salt marsh in the area of potential effect (i.e., > 4 ppt) over estimated the amount of saltmarsh in the system and under estimated the amount of brackish marsh. As such, the described conversion of salt marsh to brackish marsh, which would occur as a result of harbor deepening, would likely be much less if one takes into account vegetative characteristics for wetland environments with associated salinities that are more commonly associated with a brackish marsh (i.e., range between 0.5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, Savannah District concludes that the 740-acre calculated conversion of saltmarsh to brackish marsh if the harbor is deepened to 47-feet is conservative, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah. That said, the District was inclusive in its assessment of the

potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts.

The conversion of 223 acres of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 47-feet as proposed. It is important to note that the ecological values of the impacted 223 acres of freshwater wetlands would not be completely lost. Instead, those acres would be converted to brackish marsh. The Corps' calculation of the number of acres of freshwater wetland that have the potential to be converted to brackish marsh is based on a shift in the location of 0.5 ppt salinity, a traditional rule-of-thumb for differentiating between freshwater marsh and brackish marsh. However, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994).

Deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined as brackish marsh (Latham et. al., 1994). Likewise, the 47-foot depth would result in a conversion of the dominant vegetative species typically observed in 740 acres of saltmarsh (saltmarsh to brackish marsh scenario), and dominant saltmarsh species like *Spartina alterniflora* would still be observed in areas which have salinities that define a brackish marsh. However, the overall basic wetland functions typically associated with these systems would not change. A comparison of potential changes in elements of wetland function for both conversion scenarios is provided in the following table.

Table 7. Changes in Wetland Function as a Result of Wetland Conversion

Elements of Wetland Function	Freshwater to Brackish Marsh (Approximately 223 acres)	Saltmarsh to Brackish Marsh (Approximately 740 acres)
Water Purification	Negligible	Negligible
Flood Protection	Negligible	Negligible
Shoreline Stabilization	Negligible	Negligible
Groundwater Recharge	Negligible	Negligible
Streamflow Maintenance	Negligible	Negligible
Retention of Particles	Negligible	Negligible
Surface Water Storage	Negligible	Negligible
Subsurface Storage	Negligible	Negligible
Nutrient Cycling	Negligible	Negligible
Values to Society	Negligible	Negligible
Fish and Wildlife Habitat	Minor Adverse	Negligible

Negligible Effect – the effect on the resource would be at the lowest levels of detection, barely measurable, with no perceptible consequences, either adverse or beneficial, to the resource.

Minor Effect – the effect on the resource is measurable or perceptible, but it is slight.

Adverse Effect: the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result

As illustrated in the table above, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. The USACE recognizes that a comparison of fish and wildlife habitat between freshwater and brackish marsh systems yields fewer similarities. However, the conversion in fish and wildlife habitat will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation after deepening in wetland areas that would be classified as brackish marsh. For additional information pertaining to the functional assessment, please see EIS-Appendix C, Section VII Consideration of Final Compensatory Mitigation Rule.

Since there would be a minor adverse effect to the fish and wildlife habitat function in 223 acres of tidal freshwater wetlands if the selected plan is implemented, an assessment was conducted to determine how to best mitigate for that impact. Once the extent of the impacts to wetlands was known, the Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs. No sites could be identified where tidal freshwater restoration or creation was feasible. Consequently, the acquisition and preservation of lands that would be ecologically significant to the Savannah National Wildlife Refuge was determined to be appropriate mitigation.

The Corps has completed its initial assessment of properties in the SNWR's Acquisition Plan to determine potential properties that could meet the wetland mitigation needs of the SHEP. This assessment (Consideration of 2008 USEPA/USACE Mitigation Rule) is in Appendix C. The lands proposed for preservation consist of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain estuarine emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer would provide a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion.

5.0 OTHER AREAS OF ENVIRONMENTAL CONCERN

Some of the major environmental concerns associated with the SHEP have been previously addressed in this document. Other environmental concerns include the dredging and disposal of sediments with elevated concentrations of naturally occurring cadmium, beach erosion, possible impacts to the Floridan aquifer, and impacts to Threatened and Endangered Species. These impacts are discussed in detail in Section 5.0, Environmental Consequences, of the EIS and the Mitigation Plan in Appendix C.

5.1 Sediment Quality

Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built upon the results of the previous work. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45and000 to 94+000 (River Mile 8.5 to 17.8).

Additional studies were conducted in 2007 to assess the potential pathways by which cadmium could enter the environment during the dredging and disposal process. The additional studies included the following activities:

- Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
- Side scan sonar survey to identify and map bottom characteristics in the channel;
- Benthic community assessment;
- Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);

- Collecting dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
- Compositing and processing sediment cores to create "high cadmium" and "low cadmium" composite samples for further testing;
- Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
- Analytical testing of porewater and SLRP samples at the high cadmium locations only;
- Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and
- Risk evaluation and report preparation.

Based on the results of the above studies, the following conclusions were reached relative to the dredging and disposal of cadmium-laden sediments associated with the SHEP:

A. The existing bottom habitats within the Savannah Harbor Navigation Channel support benthic communities that are diverse and provide an available food resource.

B. Although substantial benthic communities reside in the clay/sand veneer substrates which have naturally-occurring high levels of cadmium, studies indicate that the cadmium is not freely soluble or readily available bioavailable to organisms.

C. High cadmium composite samples (average concentration of 30 mg/km) and low cadmium composite samples (average of 15 mg/kg) were created from bottom sediments and used for physical and chemical analyses, standard and effluent elutriate creation, simplified laboratory procedure (SLRP), aquatic bioaccumulation testing, and plant uptake studies.

D. Sequential Extraction Procedures (SEP) were used to determine the amount of metal bound in different fractions of the sediment or soil. SEP results can be used to predict the metal concentrations that would most likely be available to aquatic organisms, plants, and wildlife. Results of the SEP for both the high cadmium and the low cadmium composite samples indicated that no cadmium was detected in the exchangeable fraction, and that about 98 percent of the cadmium in the Miocene layer was bound in relatively insoluble forms. These results suggest that the majority of the cadmium is not freely soluble or readily bioavailable.

E. Analysis of site (dredging) water, receiving water, standard elutriate, and effluent elutriate results included both the total and dissolved fractions and comparisons of detected chemical constituents to Federal and state (South Carolina) saltwater acute and chronic water criteria for the protection of aquatic life. In the dredging and receiving water, nutrient and metal concentrations in both the total and dissolved fractions were low, and generally below the USEPA/South Carolina saltwater criteria for the protection of aquatic life. Cadmium was not detected in either the total or dissolved fraction of the dredging water sample or the receiving water sample.

F. Porewater analysis of two core samples collected from high cadmium locations indicate that concentrations of dissolved cadmium in the porewater were low and below the laboratory reporting limit and applicable water quality criteria.

G. For both the standard and the effluent elutriates, the concentrations of metals detected in the total fraction of the standard elutriates created using the high and low cadmium composite samples were high, exceeding South Carolina water quality criteria for the protection of aquatic life. However, cadmium concentrations did not exceed USEPA chronic saltwater criteria in the dissolved fraction of both the standard and the elutriate samples. Therefore, the cadmium detected in the total fraction is most likely bound to the fine grained particles.

H. Aquatic bioaccumulation studies conducted were designed to evaluate the potential of benthic organisms to bioaccumulate contaminants of concern from the dredged material. These tests used *Nereis virens* (sand worm) and *Macoma nasuta* (blunt-nose clam) After 28 days of exposure using the high and low cadmium composite sample and a reference sediment sample from New River, none of the test sediments had significantly lower survival than the reference sediment. After the bioaccumulation testing, the organism tissues were analyzed. In the worm tissue, cadmium concentrations statistically exceeded the reference site tissue concentrations for tissue exposed to sediment from both the high and low cadmium composite samples. In the clam tissue, cadmium tissue concentrations from the high and low cadmium composite samples were not statistically different from the reference.

I. Plant uptake studies (45-day) were conducted using *Cyperus esculentus* (yellow nutsedge), the high and low cadmium composite samples and reference soil collected from a dike in one of the CDFs. Plant tissues were exposed to the prepared soils from the navigation channel. The mean concentration of cadmium in plant tissue exposed to the samples taken from the navigation channel statistically exceeded concentrations in reference tissue for both the high and low cadmium composite samples indicating that uptake from the soil to the plants occurred for each of these concentrations.

A risk assessment was conducted to identify the potential for impacts on human health or the environment from elevated cadmium concentrations in new work sediments that would be dredged. The risk assessment evaluated potential exposures and impacts of cadmium on aquatic and benthic organisms, wildlife, and fishermen in the Savannah River and on plants, aquatic and benthic organisms, and wildlife in the CDF. The risk assessment reached the following conclusions:

A. Cadmium in new work sediments is not likely to cause adverse impacts to aquatic and benthic organisms in the Savannah River. This determination was based on the various tests that indicate that cadmium is bound to the sediments and not readily soluble and bioavailable to aquatic organisms.

B. While cadmium concentrations are likely to be elevated in sediment and water during and after dredging in Savannah Harbor, the limited bioavailability and bioaccumulation potential of cadmium results in relatively low doses to wildlife and no potential for adverse effects. This determination was based on risk analysis studies using food web ingestion models which were used to quantify exposures to evaluate potential adverse impacts to wildlife from cadmium in new work sediments that would be placed in the CDFs.

C. The predicted concentration in game fish was below that protective of human health, indicating there are no adverse impacts to humans. This determination was based on model projections of concentration in flounder which were compared to fish tissue benchmarks protective of human consumption.

D. Cadmium concentrations in dredged material and held at the CDF in a wet condition and in effluent, runoff, and sediment discharged from the CDF are not likely to cause adverse impacts to plants in drainage areas and wetlands. This determination was based on the fact that while total concentrations of cadmium in sediment and water were elevated, the bioavailable concentrations in sediment and the dissolved concentrations of cadmium in effluent elutriates were below benchmarks protective of plants. Cadmium concentrations in the overlying water from the bioaccumulation tests were also below benchmarks.

E. Cadmium in sediments placed in the CDFs is not likely to cause adverse impacts to aquatic and benthic organisms in drainage areas impoundments, and wetland areas of the CDF. This determination is based on the fact that while total concentrations of cadmium in sediment and water were elevated above benchmarks, the bioavailability of cadmium is limited and unlikely to cause adverse impacts. Dissolved concentrations of cadmium in porewater, effluent elutriates, and overlying water from bioaccumulation tests were lower than benchmark concentrations protective of aquatic and benthic organisms. SEP analysis of the sediments demonstrated that more than 98 percent of the cadmium sediments are not likely to be bioavailable to aquatic and benthic organisms. Bioaccumulation tests indicate that test tissue concentrations of cadmium were either similar to reference concentrations or below no-effects residue benchmarks, and estimated tissue concentrations for higher trophic level fish were also below no-effects residue benchmarks.

F. There is a strong indication that cadmium is not likely to cause adverse effects to wildlife using drainage areas, impoundments, and wetlands at the CDF. This determination is based on analyses using food web ingestion models to quantify exposures. The assessment evaluated exposures for birds and mammals that consume plants, fish, and benthic organisms, and modeled doses were compared to no-effects and lowest observable effects benchmarks. Great blue heron, spotted sandpiper, osprey, Canada goose, muskrat, and river otter were used as representative or surrogate receptor species.

G. Evidence from measurement endpoints indicates that there is a limited potential for adverse impacts to plant growth from cadmium in new work sediments placed in the CDF. This determination is based on plant growth observed in the bioassays. Bioaccumualtion test results indicated that plant tissue concentrations for high and low cadmium composites were higher than reference concentration, but the plant tissue concentrations were below tissue residue benchmarks. Plant growth in the bioassays was statistically significantly lower for plants grown on high in high and low cadmium composites than for control and reference treatments. This reduced plant growth may be related to cadmium concentrations and/or the fine grain size of the dredged material.

H. Cadmium concentrations in about 3 million cubic yards of dredged material to be deposited into CDFs 14A and 14B may cause adverse effects to wildlife using uplands. Approximately 7 million cubic yards of dredged material that would be removed from the inner harbor is cadmium laden. About 4 million cubic yards of this sediment is expected to average 6.9 mg/kg cadmium which is below both no-effects and lowest observable effects limiting dose benchmarks. Approximately 3 million cubic yards of this sediment is expected to average 21.4 mg/kg cadmium which exceeds no-effects and lowest observable effects limiting dose benchmarks for soil. Risks to wildlife from cadmium in upland habitats were evaluated using food web ingestion models to quantify exposures. Models included site-specific bioavailability factors developed based on SEP analyses of the sediments and site-specific bioaccumulation factors developed based on sediment bioassays using plants. Modeled doses were compared to no-effects and lowest observable effects benchmarks. The assessment evaluated impacts for birds and mammals that consume plants, invertebrates, and small mammals which included the song sparrow, marsh wren, red-tailed hawk, meadow vole short-tailed shrew and red fox. When modeled based on concentrations in sediment composites and effluent or runoff, modeled doses for song sparrow, marsh wren, and shrew for both low and high cadmium scenarios exceeded both no-effects and low-effects benchmarks. This indicates that there is a potential for adverse effects to these receptors.

Based on the findings of the various studies relating to the dredging and disposal of cadmium-laden sediments, a separate sediment disposal and monitoring plan was developed for the Savannah Harbor Expansion Project. All of the cadmium-laden sediments that would be dredged from the inner harbor would be deposited into existing CDFs 14A and/or 14B. These sediments would be kept in a wet environment until a covering layer of sediments could placed and sediment samples taken from that cover indicate that cadmium concentrations in the surface sediments are less than 4 mg/kg. Studies indicate that allowing the sediments in the CDF to dry would change the behavior of the cadmium in the sediments. Sequential extraction procedures performed on washed and dried sediment showed that cadmium becomes more available in dried sediment. Plant uptake studies showed that plants can accumulate cadmium from dried sediments. An exposure model found that both birds and mammals exposed to the dried cadmium sediments are likely to accumulate cadmium at levels shown to have impacts. Following placement of cadmium-laden sediments, eighty-six (86) grab samples would be collected from a depth of 15 cm to characterize the cadmium levels of surface sediments. The sediments would then be covered with at least two feet of material consisting of sediments that are expected to have cadmium concentrations of 4 mg/kg or less. After this cover has been applied, sediment samples from the cap would be obtained and analyzed. Eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If cadmium levels in the cover are less than 4 mg/kg, the sampling would be considered complete. If cadmium levels in the cover are equal to or exceed 4 mg/kg in a cumulative area of 25 acres or greater, an additional cover material from operation and maintenance dredging would be applied as soon as possible. Sediment sampling would then be conducted as previously performed. This process would be repeated until the concentration of cadmium in the samples was less than 4 mg/kg. The cadmium-laden sediments would remain in CDFs 14A and/or 14B and not used for other purposes (dike construction, etc.).

Monitoring would also include evaluation of the inflow and the effluent discharged from the disposal areas. Samples would be taken from the head section of the discharge pipe from the dredge and analyzed for cadmium. Samples of the effluent leaving the disposal area would be taken and analyzed to ensure that state water quality standards are being met. The Section 401 Water Quality Certification issued by the Georgia DNR-EPD requires cadmium concentrations to be monitored on a weekly basis at the point of discharge from the CDFs where cadmium-laden sediments are placed. Monitoring shall continue at these CDFs for as long as the discharge of effluent is present, and until all dredged sediments have been dewatered, stabilized and capped. Following the installation of a stable, clean cap, cadmium must be monitored for one year.

If analytical results indicate standards are not being met, corrective actions include reducing the pumping rate of the dredge and/or boarding up the weir to decrease the amount of effluent being discharged from the CDF.
Other monitoring efforts associated with cadmium-laden sediments include wildlife use surveys in CDFs 14A and 14B, vegetation sampling and removal (if required), and biological monitoring (analysis of cadmium concentrations in birds).

The Corps would perform monthly wildlife surveys of the CDFs. These one-day surveys would record all birds and other major vertebrates seen within CDFs 14A and 14B. Monitoring would be performed during placement of sediment (including any placement of required cover) and for 3 years after any required placement is completed. If there is a concern about the number of birds or other animals or a particular species using the CDFs, some type of hazing may be appropriate (with concurrence of the USFWS).

If analyses of the sediment samples from the cap or cover show that concentrations of cadmium equal or exceed 4 mg/kg, vegetation sampling would be required. This sampling would be conducted on a quarterly basis in "hot spots" to determine cadmium uptake by plants. Samples collected from the CDFs would be compared to control samples taken from areas with low cadmium content found in adjacent CDFs. If vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place additional, low-cadmium sediments over the covering layer. These contingency measures would eliminate wildlife exposure should vectors for cadmium uptake be identified. Vegetation sampling would be considered complete once sustained cadmium concentrations in the surface sediments of the cap are less than 4 mg/kg.

Blood samples would be collected birds that use the CDFs and analyzed for cadmium before sediment placement (to obtain baseline data), during placement of cadmium-laden sediments and the cap/cover and for 3 years after placement. The tissue monitoring protocols take into account the hydrologic conditions of the CDF (wet/ dry) and the season since these factors greatly influence which birds are using the CDFs at a given time. Tissue (liver) monitoring would be conducted if cadmium levels in the samples taken during and after sediment placement have significantly higher levels than those observed in the pre-placement samples.

At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc). Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediments at the sediment/water interface.

The Georgia Section 401 Water Quality Certification also requires monitoring of maintenance dredging activities that would occur in areas of the channel with known high cadmium concentrations. Sediments to be dredged would require testing for cadmium from two locations that are representative of average sediment accumulation in that reach. This protocol would remain in effect for at least two maintenance dredging cycles and would continue if the sampling indicates cadmium levels of concern.

Details of cadmium monitoring are fully discussed in Appendix M.

5.2 Beach Erosion

It has been long surmised that construction and maintenance of the Savannah Harbor Navigation Project, particularly the entrance channel, plays a major role in beach erosion on Tybee Island. A study completed by ERDC in 2008, Impact of Savannah Harbor Deep Draft Navigation Channel on Tybee Island Shelf and Shoreline" confirmed that construction and maintenance of the entrance channel and the construction of two large jetties near the mouth of the harbor have disrupted sediment pathways across the entrance channel. The major impacts of this disruption are loss of sand from the Tybee shelf which would be available to move towards Tybee Island and erosion of the north end of the Tybee Island beach. The estimated combined shelf and shoreline impact at Tybee Island was calculated to be 78.5 percent. This means that an estimated 78.5 percent of the reduction in sand volume on the Tybee shelf and shoreline is due to the project. The remainder of the erosion is attributed to natural processes.

Further studies were conducted during the SHEP to evaluate the potential impacts of deepening of the inner harbor channel to -48 feet MLW and the entrance channel to -50 feet MLW on beach erosion at Tybee Island. These studies included a bathymetry and volume change analysis to obtain the historical perspective of the Savannah nearshore evolution, numerical modeling of circulation, waves, and sediment transport to compare pre-and post-deepening of the channel impacts on coastal processes. Based on this work, the following determinations were made:

1. Modeling results indicate that deepening of the entrance channel would result in only minor changes in nearhsore wave patterns. Consequently, the proposed deepening project would be expected to have very little impact on the Tybee Island shoreline.

2. The circulation and wave modeling indicate very small changes associated with the proposed deepening project. The proposed deepening project would not change the general overall pattern of sediment transport in the region. The most noticeable changes would occur in the channel. Channel deepening would have only a negligible effect on the Tybee Island Shelf.

4. The current navigation channel appears to be nearly a complete sink for any sediment from moving north to south along the shelf. Placement of dredged sediment back into the nearshore zone of Tybee Island would be a means restoring this supply of sand to the nearshore sand sharing system, including that of Tybee Island.

Based on the results of the studies conducted during the SHEP, much of the loss of sand from the Tybee Island shelf and the erosion of the north end of Tybee Island Beach can be attributed to the existing navigation project. The SHEP cannot mitigate for those impacts.

Deepening of the Savannah Harbor project would have very little impact on the Tybee Island shoreline or the Tybee Shelf. However, the proposed project would provide an opportunity for suitable sediments to be placed in the Tybee nearshore area thereby providing an opportunity for those sediments to enter the sand sharing system for Tybee Island.

The LTMS (USACE 1996) authorized the placement of maintenance sediment within the nearshore area off Tybee Island and into areas just south of the entrance channel to construct feeder berms and placement of suitable maintenance material on the beach at Tybee Island.

Using the concepts developed in the LTMS, several alternative disposal plans for the SHEP were considered, including beneficial uses of dredged material. Suitable dredged sediments (80 percent or better sand content) would be placed in the nearshore zone of Tybee Island to construct feeder berms which would add this sand to the Tybee Island beach system (USACE 2007). The feeder berms would allow wave action to move the sediment towards the beach. These berms would also provide protection from storm events. Initial project plans also provided for five sites (Sites 2-6) just south of the entrance channel where dredged material would be used to construct submerged feeder berms. In addition, two mounds (Sites 11 and 12) would be constructed in deeper water to provide additional fish habitat. The final locations of the sites were based on the results of coordination with the City of Tybee Island and the GA DNR-CRD to obtain the benefit of their input.

Placement of suitable sediment in the nearshore sites and the sites south of the entrance channel would provide beneficial uses of dredged sediment (for both new work and maintenance of the -47 foot project) and would comply with the Georgia Coastal Management Program, including the changes that incorporate Georgia HB 727. The sediment placement sites identified in this plan are shown in Figure 2 and described below:

a. MLW 200 has a total capacity of 217,000 cubic yards and is located west of the North Groin on Tybee Island. The sediment would be placed at the mean low water (MLW) line and be allowed to mound up to mean sea level (MSL) or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 200 feet wide and 3,200 feet long.

b. MLW 500 has a total capacity of 1.9 million cubic yards and is located south of the North Groin on Tybee Island. The sediment would be placed at the MLW line and be allowed to mound up to MSL or mid-tide. When filled to capacity, the placement would create a mid-tide berm about 500 feet wide and 11,000 feet long.

c. ERDC Nearshore has a total capacity of 1.2 million cubic yards and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be -4 feet so as not to interfere with boaters but allow potential for movement of material towards the Tybee Island shoreline by wave action.

d. Site 2 has a total capacity of 3.2 million cubic yards and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would be at mean high water (Elevation +8 feet MLW). Site 2 would also provide bird and fish habitats.

e. Site 2 Extension has a total capacity of 4.3 million cubic yards and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -4 feet MLW.

f. Sites 3-6 are located south of the entrance channel and between Site 2 and the ODMDS. These sites were authorized within the LTMS (USACE 1996).

g. Savannah Harbor Ocean Dredged Material Disposal Site (ODMDS). The USEPA-approved ODMDS is a 4.26 square mile (or 2,726.4 acres) site and is centered at 31 56' 54" N and 80 45' 34" W. Total capacity is about 56.8 million cubic yards and at capacity the top elevation would be -26 feet MLW.

h. Site 11 has a total capacity of 2.0 million cubic yards and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat.

i. Site 12 has a total capacity of 3.0 million cubic yards and is located below the mean low water contour (MLW) in the nearshore area off Tybee Island. At total capacity, the top elevation of the placement site would extend to -10 feet MLW. This mound would provide fish habitat. This site would provide habitat by establishing a variation in contours of the water bottoms.

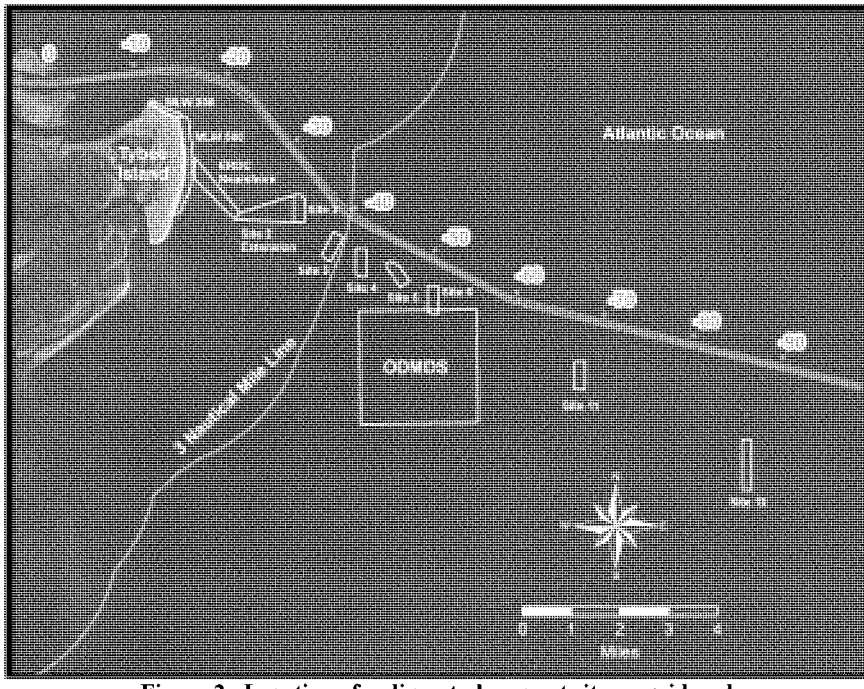

Figure 2. Location of sediment placement sites considered.

To address environmental acceptability, sediments with a fines content exceeding 20 percent would not be placed near the beach. Since sediments located reasonably close to the beach contain more than a very low (5 percent) content of fines, there will be no attempt to create a dry beach (above MHW). All placement of sediment at Tybee would occur at or just oceanward of the MLW line to protect the existing beach from scour during the deposition. The placement of sediment at or below the MLW should also reduce the appearance of clay balls on the beach when construction is complete.

A substantial volume of sediments would be deposited in the nearshore area between the beach and Site 2 (located directly east of the middle of the island). This placement would be an attempt to raise the elevation of some of the nearshore in front of the beach. Also, the shallower depth would increase the likelihood of waves moving sediments toward the beach.

The crest of the deposition in the nearshore sites would occur at -5 feet MLW to ensure recreational boats would not be severely impacted. That elevation represents a balance between producing no impact to recreational boaters and providing sediments that would be affected by both small and large waves. If sediments are too deep to be affected by waves, the waves cannot move those sediments toward the beach.

An intertidal mound would be created at Site 2, roughly 13,000 feet from the beach. The mound would provide isolated resting habitat for sea birds and some shorebirds for a period of time. The mound would serve as a source of sediments pushed by waves toward the beach. Those waves would reduce the size of the island, eventually making it subtidal and of no value to birds. While it is intertidal, the mound would provide shelter from the ocean waves and a varied habitat for fish. The base of this mound (Site 2) would be created using sediments with the poorest quality. Using those sediments as a base ensures they would be beneficially used, while covering them with better sediments ensures that sediments which subsequently migrate from the site would contain a higher sand content.

Sediment placed at Site 11 or 12 (oceanward of the Savannah ODMDS) would be placed in a manner to create a mound rising about 10-feet above the ocean floor. This mound would provide a different habitat for fish than the adjacent ocean floor, thereby improving fish habitat to a small degree. Placing the sediments at that location would also keep them from being disposed of in the Savannah Harbor Ocean Dredged Material Disposal Site, thereby preserving some of the capacity of that site.

The City of Tybee Island reviewed the DEIS including the proposal to place some of the dredged material into the nearshore sites. The City of Tybee Island believes that use of the nearshore sites would adversely affect the quality of the Tybee nearshore environment because of the fines content of the material. The Georgia DNR-CRD concurred with this determination and requested that the nearshore areas not be used for placement of dredged material from the SHEP. The Georgia DNR-CRD also requested that Sites 11 and 12 not be used because of potential adverse effects to marine habitat and commercial and recreational fishing. Consequently, all new work dredged material removed from the entrance channel from the SHEP would be placed in the ODMDS or one of the existing CDFs.

Although none of the nearshore sites or dredged material placement sites south of the entrance channel would be used for placement of new work material, some of these sites would be available for suitable maintenance material. The LTMS authorized placement of suitable maintenance material on the beach at Tybee Island, in the nearshore off Tybee Island and in various areas south of the entrance channel to construct feeder berms. These areas would thus be available for suitable maintenance material from the completed 47-foot project with one exception. EPA has determined that any dredged material placement site beyond the 3-mile line is considered an ocean dredged material disposal site. Consequently, the appropriate site designation studies (Section 103 of the MPRSA) would have to be conducted at such sites and the sites approved by the EPA as ocean dredged material disposal sites. Sites 4, 5, 6, 11 and 12 in Figure 2 are beyond the 3-mile line and thus unavailable for maintenance material unless they are designated by EPA in the future as ocean dredged material disposal sites.

The Georgia DNR-CRD also requested that new work material removed from the area including the entrance channel extension (Station -57+000B to Station -97+680B) be considered for nearshore placement or beach nourishment since this material contains 10% or less fines and minimal marine clays. The material that would be removed to extend the entrance channel would be placed in the ODMDS because this represents the least cost environmentally-acceptable disposal alternative for the SHEP. Use of this material for nearshore placement or

direct beach nourishment would require a non-Federal project sponsor who would be willing to incur the extra costs associated with this disposal alternative versus placing the material in the ODMDS.

5.3 Groundwater

Concern was raised during SHEP studies that deepening of the navigation channel could adversely affect the principal drinking water aquifer in the coastal area-the upper Floridan aquifer. The concern is that excavation of sediment required to deepen the harbor would allow saltwater to enter the freshwater aquifer, thereby degrading its quality and rendering it unacceptable for drinking purposes. Three potential pathways were identified whereby deepening of the navigation channel could possibly increase saltwater intrusion into the aquifer:

1. Deepening of the channel would require the removal of some of the top portion of the aquifer's protective layer (Miocene cap) which could result in saltwater intrusion into the aquifer.

2. Removal of sediments from paleochannels (former Pleistocene-age stream channels that have eroded into the Miocene cap) would increase the potential for intrusion into the aquifer.

3. Water with increased salinity levels could enter could enter aquifer via fractures or joints in the Miocene cap.

Various studies were conducted during the SHEP to address these issues. Based on the results of these studies, the following major conclusions were determined:

1. The primary cause of saltwater intrusion into the Floridan aquifer is long-term pumping from the aquifer to meet groundwater needs. The long-term pumping of water from the Upper Floridan aquifer and surrounding coastal counties has lowered ground water levels and reversed the seaward hydraulic gradient that existed before development. The increased withdrawal of water from the upper Floridan aquifer has resulted in a radial flow directed towards the center of pumping and a cone of depression beneath Savannah. Sustained pumping of water from the aquifer has also resulted in a downward hydraulic gradient and induced significant head differences between the surficial aquifer and the confined Upper Floridan aquifer. This effect has resulted in the downward intrusion of water through the Miocene layer into the aquifer.

2. Improvements (deepening) and maintenance of the Savannah Harbor Navigation Project have also had some impact on the downward migration of water through Miocene layer into the aquifer. Channel dredging has removed portions of the Pleistocene sands and Miocene clays that reside above the upper Floridan aquifer. GIS analysis conducted during the SHEP indicates that about 5 feet of the confining layer that protects the aquifer has been removed. Significant exposure of the Miocene layer appears to be a relatively recent event. GIS studies conducted during the SHEP also indicate that exposures of large stretches of the Miocene along the Bight Channel (Elba Island) and near the Kings Island Turning Basin appeared to have occurred between 1992 and 1998. The 42-foot deep navigation project was completed in 1994. Although deepening of the navigation channel has removed some of the Miocene cap, GIS analysis and

groundwater model studies indicate that historical dredging has probably had minimal influence on the rate of saltwater intrusion into the aquifer.

3. Underneath the navigation channel, the overall thickness of the confining unit ranges from about 30 feet thick near the Tybee high to over 150 feet thick near downtown Savannah. Model studies indicate that the expected increase in the downward flow of saline water from the area underlying the navigation channel due to channel deepening would be very low. The area that would have to be dredged to deepen the channel to 48 feet MLW accounts for a total downward flow between 50 and 250 gallons per minute. Deepening the navigation channel increases the downward flow between 2 and 7 gallons per minute which translates to a 3-4 percent increase. This contribution is negligible when compared to groundwater production in the Savannah area from the aquifer which is about 80 million gallons per day (55,555 gallons per minute).

4. SHEP studies identified eight significant paleochannels that have incised deeply into the Miocene confining layer between Stations 30+000 and -30+000B. Groundwater model study results indicate that the impacts of dredging sediments within the paleochannels would be small when compared to the impacts of dredging elsewhere in the channel where the Miocene unit is impacted. The bottom of the paleochannels represents the areas of minimum thickness of the Miocene confining layer in the harbor. Dredging to these depths would not be required.

5. Analysis conducted during SHEP studies indicates that the Savannah Harbor Project area is not likely characterized by joints or fractures which could serve as pathways for enhanced downward flow of water into the aquifer. This is evidenced by the absence of observable vertical joints in Miocene-aged surface exposures and the lack of evidence of joints or fractures in sub-surface cores of the Miocene. Also, there is no historical evidence (springs, etc.) of joints or fractures in the area.

5.4 Threatened and Endangered Species

A Biological Assessment of Threatened and Endangered Species (BATES) has been prepared for the SHEP. The BATES is included in the EIS as Appendix B. The BATES concludes that the proposed SHEP "may affect-is not likely to adversely affect" piping plover, wood stork, West Indian manatee, right whale and humpback whales, sea turtles, and Shortnose sturgeon. The BATES is subject to the review and approval of the US Fish and Wildlife Service and the National Marine Fisheries Service. The USFWS has issued a letter of concurrence with the determinations in the BATES with respect to those species for which they have responsibility. NOAA Fisheries issued a Biological Opinion. The concurrence letter from the USFWS and the BO issued by the NMFS are included in Appendix Z of the EIS.

6.0 STATE ENFORCEABLE POLICIES

6.1 Introduction

The goals of the Georgia Coastal Management Program are attained by enforcement of the policies of the State as codified within the Official Code of Georgia Annotated. "Policy" or "policies" of the Georgia Coastal Management Program means the enforceable provisions of present or future applicable statutes of the State of Georgia or regulations promulgated duly there under (O.C.G.A. 12-5-322). The statutes cited as policies of the Program were selected because they reflect the overall Program goals of developing and implementing a balanced program for the protection of the natural resources, as well as promoting sustainable economic development of the coastal area.

The list of state laws shown below, which -- along with their associated regulations – describe the legal authority for the state's regulation of its salt marshes, beaches and dune fields, and tidal water bottoms. Each of the coastal resources and use areas of concern is discussed separately in this section, in alphabetical order. For each coastal resources and use areas of concern, a policy statement is provided with a direct citation to Georgia law. The laws are not cited in their entirety. Instead, the purpose of the statute, or a pertinent section of the statute, is cited. The Program policies are the enforceable provisions of the laws cited. A policy statement for each law describes the spirit of the law, directly cited from statements set out in the particular law. In each case, the citation for the statement is provided. The particular statements may or may not be enforceable as written, but the laws to which they relate contain enforceable provisions that have been enacted by the Georgia General Assembly to implement the policies as stated. The policies cited here are, therefore, supported by legally binding laws of the State of Georgia, through which Georgia is able to exert control over impacts to the land and water uses and natural resources in the coastal area. The statutes referenced herein can be found in the Official Code of Georgia Annotated (O.C.G.A.), copies of which are located in headquarters offices of State and local agencies, most public libraries, local courthouses, and numerous other public offices.

A paragraph titled "General Description" is included after each cited policy to serve as a quick reference to the relevant provisions of the law. The General Description is not intended to be, nor should it be interpreted as, law, policy, or restatement of the law. It is merely provided for the convenience of the reader to gain an initial concept as to the content of the related law. The reader is advised to refer to the actual law cited, and not to rely on the General Description as a basis for a legal interpretation of the law on any particular issue. The "Policy Statement" and "General Description" paragraphs were copied directly from the Georgia CZM Program. A paragraph titled "Consistency" follows those two paragraphs to explain Savannah District's position on the extent to which the proposed project is consistent with that enforceable provision.

6.2 List of Pertinent State Laws and Authorities

Georgia Coastal Management Act
Coastal Marshlands Protection Act
Department of Natural Resources Authority
Endangered Wildlife Act
Game and Fish Code
Georgia Aquaculture Development Act
Georgia Air Quality Act
Historic Area Act
Georgia Boat Safety Act
Georgia Administrative Procedures Act (Revocable License Program)
Georgia Comprehensive Solid Waste Management Act
Georgia Environmental Policy Act
Georgia Erosion and Sedimentation Control Act
Georgia Fisheries Law Pertaining to Shellfish
Georgia Hazardous Waste Management Act
Georgia Heritage Trust Act
Georgia Natural Areas Act
Georgia Environmental Policy Act
Georgia Oil and Gas Deep Drilling Act
Georgia River and Harbor Development
Georgia Safe Dams Act
Georgia Safe Drinking Water Act
Georgia Scenic Rivers Act
Georgia Scenic Trails Act
Georgia Surface Mining Act
Georgia Underground Storage Tank Act
Georgia Water Quality Control Act
Groundwater Use Act
Licenses to Dig, Mine, and Remove Phosphate Deposits
Protection of Tidewaters Act
River Corridor Protection Act
Title 31 - Health (Septic Tank Law)
Shore Protection Act
Water Wells Standards Act
Wildflower Preservation Act

6.3 Aquaculture

6.3.1 Policy Statement

Georgia Aquaculture Development Act (O.C.G.A. 27-4-251, et seq.) 27-4-254. Duty of commission to develop aquaculture development plan; contents of plan; meetings of commission; staff support. The commission shall make a thorough study of aquaculture and the potential for development and enhancement of aquaculture in the state. It shall be the duty of the

commission to develop, distribute, and, from time to time, amend an aquaculture development plan for the State of Georgia for the purpose of facilitating the establishment and growth of economically viable aquaculture enterprises in Georgia. (Code 1981. SS 27-4-254, enacted by Ga.L. 1992, p. 1507, SS 8.)

6.3.2 General Description

The Georgia Aquaculture Development Act was enacted in 1992 to study aquaculture development in Georgia. A 14-member Aquaculture Development Commission composed of industry representatives, scientists, agency representatives, and others is created. The Department of Natural Resources, with assistance from the Department of Agriculture and the Department of Industry, Trade, and Tourism provides staff support for the Commission.

6.3.3 Consistency

This policy is not applicable to the proposed project.

6.4 Air Quality

6.4.1 Policy Statement.

Georgia Air Quality Act (0.C.G.A. 12-9-1, et seq.) 12-9-2. Declaration of public policy. It is declared to be the public policy of the State of Georgia to preserve, protect, and improve air quality and to control emissions to prevent the significant deterioration of air quality and to attain and maintain ambient air quality standards so as to safeguard the public health, safety, and welfare consistent with providing for maximum employment and full industrial development of the state. (Code 1933, 88-901, enacted by Ga.L. 1967, p. 581, SS 1; Ga.L. 1978, p. 275, SS 1; Ga.L. 1992, p. 918, SS 2; Ga.L. 1992, p. 2886, SS 1.)

6.4.2 General Description

The Georgia Air Quality Act provides authority to GA DNR's Environmental Protection Division to promulgate rules and regulations necessary to abate or to control air pollution for the State as a whole or from area to area, as may be appropriate. Establishment of ambient air quality standards, emission limitations, emission control standards, and other measures are necessary to provide standards that are no less stringent than the Federal Clean Air Act are mandated. The Act also requires establishment of a program for prevention and mitigation of accidental releases of hazardous air contaminants or air pollutants, training and educational programs to ensure proper operation of emission control equipment, and standards of construction no less stringent than the federal Act. The Environmental Protection Division administers the Georgia Air Quality Act throughout the State. The Memorandum of Agreement between the Georgia Coastal Resources Division and the Environmental Protection Division ensures cooperation and coordination in the achievement of the policies of the Program.

6.4.3 Consistency

The Georgia Department of Natural Resources, Environmental Protection Division, Air Protection Branch (GADNR- EPD, APB) and the South Carolina Department of Health and Environmental Control, Bureau of Air Quality (SC DHEC, BAQ), has air quality jurisdiction for the project area for Chatham County, Georgia and Jasper County, South Carolina, respectively. The ambient air quality for Chatham County, Georgia and Jasper County, South Carolina have been determined to be in compliance with the National Ambient Air Quality Standards, and both counties have been designated as an attainment area (Personal Communication, 20 February 2007, Jim Kelly, GADNR-EPD, APB and Fatina Washburn, SC DHEC, BAQ).

Adverse impacts to air quality stemming from the use of construction equipment would be minimal in extent, temporary in nature, and distributed over 50 miles of area. Construction of the SHEP would improve ambient air quality in Savannah Harbor. With a deeper channel, larger vessels would call at the Port. The total number of container ships calling at the port would decrease in a given year since more goods would be carried in each of the larger vessels. A more detailed description of the impacts of the proposed action on air quality is found in the EIS in Appendix K– Air Emission Inventory. The proposed project is fully consistent with this policy.

6.5 Boating Safety

6.5.1 Policy Statement

Georgia Boat Safety Act (O.C.G.A. 52-7-1. et seq.) 52-7-2. Declaration of policy. It is the policy of this state to promote safety for persons and property in and connected with the use, operation, and equipment of vessels and to promote the uniformity of laws relating thereto. (Ga.L. 1973, p. 1427, SS 2)

6.5.2 General Description

The Georgia Boat Safety Act provides enforceable rules and regulations for safe boating practices on Georgia's lakes, rivers, and coastal waters. This Act establishes boating safety zones for a distance of 1,000 feet from the high-water mark on Jekyll Island, Tybee Island, St. Simons Island, and Sea Island. All motorized craft, including commercial fishing vessels, jet skis, and powerboats, are prohibited from these waters, except at certain pier and marina access points. This Act defines "abandoned vessels" as any left unattended for five days and provides for their removal. The Law Enforcement Section of the Georgia Department of Natural Resources, Wildlife Resources Division and the Georgia Bureau of Investigation enforces these regulations.

6.5.3 Consistency

The proposed deepening of the Federal navigation channel would comply with all required US Coast Guard safety regulations. The deepened channel (including the ocean bar channel) would be identified with the required US Coast Guard buoys and channel markers.

6.6 Coastal Management

6.6.1 Policy Statement.

Georgia Coastal Management Act (0.C.G.A. 12-5-320, et seq.) 12-5-321. Legislative purpose. The General Assembly finds and declares that the coastal area of Georgia comprises a vital natural resource system. The General Assembly recognizes that the coastal area of Georgia is the habitat of many species of marine life and wildlife, which must have clean waters, and suitable habitat to survive. The General Assembly further finds that intensive research has revealed that activities affecting the coastal area may degrade water quality or damage coastal resources if not properly planned and managed. The General Assembly finds that the coastal area provides a natural recreation resource, which has become vitally linked to the economy of Georgia's coast and to that of the entire state. The General Assembly further finds that resources within this coastal area are costly, if not impossible, to reconstruct or rehabilitate once adversely affected by human-related activities and it is important to conserve these resources for the present and future use and enjoyment of all citizens and visitors to this state. The General Assembly further finds that the coastal area is a vital area of the state and that it is essential to maintain the health, safety, and welfare of all the citizens of the state. Therefore, the General Assembly declares that the management of the coastal area has more than local significance, is of equal importance of all citizens of the state, is of state-wide concern, and consequently is properly a matter for coordinated regulation under the police power of the state. The General Assembly further finds and declares that activities and structures in the coastal area must be regulated to ensure that the values and functions of coastal waters and natural habitats are not impaired and to fulfill the responsibilities of each generation as public trustees of the coastal waters and habitats for succeeding generations.

6.6.2 General Description

The Coastal Management Act provides enabling authority for the State to prepare and administer a coastal management program. The Act does not establish new regulations or laws; it is designed to establish procedural requirements for the Department of Natural Resources to develop and implement a program for the sustainable development and protection of coastal resources. It establishes the Department of Natural Resources as the State agency to receive and disburse federal grant moneys. It establishes the Governor as the approving authority of the program and as the person that must submit the program to the Federal government for approval under the Federal Coastal Zone Management Act. It requires other State agencies to cooperate with the Coastal Resources Division when exercising their activities within the coastal area.

6.6.3 Consistency

Preparation of this Consistency Determination is evidence that the Corps of Engineers agrees that Georgia's coast is a vital natural resource that deserves protection from unwise use. The proposed project fully adheres to the state's enforceable policies concerning development on the coast. The proposed project is fully consistent with this policy.

6.7 Coastal Marshlands

6.7.1 Policy Statement

Coastal Marshlands Protection Act (O.C.G.A. 12-5-280, et seq.) 12-5-281. Legislative findings and declarations. The General Assembly finds and declares that the coastal marshlands of Georgia comprise a vital natural resource system. It is recognized that the estuarine area of Georgia is the habitat of many species of marine life and wildlife and, without the food supplied by the marshlands, such marine life and wildlife cannot survive. The General Assembly further finds that intensive marine research has revealed that the estuarine marshlands of coastal Georgia are among the richest providers of nutrients in the world. Such marshlands provide a nursery for commercially and recreationally important species of shellfish and other wildlife, provide a great buffer against flooding and erosion, and help control and disseminate pollutants. Also, it is found that the coastal marshlands provide a natural recreation resource, which has become vitally linked to the economy of Georgia's coastal zone and to that of the entire state. The General Assembly further finds that this coastal marshlands resource system is costly, if not impossible, to reconstruct or rehabilitate once adversely affected by man related activities and is important to conserve for the present and future use and enjoyment of all citizens and visitors to this state. The General Assembly further finds that the coastal marshlands are a vital area of the state and are essential to maintain the health, safety, and welfare of all the citizens of the state. Therefore, the General Assembly declares that the management of the coastal marshlands has more than local significance, is of equal importance to all citizens of the state, is of state-wide concern, and consequently is properly a matter for regulation under the police power of the state. The General Assembly further finds and declares that activities and structures in the coastal marshlands must be regulated to ensure that the values and functions of the coastal marshlands are not impaired and to fulfill the responsibilities of each generation as public trustees of the coastal marshlands for succeeding generations. (Code 1981, SS 12-5-281, enacted by Ga.L. 1992, p. 2294, SS 1.)

6.7.2 General Description

The Coastal Marshlands Protection Act provides the Coastal Resources Division with the authority to protect tidal wetlands. The Coastal Marshlands Protection Act limits certain activities and structures in marsh areas and requires permits for other activities and structures. Erecting structures, dredging, or filling marsh areas requires a Marsh Permit administered through the Coastal Management Program. In cases where the proposed activity involves construction on State-owned tidal water bottoms, a Revocable License issued by the Coastal Resources Division may also be required. Marsh Permits and Revocable Licenses are not issued for activities that are inconsistent with the Georgia Coastal Management Program.

The jurisdiction of the Coastal Marshlands Protection Act extends to "coastal marshlands" or "marshlands", which includes marshland, intertidal area, mudflats, tidal water bottoms, and salt marsh area within estuarine area of the state, whether or not the tidewaters reach the littoral areas through natural or artificial watercourses. The estuarine area is defined as all tidally influenced waters, marshes, and marshlands lying within a tide-elevation range from 5.6 feet above mean high-tide level and below. Exemptions from the jurisdiction of the Act include: Georgia Department of Transportation activities, generally; agencies of the United States charged with

maintaining navigation of rivers and harbors; railroad activities of public utilities companies; activities of companies regulated by the Public Service Commission; activities incident to water and sewer pipelines; and, construction of private docks that don't obstruct tidal flow.

Any agricultural or silvicultural activity that directly alters lands within the jurisdictional areas of the Coastal Marshlands Protection Act must meet the permit requirements of the Act and must obtain a permit issued by the Coastal Resources Division on behalf of the Coastal Marshlands Protection Committee. Permits for marinas, community docks, boat ramps, recreational docks, and piers within the jurisdiction of the Coastal Marshlands Protection Act are administered by the Coastal Resources Division. To construct a marina, a marina lease is required. Private-use recreational docks are exempt from the Coastal Marshlands Protection Act, but must obtain a Revocable License and a State Programmatic General Permit.

6.7.3 Consistency

The project would be constructed in Georgia and South Carolina waters and would affect wetlands within the jurisdiction of the Georgia Coastal Marshlands Protection Act. As indicated in the EIS and Mitigation Plan found in Appendix C, approximately 223 acres of tidal freshwater marsh in the Savannah National Wildlife Refuge would convert to brackish marsh if the 47-foot project is constructed. This change would be attributable to an increase in upstream salinity levels caused by deepening of the navigation channel. Approximately 740 acres of salt marsh may convert to brackish marsh (with the 47-foot project) as a result of the flow rerouting mitigation features. The mitigation plan for the SHEP provides for acquisition of about 2,245 acres of lands identified on the Refuge's Acquisition Plan. Lands placed on the acquisition plan have been evaluated and determined to be ecologically significant. The acquired lands would be preserved and become part of the National Wildlife Refuge.

Approximately 3.2 acres of brackish marsh would be lost as result of the expansion of the Kings Island Turning Basin and about 4.0 acres of brackish marsh would be lost as a result of excavation requirements for the project. An additional 7.63 acres of brackish marsh would be lost on the Georgia side of Back River where the Tidegate Structure end wall is removed. In-kind mitigation would be provided for this loss of brackish marsh. Approximately 40.3 acres of estuarine emergent wetlands would be restored in Savannah Harbor. This restoration would be achieved by grading down uplands to marsh elevation (formerly wetlands) in Disposal Area 1S near the juncture of Front River and Middle River. Site preparation would also include the construction of finger streams to ensure the site is subjected to tidal influence.

Since the project provides mitigation for all affected wetlands, the proposed project is consistent with this policy. This document will be coordinated with the GA DNR-CRD for their review and concurrence with this determination.

6.8 Dams

6.8.1 Policy Statement

Georgia Safe Dams Act (O.C.G.A. 12-5-370, et seq.) 12-5-371. Declaration of purpose. It is the purpose of this part to provide for the inspection and permitting of certain dams in order to protect the health, safety, and welfare of all the citizens of the state by reducing the risk of failure of such dams. The General Assembly finds and declares that the inspection and permitting of certain dams is properly a matter for regulation under the police powers of the state. (Ga.L. 1978, p. 795. SS 2)

6.8.2 General Description

The Georgia Safe Dams Act provides for the inspection and permitting of certain dams to protect the health, safety, and welfare of Georgia residents. The Environmental Protection Division of the Georgia Department of Natural Resources is responsible for inspecting and certifying dams.

6.8.3 Consistency

Construction or operation of a dam is not included in this project.

6.9 Department of Natural Resources

6.9.1 Policy Statement

12-2-3. Departmental purposes. It shall be the objectives of the department: a. To have the powers, duties, and authority formerly vested in the Division of Conservation and the commissioner of conservation; b. By means of investigation, recommendation, and publication, to aid: (1) In the promotion of the conservation and development of the natural resources of the state; (2) In promoting a more profitable use of lands and waters; (3) In promoting the development of commerce and industry; and In coordinating existing scientific investigations with any related work of other agencies for the purpose of formulating and promoting sound policies of conservation and development. c. To collect and classify the facts derived from such investigations and from the work of other agencies of the state as a source of information accessible to the citizens of the state and to the public generally, which facts set forth the natural, economic, industrial, and commercial advantages of the state; and d. To establish and maintain perfect cooperation with any and every agency of the federal government interested in or dealing with the subject matter of the department. (Ga. L. 1937, p. 264, SS 4; Ga. L. 1949, p. 1079, SS 1; Ga.L. 1992, p. 6. SS 12.)

6.9.2 General Description

The authority for the Department of Natural Resources is found at O.C.G.A. 12-21, et seq. The objectives for the Department are described, including to aid: in promoting the conservation and development of the State's natural resources; in promoting a more profitable use of lands and waters; in promoting the development of commerce and industry; and in coordinating existing

scientific investigations with related work of other agencies for the purpose of formulating and promoting sound policies of conservation and development. The Act also requires the Department to establish and maintain perfect cooperation with any and every agency of the federal government interested in or dealing with the subject matter of the department."

The powers of the Department are established, including: investigations of the natural mining industry and commercial resources of the State and promotion of the conservation and development of such resources; the care of State parks and other recreational areas now owned or to be acquired by the State; examination, survey, and mapping of the geology, mineralogy, and topography of the State, including their industrial and economic utilization; investigation of the water supply and water power of the State with recommendations and plans for promoting their more profitable use and promotion of their development; investigations of existing conditions of trade, commerce, and industry in the State, with particular attention to the causes that may hinder or encourage their growth, and recommendations of plans that promote development of their interests.

The Department is set up in several Divisions. The Wildlife Resources Division is empowered to acquire land areas and to enter into agreements with landowners and the federal government for purposes of managing wildlife species and establishing specific sanctuaries, wildlife management areas, and public fishing areas. The Wildlife Resources Division administers a management plan for each area, which establishes short- and long-term uses, and guidelines for protection and use of each specific area. These areas owned and/or managed by the Wildlife Resources Division are important resources of the coastal area for conservation of wildlife and also for recreational hunting and fishing opportunities. Wildlife management areas within the jurisdiction of the Coastal Marshlands Protection Act and/or Shore Protection Act receive the additional protection provided by said legislation. The Environmental Protection Division is empowered to manage the State's air and water resources. The Coastal Resources Division is charged with management of coastal resources, which includes implementation of the Coastal Marshlands Protection Act and the Shore Protection Act. The Coastal Resources Division responsibilities also include management of marine fisheries resources. The Pollution Prevention Assistance Division provides technical assistance and education for reducing pollution throughout Georgia, including development of Best Management Practices for various industries. The Historic Preservation Division is charged with cataloging, protecting, and preserving the State's historic sites and areas. The Parks, Recreation, and Historic Sites Division has primary responsibility for development and maintenance of the State's parks and historic sites. The Program Support Division provides administrative support for the Department.

6.9.3 Consistency

The District coordinated mitigation plans for the proposed work with the GA DNR to obtain their views during development of the project. The EIS will be coordinated with GA DNR. The proposed project is consistent with this policy.

6.10 Endangered Wildlife

6.10.1 Policy Statement

Endangered Wildlife Act (0.C.G.A. 2 7-3-130, et seq.) 27-3-132. Powers and duties of department and board. The department shall identify and inventory any species of animal life within this state which it determines from time to time to be rare, unusual, or in danger of extinction; and, upon such determination, such species shall be designated protected species and shall become subject to the protection of this article.

The board shall issue such rules and regulations as it may deem necessary for the protection of protected species and for the enforcement of this article. Such rules and regulations shall not affect rights in private property or in public or private streams, nor shall such rules and regulations impede construction of any nature. Such rules and regulations shall be limited to the regulation of the capture, killing, or selling of protected species and the protection of the habitat of the species on public lands.

6.10.2 General Description

The Endangered Wildlife Act provides for identification, inventory, and protection of animal species that are rare, unusual, or in danger of extinction. Additional species may be added by the Board of Natural Resources at any time. The protection offered to these species is limited to those that are found on public lands of the State. It is a misdemeanor to violate the rules prohibiting capture, killing, or selling of protected species, and protection of protected species habitat on public lands. The rules and regulations are established and administered by the Department of Natural Resources for implementation of this Act.

Projects permitted under the authority of the Coastal Marshlands Protection Act, the Shore Protection Act, and the Revocable License require full compliance with the protection of endangered and protected species. Outside the jurisdiction of these laws, for those areas that are not public lands of Georgia, protection of endangered species is provided by the federal Endangered Species Act, which has jurisdiction over both private and public lands.

6.10.3 Consistency

A Biological Assessment of Threatened and Endangered Species (BATES) [Appendix B of the EIS] has been prepared for the SHEP. The BATES includes an evaluation of potential effects to state listed species. Based on information developed in the BATES, a Summary Effect Determination has been developed to the effect that the project "may affect – is not likely to adversely affect" piping plover, wood stork, West Indian manatee, right whale and humpback whales, sea turtles, and Shortnose sturgeon. The BATES was submitted to the USFWS and NOAA for their review. The report prepared by the USFWS on threatened and endangered species and the BO prepared by NOAA are in Appendix Z. The BO includes reasonable and prudent measures to protect Loggerhead and Kemp's Ridley sea turtles and Shortnose and Atlantic sturgeon.

As shown in Table 6, the proposed 47-foot deepening of the navigation channel would beneficially affect 89 acres of Shortnose sturgeon summer habitat. However, it would also adversely impact up to 266 acres of adult winter Shortnose sturgeon habitat and about 251 acres of juvenile winter Shortnose sturgeon habitat even with implementation of the Mitigation Plan. As additional mitigation for this species, a fish bypass structure (off-channel rock ramp design) would be constructed around the lowest dam on the river, the New Savannah Bluff Lock & Dam (NSBL&D) at Augusta, Georgia. A fishway around the structure would allow migrating fish to access historic spawning areas upstream at the Augusta Shoals. The structure would also open up the upper river and the Shoals to American shad and other anadromous fish species.

Standard manatee, Shortnose sturgeon, sea turtle, and right whale conditions would be included in any construction contract for the work. As required by the Section 401 Water Quality Certification issued for the project, all hopper dredging activities would be restricted to December 15 through March 31, when sea turtles are least abundant. Hopper dredges would have fully functional inflow and outflow screening and protected species observers.

Construction of the SHEP would not adversely affect any plant or animal listed as threatened or endangered in the State of Georgia.

With the proposed mitigation in place for the Shortnose sturgeon, the proposed project is fully consistent with this policy.

6.11 Environmental Policy

6.11.1 Policy Statement

Georgia Environmental Policy Act (0.C.G.A. 12-16-1, et seq.) 12-16-2. Legislative findings. The General Assembly finds that: a. The protection and preservation of Georgia's diverse environment is necessary for the maintenance of the public health and welfare and the continued viability of the economy of the state and is a matter of the highest public priority; b. State agencies should conduct their affairs with an awareness that they are stewards of the air, land, water, plants, animals, and environmental, historical, and cultural resources; c. Environmental evaluations should be a part of the decision-making processes of the state; and d. Environmental effects reports can facilitate the fullest practicable provision of timely public information, understanding, and participation in the decision-making processes of the state. (Code 1981, SS 12-16-2, enacted by Ga. L. 1991, p. 1728, SS 1.)

6.11.2 General Description

The Georgia Environmental Policy Act (GEPA) requires that all State agencies and activities prepare an Environmental Impact Report as part of the decision-making process. This is required for all activities that may have an impact on the environment. Alternatives to the proposed project or activity must be considered as part of the report.

6.11.3 Consistency

This Coastal Zone Management Consistency Determination is a component of the EIS, which evaluates the impacts of the proposed SHEP. The Georgia Ports Authority has been a Cooperating Agency in the preparation of the EIS. The Georgia DOT may be the non-Federal sponsor in the implementation of the project. Although GEPA does not directly apply to a proposed Federal navigation project, Federal agencies must comply with a similar law, the National Environmental Policy Act (NEPA). Preparation of the EIS is fully consistent with both this state law and NEPA.

6.12 Erosion and Sedimentation

6.12.1 Policy Statement

Georgia Erosion and Sedimentation Act (O.C.G.A. 12-7-1. et seq.) 12-7-2. Legislative findings; policy of state and intent of chapter. It is found that soil erosion and sediment deposition onto lands and into waters within the watersheds of this state are occurring as a result of widespread failure to apply proper soil erosion and sedimentation control practices in land clearing, soil movement, and construction activities and that such erosion and sediment deposition result in pollution of state waters and damage to domestic, agricultural, recreational, fish and wildlife, and other resource uses. It is therefore declared to be the policy of this state and the intent of this chapter to strengthen and extend the present erosion and sediment control activities and programs of this state and to provide for the establishment and implementation of a state-wide comprehensive soil erosion and sediment control program to conserve and protect the land, water, air, and other resources of this state. (Ga. L. 1975, p.994, SS 2.)

6.12.2 General Description

The Georgia Erosion and Sedimentation Act requires that each county or municipality adopt a comprehensive ordinance establishing procedures governing land disturbing activities based on the minimum requirements established by the Act. The Erosion and Sedimentation Act is administered by the Environmental Protection Division of the Georgia Department of Natural Resources, and by local governments. Permits are required for specified "land-disturbing activities," including the construction or modification of manufacturing facilities, construction activities, certain activities associated with transportation facilities, activities on marsh hammocks, etc. With certain constraints, permitting authority can be delegated to local governments.

One provision of the Erosion and Sedimentation Act requires that land-disturbing activities shall not be conducted within 25 feet of the banks of any State waters unless a variance is granted (O.C.G.A. 12-7-6-(15)). Construction of single-family residences under contract with the owner are exempt from the permit requirement but are still required to meet the standards of the Act (O.C.G.A. 12-7-17-(4)). Large development projects, both residential and commercial, must obtain a permit and meet the requirements of the Act. According to the Georgia Coastal Management Act, any permits or variances issued under the Erosion and Sedimentation Act must be consistent with the Georgia Coastal Management Program. Permits within the jurisdiction of

the Coastal Marshlands Protection Act and the Shore Protection Act can include requirements that certain minimum water quality standards be met as a condition of the permit.

There are specific exemptions to the requirements of the Erosion and Sedimentation Act (O.C.G.A. 12-7-17 - Exemptions). The exemptions include: surface mining, granite quarrying, minor land-disturbing activities such as home gardening, construction of single-family homes built or contracted by the homeowner for his own occupancy, agricultural practices, forestry land management practices, dairy operations, livestock and poultry management practices, construction of farm buildings, and any projects carried out under the supervision of the Natural Resource Conservation Service of the US Department of Agriculture. Exemptions from the requirements of the Act also apply to any project involving 1.1 acres or less, provided that the exemption does not apply to any land-disturbing activities within 200 feet of the bank of any State waters. Construction or maintenance projects undertaken or financed by the Georgia Department of Transportation, the Georgia Highway Authority, or the Georgia Tollway Authority, or any road or maintenance project undertaken by any county or municipality, are also exempt from the permit requirements of the Act, provided that such projects conform to the specifications used by the Georgia Department of Transportation for control of soil erosion. Exemptions are also provided to land-disturbing activities by any airport authority, and by any electric membership corporation or municipal electrical system, provided that such activities conform as far as practicable with the minimum standards set forth at Code Section 12-7-6 of the Erosion and Sedimentation Act. The Georgia Department of Transportation has developed a "Standard Specifications -- Construction of Roads and Bridges," which describes contractor requirements, including controls for sedimentation and erosion. The specifications describe the requirements for both temporary control measures for use during the construction phase, and permanent erosion and sedimentation control measures that need to be incorporated into the design of the project. Failure to comply with the provisions of the specification will result in cessation of all construction activities by the contractor, and may result in the withholding of moneys due to the contractor according to a schedule of non-performance of erosion control, enforced by the Georgia Department of Transportation. Forestry and agricultural land-disturbing activities are subject to the Best Management Practices of the Georgia Forest Commission and the Georgia Soil and Water Conservation Commission, respectively.

6.12.3 Consistency

The primary land disturbing activity for the proposed action would be within the seven existing upland CDFs. Any dike construction, raising, surface preparation or similar activities would use Best Management Practices and conform to the erosion control requirements of the responsible county.

The Georgia Erosion and Sedimentation Control Act requires that land-disturbing activities not be conducted within 25 feet of the banks of any State waters unless a variance is granted. Buffer zone variances may be required for various project elements including shore bank construction for the oxygen injection systems support structures, the boat ramp, the marsh restoration activities in Disposal Area 1S, cut closures, bank stabilization, etc. The Corps would coordinate plans and specifications as they become available with the Georgia DNR-EPD to determine if buffer variances would be required for the various features of the project. If appropriate, buffer

variances would be obtained from the Georgia DNR-EPD as required. The proposed project is therefore consistent with this policy.

6.13 Game and Fish

6.13.1 Policy Statement

27-1-3. Ownership and custody of wildlife; privilege to hunt, trap, or fish; general offenses. (Game and Fish Code) The ownership of, jurisdiction over, and control of all wildlife, as defined in this title, are declared to be in the State of Georgia, in its sovereign capacity, to be controlled, regulated, and disposed of in accordance with this title. All wildlife of the State of Georgia are declared to be within the custody of the department for purposes of management and regulation in accordance with this title. However, the State of Georgia, the department, and the board shall be immune from suit and shall not be liable for any damage to life, person, or property caused directly or indirectly by any wildlife.

To hunt, trap, or fish, as defined in this title, or to possess or transport wildlife is declared to be a privilege to be exercised only in accordance with the laws granting such privilege. Every person exercising this privilege does so subject to the right of the state to regulate hunting, trapping, and fishing; and it shall be unlawful for any person participating in the privileges of hunting, trapping, fishing, possessing, or transporting wildlife to refuse to permit authorized employees of the department to inspect and count such wildlife to ascertain whether the requirements of the wildlife laws and regulations are being faithfully complied with. Any person who hunts, traps, fishes, possesses, or transports wildlife in violation of the wildlife laws and regulations violates the conditions under which this privilege is extended; and any wildlife then on his person or within his immediate possession are deemed to be wildlife possessed in violation of the law and are subject to seizure by the department pursuant to Code Section 27-1-21.

It shall be unlawful to hunt, trap, or fish except during an open season for the taking of wildlife, as such open seasons may be established by law or by rules and regulations promulgated by the board or as otherwise provided by law.

It shall be unlawful to hunt, trap, or fish except in compliance with the bag, creel, size, and possession limits and except in accordance with such legal methods and weapons and except at such times and places as may be established by law or by rules and regulations promulgated by the board.

It shall be unlawful to hunt, trap, or fish for any game species after having obtained the daily or season bag or creel limit for that species.

A person who takes any wildlife in violation of this title commits the offense of theft by taking. A person who hunts, traps, or fishes in violation of this title commits the offense of criminal attempt. Any person who violates any provision of this Code section shall be guilty of a misdemeanor.

If any court finds that any criminal violation of the provisions of this title is so egregious as to display a willful and reckless disregard for the wildlife of this state, the court may, in its discretion, suspend the violator's privilege to hunt, fish, trap, possess, or transport wildlife in this state for a period not to exceed five years. Any person who hunts, fishes, traps, possesses, or transports wildlife in this state in violation of such suspension of privileges shall be guilty of a misdemeanor of a high and aggravated nature and upon conviction thereof shall be punished by a fine of not less than $1,500.00 nor more than $5,000.00 or imprisonment for a period not exceeding 12 months or both. (Ga. L. 1968, p. 497, SS 1; Code 1933, SS 45-201, enacted by Ga. L. 1977, p. 396, SS 1; Ga. L. 1978, p. 816, SS 13, 14; Ga. L. 1992, p. 2391, SS 1.) 27-1-4.

Powers and duties of board generally. The board shall have the following powers and duties relative to this title:

a. Establishment of the general policies to be followed by the department under this title;

b. Promulgation of all rules and regulations necessary for the administration of this title including, but not limited to, rules and regulations to regulate the times, places, numbers, species, sizes, manner, methods, ways, means, and devices of killing, taking, capturing, transporting, storing, selling, using, and consuming wildlife and to carry out this title, and rules and regulations requiring daily, season, or annual use permits for the privilege of hunting and fishing in designated streams, lakes, or game management areas; and

c. Promulgation of rules and regulations to protect wildlife, the public, and the natural resources of this state in the event of fire, flood, disease, pollution, or other emergency situation without complying with Chapter 13 of Title 50, the "Georgia Administrative Procedure Act." Such rules and regulations shall have the force and effect of law upon promulgation by the board. (Ga. L. 1911, p. 137, SS 1; Ga. L. 1924, p. 101, SSSS 1, 3,4; Ga. L. 1931, p. 7, SS 25; Ga. L. 1937, p. 264, SSSS 1, 4, 9; Ga. L. 1943, p. 128, SSSS 1, 2, 14; Ga. L. 1955, p. 483, SS 3; Ga. L. 1972, p. 1015, SS 1527; Ga. L. 1973, p. 344, SS 1; Code 1933, SS 45-103, enacted by Ga. L. 1977, p. 396, SS 1; Ga. L. 1978, p. 816, SS 7; Ga. L. 1979, p. 420, SS 3; Ga. L. 1987, p. 179, SS 1)

6.13.2 General Description

The Official Code of Georgia Annotated, Title 27, Chapter I (known as the Game and Fish Code) provides the ownership of, jurisdiction over, and control of all wildlife to be vested in the State of Georgia. The section declares that custody of all wildlife in the State is vested with the Georgia Department of Natural Resources for management and regulation. The Wildlife Resources Division is the principal State agency vested with statutory authority for the protection, management and conservation of terrestrial wildlife and fresh water wildlife resources, including fish, game, non-game, and endangered species. All licensing of recreational and commercial fish and wildlife activities, excluding shellfish, is performed by the Wildlife Resources Division. The Coastal Resources Division issues shellfish permits, regulates marine fisheries activities including the opening and closing of the commercial shrimp harvesting season, areas of shrimp harvest, regulates marine species size and creel limits, and enforces the National Shellfish Sanitation Program. The Commissioner of the Department of Natural

Resources has directed that there will be cooperation and coordination between the Divisions of the Department in the administration of their respective responsibilities.

6.13.3 Consistency

The proposed project includes no feature to hunt, trap, fish, possess or transport any recreational and commercial fish or wildlife species. Therefore, no such license is required by the project.

6.14 Georgia Heritage

6.14.1 Policy Statement

Georgia Heritage Trust Act (O.C.G.A. 12-3-70, et seq.) 12-3-71. Legislative purpose. The General Assembly finds that certain real property in Georgia, because it exhibits unique natural characteristics, special historical significance, or particular recreational value, constitutes a valuable heritage, which should be available to all Georgians, now and in the future. The General Assembly further finds that much of this real property, because of Georgia's rapid progress over the past decade, has been altered, that its value as part of our heritage has been lost, and that such property, which remains, is in danger of being irreparably altered. The General Assembly declares, therefore, that there is an urgent public need to preserve important and endangered elements of Georgia's heritage, so as to allow present and future citizens to gain an understanding of their origins in nature and their roots in the culture of the past and to ensure a future sufficiency of recreational resources. The General Assembly asserts the public interest in the state's heritage by creating the Heritage Trust Program which shall be the responsibility of the Governor and the Department of Natural Resources and which shall seek to protect this heritage through the acquisition of fee simple title or lesser interests in valuable properties and by utilization of other available methods. (Ga. L. 1975, p. 962, SS 2.)

6.14.2 General Description

Georgia's Heritage Trust Act of 1975 seeks to preserve certain real property in Georgia that exhibits unique natural characteristics, special historical significance, or particular recreational value. This Act created the Heritage Trust Commission, composed of 15 members appointed by the Governor who represent a variety of interests and expertise. The Commission served as an advisory body to the Governor and to the Board of the Department of Natural Resources, making recommendations concerning the identification, designation, and acquisition of heritage areas. Although this Act is still in Georgia law, the Commission's term expired and the implementation and administration of many of the goals of the Act has been superseded by the Heritage 2000 Program.

6.14.3 Consistency

There are no known designated heritage areas within the proposed project area.

The USACE is developing a survey strategy to understand the effects the proposed project will have on significant submerged resources and will be implementing a Programmatic Agreement

(PA) as specified under 36 CFR 800.14b(1)(ii). The PA will allow the USACE to complete needed studies, determine significance and develop mitigation plans if significant resources cannot be avoided. The PA has been reviewed and signed by the Georgia and South Carolina State Historic Preservation Officers. The *CSS Georgia*, a Confederate ironclad, is a significant resource that may be impacted by the proposed project. The resource is owned by the US Navy. As the owner of the vessel, the Navy requested signatory status and has signed the PA. The agreement has also been coordinated with appropriate federally recognized tribes. The PA is included as Appendix G in the final Environmental Impact Statement.

The project is consistent with this policy.

6.15 Groundwater Use

6.15.1 Policy Statement.

Groundwater Use Act (O.C.G.A. 12-5-90, et seq.) 12-5-91. Declaration of policy. The general welfare and public interest require that the water resources of the state be put to beneficial use to the fullest extent to which they are capable, subject to reasonable regulation in order to conserve these resources and to provide and maintain conditions, which are conducive to the development and use of water resources. (Ga. L. 1972, p. 976, SS 2.)

6.15.2 General Description

The Groundwater Use Act charges the Board of Natural Resources with the responsibility to adopt rules and regulations relating to the conduct, content, and submission of water conservation plans, including water conservation practices, water drilling protocols, and specific rules for withdrawal and utilization of groundwater. The Environmental Protection Division administers these rules and regulations. Groundwater withdrawals of greater than 100,000 gallons per day require a permit from the Environmental Protection Division. Permit applications that request an increase in water usage must also submit a water conservation plan approved by the Director of Environmental Protection Division (O.C.G.A. 12-5-96). The Environmental Protection Division has prepared a comprehensive groundwater management plan for coastal Georgia that addresses water conservation measures, protection from saltwater encroachment, reasonable uses, preservation for future development and economic development issues. The Memorandum of Agreement with the Environmental Protection Division ensures that permits issued under the Groundwater Use Act must be consistent with the Coastal Management Program.

6.15.3 Consistency

Sections 4.02 and 5.02 within the EIS discuss groundwater within the project area. As discussed previously in this document, deepening of the navigation channel would have a negligible effect on the movement of saltwater through the Miocene layer into the upper Floridan aquifer. However, The Georgia DNR-EPD has requested a detailed monitoring plan be implemented to provide early detection of potential chloride migration into the aquifer as a condition of the Section 401 Water Quality Certification for the project. Monitoring of chloride levels in the

upper Floridan aquifer must be conducted along critical groundwater flow paths to ensure that the SHEP does not result in the significant migration of chlorides downward through the confining layer that could move towards production wells in the Savannah area. The monitoring would involve the establishment of sentry wells along critical groundwater flow paths. These wells would be installed near the top of the aquifer to monitor downward migration of chlorides through the confining unit and deeper in the aquifer to monitor how horizontal flow of freshwater within the aquifer mixes with and dilutes the chloride.

Monitoring wells would also be established up-gradient of critical groundwater flow paths to provide information on background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Background wells would be established near the top of the aquifer and deeper in the aquifer to establish background concentrations. Annual monitoring of these wells would be conducted for the life of the project and differences in the long-term trends of chloride concentrations in the sentry and background wells would be used to evaluate the impacts of the SHEP from impacts of groundwater withdrawal on chloride concentrations in the aquifer.

Groundwater monitoring would also include the establishment of benchmark chloride concentrations for each sentry well. These benchmark chloride concentrations would be established to protect Savannah area production wells. The monitoring would also include development of a mitigation plan if monitoring indicates that the Savannah area production wells may be affected by downward migration of chloride through the confining unit as a result of SHEP dredging activities.

These monitoring requirements have been included in the project's monitoring plan. (See Appendix D of the EIS).

The proposed project is fully consistent with this policy.

6.16 Hazardous Waste

6.16.1 Policy Statement

Georgia Hazardous Waste Management Act (0.C.G.A. 12-8-60, et seq.) F-20 12-8-61. Legislative policy. It is declared to be the public policy of the State of Georgia, in furtherance of its responsibility to protect the public health, safety, and well-being of its citizens and to protect and enhance the quality of its environment, to institute and maintain a comprehensive state-wide program for the management of hazardous wastes through the regulation of the generation, transportation, storage, treatment, and disposal of hazardous wastes. (Ga. L. 1979, p. I 1 27, SS 2; Ga. L. 1992, p. 2234, SS 5.)

6.16.2 General Description

The Georgia Hazardous Waste Management Act describes a comprehensive, statewide program to manage hazardous wastes through regulating hazardous waste generation, transportation, storage, treatment, and disposal. Hazardous waste is defined by the Board of Natural Resources, and it includes any waste that the Board concludes is capable of posing a substantial present or future hazard to human health or the environment when improperly treated, transported, stored, disposed, or otherwise managed, based on regulations promulgated by the US Environmental Protection Agency. The Hazardous Waste Management Act is administered and implemented by the Environmental Protection Division.

6.16.3 Consistency

A survey of areas outside of the inner harbor navigation channel (bend wideners, etc.) that would be dredged was conducted to ensure that no hazardous or toxic wastes would be encountered during the dredging process. No such materials were discovered. Contractors that assist with construction of the project would be required to abide by all applicable toxic and hazardous waste regulations such as those that regulate the cleanup of spills and storage of any hazardous materials. The proposed project is fully consistent with this policy.

6.17 Historic Areas

6.17.1 Policy Statement

Historic Areas (0.C.G.A. 12-3-50, et seq.) 12-3-50. 1. Grants for the preservation of "historic properties"; additional powers and duties of department. It is declared to be the public policy of the State of Georgia, in furtherance of its responsibility to promote and preserve the health, prosperity, and general welfare of the people, to encourage the preservation of historic properties, which have historical, cultural, and archeological significance to the state. (Code 1981, SS 12-3-50.1, enacted by Ga. L. 1986, p. 399, SS 1; Ga. L. 1996, p. 6, SS 12.)

6.17.2 General Description

The authority found at O.C.G.A. 12-3-50 provides the Department of Natural Resources with the powers and duties to "promote and increase knowledge and understanding of the history of this State from the earliest times to the present, including the archeological, Indian, Spanish, colonial, and American eras, by adopting and executing general plans, methods, and policies for permanently preserving and marking objects, sites, areas, structures, and ruins of historic or legendary significance, such as trails, post roads, highways, or railroads; inns or taverns; rivers, inlets, millponds, bridges, plantations, harbors, or wharves; mountains, valleys, coves, swamps, forests, or Everglade; churches, missions, campgrounds, and places of worship; schools, colleges, and universities; courthouses and seats of government; places of treaties, councils, assemblies, and conventions; factories, foundries, industries, mills, stores, and banks; cemeteries and burial mounds; and battlefields, fortifications, and arsenals. Such preservation and marking may include the construction of signs, pointers, markers, monuments, temples, and museums, which structures may be accompanied by tablets, inscriptions, pictures, paintings, sculptures,

maps, diagrams, leaflets, and publications explaining the significance of the historic or legendary objects, sites, areas, structures, or ruins." The Department is also required to "promote and assist in the publicizing of the historical resources of the State by preparing and furnishing the necessary historical material to agencies charged with such publicity; to promote and assist in making accessible and attractive to travelers, visitors, and tourists the historical features of the State by advising and cooperating with State, federal, and local agencies charged with the construction of roads, highways, and bridges leading to such historical-points." The Historical Preservation Division is charged with carrying out these duties, and coordinates its activities in the coastal area with the Coastal Resources Division.

6.17.3 Consistency

The USACE is developing a survey strategy to understand the effects the proposed project will have on significant cultural resources and will be implementing a Programmatic Agreement (PA) as specified under 36 CFR800.14b(1)(ii). The PA will allow the USACE to complete needed studies, determine significance and develop mitigation plans if significant resources cannot be avoided. The PA has been reviewed and signed by the Georgia and South Carolina State Historic Preservation Officers. The *CSS Georgia*, a Confederate ironclad, is a significant resource that will be impacted by the proposed project. The resource is owned by the US Navy. As the owner of the vessel, the Navy requested signatory status and has also signed the PA. The agreement has been coordinated with appropriate federally recognized tribes. The PA is included as Appendix G in the final Environmental Impact Statement.

The project is consistent with this policy.

6.18 Natural Areas

6.18.1 Policy Statement

Georgia Natural Areas Act (O.C.G.A. 12-3-90, et seq.) 12-3-91. Legislative findings and declaration of purpose. The General Assembly finds that there is an increasing nation-wide concern over the deterioration of man's natural environment in rural as well as urban areas; that there is a serious need to study the long-term effects of our civilization on our natural environment; that while the State of Georgia is still richly endowed with relatively undisturbed natural areas, these areas are rapidly being drastically modified and even destroyed by human activities; that it is of the utmost importance to preserve examples of such areas in their natural state, not only for scientific and educational purposes but for the general well-being of our society and its people. Therefore, it shall be the purpose and function of the Department of Natural Resources to:
a. Identify natural areas in the State of Georgia, which are of unusual ecological significance;
b. Use its influence and take any steps within its power to secure the preservation of such areas in an undisturbed natural state in order that such areas may:

(1) Be studied scientifically;
(2) Be used for educational purposes;
(3) Serve as examples of nature to the general public; and

(4) Enrich the quality of our environment for present and future generations; and
c. Recommend areas or parts of areas for recreational use. (Ga.L. 1969, p. 750, SS 2; Ga.L. 1972, p. 10 1 5, SS 151 1.) 12-3-92.

"Natural areas" defined. As used in this article, the term "natural areas" means a tract of land in its natural state which may be set aside and permanently protected or managed for the purpose of the preservation of native plant or animal communities, rare or valuable individual members of such communities, or any other natural features of significant scientific, educational, geological, ecological, or scenic value. (Ga. L. 1966, p.330, SS 2; Ga. L. 1969, p.750, SS 3.)

6.18.2 General Description

The Georgia Natural Areas Act authorizes the Department of Natural Resources to identify areas in the State of Georgia, which are of unusual ecological significance, and to secure the preservation of such areas in an undisturbed natural state. The purpose for such acquisition is to allow scientific study of the property, to educate, to "serve as examples of nature to the general public," and to "enrich the quality of our environment for present and future generations." Natural areas, as defined by the Act, are tracts of land in their natural state that are to be set aside and permanently protected or managed for the purpose of preserving natural plant or animal communities, rare or valuable members of such communities, or any other natural features of significant scientific, educational, geologic, ecological, or scenic value.

6.18.3 Consistency

The Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section provided an updated list of Georgia's Known Occurrences of Conservation Areas on or near the Savannah Harbor Navigation Project, Chatham County, Georgia.

Georgia's Known Occurrences of Conservation Areas

Fort Pulaski National Monument [National Park Service]	Adjacent to project area
Greenspace [Chatham County]	Near project area
Hunter Army Airfield [US Department of' Defense]	Near project area
Little Tybee-Cabbage Island Natural Area [Georgia DNR]	Near project area
Savannah NWR [US Fish and Wildlife Service]	Near project area
Savannah River [High Priority Stream]	On site
Skidaway Island State Park [Georgia DNR]	Near project area
Tybee Island Tract [Georgia DNR]	Near project area
Wormsloe Historic Site [Georgia DNR]	Near project area

The following conservation areas in Chatham County, Georgia will not be adversely affected by the proposed deepening of the navigation channel since they are located on uplands (Greenspace in Chatham County, Hunter Army Airfield, and Tybee Island Tract) or some distance from the project site (Little Tybee Island and Cabbage Island, Skidaway Island State Park, Wormsloe historic site.

The following conservation areas may be affected by the proposed action:

Fort Pulaski National Monument [National Park Service]. Ship wake studies were conducted and no significant impacts to ongoing shoreline erosion rates are expected from the proposed action (see Section 5.06 of the EIS).

Savannah National Wildlife Refuge (SNWR) [US Fish and Wildlife Service]. Deepening of the Savannah Harbor Navigation Channel to -48 feet MLW would increase salinity levels in the vicinity of the SNWR. This would adversely affect fishery habitat and tidal freshwater marshes. The SHEP mitigation plan includes various features to mitigate these predicted impacts. Aspects of the SHEP mitigation plan that specifically address these issues include implementation of the flow diversion measures to minimize anticipated upstream increases in salinity, injection of dissolved oxygen at strategic locations in Savannah Harbor, and purchase of about 2,245 acres of land for preservation to offset the conversion of tidal freshwater marsh to brackish marsh. Approximately 3.2 acres of brackish marsh in the SNWR would be excavated as part of the Kings Island Turning Basin Expansion. In-kind restoration would be provided by restoring about 40.3 acres of estuarine emergent wetlands in Disposal Area 1S near the juncture of Front River and Middle River.

Savannah River [High Priority Stream]. The anticipated impacts from construction of the SHEP on the water quality regime in the Savannah River and the mitigation measures to offset those impacts are addressed in the previous paragraph and in detail in Appendix C of the EIS. Without mitigation, construction of the SHEP would impact the dissolved oxygen regime in Savannah Harbor. Therefore, the project includes the construction and operation of three oxygen injection systems to mitigate for the project's expected impacts. Injection of oxygen during the summer months would remove the incremental effects of the SHEP on the dissolved oxygen regime in Savannah Harbor.

The proposed project with mitigation features fully implemented is fully consistent with this policy.

6.19 Oil and Gas and Deep Drilling

6.19.1 Policy Statement

Georgia Oil and Gas and Deep Drilling Act (O.C.G.A. 12-440, et seq.) 12-441. Legislative findings and declaration of policy. The General Assembly finds and declares that its duty to protect the health, safety, and welfare of the citizens of this state requires that adequate protection of underground fresh water supplies be assured in any drilling operation which may penetrate through any stratum which contains fresh water. This duty further requires that adequate protection be assured in any drilling or the use of such drilled wells in certain other environmentally sensitive areas or in other circumstances where the result of such drilling and use may endanger the health, safety, and welfare of the citizens of this state. It is not the policy of the General Assembly to regulate the drilling of shallow exploration or engineering holes except in such environmentally sensitive areas as defined in this part. The General Assembly further finds and declares that, with the current energy shortage which this state and nation face,

it must encourage oil and gas exploration to identify new sources of energy, but not at the expense of our important natural resources such as residential, municipal, and industrial supplies of fresh water. The General Assembly further finds and declares that with an increase in oil exploration, it must provide assurances to persons engaging in such exploration that adequate safeguards regarding results of exploration will remain privileged information for a specified time. The General Assembly further finds and declares that it is in the public interest to obtain, protect, and disseminate all possible geologic information associated with drilling operations in order to further the purposes of future energy related research. (Ga. L. 1975, p. 966, SS 1.)

6.19.2 General Description

Georgia's Oil and Gas and Deep Drilling Act regulates oil and gas drilling activities to provide protection of underground freshwater supplies and certain "environmentally sensitive" areas. The Board of Natural Resources has the authority to implement this Act. The Act establishes requirements for drilling, casing, and plugging of wells for oil, gas, or mineral exploration: (1) to alleviate escape of gas or oil from one stratum to another; (2) to prevent the pollution of freshwater by oil, gas, salt water or other contaminants; (3) to prevent drowning of any stratum that might reduce the total ultimate recovery of gas or oil; and, (4) to prevent fires, waste, and spillage of contaminants such as oil.

6.19.3 Consistency

No oil and/or gas drilling operations are proposed for this project.

6.20 Phosphate Mining

6.20.1 Policy Statement

Licenses to dig, mine, and remove phosphate deposits; restrictions on license holders. (O.C.G.A. 12-4-100, et seq.) 12-4-101. Restrictions on license holders. Whenever any person discovers phosphate rock or phosphatic deposits in the navigable streams or waters of this state or in any public land on their banks or margins and files with the Secretary of State notice of such discovery and a description of the location thereof, he shall be entitled to receive from the Secretary of State a license giving him or his assigns the exclusive right, for ten years from the date of the license, of digging, mining, and removing from such location and from an area for a distance of five miles in any or all directions there from the phosphate rock and phosphatic deposits that may be found therein, provided that persons receiving or holding such licenses shall in no way interfere with the free navigation of the streams and waters or the private rights of any citizen residing on or owning the lands upon the banks of such navigable rivers and waters; provided, further, that as long as the license remains in effect, no person, natural or artificial, shall have the privilege of locating a claim within 20 miles of any other claim for which he has received a license. (Ga. L. 1884-85, p. 125, SS 1; Civil Code 1895, SS 1726; Civil Code 1910, SS 1977; Code 1933, SS 43-401.)

6.20.2 General Description

The laws found at O.C.G.A. 12-4-100, et seq., describe the State's management of phosphate deposits. There is great interest in phosphate mining in Georgia. In fact, the citizens of Georgia developed the Coastal Marshlands Protection Act in an effort to limit potential adverse environmental impacts from a proposed phosphate mining operation. The Secretary of State is charged with the administration of this statute, and is networked with the Georgia Coastal Management Program.

6.20.3 Consistency

No mining of phosphates is proposed for this project.

6.21 Protection of Tidewaters

6.21.1 Policy Statement.

Protection of Tidewaters Act (O.C.G.A. 52-1-1. et seq.) 52-1-2. Legislative findings and declaration of policy. The General Assembly finds and declares that the State of Georgia became the owner of the beds of all tidewaters within the jurisdiction of the State of Georgia as successor to the Crown of England and by the common law. The State of Georgia continues to hold title to the beds of all tidewaters within the state, except where title in a private party can be traced to a valid Crown or state grant which explicitly conveyed the beds of such tidewaters. The General Assembly further finds that the State of Georgia, as sovereign, is trustee of the rights of the people of the state to use and enjoy all tidewaters which are capable of use for fishing, passage, navigation, commerce, and transportation, pursuant to the common law public trust doctrine. Therefore, the General Assembly declares that the protection of tidewaters for use by the state and its citizens has more than local significance, is of equal importance to all citizens of the state, is of state-wide concern, and, consequently, is properly a matter for regulation under the police powers of the state. The General Assembly further finds and declares that structures located upon tidewaters which are used as places of habitation, dwelling, sojournment, or residence interfere with the state's proprietary interest or the public trust, or both, and must be removed to ensure the rights of the state and the people of the State of Georgia to the use and enjoyment of such tidewaters. It is declared to be a policy of this state and the intent of this article to protect the tidewaters of the state by authorizing the commissioner of natural resources to remove or require removal of certain structures from such tidewaters in accordance with the procedures and within the timetable set forth in this article. (Code 1981, SS 52-1-2, enacted by Ga. L. 1992, p. 2317, SS 1.)

6.21.2 General Description

The Protection of Tidewaters Act establishes the State of Georgia as the owner of the beds of all tidewaters within the State, except where title by a private party can be traced to a valid British Crown or State land grant. The Act provides the Department of Natural Resources the authority to remove those "structures" that are capable of habitation, or incapable of or not used for transportation. Permits for such structures may not extend past June 30, 1997. The Act provides

procedures for removal, sale, or disposition of such structures. (This is similar to the Right of Passage Act, except that it is specific to tidewaters rather than all waters of Georgia.)

6.21.3 Consistency

It is understood that the State of Georgia has ownership of the beds of all tidewaters within the state. No structures associated with habitation would be built on these lands. Pilings maybe needed to locate equipment required by the mitigation plans. The proposed project is fully consistent with this policy.

6.22 Recreational Docks

6.22.1 Policy Statement

50-16-61. General supervision and office assignment (Under the Administrative Procedures Act, Revocable License Program) The Governor shall have general supervision over all property of the state with power to make all necessary regulations for the protection thereof, when not otherwise provided for.

6.22.2 General Description

The provisions of O.C.G.A. 50-16-61 describe the general supervision of State properties as the responsibility of the Governor. Under this authority, the Department of Natural Resources, Coastal Resources Division issues Revocable Licenses for recreational docks on State-owned tidal water bottoms. In 1995, the Georgia Supreme Court found that the State owns fee simple title to the foreshore on navigable tidal waters and, as a result, owns the river's water bottoms up to the high water mark and may regulate the use of these tidelands for the public good. (Dorroh v. McCarthy 265 Ga. 750, 462 S.E. 2d 708 (1995). The opinion of the State Attorney General states: "In managing tidelands, the Department of Natural Resources acts under the authority of this section and the Department's employment of the extension of property lines method of allocating use of State-owned water bottoms may be generally acceptable, but rigid adherence to such a policy when it denies deep water access to a riparian or littoral owner, may cause inequitable results (1993 Opinion Attorney General No. 93-25). As described in the State Properties Code (O.C.G.A. 50-16-30, et seq.), the term "Revocable License" means "the granting, subject to certain terms and conditions contained in a written revocable license or agreement, to a named person or persons (licensee), and to that person or persons only, of a revocable privilege to use a certain described parcel or tract of the property to be known as the licensed premises for the named purpose." A Revocable License may be revoked, canceled, terminated, with or without cause, at any time by the licensor.

6.22.3 Consistency

The mitigation plan provides for the construction of a boat ramp in Back River which would be located on State owned tidal water bottoms. This boat ramp would replace fishermen access to Back River lost as result of the closure of Rifle Cut. This proposal has been fully coordinated with the Georgia DNR. Therefore, this project is fully consistent with this policy.

6.23 Right of Passage

6.23.1 Policy Statement Right of Passage Act (O.C.G.A. 52-1-30, et seq.) 52-1-31. Legislative findings and declaration of policy. The General Assembly finds and declares that by the common law the citizens of this state have an inherent right to use as highways all navigable streams and rivers which are capable of transporting boats loaded with freight in the regular course of trade either for the whole or part of the year and that this right of use extends to the entire surface of the stream or river from bank to bank. The General Assembly further finds that the common law regarding such right of use has not been modified by statute nor is it incompatible with the federal or state constitutions. Therefore, the General Assembly declares that ensuring the right of use by all the citizens of this state of navigable streams and rivers which are capable of transporting boats loaded with freight in the regular course of trade either for the whole or part of the year as highways has more than local significance, is of equal importance to all citizens of the state, is of state-wide concern, and, consequently, is properly a matter for regulation under the police powers of the state. The General Assembly further finds and declares that structures located upon navigable streams and rivers which are used as places of habitation, dwelling, sojournment, or residence interfere with the citizens' right to use the entire surface of such streams and rivers which are capable of transporting boats loaded with freight in the regular course of trade either for the whole or part of the year from bank to bank as highways and must be removed to ensure the rights of the citizens of this state to such usage. It is declared to be a policy of this state and the intent of this article to ensure such rights of the citizens of this state by authorizing the commissioner of natural resources to remove or require removal of certain structures from such streams and rivers which are capable of transporting boats loaded with freight in the regular course of trade either for the whole or part of the year in accordance with the procedures and within the timetable set forth in this article. (Code 1981, SS 52-1-31, enacted by Ga. L. 1992, p. 2317, SS 1.)

6.23.2 General Description

The Right of Passage Act declares the right of use of all navigable waterways of the state by all citizens of Georgia. The Act establishes the mechanism to remove "structures" that are capable of being used as a place of habitation, are not used as or are not capable of use as a means of transportation, and do not have a permit under the Act. Permits shall not be issued for a term ending after June 30, 1997. The Right of Passage Act is implemented by the Department of Natural Resources Law Enforcement Division. (This is similar to the Protection of Tidewaters Act, except that it is specific to all navigable waters rather than tidewaters Georgia.)

6.23.3 Consistency

The mitigation features of the proposed deepening project include closure of Rifle Cut which would impede the public's passage between Middle River and Little Back River. Although boaters would have to travel a longer distance, the public would still have access to both of these waterways. A boat ramp would be constructed at the location of the Tidegate on the Georgia side to provide additional access to lower Back River and Middle River. Therefore the proposed project is consistent with this act.

6.24 River Corridors

6.24.1 Policy Statement Mountain and River Corridor Protection Act (O.C.G.A. 12-2-1. et seq.) 12-2-8. Promulgation of minimum standards and procedures for protection of natural resources, environment, and vital areas of the state. The local governments of the State of Georgia are of vital importance to the state and its citizens. The state has an essential public interest in promoting, developing, sustaining, and assisting local governments. The natural resources, environment, and vital areas of the state are also of vital importance to the state and its citizens. The state has an essential public interest in establishing minimum standards for land use in order to protect and preserve its natural resources, environment, and vital areas. The purpose of this Code section shall be liberally construed to achieve its purpose. This Code section is enacted pursuant to the authority granted the General Assembly in the Constitution of the State of Georgia, including, but not limited to, the authority provided in Article 111, Section VI, Paragraphs I and 11(a)(1) and Article IX, Section 11, Paragraphs Ill and IV.

The department is therefore authorized to develop minimum standards and procedures, in accordance with paragraph (2) of subsection (b) of Code Section 50-8-7.1 and in accordance with the procedures provided in Code Section 50-8-7.2 for the promulgation of minimum standards and procedures, for the protection of natural resources, environment, and vital areas of the state, including, but not limited to, the protection of mountains, the protection of river corridors, the protection of watersheds of streams and reservoirs which are to be used for public water supply, for the protection of the purity of ground water, and for the protection of wetlands, which minimum standards and procedures shall be used by local governments in developing, preparing, and implementing their comprehensive plans as that term is defined in paragraph (3) of subsection (a) of Code Section 50-8-2. (Code 1981, SS 12-2-8, enacted by Ga. L. 1989, p. 1317, SS 5. 1; Ga. L. 199 1, p. 1719, SS 1; Ga. L. 1992, p. 6. SS 12; Ga. L. 1993, p. 91, SS 12.)

6.24.2 General Description

The statute that is informally known as the Mountain and River Corridor Protection Act (O.C.G.A. 12-2-8) authorizes the Department of Natural Resources to develop minimum standards for the protection of river corridors (and mountains, watersheds, and wetlands) that can be adopted by local governments. The Act is administered by the Environmental Protection Division. All rivers in Georgia with an average annual flow of 400 cubic feet per second are covered by the Act, except those within the jurisdiction of the Coastal Marshlands Protection Act. Some of the major provisions of the Act include: requirements for a 100-foot vegetative buffer on both sides of rivers; consistency with the Georgia Erosion and Sedimentation Act; and local governments must identify river corridors in land-use plans developed under their respective comprehensive planning acts.

Regional Development Centers are instrumental in helping local governments enact the provisions of this Act. The Coastal Georgia Regional Development Center prepared a Regional River Corridor Protection Plan for counties within their jurisdiction. The Plan describes the ten local governments and the associated rivers that are affected by the River Corridor Protection Act, and puts forward a regional plan for the protection of river corridors. Regional plans are preferable to having local governments prepare individual plans. The plan provides for

construction of road crossings, acceptable uses of river corridors, maintenance of a vegetative buffer along the river for a minimum of 100 feet from the river's edge (residential structures are allowed within the buffer zone), timber production standards, wildlife and fisheries management, recreation, and other uses. The local governments within the Coastal Regional Development Center jurisdiction affected by the River Corridor Protection Act, and their respective rivers are listed below. Eight coastal counties and two coastal cities (Richmond Hill and Woodbine) are affected.

Adoption of language addressing the River Corridor Protection Act is required in local comprehensive plans. The following counties and cities have adopted a Regional River Corridor Protection Plan.

COUNTY/CITY	RIVER
Bryan County	Canoochee River Ogeechee River
City of Richmond Hill	Ogeechee River
Camden County	Satilla River St. Mary's River
City of Woodbine	Satilla River
Chatham County	Savannah River
Effingham County	Ogeechee River Savannah River
Glynn County	Altamaha River
Liberty County	Canoochee River
Long County	Altamaha River
McIntosh County	Altamaha River

Jurisdiction of the River Corridor Protection Act extends along the above named rivers from the limit of Coastal Marshlands Protection Act jurisdiction upstream through the coastal counties.

6.24.3 Consistency

Waters adjacent to the project area are under the jurisdiction of the Coastal Marshlands Protection Act, rather than the River Corridor Protection Act. The proposed project is fully consistent with this policy.

6.25 River and Harbor Development (Includes Burke-Day requirements)

6.25.1 Policy Statement

Rivers and Harbor Development (O.C.G.A. 52-9-2). The State of Georgia recognizes the need for maintaining navigation inlets, harbors, and rivers to promote commercial and recreational uses of our coastal waters and their resources. The State of Georgia further recognizes that dredging activities to deepen or maintain navigation channels within tidal inlets, as well as the entrances to harbors and rivers, often alter the natural drift of sand resources within the littoral zone. This alteration can be exacerbated when the sand resources are deposited in designated upland or offshore disposal areas instead of being returned to the natural river-sand transport-beach system. This alteration can adversely impact natural resources, recreation, tourism, and associated coastal economies. Moreover, the State of Georgia believes in the duties of government to protect life and property. Therefore, it is the policy of this state that there shall be no net loss of sand from the state's coastal barrier beaches resulting from dredging activities to deepen or maintain navigation channels within tidal inlets, as well as the entrances to harbors and rivers. Ga. L. 1967, p. 516; Ga. L. 1972, p. 1015, § 1516; Ga. L. 2002, p. 569, § 2; Ga. L. 2004, p. 784, § 1; Ga. L. 2005, p. 60, § 52/HB 95.

6.25.2 General Description

Disposal of sand and sediment originating from water navigation related projects

(a) With regard to all sand that is suitable for beach replenishment originating from the dredging of navigation channels within tidal inlets, as well as the entrances to harbors and rivers:

(1) Such sand shall be used to replenish the adjacent coastal beaches, if feasible, either by deposition of sand into the nearshore littoral zone or direct placement on affected beaches;

(2) If such sand is placed elsewhere, then a quality and quantity of sand from an alternate location necessary to mitigate any adverse effects caused by the dredging shall be used to replenish affected coastal beaches; provided, however, that this paragraph shall apply only where beach replenishment is necessary to mitigate effects from the dredging and dredged material removal from the natural river-sand transport-beach system of a specific project and beach replenishment from another source is the least costly environmentally sound mitigation option;

(3) The disposition of sand shall be completed in cooperation with and, when required by applicable state or federal law, with the approval of the local governing authority and the Department of Natural Resources according to the requirements of Part 2 of Article 4 of Chapter 5 of Title 12, the "Shore Protection Act"; and

(4) All such activities shall provide protection to coastal marshlands as defined in paragraph (3) of Code Section 12-5-282 and to nesting sea turtles and hatchlings and their habitats.

(b) The Department of Natural Resources and the party undertaking the dredging shall coordinate to determine the option under subsection (a) of this Code section for beach replenishment that is most beneficial to the adjacent or affected coastal beaches, including, where applicable, identifying an alternate source of sand for purposes of paragraph (2) of subsection (a) of this Code section, after taking into consideration environmental impacts and any limitation of applicable state and federal law.

6.25.3 Consistency

The potential impacts of the SHEP on Tybee Beach and the Tybee Island Shelf were evaluated. The results of this analysis indicate that channel deepening would have very little impact on Tybee Beach and would not significantly contribute to depletion of the Tybee Shelf.

The Draft EIS proposed placement of some of the new work dredged sediment from the entrance channel in nearshore areas of Tybee Beach where the sediment would be available to move towards the beach. The sediment placed in those nearshore sites would have been material with a fines content of 20 percent or less. The Georgia DNR-CRD and the City of Tybee Island requested that those sites not be used since the sediments are not comprised of <10 percent fines. As a result, the District removed nearshore placement from the project. All new work material would be placed in the existing CDFs or the ODMDS.

The Georgia DNR-CRD also requested that material from the area of the entrance channel extension (Station -57+000B to Station -97+680B) be considered for nearshore placement or beach nourishment. The Corps must use the least cost environmentally acceptable method of disposal. In this case, placement of the sediments from the entrance channel extension into the Savannah Harbor ODMDS is the least costly environmentally acceptable alternative. Placement of that sediment into nearshore areas or directly onto Tybee Beach would require a non-Federal sponsor to incur the extra costs of placing it in those areas.

The Georgia DNR-CRD also requested that future maintenance dredging material from Stations -30+000B to -40+000B and Stations 28+000 to 0+000 be used for beach nourishment. The least cost environmentally acceptable method of disposal for O&M sediments from Stations -30+000B to -40+000B would be in the ODMDS or Site 2 and Site 3 adjacent to the entrance channel. Similarly, maintenance sediments from Stations 28+000 to 0+000 would be placed in the existing CDFs along the river. The maintenance material disposal plans for these two reaches of the harbor comply with NOAA and US Army Corps of Engineers policy and regulations. Use of the channel sediments for beach nourishment from these two portions of the harbor would require a non-Federal sponsor who would be willing to pay the additional costs that would be required to place the material on the beach.

This practice is consistent with current Federal laws and regulations concerning cost sharing. Consequently, the SHEP is consistent with Georgia Port and Harbor Development Act to the maximum extent practicable.

6.26 Safe Drinking Water

6.26.1 Policy Statement

Georgia Safe Drinking Water Act (0.C.G.A. 12-5-1 70, et seq.) 12-5-171. Declaration of policy; legislative intent; Environmental Protection Division to administer part. As a guide to the interpretation and application of this part, it is declared to be the policy of the State of Georgia that the drinking waters of the state shall be utilized prudently to the maximum benefit of the people and that the quality of such waters shall be considered a major factor in the health and

welfare of all people in the State of Georgia. To achieve this end, the government of the state shall assume responsibility for the quality of such waters and the establishment and maintenance of a water-supply program adequate for present needs and designed to care for the future needs of the state.

This requires that an agency of the state be charged with this duty and that it have the authority to require the use of reasonable methods, that is, those methods which are economically and technologically feasible, to ensure adequate water of the highest quality for water-supply systems. Because of substantial and scientifically significant variations in the characteristics, usage, and effect upon public interest of the various surface and underground waters of the state, uniform requirements will not necessarily apply to all waters or segments thereof. It is the intent of this part to confer discretionary administrative authority upon such agency to take the above and related circumstances into consideration in its decisions and actions in determining, under the conditions prevailing in specific cases, those procedures to best protect the public interests. The Environmental Protection Division of the Department of Natural Resources shall be the state agency to administer the provisions of this part consistent with the above-stated policy. (Code 1933, SS 88-2601, enacted by Ga. L. 1964, p.499, SS 1; Ga. L. 1977, p.351, SS 1.)

6.26.2 General Description

The Georgia Safe Drinking Water Act of 1977 charges the Environmental Protection Division with the responsibility for maintaining the quality of drinking water and for maintaining a water-supply program adequate for present and future needs of the State. The Environmental Protection Division is designated as the agency to establish rules and policies for the proper administration of drinking water management programs.

6.26.3 Consistency

The proposed deepening of the existing navigation channel would not adversely impact the principal drinking water aquifer (upper Floridan) in the coastal area. The proposed project would not be expected to adversely impact aquifer and production wells in and around Savannah. As previously discussed in this document, in the Section 401 Water Quality Certification the Georgia DNR-EPD required the Corps implement a detailed monitoring plan to ensure the project does not result in substantial chloride intrusion into the aquifer. The Corps will comply with that condition of the certification.

Studies conducted for this project indicate that the SHEP would increase chloride levels in Abercorn Creek at the intake of the City of Savannah's Water Treatment Plant during low flow and high tide conditions. Impacts would not occur under normal or high river flows. The mitigation plan for the project includes the construction of a raw water storage impoundment which would allow the City to store water for use during times of high chloride events. The project would monitor chloride levels at the City of Savannah's water intake during construction and five years after construction is complete to ensure predicted levels of impacts are not exceeded.

The proposed project is consistent with this Act.

6.27 Scenic Rivers

6.27.1 Policy Statement.

Georgia Scenic Rivers Act (O.C.G.A. 12-5-350, et seq.) 12-5-352. Rivers comprising the Georgia Scenic River System. The Georgia Scenic River System shall be comprised of the following:

a. That portion of the Jacks River contained within the Cohutta National Wilderness Area and located in Fannin and Murray counties, Georgia, which portion extends a length of approximately 16 miles;

b. That portion of the Conasauga River located within the Cohutta National Wilderness Area and located in Fannin, Gilmer, and Murray counties, Georgia, which portion extends a length of approximately 17 miles;

c. That portion of the Chattooga River and its West Fork which are now designated as part of the Chattooga National Wild and Scenic River and located in Rabun County, Georgia, which portion extends a length of approximately 34 miles; and (4) That portion of Ebenezer Creek from Long Bridge on County Road S 393 to the Savannah River and located in Effingham County, Georgia, which portion extends a length of approximately seven miles. The Georgia Scenic River System shall also be comprised of any river or section of a river designated as a scenic river by Act or resolution of the General Assembly. (Ga. L. 1969, p. 933, SS 3; Ga. L. 1978, p. 2207, SS 1; Ga. L. 1981, p. 459, SS 1.)

6.27.2 General Description

The Georgia Scenic Rivers Act of 1969 defines "scenic river" to mean certain rivers or section of rivers that have valuable scenic, recreational, or natural characteristics that should be preserved for the benefit and enjoyment of present and future generations. Certain sections of rivers are named in the Act, and the process for designating other sections of Georgia rivers is described. The Georgia Scenic Rivers Act is administered by the Environmental Protection Division.

6.27.3 Consistency

The project area does not include any rivers covered under this act. The project is fully consistent with this policy.

6.28 Scenic Trails

6.28.1 Policy Statement

Georgia Scenic Trails Act (O.C.G.A. 12-3-110, et seq.) 12-3-111. Legislative purpose.

In order to provide for the increasing outdoor recreation needs of an expanding population with an increasing amount of leisure time, in order to promote the enjoyment and appreciation of the outdoor areas of Georgia, and in order to provide for a healthful alternative to motorized travel, trails should be established in urban, suburban, rural, and wilderness areas of Georgia. Therefore, the purpose of this article is to provide for a Georgia Scenic Trails System. (Ga. L. 1972, p. 142, SS 2.)

6.28.2 General Description

The Georgia Scenic Trails Act authorizes the Department of Natural Resources to establish a Scenic Trails System in Georgia. The Department is authorized to construct, maintain, and manage trails on lands acquired through purchase, easement, lease or donation. The purpose is to create a balanced system of trails throughout the State, including urban, bicycle, horse, rural hiking, primitive hiking, historical, bikeways and combination trails. The Georgia Department of Transportation is authorized to construct the bicycle trails and bikeways after the Department of Natural Resources has determined their routes.

6.28.3 Consistency

The SHEP would not involve lands that could be considered suitable for establishing a scenic trail. The proposed project is fully consistent with this policy.

6.29 Septic Tanks

6.29.1 Policy Statement

Title 31 -- Health (O.C.G.A. Title 31 generally) (Septic Tank Law) 31-2-7. Standards for individual sewage management systems.
The Department of Human Resources shall have the authority as it deems necessary and proper to adopt statewide minimum standards for on-site, individual sewage management systems, including but not limited to standards for the size and construction of septic tanks. The Department is authorized to require that any on-site, individual sewage management system be examined and approved prior to allowing the use of such system in the state. Any on-site, individual sewage management system which has been properly approved shall, by virtue of such approval and by operation of law, be approved for installation in every county of the state; provided, however, that such on-site, individual sewage management system shall be required to meet local regulations authorized by law. Upon written request of three or more health districts, the department is authorized to require the reexamination of any such system or component thereof, provided that documentation is submitted indicating unsatisfactory service of such system or component thereof. Before any such examination or reexamination, the department

may require the person, persons, or organization manufacturing or marketing the system to reimburse the department or its agent for the reasonable expenses of such examination. (Code 1981, SS 31-2-7, enacted by Ga. L 1992, p. 3308, SS 1; Ga. L. 1994, p. 1777, SS 1.) 31-3-5.1. Regulations for septic tanks for individual sewage management systems in unincorporated areas; conformity to building permit.

No building permit for the construction of any residence, building, or other facility which is to be served by a septic tank or individual sewage management system shall be issued by or pursuant to the authority of a county governing authority unless the septic tank or individual sewage management system installation permit is in conformity with any statewide minimum standards for sewage management systems or the rules and regulations of the county board of health adopted pursuant to the authority of subsection (a) of this Code section. No person, firm, corporation, or other entity shall install a septic tank or individual sewage management system in violation of any state-wide minimum standards or the regulations of a county board of health adopted pursuant to the authority of subsection (a) of the Code section. Each county governing authority shall provide by ordinance or resolution for the enforcement of the provisions of this subsection. (Code 198 1, SS 31-3-5. 1, enacted by Ga. L. 1986, p. 227, SS 1; Ga. L. 1992, p. 3308. SS 2; Ga. L. 1994, p. 1777, SS 2.)

6.29.2 General Description

As stated above, the standards and regulations for individual sewage management systems are found at O.C.G.A. 31-2-7 and 31-3-5.1. The Department of Human Resources and the county boards of health are described and established by Title 31. There are other references for managing septic systems throughout the Code, including references within the River Corridor Protection Act (O.C.G.A. 12-2-8), the Georgia Water Quality Control Act (O.C.G.A. 12-5-20), and others, which make reference to safe siting of septic systems to ensure that leakage from those systems does not infiltrate the waters of the State. The county board(s) of health is provided the authority and the responsibility to ensure safe installation and maintenance of septic systems.

6.29.3 Consistency

No septic tanks are proposed as part of this project. The proposed project is fully consistent with this policy.

6.30 Shellfish

6.30.1 Policy Statement

Game and Fish Code (O.C.G.A. 27-1-1. et seq.) 27-4-190. Master collecting and picker's permits; hours for taking shellfish; recreational harvesting.

(a) It shall be unlawful to take or possess shellfish in commercial quantities or for commercial purposes without first having obtained a master collecting permit or without proof of purchase that such shellfish were purchased from a certified shellfish dealer. Master collecting permits shall specify whether the permittee is authorized to take oysters, clams, or other shellfish

and shall only be issued to persons certified by the Department of Agriculture to handle shellfish unless permission to take and possess shellfish for mariculture purposes has been granted by the department as described in subsection (d) of Code Section 27-4-197. Such permits shall be provided annually at no cost by the department but shall only be issued to persons with the right to harvest shellfish pursuant to Code Sections 44-8-6 through 44-8-8 or to holders of leases from such persons. A permittee may request authorization from the department for employees or agents, who shall be referred to as pickers, of such permittee to take shellfish from permitted areas. Such request shall be in writing to the department and shall include the name, address, and personal commercial fishing license number of the picker. It shall be unlawful for pickers to take or possess shellfish as authorized under their employer's master collecting permit unless they carry on their person while taking or in possession of shellfish a picker's permit as provided by the department indicating the exact area and circumstances allowed for taking. Such pickers' permits and charts shall be provided annually by the department at no cost and shall be in a form as prescribed by the department. Pickers must possess a valid personal commercial fishing license as provided for in Code Section 27-4-110 and, when a boat is used, a valid commercial fishing boat license as provided in Code Section 27-2-8. Master collecting permits and pickers' permits shall not be issued to persons who have been convicted three times in the two years immediately preceding the filing of an application for a permit of violations of this Code section, subsection

(b) of Code Section 27-4-193, subsections (a) and (b) of Code Section 27-4-195, or Code Section 27-4-199. Master collecting permits and pickers' permits issued to master collecting permittee's agents shall be surrendered to the department upon termination of Department of Agriculture certification for handling shellfish, upon termination of right to harvest shellfish, or upon violation of any provision of this title. If a picker is removed from authorization to take shellfish by the master collecting permittee, that picker shall immediately surrender to the department his picker's permit. It shall be unlawful to possess unauthorized pickers' permits or pickers' permits issued to another person.

(c) It shall be unlawful for any person to take or possess shellfish from unauthorized locations and during unauthorized periods of taking. It shall be unlawful to take shellfish except between the hours of one-half hour before sunrise and one-half hour after sunset.

(Code 1981, SS 27-4-190, enacted by Ga. L. 1991, p. 693, SS 6.) 27-4-193. Taking shellfish from unapproved growing areas; operating facility for controlled purification of shellfish.

(a) As used in this Code section, the term "approved growing area" means that area or areas approved by the department for shellfish harvesting and "unapproved growing area" means all other areas.

(b) It shall be unlawful to take or possess shellfish from unapproved growing areas except at such times and places as the department may establish. The department is authorized to close approved growing areas to allow transplanting at any time between January 1 and December 31. It shall be unlawful to engage in transplanting of shellfish from unapproved growing areas without written authorization from the department. Such authorization may condition the transplanting upon compliance with current, sound principles of wildlife research and management. In approving growing areas, the department shall consider such current guidelines as have been established by the National Shellfish Sanitation Program at the time of approval of the growing areas and current, sound principles of wildlife research and management. (Code 1981, SS 27-4-193, enacted by Ga. L. 1991, p. 693, SS 6; Ga. L. 1992, p. 6, SS 27.)

6.30.2 General Description

The provisions of O.C.G.A. Title 27 (Game and Fish Code), Part 4 describe the regulation of shellfish in Georgia. The provisions describe the requirements for a commercial shellfish harvester to have a license, issued by the Department of Natural Resources pursuant to the requirements of the US Department of Agriculture. The Department also is authorized to approve shellfish growing areas for commercial harvest, and must consider the guidelines established by the National Shellfish Sanitation Program. The Department conducts water sampling in areas that are approved for shellfish in conjunction with the National Shellfish Sanitation Program.

6.30.3 Consistency

No commercial shellfish harvesting areas would be impacted as part of this project. According to GA DNR-CRD, there are three shellfish harvesting leases near the project area, these are the Chatham County Recreational Shellfish Harvest Area and two commercial leases; Halfmoon and Wilmington. All three shellfish harvesting areas are located a sufficient distance from the proposed project area to ensure that they would not be adversely affected. The EIS will be coordinated with Coastal Resources Division, GA DNR. The proposed project is fully consistent with this policy.

6.31 Shore Protection

6.31.1 Policy Statement

Shore Protection Act (O.C.G.A. 2-5-230, et seq.) 12-5-231. Legislative findings and declarations. The General Assembly finds and declares that coastal sand dunes, beaches, sandbars, and shoals comprise a vital natural resource system, known as the sand-sharing system, which acts as a buffer to protect real and personal property and natural resources from the damaging effects of floods, winds, tides, and erosion. It is recognized that the coastal sand dunes are the most inland portion of the sand-sharing system and that because the dunes are the fragile product of shoreline evolution, they are easily disturbed by actions harming their vegetation or inhibiting their natural development. The General Assembly further finds that offshore sandbars and shoals are the system's first line of defense against the potentially destructive energy generated by winds, tides, and storms, and help to protect the onshore segment of the system by acting as reservoirs of sand for the beaches. Removal of sand from these bars and shoals can interrupt natural sand flows and can have unintended, undesirable, and irreparable effects on the entire sand-sharing system, particularly when the historical patterns of sand and water flows are not considered and accommodated. Also, it is found that ocean beaches provide an unparalleled natural recreation resource which has become vitally linked to the economy of Georgia's coastal zone and to that of the entire state. The General Assembly further finds that this natural resource system is costly, if not impossible, to reconstruct or rehabilitate once adversely affected by man related activities and is important to conserve for the present and future use and enjoyment of all citizens and visitors to this state and that the sand-sharing system is an integral part of Georgia's barrier islands, providing great protection to the state's marshlands and estuaries. The General Assembly further finds that this sand-sharing system is a vital area of the state and is essential to

maintain the health, safety, and welfare of all the citizens of the state. Therefore, the General Assembly declares that the management of the sand-sharing system has more than local significance, is of equal importance to all citizens of the state, is of state-wide concern, and consequently is properly a matter for regulation under the police power of the state. The General Assembly further finds and declares that activities and structures on offshore sandbars and shoals, for all purposes except federal navigational activities, must be regulated to ensure that the values and functions of the sand-sharing system are not impaired. It is declared to be a policy of this state and the intent of this part to protect this vital natural resource system by allowing only activities and alterations of the sand dunes and beaches which are considered to be in the best interest of the state and which do not substantially impair the values and functions of the sand-sharing system and by authorizing the local units of government of the State of Georgia to regulate activities and alterations of the ocean sand dunes and beaches and recognizing that, if the local units of government fail to carry out the policies expressed in this part, it is essential that the department undertake such regulation. (Code 1981, SS12-5-231, enacted by Ga. L. 1992, p.1362, SS 1.)

6.31.2 General Description

The Shore Protection Act is the primary legal authority for protection and management of Georgia's shoreline features including sand dunes, beaches, sandbars, and shoals, collectively known as the sand-sharing system. The value of the sand-sharing system is recognized as vitally important in protecting the coastal marshes and uplands from Atlantic storm activity, as well as providing valuable recreational opportunities.

The Shore Protection Act limits activities in shore areas and requires a permit for certain activities and structures on the beach. Construction activity in sand dunes is limited to temporary structures such as crosswalks, and then only by permit from the Georgia Coastal Resources Division. Structures such as boat basins, docks, marinas, and boat ramps are not allowed in the dunes. Shore Permits, which are administered by the Coastal Resources Division, are not granted for activities that are inconsistent with the Georgia Coastal Management Program. The Shore Protection Act prohibits operation of any motorized vehicle on or over the dynamic dune fields and beaches, except as authorized for emergency vehicles, and governmental vehicles for beach maintenance or research. The Shore Protection Act also prohibits storage or parking of sailboats, catamarans, or other marine craft in the dynamic dune field.

Direct permitting authority regarding any proposed facilities located within the jurisdictional area the Shore Protection Act lies with the Shore Protection Committee. These permits are administered by the Georgia Coastal Resources Division. This authority is a very important aspect of the Georgia Coastal Management Program, since recreation at the water's edge is a significant demand. Providing public access and recreational opportunities at or near the beach while protecting the sand sharing system is an important component of the Program.

6.31.3 Consistency

As discussed previously in this document, studies have concluded that construction and maintenance of the existing Savannah Harbor Project has deflated the Tybee shelf and beach.

Resolution of these issues could be addressed through a separate study between Savannah District and the City of Tybee Island.

Construction of the SHEP would have little impact on Tybee Beach or the Tybee Shelf. The Corps evaluated the potential beneficial use of the new work sediments by depositing them in the nearshore area off Tybee Island, but GA DNR-CRD and the City of Tybee Island requested the project not deposit those sediments in that location. No sediment would be placed on the beach and no construction would occur in dune areas.

Maintenance material from the first part of the inner harbor or the entrance channel could be placed directly on the beach at Tybee Island or in the nearshore area off Tybee Island as provided for in the LTMS. However, a non-Federal sponsor would have to pay any additional costs to put the material into these areas over the costs of the Base Plan (most cost effective and environmentally acceptable) for these two channel segments.

The proposed SHEP is consistent with the provisions of the Shoreline Protection Act.

6.32 Solid Waste Management

6.32.1 Policy Statement

Georgia Comprehensive Solid Waste Management Act (0.C.G.A. 12-8-21, et seq.) 12-8-21. Declaration of policy; legislative intent.
(a) It is declared to be the policy of the State of Georgia, in furtherance of its responsibility to protect the public health, safety, and well-being of its citizens and to protect and enhance the quality of its environment, to institute and maintain a comprehensive state-wide program for solid waste management which will assure that solid waste facilities, whether publicly or privately operated, do not adversely affect the health, safety, and well-being of the public and do not degrade the quality of the environment by reason of their location, design, method of operation, or other means and which, to the extent feasible and practical, makes maximum utilization of the resources contained in solid waste.
(b) It is further declared to be the policy of the State of Georgia to educate and encourage generators and handlers of solid waste to reduce and minimize to the greatest extent possible the amount of solid waste which requires collection, treatment, or disposal through source reduction, reuse, composting, recycling, and other methods and to promote markets for and engage in the purchase of goods made from recovered materials and goods which are recyclable. (Code 1981, SS 12-8-21, enacted by Ga. L. 1990, p. 412, SS 1; Ga. L. 1992, p. 3259, SS 1; Ga. L. 1993, p. 399, SSSS 1, 2.)

6.32.2 General Description

The Georgia Comprehensive Solid Waste Management Act defines the rules regarding solid waste disposal in the State. Solid waste handling facilities must be permitted by the State unless an individual is disposing of waste from his own residence onto land or facilities owned by him and disposal of such waste does not adversely affect human health (O.C.G.A. 12-8-30.10). State

law mandates that a county, municipality, or group of counties beginning a process to select a site for municipal waste disposal must first call at least one public meeting.
In addition to the above-named jurisdictions, a regional solid waste management authority must hold at least one meeting within the jurisdiction of each participating authority. Meetings held to make siting decisions for any publicly or privately owned municipal solid waste disposal facility must be publicized before the meeting is held (O.C.G.A. 12-8-26). Each city and county is required to develop a comprehensive solid waste management plan that, at a minimum, provides for the assurance of adequate solid waste handling capability and capacity for at least ten years. This plan must identify those sites that are not suitable for solid waste facilities based upon environmental and land use factors (O.C.G.A. 12-8-3 1. 1); these factors may include historic and archeological sites. Solid waste facilities within 5,708 yards of a national historic site are not permitted (O.C.G.A. 12-8-25. 1). Solid waste facilities on property owned exclusively by a private solid waste generator are generally exempt from these provisions. Local governments have the authority to zone areas of environmental, historic, or cultural sensitivity and to protect those sites from becoming waste disposal areas regardless of whether they are public or privately owned.

6.32.3 Consistency

The dredged sediments do not meet the definition of a solid waste and, therefore, do not require to be treated as such. The proposed project is fully consistent with this policy.

6.33 Surface Mining

6.33.1 Policy Statement

Georgia Surface Mining Act (O.C.G.A. 12-4-70, et seq.) 12-4-71. Legislative purpose; duty of Environmental Protection Division to administer part.

(a) The purposes of this part are:
(1) To assist in achieving and maintaining an efficient and productive mining industry and to assist in increasing economic and other benefits attributable to mining;
(2) To advance the protection of fish and wildlife and the protection and restoration of land, water, and other resources affected by mining;
(3) To assist in the reduction, elimination, or counteracting of pollution or deterioration of land, water, and air attributable to mining;
(4) To encourage programs which will achieve comparable results in protecting, conserving, and improving the usefulness of natural resources to the end that the most desirable conduct of mining and related operations may be universally facilitated;
(5) To assist in efforts to facilitate the use of land and other resources affected by mining so that such use may be consistent with sound land use, public health, and public safety, and to this end to study and recommend, wherever desirable, techniques for the improvement, restoration, or protection of such land and other resources.

(b) The Environmental Protection Division of the department shall administer this part consistent with the above-stated purposes. (Ga. L. 1968, p. 9, SS 2.)

6.33.2 General Description

Georgia's Surface Mining Act regulates all surface mining in Georgia, including the coastal zone. Dredging or ocean mining of materials are not directly regulated by State authority, except that sand and gravel operations are subject to the Shore Protection Act.

6.33.3 Consistency

The proposed deepening of the Federal navigation channel is not considered a mining operation. The resultant sediment from the channel would not be sold or processed. The proposed project is fully consistent with this policy.

6.34 Underground Storage Tanks

6.34.1 Policy Statement

Georgia Underground Storage Tank Act (O.C.G.A. 12-3-1. et seq.) 12-13-2. Public policy.

(a) It is declared to be the public policy of the State of Georgia, in furtherance of its responsibility to protect the public health, safety, and well-being of its citizens and to protect and enhance the quality of its environments, to institute and maintain a comprehensive state-wide program for the management of regulated substances stored in underground tanks.

(b) It is the intent of the General Assembly that the Environmental Protection Division of the Department of Natural Resources shall be designated as the state agency to administer the provisions of this chapter. The director of the Environmental Protection Division of the Department of Natural Resources shall be the official charged with the primary responsibility for the enforcement of this chapter. In exercising any authority or power granted by this chapter and in fulfilling duties under this chapter, the director shall conform to and implement the policies outlined in this chapter.

(c) It is the intent of the General Assembly to create an environmental assurance fund which, in addition to those purposes set forth in subsections (f) and (g) of Code Section 1 2-1 3-9, may also be used by owners and operators as an alternate to insurance purchased from insurance companies for purposes of evidencing financial responsibility for taking corrective action and compensation of third parties for bodily injury and property damage caused by sudden and non-sudden accidental releases arising from operating underground storage tanks. (Code 1981, SS 12-13-2, enacted by Ga.L. 1988, p. 2072, SS 1; Ga.L. 1989, p. 14, SS 12.)

6.34.2 General Description

The Underground Storage Tank Law provides the authority for the Environmental Protection Division to define the State criteria for operating, detecting releases, corrective actions, and enforcement of the utilization of underground storage tanks (USTs). The rules, found at Chapter 391-3-15 of the Rules and Regulations of the State of Georgia, establish minimum standards and procedures to protect human health and safety and to protect and maintain the quality of groundwater and surface water resources from environmental contamination that could result from any releases of harmful substances stored in such tanks. These requirements reflect the federal law regulating underground storage tanks as well as the applicable State rules. All

facilities with underground storage tanks are subject to these requirements. The Memorandum of Agreement between the Coastal Resources Division and the Environmental Protection Division ensures cooperation and coordination in the implementation of UST standards within the coastal area.

6.34.3 Consistency

No installation of USTs is proposed for this project. The proposed project is fully consistent with this policy.

6.35 Water Quality

6.35.1 Policy Statement

Georgia Water Quality Control Act (O.C.G.A. 12-5-20) 12-5-21. Declaration of policy, legislative intent.

(a) The people of the State of Georgia are dependent upon the rivers, streams, lakes, and subsurface waters of the state for public and private water supply and for agricultural, industrial, and recreational uses. It is therefore declared to be the policy of the State of Georgia that the water resources of the state shall be utilized prudently for the maximum benefit of the people, in order to restore and maintain a reasonable degree of purity in the waters of the state and an adequate supply of such waters, and to require where necessary reasonable usage of the waters of the state and reasonable treatment of sewage, industrial wastes, and other wastes prior to their discharge into such waters. To achieve this end, the government of the state shall assume responsibility for the quality and quantity of such water resources and the establishment and maintenance of a water quality and water quantity control program adequate for present needs and designed to care for the future needs of the state, provided that nothing contained in this article shall be construed to waive the immunity of the state for any purpose.

(b) The achievement of the purposes described in subsection (a) of this Code section requires that the Environmental Protection Division of the Department of Natural Resources be charged with the duty described in that subsection, and that it have the authority to regulate the withdrawal, diversion, or impoundment of the surface waters of the state, and to require the use of reasonable methods after having considered the technical means available for the reduction of pollution and economic factors involved to prevent and control the pollution of the waters of the state.

(c) Further, it is the intent of this article to establish within the executive branch of the government administrative facilities and procedures for determining improper usage of the surface waters of the state and pollution of the waters of the state, and to confer discretionary administrative authority upon the Environmental Protection Division to take these and related circumstances into consideration in its decisions and actions in determining, under the conditions and specific cases, those procedures which will best protect the public interest. (Ga. L. 1957, p. 629, SS 2; Ga. L. 1964, p. 416, SS 2; Ga. L. 1977, p. 368, SS 1.)

6.35.2 General Description

The Georgia Water Quality Control Act grants the Environmental Protection Division authority to ensure that water uses in the State of Georgia are used prudently, are maintained or restored to a reasonable degree of purity, and are maintained in adequate supply. In the administration of this law, the Environmental Protection Division can revise rules and regulations pertaining to water quality and quantity, set permit conditions and effluent limitations, and set permissible limits of surface water usage for both consumptive and non-consumptive uses through the Board of Natural Resources. Through a Memorandum of Agreement between the Environmental Protection Division and the Coastal Resources Division, the rules and permits of the Environmental Protection Division are administered in a manner consistent with the enforceable policies of the Coastal Management Program.
The authority to regulate the rivers, streams, lakes, and subsurface waters throughout the State for public and private water supply and agricultural, industrial, and recreational uses is provided to the Environmental Protection Division. The Act makes it unlawful for any person to dispose of sewage, industrial wastes, or other wastes, or to withdraw, divert, or impound any surface waters of the State without a permit. Tourism and recreational entities, manufacturing and transportation facilities, and other activities found in the coastal zone covered under the policies of the Georgia Coastal Management Program are responsible for compliance with the regulations implementing the Georgia Water Quality Control Act.

6.35.3 Consistency

Water quality would be routinely monitored during construction to ensure that applicable water quality standards are not violated. Effluent leaving the weirs in the seven CDFs would be routinely monitored for physical parameters such as dissolved oxygen, pH, suspended solids, etc.). As previously discussed in this document, a stringent monitoring plan would be implemented for Disposal Areas 14A and 14B where the cadmium-laden sediments would be placed.

Without mitigation, deepening the channel in Savannah Harbor would impact the dissolved oxygen regime in Savannah Harbor. Mitigation of this potential adverse effect is critical since the section of the Savannah River between Fort Pulaski (mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 27.4) is on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen. The EPA has issued a Revised Draft Total Maximum Daily Load (TMDL) for dissolved oxygen

Model studies indicate that oxygen injection can be used to remove the effects of the SHEP on the dissolved oxygen regime. The SHEP mitigation plan includes installation and operation of an oxygen injection system at three locations that would remove the incremental effects of harbor deepening on the dissolved oxygen regime. Due to their wide spacing, those systems would also incidentally increase dissolved oxygen levels above their present levels over much of the harbor. The Georgia DNR-EPD has mandated that the two oxygen injection systems on Hutchinson Island be installed and operating before the SHEP inner harbor dredging begins. The oxygen injection system that would be located further upstream near Georgia Power's Plant

McIntosh would be installed and operating within one year after commencement of the inner harbor dredging.

The proposed project has been issued a Section 401 Water Quality Certification by the Georgia DNR Environmental Protection Division.

The proposed project is fully consistent with this policy.

6.36 Water Wells

6.36.1 Policy Statement

Water Wells Standards Act (O.C.G.A. 12-5-120, et seq.) 12-5-121. Legislative intent. It is the intent of the General Assembly to provide in this part for the application of standards for the siting, construction, operation, maintenance, and abandonment of wells and boreholes so as to protect the public health and the water resources of this state. (Ga.L. 1976, p. 974, SS 2; Ga.L. 1985, p. 1192, SS 1.)

6.36.2 General Description

The Water Wells Standards Act of 1985 provides standards for siting, constructing, operating, maintaining, and abandoning wells and boreholes. The Act requires that individual and non-public wells must be located as far removed from known or potential sources of pollutants as possible. Licensing requirements for drilling contractors are established by the Act, as well a State Water Well Standards Advisory Council. The Council is authorized to adopt and amend rules and regulations that are reasonable to govern the licensing of well contractors. Compliance with the Water Wells Standards Act is required for all activities that utilize well water. The provisions of the Act are enforceable under Georgia law. The Council may file a petition for an injunction in the appropriate superior court against any person that has violated any provisions of the Act.

6.36.3 Consistency

Borings and test wells that were taken or installed during the study period complied with the state standards for casing, capping and plugging. Additional similar work, including monitoring wells, would also be conducted in a manner that complies with these standards. The proposed project is fully consistent with this policy.

6.37 Wildflower Preservation

6.37.1 Policy Statement

The Wildflower Preservation Act (O.C.G.A. 12-6-170, et seq.) 12-6-172. Powers and duties of Department and Board of natural Resources as to wildflower preservation.
(a) The Department of Natural Resources shall from time to time designate as a protected species and species of plant life within this state which it may determine to be rare, unusual, or in danger

of extinction, and upon such designation such species will become subject to the protection of this article. (Ga.L. 1973, p. 333, SS 3; Ga.L. 1982, p. 3, SS 12.)

6.37.2 General Description

The Wildflower Preservation Act provides for designation of and protection of plant species that are rare, unusual, or in danger of extinction. Additional species may be added by the Board of Natural Resources at any time. The protection offered to these species is limited to those that are found on public lands of the State. It is a misdemeanor to transport, carry, convey, sell, cut, pull up, dig up, or remove protected species listed by this Act.

6.37.3 Consistency

The proposed work would not impact any land which contain wildflowers that are considered rare, unusual, or in danger of extinction. The proposed project is fully consistent with this policy.

7.0 OTHER MANAGEMENT AUTHORITIES

The paragraphs in this section describe management authorities which provide the Coastal Resources Division with additional tools and mechanisms to accomplish the goals of the Georgia Coastal Management Program. Although these authorities are not listed as policies of the Program, they are laws of the State. Most of the statutes referenced here are primarily procedural. These laws and programs are not considered enforceable policies of the Georgia Coastal Management Program and thus are not used in preparing or reviewing Federal Consistency Determinations and certifications.

7.1 Coordinated and Comprehensive Planning by Counties

(Informally known as the Georgia Planning Act) The Georgia Planning Act (O.C.G.A. 45-12-200, et seq.) requires each local government to develop a comprehensive plan to guide growth and development as a condition to receive State funding assistance. Under the Georgia Planning Act, minimum planning standard was developed for the preparation, adoption, and implementation of local comprehensive plans. The planning standards constitute a three-step planning process: inventory and assessment; needs and goals; and implementation and strategy. The Act establishes Regional Development Centers (RDCs) throughout Georgia. Three of these Centers have jurisdiction within the coastal zone: the Southeast Georgia RDC includes Brantley and Charlton counties; the Heart of Georgia RDC includes Wayne County; and the Coastal Georgia RDC includes the remaining eight counties (Bryan, Camden, Chatham, Effingham, Glynn, Liberty, Long, and McIntosh). The role of the RDCs is to work with local and county governments individually and on a regional basis to improve services and programs, consistent with local comprehensive plans, to benefit residents of the region. The Coastal Management Program works closely with the RDCs to implement the policies of the Program. Many of the goals, objectives and policies of the Georgia Coastal Management Program can be achieved by

local comprehensive planning processes and implemented through local land-use controls and the public infrastructure.

The proposed work would take place in Georgia and South Carolina. The Coastal Georgia RDC has jurisdiction for projects located within Chatham County. The proposed project will be coordinated with interested agencies, the public, and the Coastal Georgia RDC. It is not expected that the proposed work would conflict with any aspect of an existing long term comprehensive land use plan.

7.2 Georgia Administrative Procedures Act

The Georgia Administrative Procedures Act (O.C.G.A. 50-13-4, et seq.) establishes the procedural requirements for adoption, amendment, or repeal of rules and regulations, among other things. New rules require at least 30 days notice of intended action. Similar public comment requirements are required for federal regulatory actions. Public comment and input is important for any regulatory action, both to provide an opportunity for presentation of citizens' ideas and concerns and to provide time for implementation by those entities that may be potentially impacted.

The 45-day public comment period for the DEIS and the 30-day public comment period for the FEIS which are requirements of the NEPA process provide a formal avenue for the public to provide input on the proposed project. A public information meeting was also held during the 45-day comment period on the DEIS. The proposed project complies fully with the spirit of the Georgia Administrative Procedures Act.

7.3 Georgia Litter Control Law

The Georgia Litter Control Law (O.C.G.A. 16-7-40, et seq.) makes it unlawful for any person or persons, "...to dump, deposit, throw, or leave or to cause or permit the dumping, placing, throwing, or leaving of litter on any public or private property in this state or any waters in this state" unless the situation meets one of three conditions. Litter may be disposed at a site if (1) the property is designated as a litter disposal site, (2) litter is placed in a proper receptacle, and/or (3) litter is disposed of by permission of the property owner in a manner consistent with the public welfare.

Construction contracts would contain provisions which require the contractors to remove all construction debris from the project sites as part of their demobilization activities. The proposed SHEP complies with the intent of the Georgia Litter Control Law.

7.4 Georgia Uniform Conservation Easement Act

The Georgia Uniform Conservation Easement Act (O.C.G.A. 44-10-1, et seq.) defines "conservation easement" to mean a non-possessory interest in real property, with limitations or affirmative obligations, the purposes of which include retaining or protecting natural property; assuring its availability for agricultural, forest, recreational, or open space use; protecting natural resources; maintaining or enhancing air or water quality; or preserving the historical,

archeological, or cultural aspects of real property. A landholder may be a government agency or a charitable organization.

The proposed action would not include or adversely affect any "conservation easements" and therefore the proposed action is in compliance with this act.

8.0 STATE PROGRAMS

The following State programs contribute towards effective management of Georgia's coastal resources. As non-regulatory programs, they do not constitute enforceable policies of the Program and are not used in Federal consistency reviews. The District has included a discussion of these programs in this Consistency Determination because of the goals of these programs. In general, these programs would be expected to apply to work in Georgia.

8.1 Acres for Wildlife Program

The Acres for Wildlife Program is administered by the Non-game and Endangered Wildlife Program of the Georgia Department of Natural Resources to provide technical assistance to private landowners for resource and habitat management. The Program helps to identify wildlife habitat and provides advice to help the landowner manage the property for the welfare of the wildlife.

This program does not apply to the proposed SHEP.

8.2 Certified Burner Program

The Certified Burner Program is administered by the Georgia Forestry Commission to educate the citizens of Georgia about safe burning techniques. The Georgia General Assembly declared that prescribed burning is a resource protection and land management tool that benefits the safety of the public, Georgia's forest resources, the environment and the economy of the State (O.C.G.A. 12-6-146).

The proposed action does not include any prescribed burning.

8.3 Community Wildlife Project

The Community Wildlife Project is the only wildlife habitat certification program directed to the community as a whole. It is designed to encourage and improve management of wildlife habitats found in urban, suburban, and semi-rural areas. The program is administered by local garden clubs affiliated with the Garden Clubs of Georgia in concert with the Non-game and Endangered Wildlife Program of the Georgia Department of Natural Resources. The Community Wildlife Project establishes minimum criteria for community-based habitat management projects.

This policy does not apply to the proposed action.

8.4 Forest Stewardship Program

The Forest Stewardship Program is administered by the Georgia Forestry Commission in cooperation with the Non-game and Endangered Wildlife Division of the Department of Natural Resources. The Program is designed to provide technical assistance to private landowners for management of forest lands. A concomitant Stewardship Incentive Program provides State funding on a cost-sharing basis to implement certain aspects of the program.

This policy does not apply to the proposed action.

8.5 Heritage 2000

Heritage 2000 is a public-private partnership program designed by Governor Miller to acquire historic property and resources throughout Georgia. The initiative is modeled after Preservation 2000.

This policy does not apply to the proposed action.

8.6 Georgia's Non-game Wildlife Conservation and Habitat Fund

Georgia's Non-game Wildlife Conservation and Habitat Fund (O.C.G.A. 12-3-600, et seq.) provides the Department of Natural Resources a mechanism to establish non-game wildlife conservation and habitat acquisition, as well as education programs to enhance the protection of non-game flora and fauna. The Department of Natural Resources may solicit voluntary contributions through an income tax return contribution mechanism, by offers to match contributions, or by fund raising or other promotional techniques. Any funds collected are placed into a "Non-game Wildlife Conservation and Wildlife Habitat Acquisition Fund."

This policy does not apply to the proposed action.

8.7 Preservation 2000

Preservation 2000 is a three-year program implemented by Governor Miller in 1994 to acquire approximately 100,000 acres for the State of Georgia to preserve natural areas, historic sites, parks, wildlife management areas and similar sites. It is funded by a $65 million bond fund, approximately $1.45 million in gifts, and small amounts of Federal funds. Since its inception, over 84,000 acres have been acquired and approximately 33,000 acres are under negotiation during the summer of 1997. There were over 450 nominations of various parcels throughout the State. Currently, there are four natural areas and two wildlife management areas designated within the coastal area as a result of Preservation 2000. Some of the 33,000 acres under negotiation lies within the coastal area. The areas acquired provide such uses as protection for bald eagles and other endangered species, hunting, fishing, boating, nature observation, primitive camping, scientific study and protection of water quality for shellfish. A concomitant part of the Preservation 2000 program is the Georgia Greenways Council, a coalition of trail organizations and local, State and Federal agencies involved with trail development. The coalition promotes the protection of linear corridors and coordinates trail development throughout the State. A

proposed Coastal Water Trail, the aquatic equivalent of the Appalachian Trail, would run along Georgia's coast from the Savannah River to the St. Mary's River. This trail would provide routing for sea kayaks and other small craft, and include access trails, boat launching sites and camping areas.

This policy does not apply to the proposed action.

8.8 River Care 2000

River Care 2000 is a public-private partnership program designed by Governor Miller to acquire natural areas and historic property along Georgia's riverbanks. The initiative is modeled after Preservation 2000. River Care 2000 is intended to provide recreation and park land, and to allow better flood management.

This policy does not apply to the proposed action.

9.0 LOCAL LAND USE PLANS

The EIS has been coordinated with interested parties in Georgia and South Carolina. The proposed action is in compliance with all local land use plans.

10.0 CONCLUSION

In accordance with the CZMA, 16 U.S.C. SS 1456(c), as amended, it has been determined that the proposed deepening of the Federal navigation channel would be carried out in a manner which is fully consistent with the enforceable policies of the Georgia Coastal Management Plan. This determination applies to the preferred alternative (-47 foot MLW depth alternative) and the effects of the preferred alternative on the land or water uses or natural resources of the coastal zone, as directed by 15 C.F.R. SS 930.39.

facilities with underground storage tanks are subject to these requirements. The Memorandum of Agreement between the Coastal Resources Division and the Environmental Protection Division ensures cooperation and coordination in the implementation of UST standards within the coastal area.

6.34.3 Consistency

No installation of USTs is proposed for this project. The proposed project is fully consistent with this policy.

6.35 Water Quality

6.35.1 Policy Statement

Georgia Water Quality Control Act (O.C.G.A. 12-5-20) 12-5-21. Declaration of policy, legislative intent.

(a) The people of the State of Georgia are dependent upon the rivers, streams, lakes, and subsurface waters of the state for public and private water supply and for agricultural, industrial, and recreational uses. It is therefore declared to be the policy of the State of Georgia that the water resources of the state shall be utilized prudently for the maximum benefit of the people, in order to restore and maintain a reasonable degree of purity in the waters of the state and an adequate supply of such waters, and to require where necessary reasonable usage of the waters of the state and reasonable treatment of sewage, industrial wastes, and other wastes prior to their discharge into such waters. To achieve this end, the government of the state shall assume responsibility for the quality and quantity of such water resources and the establishment and maintenance of a water quality and water quantity control program adequate for present needs and designed to care for the future needs of the state, provided that nothing contained in this article shall be construed to waive the immunity of the state for any purpose.

(b) The achievement of the purposes described in subsection (a) of this Code section requires that the Environmental Protection Division of the Department of Natural Resources be charged with the duty described in that subsection, and that it have the authority to regulate the withdrawal, diversion, or impoundment of the surface waters of the state, and to require the use of reasonable methods after having considered the technical means available for the reduction of pollution and economic factors involved to prevent and control the pollution of the waters of the state.

(c) Further, it is the intent of this article to establish within the executive branch of the government administrative facilities and procedures for determining improper usage of the surface waters of the state and pollution of the waters of the state, and to confer discretionary administrative authority upon the Environmental Protection Division to take these and related circumstances into consideration in its decisions and actions in determining, under the conditions and specific cases, those procedures which will best protect the public interest. (Ga. L. 1957, p. 629, SS 2; Ga. L. 1964, p. 416, SS 2; Ga. L. 1977, p. 368, SS 1.)

6.35.2 General Description

The Georgia Water Quality Control Act grants the Environmental Protection Division authority to ensure that water uses in the State of Georgia are used prudently, are maintained or restored to a reasonable degree of purity, and are maintained in adequate supply. In the administration of this law, the Environmental Protection Division can revise rules and regulations pertaining to water quality and quantity, set permit conditions and effluent limitations, and set permissible limits of surface water usage for both consumptive and non-consumptive uses through the Board of Natural Resources. Through a Memorandum of Agreement between the Environmental Protection Division and the Coastal Resources Division, the rules and permits of the Environmental Protection Division are administered in a manner consistent with the enforceable policies of the Coastal Management Program.
The authority to regulate the rivers, streams, lakes, and subsurface waters throughout the State for public and private water supply and agricultural, industrial, and recreational uses is provided to the Environmental Protection Division. The Act makes it unlawful for any person to dispose of sewage, industrial wastes, or other wastes, or to withdraw, divert, or impound any surface waters of the State without a permit. Tourism and recreational entities, manufacturing and transportation facilities, and other activities found in the coastal zone covered under the policies of the Georgia Coastal Management Program are responsible for compliance with the regulations implementing the Georgia Water Quality Control Act.

6.35.3 Consistency

Water quality would be routinely monitored during construction to ensure that applicable water quality standards are not violated. Effluent leaving the weirs in the seven CDFs would be routinely monitored for physical parameters such as dissolved oxygen, pH, suspended solids, etc.). As previously discussed in this document, a stringent monitoring plan would be implemented for Disposal Areas 14A and 14B where the cadmium-laden sediments would be placed.

Without mitigation, deepening the channel in Savannah Harbor would impact the dissolved oxygen regime in Savannah Harbor. Mitigation of this potential adverse effect is critical since the section of the Savannah River between Fort Pulaski (mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 27.4) is on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen. The EPA has issued a Revised Draft Total Maximum Daily Load (TMDL) for dissolved oxygen

Model studies indicate that oxygen injection can be used to remove the effects of the SHEP on the dissolved oxygen regime. The SHEP mitigation plan includes installation and operation of an oxygen injection system at three locations that would remove the incremental effects of harbor deepening on the dissolved oxygen regime. Due to their wide spacing, those systems would also incidentally increase dissolved oxygen levels above their present levels over much of the harbor. The Georgia DNR-EPD has mandated that the two oxygen injection systems on Hutchinson Island be installed and operating before the SHEP inner harbor dredging begins. The oxygen injection system that would be located further upstream near Georgia Power's Plant

McIntosh would be installed and operating within one year after commencement of the inner harbor dredging.

The proposed project has been issued a Section 401 Water Quality Certification by the Georgia DNR Environmental Protection Division.

The proposed project is fully consistent with this policy.

6.36 Water Wells

6.36.1 Policy Statement

Water Wells Standards Act (O.C.G.A. 12-5-120, et seq.) 12-5-121. Legislative intent. It is the intent of the General Assembly to provide in this part for the application of standards for the siting, construction, operation, maintenance, and abandonment of wells and boreholes so as to protect the public health and the water resources of this state. (Ga.L. 1976, p. 974, SS 2; Ga.L. 1985, p. 1192, SS 1.)

6.36.2 General Description

The Water Wells Standards Act of 1985 provides standards for siting, constructing, operating, maintaining, and abandoning wells and boreholes. The Act requires that individual and non-public wells must be located as far removed from known or potential sources of pollutants as possible. Licensing requirements for drilling contractors are established by the Act, as well a State Water Well Standards Advisory Council. The Council is authorized to adopt and amend rules and regulations that are reasonable to govern the licensing of well contractors. Compliance with the Water Wells Standards Act is required for all activities that utilize well water. The provisions of the Act are enforceable under Georgia law. The Council may file a petition for an injunction in the appropriate superior court against any person that has violated any provisions of the Act.

6.36.3 Consistency

Borings and test wells that were taken or installed during the study period complied with the state standards for casing, capping and plugging. Additional similar work, including monitoring wells, would also be conducted in a manner that complies with these standards. The proposed project is fully consistent with this policy.

6.37 Wildflower Preservation

6.37.1 Policy Statement

The Wildflower Preservation Act (O.C.G.A. 12-6-170, et seq.) 12-6-172. Powers and duties of Department and Board of natural Resources as to wildflower preservation.
(a) The Department of Natural Resources shall from time to time designate as a protected species and species of plant life within this state which it may determine to be rare, unusual, or in danger

of extinction, and upon such designation such species will become subject to the protection of this article. (Ga.L. 1973, p. 333, SS 3; Ga.L. 1982, p. 3, SS 12.)

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The Wildflower Preservation Act provides for designation of and protection of plant species that are rare, unusual, or in danger of extinction. Additional species may be added by the Board of Natural Resources at any time. The protection offered to these species is limited to those that are found on public lands of the State. It is a misdemeanor to transport, carry, convey, sell, cut, pull up, dig up, or remove protected species listed by this Act.

6.37.3 Consistency

The proposed work would not impact any land which contain wildflowers that are considered rare, unusual, or in danger of extinction. The proposed project is fully consistent with this policy.

7.0 OTHER MANAGEMENT AUTHORITIES

The paragraphs in this section describe management authorities which provide the Coastal Resources Division with additional tools and mechanisms to accomplish the goals of the Georgia Coastal Management Program. Although these authorities are not listed as policies of the Program, they are laws of the State. Most of the statutes referenced here are primarily procedural. These laws and programs are not considered enforceable policies of the Georgia Coastal Management Program and thus are not used in preparing or reviewing Federal Consistency Determinations and certifications.

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(Informally known as the Georgia Planning Act) The Georgia Planning Act (O.C.G.A. 45-12-200, et seq.) requires each local government to develop a comprehensive plan to guide growth and development as a condition to receive State funding assistance. Under the Georgia Planning Act, minimum planning standard was developed for the preparation, adoption, and implementation of local comprehensive plans. The planning standards constitute a three-step planning process: inventory and assessment; needs and goals; and implementation and strategy. The Act establishes Regional Development Centers (RDCs) throughout Georgia. Three of these Centers have jurisdiction within the coastal zone: the Southeast Georgia RDC includes Brantley and Charlton counties; the Heart of Georgia RDC includes Wayne County; and the Coastal Georgia RDC includes the remaining eight counties (Bryan, Camden, Chatham, Effingham, Glynn, Liberty, Long, and McIntosh). The role of the RDCs is to work with local and county governments individually and on a regional basis to improve services and programs, consistent with local comprehensive plans, to benefit residents of the region. The Coastal Management Program works closely with the RDCs to implement the policies of the Program. Many of the goals, objectives and policies of the Georgia Coastal Management Program can be achieved by

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The 45-day public comment period for the DEIS and the 30-day public comment period for the FEIS which are requirements of the NEPA process provide a formal avenue for the public to provide input on the proposed project. A public information meeting was also held during the 45-day comment period on the DEIS. The proposed project complies fully with the spirit of the Georgia Administrative Procedures Act.

7.3 Georgia Litter Control Law

The Georgia Litter Control Law (O.C.G.A. 16-7-40, et seq.) makes it unlawful for any person or persons, "...to dump, deposit, throw, or leave or to cause or permit the dumping, placing, throwing, or leaving of litter on any public or private property in this state or any waters in this state" unless the situation meets one of three conditions. Litter may be disposed at a site if (1) the property is designated as a litter disposal site, (2) litter is placed in a proper receptacle, and/or (3) litter is disposed of by permission of the property owner in a manner consistent with the public welfare.

Construction contracts would contain provisions which require the contractors to remove all construction debris from the project sites as part of their demobilization activities. The proposed SHEP complies with the intent of the Georgia Litter Control Law.

7.4 Georgia Uniform Conservation Easement Act

The Georgia Uniform Conservation Easement Act (O.C.G.A. 44-10-1, et seq.) defines "conservation easement" to mean a non-possessory interest in real property, with limitations or affirmative obligations, the purposes of which include retaining or protecting natural property; assuring its availability for agricultural, forest, recreational, or open space use; protecting natural resources; maintaining or enhancing air or water quality; or preserving the historical,

archeological, or cultural aspects of real property. A landholder may be a government agency or a charitable organization.

The proposed action would not include or adversely affect any "conservation easements" and therefore the proposed action is in compliance with this act.

8.0 STATE PROGRAMS

The following State programs contribute towards effective management of Georgia's coastal resources. As non-regulatory programs, they do not constitute enforceable policies of the Program and are not used in Federal consistency reviews. The District has included a discussion of these programs in this Consistency Determination because of the goals of these programs. In general, these programs would be expected to apply to work in Georgia.

8.1 Acres for Wildlife Program

The Acres for Wildlife Program is administered by the Non-game and Endangered Wildlife Program of the Georgia Department of Natural Resources to provide technical assistance to private landowners for resource and habitat management. The Program helps to identify wildlife habitat and provides advice to help the landowner manage the property for the welfare of the wildlife.

This program does not apply to the proposed SHEP.

8.2 Certified Burner Program

The Certified Burner Program is administered by the Georgia Forestry Commission to educate the citizens of Georgia about safe burning techniques. The Georgia General Assembly declared that prescribed burning is a resource protection and land management tool that benefits the safety of the public, Georgia's forest resources, the environment and the economy of the State (O.C.G.A. 12-6-146).

The proposed action does not include any prescribed burning.

8.3 Community Wildlife Project

The Community Wildlife Project is the only wildlife habitat certification program directed to the community as a whole. It is designed to encourage and improve management of wildlife habitats found in urban, suburban, and semi-rural areas. The program is administered by local garden clubs affiliated with the Garden Clubs of Georgia in concert with the Non-game and Endangered Wildlife Program of the Georgia Department of Natural Resources. The Community Wildlife Project establishes minimum criteria for community-based habitat management projects.

This policy does not apply to the proposed action.

8.4 Forest Stewardship Program

The Forest Stewardship Program is administered by the Georgia Forestry Commission in cooperation with the Non-game and Endangered Wildlife Division of the Department of Natural Resources. The Program is designed to provide technical assistance to private landowners for management of forest lands. A concomitant Stewardship Incentive Program provides State funding on a cost-sharing basis to implement certain aspects of the program.

This policy does not apply to the proposed action.

8.5 Heritage 2000

Heritage 2000 is a public-private partnership program designed by Governor Miller to acquire historic property and resources throughout Georgia. The initiative is modeled after Preservation 2000.

This policy does not apply to the proposed action.

8.6 Georgia's Non-game Wildlife Conservation and Habitat Fund

Georgia's Non-game Wildlife Conservation and Habitat Fund (O.C.G.A. 12-3-600, et seq.) provides the Department of Natural Resources a mechanism to establish non-game wildlife conservation and habitat acquisition, as well as education programs to enhance the protection of non-game flora and fauna. The Department of Natural Resources may solicit voluntary contributions through an income tax return contribution mechanism, by offers to match contributions, or by fund raising or other promotional techniques. Any funds collected are placed into a "Non-game Wildlife Conservation and Wildlife Habitat Acquisition Fund."

This policy does not apply to the proposed action.

8.7 Preservation 2000

Preservation 2000 is a three-year program implemented by Governor Miller in 1994 to acquire approximately 100,000 acres for the State of Georgia to preserve natural areas, historic sites, parks, wildlife management areas and similar sites. It is funded by a $65 million bond fund, approximately $1.45 million in gifts, and small amounts of Federal funds. Since its inception, over 84,000 acres have been acquired and approximately 33,000 acres are under negotiation during the summer of 1997. There were over 450 nominations of various parcels throughout the State. Currently, there are four natural areas and two wildlife management areas designated within the coastal area as a result of Preservation 2000. Some of the 33,000 acres under negotiation lies within the coastal area. The areas acquired provide such uses as protection for bald eagles and other endangered species, hunting, fishing, boating, nature observation, primitive camping, scientific study and protection of water quality for shellfish. A concomitant part of the Preservation 2000 program is the Georgia Greenways Council, a coalition of trail organizations and local, State and Federal agencies involved with trail development. The coalition promotes the protection of linear corridors and coordinates trail development throughout the State. A

proposed Coastal Water Trail, the aquatic equivalent of the Appalachian Trail, would run along Georgia's coast from the Savannah River to the St. Mary's River. This trail would provide routing for sea kayaks and other small craft, and include access trails, boat launching sites and camping areas.

This policy does not apply to the proposed action.

8.8 River Care 2000

River Care 2000 is a public-private partnership program designed by Governor Miller to acquire natural areas and historic property along Georgia's riverbanks. The initiative is modeled after Preservation 2000. River Care 2000 is intended to provide recreation and park land, and to allow better flood management.

This policy does not apply to the proposed action.

9.0 LOCAL LAND USE PLANS

The EIS has been coordinated with interested parties in Georgia and South Carolina. The proposed action is in compliance with all local land use plans.

10.0 CONCLUSION

In accordance with the CZMA, 16 U.S.C. SS 1456(c), as amended, it has been determined that the proposed deepening of the Federal navigation channel would be carried out in a manner which is fully consistent with the enforceable policies of the Georgia Coastal Management Plan. This determination applies to the preferred alternative (-47 foot MLW depth alternative) and the effects of the preferred alternative on the land or water uses or natural resources of the coastal zone, as directed by 15 C.F.R. SS 930.39.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX I: Federal Consistency Determination for the Georgia Coastal Management Program

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

ATTACHMENT A

NOAA Letter to GADNR-CRD

US Army Corps of Engineers
Savannah District
South Atlantic Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
Silver Spring, Maryland 20910

SEP 16 2005

Mr. Brad Gane
Assistant Director for Ecological Services
Coastal Resources Division
Georgia Department of Natural Resources
One Conservation Way
Brunswick, GA 31520

Dear Mr. Gane:

Thank you for your request dated August 15, 2005, to incorporate changes to the Georgia Coastal Management Program (GCMP). You requested that these program changes be incorporated as routine program changes (RPCs) pursuant to the Coastal Zone Management Act (CZMA) regulations at 15 C.F.R. part 923, subpart H and the Office of Ocean and Coastal Resource Management's (OCRM's) Program Change Guidance (July 1996).

After evaluating your submittal, we concur with your determination that the addition of GA. CODE ANN. §§ 52-9-1, and 52-9-2 (May 14, 2004) are RPCs and should be approved as an enforceable policy of the GCMP. The April 2004 Memorandum of Understanding (MOU) between the U.S. Army Corps of Engineers (Corps) and Georgia Department of Natural Resources (GADNR) is also incorporated as part of the GCMP, however, as described below, federal consistency will not apply to the MOU.

SECTIONS APPROVED

O.C.G.A. Title 52, Chapter 9, River and Harbor Development
Sections added: GA. CODE ANN. §§ 52-9-1, and 52-9-2 (May 14, 2004)

Memorandum of Understanding
"Memorandum of Understanding Between U.S. Army Corps of Engineers, Savannah District and the Georgia Department of Natural Resources" (April 2004)

As described in your August 15, 2005, request, the "limitation of applicable state and federal law" in GA. CODE ANN. § 52-9-2 (May 14, 2004) considers the availability of state, local and/or sponsor funding and federal cost-sharing requirements in regard to beneficial use of dredged materials. Therefore, when applying federal consistency to federal dredging activities, Georgia will consider the applicable beneficial use and federal cost-sharing requirements of the Water Resources Development Act (WRDA) and implementing regulations.

Federal consistency will not apply to the April 2004 MOU between the Corps and GADNR. As described in item No. 7 of the April 2004 MOU, the document is not legally binding or

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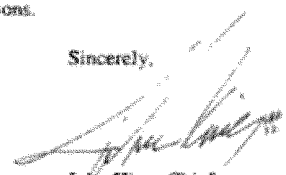
enforceable under state law. Therefore, although the April 2004 MOU is incorporated into the GCMP with this approval, federal consistency will not apply to the MOU because it does not contain enforceable policies as defined in 15 C.F.R. § 930.11(h).

Federal consistency shall apply to the approved changes to GA. CODE ANN. §§ 52-9-1, and 52-9-2 (May 14, 2004) only after you publish notice of this approval pursuant to 15 C.F.R. § 923.84(b)(4). Please include in the public notice the list of changes to enforceable policies provided in this letter and send a copy of the notice to OCRM.

Thank you for your cooperation in this review. Please contact Bill O'Beirne at (301)713-3155 extension 160, if you have any questions.

Sincerely,



John King, Chief
Coastal Programs Division

cc: James R. Thornton, Jr.
Acting District Counsel
Department of the Army
Savannah District, Corps of Engineers
100 W. Oglethorpe Ave.
Savannah, GA 31401-3640

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX I: Federal Consistency Determination for the Georgia Coastal Management Program

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

APPENDIX I-1

Grain Size Analysis for New Work Sediment and Maintenance Material in the Savannah Harbor Expansion Project

US Army Corps of Engineers
Savannah District
South Atlantic Division

Table 4-1 provides the results of the Grain Size Analysis for O&M sediments in the Federal navigation channel.

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger* (#200 Sieve Cutoff)	Percent Sand or Larger* (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T27-N	+27,000 North	94.0	94.0	0.0	521
T27-C	+27,000 Center	95.2	95.3	-0.1	574
T27-S	+27,000 South	46.3	48.8	-2.5	416
T26-N	+26,000 North	99.2	99.3	-0.1	363
T26-C	+26,000 Center	95.2	95.2	0.0	654
T26-S	+26,000 South	97.1	97.2	-0.1	337
T25	+25,000	93.2	93.3	-0.1	415
T25-N	+25,000 North	87.7	87.8	-0.1	525
T25-C	+25,000 Center	91.7	91.7	0.0	562
T25-S	+25,000 South	96.9	97.0	-0.1	373
T24-N	+24,000 North	92.4	92.5	-0.1	677
T24-C	+24,000 Center	92.7	92.7	0.0	537
T24-S	+24,000 South	98.2	98.3	-0.1	274
T23-N	+23,000 North	98.8	98.9	-0.1	505
T23-C	+23,000 Center	99.4	99.5	-0.1	579
T23-S	+23,000 South	98.1	98.2	-0.1	276
T22-N	+22,000 North	99.6	99.6	0.0	374
T22-C	+22,000 Center	99.9	99.9	0.0	436
T22-S	+22,000 South	78.6	79.0	-0.4	578
T21-N	+21,000 North	90.5	90.5	0.0	466
T21-C	+21,000 Center	97.7	97.7	0.0	484
T21-S	+21,000 South	97.0	97.1	-0.1	245
T20-N	+20,000 North	94.0	94.1	-0.1	656
T20-C	+20,000 Center	97.6	97.6	0.0	566
T20-S	+20,000 South	91.0	92.3	-1.3	147
T19-N	+19,000 North	97.8	97.7	-0.1	392
T19-C	+19,000 Center	98.7	98.7	0.0	548
T19-S	+19,000 South	97.1	97.3	-0.2	299
T18-N	+18,000 North	78.9	79.1	-0.2	652
T18-C	+18,000 Center	85.6	85.7	-0.1	608
T18-S	+18,000 South	96.2	96.3	-0.1	332
T17-N	+17,000 North	53.4	55.1	-1.7	462
T17-C	+17,000 Center	93.2	93.2	0.0	830
T17-S	+17,000 South	97.2	97.2	0.0	414
T16-N	+16,000 North	79.8	79.7	-0.1	865
T16-C	+16,000 Center	34.9	36.2	-1.3	461
T16-S	+16,000 South	96.1	96.1	0.0	461
T15	+15,000	89.2	89.3	-0.1	679
T15-N	+15,000 North	37.5	38.0	-0.5	897
T15-C	+15,000 Center	96.4	96.4	0.0	545
T15-S	+15,000 South	95.6	95.6	0.0	503
T14-N	+14,000 North	98.2	98.2	0.0	408
T14-C	+14,000 Center	97.8	97.9	-0.1	639

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T14-S	+14,000 South	98.8	98.8	0.0	668
T13-N	+13,000 North	87.1	87.3	-0.2	289
T13-C	+13,000 Center	98.9	99.0	-0.1	568
T13-S	+13,000 South	95.9	95.9	0.0	648
T12-N	+12,000 North	96.7	96.7	0.0	450
T12-C	+12,000 Center	83.5	83.9	-0.4	873
T12-S	+12,000 South	85.2	85.5	-0.3	513
T11-N	+11,000 North	66.1	66.4	-0.3	480
T11-C	+11,000 Center	86.4	86.8	-0.4	619
T11-S	+11,000 South	59.7	60.9	-1.2	605
T10-N	+10,000 North	95.8	95.8	0.0	580
T10-C	+10,000 Center	91.1	91.3	-0.2	775
T10-S	+10,000 South	82.4	82.6	-0.2	564
T9-N	+9,000 North	91.8	91.9	-0.1	460
T9-C	+9,000 Center	89.6	90.0	-0.4	591
T9-S	+9,000 South	66.3	66.3	0.0	794
T8-N	+8,000 North	98.1	98.1	0.0	472
T8-C	+8,000 Center	92.7	92.7	0.0	722
T8-S	+8,000 South	95.7	95.7	0.0	659
T7-N	+7,000 North	75.7	76.4	-0.7	486
T7-C	+7,000 Center	85.5	85.5	0.0	747
T7-S	+7,000 South	88.6	88.6	0.0	526
T6-N	+6,000 North	96.4	96.4	0.0	477
T6-C	+6,000 Center	95.0	95.0	0.0	548
T6-S	+6,000 South	92.4	92.5	-0.1	615
T05	+5,000	90.8	91.0	-0.2	535
T5-N	+5,000 North	76.4	77.0	-0.6	611
T5-C	+5,000 Center	77.6	77.7	-0.1	998
T5-S	+5,000 South	98.7	98.8	-0.1	248
T4.5-N	+4,500 North	70.7	71.1	-0.4	843
T4.5-C	+4,500 Center	95.1	95.1	0.0	572
T4-N	+4,000 North	88.5	89.7	-1.2	449
T4-C	+4,000 Center	88.3	88.7	-0.4	1064
T4-S	+4,000 South	93.7	94.1	-0.4	169
T3.5-N	+3,500 North	55.9	56.1	-0.2	1235
T3.5-C	+3,500 Center	85.9	86.1	-0.2	986
T3.5-S	+3,500 South	96.0	96.0	0.0	500
T3-N	+3,000 North	88.6	89.1	-0.5	704
T3-C	+3,000 Center	98.0	98.1	-0.1	552
T3-S	+3,000 South	55.7	56.2	-0.5	600
T2.5-N	+2,500 North	89.5	89.8	-0.3	585
T2.5-C	+2,500 Center	90.3	90.7	-0.4	546
T2.5-S	+2,500 South	88.8	89.5	-0.7	415

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T2-N	+2,000 North	98.7	98.7	0.0	707
T2-C	+2,000 Center	90.6	90.7	-0.1	626
T2-S	+2,000 South	80.9	81.2	-0.3	821
T1.5-N	+1,500 North	96.9	96.9	0.0	363
T1.5-C	+1,500 Center	90.4	90.5	-0.1	574
T1.5-S	+1,500 South	78.6	79.1	-0.5	674
T1-N	+1,000 North	97.3	97.4	-0.1	421
T1-C	+1,000 Center	94.6	94.7	-0.1	712
T1-S	+1,000 South	93.0	93.2	-0.2	453
T0.5-N	+500 North	99.0	99.0	0.0	323
T0.5-C	+500 Center	84.5	84.9	-0.3	639
T0.5-S	+500 South	81.3	81.7	-0.4	567
T0-N	0 North	95.6	95.7	-0.1	277
T0-C	0 Center	78.6	79.1	-0.3	824
T0-S	0 South	72.2	72.9	-0.7	514
T0.5B-N	-500 North	95.3	95.4	-0.1	531
T0.5B-C	-500 Center	80.8	80.9	-0.1	817
T0.5B-S	-500 South	88.7	89.4	-0.7	370
T1B-N	-1,000 North	98.4	98.4	0.0	432
T1B-C	-1,000 Center	86.3	86.3	0.0	824
T1B-S	-1,000 South	87.3	87.4	-0.1	998
T1.5B-N	-1,500 North	97.2	97.3	-0.1	513
T1.5B-C	-1,500 Center	98.5	98.5	0.0	766
T1.5B-S	-1,500 South	93.2	93.2	0.0	616
T2B-N	-2,000 North	84.9	85.4	-0.5	198
T2B-C	-2,000 Center	65.3	65.3	0.0	653
T2B-S	-2,000 South	97.2	97.2	0.0	801
T2.5B-N	-2,500 North	95.6	96.5	-0.9	162
T2.5B-C	-2,500 Center	97.3	97.4	-0.1	581
T2.5B-S	-2,500 South	98.9	99.0	-0.1	730
T3B-N	-3,000 North	91.6	92.5	-0.9	159
T3B-C	-3,000 Center	97.7	97.9	-0.2	393
T3B-S	-3,000 South	96.1	96.1	0.0	525
T3.5B-N	-3,500 North	97.0	97.9	-0.9	196
T3.5B-C	-3,500 Center	99.1	99.3	-0.2	434
T3.5B-S	-3,500 South	84.1	84.6	-0.5	663
T4B-N	-4,000 North	77.2	77.5	-0.3	350
T4B-C	-4,000 Center	95.3	95.4	-0.1	426
T4B-S	-4,000 South	93.7	94.1	-0.4	445
T4.5B-N	-4,500 North	89.5	90.6	-1.1	185
T4.5B-C	-4,500 Center	99.9	99.9	0.0	387
T4.5B-S	-4,500 South	95.0	95.1	-0.1	495
T5B	-5,000	84.1	85.8	-1.7	428

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T5B-N	-5,000 North	71.0	71.8	-0.8	283
T5B-C	-5,000 Center	97.9	98.0	-0.1	502
T5B-S	-5,000 South	93.1	93.4	-0.3	424
T5.5B-N	-5,500 North	80.4	82.0	-1.6	309
T5.5B-C	-5,500 Center	90.2	90.3	-0.1	600
T5.5B-S	-5,500 South	98.7	98.8	-0.1	580
T6B-N	-6,000 North	87.8	88.8	-1.0	409
T6B-C	-6,000 Center	99.0	99.3	-0.3	800
T6B-S	-6,000 South	95.2	95.4	-0.2	1281
T6.5B-N	-6,500 North	57.9	87.3	-29.4	269
T6.5B-C	-6,500 Center	84.7	85.8	-1.1	332
T6.5B-S	-6,500 South	79.9	79.9	0.0	919
T7B-N	-7,000 North	95.5	96.1	-0.6	421
T7B-C	-7,000 Center	93.9	94.0	-0.1	1319
T7B-S	-7,000 South	94.7	94.9	-0.2	953
T7.5B-N	-7,500 North	51.5	54.0	-2.5	222
T7.5B-C	-7,500 Center	93.8	93.8	-0.2	467
T7.5B-S	-7,500 South	92.5	93.2	-0.7	451
T8B-N	-8,000 North	24.5	26.7	-2.2	193
T8B-C	-8,000 Center	98.1	98.8	-0.7	293
T8B-S	-8,000 South	77.2	77.6	-0.4	665
T8.5B-N	-8,500 North	44.3	47.5	-3.2	281
T8.5B-C	-8,500 Center	76.4	80.4	-4.0	109
T8.5B-S	-8,500 South	81.9	84.6	-2.7	184
T9B-N	-9,000 North	40.7	43.7	-3.0	155
T9B-C	-9,000 Center	68.7	71.2	-2.5	101
T9B-S	-9,000 South	86.8	89.7	-2.9	150
T9.5B-N	-9,500 North	41.1	42.9	-1.8	226
T9.5B-C	-9,500 Center	91.7	94.2	-2.5	105
T9.5B-S	-9,500 South	73.5	76.8	-3.3	139
T10B-N	-10,000 North	42.9	46.0	-3.1	229
T10B-C	-10,000 Center	93.7	96.3	-2.6	128
T10B-S	-10,000 South	86.5	88.9	-2.4	221
T10.5B-N	-10,500 North	64.9	65.6	-0.7	533
T10.5B-C	-10,500 Center	74.9	77.0	-2.1	304
T10.5B-S	-10,500 South	78.1	81.0	-2.9	121
T11B-N	-11,000 North	71.8	72.1	-0.3	535
T11B-C	-11,000 Center	95.3	96.5	-1.2	293
T11B-S	-11,000 South	69.2	72.7	-3.5	159
T11.5B-N	-11,500 North	48.4	49.8	-1.4	368
T11.5B-C	-11,500 Center	89.6	89.9	-0.3	665
T11.5B-S	-11,500 South	80.0	83.9	-3.9	101
T12B-N	-12,000 North	42.8	44.7	-1.9	399

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T12B-C	-12,000 Center	98.8	98.9	-0.1	392
T12B-S	-12,000 South	67.0	70.4	-3.4	92
T12.5B-N	-12,500 North	79.9	81.6	-1.7	544
T12.5B-C	-12,500 Center	95.2	95.7	-0.5	753
T12.5B-S	-12,500 South	63.2	67.0	-3.8	95
T13B-N	-13,000 North	86.5	87.0	-0.5	716
T13B-C	-13,000 Center	96.4	96.5	-0.1	721
T13B-S	-13,000 South	54.2	57.5	-3.3	94
T13.5B-N	-13,500 North	90.1	90.7	-0.6	553
T13.5B-C	-13,500 Center	92.2	92.5	-0.3	706
T13.5B-S	-13,500 South	79.7	82.2	-2.5	153
T14B-N	-14,000 North	74.2	74.9	-0.7	593
T14B-C	-14,000 Center	80.0	80.6	-0.6	452
T14B-S	-14,000 South	68.3	71.0	-2.7	99
T15B	-15,000	77.9	80.6	-2.7	104
T15B-CL	-15,000	81.1	83.6	-2.5	253
T15B-N	-15,000 North	82.8	83.4	-0.6	720
T15B-C	-15,000 Center	80.0	80.1	-0.1	188
T15B-S	-15,000 South	71.7	74.9	-3.2	363
T16B-N	-16,000 North	82.0	82.6	-0.6	777
T16B-C	-16,000 Center	96.5	97.4	-0.9	676
T16B-S	-16,000 South	68.1	69.7	-1.6	117
T17B-N	-17,000 North	93.6	95.9	-2.3	439
T17B-C	-17,000 Center	84.1	84.3	-0.2	696
T18B-N	-18,000 North	95.2	95.2	0.0	1047
T18B-C	-18,000 Center	95.5	95.8	-0.3	916
T18B-S	-18,000 South	88.7	89.0	-0.3	671
T19B-N	-19,000 North	91.8	92.0	-0.2	966
T19B-C	-19,000 Center	99.4	99.4	0.0	1020
T19B-S	-19,000 South	54.9	56.5	-1.6	624
T20B-N	-20,000 North	95.8	95.9	-0.1	1008
T20B-C	-20,000 Center	97.6	97.6	0.0	1070
T20B-S	-20,000 South	71.3	73.7	-2.4	798
T21B-N	-21,000 North	96.7	97.4	-0.7	410
T21B-C	-21,000 Center	96.3	96.4	-0.1	1042
T21B-S	-21,000 South	98.6	98.6	0.0	728
T22B-N	-22,000 North	74.6	74.9	-0.3	638
T22B-C	-22,000 Center	98.4	98.5	-0.1	935
T22B-S	-22,000 South	90.8	90.9	-0.1	366
T23B-N	-23,000 North	95.2	95.5	-0.3	479
T23B-C	-23,000 Center	93.5	93.7	-0.2	612
T23B-S	-23,000 South	97.5	98.1	-0.6	162
T24B-N	-24,000 North	97.5	98.2	-0.7	450

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T24B-C	-24,000 Center	90.4	90.6	-0.2	865
T24B-S	-24,000 South	75.1	77.9	-2.8	121
T25B	-25,000	82.0	85.1	-3.1	136
T25B-N	-25,000 North	81.4	82.7	-1.3	263
T25B-C	-25,000 Center	98.2	98.5	-0.3	169
T25B-S	-25,000 South	72.5	75.6	-3.1	152
T26B-N	-26,000 North	97.1	97.8	-0.7	532
T26B-C	-26,000 Center	98.1	98.7	-0.6	178
T26B-S	-26,000 South	44.8	47.9	-3.1	127
T27B-N	-27,000 North	49.6	51.5	-1.9	255
T27B-C	-27,000 Center	97.6	98.5	-0.9	117
T27B-S	-27,000 South	36.1	40.5	-4.4	125
T28B-N	-28,000 North	97.4	97.5	-0.1	423
T28B-C	-28,000 Center	97.0	97.9	-0.9	135
T28B-S	-28,000 South	43.4	48.4	-5.0	108
T29B-N	-29,000 North	97.7	98.2	-0.5	162
T29B-C	-29,000 Center	94.9	95.9	-1.0	122
T29B-S	-29,000 South	34.8	39.2	-4.4	119
T30B-N	-30,000 North	95.0	95.1	-0.1	204
T30B-C	-30,000 Center	78.2	81.3	-3.1	120
T30B-S	-30,000 South	60.0	63.7	-3.7	100
T31B-N	-31,000 North	82.3	84.7	-2.4	141
T31B-C	-31,000 Center	95.6	96.6	-1.0	121
T31B-S	-31,000 South	55.8	60.9	-5.1	100
T32B-N	-32,000 North	90.5	90.8	-0.3	164
T32B-C	-32,000 Center	95.6	96.5	-0.9	132
T32B-S	-32,000 South	54.0	57.6	-3.6	94
T33B-N	-33,000 North	65.3	69.3	-4.0	101
T33B-C	-33,000 Center	94.5	96.0	-1.5	107
T33B-S	-33,000 South	56.9	60.5	-3.6	126
T34B-N	-34,000 North	75.7	80.3	-4.6	94
T34B-C	-34,000 Center	95.9	97.2	-1.3	130
T34B-S	-34,000 South	45.0	48.1	-3.1	237
T35B	-35,000	77.4	80.4	-3.0	112
T35B-N	-35,000 North	95.6	96.0	-0.4	145
T35B-C	-35,000 Center	48.7	50.9	-2.2	143
T35B-S	-35,000 South	77.3	80.2	-2.9	163
T36B-N	-36,000 North	79.7	84.1	-4.4	98
T36B-C	-36,000 Center	94.3	96.1	-1.8	104
T36B-S	-36,000 South	64.4	68.6	-4.2	207
T37B-N	-37,000 North	71.1	76.5	-5.4	90
T37B-C	-37,000 Center	90.7	92.6	-1.9	134
T37B-S	-37,000 South	70.2	74.5	-4.3	128

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger* (#200 Sieve Cutoff)	Percent Sand or Larger* (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T38B-N	-38,000 North	83.7	85.6	-1.9	153
T38B-C	-38,000 Center	95.5	97.4	-1.9	199
T38B-S	-38,000 South	77.8	81.8	-4.0	142
T39B-N	-39,000 North	82.0	87.3	-5.3	177
T39B-C	-39,000 Center	93.1	94.9	-1.8	406
T39B-S	-39,000 South	76.7	81.1	-4.4	116
T40B-N	-40,000 North	78.7	83.0	-4.3	99
T40B-C	-40,000 Center	69.0	69.1	-0.1	1019
T40B-S	-40,000 South	80.6	84.4	-3.8	147
T41B-N	-41,000 North	89.1	91.3	-2.2	165
T41B-C	-41,000 Center	90.5	91.5	-1.0	621
T41B-S	-41,000 South	79.5	83.3	-3.8	116
T42B-N	-42,000 North	51.5	54.8	-3.3	116
T42B-C	-42,000 Center	98.0	99.1	-1.1	141
T42B-S	-42,000 South	77.1	81.2	-4.1	87
T43B-N	-43,000 North	69.2	74.0	-4.8	103
T43B-C	-43,000 Center	96.3	97.6	-1.3	145
T43B-S	-43,000 South	82.4	85.3	-2.9	103
T44B-N	-44,000 North	86.4	88.2	-1.8	112
T44B-C	-44,000 Center	97.3	98.3	-1.0	243
T44B-S	-44,000 South	57.7	60.9	-3.2	106
T45B	-45,000	72.4	75.3	-2.9	146
T45B-N	-45,000 North	90.7	92.0	-1.3	163
T45B-C	-45,000 Center	99.5	99.5	0.0	1406
T45B-S	-45,000 South	23.5	25.2	-1.7	127
T46B-N	-46,000 North	70.2	74.1	-3.9	104
T46B-C	-46,000 Center	95.8	96.3	-0.5	280
T46B-S	-46,000 South	75.1	78.2	-3.1	105
T47B-N	-47,000 North	75.5	78.5	-3.0	116
T47B-C	-47,000 Center	95.6	96.9	-1.3	383
T47B-S	-47,000 South	67.6	70.6	-3.0	111
T48B-N	-48,000 North	71.3	76.1	-4.8	104
T48B-C	-48,000 Center	85.9	86.4	-0.5	636
T48B-S	-48,000 South	80.8	82.8	-2.0	138
T49B-N	-49,000 North	96.0	96.6	-0.6	153
T49B-C	-49,000 Center	77.3	77.4	-0.1	921
T49B-S	-49,000 South	92.3	94.6	-2.3	188
T50B-N	-50,000 North	93.9	94.9	-1.0	142
T50B-C	-50,000 Center	87.0	87.0	0.0	1088
T50B-S	-50,000 South	82.7	85.0	-2.3	173
T51B-N	-51,000 North	77.2	79.0	-1.8	320
T51B-C	-51,000 Center	90.8	91.1	-0.3	409
T51B-S	-51,000 South	83.6	85.6	-2.0	360

TABLE 4-1 Results of Grain Size Analysis

Sample ID	Location	Percent Sand or Larger[a] (#200 Sieve Cutoff)	Percent Sand or Larger[a] (#230 Sieve Cutoff)	Difference in Percent Sand with #200 and #230 Sieves	Average Grain Size of Sand Fraction (um)
T52B-N	-52,000 North	86.9	89.3	-2.4	114
T52B-C	-52,000 Center	79.4	79.4	0.0	1510
T52B-S	-52,000 South	81.0	81.5	-0.5	1012
T53B-N	-53,000 North	94.6	95.8	-1.2	158
T53B-C	-53,000 Center	92.4	92.4	0.0	1293
T53B-S	-53,000 South	95.8	96.1	-0.3	342
T54B-N	-54,000 North	95.3	95.6	-0.3	187
T54B-C	-54,000 Center	92.9	93.3	-0.4	377
T54B-S	-54,000 South	97.4	97.5	-0.1	690
T55B	-55,000	99.2	99.3	-0.1	389
T55B-N	-55,000 North	96.0	96.4	-0.4	194
T55B-C	-55,000 Center	86.1	86.1	0.0	1317
T55B-S	-55,000 South	98.3	98.6	-0.3	275
T56B-N	-56,000 North	96.0	96.1	-0.1	249
T56B-C	-56,000 Center	98.2	98.2	0.0	627
T56B-S	-56,000 South	97.2	97.4	-0.2	253
T57B-N	-57,000 North	97.7	97.8	-0.1	213
T57B-C	-57,000 Center	85.5	85.5	0.0	1209
T57B-S	-57,000 South	95.4	95.6	-0.2	261
T58B-N	-58,000 North	97.7	97.7	0.0	325
T58B-C	-58,000 Center	96.2	96.2	0.0	819
T58B-S	-58,000 South	95.8	95.9	-0.1	337
T59B-N	-59,000 North	91.1	91.1	0.0	342
T59B-C	-59,000 Center	94.4	94.4	0.0	322
T59B-S	-59,000 South	97.5	97.6	-0.1	240
T60B-N	-60,000 North	97.1	97.2	-0.1	328
T60B-C	-60,000 Center	97.0	97.1	-0.1	261
T60B-S	-60,000 South	97.3	97.4	-0.1	194

a) Includes shell hash/gravel/cobble fraction

Tables 2 and 3 (taken from the DMMP) show the O&M Sediment characterization by reach for the Inner Harbor by reach.

Table 2: Sediment Characterization by Station

Station	Channel	% Sand	% Fines
5+250	Inner	94.4	5.6
15+000	Inner	88.2	11.8
25+000	Inner	93.7	6.3
35+000	Inner	12.1	87.9
36+000	Inner	0.0	100.0
44+000	Inner	32.2	67.8
55+750	Inner	27.2	72.5
56+000	Inner	10.6	89.4
61+500	Inner	13.4	86.6
64+000	Inner	2.7	97.3
67+250	Inner	78.4	21.6
75+000	Inner	5.7	94.3
90+000	Inner	9.6	90.2
99+000	Inner	14.4	85.6
2+750	Sed Basin	17.5	82.5
5+250	Sed Basin	0.0	100.0
8+000	Sed Basin	0.0	100.0
10+500	Sed Basin	17.6	82.4

Table 3: Sediment Characterization by Reach

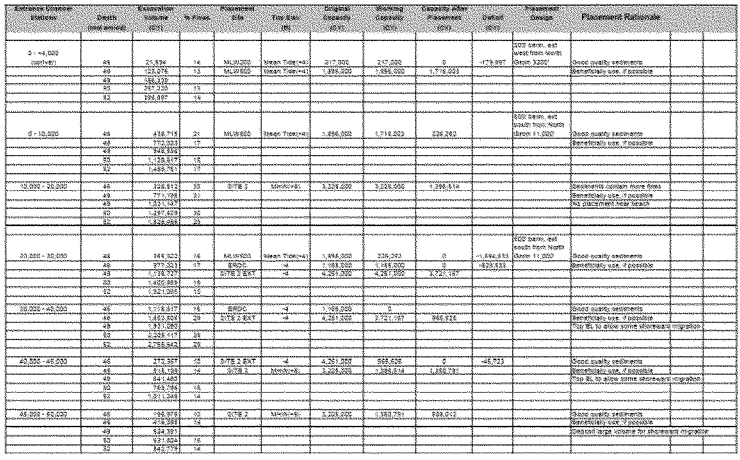
STATIONS	SAND (CY)	SAND (%)	FINES (CY)	FINES (%)	TOTAL (CY)
112+5000 to 105+000	83,600	80	20,900	20	104,500
105+000 to 79+000	896,850	68	422,050	32	1,318,900
79+000 to 63+000	87,500	10	787,100	90	874,600
63+000 to 40+000	247,850	20	991,400	80	1,239,250
40+000 to 0+000	584,900	60	389,900	40	974,800
Sediment Basin	321,850	10	2,896,650	90	3,218,500
TOTAL	**2,222,500**		**5,508,100**		**7,730,600**

Table 6 (taken from the updated DMMP) contains a breakdown of the amount of new work dredged sediment by reach and characteristics of that sediment in the Inner Harbor. The volume to be dredged is based on a 48-foot deepening with 100% for overdepth (that portion of the dredging template below the authorized depth, usually two feet in Savannah Harbor).

Table 6: New Work Material by Reach

Station	% Sand	Volume CY	% Fines	Volume CY
0+000				
	87	2,199,947	13	328,728
24+000				
	36	882,538	64	1,568,956
40+000				
	69	1,486,522	32	699,540
50+000				
	68	2,906,215	32	1,367,630
70+000				
	70	706,426	30	302,754
79+000				
	54	2,229038	46	1,898,810
103+000				

The following tables show the percent fines of new work material found in the Entrance Channel that were originally proposed for placement in the nearshore areas.



Entrance Channel Stations	Depth (mid annual)	Excavation Volume (CY)	% Fines	Placement Site	Top Elev (ft)	Original Capacity (CY)	Working Capacity (CY)	Capacity After Placement (CY)	Deficit (CY)	Placement Design	Placement Rationale
0 - +4,000 (spillway)	46	21,594	14	MLW800	Mean Tide(+4)	217,000	217,000	0	-178,997	300 berm, ext west from North Groin 3200'	Good quality sediments
	48	123,276	13	MLW800	Mean Tide(+4)	1,896,000	1,896,000	1,716,003			Beneficially use, if possible
	49	188,339									
	50	287,326	13								
	52	394,997	14								
0 - 10,000	46	438,718	21	MLW800	Mean Tide(+4)	1,896,000	1,716,000	228,282		600 berm, ext south from North Groin 11,000'	Good quality sediments
	48	772,033	17								Beneficially use, if possible
	49	946,634									
	50	1,128,617	16								
	52	1,485,741	17								
10,000 - 20,000	46	328,812	33	SITE 2	MWH(+8)	3,225,000	3,225,000	1,296,514			Sediments contain more fines
	48	771,198	31								Beneficially use, if possible
	49	1,031,147									No placement near beach
	50	1,257,629	30								
	52	1,528,486	29								
20,000 - 30,000	46	368,322	19	MLW800	Mean Tide(+4)	1,896,000	226,262	0	-1,694,833	300 berm, ext south from North Groin 11,000'	Good quality sediments
	48	577,023	17	BRDC	-4	1,165,000	1,165,000	0	-829,933		Beneficially use, if possible
	49	1,128,727		SITE 2 EXT	-4	4,261,000	4,261,000	3,721,167			
	50	1,400,389	16								
	52	1,921,286	15								
30,000 - 40,000	46	1,519,617	16	BRDC	-4	1,165,000	0				Good quality sediments
	48	1,663,106	29	SITE 2 EXT	-4	4,261,000	3,721,167	966,626			Beneficially use, if possible
	49	1,931,280									Top SL to allow some shoreward migration
	50	2,209,117	28								
	52	2,758,443	28								
40,000 - 45,000	46	272,387	13	SITE 2 EXT	-4	4,261,000	966,626	0	-46,723		Good quality sediments
	48	518,139	14	SITE 2	MWH(+8)	3,225,000	1,356,514	1,350,791			Beneficially use, if possible
	49	641,480									Top SL to allow some shoreward migration
	50	765,799	16								
	52	1,011,248	14								
45,000 - 50,000	46	194,979	10	SITE 2	MWH(+8)	3,225,000	1,350,791	826,012			Good quality sediments
	48	416,393	14								Beneficially use, if possible
	49	524,391									Deposit large volume for shoreward migration
	50	631,924	15								
	52	842,779	13								
50,000 - 55,000	46	66,224	11	SITE 2	MWH(+8)	3,225,000	826,012	2,487			Good quality sediments
	48	226,653	11								Beneficially use, if possible
	49	283,667									Deposit large volume for shoreward migration
	50	357,713	10								
	52	508,518	12								

Entrance Channel Stations	Depth (incl allowd)	Excavation Volume (CY)	% Fines	Placement Site	Top Elev (ft)	Original Capacity (CY)	Working Capacity (CY)	Capacity After Placement (CY)	Deficit (CY)	Placement Design	Placement Rationale
53,500 - 57,000	46	58,668	11	ODMDS	-26	99,837,000	99,837,000	99,414,819			Good quality sediments
	48	241,899	11								Beneficially use, if possible
	49	317,433									Large volume of sediments
	50	392,491	10								Located adjacent to ODMDS
	52	540,283	10								
57,000 - 61,000	46	100,626	N/A	SITE 11	-10	2,075,000	2,075,000	1,460,678			Good quality sediments
	48	274,078	N/A								Beneficially use, if possible
	49	360,747									Submerged berm for fish habitat
	50	446,827	2								
	52	619,424	6								
61,000 - 64,500	46	2,301	N/A	SITE 11	-10	2,075,000	1,460,678	1,266,301			Good quality sediments
	48	18,991	N/A								Beneficially use, if possible
	49	36,434									Submerged berm for fish habitat
	50	70,348	9								
	52	225,379	7								
64,500 - 68,000	46	3	N/A	SITE 11	-10	2,075,000	1,266,301	1,027,812			Good quality sediments
	48	4,449	N/A								Beneficially use, if possible
	49	31,439									Submerged berm for fish habitat
	50	87,597	9								
	52	227,769	7								
68,000 - 72,000	46	0	N/A	SITE 11	-10	2,075,000	1,027,812	791,660			Good quality sediments
	48	17,093	N/A								Beneficially use, if possible
	49	74,227									Submerged berm for fish habitat
	50	187,220	2								
	52	328,982	6								
72,000 - 75,500	46	0	N/A	SITE 11	-10	2,075,000	791,660	419,294			Good quality sediments
	48	17,793	6								Beneficially use, if possible
	49	69,128									Submerged berm for fish habitat
	50	134,677	4								
	52	282,982	3								
75,500 - 79,000	46	0	N/A	SITE 11	-10	2,075,000	419,294	197,939			Good quality sediments
	48	841	5								Beneficially use, if possible
	49	15,382									Submerged berm for fish habitat
	50	74,233	4								
	52	221,355	3								
79,000 - 82,500	46	0	N/A	SITE 11	-10	2,075,000	197,939	9,908			Good quality sediments
	48	1,444	N/A								Beneficially use, if possible
	49	20,636									Submerged berm for fish habitat
	50	62,514	2								
	52	208,031	3								
82,500 - 86,000	46	0	N/A	SITE 11	-10	2,075,000	9,908	-11,436			Good quality sediments
	48	0	N/A								Beneficially use, if possible
	49	0									Submerged berm for fish habitat
	50	0	3								
	52	11,344	3								

Entrance Channel Stations	Depth (incl allowd)	Excavation Volume (CY)	% Fines	Placement Site	Top Elev (ft)	Original Capacity (CY)	Working Capacity (CY)	Capacity After Placement (CY)	Deficit (CY)	Placement Design	Placement Rationale
0 - +6,000 (upriver)	52	396,997	14	MLW200	Mean Tide(+4)	217,000	217,000	0	<179,997	200' Berm, Ext west from North Groin 3200'	Good quality sediments
				MLW500	Mean Tide(+4)	1,896,000	1,896,000	1,716,003			Beneficially use, if possible

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX J: Federal Consistency Determination for the South Carolina Coastal Zone Management Program

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps
of Engineers
Savannah District
South Atlantic Division

Federal Consistency Determination for the South Carolina Coastal Zone Management Program

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Federal Consistency Determination
South Carolina Coastal Zone Management Program

1.0 SUMMARY DETERMINATION

The Federal Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 et seq., as amended, requires each Federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved state management programs. A direct Federal activity is defined as any function, including the planning and/or construction of facilities that is performed by or on behalf of a Federal agency in the exercise of its statutory responsibilities. A Federal development project is a Federal activity involving the planning, construction, modification or removal of public works, facilities or other structures, and the acquisition, use or disposal of land or water resources.

To implement the CZMA and to establish procedures for compliance with its Federal consistency provisions, the US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), has promulgated regulations which are contained in 15 C.F.R. Part 930. This Consistency Determination is being submitted in compliance with Part 930.30 through 930.44 of those regulations.

NOAA approved South Carolina's Coastal Management Plan (SCCMP) in 1977. Since the proposed action would affect estuarine waters and adjacent wetlands, the proposed action must be evaluated to determine its consistency with the State's CMP. This evaluation will be included in the Environmental Impact Statement (EIS) that is prepared for this proposal. This Consistency Determination will be submitted to the Office of Ocean and Coastal Resource Management of the South Carolina Department of Health and Environmental Control for review and approval.

The information contained within this Consistency Determination is derived primarily from the EIS prepared for the proposed action. References to that document are included in some of the discussions on the Project's compliance with certain individual state policies. Should further information concerning the proposed project be desired, please refer to the EIS, of which this Determination is a component.

In accordance with the CZMA, the US Army Corps of Engineers, Savannah District, has determined that the proposed deepening of the Federal navigation channel would be carried out in a manner that is fully consistent with the enforceable policies of the South Carolina Coastal Management Program. The evaluations supporting this determination are presented in Sections 6.00 and 11.00 of this document. In addition, this determination is supported by information and analysis in the EIS, which is incorporated by reference to

the extent relevant to South Carolina coastal zone consistency issues.

The proposed deepening would not adversely impact any beaches or dunes in South Carolina. Activities that would affect the coastal zone of South Carolina include deepening of the inner harbor and deepening and extending the entrance channel. Sediments that would be removed from the inner harbor channel would be placed into existing upland confined disposal facilities (CDFs) along Savannah Harbor including 12A, 12B, 13A, 13B, 14A, 14B and Jones/Oysterbed Island which are located in Jasper County, South Carolina. Sediments from the entrance channel would be placed in the Offshore Dredged Material Disposal Site (ODMDS) or one of the existing CDFs. Other activities associated with the proposed channel deepening project that would affect the coastal zone of the State of South Carolina include implementation of some of the mitigation features of the project which would include dredging in Little Back River to increase freshwater flows in that stream, construction of a flow diversion structure in McCoys Cut, a closure structure in the lower end of McCoys Cut, construction of a submerged berm in Back River across the mouth of the Sediment Basin, and removal of the Tidegate abutment in Back River on the South Carolina side of the river. Some of the concrete removed from the Tidegate would be placed along the bank of Back River and other appropriate locations to provide fish habitat.

The CDFs will continue to be used for the placement of maintenance sediments from the improved channel. The footprint of the existing diked CDFs will not be expanded as a result of the proposed action. Dike raising is performed from the inside of the CDF to prevent further encroachment into adjacent wetlands.

This Determination has been updated since the November 2010 Draft EIS which SC DHEC reviewed concerning the project's consistency with the State's Coastal Management Programs. The update is primary the result of new information that was developed or became available since the Draft EIS. Substantive information that Savannah District provided to SC DHEC since the Draft EIS can be found in Appendix N, Agency Coordination.

2.0 BACKGROUND

2.1 Purpose

This Consistency Determination addresses the consistency of the proposed deepening of the Savannah Harbor Navigation Project with the South Carolina Coastal Management Programs (CMP) as required by the Federal Coastal Zone Management Act (CZMA). Savannah Harbor was last deepened in 1993/1994. Since that time, container vessels have grown in size. In excess of 70% of the vessels do not call on Savannah Harbor at their maximum capacity or design draft. The "light loading" of vessels increase costs to the shipper, which are eventually passed onto the consumer. Smaller, less efficient vessels generally result in higher shipping costs. This situation is expected to worsen as the larger, Post-Panamax vessels replace the older, smaller vessels in the

near future. Studies indicate that harbor deepening is the only viable alternative to solve these problems. The proposed deepening of the Federal Navigation Project will not increase ship traffic volume calling at the port but would allow vessels to be loaded to their maximum capacity or design draft.

The SHEP EIS and GRR were prepared as directed by the authorization for the project which was provided in the Water Resources Development Act of 1999 (Public Law 106-53, Section 102 (b)(9)). The project was authorized to include (1) an analysis of the impacts of project depth alternatives ranging from 42 feet through 48 feet, and (2) a selected plan for navigation and an associated mitigation plan as required under Section 906 (a) of the Water Resources Development Act of 1986 (33 U.S.C. 2283 (a)).

2.2 Authority

The Federal Coastal Zone Management Act (CZMA), 16 U.S.C. § 1451 et seq., as amended, is the legislative authority regarding the consistency of Federal actions with state coastal policies. Section 1456(c)(1)(A) of the CZMA states: "Each Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall he carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved state management programs." A Federal activity is defined as any function, including the planning and/or construction of facilities that is performed on behalf of a Federal agency in the exercise of its statutory responsibilities.

To implement the CZMA and to establish procedures for compliance with its federal consistency provisions, the US Department of Commerce, National Oceanographic and Atmospheric Administration, has promulgated regulations, 15 C.F.R. Part 930. This Consistency Determination was prepared in compliance with § 930.30 through 930.44 of those regulations.

3.0 PROJECT DESCRIPTION

3.1 Identification of Alternatives

The Savannah Harbor Expansion Project involves various investigations relating to the feasibility and need to deepen the Savannah Harbor Navigation Project. The six detailed alternative plans evaluated include the No Action Alternative (maintaining the existing inner harbor depth of -42 feet MLW between Stations 000+000 and 103+000) as well as deepening the inner harbor channel to -44, -45, -46, -47 or -48 feet MLW. All five of the alternative plans that would provide for deepening of the existing -42 foot channel would include deepening and expanding the existing Kings Island Turning Basin, deepening of eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), construction of two meeting areas, construction of two bend wideners along the inner harbor, deepening the existing entrance channel, extending the entrance channel from its end at Station -60+000B, and construction of a bend widener in the entrance channel (Station -14+000B to -23+000B).

All of the proposed deepening alternatives are designed to maintain the existing side slopes of the channel. Although maintaining the existing side slopes would result in a narrower channel, this design would reduce the environmental impacts associated with deepening the harbor by confining the dredging impacts to the existing channel... Consequently, the adjacent marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, sedimentation and shoaling within the new deeper channel would be minimized. The navigation channel side slopes will be 5H:1V in the entrance channel area (Stations 0+000 to -98+600B) and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V means for every 5 and 3 feet of horizontal distance there would be a change of 1 foot of vertical distance. Although maintaining the existing side slopes of the channel would greatly reduce the adverse environmental impacts of the project, some channel widening would be necessary in those areas where the construction of meeting areas and bend wideners are required.

For all dredging alternatives, dredging depths will include 2 feet of allowable over depth and advanced maintenance (See Table 1 below). The practice of allowing 2 feet of over depth during dredging accounts for the inaccuracies of the dredging process. The practice of advance maintenance dredging (used in heavy shoaling areas) allows the project to remain at the authorized project depth between maintenance dredging cycles.

The environmental impacts and effects of the No Action Alternative and the five deepening plans are found in Chapters 4 and 5 of the EIS, respectively and in Tables 5 and 6 below. The following is a brief summary of the alternatives that have been evaluated in the EIS:

3.2 Alternatives

Six harbor deepening plans (i.e., No Action Alternative or the Without Project Condition, which is the existing project depth of -42 feet MLW, -44 feet MLW, -45 feet MLW, -46 feet MLW, -47 feet MLW, and -48 feet MLW) were considered in detail for Savannah Harbor. Please see Figure 1 below for a review of the project vicinity. All of the harbor deepening alternatives would include the existing Kings Island Turning Basin, the eight berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9), two proposed meeting areas (see Table 2), two proposed bend wideners (see Table 3). However, the length of the bar channel extension varies with the proposed depth alternative (Table 4).

All of the proposed deepening alternatives would produce a narrower channel at the project depth than currently exists by maintaining the existing side slopes. By slightly decreasing the channel width (by maintaining the existing side slopes at different depths), the adjacent marine and estuarine habitat (substrate and tidal marsh) would not be adversely impacted. Moreover, by not disturbing the existing channel side slopes, the effects on sedimentation and shoaling within the new deeper channel would be minimized.

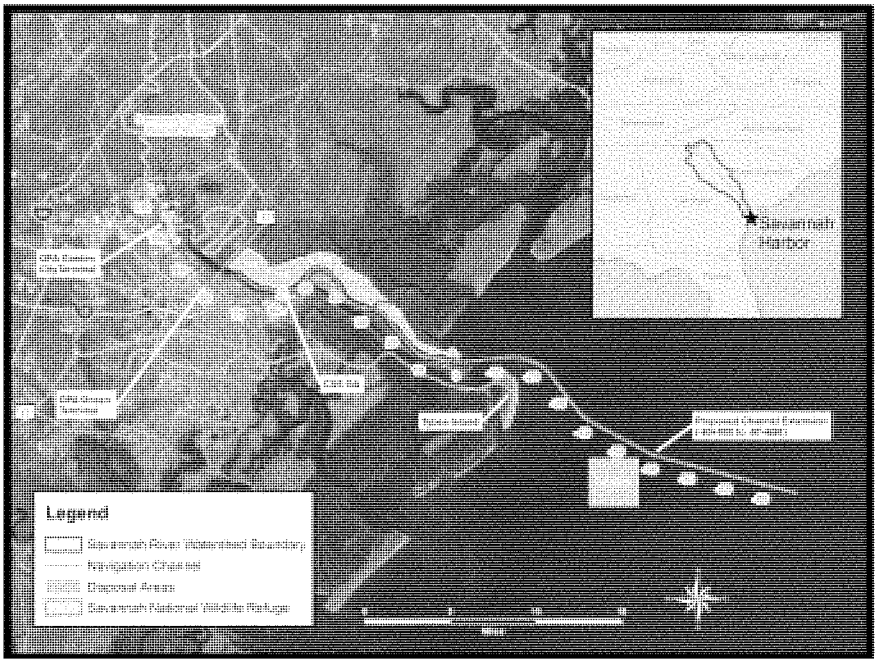

Figure 1. Current Savannah Harbor navigation project.

The navigation channel side slopes will be 5H:1V in the ocean bar area (Stations 0+000 to -98+600B) and 3H:1V in the rest of the harbor. 5H:1V and 3H:1V means for every 5 and 3 feet of horizontal distance there would be a change of 1 foot of vertical distance.

For all dredging alternatives, dredging depths will include 2 feet of allowable overdepth and advanced maintenance. The allowable overdepths and advance maintenance allow for dredging inaccuracies and help the project remain at project depth between maintenance events).

3.3 Alternative A: No Action Alternative (-42 feet depth MLW) or Without Project Condition

Savannah Harbor is an approximately 32 mile Federal navigation project located along the Savannah River in southeastern Georgia. The current Savannah Harbor Navigation Project (Figure 1) has an authorized project depth of 30 feet Mean Low Water (MLW) in the inner harbor (Stations112+000 to 105+000), 36 feet MLW (Stations 105+000 to 103+000), 42 feet MLW (Stations 103+000 to 0+000), 42 feet MLW in the entrance channel (Stations 0+000 to –14+000B), and 44 feet MLW in the remainder of the entrance channel (Stations –14+000B to –60+000B). The current channel width is 600 feet across the ocean bar to the entrance channel (Stations -14+000B to -60+000B), 500

feet from the entrance channel to Kings Island Turning Basin (Stations -14+000B to 103+000, with the exception of 400 feet wide from stations 58+000 to 59+000), 400 feet from the Kings Island Turning Basin to the Argyle Island Turning Basin, and 200 feet from the Argyle Turning Basin to the upstream limit of the authorized project.

Annual maintenance dredging requires the removal of about 6 million cubic yards of material from the inner harbor and about 1 million cubic yards of material from the entrance channel. Material removed from the inner harbor is placed in Confined Disposal Facilities (CDFs) located along Savannah Harbor. Material removed from the entrance channel is placed in the Savannah Harbor Offshore Dredged Material Disposal Site (ODMDS) or in submerged berms just south of the entrance channel. Use of these sediments to construct submerged berms in the nearshore area makes that material available to be moved by wave action towards the Tybee Island Beach.

3.4 Alternative B: -44-FOOT ALTERNATIVE MLW (2 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.3, above) to -44 feet (2 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, below), and two bend wideners (see Table 3, below). Improvements in the entrance channel would involve deepening of the existing channel to -46 feet MLW from Stations -14+000B to -60+000B. The depth of -46 feet MLW would extend an additional 35,680 feet for the ocean bar channel extension (from Stations -60+000B to -95+680B). A bend widener would be constructed between Station -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 10.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.5 Alternative C: -45-FOOT ALTERNATIVE MLW(3 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.3, above) to -45 feet MLW (3 feet deeper) from the mouth of the harbor (Station 0+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2), and two bend wideners (see Table 3). Improvements in the entrance channel would involve deepening of the existing channel to -47 feet MLW from Stations -14+000B to -60+000B and to -45 feet MLW from Stations -14+000B to Station 0+000. The depth of -47 feet MLW would extend an additional 36,880 feet for the ocean bar channel extension (from Stations -60+000B to -96+800B) (Table 4). A bend widener would be constructed between Station -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 14.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

Table 1. Present Advance Maintenance Sections

Begin Station	End Station	Authorized Advanced Maintenance (feet)	Required Contract Depth (feet MLLW)
Inner Harbor			
112+500	105+500	2.0	32.0
105+500	103+000	2.0	38.0
103+000	102+000	0.0	42.0
102+000	100+000	2.0	44.0
100+000	79+600	2.0	44.0
79+600	70+000	2.0	44.0
70+000	50+000	4.0	46.0
50+000	37+000	4.0	46.0
37+000	35+000	6.0	48.0
35+000	24+000	4.0	46.0
24+000	0+000	2.0	44.0
Port Wentworth TB		0.0	30.0
Argyle Island TB		0.0	30.0
Kings Island TB		8.0	50.0
Marsh Island TB		0	34.0
Fig Island TB		4.0	38.0
Entrance Channel			
0+000	-14+000(B)	2	44.0
-14+000(B)	-60+000(B)	0	44.0

No advance maintenance is presently performed between Stations 58+000 and 59+000 to reduce potential impacts to the CSS GEORGIA, which is located along that reach.

Table 2. Proposed Two New Meeting Areas (see Figure 3-1)

Location	Description
GA waters: Station 14+000 to 22+000	The existing 400 foot wide channel would be widened 100 feet on the south to provide an average width of 500 feet. Side slopes would be 3H:1V.
GA and SC waters: Station 55+000 to 59+000	The existing 400 foot wide channel would be widened 100 feet to the north to provide an average width of 500 feet. Side slopes would be 3H:1V.

Table 3. Proposed New Channel Bend Wideners (see Figure 1-1)

Widener N	Location	Description
1	SC waters: Stations -23+000 to -14+000	76-foot bottom width plus side slope of ~20 feet. North side of channel.
2	GA waters: Stations 27+500 to 31+500	156-foot bottom width plus slide slope of less than 100 feet. North side of channel
3	SC waters: Stations 52+250 to 55+000	76-foot width plus slope of less than 100 feet. North side of channel.

Table 4. Length of Bar Channel Extension Required for Depth Alternatives

Length of Bar Channel Extension Required for Depth Alternatives		
Depth (Feet)	**Bar Channel Extension (Stations)**	**Length of Extension (Feet)**
44	-60+000B to -95+680B	35,680
45	-60+000B to -96+880B	36,880
46	-60+000B to -97+510B	37,510
47	-60+000B to -97+680B	37,680
48	-60+000B to -98+600B	38,600

3.6 Alternative D: -46-FOOT ALTERNATIVE MLW (4 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.3 above) to -46 feet MLW (4 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table2, above), three bend wideners (see Table 3, above). Improvements in the entrance channel would involve deepening of the existing channel to -48 feet MLW from Stations-14+000B to -60+000B and -46 feet MLW from Station -14+000B to 0+000. The depth of -48 feet MLW would extend an additional 37,510 feet for the ocean bar channel extension (from Stations -60+000B to -97+510B) (Table 4). A bend widener would be constructed between Station -14+000B and -23+000B. The total volume of excavated

sediment associated with this project is about 19.0 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.7 Alternative E: -47-FOOT ALTERNATIVE MLW (5 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.3, above) to -47 feet MLW (5 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, above), three bend wideners (see Table 3, above). Improvements in the entrance channel would involve deepening of the existing channel to -49 feet MLW from Stations 0+000B to -60+000B and -47 feet MLW between Stations -14+000B and 0+000. The depth of -49 feet MLW would extend an additional 37,680 feet for the ocean bar channel extension (from Stations -60+000B to -97+680B) (Table 4). A bend widener would be constructed between Station -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 23.6 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.8 Alternative F: -48-FOOT ALTERNATIVE MLW (6 FEET DEEPER). This plan would involve dredging the inner harbor (described in Section 3.3, above) to -48 feet MLW (6 feet deeper) from the mouth of the harbor (Station 000+000) to the end of the project Station 103+000. Dredging improvements in the inner harbor would also include deepening and expanding the Kings Island Turning Basin and deepening of the eight container vessel berths at Garden City Terminal (Berths 2, 3, 4, 5, 6, 7, 8, and 9). Inner harbor channel deepening would also require the construction of two meeting areas (see Table 2, above), three bend wideners (see Table 3 above). Improvements in the entrance channel would involve deepening of the existing channel to -50 feet MLW from Stations 000+000B to -60+000B and -48 feet MLW from Station -14+000B to 0+000. The depth of -50 feet MLW would extend an additional 38,600 feet for the ocean bar channel extension (from Stations -60+000B to -98+600B) (Table-4). A bend widener would be constructed between Station -14+000B and -23+000B. The total volume of excavated sediment associated with this project is about 28.3 million cubic yards. Estimated annual volume for maintenance dredging would be approximately 7.2 million cubic yards.

3.9 SELECTED PLAN

The District developed and evaluated five channel deepening alternatives, in addition to the No Action Alternative. Each channel deepening alternative contains mitigation features to address adverse environmental impacts that they would otherwise produce. With inclusion of the mitigation features, each depth alternative is environmentally acceptable. The 47-foot depth alternative is the National Economic Development (NED) Plan, the plan that maximizes net economic benefits to the Nation (See GRR). Under current Federal planning policy, the NED plan would be recommended for implementation unless there are overriding considerations that favor recommendation of another plan. Benefits that would accrue from the deepening of Savannah Harbor include

reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The economic benefits increase with each additional increment of channel deepening. Environmental impacts associated with a shallower depth would be less than those associated with the NED plan, but the lesser impacts of the 44-foot depth, 45-foot depth, and 46-foot depth alternatives are not considered sufficient to justify recommendation of these alternatives instead of the NED Plan. The 47-foot depth alternative is the selected plan.

The State of Georgia has asked the Corps to consider the 48-foot depth alternative as the Locally Preferred Plan (LPP). After reviewing the comments on the Draft GRR and DEIS and after further discussions with the non-Federal sponsor, the Corps has selected the NED 47-foot depth alternative for implementation.

4.0 EFFECTS OF PROPOSED PROJECT

State-of-the-art hydrodynamic and water quality models were used to assess potential impacts of the project in the inner harbor. State-of-the-art models were also used to assess potential impacts in the nearshore area. The development of the various models was accomplished through coordination with the various Cooperating Agencies and state resource agencies. Development and approval of the inner harbor models occurred between 1999 and 2005. After the agencies approved use of the models on this project, the tools were applied and the modeling was performed (2006 and 2007). The project-related impacts (without mitigation) predicted by the various models for the deepening alternatives are summarized in Table 5.

Table 5. Summary of Project-Related Impacts Without Mitigation

	---------- DEPTH ALTERNATIVES ----------				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres
Brackish Marsh	-7.2 acres	Same	Same	Same	Same
Dissolved Oxygen	Reductions at mid-depth and bottom	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater amount	Same effect, but greater amount
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (185.0)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flonnder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 77 mg/L	Max hourly increase of 105 mg/L	Max hourly increase of 121 mg/L	Max hourly increase of 149 mg/L	Max hourly increase of 170 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining unit by 3-4%
Hurricane Surge	Minor, max increase in WSE of 0.3 feet	Minor, max increase in WSE of 0.5 feet	Minor, max increase in WSE of 0.6 feet	Minor, max Increase in WSE of 0.8 feet	Minor, max increase in WSE of 0.9 feet
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

After the expected impacts to these resources were identified, the hydrodynamic and water quality models were used to evaluate ways to reduce those impacts. Major impacts of concern that were evaluated included a predicted increase in upstream salinity levels and a decrease in dissolved oxygen levels that would be caused by harbor deepening. A flow diversion plan was developed for each depth alternative that decreases the amount of salty water entering Middle River and Little Back River and increases the amount of freshwater entering these streams. Consequently, these mitigation plans would minimize the adverse affects to tidal freshwater marsh, Striped bass habitat, and Shortnose sturgeon habitat that would result from increased salinity levels.

Additional studies identified oxygen injection as being the best method to improve dissolved oxygen levels in the harbor. Mitigation of low dissolved oxygen levels caused by harbor deepening would require the injection of oxygen at various locations in Savannah Harbor. The exact locations where oxygen injection would be required and the amount of oxygen that would have to be injected depend on the deepening alternative selected. The mitigation plan for the 47-foot project includes construction and operation of three oxygen injection systems, all in Georgia. Two of these systems would be located on Hutchinson Island (one discharging in Back River and one discharging in Front River) while the third system would be located upstream of the Georgia Highway 25 crossing near Georgia Power's Plant McIntosh. Table 6 shows the impacts of the deepening alternatives with the flow diversion and oxygen injection plans in place.

Even with the flow diversion plan and oxygen injection, impacts to Striped bass habitat, Shortnose sturgeon habitat, and tidal freshwater wetlands would not be totally mitigated (See Table 6). Consequently, other mitigation features of the project include funding for the Georgia Department of Natural Resources to stock Striped bass in the Savannah River, construction of a fish passage facility at New Savannah Bluff Lock and Dam to benefit Shortnose sturgeon, and purchase of lands to be deeded to the US Fish and Wildlife Service for preservation. The mitigation plan for the project also includes restoration of 40.3 acres of estuarine emergent wetlands in Disposal Area 1S in Savannah Harbor as in-kind mitigation for wetlands that would be excavated as a result of the Kings Turning Basin expansion, removal of the Tidegate Structure end walls, and other project requirements.

Table 6. Summary of Project-Related Impacts With Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary up Front River	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater Amount	Same effect, but greater amount
Freshwater Wetlands (Conversion)	+ 322 acres	- 32 acres	- 201 acres	-223 acres	- 337 acres
Brackish Marsh (Conversion)	+ 488 acres	+ 861 acres	+959 acres	+964 acres	+1068 acres
Salt Marsh (Conversion)	- 808 acres	-828 acres	-757 acres	-740 acres	-730 acres
Brackish Marsh (Loss)	-15.68 acres	Same	Same	Same	Same
Dissolved Oxygen	Minimal Net improvement	Same	Same	Same	Same
Fisheries	**Loss (-) or Gain (+) of Acceptable Habitat**				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	-4.6 % (-179.0 acres)	-6.2 % (-240.0 acres)	- 6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+19.0 % (+260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	+6.5 % (+89.0)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	- 6.7% (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6% (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0acres)	+ 54.2 % (+1014.0acres)	+ 57.3 % (+1072.0acres)	+57.3 % (+1072.0acres)	+ 52.9 % (+989.0 acres)
Chlorides @ City's M&I Water Treatment Plant	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L	Max hourly increase of 4 mg/L
Drinking Water Aquifer	Same type of effect, but less than 45-foot alternative	Same type of effect, but less than 46-foot alternative	Same type of effect, but less than 47-foot alternative	Same type of effect, but less than 48-foot alternative	Increase flow through confining uuit by 3-4%
Hurricane Surge	Minor, Max increase in WSEL = 0.5 ft	Minor, Max increase in WSEL = 0.6 ft	Minor, Max increase in WSEL = 0.7 ft	Minor, Max Increase in WSEL= 0.8ft	Minor, Max increase in WSEL = 0.8 ft
Beach Erosion	Minor; within accuracy of evaluation	Same	Same	Same	Same
Bank Erosion due to ship traffic	No measurable addition to ongoing erosion	Same	Same	Same	Same
Shoaling	Minimal upstream shift	Same	Same	Same	Same
Velocity	Theoretical reduction, but not measurable	Same	Same	Same	Same

The project's mitigation plan (Appendix C) includes funding for the Georgia Department of Natural Resources to stock Striped bass fingerlings in the lower Savannah River to compensate for the loss of spawning, egg, and larvae habitat. The project's monitoring and adaptive management plan (Appendix D) includes a study during the post-construction monitoring to quantify the impacts on Striped bass habitat. The hydrodynamic and water quality models would be used along with the field data collected to assess project impacts on Striped bass habitat. Further mitigation could be provided should the results of this study indicate that to be appropriate.

A horseshoe rock ramp fish passage structure at New Savannah Bluff Lock and Dam was proposed in the DEIS as mitigation for the loss of Shortnose sturgeon habitat in the lower Savannah River. This fish passage facility would permit Shortnose sturgeon (and other species of anadromous fish to move above the dam to traditional upstream spawning areas. Comments on the DEIS indicated that some of the resource agencies had concerns about the fish passage efficiency of the horseshoe design (mainly based on flow volume through the structure). As a result, the Corps convened a fish passage workshop in April 2011. Based on the guidance received at that workshop and later coordination with NOAA Fisheries, the Corps revised the fish passage design (off-channel rock ramp) at the New Savannah Bluff Lock and Dam. This structure would capture much more of the river flow (100% vs 5%), which is expected to produce a much higher fish passage effectiveness (See Appendix C for more details).

As shown in Table 6, the project would have both indirect and indirect effects on wetlands. Approximately 15.68 acres (14.83 acres in Georgia and 0.85 acres in South Carolina) of brackish marsh would be lost as a result of various excavation requirements of the project. The excavation requirements (in regards to the amount of wetlands that would be affected) for all five channel depth alternatives are the same. Approximately 2.2 acres would be removed at Station 102+600 and 0.8 acres would be removed as part of the Kings Island Turning Basin expansion. The project would remove brackish marsh from two locations on Hutchinson Island, where approximately 3.4 acres would be excavated at Station 88+000 and 0.8 acres at Station 70+00. The project also includes the removal of the Tidegate Structure abutments on both the Georgia and South Carolina sides of the river. Removal of the Tidegate abutment on the Georgia side would result in the loss of about 7.63 acres of brackish marsh while about 0.85 acres would be lost on the South Carolina side of the River.

The project's mitigation plan includes restoration of 40.3 acres of brackish marsh in Disposal Area 1S to compensate for the loss of 15.68 acres of brackish marsh from project excavation requirements. Restoration of wetlands on this site would provide the required 138 wetland credits (28.8 acres using Savannah District Regulatory SOP) of in-kind mitigation for the impacts of the project. The additional 11.5 acres of wetland restoration would be used by the Corps for any additional wetland mitigation needs of the SHEP or mitigation needs associated with the operation and maintenance of the Savannah Harbor Navigation Project.

As discussed in the previous paragraphs, indirect impacts associated with the proposed deepening would result in a vegetative shift in 223 acres of tidal freshwater marsh to brackish marsh with implementation of the selected plan (47-foot channel depth alternative) even with the flow routing. Approximately 740 acres of saltmarsh may also shift to more brackish species as a result of the flow rerouting to provide more freshwater in Little Back and Middle Rivers. As previously discussed, the Corps used the EFDC model to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary, as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where riverine surface salinity levels are extrapolated across the adjacent marshes. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.5-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh.

The results of the functional assessment concluded that the differentiation between salt marsh and brackish marsh recommended by the Wetland Interagency Coordination Team and used in the DEIS was somewhat constrained. The salinity range used in the SHEP to differentiate between brackish marsh (0.6-4 ppt) and salt marsh (> 4ppt) was restrictive, given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt) which occur within the area of potential effect, also supports those findings. The EFDC value for saltmarsh (> 4.0 ppt) is approximately 2.5 times less than that reported by NOAA (2010). Additionally, the NOAA (2010) range for brackish marsh includes areas determined by the EFDC model to be saltmarsh. When considering values reported in the literature, the acreage of saltmarsh conversion (740 acres) which was calculated using the EFDC model is a very inclusive value and includes existing vegetative areas that would not transition to brackish marsh flowing deepening because these areas currently exist within the salinity range of a brackish marsh (0.5-10 ppt). Thus, the salinity range used to quantify salt marsh in the area of potential effect (i.e., > 4 ppt) likely over-estimated the amount of saltmarsh in the system and under-estimated the amount of brackish marsh. As such, the described conversion of salt marsh to brackish marsh, which was calculated to occur as a result of harbor deepening, would likely be much less if one takes into account vegetative characteristics for wetland environments with associated salinities that are more commonly associated with a brackish marsh (i.e., range between 0.5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, Savannah District concludes that the 740-acre calculated conversion of saltmarsh to brackish marsh if the harbor is deepened to 47-feet is

conservative, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah. That said, the District was inclusive in its assessment of the potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts.

The conversion of 223 acres of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 47 feet as proposed. It is important to note that the ecological values of the impacted 223 acres of freshwater wetlands would not be completely lost. Instead, those acres would be converted to brackish marsh. The Corps' calculation of the number of acres of freshwater wetland that have the potential to be converted to brackish marsh is based on a shift in the location of 0.5 ppt salinity, a traditional rule-of-thumb for differentiating between freshwater marsh and brackish marsh. However, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994).

Deepening the harbor to a 47-foot depth would result in a conversion of the dominant vegetative species typically observed in approximately 223 acres of freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined as brackish marsh (Latham et. al., 1994). Likewise, the 47-foot depth would result in a conversion of the dominant vegetative species typically observed in 740 acres of saltmarsh (saltmarsh to brackish marsh scenario), and dominant saltmarsh species like *Spartina alterniflora* would still be observed in areas which have salinities that define a brackish marsh. However, the overall basic wetland functions typically associated with these systems would not change. A comparison of potential changes in elements of wetland function for both conversion scenarios is provided in the following table.

Table 7. Change in Wetland Function as a Result of Wetland Conversion

Elements of Wetland Function	Freshwater to Brackish Marsh (Approximately 223 acres)	Saltmarsh to Brackish Marsh (Approximately 740 acres)
Water Purification	Negligible	Negligible
Flood Protection	Negligible	Negligible
Shoreline Stabilization	Negligible	Negligible
Groundwater Recharge	Negligible	Negligible
Streamflow Maintenance	Negligible	Negligible
Retention of Particles	Negligible	Negligible
Surface Water Storage	Negligible	Negligible
Subsurface Storage	Negligible	Negligible
Nutrient Cycling	Negligible	Negligible
Values to Society	Negligible	Negligible
Fish and Wildlife Habitat	Minor Adverse	Negligible

Negligible Effect – the effect on the resource would be at the lowest levels of detection, barely measurable, with no perceptible consequences, either adverse or beneficial, to the resource.

Minor Effect – the effect on the resource is measurable or perceptible, but it is slight.

Adverse Effect: the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result

As illustrated in the table above, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. USACE recognizes that a comparison of fish and wildlife habitat between freshwater and brackish marsh systems yields fewer similarities. However, the conversion in fish and wildlife habitat will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation after deepening in wetland areas that would be classified as brackish marsh. For additional information pertaining to the functional assessment, please see Section VII Consideration of Final Compensatory Mitigation Rule.

Since there would be a minor adverse effect to the fish and wildlife habitat function in 223 acres of tidal freshwater wetlands if the selected plan is implemented, an assessment was conducted to determine how to best mitigate for that impact. Once the extent of the impacts to wetlands was known, the Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs. No sites could be identified where

tidal freshwater restoration or creation was feasible. Consequently, the acquisition and preservation of lands that would be ecologically significant to the Savannah National Wildlife Refuge was determined to be appropriate mitigation.

The Corps has completed its initial assessment of properties in the SNWR's Acquisition Plan to determine potential properties that could meet the wetland mitigation needs of the SHEP. This assessment (Consideration of 2008 USEPA/USACE Mitigation Rule) is in Appendix C. The lands proposed for preservation consist of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain estuarine emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer would provide a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion.

The effects of the proposed work are described in detail in Section 5.0 of the Environmental Consequences of the DEIS. The Mitigation Plan can be found in Appendix C of the DEIS.

5.0 OTHER AREAS OF ENVIRONMENTAL CONCERN

Some of the major environmental concerns associated with the SHEP have been previously addressed in this document. Other environmental concerns include the dredging and disposal of sediments with high concentrations of cadmium, beach erosion, possible impacts to the Floridan aquifer, and impacts to Threatened and Endangered Species. These impacts are discussed in detail in Section 5.0, Environmental Consequences, of the EIS and the Mitigation Plan in Appendix C.

5.1 Contaminated Sediments

Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built upon the results of the previous work. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45and000 to 94+000 (River Mile 8.5 to 17.8).

Additional studies were conducted in 2007 to assess the potential pathways by which cadmium could enter the environment during the dredging and disposal process. The additional studies included the following activities:

- Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
- Side scan sonar survey to identify and map bottom characteristics in the channel;
- Benthic community assessment;
- Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);
- Collecting dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
- Compositing and processing sediment cores to create "high cadmium" and "low cadmium" composite samples for further testing;
- Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
- Analytical testing of porewater and SLRP samples at the high cadmium locations only;
- Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and
- Risk evaluation and report preparation.

Based on the results of the above studies, the following conclusions were reached relative to the dredging and disposal of cadmium enriched sediments associated with the SHEP:

A. The existing bottom habitats within the Savannah Harbor Navigation Channel support benthic communities that are diverse and provide an available food resource.

B. Although substantial benthic communities reside in the clay/sand veneer substrates which have naturally occurring high levels of cadmium, studies indicate that the cadmium is not freely soluble or readily bioavailable to organisms.

C. High cadmium composite samples (average concentration of 30 mg/km) and low cadmium composite samples (average of 15 mg/kg) were created from bottom sediments and used for physical and chemical analyses, standard and effluent elutriate creation, simplified laboratory procedure (SLRP), aquatic bioaccumulation testing, and plant uptake studies.

D. Sequential Extraction Procedures (SEP) were used to determine the amount of metal bound in different fractions of the sediment or soil. SEP results can be used to predict the metal concentrations that would most likely be available to aquatic organisms, plants, and wildlife. Results of the SEP for both the high cadmium and the low cadmium composite samples indicated that no cadmium was detected in the exchangeable fraction, and that about 98 percent of the cadmium in the Miocene layer was bound in relatively

insoluble forms. These results suggest that the majority of the cadmium is not freely soluble or readily bioavailable.

E. Analysis of site (dredging) water, receiving water, standard elutriate, and effluent elutriate results included both the total and dissolved fractions and comparisons of detected chemical constituents to Federal and state (South Carolina) saltwater acute and chronic water criteria for the protection of aquatic life. In the dredging and receiving water, nutrient and metal concentrations in both the total and dissolved fractions were low, and generally below the USEPA/South Carolina saltwater criteria for the protection of aquatic life. Cadmium was not detected in either the total or dissolved fraction of the dredging water sample or the receiving water sample.

F. Porewater analysis of two core samples collected from high cadmium locations indicate that concentrations of dissolved cadmium in the porewater were low and below the laboratory reporting limit and applicable water quality criteria.

G. For both the standard and the effluent elutriates, the concentrations of metals detected in the total fraction of the standard elutriates created using the high and low cadmium composite samples were high, exceeding South Carolina water quality criteria for the protection of aquatic life. However, cadmium concentrations did not exceed USEPA chronic saltwater criteria in the dissolved fraction of both the standard and the effluent elutriate samples. Therefore, the cadmium detected in the total fraction is most likely bound to the fine grained particles.

H. Aquatic bioaccumulation studies conducted were designed to evaluate the potential of benthic organisms to bioaccumulate contaminants of concern from the dredged material. These tests used *Nereis virens* (sand worm) and *Macoma nasuta* (blunt-nose clam) After 28 days of exposure using the high and low cadmium composite sample and a reference sediment sample from New River, none of the test sediments had significantly lower survival than the reference sediment. After the bioaccumulation testing, the organism tissues were analyzed. In the worm tissue, cadmium concentrations statistically exceeded the reference site tissue concentrations for tissue exposed to sediment from both the high and low cadmium composite samples. In the clam tissue, cadmium tissue concentrations from the high and low cadmium composite samples were not statistically different from the reference.

I. Plant uptake studies (45-day) were conducted using *Cyperus esculentus* (yellow nutsedge), the high and low cadmium composite samples and reference soil collected from a dike in one of the CDFs. Plant tissues were exposed to the prepared soils from the navigation channel. The mean concentration of cadmium in plant tissue exposed to the samples taken from the navigation channel statistically exceeded concentrations in reference tissue for both the high and low cadmium composite samples indicating that uptake from the soil to the plants occurred for each of these concentrations.

A risk assessment was conducted to identify the potential for impacts on human health or the environment from elevated cadmium concentrations in new work sediments that would be dredged. The risk assessment evaluated potential exposures and impacts of cadmium on aquatic and benthic organisms, wildlife, and fishermen in the Savannah River and on plants, aquatic and benthic organisms, and wildlife in the CDFs. The risk assessment reached the following conclusions:

A. Cadmium in new work sediments is not likely to cause adverse impacts to aquatic and benthic organisms in the Savannah River. This determination was based on the various tests that indicate that cadmium is bound to the sediments and not readily soluble and bioavailable to aquatic organisms.

B. While cadmium concentrations are likely to be elevated in sediment and water during and after dredging in Savannah Harbor, the limited bioavailability and bioaccumulation potential of cadmium results in relatively low doses to wildlife and no potential for adverse effects. This determination was based on risk analysis studies using food web ingestion models which were used to quantify exposures to evaluate potential adverse impacts to wildlife from cadmium in new work sediments that would be placed in the CDFs.

C. The predicted concentration in gamefish was below that protective of human health, indicating there are no adverse impacts to humans. This determination was based on model projections of concentration in flounder which were compared to fish tissue benchmarks protective of human consumption.

D. Cadmium concentrations in dredged material held in the CDFs in a wet condition and in effluent, runoff, and sediment discharged from the CDF are not likely to cause adverse impacts to plants in drainage areas and wetlands. This determination was based on the fact that while total concentrations of cadmium in sediment and water were elevated, the bioavailable concentrations in sediment and the dissolved concentrations of cadmium in effluent elutriates were below benchmarks protective of plants. Cadmium concentrations in the overlying water from the bioaccumulation tests were also below benchmarks.

E. Cadmium in sediments placed in the CDFs is not likely to cause adverse impacts to aquatic and benthic organisms in drainage areas impoundments, and wetland areas of the CDF. This determination is based on the fact that while total concentrations of cadmium in sediment and water were elevated above benchmarks, the bioavailability of cadmium is limited and unlikely to cause adverse impacts. Dissolved concentrations of cadmium in porewater, effluent elutriates, and overlying water from bioaccumulation tests were lower than benchmark concentrations protective of aquatic and benthic organisms. SEP analysis of the sediments demonstrated that more than 98 percent of the cadmium sediments are not likely to be bioavailable to aquatic and benthic organisms. Bioaccumulation tests indicate that test tissue concentrations of cadmium were either similar to reference concentrations or below no-effects residue benchmarks. The tests

also indicate that estimated tissue concentrations for higher trophic level fish were below no-effects residue benchmarks.

F. There is a strong indication that cadmium is not likely to cause adverse effects to wildlife using drainage areas, impoundments, and wetlands at the CDF. This determination is based on analyses using food web ingestion models to quantify exposures. The assessment evaluated exposures for birds and mammals that consume plants, fish, and benthic organisms, and modeled doses were compared to no-effects and lowest observable effects benchmarks. Great blue heron, spotted sandpiper, osprey, Canada goose, muskrat, and river otter were used as representative or surrogate receptor species.

G. Evidence from measurement endpoints indicates that there is a limited potential for adverse impacts to plant growth from cadmium in new work sediments placed in the CDFs. This determination is based on plant growth observed in the bioassays. Bioaccumulation test results indicated that plant tissue concentrations for high and low cadmium composites were higher than reference concentration, but the plant tissue concentrations were below tissue residue benchmarks. Plant growth in the bioassays was statistically significantly lower for plants grown on high in high and low cadmium composites than for control and reference treatments. This reduced plant growth may be related to cadmium concentrations and/or the fine grain size of the dredged material.

H. Cadmium concentrations in about 3 million cubic yards of dredged material to be discharged into the CDFs may cause adverse effects to wildlife using uplands. Approximately 7 million cubic yards of dredged material that would be removed from the inner harbor is cadmium-laden. About 4 million cubic yards of this material is expected to average 6.9 mg/kg cadmium which is below both no-effects and lowest observable effects limiting dose benchmarks. Approximately 3 million cubic yards of this material is expected to average 21.4 mg/kg cadmium which exceeds no-effects and lowest observable effects limiting dose benchmarks for soil. Risks to wildlife from cadmium in upland habitats were evaluated using food web ingestion models to quantify exposures. Models included site-specific bioavailability factors developed based on SEP analyses of the sediments and site-specific bioaccumulation factors developed based on sediment bioassays using plants. Modeled doses were compared to no-effects and lowest observable effects benchmarks. The assessment evaluated impacts for birds and mammals that consume plants, invertebrates, anode small mammals which included the song sparrow, marsh wren, red-tailed hawk, meadow vole short-tailed shrew and red fox. When modeled based on concentrations in sediment composites and effluent or runoff, modeled doses for song sparrow, marsh wren, and shrew for both low and high cadmium scenarios exceeded both no-effects and low-effects benchmarks. This indicates that there is a potential for adverse effects to these receptors.

Based on the findings of the various studies relating to the dredging and disposal of cadmium-laden sediments, a disposal and monitoring plan was developed for the Savannah Harbor Expansion Project. All of the cadmium-laden sediments that would be dredged would be deposited into existing CDFs 14A and/or 14B. These sediments would

be kept in a wet environment until a covering layer could placed on the material and sediment samples taken from that cover indicate that cadmium concentrations in the surface sediments are less than 4 mg/kg. Studies indicate that allowing the sediments in the CDF to dry changed the behavior of the cadmium in the sediments. Sequential extraction procedures on washed and dried sediment showed that cadmium becomes more available in the dried sediment. Plant uptake studies showed that plants can accumulate cadmium from dried sediments. An exposure model found that both birds and mammals exposed to the dried cadmium sediments are likely to accumulate cadmium at levels shown to have impacts. Following placement of cadmium-laden sediments, eighty-six (86) grab samples would be collected from a depth of 15 cm to characterize the cadmium levels of surface sediments. The sediments would then be covered with at least two feet of sediments that are expected to have cadmium concentrations of 4 mg/kg or less. After this cover has been applied, sediment samples would be obtained and analyzed. Eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If cadmium levels in the cap are less than 4 mg/kg, the sampling would be considered complete. If cadmium levels in the cover are equal to or exceed 4 mg/kg in a cumulative area of 25 acres or greater, an additional cover of sediments from operation and maintenance dredging would be applied as soon as possible. Sediment sampling would then be conducted as previously performed. This process would be repeated until the concentration of cadmium in the samples was less than 4 mg/kg. The cadmium-laden sediments would remain in CDFs 14A and/or 14B and not used for other purposes (dike construction, etc.).

Monitoring would also include evaluation of the inflow and the effluent discharged from the disposal areas. Samples would be taken from the head section of the discharge pipe from the dredge and analyzed for cadmium. Samples of the effluent leaving the disposal area would be taken and analyzed to ensure that state water quality standards are being met. The Section 401 Water Quality Certification issued by the Georgia DNR-EPD requires cadmium concentrations to be monitored on a weekly basis at the point of discharge from the CDFs where cadmium-laden sediments are placed. Monitoring shall continue at these CDFs for as long as the discharge of effluent is present, and until all dredged sediments have been dewatered, stabilized and covered. Following the installation of a stable, clean cover, cadmium must be monitored for one year.

If analytical results indicate standards are not being met, corrective actions include reducing the pumping rate of the dredge and/or boarding up the weir to decrease the amount of effluent being discharged from the CDF.

Other monitoring efforts associated with cadmium-laden sediments include wildlife use surveys in CDFs 14A and 14B, vegetation sampling and removal (if required), and biological monitoring (bird tissue analysis)

The Corps would perform monthly wildlife surveys of the CDFs. These one-day surveys would record all birds and other major vertebrates seen within CDFs 14A and 14B. Monitoring would be performed during sediment placement and for 3 years after the placement is complete. If there is a concern about the number of birds or other animals

or a particular species using the CDFs, some type of hazing may be appropriate (with concurrence of the USFWS).

If analyses of the sediment samples from the cover show that concentrations of cadmium equal or exceed 4 mg/kg, vegetation sampling would be required. This sampling would be conducted on a quarterly basis in "hot spots" to determine cadmium uptake by plants. Samples collected from the CDFs would be compared to control samples taken from other, areas with low cadmium content found in adjacent CDFs. If vegetation samples have significantly elevated cadmium concentrations, efforts would be initiated to eradicate vegetation and/or place additional, low-cadmium sediments over the covering layer. These contingency measures would eliminate wildlife exposure should vectors for cadmium uptake be identified. Vegetation sampling would be considered complete once sustained cadmium concentrations in the surface sediments of the cap are less than 4 mg/kg.

Blood samples would be taken from birds and analyzed for cadmium prior to sediment placement in the CDFs (to obtain baseline data), during placement of cadmium-laden sediments and the cover and for 3 years afterward. The tissue monitoring protocols take into account the hydrologic conditions of the CDF (wet/ dry) and the season, since these factors greatly influence which birds are using the CDFs at a given time. Tissue (liver) samples would also be taken should the results of the samples taken during and after sediment placement show significantly higher cadmium levels than the baseline samples.

At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc.) Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediments at the sediment/water interface.

The Georgia Section 401 Water Quality Certification also requires monitoring of maintenance dredging activities that would occur in areas of the channel with known high cadmium concentrations. Sediments to be dredged would require testing for cadmium from two locations that are representative of average sediment accumulation in that reach. This protocol would remain in effect for at least two maintenance dredging cycles and would continue if the sampling indicates cadmium levels of concern.

Details of cadmium monitoring are fully discussed in Appendix M.

5.2 Beach Erosion

It has been long surmised that construction and maintenance of the Savannah Harbor Navigation Project, particularly the entrance channel, plays a major role in beach erosion on Tybee Island. A study completed in 2008, Impact of Savannah Harbor Deep Draft Navigation Channel on Tybee Island Shelf and Shoreline" confirmed that construction and maintenance of the entrance channel and the construction of two large jetties near the mouth of the harbor have disrupted sediment pathways across the entrance channel. The major impacts of this disruption are loss of sand from the Tybee shelf which would be

available to move towards Tybee Island and erosion of the north end of the Tybee Island beach. The estimated combined shelf and shoreline impact at Tybee Island was calculated to be 78.5 percent. This means that an estimated 78.5 percent of the reduction in sand volume on the Tybee shelf and shoreline is due to the project. The remainder of the erosion is attributed to natural processes.

Further studies were conducted during the SHEP to evaluate the potential impacts of deepening of the inner harbor channel to -48 feet MLW and the entrance channel to -50 feet MLW on beach erosion at Tybee Island. These studies included a bathymetry and volume change analysis to obtain the historical perspective of the Savannah nearshore evolution, numerical modeling of circulation, waves, and sediment transport to compare pre-and post-deepening of the channel impacts on coastal processes. Based on this work, the following determinations were made:

1. Modeling results indicate that deepening of the entrance channel would result in only minor changes in nearshore wave patterns. Consequently, the proposed deepening project would be expected to have very little impact on the Tybee Island shoreline.

2. The circulation and wave modeling indicate very small changes associated with the proposed deepening project. The proposed deepening project would not change the general overall pattern of sediment transport in the region. The most noticeable changes were computed in the channel. Channel deepening would have only a negligible effect on the Tybee Island Shelf.

3. The current navigation channel appears to be nearly a complete sink for any sediment from moving north to south along the shelf. Placement of dredged material back into the nearshore zone of Tybee Island would be a means restoring this supply of sand to the Tybee Island beach system.

Based on the results of the studies conducted during the SHEP, much of the loss of sand from the Tybee Island shelf and the erosion of the north end of Tybee Island Beach can be attributed to the existing project. Consequently, this impact is an operation and maintenance issue.

Deepening of the Savannah Harbor project would have little impact on the Tybee Island shoreline or the Tybee Shelf.

The studies that were conducted (wave refraction, sediment budget, etc.) did not identify any substantial impacts to South Carolina beaches or nearshore areas.

5.3 Groundwater

Concern was raised during SHEP studies that deepening of the navigation channel could adversely affect the principal drinking water aquifer in the coastal area-the upper Floridan aquifer. The concern is that excavation of material required to deepen the harbor would allow saltwater to enter the freshwater aquifer, thereby degrading its quality and rendering it unacceptable for drinking purposes. Three potential pathways were identified whereby deepening of the navigation channel could possibly increase saltwater intrusion into the aquifer:

1. Deepening of the channel would require the removal of some of the top portion of the aquifer's protective layer (Miocene cap) which could result in saltwater intrusion into the aquifer.

2. Removal of sediments from paleochannels (former Pleistocene-age stream channels that have eroded into the Miocene cap) would increase the potential for intrusion into the aquifer.

3. Water with increased salinity levels could enter could enter aquifer via fractures or joints in the Miocene cap.

Various studies were conducted during the SHEP to address these issues. Based on the results of these studies, the following major conclusions were determined:

1. The primary cause of saltwater intrusion into the Floridan aquifer is long-term pumping from the aquifer to meet groundwater needs. The long-term pumping of water from the Upper Floridan aquifer and surrounding coastal counties has lowered ground water levels and reversed the seaward hydraulic gradient that existed before development. The increased withdrawal of water from the upper Floridan aquifer has resulted in a radial flow directed towards the center of pumping and a cone of depression beneath Savannah. Sustained pumping of water from the aquifer has also resulted in a downward hydraulic gradient and induced significant head differences between the surficial aquifer and the confined Upper Floridan aquifer. This effect has resulted in the downward intrusion of water through the Miocene layer into the aquifer.

2. Improvements (deepening) and maintenance of the Savannah Harbor Navigation Project have also had some impact on the downward migration of water through Miocene layer into the aquifer. Channel dredging has removed portions of the Pleistocene sands and Miocene clays that reside above the upper Floridan aquifer. GIS analysis conducted during the SHEP indicates that about 5 feet of the confining layer that protects the aquifer has been removed. Significant exposure of the Miocene layer appears to be a relatively recent event. GIS studies conducted during the SHEP also indicate that exposures of large stretches of the Miocene along the Bight Channel (Elba Island) and near the Kings Island Turning Basin appeared to have occurred between 1992 and 1998. Completion of the 42-foot project in 1994 may at least partially explain this observation. Although deepening of the navigation channel has removed some of the Miocene cap, GIS analysis

and groundwater model studies indicate that historical dredging has probably had minimal influence on the rate of saltwater intrusion into the aquifer.

3. Underneath the navigation channel, the overall thickness of the confining unit ranges from about 30 feet thick near the Tybee high to over 150 feet thick near downtown Savannah. Model studies indicate that the expected increase in the downward flow of saline water from the area underlying the navigation channel due to channel deepening would be very low. The area that would have to be dredged to deepen the channel to 48 feet MLW accounts for a total downward flow between 50 and 250 gallons per minute. Deepening the navigation channel increases the downward flow between 2 and 7 gallons per minute which translates to a 3-4 percent increase. This contribution is negligible when compared to groundwater production in the Savannah area from the aquifer which is about 80 million gallons per day (55,555 gallons per minute).

4. SHEP studies identified eight significant paleochannels that have incised deeply into the Miocene confining layer between Stations 30+000 and -30+000B. Groundwater model study results indicate that the impacts of dredging sediments within the paleochannels would be small when compared to the impacts of dredging elsewhere in the channel where the Miocene unit is impacted. The bottom of the paleochannels represents the areas of minimum thickness of the Miocene confining layer in the harbor. Dredging to these depths would not be required.

5. Analysis conducted during SHEP studies indicates that the Savannah Harbor Project area is not likely characterized by joints or fractures which could serve as pathways for enhanced downward flow of water into the aquifer. This is evidenced by the absence of observable vertical joints in Miocene-aged surface exposures and the lack of evidence of joints or fractures in sub-surface cores of the Miocene. Also, there is no historical evidence (springs, etc.) of joints or fractures in the area.

5.4 Threatened and Endangered Species

A Biological Assessment of Threatened and Endangered Species (BATES) has been prepared for the SHEP. The BATES is included in the EIS as Appendix B. The BATES concludes that the proposed SHEP "may affect-is not likely to adversely affect" piping plover, wood stork, West Indian manatee, right whale and humpback whales, sea turtles, and Shortnose sturgeon. The BATES is subject to the review and approval of the US Fish and Wildlife Service and the National Marine Fisheries Service. The USFWS has issued a letter of concurrence with the findings of the BATES in regards to those species for which they have responsibility. Similarly, NOAA has issued a Biological Opinion which includes reasonable and prudent measures to protect Loggerhead and Kemp's Ridley sea turtles and Shortnose and Atlantic sturgeon. The USFWS report and the BO are included in Appendix Z.

6.0 STATE ENFORCEABLE POLICIES

6.1 Introduction

The goals of the South Carolina Coastal Management Program are attained by enforcement of the policies of the State as codified within the South Carolina Code of Regulations. "Policy" or "policies" of the South Carolina Coastal Management Program means the enforceable provisions of present or future applicable statutes of the State of South Carolina or regulations promulgated duly there under (SC Code of Regulations Chapter 30). The statutes cited as policies of the Program were selected because they reflect the overall Program goals of developing and implementing a balanced program for the protection of the natural resources, as well as promoting sustainable economic development of the coastal area. Each section of the South Carolina coastal management laws are discussed separately in this section, in numerical order. These sections are then followed by a paragraph titled "Consistency" that explains the extent to which the proposed project is consistent with that enforceable provision.

6.2 Statement of Policy (SC CODE 30-1)

6.2.1 South Carolina Coastal Zone Management Act

The South Carolina Coastal Zone Management Act was passed by the 1977 General Assembly of South Carolina to provide for the protection and enhancement of the State's coastal resources. This legislation creates the South Carolina Coastal Council which is given the task of promoting the economic and social welfare of the citizens of this State while protecting the sensitive and fragile areas in the coastal counties and promoting sound development of coastal resources. The South Carolina Coastal Zone Management Act was amended by Act 181 of 1993, which merged South Carolina Coastal Council with the South Carolina Department of Health and Environmental Control. The South Carolina Coastal Council became the Office of Ocean and Coastal Resource Management (OCRM).

Through the efforts of an overall coastal zone management program and permitting process, the Department seeks to guide the wise preservation and utilization of coastal resources. These rules and regulations are intended to: (a) aid developers and others in taking advantage of state-of-the-art techniques in developing projects compatible with the natural environment; (h) insure consistent permit evaluations by the Department; and (c) serve as a stimulus for implementation of better and more consistent management efforts for the coastal zone.

These regulations are the Department statements of general public applicability that implement and prescribe policy and practice requirements of the Department. They are to be read as part of, and to be construed with, the policies set forth in the South Carolina Coastal Management Program.

6.2.2 The Value of Tidelands and Coastal Waters

The tidelands and coastal waters of the South Carolina coast are a very dynamic ecosystem and a valuable natural resource for the people of the State. The tides regularly ebb and flood through the coastal inlets, bays and marshes which constitute a fragile area, vulnerable to the impacts of many human activities. Tidelands and coastal waters are identified as "critical areas" over which the Department has direct permitting authority.

The saline marshes are highly productive components of the marine food web of coastal waters and estuaries. Decaying organic material, called detritus, serves as the basis of the food web and is the major biological contribution of the saline marshes. Many commercially and recreationally important fish and shellfish species depend on the marshlands and estuaries for all or part of their life cycle. In addition, many birds and other forms of wildlife utilize wetlands as habitat as well as a source of food. Tidelands and coastal waters also have become increasingly important in recent years for the purposes of aquaculture.

Among the important functions of the salt and brackish marshes is their role in protecting adjacent highlands from erosion and storm damage. Marsh vegetation absorbs and dissipates wave energy and establishes a root system which stabilizes the soils. Its effectiveness as a buffer depends on the surface area available which, combined with the composition of the underlying substrate, allows tidelands to act as "sponges," absorbing and releasing waters during storms or times of heavy riverine discharge.

Marshes also perform a valuable waste treatment function since the dense vegetation acts as a filter, trapping sediments and pollutants which enter as run-off from the upland areas. The trapping of sediments helps maintain water clarity, a factor important to clam, oyster, and phytoplankton productivity. The marshes also assimilate pollutants and recycle nutrients through various biochemical processes.

Coastal waters and the adjacent marshes are also significant as aesthetic, recreational and educational resources. Much of the expenditure for recreation and tourism in the South Carolina coastal zone is for purposes of enjoying outdoor activities and the aesthetic pleasures of undisturbed tideland areas. These natural areas lend themselves to meaningful and important academic pursuits such as bird-watching and wildlife population and nutrient recycling studies.

These same unique natural resource areas face increasing land development pressure and negative impacts from human activities in and around them. The marshes constitute a fragile ecosystem; consequently, indiscriminate dredging and filling, degradation of water quality or unsound building and development practices can have long-term detrimental effects. All development need not be prohibited; rather, the range of favorable and unfavorable results needs to be realized, and analysis made to determine priorities, evaluate alternatives, anticipate impacts, and suggest the best methods and

designs to carry out wise development of these resources.

6.2.3 The Value of Beaches and Dunes

In 1977, the South Carolina General Assembly enacted the Coastal Tidelands and Wetlands Act (Coastal Zone Management Act) to protect, preserve, restore and enhance the coastal resources of South Carolina. The Act created a new state agency, the South Carolina Coastal Council, and charged it with the responsibility of administering and enforcing the statute. This legislation, however, proved ineffective for managing the beach/dune system because regulatory authority over these areas given to the Coastal Council was not sufficient. From the State's beaches, the Coastal Council could regulate landward only to the primary oceanfront sand dune or to the highest uprush of the waves where no such dune existed.

Lacking adequate authority, the Coastal Council was unable to prevent structures from being sited unwisely close to the eroding shore, thus making them extremely vulnerable to the effects of storms and high tides. The owners of the structures, in most instances, quickly sought permits from the Coastal Council (herein referred to as the Department) to construct hard erosion control devices in order to protect their erosion threatened structures. Unfortunately, hard erosion control devices can sometimes result in increased erosion, a lowering of the beach profile (thereby reducing the beach/dune system's tourist and recreational value), and a decrease in the ability of the beach/dune system to protect upland property from storms and high tides.

In 1986, the Blue Ribbon Committee on Beachfront Management was formed in response to the growing recognition that existing law was inadequate to protect the fragile beach/dune resource. The Committee determined that the beach/dune system of the State was in a state of crisis. The report concluded that "over fifty-seven miles of our beaches are critically eroding. This erosion is threatening the continued existence of our beach/dune system and thereby threatening life, property, the tourist industry, vital State and local revenue, marine habitat, and a national treasure". The 1988 Beachfront Management Act was enacted by the South Carolina General Assembly in response to the concerns presented in this report.

It has been clearly demonstrated that the erosion problems of this State are caused by a persistent rise in sea level, a lack of comprehensive beach management planning, and poorly planned oceanfront development, including construction of hard erosion control structures, which encroach upon the beach/dune system. Sea level rise in this century is a scientifically documented fact. The South Carolina shoreline is suffering from its effects today. It must be accepted that regardless of attempts to forestall the process, the Atlantic Ocean, as a result of sea level rise and periodic storms, is ultimately going to force those who have built too near the beachfront to retreat.

There are three basic approaches to beachfront management: (a) armor the beach with hard erosion control devices; (b) renourish the beach with sand; and (c) retreat from the beach.

The 1977 Coastal Zone Management Act, as amended, rejects construction of new erosion control devices and adopts retreat and renourishment as the basic state policy towards preserving and restoring the beaches of our state. The Department, as steward of the State's coastal resources, has the responsibility under the new statute to implement the forty-year retreat policy by designating a baseline and setback line on all oceanfront properties of the State, developing a long-range comprehensive State plan for management of the beach/dune resource, and supporting the efforts of local governments in developing local long-range beach management plans. In addition, the Department shall require property owners to move new construction and reconstruction as far landward as possible, to limit the size of structures within the constraints of the Act, and to seek innovative ways to ameliorate the effects of beach erosion.

In the final analysis, the long-range public good is the same as the long-range private good. If the dry sand beaches of this State disappear because of the failure of its people and governmental natural resource managers to protect the beach/dune system, future generations will never have the opportunity to use and enjoy this valuable resource.

6.2.4 Consistency

The proposed SHEP would affect coastal waters and tidelands which are considered critical areas. Dredging would be conducted in the Savannah Harbor entrance channel (a portion of which is located within the State of South Carolina). Material would be removed from the inner harbor channel and placed in the existing CDFs along Savannah Harbor. Seven of these CDFS 12A, 12B, 13A, 13B, 14A, 14B and Jones/Oysterbed Island) are located in Jasper County, South Carolina. Effluent discharged from these CDFs would enter Wright River, Savannah River, Back River, or the Intracoastal Waterway. Other areas in the coastal zone of the State of South Carolina would be impacted by implementation of the mitigation plan for the project, which includes construction of a submerged berm across Back River at the mouth of the Sediment Basin, placement of about 2.1 million cubic yards of dredged sediment behind the berm, removal of the Tidegate end walls, and placement of some of the concrete from Tidegate demolition along the banks of Back River and other appropriate locations for fish habitat. Removal of the Tidegate end walls on the South Carolina side would result in the excavation of 0.85 acres of brackish marsh. Implementation of the mitigation plan for the 45, 46, 47 and 48-foot channels would also require dredging in Little Back River to increase the flow of freshwater into that stream. A flow diversion structure would be constructed in McCoys Cut to increase the flow of freshwater into Little Back River. The lower portion (western arm) of McCoys Cut would be closed to maintain the additional flow of freshwater into Little Back River.

As previously discussed in this Consistency Determination, the major impacts to South Carolina coastal waters and tidelands would be an increase in upstream salinity levels that would impact fishery habitat of several species and the loss of 0.85 acres of brackish marsh resulting from the removal of the Tidegate structure end wall in South Carolina. As discussed above and in more detail in the paragraphs below, the SHEP avoids and minimizes adverse impacts to resources in the coastal waters and tidelands to the

maximum extent possible. The SHEP mitigation plan provides compensation for any impacts that cannot be avoided.

The South Carolina DHEC-OCRM must evaluate projects to determine the extent to which the project would further its major objectives which are to "protect and where possible, to restore and enhance the resources of the State's coastal zone for this and succeeding generations". While implementation of the SHEP would not restore or enhance resources in the State's coastal zone, the project's mitigation and adaptive management features provide protection for those resources by providing adequate mitigation where adverse impacts cannot be avoided. Consequently, the SHEP is fully consistent with this provision of the State of South Carolina's Coastal Zone Management Program.

While, the SHEP would impact coastal waters and tidelands, the proposed SHEP would not affect any beaches or dunes in the State of South Carolina.

7.0 CRITICAL AREA BOUNDARIES (SC CODE 30-10)

7.1.1 Coastal Waters and Tidelands

The Department has permit authority over the coastal waters and tidelands critical areas defined in Section 48-39-10 as follows:

a. "Coastal waters" means the navigable waters of the United States subject to the ebb and flood of the tide and which are saline waters, shoreward to their mean high-water mark. Provided, however, that the Department may designate boundaries which approximate the mean extent of saline waters until such time as the mean extent of saline waters can be determined scientifically.

b. "Tidelands" means all areas which are at or below mean high tide arid coastal wetlands, mudflats, and similar areas that are contiguous or adjacent to coastal waters and are an integral part of the estuarine systems involved. Coastal wetlands include marshes, mudflats, and shallows and mean those areas periodically inundated by saline waters whether or not the saline waters reach the area naturally or through artificial water courses and those areas that are normally characterized by the prevalence of saline water vegetation capable of growth and reproduction. Provided, however, nothing in this definition shall apply to wetland areas that are not an integral part of an estuarine system. Further, until such time as the exact geographic extent of this definition can be scientifically determined, the Department shall have the authority to designate its approximate geographic extent.

c. Using biological field surveys and aerial photography, the Department has found the point on the upper reaches of the estuarine systems where tideland vegetation changes from predominately brackish to predominately fresh and has established a boundary using the nearest recognizable physical features within this area. This boundary has been posted on an official map in SC DHEC-OCRM'S

principal offices of business and is available for public review. An approximate description of this boundary is as follows: NOTE: The remainder of this section has been deleted from this Consistency Determination. The deleted section describes an approximate boundary where tideland vegetation changes from predominantly brackish to predominately fresh.

d. All coastal waters and tidelands seaward from this boundary to the State jurisdictional limit are included within the critical areas.

7.1.2 Beaches and Beach/Dune System

The Department has permitting authority over beaches and the beach/dune system. In determining the boundaries of this critical area, the Department will be guided by Section 48-39-270, Section 48-39-280 and Section 48-39-360.

7.1.3 Consistency

Section 30-10 defines the critical areas covered by the SC Coastal Management Plan. The proposed SHEP would not impact any upland beaches or dunes. The proposed SHEP would impact South Carolina coastal waters and tidelands as previously described. This Consistency Determination has been prepared to ensure that the SHEP complies with the South Carolina Coastal Management Program in regards to impacts to coastal waters and tidelands.

7. 2.1 General Guidelines for all Critical Areas (SC CODE 30-11)

The critical areas are of vital importance to the State, and there is strong and growing pressure for the development of these areas. The Department has established these rules and regulations for permit applications in an effort to reduce the irreversible loss of productive tidelands, coastal waters, beaches, and dunes while meeting long-range State development needs.

7.2.2 General Considerations

In assessing the potential impacts of projects in critical areas, the Department will be guided by the policy statements in Sections 48-39-20 and 48-39-30 and the following ten considerations in Section 48-39-150:

a. The extent to which the activity requires a waterfront location or is economically enhanced by its proximity to the water;

b. The extent to which the activity would harmfully obstruct the natural flow of navigable water. If the proposed project is in one or more of the State's harbors, or in a waterway used for commercial navigation and shipping, or in an area set aside for port development in an approved management plan, then a certificate from the South Carolina State Ports Authority declaring that the proposed project or activity would not unreasonably interfere with commercial navigation and shipping must be obtained by the

Department prior to issuing a permit;

c. The extent to which the applicant's completed project would affect the production of fish, shrimp, oysters, crabs, or clams or any marine life or wildlife, or other natural resources in a particular area, including but not limited to water and oxygen supply;

d. The extent to which the activity could cause erosion, shoaling of channels or creation of stagnant water;

e. The extent to which the development could affect existing public access to tidal and submerged lands, navigable waters and beaches, or other recreational coastal resources;

f. The extent to which the development could affect the habitats for rare and endangered species of wildlife or irreplaceable historic and archeological sites of South Carolina's coastal zone;

g. The extent of the economic benefits as compared with the benefits from preservation of an area in its unaltered state;

h. The extent of any adverse environmental impact which cannot be avoided by reasonable safeguards;

i. The extent to which all feasible safeguards are taken to avoid adverse environmental impact resulting from a project;

j. The extent to which the proposed use could affect the value and enjoyment of adjacent owners.

7.2.3 Further Guidelines

In the fulfilling of its responsibility under Section 48-39-150, t**he** Department must in part base its decisions regarding permit applications on the policies specified in Sections 48-39-20 and 48-3930, and thus, be guided by the following:

a. The extent to which long-range, cumulative effects of the project may result within the context of other possible development and the general character of the area.

b. Where applicable, the extent to which the overall plans and designs of a project can be submitted together and evaluated as a whole, rather than submitted piecemeal and in a fragmented fashion which limits comprehensive evaluation.

c. The extent and significance of negative impacts on Geographic Areas of Particular Concern (GAPC). The determination of negative impacts will be made by the Department in each case with reference to the priorities of use for the particular GAPC.

The priorities of use are found in Chapter IV of the Coastal Management Program.

7.2.4 General Guidelines for Beaches and the Beach/Dune System

These guidelines are not included in this Consistency Determination because the SHEP would not affect any beaches or dunes in South Carolina.

7.2.5 Consistency.

Consideration One. The extent to which the activity requires a waterfront location or is economically enhanced by its proximity to the water.

As previously addressed in this document, deepening of the Savannah Harbor Navigation Channel is the only viable alternative to address the navigation inefficiencies associated with the current controlling depth of -42 feet MLLW. Other alternatives, including non-structural alternatives, were considered early in the study process as documented in Appendix O of the EIS. Consequently, there are no known alternatives that could be implemented to avoid construction work in the aquatic and marine environment.

Consideration Two. The extent to which the activity would harmfully obstruct the natural flow of navigable water. If the proposed project is in one or more of the State's harbors, or in a waterway used for commercial navigation or shipping, or in an area set aside for port development in an approved management plan, then a certificate from the South Carolina State Ports Authority declaring that the proposed project or activity would not unreasonably interfere with commercial navigation or shipping must be obtained by the Department prior to issuing a permit.

The proposed SHEP would improve navigation by remedying navigation restraints in an existing Federal deep-draft navigation project (Savannah Harbor) used for commercial navigation and shipping.

Various features of the SHEP mitigation plan would alter but not harmfully obstruct the natural flow of navigable water in the estuary. Flows from Front River into Back River will be reduced by constructing the submerged berm in Back River. This berm is part of the project's mitigation plan and is designed to reduce the amount of salt water from Front River moving up Back River to brackish and freshwater marsh areas. The flow diversion structure to be constructed at McCoys Cut would allow more freshwater from the Savannah River to flow into Middle River and Little Back River. The closure structure in the western arm of McCoys Cut would help maintain this increased flow of freshwater into Middle River and Little Back River. Although this closure structure would remove a "short cut" between Front River and McCoys Cut, it would not prevent access for recreational boaters to any waterway in the area. None of these streams (McCoys Cut, Middle River, Little Back River) are used for commercial navigation or shipping.

Construction of these flow diversion structures is critical to the success of the project's mitigation plan. The diversion of additional freshwater into these streams would help to

offset the expected upstream increases in salinity resulting from construction of the project. In turn, this increase in freshwater into these areas would maintain a dependable source of freshwater for the SNWR and minimize adverse (salinity) impacts to tidal freshwater marshes, and Striped bass and Shortnose sturgeon habitat in the area.

Consideration Three. The extent to which the applicant's completed project would affect the production of fish, shrimp, oysters, crabs, clams or any marine life or wildlife, or other natural resources in a particular area, including but not limited to water and oxygen supply.

Construction of the SHEP would not adversely affect the production of fish, shrimp, oysters, crabs, clams or other marine life. The dredging requirements for the SHEP in South Carolina would be confined to the existing channel (except in the area of one of the meeting areas and two of the channel bend wideners) in the inner harbor and the entrance channel, McCoys Cut, and the upper portion of Little Back River. Most of the dredged material would be discharged into the existing CDFs routinely used for Savannah Harbor.

Essential fish habitat (See Appendix S) in the project area includes estuarine emergent wetlands (includes palustrine, emergent, and forested wetlands), estuarine scrub/Shrub, submerged aquatic vegetation, oyster reefs and shell banks, intertidal flats, aquatic beds, estuarine water column (during construction) and estuarine water column (dissolved oxygen). Some dredged material (and clean fill material) would be placed in open water areas to construct the various mitigation features of the project. This dredged material does not contain contaminants at levels of concern. The dredged material used to construct the mitigation features of the project would not be discharged into any estuarine emergent wetlands. Adverse effects to other essential fish habitat (water column, etc.) would be avoided by not placing any dredged material into open water areas upstream of Station 63+000 during the Striped bass spawning season (April 1- May 15) and by not depositing dredged material into open water areas during periods of low dissolved oxygen levels in Savannah Harbor.

Hydrodynamic and water quality modeling conducted during SHEP studies predict that without mitigation, channel deepening would decrease upstream dissolved oxygen levels. Consequently, the project's mitigation plan includes injection of oxygen at three locations in the estuary to remedy this effect. Injection of oxygen into Savannah Harbor during periods of low dissolved oxygen (summer months) would remove the adverse incremental effects of the SHEP on the dissolved oxygen regime in Savannah Harbor. Due to the spacing of the systems, the dissolved oxygen regime would be improved in over 90 percent of the estuary when compared to existing conditions.

Modeling conducted during SHEP studies indicates that channel deepening would adversely affect Striped bass and Shortnose sturgeon habitat. These adverse effects are mainly related to predicted increases in upstream salinity levels. The flow modifications in McCoys Cut, Middle River, and Little Back River are designed to increase the amount of freshwater entering these waterways, while the sill in Back River is designed to decrease the amount of salty water entering Back River.

As shown in the preceding tables in this Consistency Determination, additional mitigation would be required for adverse impacts to Striped bass and Shortnose sturgeon habitat,

despite implementation of the flow diversion measures and oxygen injection. Additional mitigation to offset adverse impacts to Striped bass would consist of funding the Georgia DNR to stock fingerling Striped bass in the lower Savannah River. This would mitigate for the loss of Striped bass spawning, egg, and larvae habitat. The fingerlings would replace juvenile fish that might not reach the fingerling stage because of this loss of habitat. The Georgia Department of Natural Resources Wildlife Resources Division has stocked this species in the estuary in the past. The recent growth in the Striped bass population in the lower Savannah River indicates that stocking is effective in getting the species past those bottlenecks in its life cycle. Annual stocking of fingerling Striped bass would ensure that the Striped bass sport fishery in the lower Savannah River is protected and remains viable.

The SHEP mitigation plan provides for a sufficient post-construction monitoring period to ensure project features function as intended and impacts are within the range of those predicted. As part of that plan, the data collected from the field data collection efforts would be used in conjunction with the hydrodynamic and water quality models to assess the impacts of the SHEP on Striped bass habitat. This study would be conducted during years 2, 4 and 9 of the Post-Construction monitoring period. Additional funding could be provided for Striped bass stocking if the data indicates that is appropriate.

Additional mitigation for project impacts to Shortnose sturgeon habitat would be provided by constructing a fish bypass at the New Savannah Bluff Lock and Dam. This bypass would be designed to provide Shortnose sturgeon (as well as other species of anadromous fish) access to traditional spawning grounds above the dam. The mitigation for Shortnose sturgeon habitat is discussed in more detail below in the section addressing endangered species and in Appendix C of the EIS.

Consideration Four. The extent to which the activity could cause erosion, shoaling of channels or creation of stagnant water.

The proposed SHEP would not have any major impacts on existing shoaling rates, bank erosion nor would it create any areas of stagnant water.

Consideration Five. The extent to which the development could affect existing public access to tidal and submerged lands navigable waters and beaches, other recreational coastal resources.

The proposed SHEP would not block public access to tidal and submerged lands, navigable waters and beaches, or recreational coastal resources. Closures would occur at Rifle Cut (a man-made passage in Georgia) and the western end of McCoys Cut (South Carolina). Both of these areas are within the Savannah National Wildlife Refuge and are not used by commercial traffic. Closing Rifle Cut would lengthen the transit of recreational boaters using the existing boat ramp at the Houlihan Bridge who travel to Back River. The project would address those impacts by constructing a new boat ramp on Hutchinson Island to provide more direct access to Back River for recreational boaters. The Corps would give the ramp to Chatham County to operate the facility in perpetuity. The project does not include any closure structures on Little Back River.

Consideration Six. The extent to which the development could affect the habitats for

rare and endangered species of wildlife or irreplaceable historic and archaeological sites of South Carolina's coastal zone.

A Biological Assessment of Threatened and Species (BATES) was prepared to evaluate the potential impacts of the SHEP on threatened and endangered species (See EIS-Appendix B). The conclusion reached in the BATES is that the proposed SHEP may affect but is not likely to adversely affect piping plover, wood stork, West Indian manatee, right whale and humpback whale, sea turtles, and Shortnose sturgeon. The BATES was sent to the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) for their review and comment and/or Biological Opinion. The USFWS has concurred with the findings of the BATES in regards to the species for which they have responsibility: the Piping plover, Wood stork, West Indian Manatee, and nesting sea turtles. NOAA has issued a Biological Opinion for the species for which they are responsible. The BO includes reasonable and prudent measures to protect Loggerhead and Kemp's Ridley sea turtles and Shortnose and Atlantic sturgeon. The report prepared by the USFWS and the BO prepared by NOAA are included in Appendix Z.

As discussed in the previous section, additional mitigation would be required because of SHEP impacts on Shortnose sturgeon habitat. The SHEP mitigation plan includes construction of a fish bypass structure at the New Savannah Bluff Lock and Dam to provide Shortnose sturgeon access to traditional spawning grounds above the dam. Construction of the fish bypass to expand the spawning area of Shortnose sturgeon is appropriate mitigation for the remaining impacts to that species habitat. The adverse impacts of previous developments on the Savannah River on Shortnose sturgeon (i.e. dams that block access to traditional upstream spawning areas) is well documented. Successful fish passage of Shortnose sturgeon at the New Savannah Bluff Lock and Dam would also benefit other species of fish such as American Shad and Atlantic sturgeon. A horseshoe rock ramp design was proposed in the DEIS. However based on comments received during the review of the DEIS and a fish passage workshop held in April 2011. As a result of that workshop and subsequent coordination with NOAA Fisheries, the Corps has revised the design and now proposes an off-channel rock ramp at that site. The off-channel rock ramp design would capture substantially more of the river flow and provide a greater effectiveness in regards to fish passage than the horseshoe design. The success of fish passage at the New Savannah Bluff Lock and Dam would be monitored during the Post-Construction phase of the project.

It should be noted that the adverse impacts of the SHEP on Shortnose sturgeon habitat are mainly in the Savannah River within the State of Georgia. With the flow modifications and oxygen injection, there would be a slight increase in Shortnose sturgeon habitat in South Carolina in Little Back River in the vicinity of the SNWR.

Construction of the SHEP may affect significant archaeological, historic and submerged resources in South Carolina. Specifically, two anomalies are located in South Carolina waters between Stations 41+500 and 49+500, two Confederate crib obstructions are located between Stations 55+000 and 68+500, and the *CSS Georgia* is located in Back River. A Programmatic Agreement (PA) has been prepared in accordance with 36 CFR 800.14b(1)(ii) that outlines a strategy for conducting surveys, determinations of

significance and effect, and mitigation. The PA has been coordinated with and signed by the Georgia and South Carolina State Historic Preservation Offices, and the US Navy, the owner of the *CSS Georgia*. The PA has been coordinated with appropriate federally recognized tribes. The agreement is included at Appendix G in the final Environmental Impact Statement.

Consideration Seven. The extent of the economic benefits as compared to the benefits from preservation of an area in an unaltered state.

Navigation studies undertaken by the US Army Corps of Engineers evaluate the benefits of a proposed project from a national perspective and do not focus on an individual state or region when selecting the National Economic Development Plan. The proposed 47-foot depth alternative is expected to result in economic benefits to the Nation of $177 million per year. The economic benefits remaining after project costs (including environmental mitigation) are included would be $116 million per year. The economic benefits of the proposed project are substantial.

Consideration Eight. The extent of any adverse environmental impact which cannot be avoided by reasonable safeguards.

US Army Corps of Engineers procedures for evaluating project impacts and developing appropriate mitigation measures were followed in developing the various plans considered in the SHEP. Impacts have been avoided and minimized to the maximum extent practicable. Impacts that cannot be avoided include the loss of 15.68 acres of brackish marsh due to excavation requirements of the project, the conversion of up to 223 acres of tidal freshwater marsh to brackish marsh, the loss of Striped bass spawning, egg, and larvae habitat in the lower Savannah River, and the loss of Shortnose sturgeon habitat in the lower Savannah River. Since these impacts cannot be avoided, mitigation is included to compensate for these impacts.

As previously discussed, model studies indicate that the injection of oxygen would remove the incremental impacts of the SHEP on dissolved oxygen levels in Savannah Harbor. Because of the spacing of the systems, incidental improvements to dissolved oxygen levels would occur in over 90 percent of the estuary. The systems would be operated during the summer months when dissolved oxygen levels are traditionally low.

Approximately 15.68 acres of brackish marsh would be lost as result of the expansion of the Kings Island Turning Basin (3.0 acres-Georgia), removal of the Tidegate Structure end walls (7.63 acres in Georgia and 0.85 acres in South Carolina), and miscellaneous excavation requirements of the project (4.2 acres-Georgia). In-kind mitigation would be provided by grading down dredged material deposits (about 40.3 acres) in Disposal Area 1S located at the juncture of Front River and Middle River to allow the area to re-vegetate with indigenous marsh species. The area would be sprigged with *Spartina alterniflora*, if required. The marsh restoration site would be monitored to ensure that the marsh restoration is successful. Monitoring would include checking for invasive species and their removal if required. The restoration of 40.3 acres of marsh in Disposal Site 1S would provide the required compensation (28.8 acres) for SHEP impacts. The remaining 11.5 acres of restored marsh would be used for any additional mitigation needs of the SHEP and wetland mitigation needs associated with the operation and maintenance of the

Savannah Harbor Navigation Project.

All channel depths evaluated in the SHEP would affect some of the tidal freshwater marshes (via increased salinity levels) located in the estuary. This would be the case irrespective of the proposed mitigation features (flow rerouting). Adverse impacts to tidal freshwater marsh would occur in Georgia in areas mainly between Front and Middle Rivers from just below the Georgia Highway 25 crossing to just above Front River's juncture with the Steamboat River. With the flow diversion measures in place, the amount of tidal freshwater marsh in South Carolina should increase along the Little Back River in the vicinity of the SNWR.

The SHEP would not destroy tidal freshwater marsh. Instead, up to 223 acres (with the 47-foot project) is calculated to transition to a brackish marsh community. Many of the emergent plant species associated with the tidal freshwater marsh communities would still flourish after project implementation. Emergent plant species often associated with freshwater communities are readily observed in environments that have been defined as brackish marsh (Latham et. al., 1994).

Although the composition of tidal freshwater vegetation would change with brackish marsh species becoming more prevalent, the basic wetland functions associated with these plant communities would not be materially transformed. A comparison of potential changes in wetland function after conversion of freshwater wetlands to brackish wetlands reveals there are only negligible alteration to functions such as water purification, flood protection, shoreline stabilization, groundwater recharge, streamflow maintenance, retention of particles, surface water storage, subsurface storage, nutrient cycling, and values to society as shown in Table 7. There would be a minor effect on the fish and wildlife element, as a result of converting tidal freshwater marsh to brackish marsh.

As shown in Table 7, approximately 740 acres of saltmarsh is calculates to change through time to a brackish marsh. Dominant saltmarsh species like *Spartina alterniflora* would still be observed in areas which have salinities that define a brackish marsh. However, the overall basic wetland functions would not change. As shown in Table 7, the conversion of a saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species.

A comparison of fish and wildlife habitat between freshwater and brackish marsh yields fewer similarities. However, the conversion in fish and wildlife habitat would still be minor when considering the total function of the wetland and the continued existence of some freshwater vegetation after deepening in wetland areas that would be viewed as brackish marsh. Even though there would only be a minor change in fish and wildlife habitat where tidal freshwater marsh is converted to brackish marsh, a determination was made that mitigation for this conversion was warranted.

The Corps made use of a Wetland Interagency Coordination Team (ICT) consisting of technical expert representatives from USACE, and Federal and state natural resource agencies (including SC DHEC-OCRM) to identify acceptable mitigation for the proposed project. The Corps also consulted with the Stakeholder Evaluation Group, including its

Non-Governmental Organization members, to identify any suitable mitigation alternatives. At that time, the USFWS stated that mitigation actions must be performed within the basin for impacts to SNWR wetlands.

The Wetland Interagency Coordination Team concluded there were no opportunities either to restore or create substantial acreages of tidal freshwater marsh in the estuary. Consequently, preservation of lands that are ecologically valuable and add to the purposes of the SNWR was identified as appropriate mitigation for the remaining wetland impacts. These would be properties already identified in the SNWR Acquisition Plan. It was the consensus of the team that acquisition/preservation of these lands would serve as mitigation for reducing the only wetland function (fish and wildlife habitat value of freshwater marsh) materially changed by the SHEP.

The proposed preservation parcel (s) to mitigate for the above vegetative changes would consist of 2,245 acres of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and re-growth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer would provide a functional replacement for the conversion of the only wetland function (fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion. Thus, the functional assessment conducted for all wetland areas proposed for impact and mitigation satisfies the intent of the no-net loss criterion.

As shown in Table 5, approximately 167 acres (16.1%) of Striped bass spawning habitat, about 181 acres of Striped bass egg habitat (10.8%), and approximately 20 acres of Striped bass larvae habitat (3.5%) would be adversely affected by the SHEP even with flow diversion. As discussed above, this impact would be mitigated by funding the State of Georgia to stock fingerling Striped bass.

As shown in Table 5, approximately 266 acres (6.9%) of adult winter Shortnose sturgeon habitat and about 251 acres (7.6%) of juvenile winter Shortnose sturgeon habitat would be adversely affected by the SHEP even with flow diversion and oxygen injection. Approximately 89 acres (6.5%) of summer Shortnose sturgeon habitat would be beneficially affected by the SHEP. As previously discussed, a fish bypass would be constructed at the New Savannah Bluff Lock and Dam to provide Shortnose sturgeon (and other anadromous species of fish) access to traditional spawning grounds above the dam as mitigation for this loss of habitat.

The SHEP also features an adaptive management (See Appendix D) approach to the mitigation features. The effectiveness of all of the project's mitigation features would be monitored during the Post-Construction phase of the project to determine if any modifications to the mitigation measures are warranted. Funds are also included in the project to modify the mitigation features and/or provide additional mitigation if the monitoring demonstrates that such action is necessary.

Consideration Nine. The extent to which all feasible safeguards are taken to avoid adverse environmental impact resulting from a project.

As discussed in Consideration Eight, all adverse impacts resulting from implementation of the SHEP have been avoided or minimized to the maximum extent practicable. The project features an extensive monitoring plan (See Appendix D) that would be conducted during both the construction and post-construction phases. The monitoring plan has been designed to monitor the performance of the project and its mitigation features to ensure that impacts do not exceed those expected. Funds are also included in the project to modify the mitigation features and/or provide additional mitigation if the monitoring demonstrates that such action is necessary.

Consideration Ten. The extent to which the proposed use could affect the value and enjoyment of adjacent owners. The project involves deepening an existing Federal navigation channel which is used for commercial navigation. Consequently, implementation of the SHEP would be in consonance with most of the activities along the harbor which are industrial and commercial in nature. However, an evaluation was conducted of other types of properties along and adjacent to the harbor such as Fort Pulaski, Fort Jackson, the SNWR, etc. to determine if the SHEP would adversely affect these properties. The project would adversely affect some areas of the SNWR as previously described, but also benefit other areas of the Refuge. The engineering consultant to the Joint Project Office that is evaluating development of a container terminal in Jasper County recently indicated that deposition of the new work sediments from this project on the site they are considering for development would save the developers around $300 million in the cost of fill. Deepening the harbor past the site of that facility would also save its developers the cost of deepening the navigation channel to that site (which they have stated would be necessary to successfully operate that container terminal). The State of South Carolina is one of the two joint owners of that property and is one of the entities pursuing development of the site.

7.2.6 Further Guidelines. The OCRM must also consider the following in reviewing permit applications or Federal Consistency Determinations:

The extent to which long-range, cumulative effects of the project may result within the context of other possible development and the general character of the area.

The EIS includes a Cumulative Impact Analysis (Appendix L). This cumulative impact analysis evaluated past, present and known future actions on wetlands, fisheries, the dissolved oxygen regime in Savannah Harbor, groundwater, Shortnose sturgeon, and the Tybee Island Shelf and Beach. Cumulative impacts associated with the SHEP of most concern include the conversion of tidal freshwater marsh to brackish marsh, loss of 15.68 acre of brackish marsh associated with the excavation requirements for the project, adverse effects to Striped Bass habitat, impacts to the dissolved oxygen regime in Savannah Harbor, and adverse impacts to Shortnose sturgeon habitat in the lower Savannah River. Impacts to these resources resulting from implementation of the SHEP were avoided or minimized to the maximum extent practicable. The project would provide appropriate mitigation where impacts to these resources could not be avoided.

The only other known harbor development project that could result in similar concerns is

the proposed container terminal in Jasper County. The proposed terminal would be located in what are now Corps of Engineers' CDFs 14A and 14B at about River Mile 6. If the SHEP is constructed, it is assumed that entrance channel and inner harbor channel depth requirements would be similar for that container terminal. Consequently, very little additional dredging would be required for a Jasper County facility if the SHEP is constructed.

The main cumulative impacts of concern that would be associated with a proposed Jasper facility would be the direct impacts on wetland resources in the Savannah estuary. Construction of a container facility in CDFs 14A and 14B would require extensive construction through wetland areas to provide the required rail and road infrastructure. The Corps of Engineers maintains dredged material disposal easements in CDFs 14A and 14B. The Federal government would not release its easements until it was "made whole" in regards to the replacement of dredged material disposal capacity that would be lost in CDFs 14A and 14B. Replacing this loss of dredged material disposal capacity could result in substantial wetland impacts.

Where applicable, the extent to which the overall plans and designs of a project can be submitted together and evaluated as a whole, rather than submitted piecemeal and in a fragmented fashion which limits comprehensive evaluation.

The SC DHEC-OCRM has been provided all plans associated with the SHEP in the GRR and EIS.

The extent and significance of negative impacts on Geographic Areas of Particular Concern (GAPC). The determination of negative impacts will be made by the Department in each case with reference to the priorities of use for the particular GAPC. The priorities of use are found in Chapter IV of the Coastal Management Program.

Chapter 4 of the South Carolina Coastal Management Program was consulted to determine if the SHEP would impact any Geographic Areas of Particular Concern (GPAC). Based on that review, the following GPACs could be affected by the SHEP:

a. Areas of Unique Natural Resource Value.

Marshes. Construction of the SHEP would result in the loss of 0.85 acres of brackish marsh in the State of South Carolina where the end wall of the Tidegate Structure would be removed on the South Carolina side of the river. The project provides in-kind mitigation by restoring marsh in Disposal Site 1S.

Savannah National Wildlife Refuge. Adverse impacts in the SNWR resulting from construction of the SHEP include conversion of tidal freshwater marsh to brackish marsh, loss of three acres of brackish marsh due to the expansion of the Kings Island Turning Basin, and loss of Shortnose sturgeon habitat. The project includes mitigation for these unavoidable adverse impacts. These adverse impacts are located in the State of Georgia.

b. Wildlife and game management areas under ownership and/or management of the South Carolina Wildlife and Marine Resources Department.

Turtle Island is located in Jasper County, South Carolina. It is located just north of the navigation channel near the entrance of the inner harbor. The main potential threat to Turtle Island would be increased erosion. Turtle Island is protected from any erosion caused by vessels in the inner harbor since it is sheltered from the navigation channel by the entrance channel jetties and Jones/Oysterbed Island. Wave action and subsequent erosion on Turtle Island from vessels in the entrance channel is not a major problem because of its distance from the entrance channel. Also, ship wake and erosion studies conducted during SHEP studies indicate that harbor deepening would have very little impact on shoreline erosion rates in the vicinity of the project.

c. Groundwater Resources.

As previously discussed in this Consistency Determination, studies conducted during the SHEP indicate that harbor deepening would have very little impact on the movement of saltwater through the Miocene protective layer into the Floridan aquifer.

d. Threatened or Endangered Species Habitats.

As discussed previously in this Consistency Determination, Shortnose sturgeon habitat in Georgia would be adversely affected by harbor deepening. Those impacts (increase in upstream salinity levels) would be minimized as much as possible through the flow diversion plan. The flow diversion plan includes providing more freshwater into the upper reaches of Middle River and Little Back River, while reducing the flow of saltwater into the lower ends of those streams. Potential impacts to dissolved oxygen levels would be mitigated through injection of oxygen. Even with these project features, additional mitigation would be required to offset project impacts on Shortnose sturgeon habitat. Consequently, the project's mitigation plan includes the construction of a fish bypass at the New Savannah Bluff Lock and Dam to provide Shortnose sturgeon access to about 20 miles of former spawning habitat.

e. Navigation Channels.

The proposed SHEP would involve deepening an existing navigation channel to enable vessels to enter the harbor more fully loaded, as well as accommodate larger vessels expected to call in the future. Consequently, this project fully complies with the priority use of a navigation channel as specified in Chapter 4 of the South Carolina Coastal Management Program. All adverse impacts associated with the project have been identified and mitigation measures have been included to ameliorate those impacts.

f. Areas of Special Historic, Archeological or Cultural Significance.

The Area of Potential Effect (APE) for historic properties in South Carolina includes: the north side of the existing entrance channel, the north side of the inner harbor channel from the Savannah River mouth to the Back River entrance, the entrance channel bend widener, the eastern two-thirds of the proposed passing lane located in the vicinity of the mouth of Back River, and the fish and wildlife mitigation features located along the north sides of Back River and Little Back River. Archaeological remote sensing surveys and diver evaluation of anomalies and targets have been completed for all areas, except the

Fish and Wildlife mitigation features, which were identified late in project planning. These features will be surveyed and evaluated with avoidance of impacts as the preferred mitigation alternative. All completed archaeological survey and testing reports have been reviewed and approved by the South Carolina State Historic Preservation Officer.

Two significant historic properties have been identified within the South Carolina APE. These include the National Register listed CSS Georgia wreck site and the eroded remains of two Confederate crib obstructions located north of the wreck. The wreck would be impacted by channel deepening and the construction of the passing lane. The crib site would be impacted by the construction of the passing lane. The archaeological survey and testing reports have been reviewed and approved by the South Carolina SHPO. Both sites will be mitigated through archaeological data recovery. The wreck site is located in Georgia and South Carolina. In 2003, the South Carolina SHPO determined that, due to the vessel's association with the state of Georgia (designed, built, manned, operated, and scuttled by Georgians in Georgia) and that only a recent change to the state boundary moved most of the wreck site into South Carolina, the Georgia SHPO should assume lead SHPO responsibility for compliance with the National Historic Preservation Act for this resource.

A draft Programmatic Agreement outlining compliance procedures for Section 106 of the National Historic Preservation Act was coordinated with the South Carolina and Georgia SHPO's and Native American Tribes. All approved the draft document. The document was held for signature in order to incorporate changes to the project (e.g. passing lanes) and clarification of the Fish and Wildlife mitigation features. Minor modifications have been made to the document to address these features and to include the US Navy as a consulting party. The finalized document has been coordinated and signed by the SHPOs and the US Navy. The document has been coordinated with the appropriate Federally recognized tribes.

Cultural resources surveys were conducted to identify resources that could potentially be impacted by the project. Mitigation is included in the project for adverse impacts to remains of the CSS Georgia, which is located at the junction of Front River and Back River. Additional studies will be conducted prior to construction on lands that would be impacted by the proposed mitigation. For those resources located in South Carolina, the results of those investigations will be coordinated with the South Carolina SHPO. All work would be conducted in compliance with the Programmatic Agreement for this project that was signed by the South Carolina SHPO and the Corps.

g. Living Marine Resources.

Marine resources in the State of South Carolina that would be adversely affected by the SHEP would be mainly those benthic communities located in the navigation channel that would be removed by the dredging. To protect marine resources (mainly sea turtles), the use of hopper dredges in the bar channel would be restricted to the period December 1-March 31.

Adverse impacts associated with the proposed SHEP have been evaluated and minimized

as much as possible. In those cases where adverse impacts would be unavoidable, mitigation would be provided to offset those impacts.

Based on these determinations, the proposed SHEP complies with the General Guidelines for Critical Areas.

8.0 Specific Project Standards for Tidelands and Coastal Waters (SC CODE 30-12).

8.1.1 Docks and Piers. Section 30-12 provides standards for various types of private, commercial and community docks and piers.

8.1.2 Consistency. The SHEP would not include the construction of any docks and piers

8.2.1 Boat ramps. Section 30-12 provides standards for boat ramps.

8.2.2 Consistency. The SHEP would not include the construction of any boat ramps in South Carolina. A concrete boat ramp would be constructed on the Georgia side of Back River to replace fisherman access lost as a result of blocking Rifle Cut.

8.3.1 Bulkheads and Revetments (Rip-rap) (Other than ocean front, as covered under R.30-13(N). Section 30-12 provides standards for bulkheads and revetments (rip-rap) designed to mitigate environmental losses.

8.3.2 Consistency. Most of the use of stone, rip-rap, etc. is associated with construction of the mitigation features. These activities include construction of a diversion structure at McCoys Cut, closure of the western end of McCoys Cut, and the closure of Rifle Cut. These measures are designed to increase the flow of freshwater into Middle River and Back River and to decrease the amount of saline water that enters these streams. The placement of rip-rap in Back River would also be required on the Georgia side to stabilize the shoreline in the vicinity of the proposed boat ramp.

A submerged sill (stone) would be constructed in Back River across the mouth of the Sediment Basin. The purpose of this sill and berm would be to reduce salinity levels in Back River by reducing the amount of saltwater from Front River that enters Back River. At the request of the resource agencies, concrete obtained from the Tidegate would be placed along the shoreline in areas of Back River and other appropriate locations to provide fish habitat. No marsh would be filled with this material. Some of this concrete rubble maybe placed along the shoreline in areas of heavy erosion. This material would not be used to fill any wetlands.

Based on the intended uses (mitigation, fish habitat, and erosion control) of the above material and the commitment to avoid filling wetlands, this portion of the SHEP project is consistent with the standards in 30-12 regarding bulkheads and revetment..

8.4.1 Cable, Pipelines and Transmission Lines. Section 30-12 provides standards for the installation of cables, pipelines, and transmission lines to protect the environment, especially when they require construction in wetland areas.

8.4.2 Consistency. Construction of the oxygen injection systems (in Georgia) would require some pipes to be placed in the river. This would be done in a manner to avoid or minimize adverse impacts to wetlands in the vicinity of the oxygen injection systems.

8.5.1 Marina/Community Dock Location and Design. Section 30-12 provides detailed requirements for both the construction and operation of marinas.

8.5.2 Consistency. The SHEP would not involve the construction of any marina facilities.

8.6.1 Transportation. Section 30-12 provides guidance to prevent environmental degradation in the coastal zone relevant to the construction of various types of transportation projects including highways, airports, etc.

8.6.2 Consistency. The SHEP would not involve the construction of any highway or airport. Normal maintenance of roads in the CDFs is carried out in strict accordance with South Carolina Erosion Control Procedures. The SHEP is consistent with the provisions concerning transportation projects.

8.7.1 Dredging and Filling. Section 30-12 describes various requirements and standards designed to minimize environmental degradation caused by dredging and filling actions as follows:

Development of wetland areas often has been considered synonymous with dredging and filling activities. Dredging and filling in wetlands can always be expected to have adverse environmental consequences; therefore, the Department discourages dredging and filling. There are cases, however, where such unavoidable environmental effects are justified if legitimate public needs are to be met.

The specific standards are as follows:

a. The creation of commercial and residential lots strictly for private gain is not a legitimate justification for the filling of wetlands. Permit applications for the filling of wetlands and submerged lands for these purposes shall be denied, except for erosion control, see R.30-12(C), or boat ramps, see R.30-12(B). All other dredge and fill activities not in the public interest will be discouraged;

b. Dredging and filling in wetland areas should be undertaken only if that activity is water-dependent and there are no feasible alternatives;

c. To the maximum extent feasible, dredging and filling activities should be restricted in nursery areas and shellfish grounds and during periods of migration, spawning, and early development of important sport and commercial species;

d. Dredging and excavation shall not create stagnant water conditions, lethal fish entrapments, or deposit sumps or otherwise contribute to water quality degradation;

e. Designs for dredging and excavation projects shall, where feasible, include protective measures such as silt curtains, diapers, and weirs to protect water quality in adjacent areas during construction by preventing the dispersal of silt materials;

f. Dredged materials shall be deposited and contained in such a manner so as to prevent dispersal into adjacent wetland areas and, in all cases, new facilities must have permanent upland disposal sites. Existing facilities must have either permanent upland disposal sites or EPA approved ocean disposal sites;

g. Applications for dredging in submerged and wetland areas for purposes other than access, navigation, mining, or drainage shall be denied, unless an overriding public interest can be demonstrated. Dredging permits for mining will be issued only as specified in (2) (h) below. Drainage permits must be consistent with the provisions in R.30-12(L);

h. Applications for dredging for mining activities within the critical areas will be denied unless a significant portion of the resource is located in the critical area, extraction of the resource is clearly necessary, and benefits derived from extraction would outweigh resultant detrimental impacts on coastal ecosystems. For any permit issued to allow dredging for mining operations in the critical areas, a complete site reclamation plan shall be required;

i. Wetlands shall not be utilized as depositories for waste materials except as discussed in R.30-I 2(I and J);

j. In all cases, dredging activities shall not he approved until satisfactory disposal sites have been acquired.

k. Only hydraulic dredging is permitted unless the material is being placed in a hopper barge for offshore disposal or unless the applicant can show that hydraulic dredging is infeasible in a site-specific application.

1. Marinas will usually not be allowed in areas that require maintenance dredging more often than once every four years.

8.7.2 Consistency.

No dredged sediment from the SHEP would be used to create land to be used for development purposes.

Construction of the SHEP would involve dredging primarily in open water areas in South Carolina's coastal zone, although some excavation of wetlands would also occur. Dredging in South Carolina waters would include McCoys Cut, Little Back River, and a portion of the entrance channel. Approximately 0.85 acres of saltmarsh would be removed from the South Carolina side of the Tidegate abutment. Those impacts would be mitigated through the restoration of brackish marsh at Disposal Area 1S. Sediments

would be deposited into the Sediment Basin in Back River as part of the mitigation features of the project. Approximately 100,000 cubic yards of stone would be placed in Back River to construct a submerged sill across the mouth of the Sediment Basin. Approximately 2.1 million cubic yards of sediment would be placed upstream of the sill to construct a broad berm in the lower end of the Sediment Basin. This sill and berm would reduce the upstream flow of saltwater into Back River. This part of the mitigation plan is designed to reduce the impacts on tidal freshwater marsh and fishery habitat. Effluent from the CDFs located in South Carolina would be discharged into South Carolina waters.

No dredging and filling would occur in designated shellfish areas in the State of South Carolina. Construction of the SHEP would not create stagnant water conditions, lethal fish entrapments or deposit sumps. The project's mitigation plan includes injection of oxygen at strategic locations in Savannah Harbor to offset potential impacts to dissolved oxygen levels.

Sediment dredged from the inner harbor channel would be placed into existing CDFs along the harbor. The discharge of effluent from the weirs in the CDFs would be monitored for various parameters during construction including suspended solids. No sediment would be discharged into Back River to partially fill in the Sediment Basin until the sill is in place to ensure the sediment would not be washed downstream. Sediment that would be deposited in the basin has a high sand content, minimizing increases in suspended solids.

The proposed SHEP would not involve any mining activities.

No dredged sediment would be deposited in wetlands.

Construction of the SHEP would primarily involve the use of hydraulic pipeline dredges or hopper dredges. There could be a need to use other equipment such as mechanical dredges or clamshells, especially where there is s need to remove debris.

Based on these determinations, the SHEP is consistent with the dredging and filling requirements of Section 30-12.

8.8.1 Navigation Channels and Access Canals

Section 30-12 prescribes specific standards designed to minimize the adverse effects of the disposal of dredged material. Certain dredging activities involve the creation and maintenance of navigation channels and access canals. These activities have a potential for severe environmental impacts and should meet a demonstrated public need.

Where the Department determines that such activities are justified, the following standards will he applied:

a. Dredging for establishment of new canals which involves permanent alteration of wetland habitats will be prohibited unless no feasible alternative exists. Establishment of canals for purposes of creating waterfront lots from inland property will be prohibited unless it can be demonstrated that there will be no significant environmental impacts on critical areas;

b. To the extent feasible, project plans must utilize piers or catwalks, rather than channels or canals, to reach deeper water areas;

c. Access canals shall be designed to insure adequate flushing and shall not create dead-end or stagnant water pockets. Open-ended, U-shaped, or semicircular canals are generally preferred over dead-end canals, since they usually provide better water circulation;

d. Highland waterway construction that is slated to be tied into wetland areas shall be constructed in the dry, if feasible, so that sloping and stabilization of the banks can be completed before the plug is removed for the connection to open waters. Where dry construction is not possible, temporary plugs or silt curtains at the end of canals connected to waterways should be maintained until all sediment settles out;

e. The sides of navigation channels and access canals should he gently sloping rather than vertical to facilitate biological as well as physical stabilization of the canal banks;

f. When several landowners are to be served by a project, dredging for navigation channels and access canals should be well planned to prevent unnecessary excavation. Tributary canals in the highlands leading to a central navigation channel should be used rather than separate channels for each waterfront landowner;

g. The berm of access canals should be raised so that there is a gradual slope away from the canal edge. This will help prevent introduction of contaminants into adjacent wetland areas;

h. Alignment of channels and canals should make maximum use of natural or existing channels. Alignment of channels and canals should avoid shellfish beds, nursery areas, and spawning areas in wetlands.

8.8.2 Consistency

The SHEP would not involve the construction of any access canals. In general, the side slopes of the existing navigation channel would not be affected. The existing side slopes would generally be maintained, resulting in a narrower bottom of the channel when it is deepened.

Most of the dredging would be confined to the existing Savannah Harbor Navigation Project and the existing eight container vessel berths at the Garden City Terminal of the Georgia Ports Authority. Exceptions include the dredging in McCoys Cut, Middle River and Back River, which is designed to deepen the channels in these existing waterways to allow more freshwater to enter these streams. The other exception is the extension of the entrance channel 37,680 feet from Stations -60+000B to -97+680B.

Dredging outside of the existing navigation channel in the above areas would not impact any shellfish beds, nursery areas or spawning areas in wetlands. The channel improvements in Middle River would be near the upper end of the waterway, thereby avoiding the lower end which is important for Shortnose sturgeon.

The SHEP is consistent with the objectives regarding navigation channels outlined in Chapter 30-12.

8.9.1 Deposition of Dredged Sediment

Section 30-12 provides standards to prevent and minimize impacts to the marine and aquatic environment resulting from the deposition of dredged material as follows:

a. Upland disposal of dredged material shall always be sought in preference to disposal in wetlands. Vegetated wetlands and mudflats shall not be utilized for disposal of dredged materials unless there are no feasible alternatives. Any other wetlands should not be utilized for disposal of dredged materials when other alternatives exist;

b. Open water and deep water disposal should be considered as an alternative if highland alternatives are not feasible. However, open and deep water disposal sites should be seriously considered only after careful consultation with the Department and other relevant State and Federal agencies;

c. Dredged materials containing hazardous levels of toxic material must be disposed of with extraordinary caution. These materials shall never be disposed of in wetland areas and only in highland areas which are lined and diked with impervious materials. These materials will only be disposed in open water ocean dumping sites when maximum safety has been demonstrated after thorough review by the Department and other appropriate state and federal agencies;

d. Dikes surrounding disposal areas should be shaped and vegetated immediately to minimize erosion, with outfalls positioned to empty into non-wetland areas;

e. Future disposal sites shall be reviewed on a case-by-case basis;

f. Wherever feasible, existing disposal areas shall be utilized to the fullest extent possible; this would include raising the height of the embankments to increase the holding capacity of the disposal area;

g. Consideration must be given to the temporal aspects of spoil deposition - for example, impacts on spawning, fish migrations, shellfish harvesting, waterfowl nesting and wintering areas, and mosquito control. Attention must be given to possible adverse impacts of various alternative sites on the public health and welfare as well as on critical fish and wildlife areas;

h. In all cases, dredging activities shall not be approved until satisfactory disposal sites have been acquired.

8.9.2 Consistency

Most of the dredged sediment from the inner harbor would be placed in the existing CDFs located along Savannah Harbor. Some of the better material (mostly sand) would be used to construct some components of the mitigation plan, such as the broad berm in the Sediment Basin.

All of the sediment containing elevated levels of cadmium would be placed in CDFs 14A and 14B. The dredged sediments containing the highest levels of cadmium would be placed in the CDFs first and then covered with sediments containing lower levels of cadmium. This cover could be followed by a cover of sediment obtained during maintenance dredging, if required, which would not have elevated cadmium levels. Monitoring would be conducted to ensure that effluent released from CDFs 14A and 14B complies with state water quality standards. The monitoring plan also includes sampling and analysis of the deposited sediments to ensure that the protective cover does not contain cadmium at unacceptable levels. The cadmium monitoring plan also includes wildlife and bird use monitoring in the CDFs, vegetation sampling and removal if required, and monitoring of cadmium levels I birds that use the CDFs.

All dikes in the CDFS would be raised and maintained in accordance with South Carolina erosion control requirements. The proposed SHEP would not result in the construction of any new CDFs or the expansion of existing ones into adjacent wetlands. After the initial construction of the deepening project, new work sediments that were placed in the CDFs would likely be used in the future to raise the height of those confining dikes.

Dredging and sediment placement operations for the SHEP would be carried out in accordance with the same environmental provisions used for maintenance dredging operations. These provisions include no dredging during the Striped bass spawning season (April 1-May 15), above Station 63, and various measures to protect nesting birds in the CDFs during the breeding season.

The BO submitted by the NMFS also stipulates that construction of the flow diversion structure at McCoys Cut be conducted during the period May 15-November 1 to avoid adverse impacts to sturgeon.

The SHEP is consistent with the objectives concerning dredged material deposition outlined in Section 30-12.

8.10.1 Waste Treatment Systems. This section of 30-12 provides standards applicable to the construction and operation of various types of waste treatment systems.

8.10.2 Consistency. The proposed SHEP would not involve the construction of any types of waste treatment systems.

8.11.1 Marsh Impoundments for Recreational and Commercial Activities. This section of 30-12 describes the review procedures and conditions for approval of proposals involving the impoundment of wetlands.

8.11.2 Consistency. The SHEP would not include the impoundment of any wetlands.

8.12.1 Drainage Canals or Ditches. This section of 30-12 describes under what conditions drainage canals and ditches are approved and the state standards for constructing these types of projects.

8.12.2 Consistency. The SHEP would not involve the construction of any drainage canals or ditches.

8.13.1 Non-water Dependent Structures. This section of 30-12 describes types of non-water dependent structures and the conditions under which they are considered for approval.

8.13.2 Consistency. The SHEP would not include the construction of any non-water dependent structures.

8.14.1 Access to Coastal Islands. This section of 30-12 provides guidance relative to the construction of bridges and docks as a means of gaining access to coastal islands.

8.14.2 Consistency. The SHEP would not involve the construction of any such structures.

8.15.1 Mariculture. This section of 30-12 describes the standards for the establishment of mariculture type activities which is the confined cultivation of aquatic species in the marine environment.

8.15.2 Consistency. The SHEP would not include the development of such operations,

8.16.1 Mooring Buoys. This section of 30-12 provides specifications for the placement of mooring buoys.

8.16.2 Consistency. Modification to the Navigation aids for Savannah Harbor would be required. The new/modified aids would be in strict accordance with U.S. Coast Guard requirements and specifications. The SHEP is consistent with these requirements.

9.0 LOCAL LAND USE PLANS

Much of the proposed action is located in Georgia. Activities in Jasper County, South Carolina include the placement of dredged sediment in the seven existing CDFs located in South Carolina, dredging in McCoys Cut and Little Back River, removal of the Tidegate on the South Carolina side of Back River, construction of a submerged sill across Back River at the mouth of the Sediment Basin, placement of concrete from demolition of the Tidegate in Back River and other suitable locations for fish habitat, and deepening of the entrance channel. None of these activities would result in long-term land use changes. Therefore, no impacts to local land use plans are expected.

10.0 DEMONSTRATION OF NO FEASIBLE ALTERNATIVES UNDER THE SCCMP

According to SC DHEC, the Corps is required to analyze feasible alternatives under the SCCMP and South Carolina water quality certification regulations. The following analysis demonstrates there are no feasible alternatives to the SHEP under either of these South Carolina authorities.

As part of the SHEP EIS, the Corps considered reasonable and practicable alternatives under the National Environmental Policy Act (NEPA) and the Clean Water Act (CWA). The SHEP NEPA alternatives analysis ranged from considering other potential options or sites for the project, including other South Atlantic ports, to evaluating potential specific locations for disposal of dredged or fill material along Savannah Harbor and in the Atlantic Ocean along the entrance channel. The SHEP NEPA alternatives analysis is found in various places in the Environmental Impact Statement (EIS) and General Re-Evaluation Report (GRR), including EIS Section 2.0, Purpose and Need for Action; EIS Section 3.0, Alternatives; EIS Appendix O, Formulation of Alternatives; GRR Section 6, Formulation of Alternatives; various other sections in the GRR; GRR Appendix A, Economics; GRR Appendix A, Attachment 3 (Regional Port Analysis); GRR Appendix A, Attachment 5 (Multiport Analysis); and GRR Appendix D, Plan Formulation Appendix.

The SHEP NEPA alternatives analysis includes the following key elements: (1) the statement of project purpose and need (EIS Section 2.0); (2) a Regional Port Analysis (GRR, Appendix A, Attachment 3); (3) a Multiport Analysis (GRR, Appendix A, Attachment 5); (4) analysis of various structural and non-structural alternatives (EIS, Section 3.0; GRR, Appendix D); (5) analysis of eight alternative locations or sites for a port/terminal along the Savannah River (EIS, Section 3.0 and Appendix O; GRR Section 6 and Appendix D); (6) analysis of six different depths of harbor deepening along the Savannah River (EIS, Section 3.0 and Appendix O; GRR, various sections); (7) analysis of alternative disposal sites, methods, or beneficial use of dredged sediments (EIS, Section 3.01.1 and 3.07); (8) analysis of related maintenance dredging requirements (EIS, Section 3.08-3.10); and (9) analysis of the no-action alternative (EIS, Section 3.01.1 and

Appendix O; GRR Section 6.12.1).

In addition, the Corps considered practicable alternatives under the Clean Water Act (CWA), as explained in EIS Appendix H, 404(b)(1) evaluation. The practicable alternatives analysis was largely co-extensive with the SHEP NEPA alternatives analysis.

The SHEP NEPA and CWA alternatives analysis demonstrates there is no feasible alternative to deepening Savannah Harbor under the SCCMP or South Carolina water quality certification regulations. In South Carolina, a feasible alternative must be reasonable, taking into account the likelihood that it will achieve the project purpose, the cost of the alternative, and other factors – and it must reduce adverse consequences on water quality. A proper feasible alternatives analysis includes analysis of alternative locations and sites, analysis of methods of design or construction, and analysis of the no-action alternative. The Corps's alternatives analysis for SHEP fully complied with these principles.

Originally, the local sponsor proposed the project with the purpose of improving navigation in Savannah Harbor. The Corps had a duty to take that project purpose into account. In addition, the US Congress then authorized the specific project (subject to further study and approval by other federal agencies). 1999 Water Resources Development Act, Pub. L. No. 106-53, sec. 101(b)(9). Despite the specific Congressional authorization, the Corps still undertook a wide-ranging, multi-level alternatives analysis as described.

The Regional Port Analysis specifically evaluated current and projected port capacity, demand, and growth, and environmental impacts and constraints for other South Atlantic ports (Norfolk, VA; Wilmington, NC; Charleston, SC; Savannah, GA; and Jacksonville, FL) and a proposed Jasper County Marine Terminal in South Carolina. GRR, Appendix A, Attachment 3, Final Report, pp. 1-20, and Interim Reports. In addition, the information regarding a Jasper County Marine Terminal from the Regional Port Analysis was further analyzed in a study of the potential costs and environmental impacts of locating the project at one of eight different sites along the Savannah River (four on the South Carolina side, four on the Georgia side). EIS Sec. 3.0 and Appendix O; GRR Section 6.8 and Appendix D.

The most pertinent conclusions relative to the wide range of alternatives studied for SHEP are: (1) there is no feasible alternative to improving Savannah Harbor because the major South Atlantic ports will experience so much cargo growth from 2005 to 2050 they will all need deepening or improvement as currently planned, (2) no one South Atlantic port has the ability to expand to accommodate all the growth in container volume expected in the region, (3) the proposed deepening of Savannah Harbor would not divert container traffic from other ports because the shipping cost efficiencies would not outweigh the additional landside transportation costs, and (4) the proposed Jasper Ocean Terminal is not presently a feasible alternative to improving Savannah Harbor for various reasons including the tremendous cost involved (at least $4 billion), the environmental impacts, and the timing (Jasper does not exist at present and cannot be constructed in

time to meet the growth in demand Savannah and other South Atlantic ports are currently facing).

South Carolina's Coastal Management Plan (SCCMP) specifically establishes a strong preference for developing ports in industrialized areas that have existing infrastructure. See SCCMP, Part III, Transportation Facilities, at III-19 – III-20. This preference plus the high cost associated with developing a Jasper Ocean Terminal and the approximately twenty years required to study, permit, and construct that project, weigh heavily against finding a Jasper Ocean Terminal alternative to be feasible to improving Savannah Harbor.

The SHEP and a Jasper Ocean Terminal are not viewed by the Jasper project office as alternatives. Rather, the project office believes both ports are needed. A March 11, 2011 "Update" from the Jasper Ocean Terminal project office contains numerous statements that SHEP is necessary and beneficial for the Jasper Ocean Terminal project ("The development of the Jasper site is predicated on the success of ports in Savannah and Charleston. A completed SHEP and the planned expansion of Charleston are the first steps . . . ."). The Update states that the Jasper Ocean Terminal will handle container volumes in excess of what an improved (deepened) Savannah Harbor or Charleston Harbor could handle. The Update also confirms that the Jasper Ocean Terminal will cost $4 billion (a more recent estimate by the SCSPA is $5 billion).

In light of the information provided in the Update, combined with the fact that Jasper Ocean Terminal would have its own environmental impacts requiring mitigation (Regional Port Analysis, GRR, Appendix C, Attachment 3, Final Report, at 14-20, and associated Interim Reports), Jasper Ocean Terminal is not presently a feasible alternative to SHEP. After extensive study, no other specific feasible alternative was identified or found.

The no-action or "without project" alternative was thoroughly considered in the GRR/EIS, as well, but was not selected because it would not fulfill the project purpose and need, which are to address navigation inefficiencies in Savannah Harbor. The no-action alternative would not allow deepening the harbor so that larger and/or more fully loaded vessels could use it. By not enabling more efficient navigation in the harbor, the no-action alternative would not realize approximately $177 million in net annual economic benefits that could be achieved with harbor deepening, some of which would accrue to South Carolina. And while it is true that with the no-action alternative there would be no new environmental impacts, the total project cost of SHEP does include a comprehensive mitigation plan, with monitoring and adaptive management, that would protect and in some ways, enhance, South Carolina coastal resources.

11.0 SOUTH CAROLINA WATER QUALITY CERTIFICATION

On November 15, 2011, SC DHEC issued South Carolina's Clean Water Act Section 401 water quality certification for the project, with conditions. The water quality certification constitutes a determination that the project as conditioned will not violate South Carolina

water quality standards, which constitutes additional evidence that the SHEP is fully consistent with the enforceable provisions of the SCCMP.

12.0 CONCLUSION

In accordance with the CZMA, 16 U.S.C. § 1456(c), as amended, Savannah District, US Corps of Engineers has determined that the proposed deepening of the Federal Navigation Project to 47-feet MLW would be carried out in a manner which is fully consistent with the enforceable policies of the South Carolina Coastal Management Plan. This determination applies to the selected alternative identified in the Environmental Impact Statement prepared for the project -- which is the 47-foot depth MLLW alternative -- and the effects of the that alternative on the land or water uses or natural resources of the coastal zone of South Carolina, as directed by 15 C.F.R. § 930.39.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX K: Air Emission Inventory and Assessment

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

(Revised July 2012)

US Army Corps of Engineers
Savannah District
South Atlantic Division

Air Emission Inventory & Assessment

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AIR EMISSION INVENTORY & ASSESSMENT FOR THE PORT OF SAVANNAH

1.0 INTRODUCTION

The Port of Savannah (see Figure 1) is a complex junction in the transportation of goods within the US and internationally. The port includes both public and privately-owned terminals and services a wide variety of vessel types and cargoes.

The publicly-owned Georgia Ports Authority (GPA) provides two modern, deepwater terminals: Garden City Terminal and Ocean Terminal. The Garden City Terminal (GCT) is the largest single-terminal container facility of its kind on the U.S. East and Gulf coasts. It encompasses more than 1,200 acres and moves millions of tons of containerized cargo annually. Ocean Terminal (OT) is GPA's dedicated breakbulk and Roll-on / Roll-off facility (RORO), covering 208 acres and providing customers with more than 1.3 million square feet of covered, versatile storage.

In addition to the GCT and OT, there are 20 privately-owned terminals in the Port of Savannah as shown below.

Table 1-1
Privately-Owned Terminals in the Port of Savannah

EL Paso Energy/Southern LNG	City Front	Citgo Asphalt Refining Company	SEPCO - Georgia Power Plant Kraft
Valero	Colonial 1	Georgia Kaolin Terminals	Newport Terminals
Conoco-Phillips	Colonial 2	Southern Bulk Industries	East Coast Terminal
Georgia Pacific Gypsum	Colonial 3	National Gypsum	Savannah Steel
Wood Chip Exporting Corp	Global Ship Systems	Vopak	Savannah Sugar Refinery

Figure 1-1. Current Savannah Harbor navigation project.

Economic projections indicate that containerized shipping is expected to increase throughout the world, along the US East Coast and in the Port of Savannah. In response to this growth in container volume, the shipping industry is expected to continue its trend toward larger container vessels. The planned deepening of the Panama Canal will aid in the use of these larger vessels on routes serving the eastern US. A more detailed description of the expected changes to the world fleet and the one calling at Savannah can be found in the Economic Appendix, in the GRR.

The characteristics and physical specifications of the container vessels that presently call at Savannah are shown below.

Table 1-2
Container Vessel Characteristics / Physical Specifications

Ship Class	Overall Length (feet)	Beam (feet)	Draft (feet)	TEU Capacity
Post-Panamax	1044.0	140.0	46	>=6,000
Panamax	951.0	106.0	42	4,000
Sub-Panamax	716.3	100.0	38	2,500
Handy Size	610.7	85.1	32	1,600

The Savannah Harbor navigation channel is currently authorized at a depth of 42 feet MLW. The GPA indicates that 70% percent of the container vessels that called on the port in 2006 were operationally constrained by the channel depth. As the newer, larger container vessels increase their calls at the port, that percentage will increase. The 1999 Water Resources Development Act authorized deepening the channel to a maximum depth of 48 feet to allow the Port to accommodate the larger classes of container vessels that are now being constructed. That authorization was subject to several conditions, including an evaluation of incremental amounts of harbor deepening, development of mitigation plans, and approval of the project by the Departments of the Army, Interior, Commerce and the US Environmental Protection Agency.

Under both the without and with project conditions, the Corps expects the Garden City Terminal to reach its build-out capacity in 2030 when the total number of TEUs processed through the terminal reaches 6.5 million. That capacity is the maximum number of containers that could reasonably be processed through the Garden City Terminal in a year. That determination includes factors such as the size of the terminal, the number of gates that provide access to the property, the number and size of the berths, the number and size of the container cranes, the number of jockey trucks that move the containers within the terminal, how the containers are stacked within the terminal, and the number of railroads that service the terminal and the frequency of their trains. It is anticipated that without deepening, more vessels will be required to transport the cargo that is expected to move through the port. With deepening, the total number of vessels decreases as vessels will be able to load more deeply under the improved conditions.

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers.

In 2006, the Corps' Mobile District prepared a report entitled "Air Quality Analysis, Savannah Harbor Expansion Project". That report is available from Savannah District. The analyses documented in the report described the air emissions associated with container vessels calling on the Georgia Ports Authority (GPA) Garden City and Ocean Terminals in Savannah Harbor. Emission estimates for those operations are presented in the report for the period 2004 through 2050, both with and without implementation of the proposed harbor deepening project.

In response to EPA Region 4's request, the Corps prepared an Air Emission Inventory for the Port of Savannah (an earlier version of this Appendix K). The Corps provided the report to the US Environmental Protection Agency (EPA) Region 4 office for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context. After their review of the DEIS, EPA submitted additional comments on January 28, 2011 concerning Appendix K; in response, the Corps has further revised this appendix to address those additional comments.

2.0 OBJECTIVE

The objective of this work is to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment will evaluate the air emissions (including air toxics) from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It will also compare these emissions for both the "With" (i.e., -44, -45, -46, and -47/48 foot depths) and "Without Project" (No Action) alternatives (i.e., -42 foot depth existing depth) for years 2016, 2020, 2025, 2030, and 2066. The assessment does not include a detailed dispersion modeling assessment of these emissions or a risk-based assessment of the health effects associated with the proposed project. The primary focus of this work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

For the purposes of this assessment, the area defined for vessel emissions is consistent with the area considered in the 2006 Corps report and the US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, dated April 2009**. For vessels, the area began in the ocean in the

outer half of the entrance channel where the harbor pilots join the vessel to accompany it on its inland transit, and extends to wherever the vessel is docked to load or discharge its cargo. On land, the area includes the equipment used to load and unload the vessels, and then move that cargo around within the terminal. For container cargo, the landside area includes the location/time trucks wait to enter the GPA terminal to drop off or pick up its load, as well as the location/time for the outgoing trucks to clear the immediate vicinity of the port and the city limits. The updated air emission inventory and assessment includes the following sources: Equipment used to transport containers away from the port, tugs which assist vessels moving through and docking in the harbor, Coast Guard vessels employed during the movement of LNG vessels, the shuttle boats and paddle-wheel boats which transport tourists, vessel shifts between docks within the port, and the other 20 non-GPA terminals in the port.

This emission inventory and assessment is based on information provided by GPA, the Savannah Pilots Association, the Savannah Maritime Association, EPA, other ports, and company websites. The Commodity Forecast (in Section 5.0) and Fleet Forecasts (see Economic Appendix) discussed in the GRR were also used to develop vessel calls at the port and cargo handled by the terminals. It was supplemented by dredging records maintained by Savannah District, as well as projections developed by the Corps during the Economic Analysis for the Savannah Harbor Expansion Project. The GPA staff conducted much of the local "leg work" for this analysis, contacting various equipment owners and operators to obtain information that the District needed. Without their assistance, this analysis would not contain such detailed information, and therefore would not be as accurate. Staff from the Corps' Wilmington District coordinated with EPA and other ports to obtain air inventories which have been conducted, and they performed much of the technical work.

3.0 METHODOLOGY FOR DETERMINING AIR EMISSIONS

The US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, dated April 2009** provided the framework to determine all air emissions. The expanded analysis followed a Mid-Tier approach described as Figure 2-3 in EPA's guidance document (located on page 2-20) and shown in the following flow chart taken from that report:

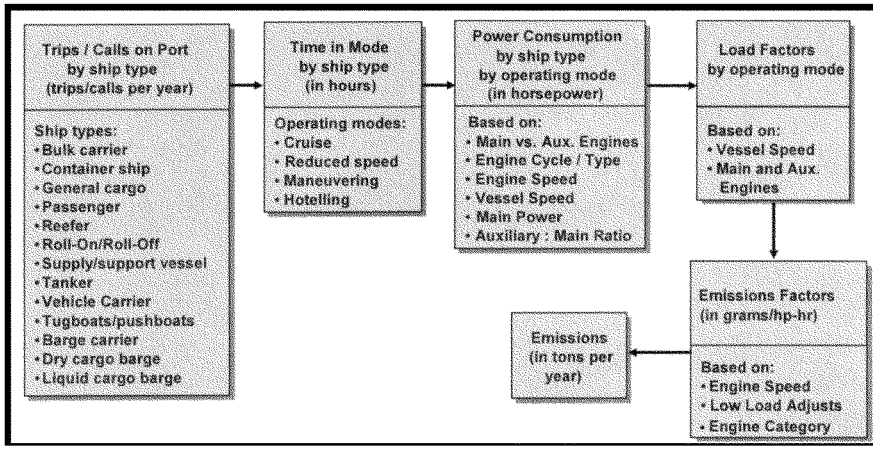


Figure 3-1. US EPA flow chart for mid-tier air emission inventory preparation (USEPA 2009).

The analysis followed EPA's overall evaluation process. In general, air emissions are calculated by determining the size of the engine, the amount of time the engine is used, the load upon the engine, and the emission rate for that type of pollutant. There are many details which can affect the final calculated value, including age of the engine and the type of fuel that it burns.

The first step to develop an air emission inventory using EPA's Mid-Tier approach (in Figure 3-1) is to determine the vessel types and calls per year at the port. The Commodity and Fleet Forecasts (see Table 4-3 and Attachment A) developed by the Mobile District, USACE, GPA, and the Harbor Pilots provided the number and types of vessels calling at the port for the No Action Alternative or baseline depth (i.e., -42 foot depth) and alternative depths (i.e., -44, -45, -46, -47 and -48 foot) for the years 2016 to 2066. Detailed descriptions of how these forecasts were developed are found in Section 5.0 and in the Economic Appendix both in the GRR.

The Fleet Forecast provided the numbers and types (Post-Panamax, Panamax, Sub-Panamax, and Handy size) of vessels calling at the port for different depths for the years 2016 to 2066. The air emissions for each different vessel engine size (includes both main and auxiliary engines working under various loads at different times with different fuels) for all depths and years were then calculated using EPA's Mid-Tier Approach (USEPA 2009). Harbor craft (tugs, tourist vessels, etc.), harbor shifts (vessel movements from one terminal to another), and dredging operations (includes both maintenance and deepening work) emissions were also calculated (USEPA 2009).

The air emissions for all land based operations (Cargo Handling Equipment, trucks going into and out of the terminals, terminal jockey trucks, trains, cranes, top lifts, etc.) using different fuels for all 22 terminals were also calculated using the formula's and methods discussed in US Environmental Protection Agency's (EPA's) "**Current Methodologies in Preparing Mobile**

Source Port-Related Emission Inventories, Final Report, dated April 2009. GPA provided equipment data and usage for its land-based operations at both Garden City and Ocean Terminals.

Once all vessel and land-based emissions for the 22 terminals at the Port of Savannah were calculated (see table 5-78) for all depths and years, then the Corps calculated the amount of air toxics emitted for these depths and years (see Tables 5-63 to 5-76). Air Toxics are generally determined as a ratio of criteria pollutants discharged. The emission rates are a proportion of other parameters such as VOC, PM10, gallons or miles. The Corps obtained information from the NMIM "SCC Toxics" database table provided by EPA, Region 5 concerning the ratios of specific air toxics to other physical parameters. These ratios are displayed in Tables 5-63 and 5-64.

In summary, the District calculated air emissions from 13 different sources that are directly associated with operations of the harbor. This includes emissions from both GPA (Garden City and Ocean Terminals) and the 20 private terminals in the Port. It also includes the vessels which call at the port, the tugs which assist those vessels, the landside equipment that moves the cargo on the terminals, ancillary vessels which operate in the harbor (dredges and tourist boats), and equipment used to move containers out of the harbor area.

This expanded air emission assessment builds upon the 2006 Air Emissions Analysis. Information was obtained on vessels which call at the non-GPA terminals. That information consisted of the number and type of vessels which call at each of the private terminals in the harbor. Details were obtained for the landside equipment associated with cargoes moving through the GPA terminals. Those details include not only the number and type of equipment, but also the specific model number, its engine size, fuel type, age, and annual use rate. The analysis used detailed information when it was accessible, but more general information when detailed data was not available. That approach follows the EPA Best Practices guidance. In this application, this approach results in the analysis being more accurate in those components which could be affected by the proposed harbor deepening.

4.0 BASELINE AND ESTIMATED FLEET FORECAST FOR THE PORT OF SAVANNAH

The Georgia Ports Authority and USACE, Mobile District developed the following table, which serves as the baseline for the emission inventory and assessment. All information within this table was developed by interviewing the harbor pilots and their traffic logs. For 2008, that information is as follows:

Table 4-1
Baseline Existing 42 Foot Depth Garden City Terminal (One-way Vessel Calls)

	Post Panamax	Panamax	Sub-Panamax	Handy-size	Total
Total	32	1,261	213	15	1,521

Table 4-2
Baseline Existing 42-Foot Depth
Ocean Terminal and Non-GPA Terminals
2008 LNG AND General Cargo
(One-Way Vessel Calls)

General Cargo	**1,083**
LNG	**120**

Currently at the Port of Savannah, the existing navigation channel has an authorized depth of -42 feet. For this air emission analysis, the Corps used 2008 as the baseline. The Corps then assumed that the project would be deepened to -48 feet in 2016 (base year), the modifications to the Panama Canal are completed in 2015, and that the end of the 50-year project life was 2066. At 2030, the capacity of the port would be reached. This means that between 2030 and 2066, no additional growth occurs in commodities or annual vessel numbers. No additional vessels could load/off-load at the port each year between 2030 and 2066. Tables 4-3 and 4-4 below show the Corps' estimated fleet forecast each year of in-bound vessels (one way only), at the various depths (i.e., 42 (Baseline), 44, 45, 46, 47, and 48 feet), and arriving at the Port of Savannah in 2016, 2020, 2025, 2030, and 2066. From Table 4-3, it is apparent that the number of vessels calling on the Port of Savannah decreases as the depth of the Federal channel increases.

Table 4-3
Summary of Vessel Calls (One-way) Calling at Garden City Terminal

2016	Post Panamax	Panamax	Sub-Panamax	Handy-size	Total
-42 feet Baseline	617	1,171	448	57	2,293
-44 feet	560	1,116	448	57	2,181
-45 feet	558	1,094	448	57	2,157
-46 feet	557	1,084	448	57	2,145
-47 feet	**557**	**1,079**	**448**	**57**	**2,141**
-48-feet	557	1,079	448	57	2,141

2020	Post-Panamax	Panamax	Sub-Panamax	Handy-Size	Total
-42 feet Baseline	1,137	778	528	65	2,509
-44 feet	1,011	700	528	65	2,304
-45 feet	1,001	671	528	65	2,265
-46 feet	995	658	528	65	2,247
-47 feet	**995**	**649**	**528**	**65**	**2,238**
-48-feet	995	649	528	65	2,238

2025	Post-Panamax	Panamax	Sub-Panamax	Handy-Size	Total
-42 feet Baseline	1,388	1,122	670	87	3,267
-44 feet	1,232	992	670	87	2,982
-45 feet	1,220	952	670	87	2,930
-46 feet	1,214	932	670	87	2,903
-47 feet	**1,211**	**924**	**670**	**87**	**2,892**
-48-feet	1,211	924	670	87	2,892

2030	Post-Panamax	Panamax	Sub-Panamax	Handy-Size	Total
-42 feet Baseline	1,948	1,196	836	111	4,092
-44 feet	1,707	1,067	836	111	3,720
-45 feet	1,693	1,007	836	111	3,647
-46 feet	1,683	982	836	111	3,613
-47 feet	**1,679**	**975**	**836**	**111**	**3,601**
-48-feet	1,679	975	836	111	3,601

2066	Post-Panamax	Panamax	Sub-Panamax	Handy-Size	Total
-42 feet Baseline	1,948	1,196	836	111	4,092
-44 feet	1,707	1,067	836	111	3,720
-45 feet	1,693	1,007	836	111	3,647
-46 feet	1,683	982	836	111	3,613
-47 feet	**1,679**	**975**	**836**	**111**	**3,601**
-48-feet	1,679	975	836	111	3,601

Table 4-4 shows the estimated number of General Cargo (Breakbulk, RORO, bulk, and tanker) and LNG vessels arriving at the Ocean Terminal and the other 20 non-GPA terminals in the Port of Savannah for all depths (i.e., -42, -44, -45, -46, -47, and -48 feet) and all years:

Table 4-4
Number of General Cargo Vessel Calls (One Way)
Arriving at the Ocean Terminal and 20 non-GPA Terminals

Vessels	2016	2020	2025	2030	2066
General Cargo	1,733	2,068	2,468	2,946	2,946
LNG	120	136	151	167	167
TOTAL	1,853	2,204	2,619	3,113	3,113

The vessel numbers and types taken from the Fleet Forecast (see Attachment A in Appendix K and the Economic Appendix in the GRR) found within the above tables (Tables 4-1, 4-2, 4-3, and 4-4) were used through-out this emission inventory.

5.0 CALCULATIONS OF AIR EMISSIONS

This report summarizes the analyses that the Corps performed. The intent is for the report to (1) summarize the information that was obtained and used in the analyses, and (2) provide sufficient information to understand the analyses that were conducted.

5.1 Harbor Fleet

Detailed information was collected on the fleet of deep-draft vessels which call at the Port of Savannah. GPA reviewed the logs of the Harbor Pilots for various years through 2008 and provided the Corps with this information. The Corps used this information in both the economic evaluation and this air quality evaluation.

For this air quality evaluation, the Corps took the Harbor Pilots information and calculated the number and types of vessels that call at the different terminals. This information is summarized below.

Table 5-1
2008 Vessel Calls by Type and Location

	Total Harbor	Elba Island LNG Terminal	Garden City Terminal	Ocean Terminal	Non-GPA Terminals
Container	1,521		1,521	---	---
Bulk	170		---	12	158
Breakbulk	362		---	240	122
Tanker	406		---	---	406
RO/RO	145		---	145	---
LNG *	120	120			
Total	2,724	120	1,521	397	686

NOTE 1: A small number of other vessels called at Savannah in 2008. They were excluded from the analysis due to their small number and unpredictability of their calls.

5.2 Transit Time

After consulting with the Harbor Pilots, GPA provided the Corps with information on the time it takes to move vessels in the harbor. The Pilots separated the typical transit into time spent in three different modes of operations: Reduced Speed (9-12 knots), Maneuvering (5-8 knots), and Docking. The Corps used this information to calculate average transit times to the various terminals.

The following table summarizes the typical transit times:

Table 5-2
2008 Transit Time by Vessel Type (Minutes)

	Reduced Speed Zone (9-12 knots)	Maneuvering (5-8 knots)	Docking
Tanker	90	44	30
Container	90	60	30
Bulk	90	56	30
Breakbulk	90	48	30
RO/RO	90	30	30

The durations reflect the time the Harbor Pilots spent on the vessels. This covers the time between the dock and when they meet/leave the vessel on the outer half of the entrance channel.

5.3 Shifts

GPA obtained information from the Harbor Pilots on the number and timing of vessel shifts which occurred within the harbor in 2008. Some vessels call at multiple berths, while others are moved while they are serviced or wait for some other reason. The time it took to move from one terminal to another was also identified. The information was provided by GPA after consultation with the Harbor Pilots. The District used this information to calculate average movement times and develop summaries of vessel shifts by vessel types.

The following tables summarize the important information collected concerning vessel shifts:

Table 5-3
Number of Vessel Shifts in 2008

Bulk	Breakbulk	Container	Tanker	Total
45	61	2	68	176

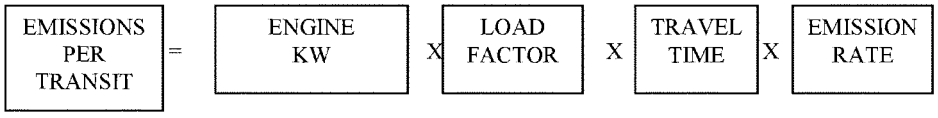
Table 5-4
Time for Vessel Shifts in 2008 (Minutes)

	Reduced Speed Zone (9-12 knots)	Maneuvering (5-8 knots)	Docking
Average Vessel	30	35	30

5.4 Container Vessels at Garden City Terminal – Georgia Ports Authority

Using the information above, one can begin to calculate air emissions from various sources within the harbor. The first category to be discussed is the Container vessels that call at the GPA terminals. In general, the Corps followed the same procedures as were followed by Mobile District in their 2006 Draft Air Quality Analysis. That procedure also follows the methodology described in EPA's 2009 Best Practices Report.

In summary, air emissions are calculated by determining the size of the engine, the amount of time the engine is used, the load upon the engine, and the emission rate for that type of pollutant. This procedure is shown below:



For the first type of information needed – **"Engine kW"** – the Corps started with information described earlier on the fleet of vessels that call at Savannah. Using that information, EPA's 2009 Best Practices Report can be consulted to obtain information on the typical sizes for the propulsion and auxiliary engines. The following information was obtained from that EPA report:

Table 5-5
Engine Size by Vessel Type

Vessel Type	Propulsion Engine (Kw)	Total Auxiliary Engine (Kw)
Bulk	8,000	1,775
Container	30,900	6,800
Cruise	39,600	10,998
General Cargo	9,300	1,775
RO/RO	11,000	2,851
Reefer	9,600	3,900
Tanker	9,400	1,985

So for Container vessels, the following Engine kW values were used:

Vessel Type	Propulsion Engine (Kw)	Total Auxiliary Engine (Kw)
Container	30,900	6,800

The next type of information needed is the **"Load Factor"**. The load factor accounts for how hard the engine is working at that time. Therefore, the emission calculations use the durations for the various modes of operation that were discussed earlier in this document. An additional category was used called "Hotelling" to capture the emissions that occur while a vessel is docked and loading or unloading cargo.

The load factors vary by the size of the Container vessel being considered. This required separate calculations to be performed for four sizes of containerships that call at the port: Post-Panamax, Panamax, Sub-Panamax, and Handy Size. This load factor values which were used were taken from EPA's Best Practices Report dated 2009.

The main engine load factors used are as follows:

Table 5-6
Main Engine Load Factors

	Post-Panamax	Panamax	Sub-Panamax	Handy Size
Reduced Speed Zone	10 %	12 %	16 %	20 %
Maneuvering	2 %	3 %	4 %	5 %
Slow / Dead Slow	2%	3%	5%	5%
Docking	2 %	3 %	4 %	5 %
Hotelling	0 %	0 %	0 %	0 %

Different load factors are used for the auxiliary engines used on these vessels. The main engine load factors used for the auxiliary engines are as follows:

Table 5-7
Auxiliary Engine Load Factors

	Auxiliary Engines
Reduced Speed Zone	25 %
Maneuvering	50 %
Slow / Dead Slow	50%
Docking	50 %
Hotelling	17 %

The third type of information needed is called the **"Travel Time"**. The travel time for Container vessels were taken from Mobile's 2006 Draft Air Quality Analysis. That information was obtained from the Harbor Pilots and is shown below.

Table 5-8 Travel Time

Mode	Location	Time (Hours)
Full Maneuvering (Reduced Speed Zone)	Pilots' Station to US Coast Guard Dock	1.40
Slow / Dead Slow	10 minutes past Fort Pulaski	0.17
Full Maneuvering (Reduced Speed Zone)	To LNG facility	0.33
Slow / Dead Slow	Past LNG facility/Elba Island	0.25
Full Maneuvering (Reduced Speed Zone)	To terminals at City	0.17
Slow / Dead Slow	To Garden City Terminal	1.50
Docking (Maneuvering)	Dock	0.50
Hotelling	Dock	16.0

The fourth type of information needed is called the **"Emission Rate"**. An emission rate is the rate at which a particular pollutant is discharged by a given engine. The emission rates used in this analysis for vessel engines were taken from EPA's Best Practices Report dated 2009. For main propulsion engines, we selected emission rates for Slow Speed Diesel engines using Marine Diesel Oil (MDO) fuel. The Savannah Harbor Pilots stated that all Ocean Going Vessels calling at the port use MDO and not Residual Oil (RO) fuel. For the Auxiliary Engines, we used the emission rates for engines using MDO.

Those selected emission rates found in Table 2-9: Emission Factors for OGV Main Engines, g/kWh (USEPA 2009) on page 2-14 and Table 2-16, Auxiliary Engine Emission Factors, g/kWh (USEPA 2009) on page 2-19 are as follows:

Table 5-9
Engine Emission Factors for MDO Fuel (Grams/kW-Hour)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Main Propulsion Engine	17.00	1.40	0.60	0.45	0.42	3.62	588.79
Auxiliary Engines	13.90	1.10	0.40	0.49	0.45	4.24	690.71

Using those emission rates and information described previously for the other three required inputs (Engine power (Kw), Load Factor, and Travel Time), one can calculate the Emissions Per Vessel.

To allow separation of air emissions while vessels are docked (hotelling), the District performed separate calculations for inbound transits, Hotelling, and Outbound transits.

The results from these calculations are shown in the following tables:

Table 5-10
Main Engine Emissions In-Bound Transits (Tons Per Transit)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.5102	0.0785	0.0595	0.0185	0.0168	0.0942	15.0838
Panamax	0.2921	0.0429	0.0233	0.0117	0.0106	0.0594	9.1650
Sub-Panamax	0.2051	0.0267	0.0152	0.0064	0.0058	0.0429	5.6915
Handy Size	0.1469	0.0170	0.0091	0.0044	0.0039	0.0310	3.6099

Table 5-11
Auxiliary Engine Emissions In-Bound Transits
(Tons Per Transit)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.3173	0.0251	0.0091	0.0112	0.0103	0.0968	15.7695
Panamax	0.1928	0.0153	0.0055	0.0068	0.0062	0.0588	9.5816
Sub-Panamax	0.1197	0.0095	0.0034	0.0042	0.0039	0.0365	5.9502
Handy Size	0.0759	0.0060	0.0022	0.0027	0.0025	0.0232	3.7740

Since concerns have been expressed about emissions from Containerships while they are docked, the Corps performed separate calculations for emissions that occur from the auxiliary engines during that period. This allows one to evaluate the potential value of cold-ironing of Container vessels in this harbor. Those calculations are summarized as follows:

Table 5-12
Hotelling Emissions Auxiliary Engine Emissions Only (Tons Per Vessel)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	0.5128	0.0406	0.0148	0.0181	0.0166	0.1564	25.4810
Panamax	0.3116	0.0247	0.0090	0.0110	0.0101	0.0950	15.4823
Sub-Panamax	0.1935	0.0153	0.0056	0.0068	0.0063	0.0590	9.6146
Handy Size	0.1227	0.0097	0.0035	0.0043	0.0040	0.0374	6.0983

Using this information and the 2008 vessel fleet shown on the next page, the total emissions from Container vessels at the Garden City Terminal while docked were calculated and are summarized as follows:

Table 5-13
Total Emissions of Container Vessels
(In and Out Bound) includes Hotelling (Tons per vessel)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
Post-Panamax	2.1679	0.2478	0.1520	0.0775	0.0707	0.5383	87.1876
Panamax	1.2815	0.1409	0.0667	0.0480	0.0438	0.3314	52.9754
Sub-Panamax	0.8432	0.0878	0.0429	0.0280	0.0256	0.2179	32.8980
Handy Size	0.5685	0.0558	0.0260	0.0184	0.0168	0.1458	20.8662

The District multiplied those emissions by the number and size of Container vessels that call at the port. The number of vessels was obtained from the Economic Analysis. For 2008, that information is as follows:

Table 5-14
2008 Container Vessel Transits by Vessel Type and Service

Service	Post Panamax	Panamax	Sub-Panamax	Handy-size	Total
Total	32	1,261	213	15	**1,521**

For 2008, 1,521 Container vessels called at Savannah, resulting in 3,042 transits through the harbor. All of these called at the Garden City Terminal.

Using those 2008 vessel numbers, the Corps calculated the air emissions of the Containerships that call at the Garden City Terminal over their entire vessel transit (In-bound, Hotelling, Out-bound for Main and Auxiliary Engines) as follows:

Table 5-15
Summary of Container Vessel Emissions Calling at GCT for 2008
at the -42 foot depth (Total Tons)

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
TOTAL	1,873.40	205.11	98.48	69.30	63.20	483.73	76,912.27

5.5 Tugs

Tugs are used to assist each vessel that moves through the harbor. They are used to dock/undock the vessels, as well as to help move them between terminals within the port (called shifts). On 28 May 2009, representatives from GPA and the Corps obtained information and discussed usage with the two companies that own and operate tugs in the Port of Savannah. Both Moran Towing and Crescent Towing each own five tugs with the following characteristics:

Table 5-16
Tug Characteristics

	Main Engine (HP)	# of Auxiliary Engines	Auxiliary Engine (HP)
Moran Towing			
1	6500	2	100
1	5100	2	100
2	3300	2	100
1	3000	2	100
Crescent Towing			
1	6500	2	100
4	4000	2	100

During this discussion with the tug owners, Moran and Crescent indicated that all ten tugs are Category 2 marine engines, their main engines displacement is 11.6 liters per cylinder, and the age of their engines are less than 3 years old (Tier 2, 2004 to 2007). In 2009, all ten tugs use ULSD fuel or 15ppm sulfur fuel. Before 2016, all tugs will be "cold ironed" at their respective docks.

Both Moran and Crescent stated that it takes 2 tugs to dock and undock vessels, as well as "shift" vessels from one terminal to another. On average, the time required to dock a vessel is about 4 hours (includes 1 hour warm up of main and auxiliary engines), undocking is about 3.5 hours (includes 1 hour warm-up of main and auxiliary engines), and shifting vessels is about 4 hours (includes 1 hour warm-up of main and auxiliary engines).

The Corps assumed that all ten tugs are used to dock/undock and shift vessels equally throughout the year. The USEPA formula that was used to calculate tug emissions for all ten tugs is found on page 3-12 in Section 3.7 entitled Emission Determination (USEPA Guidelines dated April 2009). This emission formula included both main and auxiliary engines, load factors, activity use (hours), and the criteria pollutant factor. The formula is described below:

Emissions pollutant,H/C = N H/C x {(<EF pollutant,H/C,main> x N Eng H/C,main x LFH/C.main x ActivityHC,main x HP H/C,main)
+ (<EFpollutant,H/C,aux> x N Eng H/C,aux x LF H/C,aux x Activity H/C,aux x HP H/C,aux)}

The fuel emission factors were taken from Table 3-8 (page 3-10) USEPA Current Methodologies in Preparing Mobile Source Port Related Emission Inventories, Final Report, April 2009. The emission factors were also fuel corrected for ULSD (15 ppm sulfur) Table 3-9 (page 3-10) in USEPA 2009. The following table shows the emission factors used for all ten tugs:

Table 5-17
Tug Emission factors

Pollutant	Tug Main Engine Emission Factor (g/kW-hr)	Tug Auxiliary Engine Emission Factor (g/kW-hr)
NOx	9.8000	9.8000
CO	5.0000	5.0000
VOC	0.5	0.5
PM_{10}	0.6192	0.6192
$PM_{2.5}$	0.6006	0.6006
SO_2	0.0065	0.0065
CO_2	690.0000	690.0000

The horsepower rating for each tug for both main and auxiliary engines were converted to kW (see table below). The load factors were taken from Table 3-3 (USEPA 2009).

Table 5-18
Load Factors for Tugs

COMBINED TUGS FROM MORAN AND CRESCENT*						
# of Tugs	**ME HP of Tugs**	**kW**	**Load Factor**	**# of Aux Engines**	**kW of Aux**	**Load Factor**
2	6500	4847.0492	0.85	2	74.56998714	0.56
1	5100	3803.0693	0.85	2	74.56998714	0.56
4	4000	2982.7995	0.85	2	74.56998714	0.56
2	3300	2460.8096	0.85	2	74.56998714	0.56
1	3000	2237.0996	0.85	2	74.56998714	0.56
10 Total						

Load factors are taken from table 3-3 USEPA Load Factors for Harbor Craft on page 3-6 (Final Report April 2009)

On average it takes 7.5 hours (i.e., 4 hours to dock and 3.5 hours to undock) for two tugs to dock/undock each vessel at GCT. In 2008 there were 1521 container vessels that docked/undocked. This means that 1,521 vessels times 7.5 hours or 11,407.5 hours in 2008 were used by the ten tugs to dock/undock. In 2008, each tug worked **on average** about 1141 hours. The Corps used the 1141 hours per tug for the activity of use in 2008.

Table 5-19
Docking/Undocking Emissions for all Ten Tugs at GCT (2008)

TUGS	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.103601	0.052858	0.005259	0.006546	0.006349	0.000069	7.294339
5100 HP	0.040865	0.020850	0.002075	0.002582	0.002505	0.000027	2.877233
4000 HP	0.129092	0.065863	0.006554	0.008157	0.007912	0.000086	9.089132
3300 HP	0.053611	0.027352	0.002722	0.003387	0.003286	0.000036	3.774629
3000 HP	0.024462	0.012481	0.001242	0.001546	0.001499	0.000016	1.722328
TOTAL	0.351631	0.179403	0.017851	0.022217	0.021551	0.000233	24.757661

For docking and undocking at the GPA Ocean Terminal (OT) and non-GPA terminals, the Corps assumed that all ten tugs were equally used throughout the year. In 2008, there were 1083 vessels docked/undocked times 7.5 hours per vessel or about 8122.5 hours of activity for all ten tugs. Each tug was used 812.25 hours at OT and non-GPA terminals.
The following table represents the emissions for all ten tugs at OT and non-GPA terminals:

Table 5-20
OT/non-GPA Terminal Emissions for all Ten Tugs (2008)

TOTAL Tugs	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.073767	0.037636	0.003745	0.004661	0.004521	4.89E-05	5.1937994
5100 HP	0.029097	0.014846	0.001477	0.001838	0.001783	1.93E-05	2.0486807
4000 HP	0.091918	0.046897	0.004666	0.005808	0.005633	6.1E-05	6.4717486
3300 HP	0.038172	0.019476	0.001938	0.002412	0.00234	2.53E-05	2.6876553
3000 HP	0.017418	0.008887	0.000884	0.001101	0.001068	1.16E-05	1.2263521
TOTAL	0.250372	0.127741	0.012711	0.015819	0.015345	0.000166	17.628236

For shifting vessels from one terminal to another, the Corps assumed that all ten tugs were equally used. In 2008, there were about 176 vessels shifted times 4 hours for two tugs to shift each vessel. Therefore, the total hours used to shift vessels in 2008 was 704 hours (176 times 4 = 704) and each tug was used 70.4 hours (704 divided by 10 =70.4). The following table represents the emissions for all ten tugs used to shift in 2008:

Table 5-21 Emissions for all Ten Tugs for Vessel Shifts (2008)

TOTAL Tugs	Total NO_x Emissions (ton/call)	Total CO Emissions (ton/call)	Total HC Emissions (ton/call)	Total PM_{10} Emissions (ton/call)	Total $PM_{2.5}$ Emissions (ton/call)	Total SO_2 Emissions (ton/call)	Total CO_2 Emissions (ton/call)
6500 HP	0.006394	0.003262	0.000325	0.000404	0.000392	4.24E-06	0.450161
5100 HP	0.002522	0.001287	0.000128	0.000159	0.000155	1.67E-06	0.177565
4000 HP	0.007967	0.004065	0.000404	0.000503	0.000488	5.28E-06	0.560925
3300 HP	0.003309	0.001688	0.000168	0.000209	0.000203	2.19E-06	0.232947
3000 HP	0.00151	0.00077	7.66E-05	9.54E-05	9.25E-05	1E-06	0.106291
TOTAL	0.021700	0.011072	0.001102	0.001371	0.001330	0.000014	1.527889

5.6 Other Deep-Draft Vessel Types

The distribution of vessel calls in 2008 by type is summarized as follows:

	Total Harbor
Container	1,521
Bulk	170
Breakbulk	362
Tanker	406
RO/RO	145
LNG *	120
Total	2,724

Those totals do not include some vessels which called at the port in 2008 because they appeared to be infrequent calls (one call per vessel type in that year) or were barges.

Although Container vessels dominate the Savannah Harbor fleet (1521 of 2,724 vessels in 2008), numerous other types of vessels also call at the port. Those include Bulk, Breakbulk, Tanker, and RO/RO vessels. The Corps performed separate calculations of emissions from those vessels because they generally have different engine configurations than Container vessels. The emission calculation process followed the same procedure as stated for Containerships:

EMISSIONS PER TRANSIT	=	ENGINE HORSEPOWER	X	LOAD FACTOR	X	TRAVEL TIME	X	EMISSION RATE

The typical engine horsepower for the various types of vessels was taken from Table 2-4 on page 2-7 of EPA's 2009 Best Practices Report and is shown below:

Table from EPA's 2009 Best Practices Report

Vessel Type	Propulsion Engine (Kw)	Auxiliary Engine (Kw)	Auxiliary Engine (#)	Total Auxiliary Power (Kw)
Bulk*	8,000	612	2.9	1,775
Container	30,900	1,889	3.6	6,800
Cruise	39,600	2,340	4.7	10,998
General Cargo	9,300	612	2.9	1,775
RORO	11,000	983	2.9	2,851
Reefer	9,600	975	4	3,900
Tanker	9,400	735	2.7	1,985

* Since EPA's description of Bulk and Breakbulk vessels are so similar and information could not be readily found for emissions from main engines of Breakbulk vessels, the Corps used the emission rates for Bulk vessels. Since the engine size and emissions are different for the Main Propulsion Engine and Auxiliary Engines, the Corps performed separate calculations for both of those engine types.

The Load Factor for main propulsion engines OGV were obtained from the Table 2-15 on page 2-18 of the USEPA 2009 report.

Table 5-22
Main Engine Load Factors
(From USEPA 2009 report)

Pollutant	RSZ (12% Low Load Factor)	MANEUVERING (3% Low Load Factor)	DOCKING (3% Low Load Factor)	HOTELLING (Main Engine Shut Down)
NOx	1.14	2.92	2.92	0.00
CO	1.64	6.46	6.46	0.00
HC	1.76	11.68	11.68	0.00
PM10	1.24	4.33	4.33	0.00
PM2.5	1.20	4.20	4.20	0.00
SO2	1.18	2.49	2.49	0.00
CO2	1.17	2.44	2.44	0.00

Load Factors for auxiliary engines were obtained from EPA's 2009 Best Practices Report (page 2-12).

Table 5-23
Auxiliary Engine Load Factors

Ship Type	Cruise	RSZ	Maneuver	Hotel
Auto Carrier	0.15	0.30	0.45	0.26
Bulk Carrier *	0.17	0.27	0.45	0.10
Container Ship	0.13	0.25	0.48	0.19
Cruise Ship	0.80	0.80	0.80	0.64
General Cargo	0.17	0.27	0.45	0.22
Miscellaneous	0.17	0.27	0.45	0.22
OG Tug	0.17	0.27	0.45	0.22
RORO	0.15	0.30	0.45	0.26
Reefer	0.20	0.34	0.67	0.32
Tanker	0.24	0.28	0.33	0.26

* Since EPA's description of Bulk and Breakbulk vessels are so similar and information could not be readily found for emissions from main engines of Breakbulk vessels, we used the emission rates for Bulk vessels.

Travel time was based on information provided by GPA from discussions with the Harbor Pilots. Differences in time between the vessel types are primarily the result of the different destinations (docking location). That information is summarized as follows:

Table 5-24
Travel Time (minutes)

Vessel Type	Reduced Speed Zone	Maneuvering	Docking
Container	90	60	30
Bulk	90	56	30
Breakbulk	90	48	30
Tanker	90	44	30
RO/RO	90	30	30

The emission rates were obtained from the USEPA 2009 report. Those rates are shown below.

Table 5-25
Main Engine Emission Factors

Pollutant	Main Engine Emission Factor (g/kW-hr)	Auxiliary Engine Emission Factor (g/kW-hr)
NO_X	17.00	13.90
CO	1.40	1.10
HC	0.60	0.40
PM_{10}	0.45	0.49
$PM_{2.5}$	0.42	0.45
SO_2	3.62	4.24
CO_2	588.79	690.71

Combining this information, one can calculate the emissions per transit for each of the vessel types (including Tugs). The results of those calculations are as follows:

Table 5-26
2008 Summary for Emissions of Vessels at Ocean and Non-GPA Terminals

	NOx (Tons/year)	CO (Tons/year)	CO (Tons/year)	PM_{10} (Tons/year)	$PM_{2.5}$ (Tons/tear)	SO_2 (Tons/year)	CO_2 (Tons/year)
170 Bulk Vessels in 2008	166.82	25.97	17.98	6.03	5.98	33.95	5447.00
362 Break Bulk Vessels in 2008	359.53	61.40	41.55	14.71	13.34	86.20	8587.74
406 Tanker Vessels in 2008	467.77	68.44	45.63	16.73	15.19	100.46	16156.18
145 RoRo Vessels in 2008	183.61	25.53	16.41	6.49	5.90	40.91	6589.75
TUGS **	0.25	0.13	0.01	0.02	0.02	0.00	17.63
TOTAL	1177.98	181.48	121.57	43.97	40.43	261.52	36798.30

* According to the Port of Portland Spreadsheets, VOC= 1.005* HC.
** Two Tugs used to dock/undock a total of 1083 vessels (170+362+406+145=1083)
Emissions taken from the GCT Sheet TUG2 Table 2

5.7 Intra-Harbor Shifts

Some vessels shift location once in the harbor; they move from one terminal to another. This may be to receive fuel or take on food, or to wait to take on other cargo. The air emission analysis included these vessel movements.

GPA consulted the records of the Harbor Pilots and obtained information on the number of shifts that had occurred in 2008 as well as the origin and destination of each of those vessel movements. The Harbor Pilots provided information on the length of time it took to move from one terminal to another. This information is summarized as follows:

Table 5-27
2008 Shifts by Vessel Type

	Total Harbor
Container	2
Bulk	45
General Cargo / Breakbulk	61
Tanker	68
RO/RO	0
Total	176

These numbers do not include two vessels (yachts) that were moved within the port in 2007 because they appeared to be infrequent calls by vessels that may have been receiving repairs.

The amount of time it took to shift vessels from one terminal to another was found to be independent of vessel type. Therefore, average values were calculated to shift vessels within the harbor. These are shown below.

Table 5-28
Time to Shift Vessels (minutes)

Docking	Maneuvering	Docking
30	35	30

Calculations can then be performed for the emissions for these vessel movements. The Corps used the values for Engine Horsepower, Load Factor, and Emission Rate that were used and described in the previous section titled "Emissions From Other Vessel Types". That information applies to these emissions because they are the same types of vessels. Since the values are the same, they will not be repeated here.

Combining this information, the Corps calculated the air emissions from the inner harbor shifts of non-container vessels to be as shown below. The emissions from the tugs that assist these vessels are also shown. The summary of those calculations is as follows:

Table 5-29
2008 Summary Emissions (tons/year) for all Harbor Shifts

	NOx	CO	HC	PM10	PM2.5	SO2	CO2
TOTAL	144.77	26.02	20.11	5.67	5.13	27.29	4,218.29

5.8 Maintenance Dredging

Dredges commonly operate in the harbor to maintain suitable depths for deep-draft vessels in both the navigation channel and the berths. The Corps of Engineers maintains the navigation

channel, while the berth owners are responsible for maintaining depths at the berths. The berth maintenance operations are of a smaller scale than those to maintain the navigation channel. The berth owners may use a crane with a clamshell bucket, a tug dragging apparatus to perform agitation dredging, or a small dredge. This analysis includes only emissions from the Corps dredges because those operations use larger equipment and are conducted for longer periods of time than are the berth maintenance operations. Therefore, they are expected to result in more air emissions than those used to maintain the berths.

The Corps reviewed its records of recent dredging contracts to obtain information on the dredging it conducted. The most recent dredging records (2008) were used to identify the typical dredge and supporting equipment for the inner harbor dredging. This information revealed the following:

Table 5-30
Equipment Used Inner Harbor Channel Dredging 2008

	Engine Size (Horsepower)	Days of Use	Hours of Use
Dredge	5,200	308	3,878
Booster	2,000	308	2,145

The Corps assumed that one Tug Tender Boat was used to support the operations. Based on the 2003 Port of Houston report, we assumed that support boat had a 1,100 HP engine. We also assumed it operated for 18 hours per day.

The Corps selected an average dredge engine Load Factor of 75 percent. This value was averaged from two sources reported in the Port of Houston's 2003 report titled "Improvement to the Commercial Marine Vessel Inventory in the Vicinity of Houston, Texas". Engine Load factors for dredge tug tender were averaged from values obtained from EPA's Best Practices Report for an Assist Tugboat and a Dredge Tender. Because the District's data showed information on the amount of time that a booster pump was used, we used a 100 percent Load Factor over that entire duration.

Emission rates for NOx, VOC and CO were taken from 2003 Port of Houston report for the dredge, tug support, and booster pump engines. These rates were higher for those parameters than values contained in EPA's 2009 Best Practices report. Emission rates for other parameters (HC, PM10 and SO2), some of which were not reported for Houston, were taken from that EPA report. Information on engine load factors was obtained from EPA's Best Practices Report.

The District also reviewed the record of the dredge used to maintain the Savannah Harbor entrance channel in early 2007. Those records reveal that the dredge "Glenn Edwards" worked on that channel for 24 days. There were 504 hours of effective operating time and 72 hours of non-effective time. Using the company's website for the sizes of various types of equipment on board, we calculated that the horsepower likely in use totaled 5,457 HP. This matches fairly well with the size of typical hopper dredge (6,400 HP) reported in the 2003 Port of Houston report. We used engine emission rates reported in EPA's 2009 Best Practices report.

The District combined the hours of use with the engine size, load factor and the emission rates to produce emission totals by pollutant type for the four different types of equipment. The calculations followed a variation of the standard procedure:

EMISSIONS FROM EACH EQUIPMENT TYPE	=	ENGINE HORSEPOWER	X	LOAD FACTOR	X	TIME OF USE	X	EMISSION RATE

The summary of those calculations is as follows:

Table 5-31
Summary Table for Maintenance Dredge Emissions (Ton/year)

	Total HC Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$ Emissions (ton/year)	Total SO_2 Emissions (ton/year)
Pipeline dredge	3.3571	3.3739	31.0840	161.6367	3.7301	3.6182	7.8332
Booster	0.9536	0.9584	8.8301	45.9163	1.0596	1.0278	2.2252
Tug Tender	0.6767	0.6801	6.2661	32.5835	0.7519	0.7294	1.5790
Hopper Dredge**	0.0187	0.0188	0.4668	2.5149	0.0602	0.0546	0.7379
TOTAL	5.0062	5.0312	46.6469	242.6515	5.6018	5.4300	12.3753

**Port of New York/New Jersey Marine Vessel Emission Inventory, dated April 2003. Table 7-10 on page 86 provided the following:

Hopper Dredge Emissions (gm/Kw-hr)						
NOx	**CO**	**HC*** **	**PM10**	**PM2.5**	**SO2**	**VOC**
13.36	2.48	0.0995024	0.32	0.29	3.92	0.10

5.9 Dredging During Harbor Deepening

If the harbor is deepened, dredges will be the primary equipment used to excavate the channel and relocate the sediments out of the channel. The Corps reviewed the information developed as part of the cost estimating efforts. The dredges and supporting equipment expected to be used consist of the following:

Table 5-32
Dredges Expected To Be Used

	Number	Engine Size (Horsepower)
30-inch Pipeline Dredge	1	8,700
Dredge Support Tug	2	600
Dredge Support Survey Boat	2	100
Dredge Support Derrick	2	200
30-inch Booster Pump	1	5,200
Hopper Dredge & Support	1	5,200

The same equipment would be needed to construct all depth alternatives. It is the duration of use that would vary by depth. Those estimated durations are as shown below. These durations do not include the time necessary to deepen the entrance channel extension, which is believed will take from 5.6 to 11 months, depending on depth alternative

Table 5-33
Approximate Dredging Duration By Channel Depth (Months)

	44-Feet	45-Feet	46-Feet	47-Feet	48-Feet
Pipeline	22.4	31.1	29.1	26.9	25.1
Hopper	14.1	6.2	8.8	11.8	14.9

To calculate the air emissions from this equipment, information is needed on the emission rates and load factors. The Corps obtained emission rates for NOx, VOC and CO from the 2003 Port of Houston report for the dredge, tug support, and booster pump engines. These rates were higher for those parameters than values contained in EPA's 2009 Best Practices report. Emission rates for other parameters (HC, PM10 and SO2), some of which were not reported for Houston, were taken from that EPA report.

The District combined the days of use with the engine size, effective working time, and the emission rates to produce emission totals by pollutant type for the four different types of equipment. The calculations followed a slight variation of the standard procedure:

EMISSIONS FROM EACH TYPE OF DREDGING = ENGINE HORSEPOWER X LOAD FACTOR X DURATION OF USE X EMISSION RATE

The summary of those calculations is as follows:

Table 5-34
Summary of New Work Dredging Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
44-Foot Depth Alternative							
Pipeline Dredging	26.42	26.56	244.67	1272.27	29.36	26.42	61.66
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.25
45-Foot Depth Alternative							
Pipeline Dredging	29.81	29.96	276.03	1435.33	33.12	32.13	69.56
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.24
46-Foot Depth Alternative							
Pipeline Dredging	30.94	31.10	286.49	1489.76	34.38	33.35	72.20
Hopper Dredging	0.06	0.06	1.42	7.66	0.18	0.17	2.25
47-Foot Depth* Alternative							
Pipeline Dredging	65	65	582	3015	74	65	150
Hopper Dredging	0.7	0.7	17.1	92.0	2.2	2.2	27
48-Foot Depth Alternative							
Pipeline Dredging	68.8	69.14	636.8	3311.6	76.4	74.87	160.5
Hopper Dredging	3.68	3.7	20.6	178.2	0.37	0.33	4.48

* Estimated not calculated.

This new work dredging would be performed one time, when the harbor is deepened. The work would take different lengths of time, depending on the channel depth selected.

The amount of dredging being conducted will vary during those periods of time. In some months, three pipeline dredges may be working in the inner harbor, while in others there may be only two, and in a few months only one dredge may operate. The variability is primarily the result of the availability of funding and environmental dredging windows in the upper harbor. The three pipeline dredges would operate in different parts of the harbor. As a result, their emissions would not be concentrated, but instead would be distributed along the roughly 21 miles of inner harbor navigation channel.

These emission totals do not include work that would be performed to construct the various mitigation features. The mitigation work consists of several features, including plugging a small tidal channel, deepening two other channels, constructing a flow diversion weir, removing a concrete structure, and constructing a submerged weir. This work would primarily require different and much smaller equipment, than what was evaluated above. The equipment would be similar to construction equipment which is commonly used throughout the area on a regular basis. This equipment would include backhoes, small bulldozers, small cranes, etc. Much of the

mitigation work would be performed upriver of the new work dredging, primarily in the vicinity of the area of the Savannah National Wildlife Refuge. Air emissions from this work would, therefore, be somewhat dispersed from the channel dredging work.

5.10 Tourist Boats

The Corps evaluated air emissions from the vessels which operate daily in the harbor to transport tourists. This includes the boats operated by the Chatham Transit Authority to shuttle passengers between River Street and Hutchinson Island. It also includes the paddle wheel boats which people use to tour the harbor from the river. The basic information was provided by the Savannah Maritime Association, who obtained it through coordination with the two organizations that operate those vessels.

The following table is a summary of the vessel information:

Table 5-35
Chatham County's Tourist Shuttle Boats

	Engine Size (Horsepower)	Daily Use	Type of Use
Juliette Gordon Low	115	18 hr/day	20 min @ 90% capacity 40 min @ 30% capacity
Susie King Taylor	115	10 hr/day	20 min @ 90% capacity 40 min @ 30% capacity

Table 5-36
Paddle Wheel Tourist Boats

	Engine Size (Horsepower)	Daily Use	Weekly Use	Type of Use
River Boat #1	800	4 hr/day	7 days/wk	1 hr @ 80% capacity 3 hr @ 50% capacity
River Boat #2	600	3 hr/day	7 days/wk	1 hr @ 80% capacity 2 hr @ 50% capacity

The use rates for these sources are summarized as follows:

Table 5-37
Engine Use Rates

Vessel	Use Rate (HP-hr/yr)
Juliette Gordon Low	376,740
Susie King Taylor	209,300
River Boat #1	728,000
River Boat #2	436,800

The Corps selected emission rates for the vessel engines from those given in EPA's Best Practice Report. The rates selected for the County's shuttle boats were those reported for Category 1 Harbor Craft with 100 HP engines. The rates are slightly smaller for larger engine sizes. The rates selected for the Paddle Wheel boats were those reported for Category 1 Harbor Craft with 750 and 600 HP engines.

These engine use rates were combined with the emission rates to produce emission totals by pollutant type. The summary of those calculations is as follows:

Table 5-38
Summary Table for Tourist Boat Emissions

	Total HC Emissions (ton/year)	Total VOC* Emissions (ton/year)	Total CO Emissions (ton/year)	Total NOx Emissions (ton/year)	Total PM10 Emissions (ton/year)	Total PM2.5 Emissions (ton/year)	Total SO2 Emissions (ton/year)	Total CO2 Emissions (ton/year)
Chatham County Tourist Schuttle Boats	0.13	0.13	0.82	4.82	0.19	0.19	0.30	332.39
Paddle-Wheel Tourist Boats	0.26	0.26	1.44	9.57	0.29	0.28	0.60	660.65
TOTAL	0.39	0.39	2.26	14.39	0.48	0.47	0.91	993.03

5.11 Landside Equipment at Non-GPA Terminals

The Corps analyzed emissions from equipment used on the land to load and unload cargoes at the non-GPA terminals in the harbor. Detailed information was not readily available for the equipment used at the various private terminals. The Corps reviewed the air inventories that had been prepared for other harbors to identify a harbor which most reflected the types of vessels and cargoes which are handled at the Port of Savannah. The ports of Seattle and Tacoma were identified as being most similar to Savannah. In 2002, the total tonnage handled by the ports was as follows:

Table 5-39
2002 Total Tonnage

Seattle	19.6 million
Tacoma	20.6 million
Savannah	20.7 million

As in Savannah, both Seattle and Tacoma possess container, bulk, breakbulk, RO/RO, and tanker terminals.

The Corps took information on these two ports from the April 2007 report titled "Puget Sound Maritime Air Emissions Inventory". That report describes air emissions from various sources,

including landside equipment, for several terminals in Puget Sound. The number of vessel movements by vessel type was obtained for the two Puget Sound ports, as was the emission quantity by source (CHE, fleet vehicles, etc) and pollutant.

The District calculated an average emission rate per vessel for each pollutant type for each port. We blended those values to produce an average emission rate per vessel for each pollutant type for use at the Port of Savannah. For CO and SO2, we decided to use emission rates closer to those from the Port of Seattle because 30 percent of the vessels calling at the Port of Tacoma are auto carriers or RO/RO. Such vessels make only limited calls at Savannah, so the values from Seattle should be more representative of the fleet in Savannah.

Using the Puget Sound report, the following information summarizes the emissions from the two ports for three categories of air emission sources -- Cargo Handling Equipment, Heavy Duty Vehicles, and Fleet Vehicles. These types of equipment comprise that which load, unload, and move cargoes on a terminal.

Table 5-40
Summary of Landside Emissions (2005 Data)

	NOx	VOC	CO	SO2	PM10	PM2.5	CO2
	---------- Tons per Year ----------						
Seattle	718	78	806	71	40	38	66,553
Tacoma	638	45	277	8	35	34	66,899
	---------- Pounds per Vessel ----------						
Seattle	612.6	66.6	687.7	60.6	34.1	32.4	56,786
Tacoma	609.7	43	264.7	7.6	33.4	32.5	63,926
Blended Average	611.1	54.8	581	50	33.8	32.5	60,356

To use this information, one must then know the number of vessels that call at Savannah. That information was presented previously, but is repeated here:

Table 5-41
2008 Vessel Calls by Type and Location

	Total Harbor	Elba Island LNG Terminal	Garden City Terminal	Ocean Terminal	Non-GPA Terminals
Container	1,521		1,521	---	---
Bulk	170		---	12	158
Breakbulk	362		---	240	122
Tanker	406		---	---	406
RO/RO	145		---	145	---
LNG *	120	120			
Total	2,724	120	1,521	397	686

The table shows that there were 686 vessels, other than LNG vessels, that called at non-GPA terminals in 2008.

Using those vessels numbers and the emission rates, one can quantify the 2008 air emissions by pollutant source from the landside equipment used at non-GPA terminals in Savannah. Again, that equipment is comprised of Cargo Handling Equipment, Heavy Duty Vehicles, and Fleet Vehicles. The summary of those calculations is as follows:

Table 5-42
Summary Table for Non-GPA Landside Cargo Handling Equipment and Ocean Terminal

SUMMARY TABLE FOR NON-GPA LANDSIDE CHE AND OCEAN TERMINAL								
	Total HC* Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$ Emissions (ton/year)	Total SO_2 Emissions (ton/year)	Total CO2
TOTAL	18.69493	18.788405	199.283	209.620883	11.589027	11.132487	17.15	20702.15

5.12 Liquefied Natural Gas Vessel Operations

The Corps evaluated air emissions from the operations to handle the Liquefied Natural Gas (LNG) vessels which call at the Port of Savannah. The basic information was obtained from the FERC's August 2007 Final EIS on the Elba III Project. That report provided information on air emissions by pollutant type for various components of the operation, including the following: LNG vessel transit, LNG vessel offloading, LNG vessel hotelling, tug assist vessel berthing/unberthing, tug assist vessel standby, and Coast Guard escort vessels. The list covered all aspects of the vessel handling operations. A summary of those emissions are as follows:

Table 5-43
Emissions Summary (Tons per Year)

	VOC	CO	NOx	PM	SO2
Calculated Total	34.7	530	492	58.1	527.4

The Corps used this information to calculate average emission rates per vessel call. The report also provided vessel transit numbers for the recent past and expectations for the near future (at capacity after completion of the Elba III Project). FERC's EIS stated that the expected the facility to handle its full capacity of 126 vessels after February 2006 (after completion of the Elba II Project) and handle 221 vessels after completion of the Elba III Project (now under construction). Using those values, one can calculate the present emissions and those expected in the future. The summary of those calculations is as follows:

Table 5-44
Summary of LNG Emissions

TOTAL	Total HC* Emissions (ton/year)	Total VOC Emissions (ton/year)	Total CO Emissions (ton/year)	Total NO_x Emissions (ton/year)	Total PM_{10} Emissions (ton/year)	Total $PM_{2.5}$** Emissions (ton/year)	Total SO_2 Emissions (ton/year)
126 LNG After Feb 2006	19.68	19.78	302.17	279.93	33.12	32.13	300.68
120 LNG Vessels 2016	18.74	18.84	287.78	266.60	31.54	30.60	286.37
136 LNG Vessels 2020	21.24	21.35	326.15	302.15	35.75	34.68	324.55
151 LNG Vessels 2025	23.59	23.70	362.12	335.47	39.69	38.50	360.35
167 LNG Vessels 2030	26.09	26.22	400.49	371.02	43.90	42.58	398.53
167 LNG Vessels 2066	26.09	26.22	400.49	371.02	43.90	42.58	398.53
TOTAL	**135.45**	**136.13**	**2079.23**	**1926.23**	**227.93**	**221.09**	**2069.03**

Since the values presented by FERC for the LNG facility after the Elba III Project is completed are for operation of that facility at full capacity, the Corps chose to use that value for emissions from operations associated with this overall facility in all future years. We are assuming that the facility will not expand beyond the size for which the owners obtained approval in 2007. The FERC EIS did not indicate that the owners may want to expand the facility more in the future.

5.13 GPA Cargo Handling Equipment

Since detailed information could be obtained on the Cargo Handling Equipment (CHE) used to load/unload vessels at GPA's Garden City and Ocean Terminals and transport the cargo within the terminal, The District conducted a detailed analysis of their air emissions. The Cargo Handling Equipment included in this analysis consists of Container Cranes, Rubber Tire Gantry Cranes (RTG's), Toplifts, and Jockey Trucks (or Yard Hustlers).

The information on equipment type, numbers, and amount of use was provided by GPA. Most of the information is from GPA's records, but some they provided after coordination with other companies from which they lease the equipment. The Corps obtained some equipment horsepower information from manufacturer's websites.

Seventeen of nineteen container cranes at the Garden City Terminal are electric. They were not included in this analysis. The following tables are summaries of important information in this worksheet:

Table 5-45
Summary of GPA Cargo Handling Equipment

	Engine HP	Number	Average Use (Hours/Year)
---------- GARDEN CITY TERMINAL ----------			
Rubber Tired Gantry Cranes	750	47	93,021
Container Cranes (GCT)	1,200	2	2,274
Toplifts	600	42 – FY 05	3.403
	600	43 – FY06	3,975
	600	54 – FY07	3,280
Empty Container Handlers	175	4 – FY05	3,419
	175	14 – FY06	1,201
	175	19 – FY07	2,672
Jockey Trucks	165	220	1,500
---------- OCEAN TERMINAL ----------			
Container Cranes	1,200	6	1,642
Toplifts	335	3 – FY05	474
	335	2 – FY06	254
	335	2 – FY07	111
Jockey Trucks	165	25	1,500
	200	5	1,500

The air emission rates for the various types of equipment were provided by EPA Region 5 and are from the NONROAD2005 model for the 2007 calendar year. The NONROAD2005 model for 2007 used diesel fuel with 1339 ppm Sulfur. The rates are dependent upon the horsepower of the engine.

The air emissions are calculated by equipment and pollutant type. The emission rates are multiplied by the usage rates to produce the pollutant quantity for that year. Separate calculations were made for the Garden City Terminal and Ocean Terminal.

The emissions calculated (with 1339 ppm Sulfur fuel) by equipment type are as follows:

Table 5-46 Summary of GPA CHE Emissions Tons Per Year – 2008

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
GARDEN CITY TERMINAL								
Rubber Tired Gantry Cranes	13.09	13.79	116.86	231.46	15.37	14.91	15.67	22448.96
Container Cranes	0.58	0.61	2.17	8.34	0.41	0.40	0.43	611.22
Toplifts FY07	21.55	22.71	177.04	465.00	25.31	24.55	42.30	60596.45
Empty Container Handlers FY07	1.50	1.58	6.35	18.02	1.41	1.37	1.68	2398.82
Jockey Trucks	11.55	12.16	48.84	139.67	10.89	10.56	12.89	18456.24
Total	**48.27**	**50.84**	**351.26**	**862.49**	**53.39**	**51.79**	**72.96**	**104511.69**

Table 5-47 Summary of GPA CHE Emissions Tons Per Year – 2008

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
OCEAN TERMINAL								
Container Cranes	0.4192	0.4415	1.5665	6.0272	0.2947	0.2859	0.3084	441.8825
Toplifts FY07	0.0945	0.0995	0.7760	2.0382	0.1109	0.1076	0.1854	265.6034
Jockey Trucks	1.6538	1.7411	7.0031	20.3768	1.5383	1.4918	1.9103	2735.9359
Total	**2.1674**	**2.2822**	**9.3456**	**28.4421**	**1.9439**	**1.8852**	**2.4041**	**3443.4218**

Prior to 2016, when the Federal navigation channel is deepened, the CHE for the Garden City and Ocean Terminals will be using the ULSD fuel with 15 ppm Sulfur. The emission rates for the CHE for these terminals were calculated using methods reviewed by EPA Region 5 and are from the NONROAD2008 model for the 2010 calendar year.

The emissions calculated for the CHE in both terminals using the ULSD fuel (15 ppm Sulfur) is:

Table 5-48 Summary of GPA CHE Emissions Tons Per Year – 2010

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
GARDEN CITY TERMINAL								
Rubber Tired Gantry Cranes	10.16	10.70	103.79	196.08	11.72	11.37	0.20	22,458.46
Container Cranes	0.48	0.50	1.80	7.45	0.30	0.29	0.01	611.55
Toplifts	22.10	23.27	173.80	398.34	25.76	24.98	0.60	64,496.20
Empty Container Handlers	1.77	1.86	10.32	22.58	2.38	2.31	0.04	3,881.79
Jockey Trucks	8.58	9.04	49.53	109.56	11.37	11.02	0.17	18,465.03
Total	**43.08**	**45.37**	**339.24**	**734.01**	**51.52**	**49.97**	**1.01**	**109,913.04**

Table 5-49 Summary of GPA CHE Emissions Tons Per Year – 2010

	HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
OCEAN TERMINAL								
Container Cranes	0.34	0.36	1.3	5.38	0.22	0.21	0.004	442.12
Toplifts	0.09	0.09	0.72	1.66	0.10	0.10	0.002	267.84
Jockey Trucks	1.24	1.30	7.11	16.02	1.57	1.52	0025	2,737.18
Total	1.67	1.76	9.13	23.07	1.89	1.83	0.03	3,447.14

5.14 Trucks Calling at Garden City Terminal

Trucks which transport containers to/from the port also emit pollutants into the air. The District included these emissions in its analysis. GPA provided information on the trucks calling at the Garden City Terminal. This data includes the number of trucks by month, separated into Receiving and Delivering, and the average amount of time spent at the GPA terminal by each truck. This information was provided in 2008 and is shown below:

Table 5-50
Trucks Calling at Garden City Terminal
July 2006-June 2007

	Receive	Deliver
JAN	57,601	57,227
FEB	54,950	54,449
MAR	62,984	59,698
APR	53,743	53,602
MAY	61,170	60,555
JUN	59,945	59,572
JUL	57,361	56,413
AUG	64,823	64,398
SEP	60,218	59,097
OCT	67,442	65,699
NOV	62,297	60,766
DEC	59,546	57,001
TOTAL	722,080	708,477

GPA also provided the following information on the average truck dwell time:

Table 5-51
Truck Dwell Time

	Distribution	Time on the Terminal
Single Transaction	21 %	43 minutes
Multi-Transaction	79 %	56 minutes

Based on this information, trucks spent a total of about 640,190 hours in the Garden City Terminal (GCT) in 2006/2007. The Corps then used the 2006/2007 number of truck hours spent in the Garden City Terminal for the 2008 Truck Emissions at GCT.

The Corps included 15 minutes each way for each truck to account for the time it travels in the vicinity of the port, but not on the terminal. This additional 30 minutes of engine time accounts for time spent traveling between the Interstate highway system and the Garden City Terminal. The Corps added the additional 0.5 hour per truck and added that number to 640,190 hours. Therefore, the total truck hours in 2006/2007 were about 1,001,228.8 hours.

Ultra-low sulfur diesel (ULSD) fuel was proposed by EPA as a new standard for the sulfur content in on-road diesel fuel sold in the United States since October 15, 2006, except for rural Alaska. California has required it since September 1, 2006, and rural Alaska will transition all diesel to ULSD in 2010. This new regulation applies to all diesel fuel, diesel fuel additives and distillate fuels blended with diesel for on-road use, such as kerosene. By December 1, 2010, all highway diesel fuel will be ULSD. As of September 2007, most on-highway diesel fuel sold at retail locations in the United States is ULSD. For the purpose of this analysis ULSD was used in

subsequent calculations for trucks in 2008 at the Garden City Terminal (the base year) because: (1) ULSD has been used since 2006; and (2) Conversation with US EPA indicated that the majority of trucks in 2008 use the ULSD fuel.

Moreover, the Georgia Port Authority (GPA) is in the process of converting all its truck fleet to the ULSD diesel fuel (15 ppm Sulfur) prior to the 2010 deadline.

Emission rates for the truck engines (from EPA's 1997 report numbered "EPA 420-F-97-014") are shown below:

Table 5-52
Emission Rates for Heavy Duty
Trucks/Buses - 2008 (Grams/BHP-Hour)

YEAR	HC	CO	NOX	PM
1990	1.30	15.50	6.00	0.60
1991-1993	1.30	15.50	5.00	0.25
1994-1997	1.30	15.50	5.00	0.10
1998-2003	1.30	15.50	4.00	0.10
2004		15.50		0.10
2007			0.20	0.01

US EPA, Region 5 provided the Corps with spreadsheets that used the MOBILE 6 model to calculate in-use truck emission rates (by vehicle class, model year and calendar year) for a set of calendar years. MOBILE 6 spreadsheets were used with the following assumptions:

By Model Year Runs:

Calendar Years :	**1980,1990,2000,2005,2010,2020 (July Evaluation)**
Summer Temperatures:	**72 to 92 degrees Fahrenheit , min/max**
Pollutants:	**Criteria Pollutants and PM2.5 (exhaust PM only)**
Fuels:	**Default for gasoline sulfur and 15 ppm for diesel sulfur**
Other inputs:	**Default**

The workbook consists of 21 worksheets, one for each of seven calendar years and one of three gasoline and diesel fuel types.

A description of each one of them follows:

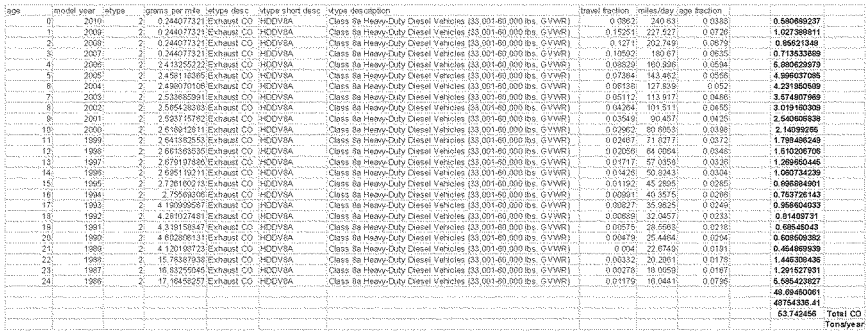
Worksheet name	Calendar Year	Sulfur content of Fuel in ppm	
		Gasoline	**Diesel**
bymy1	1980	default	15
bymy2	1990	default	15
bymy3	1995	default	15
bymy4	2000	default	15
bymy5	2005	default	15
bymy6	2010	default	15

Each of the above worksheets contain data on grams per mile for 28 vehicle classes , for ages 0 to24, for VOC,CO, NOX and total exhaust PM2.5

Also included are data on miles per day, travel fraction and age fraction.

Georgia Port Authority (GPA) provided us with the number of trucks arriving/departing at the Garden City Terminal but did not provide model year, weight, or average speed at the terminal. However, GPA did provide us with the average time for each truck at the port. The Corps increased this truck time (provided by GPA) at the terminal to cover any stand-by time at the entrance/exit gates as well as time required to enter/leave the Savannah Metro Area. The Corps then made the following assumptions: assume each truck was 33,000 lb (HDDV8A) and that **average** speed in the terminal is 27.6 miles/hr.
Below is a sample calculation for CO, where we used the MOBILE 6 spreadsheets (provided by US EPA Region 5):

Multiple gm/mile by 27.6 miles/hour equals gm/hr of criteria pollutant;
Then multiple gm/hr by travel fraction to get national average default for all model years. Sum each column to get grams of criteria pollutant and multiple by 1,001,228.8 hours/year and 0.00000110231131 to get tons/year. Therefore, the total tons of CO per year for all trucks at Garden City Terminal is 53.7 tons (see last number on the far right column, below).



age	model year	stype	grams per mile	stype desc	mype short desc	mype description	travel fraction	miles/day	age fraction		
0	2010	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.0963	240.63	0.0388	**0.580689237**	
1	2009	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.15251	227.527	0.0726	**1.027389811**	
2	2008	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.1271	202.749	0.0679	**0.95621348**	
3	2007	2	0.244077321	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.10502	180.67	0.0635	**0.713533689**	
4	2006	2	2.413255222	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.08529	160.936	0.0594	**5.880629379**	
5	2005	2	2.458116285	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.07264	143.462	0.0556	**4.996037085**	
6	2004	2	2.498070106	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.06138	127.839	0.052	**4.231850509**	
7	2003	2	2.533685991	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.05112	113.917	0.0466	**3.674807969**	
8	2002	2	2.565428393	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.04264	101.511	0.0455	**3.019160309**	
9	2001	2	2.59371578	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.03549	90.457	0.0435	**2.540606938**	
10	2000	2	2.618412811	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02962	80.6053	0.0388	**2.14099265**	
11	1999	2	2.641382553	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02467	71.8277	0.0372	**1.799406249**	
12	1998	2	2.661369535	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.02056	64.0064	0.0348	**1.510206705**	
13	1997	2	2.679197826	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01717	57.0359	0.0336	**1.269650445**	
14	1996	2	2.695119211	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01426	50.8343	0.0304	**1.060734239**	
15	1995	2	2.7261602 13	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01192	45.2895	0.0285	**0.906884901**	
16	1994	2	2.7556920 06	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00991	40.3575	0.0288	**0.763726143**	
17	1993	2	4.190995987	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00827	35.9625	0.0249	**0.956604033**	
18	1992	2	4.281027481	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00688	32.0457	0.0233	**0.91497731**	
19	1991	2	4.319158547	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00575	28.5563	0.0218	**0.68545043**	
20	1990	2	4.602806131	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00479	25.4464	0.0204	**0.608609382**	
21	1989	2	4.120198723	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.004	22.6749	0.0191	**0.464869939**	
22	1988	2	15.78387938	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00332	20.2061	0.0178	**1.446359436**	
23	1987	2	16.83255945	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.00278	18.0059	0.0167	**1.291527931**	
24	1986	2	17.16458257	Exhaust CO	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.01179	16.0441	0.0795	**5.585423827**	
										48.69450061	
										40754336.41	
										63.742456	Total CO Tons/year

The Corps then calculated the following pollutants (HC, VOC, NOx, PM_{10}, and $PM_{2.5}$) for trucks at the Garden City Terminal. Please note, that the MOBILE 6 spreadsheets did not have a VOC category for heavy duty trucks (HDDV8A). However, after reviewing the Port of Portland Air Inventory Spreadsheets, they determined that VOC= 1.005* HC. Therefore, we used this formula to calculate the VOC of heavy duty trucks (HDDV8A) at the Garden City Terminal.

Using those emission rates, the time spent by trucks on the terminal and additional time spent in the vicinity of the terminal, the emissions for each pollutant type can be calculated. The emissions for the truck fleet assumed that the ULSD (15 ppm Sulfur) was used and the following calculations were discussed with USEPA Region 5. The summary for those calculations are as follows:

Table 5-53
Summary of 2008 Truck Emissions at GCT Using ULSD (Tons)

HC	VOC	CO	NOx	PM10	PM2.5
12.2	12.3	53.7	218.4	4.78	4.64

5.15 Locomotives

GPA uses trains to move containers to and from their Garden City Terminal. The trains are powered by locomotives, some of which are Line Haul engines, while others are Switching engines that are used to combine the individual cars into long trains. The locomotives are owned by Norfolk Southern and the Savannah Port Terminal Railroad. The basic information on this equipment was provided by GPA, who obtained it from discussions with these two companies. GPA owns the Mason Intermodal Container Transfer Facility (ICTF), which is served by Norfolk Southern. The locomotive use information is summarized as follows in Table 5-54:

Table 5-54
Locomotives

	Engine Type	Number of Engines	Amount of Use	Type of Use
Norfolk Southern	GEC40	11	11 round trips per week	Line Haul
Garden City Terminal (CSX)	EMD-SW1200	3	21 hours per day	Switching
Golden Isles (CSX)	EMD-SW1500	1	6 hours per day	Switching

For the Norfolk Southern trains calling at the Mason ICTF, engine use durations were identified through further discussions with GPA. Those discussions resulted in the following summary of engine working time:

Table 5-55
Engine Work Time

	Amount of Use	Duration of Use
Mason ICTF	11 trips per week	Arrival - 20 minutes Loading – 2 1/3 hours Departure – 20 minutes

Based on the above information and further discussions with GPA, the following use rates were calculated:

Table 5-56
Amount of Engine Use

Type Of Engine	Use (Hours/Week)	Use (Hours/Year)
Line Haul	33	1,716
Switching	69	3,588
Total	102	5,304

GPA provided the following information on the **average** hours of locomotive operation:

1. Norfolk Southern used 11 locomotives for an average of 11 trips per week to and from the port. GPA stated that the line-haul locomotives only remain at the port (an **average** 3 hours see Table 5-55). Therefore, the estimated average weekly and yearly line-haul locomotive hours of operation at the port are: 33 hours per week (11 locomotives/week times 3 hours/locomotive = 33 hours) and for the year is 1,716 hours (33 times 52 weeks = 1,716).

2. CSX used a total of 4 switch locomotives an **average** of 3 times per week for a total of 21 hours per day plus 1 time per week for about 6 hours per day. Or on average about 69 hours per week (3 times 21 hours per day plus 6 hours per day = 69 hours). On average the switch locomotives were used 69 hours per week times 52 weeks in a year equals about 3,588 hours of operation in a year. Please note, both the hours of use for the line-haul and switch locomotives are **average estimates**. Cargo operations (goods being hauled in/out and switched to/from the port by train) are not carried out continuously 24 hour per day 7 day a week.

The hours provided for both line-haul and switch locomotives in Table 5-56 include idling. However, GPA did not know the exact percentage of idling versus in-operation. The NONROAD model assumes that the idling air emission rate is lower than the in-operation rate. The District assumed the same in-operation air emission rate for locomotives, whether idling or in-operation. **Therefore the locomotive air emission estimates (shown in Tables 5-57, 5-58, 5-59, and 5-60, below) are greater (more conservative) than if idling had been factored into the equation.** The District used category SCC 2285002015 for locomotives as the air emission rate NONROAD2005 model for the 2007 calendar year (using 1139 ppm Sulfur diesel fuel see Tables 5-57 and 5-58, below) and NONROAD2008 model for the 2010 calendar year (using 15 ppm Sulfur diesel fuel see Tables 5-59 and 5-60, below).

The Corps selected emission rates for the locomotive engines from information provided EPA, Region 5. We used emission rates for 2,000 HP engines, since the engine size presently in use averages 1,633 HP.

Table 5-57
Emission Rates for Diesel Railway Locomotives (Pounds/Hour-Unit)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
1.0153	1.0691	4.5034	6.4649	0.6874	0.6668	0.3284	470.51

The engine horsepower is multiplied by the emission rate and the duration of use. The product is the air emission quantity by pollutant type. The total emissions from locomotives in 2008 (using 1139 ppm Sulfur diesel fuel) are summarized as follows:

Table 5-58
Summary of 2008 Locomotive Emissions (Tons)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
2.69	2.84	11.94	17.15	1.82	1.77	0.87	1,248

EPA Region 5, (by email dated 6 February 2009) provided the **following emission standards for locomotives using ULSD (15 ppm Sulfur):**

In 2009, SCC 2285002015, Diesel Railway Maintenance HP 2000 (HP Ave is 1633). All Units are in lbs./hr/unit.

Table 5-59 Emission Rates for Diesel Railway Locomotives Using ULSD (15ppm) (Pounds/Hour-Unit)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
0.8709	0.917	3.8745	6.0419	0.5498	0.5333	0.0043	470.9581

The following table provides the total emissions for locomotives using ULSD (15 ppm Sulfur):

Table 5-60 Summary of Locomotive Emissions Using ULSD (15 ppm) (Tons)

HC	VOC	CO	NOx	PM10	PM2.5	SO2	CO2
2.3	2.4	10.3	16.0	1.45	1.41	0.01	1249.0

GPA moved 18 percent of the containers with trains in 2006. Their 2016 future facility plan calls for that to increase to 25 percent. GPA has constructed a second rail yard facility that was completed in 2008. This facility is used by CSX, which until that time did not have a dedicated on-site facility from which to support movements GPA's operations. The expected increased use of trains would be accompanied by a corresponding decrease in the use of trucks. Trains are generally viewed as being more efficient in moving containers from the perspectives of traffic and air quality. This air quality analysis does not include these future changes, so the analysis overstates the total future air emissions.

5.16 GPA Fleet Vehicles

GPA also operates a fleet of vehicles at its Garden City and Ocean Terminals. These vehicles include the automobiles and small trucks used on those two GPA facilities. GPA provided the basic information on their vehicle fleet, which includes 197 vehicles with license tags. The information was voluminous and included the type of vehicle, age, fuel type, and number of miles driven per year. The Corps summarized this information by vehicle category (Light Duty Gas Vehicles, Light Duty Diesel Trucks, etc), as shown in Table 5-61, below:

Table 5-61 GPA Vehicle Fleet (July 2006-June 2007)

EPA Classification	Typical Vehicles	Total Mileage
Light Duty Gas Vehicles	Cars, Pickups, Vans	484,069
Light Duty Gas Trucks	Heavy Duty Pickups, etc.	973,266
Light Duty Diesel Trucks		30,312

US EPA, Region 5 provided the Corps with spreadsheets that used the MOBILE 6 model to calculate in-use vehicle emission rates (by vehicle class, model year and calendar year) for a set of calendar years. The Corps used the emissions for the following vehicle categories:

LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)

The product is the air emission quantity by pollutant type, as summarized in Table 5-62, below:

Table 5-62 Summary of 2006/2007 GPA Vehicle Fleet Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5
Light Duty Gas Vehicles (LDGV)	**.40**	**0.4**	**4.20**	**0.31**	**0.002**	**0.002**
Light Duty Gas Trucks (LDGT1)	0.83	0.83	9.75	0.81	0.005	0.004
Light Duty Diesel Trucks (LDDT12)	0.01	0.01	0.03	0.03	0.002	0.002
Total	1.24	1.24	13.98	1.15	0.009	0.008

5.17 Air Toxics

In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, there are also numerous other compounds which are emitted. Some of those are classified as "air toxics". In its review of the Corps' 2006 draft Air Quality Analysis, EPA Region 4 requested that air toxics also be considered.

Air Toxics are generally determined as a ratio of criteria pollutants discharged. The emission rates are a proportion of other parameters such as VOC, PM10, gallons or miles. The Corps obtained information from the NMIM "SCC Toxics" database table provided by EPA, Region 5 concerning the ratios of specific air toxics to other physical parameters. These ratios are displayed in Tables 5-63A, 5-63B, and 5-64, below and were also used but not displayed in Tables 5-65 to 5-76.

The 28 toxics which have been identified in the highest quantity in emission inventories prepared for other ports -- and their relationship to other calculated pollutants -- are shown in Tables 5-63A and 5-63B, below.

The Corps calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2002 Chatham County EPA NEI air toxic emission. To calculate Ethyl Benzene, the Corps multiplied the total VOC emissions in 2008 for the -42 foot depth (see Table 5-78), which is 352.54 tons times 0.0031 equals about 1.09 tons. The total PM10 emissions in 2008 for the -42 foot depth (see Table 5-78) are about 229.76 tons. Additionally, the Corps calculated the percent of the 2008 air toxics emissions to the 2002 EPA NEI Chatham County data. All of these quantities are shown below in Table 5-63A, below.

Table 5-63A Summary of Air Toxic Emissions for the Port of Savannah – 2008 Compared to 2002 EPA Chatham County NEI (Tons Per Year)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2002 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2002 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.092907	56.028	1.95%
2	Styrene	VOC	0.00059448	0.209578	10.74	1.95%
3	1,3-Butadiene	VOC	0.0018616	0.656287	33.64	1.95%
4	Acrolein	VOC	0.00303165	1.068776	54.79	1.95%
5	Toluene	VOC	0.014967	5.276454	270.50	1.95%
6	Hexane	VOC	0.0015913	0.560996	28.76	1.95%
7	Anthracene	PM10	0.00000043	0.000099	0.00279	3.54%
8	Propionaldehyde	VOC	0.0118	4.159963	213.26	1.95%
9	Pyrene	PM10	0.0000029	0.000666	0.0188	3.54%
10	Xylene	VOC	0.010582	3.730570	191.25	1.95%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.000044	0.00123	3.54%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.000018	0.0005	3.54%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.000113	0.0032	3.54%
14	Fluoranthene	PM10	0.000017	0.003906	0.110	3.54%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.000080	0.00227	3.54%
16	Acenaphthylene	PM10	0.000084	0.019300	0.55	3.54%
17	Chrysene	PM10	0.0000019	0.000437	0.0123	3.54%
18	Formaldehyde	VOC	0.118155	41.654271	2135.42	1.95%
19	Benzo(a)pyrene	PM10	0.00000035	0.000080	0.00227	3.54%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.000001	0.188181	3.54%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.232676	11.93	1.95%
22	Benz(a)anthracene	PM10	0.00000071	0.000163	0.0046	3.54%
23	Benzene	VOC	0.020344	7.172058	367.68	1.95%
24	Acetaldehyde	VOC	0.05308	18.712781	959.31	1.95%
25	Acenaphthene	PM10	0.0001	0.022976	0.649	3.54%
26	Phenanthrene	PM10	0.00026	0.059738	1.69	3.54%
27	Fluorene	PM10	0.0001	0.022976	0.65	3.54%
28	Naphthalene	PM10	0.00046	0.105691	2.98	3.54%

The Corps also calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2005 EPA NEI air toxic emissions. As indicated in Section 6 entitled "Comparison of Emissions at Port with Emissions in Chatham County", the 2005 USEPA NEI Data **does not include** 2280003100 Marine Vessels, Commercial, Residual, Port emissions or 2280003200 Marine Vessels, Commercial, Residual, Underway emissions. This means that the percent 2008 Port Emissions compared to the 2005 NEI data may be slightly higher than in Table 5-63A. All of these calculated quantities are shown below in Table 5-63B below.

Table 5-63B Summary of Air Toxic Emissions – 2008 Compared to the 2005 EPA Chatham County NEI (Tons Per Year)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2005 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2005 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.09290682	54.0502	2.02%
2	Styrene	VOC	0.00059448	0.20957751	10.3648	2.02%
3	1,3-Butadiene	VOC	0.0018616	0.65628700	32.4570	2.02%
4	Acrolein	VOC	0.00303165	1.06877551	52.8568	2.02%
5	Toluene	VOC	0.014967	5.27645442	260.9496	2.02%
6	Hexane	VOC	0.0015913	0.56099565	27.7443	2.02%
7	Anthracene	PM10	0.00000043	0.00009880	0.0031	3.20%
8	Propionaldehyde	VOC	0.0118	4.15996273	205.7330	2.02%
9	Pyrene	PM10	0.0000029	0.00066631	0.0208	3.20%
10	Xylene	VOC	0.010582	3.73056997	184.4972	2.02%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.00004365	0.0014	3.20%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.00001815	0.0006	3.20%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.00011258	0.0035	3.20%
14	Fluoranthene	PM10	0.000017	0.00390596	0.1220	3.20%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.00008042	0.0025	3.20%
16	Acenaphthylene	PM10	0.000084	0.01930003	0.6027	3.20%
17	Chrysene	PM10	0.0000019	0.00043655	0.0136	3.20%
18	Formaldehyde	VOC	0.118155	41.65427087	2060.0324	2.02%
19	Benzo(a)pyrene	PM10	0.00000035	0.00008042	0.0025	3.20%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.00000067	0.0000	3.20%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.23267588	11.5071	2.02%
22	Benz(a)anthracene	PM10	0.00000071	0.00016313	0.0051	3.20%
23	Benzene	VOC	0.020344	7.17205778	354.6976	2.02%
24	Acetaldehyde	VOC	0.05308	18.71278150	925.4498	2.02%
25	Acenaphthene	PM10	0.0001	0.02297622	0.7175	3.20%
26	Phenanthrene	PM10	0.00026	0.05973818	1.8655	3.20%
27	Fluorene	PM10	0.0001	0.02297622	0.7175	3.20%
28	Naphthalene	PM10	0.00046	0.10569062	3.3005	3.20%

At the request of EPA, the Corps calculated emissions of air toxics for the Garden City Terminal. Table 5-64 below shows the emissions calculated for 2008, while the following Tables 5-65, 5-66, and 5-67 show the emissions expected in future years (i.e., 2016, 2025, and 2030) for the No Action Alternative or -42 foot depth. The numbers for the future years are based on the cargo tonnages expected in the project's economic analysis. The emissions would not increase after 2030 because that terminal is expected to reach its maximum operating capacity then and would not be able to receive additional cargoes.

Table 5-64 Summary of Air Toxic Emissions Garden City Terminal Existing -42 foot depth 2008 (Tons Per Year)

	AIR TOXIC PARAMETER	AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.0031001	0.306821	0.208215	0.00005562	0.515092
2	Styrene	0.00059448	0.058836	0.039928	0.00001067	0.098775
3	1,3-Butadiene	0.0018616	0.184245	0.125033	0.00003340	0.309311
4	Acrolein	0.00303165	0.300047	0.203618	0.00005439	0.503719
5	Toluene	0.014967	1.481304	1.005245	0.00026851	2.486818
6	Hexane	0.0015913	0.157493	0.106878	0.00002855	0.264400
7	Anthracene	0.00000043	0.000030	0.000026	0.00000001	0.000056
8	Propionaldehyde	0.0118	1.167862	0.792536	0.00021170	1.960610
9	Pyrene	0.0000029	0.000201	0.000174	0.00000006	0.000375
10	Xylene	0.010582	1.047315	0.710730	0.00018984	1.758235
11	Benzo(g,h,i)perylene	0.00000019	0.000013	0.000011	0.00000000	0.000025
12	Indeno(1,2,3,c,d)pyrene	0.000000079	0.000005	0.000005	0.00000000	0.000010
13	Benzo(b)fluoranthene	0.00000049	0.000034	0.000029	0.00000001	0.000063
14	Fluoranthene	0.000017	0.001178	0.001020	0.00000038	0.002198
15	Benzo(k)fluoranthene	0.00000035	0.000024	0.000021	0.00000001	0.000045
16	Acenaphthylene	0.000084	0.005821	0.005040	0.00000187	0.010863
17	Chrysene	0.0000019	0.000132	0.000114	0.00000004	0.000246
18	Formaldehyde	0.118155	11.693960	7.935773	0.00211974	19.631853
19	Benzo(a)pyrene	0.00000035	0.000024	0.000021	0.00000001	0.000045
20	Dibenzo(a,h)anthracene	2.9E-09	0.000000	0.000000	0.00000000	0.000000
21	2,2,4-Trimethylpentane	0.00066	0.065321	0.044328	0.00001184	0.109661
22	Benz(a)anthracene	0.00000071	0.000049	0.000043	0.00000002	0.000092
23	Benzene	0.020344	2.013473	1.366386	0.00036498	3.380224
24	Acetaldehyde	0.05308	5.253400	3.565070	0.00095227	8.819422
25	Acenaphthene	0.0001	0.006930	0.006000	0.00000222	0.012932
26	Phenanthrene	0.00026	0.018017	0.015601	0.00000578	0.033624
27	Fluorene	0.0001	0.006930	0.006000	0.00000222	0.012932
28	Naphthalene	0.00046	0.031877	0.027602	0.00001022	0.059488

Table 5-65 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.600036	0.250814	0.00008385	0.850942
2	Styrene	0.115064	0.048096	0.00001608	0.163178
3	1,3-Butadiene	0.360320	0.150613	0.00005035	0.510988
4	Acrolein	0.586788	0.245276	0.00008199	0.832153
5	Toluene	2.896921	1.210907	0.00040480	4.108271
6	Hexane	0.308002	0.128744	0.00004304	0.436794
7	Anthracene	0.000020	0.000033	0.00000001	0.000053
8	Propionaldehyde	2.283935	0.954681	0.00031914	3.238965
9	Pyrene	0.000134	0.000221	0.00000010	0.000355
10	Xylene	2.048187	0.856138	0.00028620	2.904638
11	Benzo(g,h,i)perylene	0.000009	0.000014	0.00000001	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000004	0.000006	0.00000000	0.000010
13	Benzo(b)fluoranthene	0.000023	0.000037	0.00000002	0.000060
14	Fluoranthene	0.000787	0.001296	0.00000057	0.002084
15	Benzo(k)fluoranthene	0.000016	0.000027	0.00000001	0.000043
16	Acenaphthylene	0.003888	0.006406	0.00000281	0.010297
17	Chrysene	0.000088	0.000145	0.00000006	0.000233
18	Formaldehyde	22.869356	9.559347	0.00319564	32.432199
19	Benzo(a)pyrene	0.000016	0.000027	0.00000001	0.000043
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000000
21	2,2,4-Trimethylpentane	0.127746	0.053397	0.00001785	0.181162
22	Benz(a)anthracene	0.000033	0.000054	0.00000002	0.000087
23	Benzene	3.937660	1.645934	0.00055023	5.584196
24	Acetaldehyde	10.273839	4.294445	0.00143561	14.569854
25	Acenaphthene	0.004629	0.007626	0.00000335	0.012258
26	Phenanthrene	0.012035	0.019827	0.00000871	0.031871
27	Fluorene	0.004629	0.007626	0.00000335	0.012258
28	Naphthalene	0.021293	0.035078	0.00001541	0.056388

Table 5-66 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.987080	0.349133	0.00011946	1.336332
2	Styrene	0.189284	0.066950	0.00002291	0.256257
3	1,3-Butadiene	0.592738	0.209653	0.00007174	0.802463
4	Acrolein	0.965285	0.341424	0.00011682	1.306826
5	Toluene	4.765530	1.685583	0.00057675	6.451690
6	Hexane	0.506674	0.179212	0.00006132	0.685947
7	Anthracene	0.000031	0.000046	0.00000002	0.000076
8	Propionaldehyde	3.757149	1.328915	0.00045471	5.086520
9	Pyrene	0.000207	0.000308	0.00000014	0.000515
10	Xylene	3.369335	1.191744	0.00040777	4.561487
11	Benzo(g,h,i)perylene	0.000014	0.000020	0.00000001	0.000034
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000008	0.00000000	0.000014
13	Benzo(b)fluoranthene	0.000035	0.000052	0.00000002	0.000087
14	Fluoranthene	0.001216	0.001805	0.00000081	0.003021
15	Benzo(k)fluoranthene	0.000025	0.000037	0.00000002	0.000062
16	Acenaphthylene	0.006009	0.008917	0.00000401	0.014930
17	Chrysene	0.000136	0.000202	0.00000009	0.000338
18	Formaldehyde	37.620846	13.306610	0.00455305	50.932010
19	Benzo(a)pyrene	0.000025	0.000037	0.00000002	0.000062
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000001
21	2,2,4-Trimethylpentane	0.210146	0.074329	0.00002543	0.284500
22	Benz(a)anthracene	0.000051	0.000075	0.00000003	0.000126
23	Benzene	6.477580	2.291140	0.00078395	8.769505
24	Acetaldehyde	16.900804	5.977867	0.00204541	22.880717
25	Acenaphthene	0.007154	0.010615	0.00000477	0.017773
26	Phenanthrene	0.018599	0.027599	0.00001241	0.046211
27	Fluorene	0.007154	0.010615	0.00000477	0.017773
28	Naphthalene	0.032907	0.048829	0.00002195	0.081757

Table 5-67 Summary of Air Toxic Emissions Garden City Terminal Without Project -42 foot depth -- 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.291789	0.418960	0.00014963	1.710898
2	Styrene	0.247715	0.080340	0.00002869	0.328085
3	1,3-Butadiene	0.775715	0.251584	0.00008985	1.027389
4	Acrolein	1.263266	0.409709	0.00014632	1.673122
5	Toluene	6.236640	2.022699	0.00072239	8.260061
6	Hexane	0.663083	0.215055	0.00007680	0.878214
7	Anthracene	0.000040	0.000055	0.00000003	0.000094
8	Propionaldehyde	4.916974	1.594699	0.00056953	6.512242
9	Pyrene	0.000267	0.000369	0.00000017	0.000636
10	Xylene	4.409442	1.430093	0.00051075	5.840046
11	Benzo(g,h,i)perylene	0.000017	0.000024	0.00000001	0.000042
12	Indeno(1,2,3,c,d)pyrene	0.000007	0.000010	0.00000000	0.000017
13	Benzo(b)fluoranthene	0.000045	0.000062	0.00000003	0.000108
14	Fluoranthene	0.001564	0.002165	0.00000102	0.003731
15	Benzo(k)fluoranthene	0.000032	0.000045	0.00000002	0.000077
16	Acenaphthylene	0.007729	0.010700	0.00000502	0.018434
17	Chrysene	0.000175	0.000242	0.00000011	0.000417
18	Formaldehyde	49.234326	15.967933	0.00570281	65.207961
19	Benzo(a)pyrene	0.000032	0.000045	0.00000002	0.000077
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.00000000	0.000001
21	2,2,4-Trimethylpentane	0.275017	0.089195	0.00003186	0.364244
22	Benz(a)anthracene	0.000065	0.000090	0.00000004	0.000156
23	Benzene	8.477196	2.749368	0.00098191	11.227547
24	Acetaldehyde	22.118048	7.173440	0.00256193	29.294051
25	Acenaphthene	0.009201	0.012738	0.00000598	0.021945
26	Phenanthrene	0.023924	0.033119	0.00001554	0.057058
27	Fluorene	0.009201	0.012738	0.00000598	0.021945
28	Naphthalene	0.042326	0.058594	0.00002750	0.100948

Similarly, the Corps calculated emissions of air toxics for the Garden City Terminal if the harbor is deepened. The following tables (Tables 5-68 to 5-76) show the emissions expected under those conditions. Again, the emissions would not increase after 2030 because that terminal is expected to reach its maximum operating capacity then and would not be able to receive additional cargoes. The emissions are the same for both the 47- and 48-foot alternatives because the vessel fleet is not expected to change between those alternatives (see Table 4-3 Fleet Forecast). Therefore, the same number and size of vessels would be used in those alternatives, so their air emissions would be the same.

Table 5-68 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project – 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.570728	0.250814	0.000080	0.821622
2	Styrene	0.109444	0.048096	0.000015	0.157555
3	1,3-Butadiene	0.342720	0.150613	0.000048	0.493381
4	Acrolein	0.558126	0.245276	0.000078	0.803480
5	Toluene	2.755422	1.210907	0.000385	3.966715
6	Hexane	0.292958	0.128744	0.000041	0.421743
7	Anthracene	0.000019	0.000033	0.000000	0.000052
8	Propionaldehyde	2.172378	0.954681	0.000304	3.127362
9	Pyrene	0.000128	0.000221	0.000000	0.000349
10	Xylene	1.948145	0.856138	0.000272	2.804555
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000010
13	Benzo(b)fluoranthene	0.000022	0.000037	0.000000	0.000059
14	Fluoranthene	0.000748	0.001296	0.000001	0.002045
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003698	0.006406	0.000003	0.010107
17	Chrysene	0.000084	0.000145	0.000000	0.000229
18	Formaldehyde	21.752318	9.559347	0.003040	31.314704
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.121506	0.053397	0.000017	0.174920
22	Benz(a)anthracene	0.000031	0.000054	0.000000	0.000085
23	Benzene	3.745327	1.645934	0.000523	5.391785
24	Acetaldehyde	9.772020	4.294445	0.001365	14.067830
25	Acenaphthene	0.004403	0.007626	0.000003	0.012032
26	Phenanthrene	0.011447	0.019827	0.000008	0.031282
27	Flnorene	0.004403	0.007626	0.000003	0.012032
28	Naphthalene	0.020253	0.035078	0.000015	0.055345

Table 5-69 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project – 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.561307	0.250814	0.000078	0.812200
2	Styrene	0.107637	0.048096	0.000015	0.155749
3	1,3-Butadiene	0.337063	0.150613	0.000047	0.487723
4	Acrolein	0.548914	0.245276	0.000077	0.794267
5	Toluene	2.709941	1.210907	0.000379	3.921227
6	Hexane	0.288122	0.128744	0.000040	0.416907
7	Anthracene	0.000019	0.000033	0.000000	0.000051
8	Propionaldehyde	2.136521	0.954681	0.000299	3.091500
9	Pyrene	0.000126	0.000221	0.000000	0.000347
10	Xylene	1.915988	0.856138	0.000268	2.772394
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000009
13	Benzo(b)fluoranthene	0.000021	0.000037	0.000000	0.000059
14	Fluoranthene	0.000736	0.001296	0.000001	0.002033
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003637	0.006406	0.000003	0.010045
17	Chrysene	0.000082	0.000145	0.000000	0.000227
18	Formaldehyde	21.393270	9.559347	0.002989	30.955606
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.119500	0.053397	0.000017	0.172914
22	Benz(a)anthracene	0.000031	0.000054	0.000000	0.000085
23	Benzene	3.683506	1.645934	0.000515	5.329955
24	Acetaldehyde	9.610721	4.294445	0.001343	13.906509
25	Acenaphthene	0.004330	0.007626	0.000003	0.011959
26	Phenanthrene	0.011258	0.019827	0.000008	0.031093
27	Fluoreue	0.004330	0.007626	0.000003	0.011959
28	Naphthalene	0.019919	0.035078	0.000014	0.055011

Table 5-70 Summary of Air Toxic Emissions Garden City Terminal With 47/48-Foot Project -- 2016 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.552503	0.250814	0.000078	0.803396
2	Styrene	0.105949	0.048096	0.000015	0.154060
3	1,3-Butadiene	0.331777	0.150613	0.000047	0.482437
4	Acrolein	0.540304	0.245276	0.000077	0.785657
5	Toluene	2.667436	1.210907	0.000378	3.878721
6	Hexane	0.283603	0.128744	0.000040	0.412388
7	Authracene	0.000018	0.000033	0.000000	0.000051
8	Propionaldehyde	2.103010	0.954681	0.000298	3.057988
9	Pyrene	0.000124	0.000221	0.000000	0.000345
10	Xylene	1.885936	0.856138	0.000267	2.742342
11	Benzo(g,h,i)perylene	0.000008	0.000014	0.000000	0.000023
12	Indeno(1,2,3,c,d)pyrene	0.000003	0.000006	0.000000	0.000009
13	Benzo(b)fluoranthene	0.000021	0.000037	0.000000	0.000058
14	Fluoranthene	0.000726	0.001296	0.000001	0.002023
15	Benzo(k)fluoranthene	0.000015	0.000027	0.000000	0.000042
16	Acenaphthylene	0.003588	0.006406	0.000003	0.009997
17	Chrysene	0.000081	0.000145	0.000000	0.000226
18	Formaldehyde	21.057723	9.559347	0.002984	30.620053
19	Benzo(a)pyrene	0.000015	0.000027	0.000000	0.000042
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.117626	0.053397	0.000017	0.171040
22	Benz(a)anthracene	0.000030	0.000054	0.000000	0.000084
23	Benzene	3.625732	1.645934	0.000514	5.272179
24	Acetaldehyde	9.459980	4.294445	0.001340	13.755765
25	Acenaphthene	0.004272	0.007626	0.000003	0.011901
26	Phenanthrene	0.011107	0.019827	0.000008	0.030942
27	Fluoreue	0.004272	0.007626	0.000003	0.011901
28	Naphthalene	0.019651	0.035078	0.000014	0.054744

Table 5-71 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.900971	0.349133	0.000109	1.250213
2	Styrene	0.172772	0.066950	0.000021	0.239743
3	1,3-Butadiene	0.541030	0.209653	0.000065	0.750749
4	Acrolein	0.881077	0.341424	0.000107	1.222608
5	Toluene	4.349804	1.685583	0.000526	6.035914
6	Hexane	0.462474	0.179212	0.000056	0.641742
7	Anthracene	0.000028	0.000046	0.000000	0.000074
8	Propionaldehyde	3.429391	1.328915	0.000415	4.758721
9	Pyrene	0.000189	0.000308	0.000000	0.000497
10	Xylene	3.075408	1.191744	0.000372	4.267524
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000033
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000014
13	Benzo(b)fluoranthene	0.000032	0.000052	0.000000	0.000084
14	Fluoranthene	0.001110	0.001805	0.000001	0.002915
15	Benzo(k)fluoranthene	0.000023	0.000037	0.000000	0.000060
16	Acenaphthylene	0.005485	0.008917	0.000004	0.014405
17	Chrysene	0.000124	0.000202	0.000000	0.000326
18	Formaldehyde	34.338954	13.306610	0.004156	47.649721
19	Benzo(a)pyrene	0.000023	0.000037	0.000000	0.000060
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.191813	0.074329	0.000023	0.266166
22	Benz(a)anthracene	0.000046	0.000075	0.000000	0.000122
23	Benzene	5.912502	2.291140	0.000716	8.204358
24	Acetaldehyde	15.426446	5.977867	0.001867	21.406180
25	Acenaphthene	0.006530	0.010615	0.000004	0.017149
26	Phenanthrene	0.016977	0.027599	0.000011	0.044587
27	Fluorene	0.006530	0.010615	0.000004	0.017149
28	Naphthalene	0.030036	0.048829	0.000020	0.078885

Table 5-72 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.877102	0.349133	0.000106	1.226341
2	Styrene	0.168194	0.066950	0.000020	0.235165
3	1,3-Butadiene	0.526697	0.209653	0.000064	0.736414
4	Acrolein	0.857736	0.341424	0.000104	1.199264
5	Toluene	4.234568	1.685583	0.000512	5.920663
6	Hexane	0.450222	0.179212	0.000054	0.629488
7	Anthracene	0.000027	0.000046	0.000000	0.000073
8	Propionaldehyde	3.338538	1.328915	0.000404	4.667858
9	Pyrene	0.000184	0.000308	0.000000	0.000492
10	Xylene	2.993933	1.191744	0.000362	4.186040
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000032
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000013
13	Benzo(b)fluoranthene	0.000031	0.000052	0.000000	0.000083
14	Fluoranthene	0.001081	0.001805	0.000001	0.002886
15	Benzo(k)fluoranthene	0.000022	0.000037	0.000000	0.000059
16	Acenaphthylene	0.005340	0.008917	0.000004	0.014260
17	Chrysene	0.000121	0.000202	0.000000	0.000323
18	Formaldehyde	33.429237	13.306610	0.004046	46.739893
19	Benzo(a)pyrene	0.000022	0.000037	0.000000	0.000059
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.186732	0.074329	0.000023	0.261084
22	Benz(a)anthracene	0.000045	0.000075	0.000000	0.000121
23	Benzene	5.755866	2.291140	0.000697	8.047703
24	Acetaldehyde	15.017764	5.977867	0.001818	20.997449
25	Acenaphthene	0.006357	0.010615	0.000004	0.016976
26	Phenanthrene	0.016527	0.027599	0.000011	0.044137
27	Fluorene	0.006357	0.010615	0.000004	0.016976
28	Naphthalene	0.029240	0.048829	0.000020	0.078088

Table 5-73 Summary of Air Toxic Emissions Garden City Terminal With 47/48-Foot Project -- 2025 (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	0.862111	0.349133	0.000106	1.211350
2	Styrene	0.165320	0.066950	0.000020	0.232290
3	1,3-Butadiene	0.517695	0.209653	0.000064	0.727412
4	Acrolein	0.843076	0.341424	0.000103	1.184603
5	Toluene	4.162193	1.685583	0.000511	5.848286
6	Hexane	0.442527	0.179212	0.000054	0.621793
7	Anthracene	0.000027	0.000046	0.000000	0.000072
8	Propionaldehyde	3.281478	1.328915	0.000403	4.610796
9	Pyrene	0.000181	0.000308	0.000000	0.000489
10	Xylene	2.942763	1.191744	0.000361	4.134868
11	Benzo(g,h,i)perylene	0.000012	0.000020	0.000000	0.000032
12	Indeno(1,2,3,c,d)pyrene	0.000005	0.000008	0.000000	0.000013
13	Benzo(b)fluoranthene	0.000031	0.000052	0.000000	0.000083
14	Fluoranthene	0.001061	0.001805	0.000001	0.002866
15	Benzo(k)fluoranthene	0.000022	0.000037	0.000000	0.000059
16	Acenaphthylene	0.005241	0.008917	0.000004	0.014161
17	Chrysene	0.000119	0.000202	0.000000	0.000320
18	Formaldehyde	32.857882	13.306610	0.004030	46.168523
19	Benzo(a)pyrene	0.000022	0.000037	0.000000	0.000059
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000000
21	2,2,4-Trimethylpentane	0.183540	0.074329	0.000023	0.257892
22	Benz(a)anthracene	0.000044	0.000075	0.000000	0.000120
23	Benzene	5.657490	2.291140	0.000694	7.949324
24	Acetaldehyde	14.761088	5.977867	0.001811	20.740766
25	Acenaphthene	0.006240	0.010615	0.000004	0.016859
26	Phenanthrene	0.016223	0.027599	0.000011	0.043833
27	Fluorene	0.006240	0.010615	0.000004	0.016859
28	Naphthalene	0.028702	0.048829	0.000019	0.077550

Table 5-74 Summary of Air Toxic Emissions Garden City Terminal With 44-Foot Project – 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.174354	0.418960	0.000136	1.593449
2	Styrene	0.225196	0.080340	0.000026	0.305562
3	1,3-Butadiene	0.705196	0.251584	0.000082	0.956861
4	Acrolein	1.148424	0.409709	0.000133	1.558266
5	Toluene	5.669672	2.022699	0.000657	7.693028
6	Hexane	0.602803	0.215055	0.000070	0.817927
7	Anthracene	0.000036	0.000055	0.000000	0.000091
8	Propionaldehyde	4.469976	1.594699	0.000518	6.065192
9	Pyrene	0.000243	0.000369	0.000000	0.000612
10	Xylene	4.008584	1.430093	0.000464	5.439141
11	Benzo(g,h,i)perylene	0.000016	0.000024	0.000000	0.000040
12	Indeno(1,2,3,c,d)pyrene	0.000007	0.000010	0.000000	0.000017
13	Benzo(b)fluoranthene	0.000041	0.000062	0.000000	0.000103
14	Fluoranthene	0.001422	0.002165	0.000001	0.003588
15	Benzo(k)fluoranthene	0.000029	0.000045	0.000000	0.000074
16	Acenaphthylene	0.007026	0.010700	0.000005	0.017731
17	Chrysene	0.000159	0.000242	0.000000	0.000401
18	Formaldehyde	44.758478	15.967933	0.005184	60.731595
19	Benzo(a)pyrene	0.000029	0.000045	0.000000	0.000074
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.250016	0.089195	0.000029	0.339240
22	Benz(a)anthracene	0.000059	0.000090	0.000000	0.000150
23	Benzene	7.706542	2.749368	0.000893	10.456803
24	Acetaldehyde	20.107317	7.173440	0.002329	27.283086
25	Acenaphthene	0.008365	0.012738	0.000005	0.021108
26	Phenanthrene	0.021749	0.033119	0.000014	0.054881
27	Fluorene	0.008365	0.012738	0.000005	0.021108
28	Naphthalene	0.038478	0.058594	0.000025	0.097098

Table 5-75 Summary of Air Toxic Emissions Garden City Terminal With 46-Foot Project – 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.140575	0.418960	0.000132	1.559667
2	Styrene	0.218718	0.080340	0.000025	0.299084
3	1,3-Butadiene	0.684912	0.251584	0.000079	0.936575
4	Acrolein	1.115391	0.409709	0.000129	1.525230
5	Toluene	5.506593	2.022699	0.000638	7.529930
6	Hexane	0.585464	0.215055	0.000068	0.800586
7	Anthracene	0.000035	0.000055	0.000000	0.000090
8	Propionaldehyde	4.341404	1.594699	0.000503	5.936606
9	Pyrene	0.000236	0.000369	0.000000	0.000605
10	Xylene	3.893283	1.430093	0.000451	5.323827
11	Benzo(g,h,i)perylene	0.000015	0.000024	0.000000	0.000040
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000010	0.000000	0.000016
13	Benzo(b)fluoranthene	0.000040	0.000062	0.000000	0.000102
14	Fluoranthene	0.001381	0.002165	0.000001	0.003547
15	Benzo(k)fluoranthene	0.000028	0.000045	0.000000	0.000073
16	Acenaphthylene	0.006824	0.010700	0.000004	0.017529
17	Chrysene	0.000154	0.000242	0.000000	0.000396
18	Formaldehyde	43.471070	15.967933	0.005035	59.444038
19	Benzo(a)pyrene	0.000028	0.000045	0.000000	0.000073
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.242824	0.089195	0.000028	0.332047
22	Benz(a)anthracene	0.000058	0.000090	0.000000	0.000148
23	Benzene	7.484875	2.749368	0.000867	10.235111
24	Acetaldehyde	19.528961	7.173440	0.002262	26.704664
25	Acenaphthene	0.008124	0.012738	0.000005	0.020867
26	Phenanthrene	0.021123	0.033119	0.000014	0.054255
27	Fluorene	0.008124	0.012738	0.000005	0.020867
28	Naphthalene	0.037372	0.058594	0.000024	0.095990

Table 5-76 Summary of Air Toxic Emissions Garden City Terminal Wit 47/48-Foot Project -- 2030+ (Tons Per Year)

	AIR TOXIC PARAMETER	OCEAN GOING VESSELS	LAND BASED OPERATIONS	TUGS	TOTAL EMISSIONS PER AIR TOXIC
1	Ethyl Benzene	1.118472	0.418960	0.000132	1.537564
2	Styrene	0.214480	0.080340	0.000025	0.294846
3	1,3-Butadiene	0.671639	0.251584	0.000079	0.923302
4	Acrolein	1.093776	0.409709	0.000129	1.503614
5	Toluene	5.399882	2.022699	0.000636	7.423217
6	Hexane	0.574119	0.215055	0.000068	0.789241
7	Anthracene	0.000034	0.000055	0.000000	0.000089
8	Propionaldehyde	4.257273	1.594699	0.000501	5.852473
9	Pyrene	0.000231	0.000369	0.000000	0.000600
10	Xylene	3.817836	1.430093	0.000449	5.248379
11	Benzo(g,h,i)perylene	0.000015	0.000024	0.000000	0.000039
12	Indeno(1,2,3,c,d)pyrene	0.000006	0.000010	0.000000	0.000016
13	Benzo(b)fluoranthene	0.000039	0.000062	0.000000	0.000101
14	Fluoranthene	0.001354	0.002165	0.000001	0.003520
15	Benzo(k)fluoranthene	0.000028	0.000045	0.000000	0.000072
16	Acenaphthylene	0.006689	0.010700	0.000004	0.017393
17	Chrysene	0.000151	0.000242	0.000000	0.000393
18	Formaldehyde	42.628653	15.967933	0.005019	58.601604
19	Benzo(a)pyrene	0.000028	0.000045	0.000000	0.000072
20	Dibenzo(a,h)anthracene	0.000000	0.000000	0.000000	0.000001
21	2,2,4-Trimethylpentane	0.238119	0.089195	0.000028	0.327342
22	Benz(a)anthracene	0.000057	0.000090	0.000000	0.000147
23	Benzene	7.339827	2.749368	0.000864	10.090060
24	Acetaldehyde	19.150513	7.173440	0.002255	26.326208
25	Acenaphthene	0.007963	0.012738	0.000005	0.020706
26	Phenanthrene	0.020704	0.033119	0.000014	0.053837
27	Fluorene	0.007963	0.012738	0.000005	0.020706
28	Naphthalene	0.036631	0.058594	0.000024	0.095249

5.18 Greenhouse Gases (GHGs)

Green house gases are discussed within the US Environmental Protection Agency, Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report, April 2009. The following information was taken from this document (USEPA 2009):

> *Carbon dioxide (CO2), the primary greenhouse gas associated with combustion of diesel (and other fossil fuels), accounted for about 96 percent of the transportation sector's global warming potential-weighted GHG emissions for 2003. Methane (CH4) and nitrous oxide (N2O) together account for about 2 percent of the transportation total GHG emissions in 2003. Both of these gases are released during diesel fuel consumption (although in much smaller quantities than CO2) and are also affected by vehicle emissions control technologies.*

In addition to the GHGs, another climate forcing pollutant of concern is elemental carbon.

On Page 2-16 of EPA 2009, the following information is found for marine diesel engines in OGVs: To estimate CO2 equivalents, CH4 emissions should be multiplied by 21 and N2O emissions should be multiplied by 310. Therefore, to estimate CH4 and N20, CO2 should be divided by 21 and 310, respectively. Since C02 =CH4 X 21 and CO2=N20 X 310. **CH4=CO2 / 21 and N20 = CO2 / 310.**

On Page 3-11 of EPA 2009, the following information is found for diesel commercial marine vessels: In addition to the greenhouse gas emission factors discussed above, it is possible to estimate elemental carbon emission factors from EPA's SPECIATE4 model for emissions of PM2.5. For diesel harbor craft, the diesel commercial marine vessel (SCC 2280002000) sector is appropriate. That sector is assigned an emission fraction of 77.12% elemental carbon. That is: EFEC = 77.12% x 97% x EFPM10 after adjusting the PM10 emission factor for fuel sulfur. **Elemental Carbon equals .7712 X 0.97 X PM10 implies that Carbon = 0.7712 * 0.97 * PM10**

The Corps estimated the GHGs for all marine diesel vessels within the 22 terminals in the Port of Savannah for all depths. Marine diesel vessels include OGVs, LNGs, tourist boats, tugs, shifts, pipeline and hopper dredges, etc. **The reason CO2 emissions are greater in 2016 compared to 2020 is because the harbor deepening is a one-time action and is completed in 2016.** Table 5-77 provides this GHGs information.

Table 5-77
Estimated Greenhouse Gases for All Vessels and All Depths

42-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**2,724**	131993.04	425.78	6285.38	130.42
2016	**4,146**	200896.90	648.05	9566.52	198.50
2020	**4,713**	228371.23	736.68	10874.82	225.65
2025	**5,886**	285209.64	920.03	13581.41	281.81
2030	**7,205**	349122.57	1126.20	16624.88	344.96
2066	**7,205**	349122.57	1126.20	16624.88	344.96

44-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**4,034**	268274.58	865.40	12774.98	107.61
2020	**4,508**	243821.57	786.52	11610.55	102.16
2025	**5,601**	300310.63	968.74	14300.51	122.02
2030	**6,833**	371372.78	1197.98	17684.42	146.23
2066	**6,833**	371372.78	1197.98	17684.42	146.23

45-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**4,010**	266678.50	860.25	12698.98	106.97
2020	**4,469**	241712.20	779.72	11510.10	101.27
2025	**5,549**	297522.53	959.75	14167.74	120.89
2030	**6,760**	367405.24	1185.18	17495.49	144.67
2066	**6,760**	367405.24	1185.18	17495.49	144.67

46-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	**NA**	NA	NA	NA	NA
2016	**3,998**	265880.46	857.68	12660.97	106.65
2020	**4,451**	240738.65	776.58	11463.75	100.87
2025	**5,522**	296074.86	955.08	14098.80	120.30
2030	**6,726**	365557.34	1179.22	17407.49	143.94
2066	**6,726**	365557.34	1179.22	17407.49	143.94

47-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

48-Foot Depth					
Year	**# of Vessels**	**CO_2**	**N_20**	**CH_4**	**Carbon**
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

5.19 Total Port Emissions

The District calculated air emissions from 13 different sources that are directly associated with operations of the harbor. This includes emissions from both GPA and private terminals in the Port. It also includes the vessels which call at the port, the tugs which assist those vessels, the landside equipment that moves the cargo on the terminals, ancillary vessels which operate in the harbor (dredges and tourist boats), and equipment used to move containers out of the harbor area.

The Economic Analysis predicts continued growth in the volume of containerized cargoes moving through the Port of Savannah in the future until the Garden City Terminal reaches is build-out capacity. The growth projections vary by year, trade route, and whether the cargo is an import or export. Based on those projections, the Corps expects a larger number of container vessels to call at Savannah in the future without a harbor deepening. This growth would be caused primarily by market forces outside the influence of the port itself, so growth would occur independent of a harbor deepening. These projections are described in detail in the GRR-Economic Appendix. As a general summary, the Corps expects a long term growth of roughly 3 percent per year in cargoes that are transported through the port as containers. No additional cargoes would move through the Garden City Terminal once the site reaches its build-out capacity. Based on the detailed growth rates, the Economic Analysis predicts different container fleets in the future years. Those fleets are summarized and found in Section 4.0 of this document.

Under both the Without- and With-Project conditions, the District expects the Garden City Terminal to reach its build-out capacity in 2030 when the total number of TEUs processed reaches 6.5 million. No increase in cargo is expected to occur as a result of the proposed harbor deepening. The project's economic benefits accrue from the use of larger, more cost-effective container ships, not an increase in the number of containers.

The Corps calculated air emissions for the expected future fleets of vessels expected to call at the Port and their associated landside equipment. The District used a conservative assumption that the landside equipment would grow at the same rate as the cargo volume. This assumption is conservative for this air emission inventory because it does not take into account any improvements in cargo handling efficiency that may occur in the future. Growth in such efficiency has been commonly observed in the past and is expected to continue to occur at Savannah, but the ability to predict its amount and timing are quite difficult.

Container traffic has dominated the movement of ocean cargo over the past 20 years. There is nothing to indicate that such dominance is likely to change in the foreseeable future. The Corps believes that movement of other cargoes through Savannah would also continue to grow in volume in the future. The District calculated air emissions for non-containerized cargoes assuming a 1 percent annual growth rate in those commodities. That same growth rate was applied to the associated landside equipment. The Corps included a 1 percent annual growth rate for the use of Tourist Boats in the harbor, and their resulting air emissions. The number of vessel shifts is also projected to increase by 1 percent per year. Using those projections, Table 5-78 on the following page shows the air emissions calculated for all vessels arriving/departing at the Georgia Ports Authority (Garden City and Ocean Terminals) and the 20 non-GPA terminals for the baseline (2008), 2016, 2020, 2025, 2030 and 2066. The number of OGVs calls (found in column 2 of Table 5-78) were doubled since each vessel included in-bound, docking, hotelling, undocking and out-bound emissions. Moreover, the emissions are the same for all depths from 2030 to the end of the project life in 2066. The reason is that the port reaches its capacity near 2030 of 6.5 million TEUs. The fleet forecast in Table 4-3 and in Attachment A, reflects this matter. The emissions would be the same for both the 47- and 48-foot depth alternatives because the vessel fleets are expected to be the same for both of those alternatives. With the same number and size of vessels, their air emissions would be the same. The bottom of the table 5-78 provides summaries of the air emissions in 2008, 2016, Total Without Project (50 years), Total With 48-foot Project (50 years), and during construction of a 48-foot deepening project.

Table 5-78
Summary Of All Pollutants (Tons/Year) For All 22 Terminals
Includes All Vessels And All Land-Based Emissions

BASELINE: Depth -42 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**2,724**	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	**4,146**	566.82	578.86	2,041.34	7,500.77	235.87	223.90	503.08	446,818.70
2020	**4,713**	663.09	670.16	2,130.17	6,238.08	247.18	233.98	509.67	461,222.15
2025	**5,886**	806.26	814.83	2,517.67	6,202.50	295.26	279.18	584.43	561,166.22
2030	**7,205**	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12
2066	**7,205**	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

Depth -44 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**4,034**	553.48	565.30	1,995.12	7,307.59	229.64	218.01	499.05	432,777.09
2020	**4,508**	634.79	641.41	2,036.09	5,914.58	234.59	222.06	501.57	432,816.48
2025	**5,601**	768.34	776.33	2,393.41	5,844.31	278.64	263.47	573.32	523,452.89
2030	**6,833**	941.26	950.95	2,827.68	5,995.87	331.97	313.55	656.38	635,509.88
2066	**6,833**	941.26	950.95	2,827.68	5,995.87	331.97	313.55	656.38	635,509.88

Depth -45 feet									
Year	**# of Vessels**	**HC**	**VOC**	**CO**	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_2**
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**4,010**	550.62	562.40	1,985.22	7,266.19	228.31	216.75	498.18	429,768.18
2020	**4,469**	629.40	635.94	2,018.19	5,853.03	232.20	219.79	500.03	427,412.47
2025	**5,549**	761.42	769.30	2,370.74	5,778.96	275.61	260.60	571.30	516,571.86
2030	**6,760**	931.35	940.90	2,796.19	5,917.19	327.77	309.58	653.47	625,920.74
2066	**6,760**	931.35	940.90	2,796.19	5,917.19	327.77	309.58	653.47	625,920.74

Depth -46 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,998**	549.20	560.95	1,980.27	7,245.50	227.64	216.12	497.75	428,263.72
2020	**4,451**	626.92	633.42	2,009.93	5,824.63	231.09	218.75	499.32	424,918.31
2025	**5,522**	757.83	765.65	2,358.97	5,745.02	274.04	259.11	570.25	512,999.02
2030	**6,726**	926.74	936.21	2,781.52	5,880.54	325.82	307.74	652.11	621,454.56
2066	**6,726**	926.74	936.21	2,781.52	5,880.54	325.82	307.74	652.11	621,454.56

Depth -47 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,994**	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	**4,442**	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	**5,511**	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

Depth -48 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
2016	**3,994**	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	**4,442**	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	**5,511**	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	**6,714**	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

SUMMARY								
Year	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	566.82	578.86	2,041.34	7,500.77	235.87	223.90	503.08	446,818.70
Without Project (50-Year Period of Analysis)	21,100	21,321	65,964	165,322	7,647	7,234	15,208	14,308,936
With 47/48-foot Project (50-Year Period of Analysis)	20,269	20,477	63,209	157,894	7,277	6,884	14,984	13,480,470
Harbor Deepening	70	70	671	3,495	81	78	214	181,442

958

The calculated emissions for 2030 and 2066 are likely to represent "worst case" conditions, because they do not include factors which are expected to reduce air emissions in the future. Those factors include (1) shifts to cleaner fuels, as mandated by EPA, (2) shifts to more containers being moved by rail, rather than by truck, (3) shifts to gas and electric power for landside equipment at the terminal, and (4) increases in cargo handling efficiency at the port.

Since the Corps' expectation is that a change in harbor depth in Savannah of up to 6 feet would not provide sufficient rationale for vessel lines to alter their trade routes, the amount of cargo entering the port With and Without the proposed harbor deepening would remain the same. Therefore, no changes in air emissions at the port would be expected to occur as a result of any of the proposed deepening alternatives. A growth in cargo movements and accompanying air emissions is expected in the future over time in Savannah, but those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening.

6.0 ANALYSIS

The objective of this Air Inventory and Assessment was to more thoroughly evaluate the air impacts expected from the proposed harbor deepening. Additional sources were included that provided a better understanding of the air emissions resulting from normal operations within the port. A total of 13 sources of emissions were evaluated, consisting of the following:

Containerships	GPA Cargo Handling Equipment	Tourist Boats	Maintenance Dredging
Non-Container Vessels	Landside Equipment at Non-GPA Terminals	Liquefied Natural Gas Vessel Operations	Dredging During Deepening
Tugs	GPA Fleet Vehicles	Locomotives	Tractor Trailers
Intra-Harbor Shifts			

The inventory identified the air emissions from those various sources. The calculated emission tonnages were shown in the previous section (Total Port Emissions). The various contributions from the different sources are discussed in the remainder of this section. The figure below shows that the largest sources of air pollutants in 2008 were the operations that directly support the deep-draft vessels that call at the port (Figure 6-1). Included in those categories are emissions from the vessels and the land-side operations required to handle their cargoes. The category of "Other Terminals" includes GPA's Ocean Terminal and the 20 privately-owned terminals located along the river. The Liquefied Natural Gas vessels and their supporting operations comprise the third largest source of air emissions in the port. The air emissions expected for 2016, the base year of the project are also shown. Figure 6-2 illustrates total port emissions in 2016 with the existing channel depth. Figure 6-3 shows total port emissions in 2016 with a 47/48-foot channel deepening. The effects of harbor deepening on air emissions are generally not readily apparent. The effects of the construction to deepen the harbor are shown in the figure

to show their relationship to emissions from other sources at that time. As stated previously, since no increase in the number of container ships that call on the port are expected to occur as a result of a harbor deepening, air emissions in the Port are also not expected to increase on a long term basis as a result of a harbor deepening project.

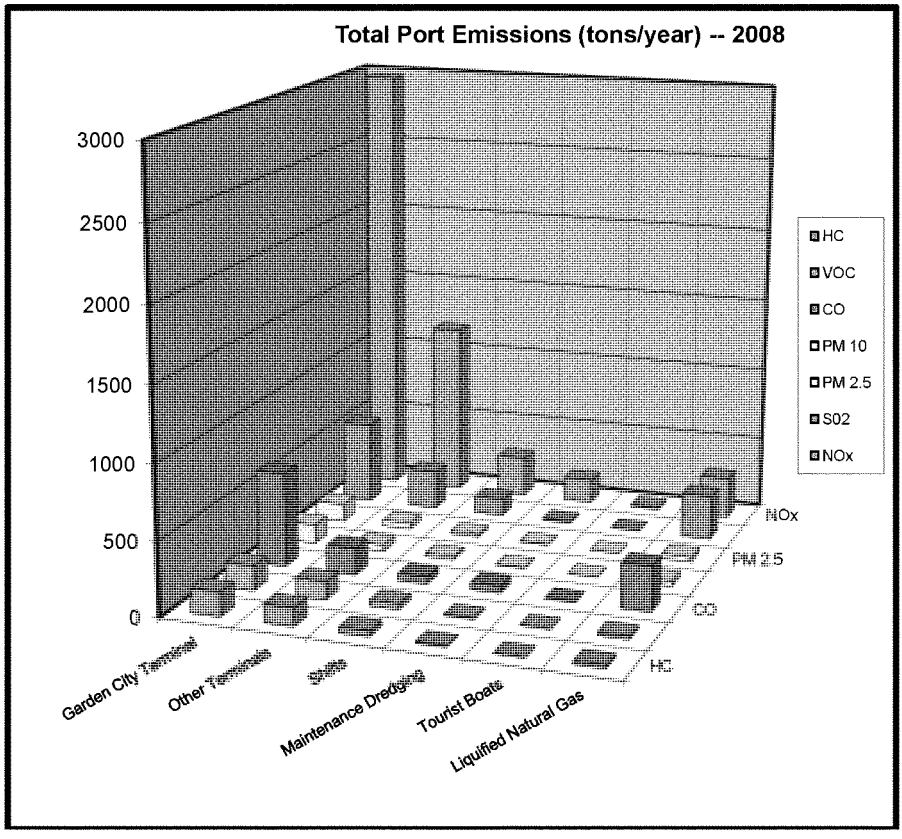


Figure 6-1. Port of Savannah - 2008 air emissions by source at existing -42 foot depth.

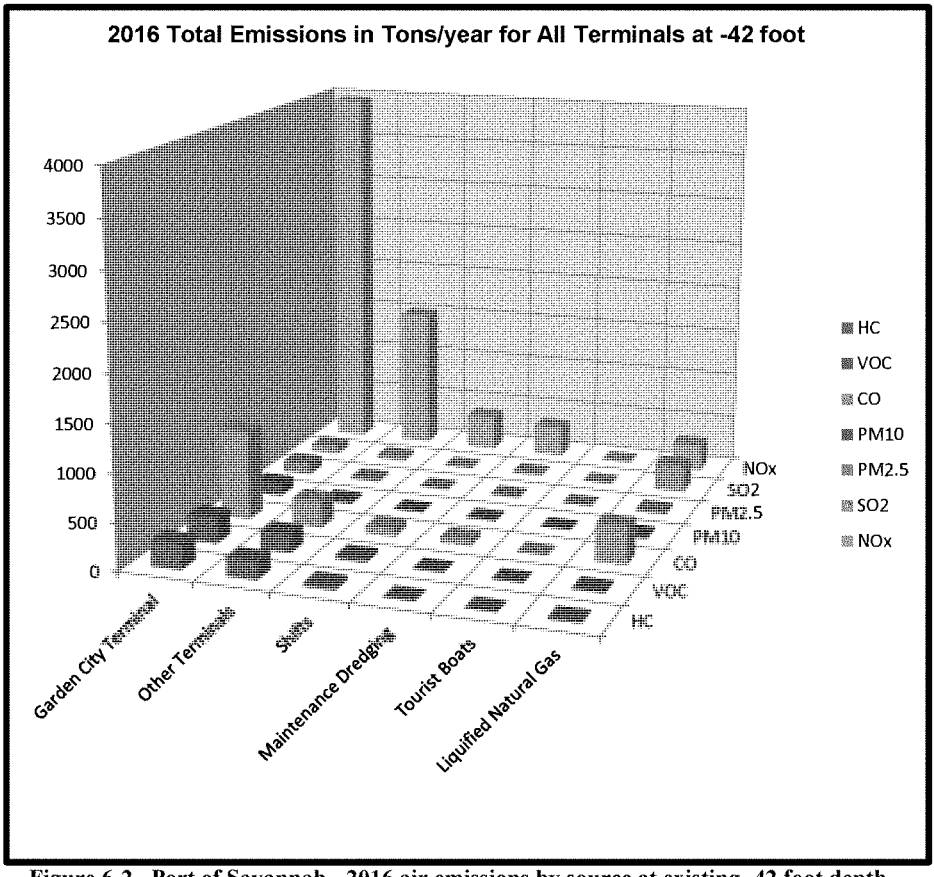


Figure 6-2. Port of Savannah - 2016 air emissions by source at existing -42 foot depth.

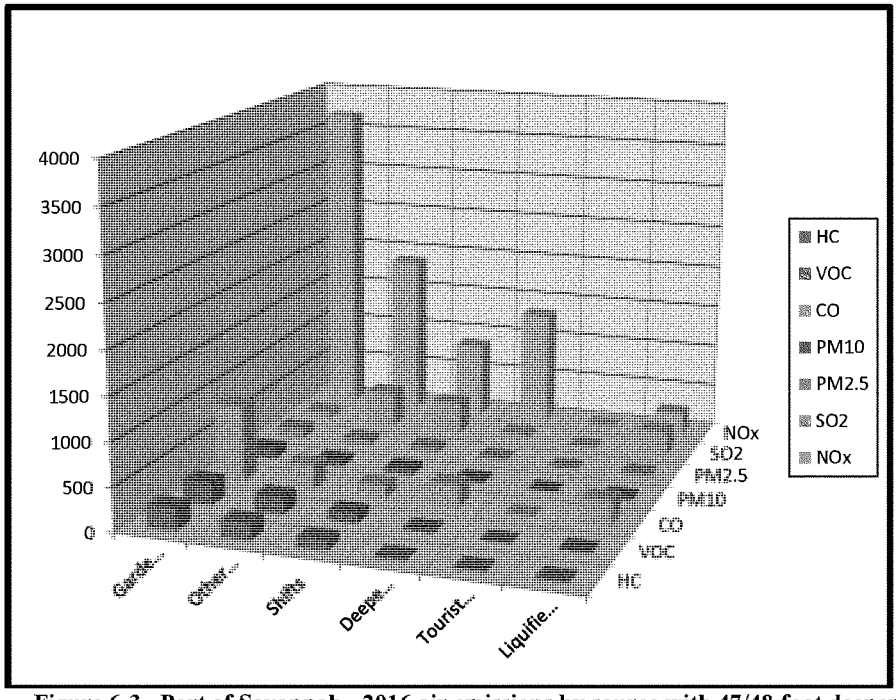


Figure 6-3. Port of Savannah - 2016 air emissions by source with 47/48-foot deepening project (assumes 3-year construction period*) (emissions in tons).

The effects of harbor deepening on air emissions are more apparent when comparing Figures 6-4 and 6-5, which show emissions in 2030/2066 With and Without a 47/48-foot harbor deepening.

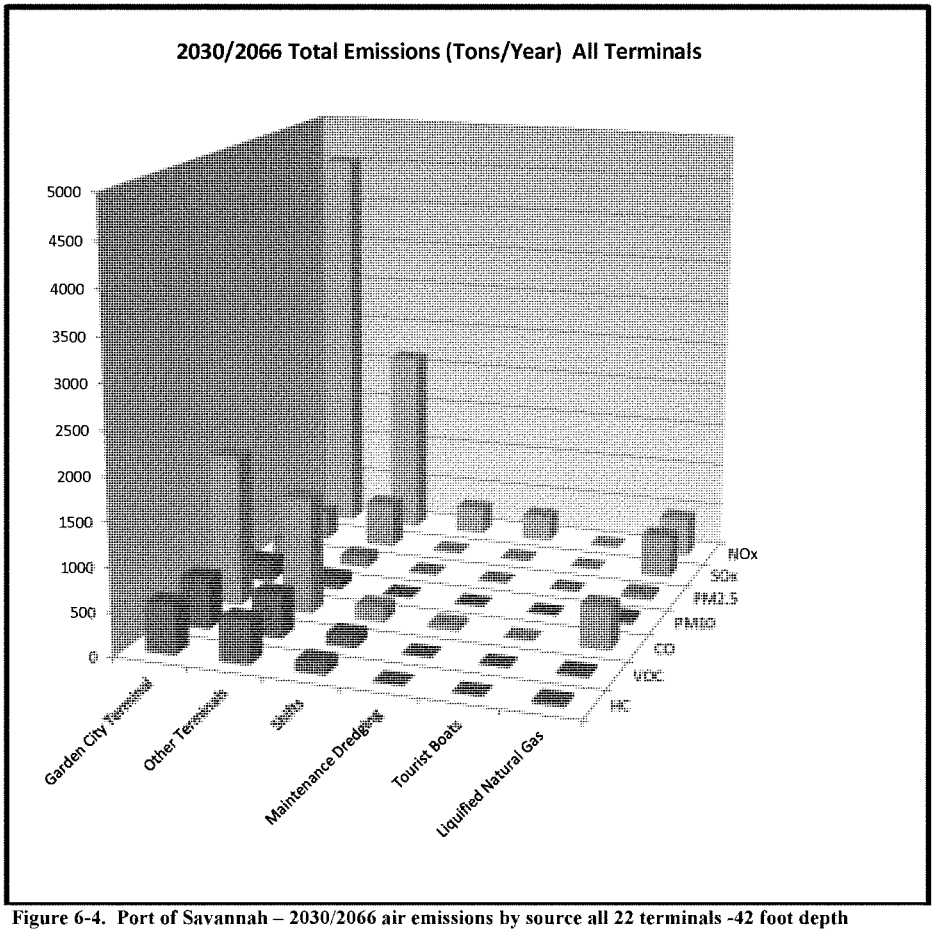


Figure 6-4. Port of Savannah – 2030/2066 air emissions by source all 22 terminals -42 foot depth (No Action Alternative).

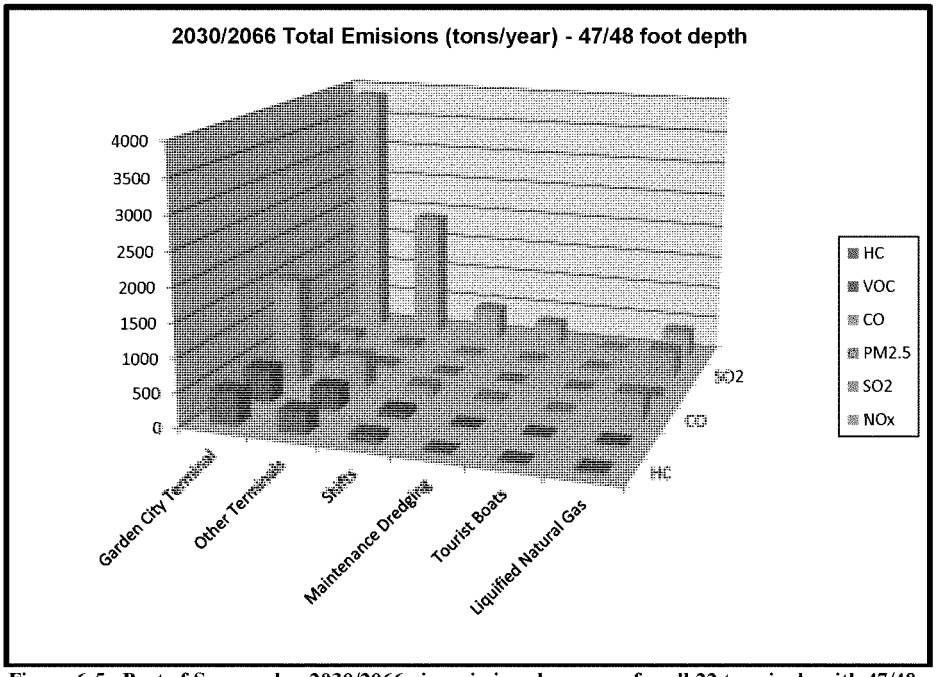


Figure 6-5. Port of Savannah – 2030/2066 air emissions by source for all 22 terminals with 47/48-foot deepening project.

Emissions By Vessel Type

Figure 6-6 and Figure 6-7 shows the air emissions from the various types of deep-draft vessels that call at the harbor. The vessel types are shown, as are the priority pollutants.

The figures show that Container vessels are the source of the most emissions, but that would be expected since more Container vessels call at the port than any other type of vessel. NOx is emitted in the largest quantity by all the vessel types. SO2 is the pollutant emitted in the second largest quantity. Tanker vessels produce the second largest amount of pollutants. When viewed on a per ship basis, Tankers followed by RO/RO vessels release more of the following pollutants than the other vessel types: NOx, HC, VOC, CO, PM10, PM2.5, and SO2. RO/RO vessels produce more NOx on a per transit basis than all other vessel types.

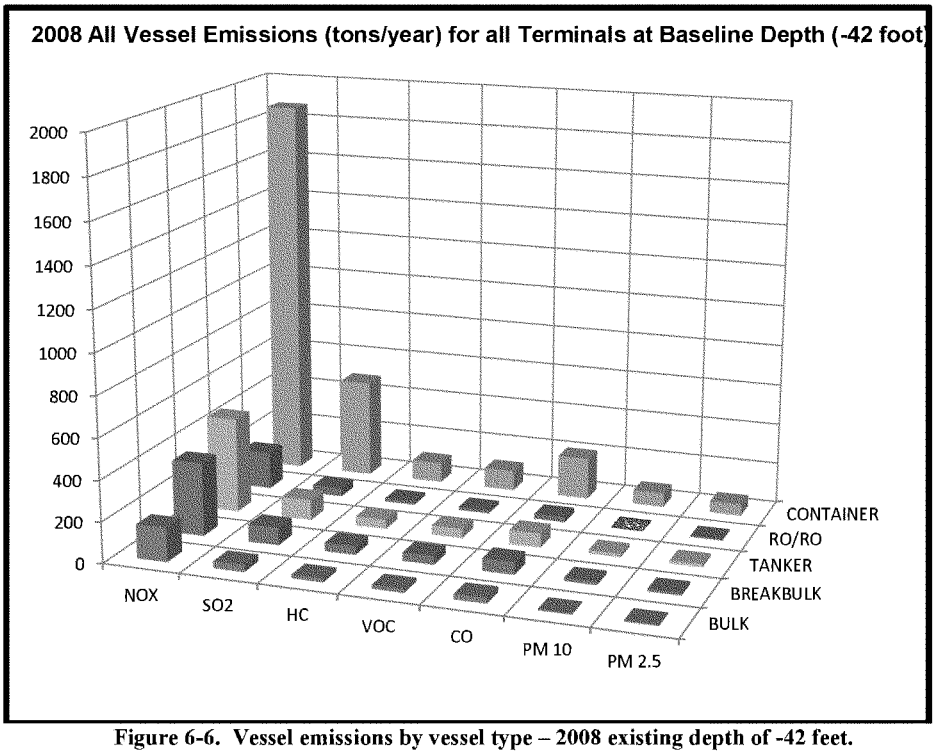


Figure 6-6. Vessel emissions by vessel type – 2008 existing depth of -42 feet.

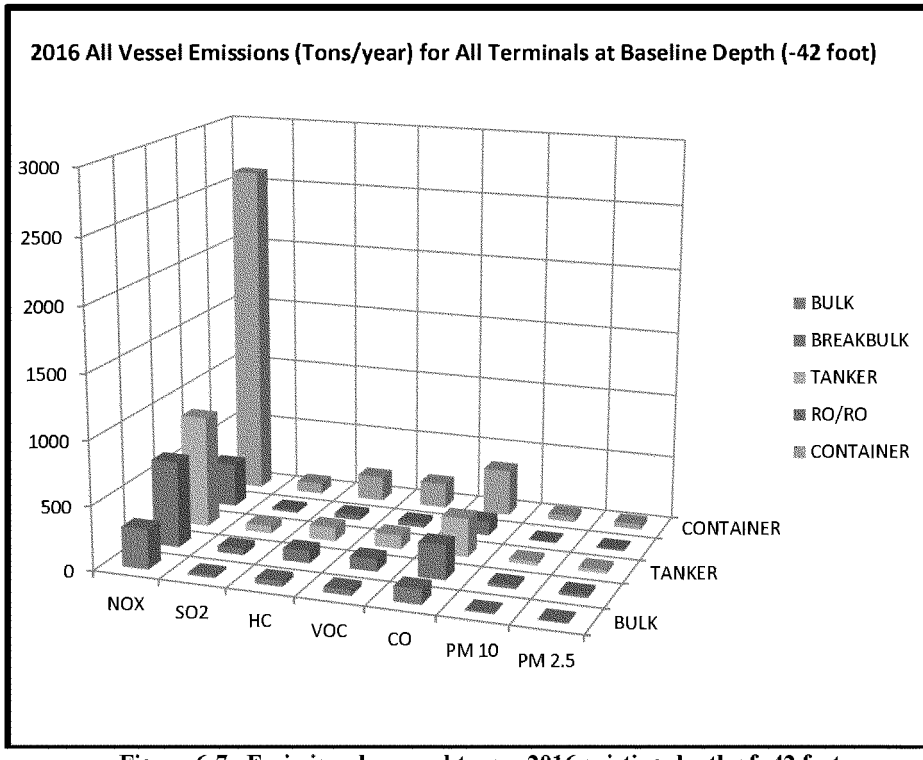


Figure 6-7. Emissions by vessel type – 2016 existing depth of -42 feet.

Figure 6-8 shows the air emissions that would occur from the various types of deep-draft vessels that call at the harbor in 2016 if a 47/48-foot deepening project is implemented.

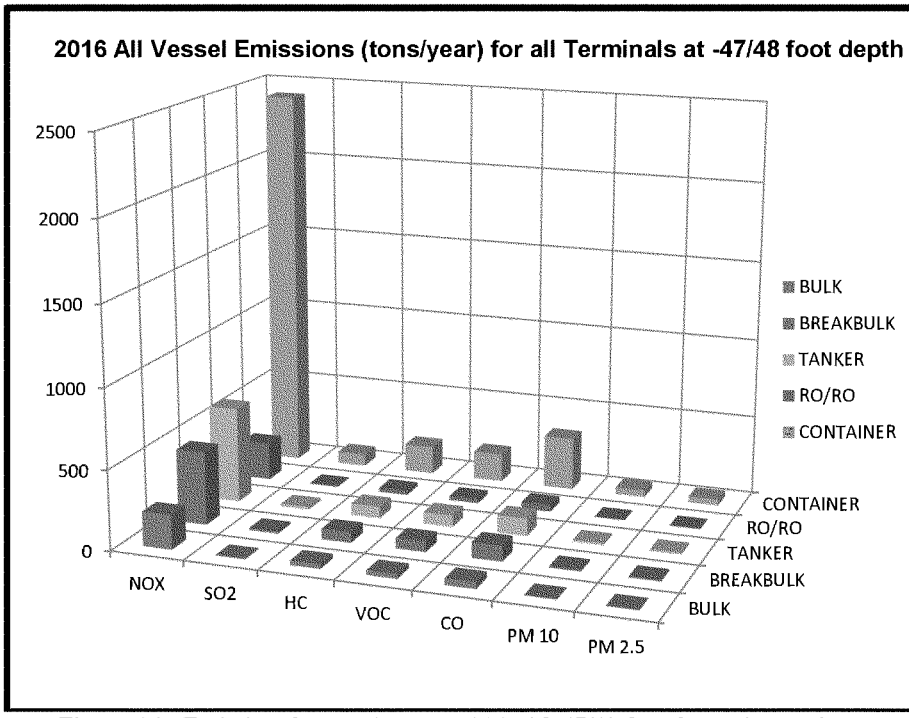


Figure 6-8. Emissions by vessel type – 2016 with 47/48-foot deepening project.

Figure 6-9 and 6-10 show the air emissions that would occur from the various types of deep-draft vessels that call at the harbor in 2025. The reduction in emissions resulting from the harbor deepening (when compared to the without project condition) is more evident than in 2016 because of the greater reduction in the number of vessels that would have called at the port in that year to handle the same volume of cargo.

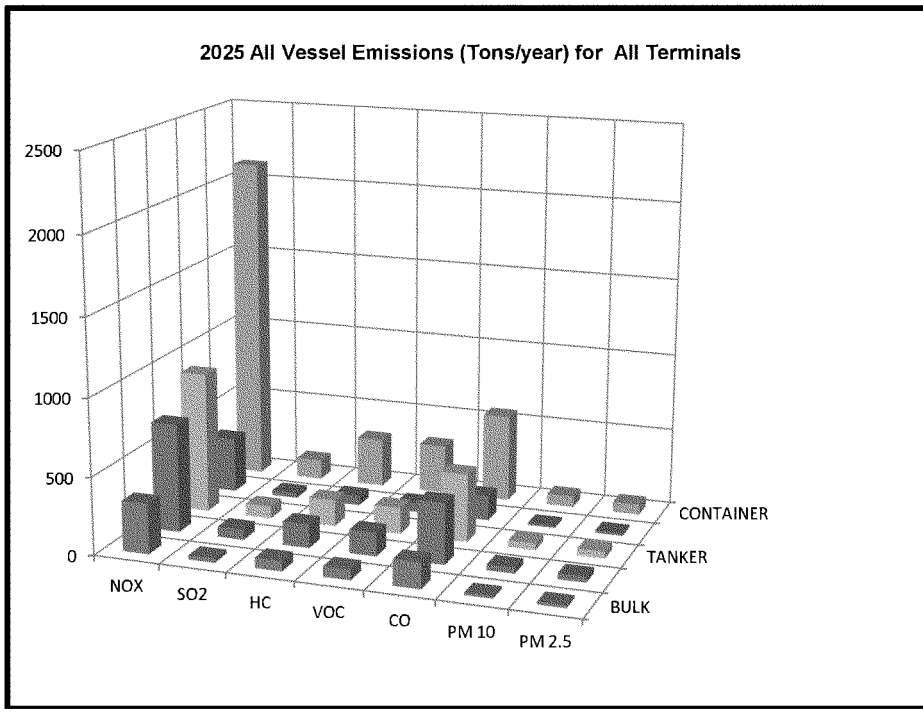


Figure 6-9. Emissions by vessel type – 2025 all terminals baseline depth (42-foot).

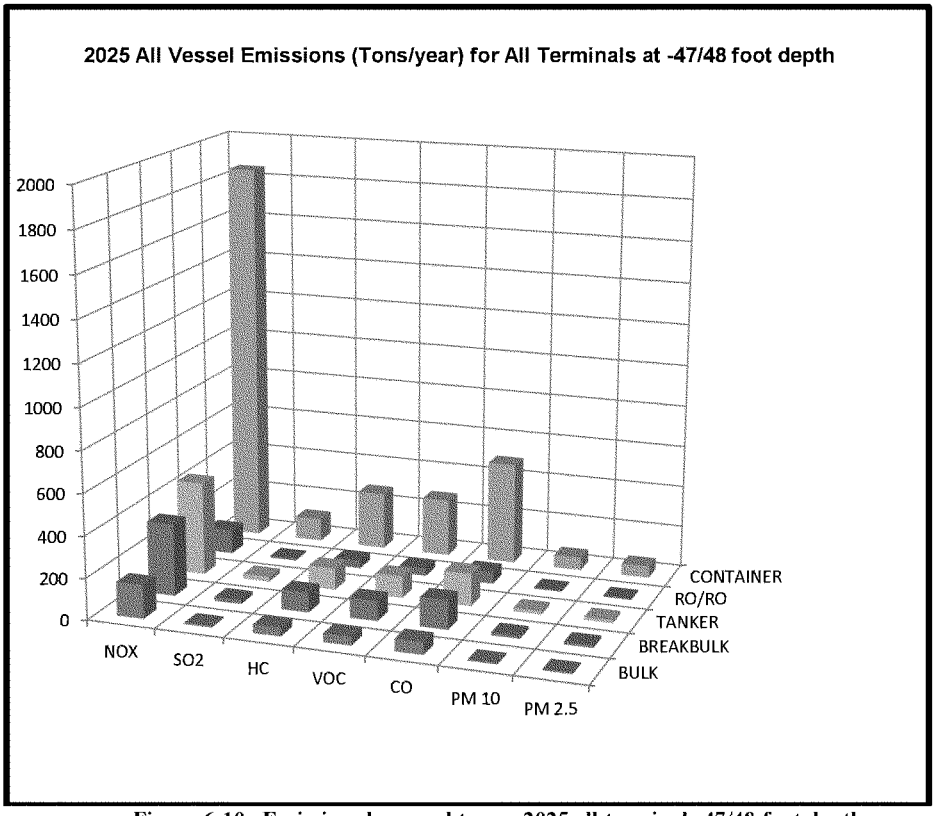


Figure 6-10. Emissions by vessel type – 2025 all terminals 47/48-foot depth.

Emissions at Garden City Terminal

The chart below shows the total air emissions associated with operations of the Garden City Terminal. The chart shows that Ocean-Going Vessels are the source of the most emissions and that NOx and SO2 are released in the largest quantity.

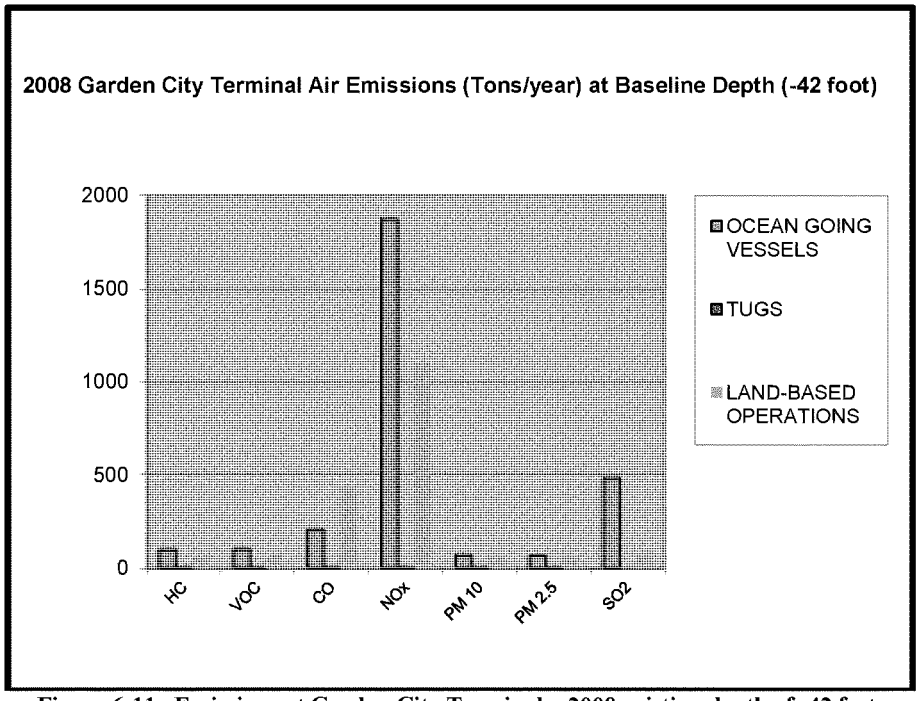


Figure 6-11. Emissions at Garden City Terminal – 2008 existing depth of -42 feet.

The following figure shows the same information for the Base Year of 2016 with the existing channel depth. The same general patterns are evident as in the previous figure, but the total quantity of emissions is expected to be higher as a result of the growth in containerized cargo volumes between 2008 and 2016.

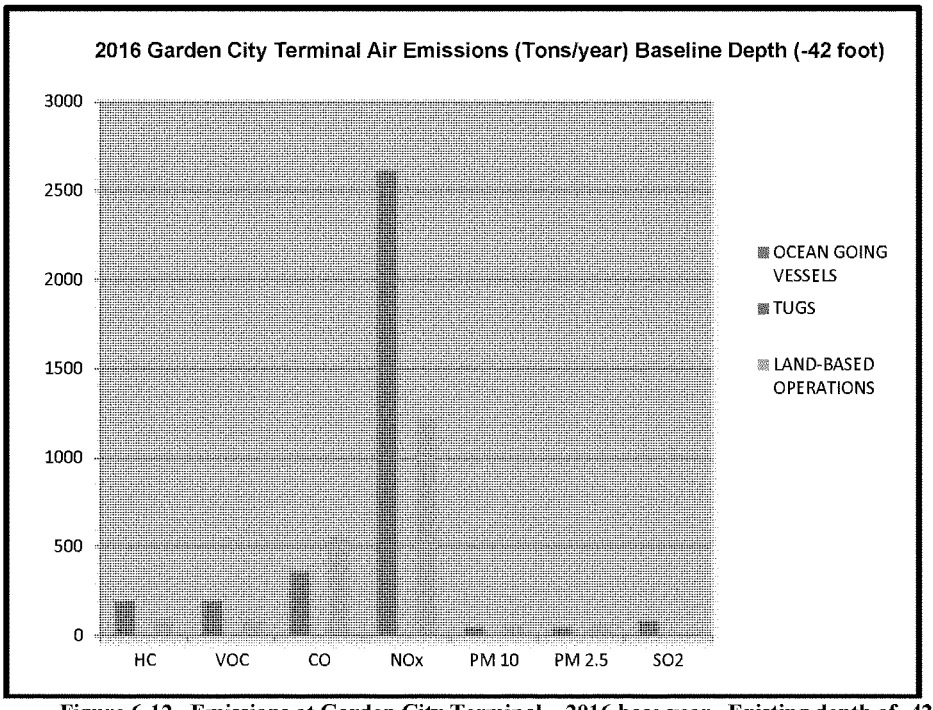


Figure 6-12. Emissions at Garden City Terminal – 2016 base year. Existing depth of -42 feet.

The following figure shows the same information for the Base Year of 2016 with a 47-48 foot harbor deepening. The minimal reduction in emissions with the deeper channel is not evident. The reduction becomes more noticeable over time as the fleet is projected to increase to handle the larger volumes of cargo expected With or Without a deepening project.

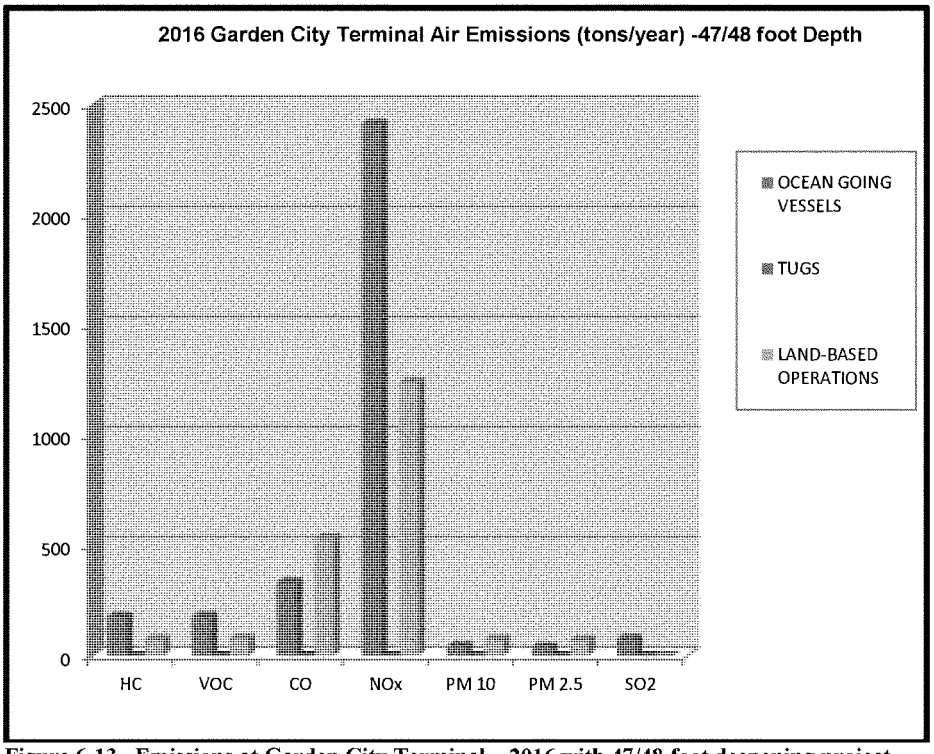


Figure 6-13. Emissions at Garden City Terminal – 2016 with 47/48-foot deepening project.

The SO2 and NOx emissions from Cargo Handling Equipment (CHE) at GPA's Garden City Terminal are shown in Figures 6-14 and 6-15. Figure 6-14 shows a decline in SO2 emissions from 2008 to 2016. That is the result of the EPA's requirements for use of cleaner fuels. The emissions would gradually increase from 2016 as the result of additional cargo being handled at the Garden City Terminal. The emissions would level off after year 2030 because the Garden City Terminal is expected to reach its full capacity at that time. Figure 6-15 shows the difference in SO2 emissions at various points in time with a 47/48 foot harbor deepening. The figure shows a slight reduction would occur in SO2 emissions if the harbor is deepened. The reduced emissions reflect the lower number of container ships that would call in a given year with a deeper harbor.

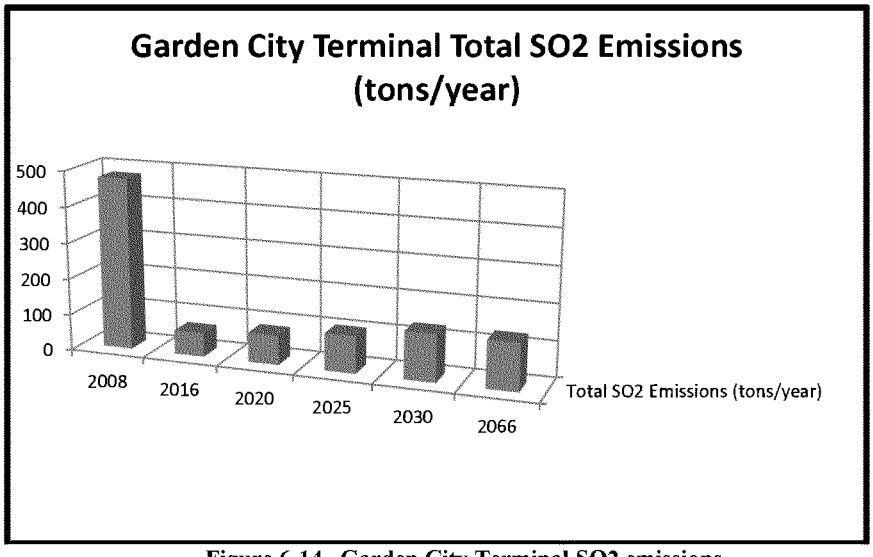


Figure 6-14. Garden City Terminal SO2 emissions.

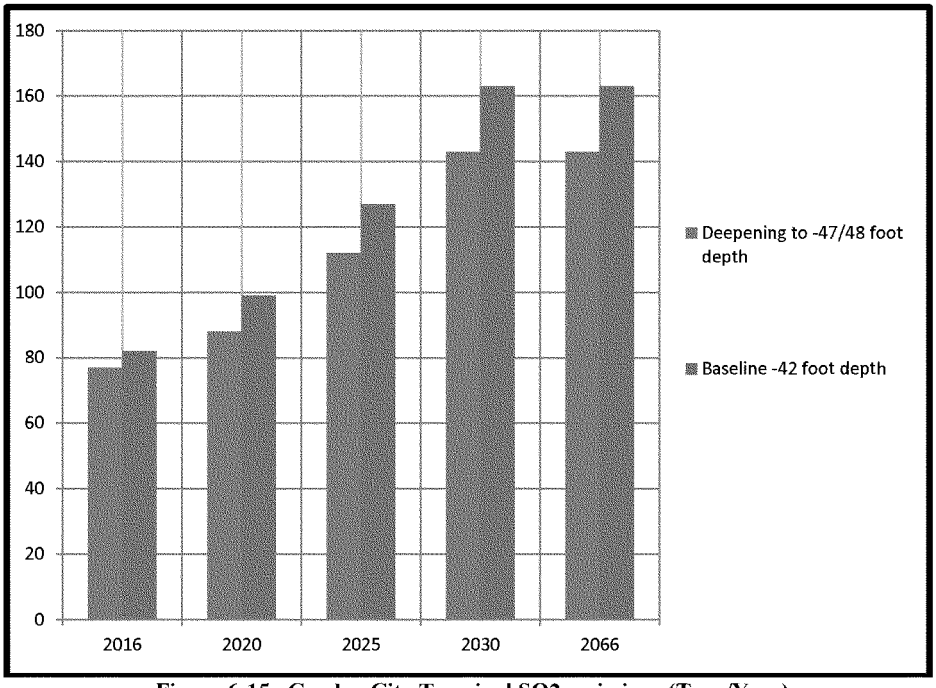


Figure 6-15. Garden City Terminal SO2 emissions (Tons/Year).

For the Garden City Terminal, the air emissions from the Land-Based Operations are shown in Figures 6-16 and 6-17. From these figures, one first sees that more NOx are emitted than any other of the priority pollutants. CO is the pollutant released in the second largest quantity. By looking at the various sources of the emissions, one sees that Rubber-Tired Gantry Cranes produce most of the air emissions at the terminal, followed by Trucks, Toplifts, and Jockey Trucks, which produce similar emissions. There were 47 RTGs at the terminal in 2008. The Toplifts produce the next highest total amount of emissions. There were 54 Toplifts (full container handlers) at the terminal in 2008.

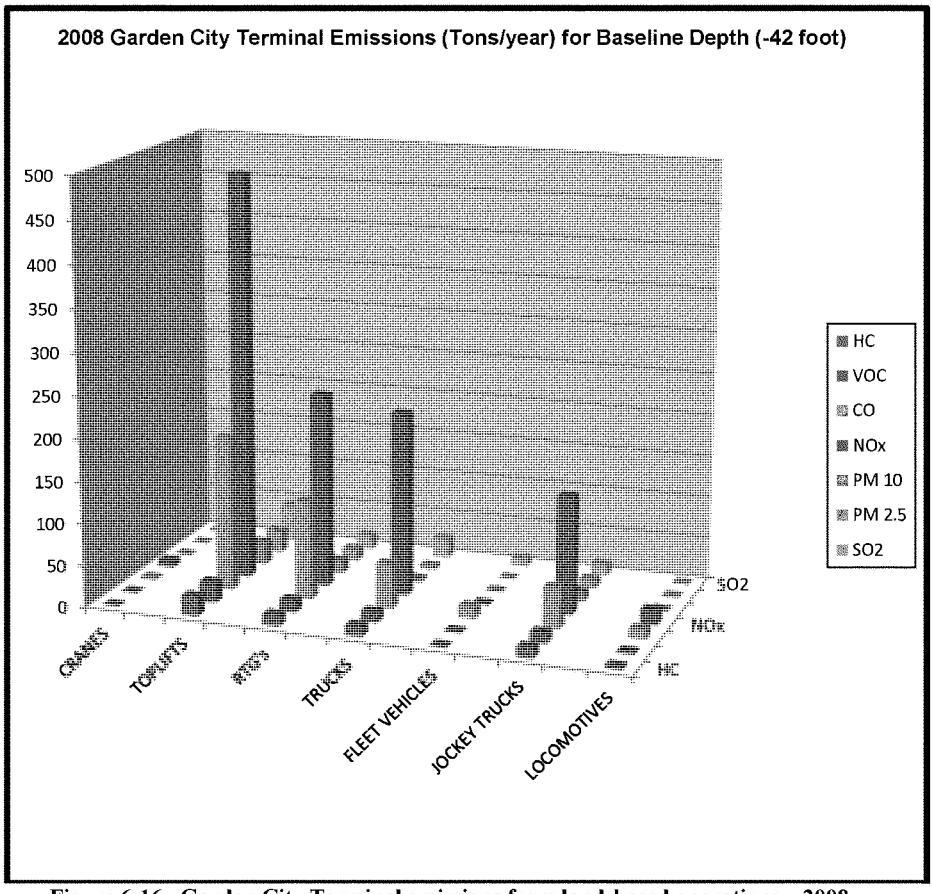


Figure 6-16. Garden City Terminal emissions from land-based operations – 2008.

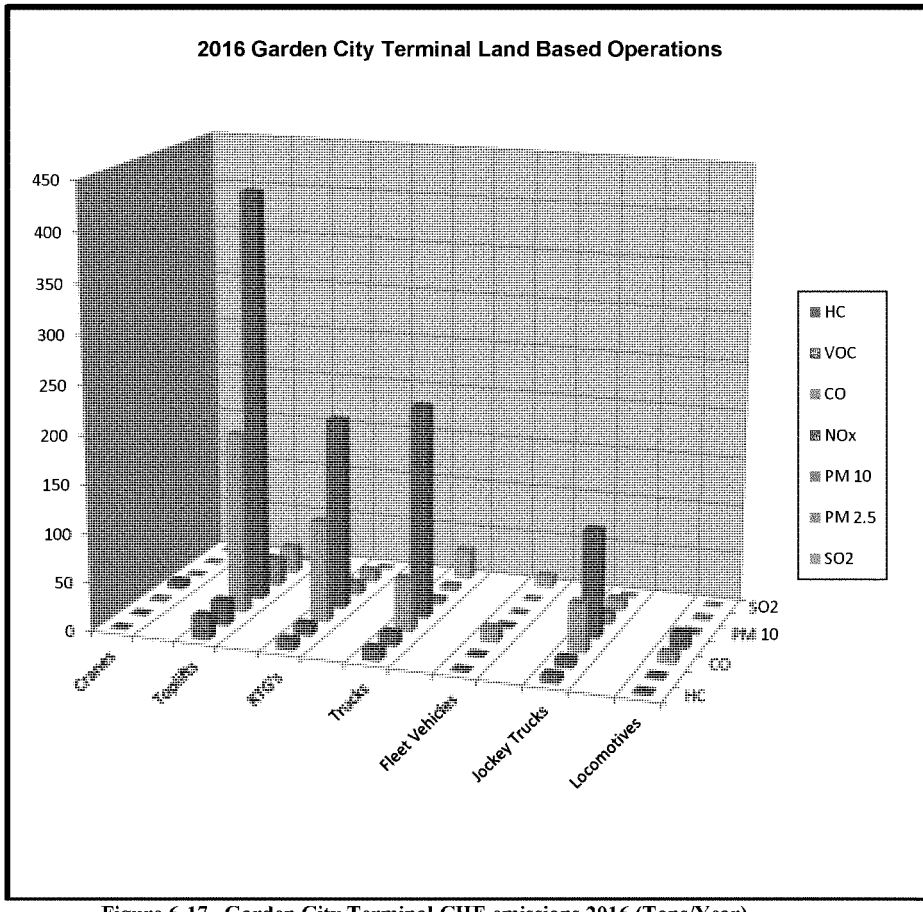


Figure 6-17. Garden City Terminal CHE emissions 2016 (Tons/Year).

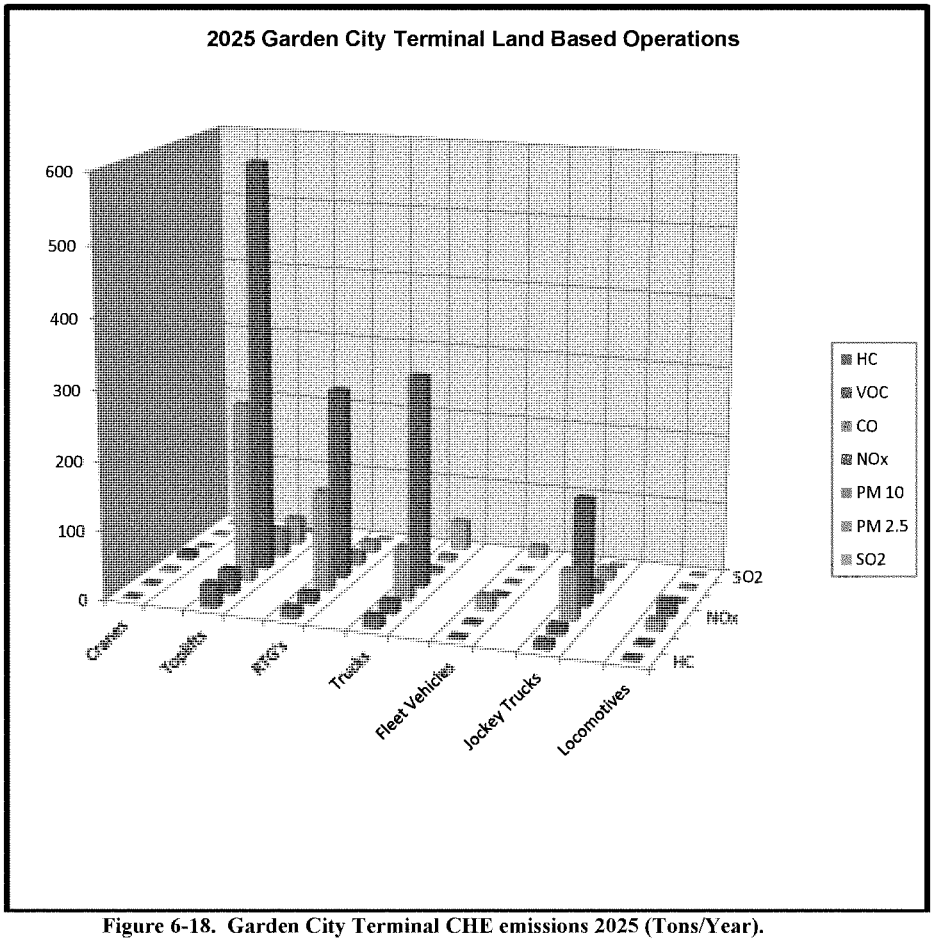


Figure 6-18. Garden City Terminal CHE emissions 2025 (Tons/Year).

The emissions from land-based terminal operations would not be affected by the proposed harbor deepening because the proposed deepening is not expected to result in more cargo moving through the port or the Garden City Terminal.

The emissions of CO2 from Cargo Handling Equipment at the Garden City Terminal are shown below. From this figure, one can see that the Rubber-Tired Gantry Cranes and Toplifts produce about equal amounts of CO2 emissions and are the largest dischargers of that pollutant, followed by Jockey Trucks.

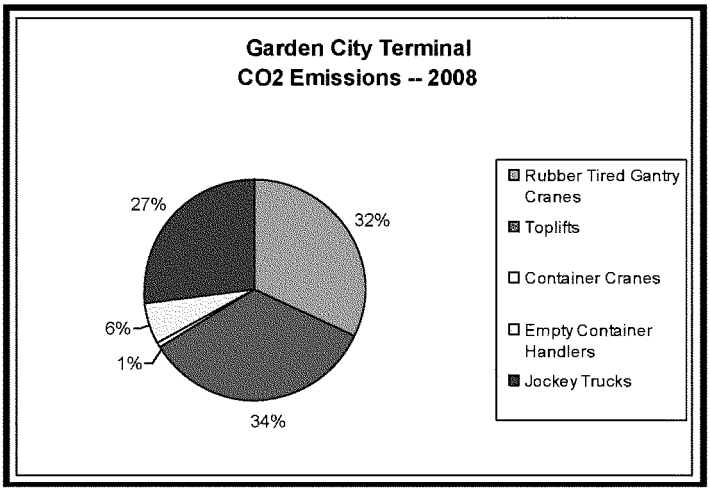


Figure 6-19. Garden City Terminal CHE -- 2008 CO2 emissions.

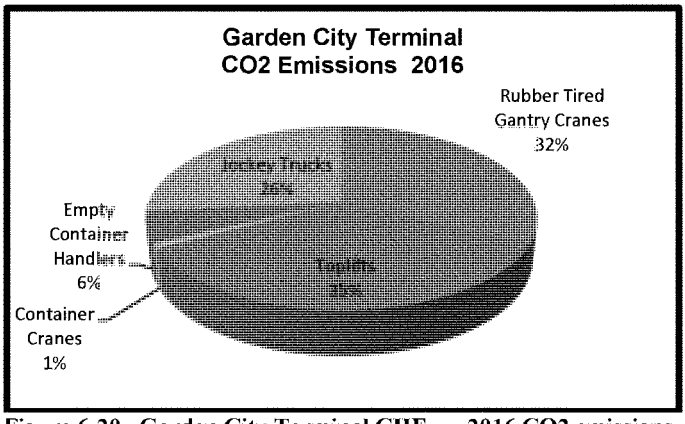


Figure 6-20. Garden City Terminal CHE -- 2016 CO2 emissions.

Emissions at GPA's Ocean Terminal

The amount of emissions from Cargo Handling Equipment (CHE) at GPA's Ocean Terminal in 2008 and 2016 is shown in Figures 6-21 and 6-22, below. From this graph, one can see that Jockey Trucks produce most of the air emissions at that terminal. Jockey Trucks comprise 30 of the total 38 pieces of equipment (Jockey Trucks, Toplifts and Container Cranes) that service that terminal. These values do not include the Fleet Vehicles that are dedicated to Ocean Terminal, since all of GPA's Fleet Vehicles were included in the emissions for the Garden City Terminal. The overwhelming majority of GPA's Fleet Vehicles service the Garden City Terminal.

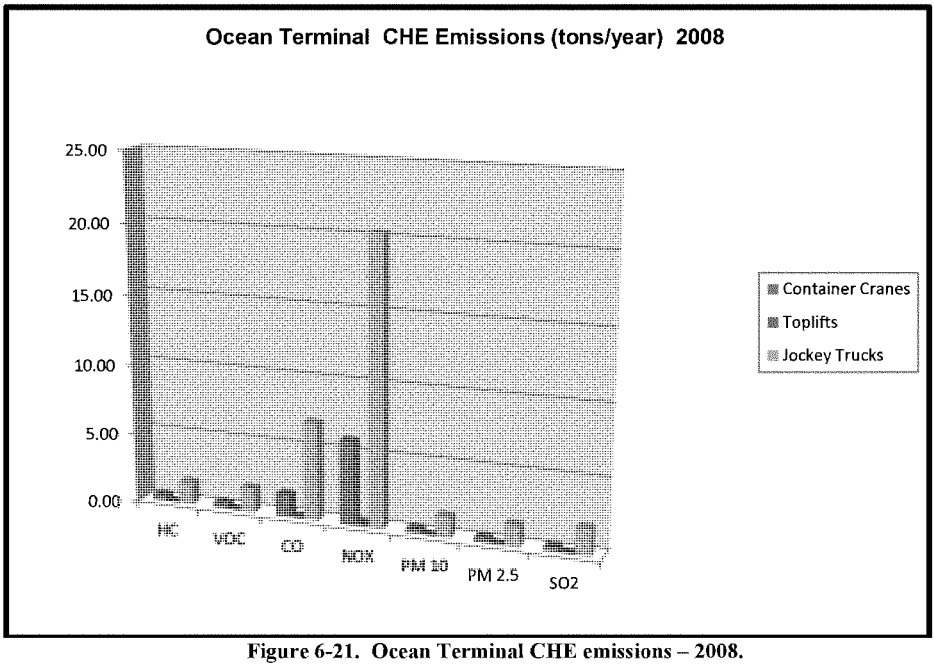


Figure 6-21. Ocean Terminal CHE emissions – 2008.

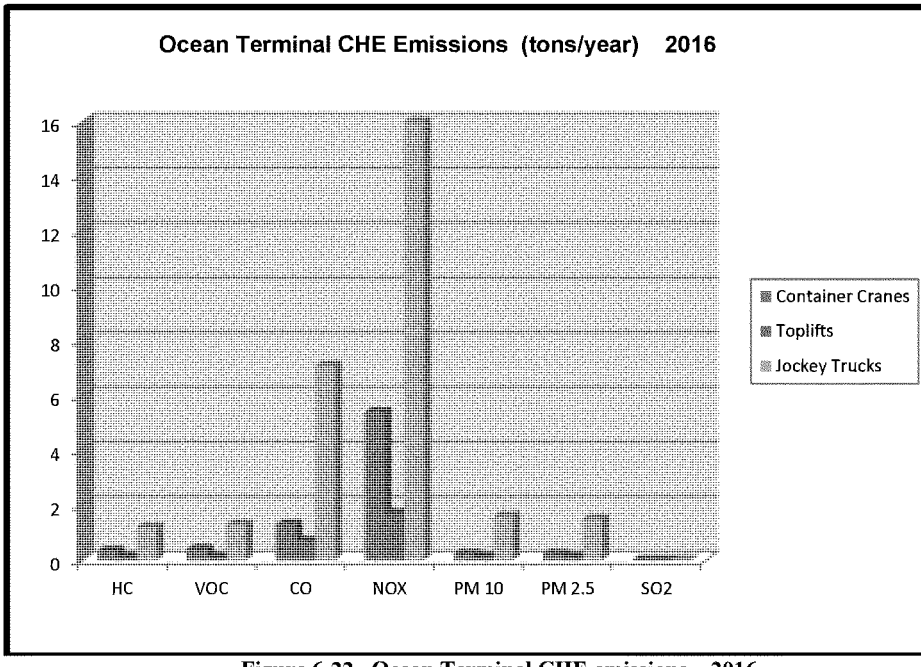


Figure 6-22. Ocean Terminal CHE emissions – 2016.

Emissions While Hotelling at GPA's Garden City Terminal

The following Table 6-1 shows the percentage of emissions from Hotelling of Container vessels at the Garden City Terminal compared to the total emissions for the port. The numbers are based on an average stay at the dock of 16 hours for each containership. This reveals that Hotelling of Containerships is a minor part of the overall port emissions for HC, VOC, CO, NOx, PM, and SO2.

Table 6-1
Emissions while Hotelling at GCT
Percentage of 2008 Hotelling Emissions compared to Total Port Emissions

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
Containerships	3.7%	3.7%	2.6%	9.0%	6.9%	6.8%	11.7%

Although small, there are at least three ways in which these emissions could be further reduced. (1) The quality of the fuel could be improved. Cleaner fuels would result in lower air emissions. Since the containerships that call at Savannah are engaged in international trade and generally call at several US ports on its round-the-world transit, multi-national treaties may be needed to alter the fuel used by these international trading vessels. Congress and EPA are presently involved in this issue. (2) The second potential method is to reduce the dwell time for each vessel (time it spends at the dock). This is an issue that GPA continues to address, as it is a direct reflection of how well it serves its customers by providing quick turn-around times. Increases on cargo handling efficiency would allow reductions in the dwell time and, thereby, the air emissions occurring while at the dock. (3) The third potential method of reducing these emissions is through a process called "cold ironing". This process allows vessels to use electrical power from land while at the dock rather than its on-board auxiliary engines. Currently the Ports of Los Angeles, Long Beach, Oakland, and Seattle are using "cold ironing" at their terminals. Along the east coast, the Ports of Charleston and Everglades (Miami) are either in the process of looking into or have implemented this alternative.

Emissions from Trucks calling at GPA's Garden City Terminal

The Corps calculated emissions from the Trucks which carry containers to and from the Garden City Terminal, see Table 6-2, below. GPA provided information on the number of trucks that called at the Garden City Terminal in 2008, and an average length of time those trucks were on the terminal. The times varied depending on whether the trucks conducted a single transaction (21 percent) (dropping off a container) or conducted multiple transactions (79 percent) (both dropped off and picked up a container).

The Corps added 15 minutes of travel time each way for each truck to account for the time trucks travel in the vicinity of the port, but outside the terminal gates. This additional 30 minutes of engine time accounts for time spent while traveling between the Interstate highway system and the Garden City Terminal. This is in addition to the time spent within the terminal dropping off or picking up its load.

Table 6-2
2008 Emissions from Trucks Calling at the Garden City Terminal

	HC	VOC	CO	NOx	PM10	PM2.5
Emissions (tons)	12.2	12.3	53.7	218.4	4.9	4.6
% of GCT	7.8	8.0	8.8	8.0	4.0	4.2
% of Total Port	3.4	3.5	3.8	4.3	2.0	2.0

These values indicate that emissions from these Trucks are a relatively small contribution to the total emissions from both the port and the Garden City Terminal. NOx represent the largest pollutant by weight from these trucks – 218 tons in 2008. That amount was 8.0 percent of the NOx emitted at the Garden City Terminal and 4.3 percent at the total emitted at the port. The largest contribution by percentage was in Carbon Monoxide (CO), where their emissions constituted 8.8 percent of the total at the Garden City Terminal. On a percentage basis, the Trucks (tractor trailers) which move containers over the roads do not comprise a major source of air pollution either at the port or at the Garden City Terminal.

Comparison of Emissions at Port with Emissions in Chatham County

This section attempts to place the emissions calculated for the Port in a larger perspective, primarily by comparing them to emissions from the entire county. Table 6-3, below shows (1) the total air emissions for Chatham County in 2001 (reported by EPA), (2) the NEI emissions reported by EPA in 2002, (3) the emissions identified by EPA in 2002 as being from Ocean-Going Vessels calling at the port, (4) the NEI emissions reported by EPA in 2005, (5) the emissions identified by EPA in 2005 as being from Ocean-Going Vessels calling at the port, and (6) emissions calculated in this Air Inventory for the port in 2008.

Table 6-3
Summary of Air Emissions in Chatham County (Tons)

DATA SOURCE	HC	VOC	CO	NOx	PM10	PM2.5	SO2
From EPA Air Data Website* (2001 Data) *	19,996	20,096	127,367	31,220	15,264	8,841	19,000
EPA 2002 National Emissions Inventory	17,983	18,073	98,653	25,531	6,489	2,183	22,086
Ocean-Going Vessels (reported in EPA 2002 NEI)	215	216	912	6,923	293	270	1,029
EPA 2005 National Emissions Inventory	17,349	17,435	81,229	34,778	7,175	2,893	23,418
Ocean Going Vessels (reported in EPA 2005 NEI) **	170	170	719	5,451	229	211	247
Corps Total Port Emissions (2008 values -42 foot depth in Table 5-78)	**348**	**352**	**1,394**	**5,042**	**230**	**216**	**1,177**

NOTE: * As reported in "Cumulative Impact Analyses Report and Interactive Area Reporter For Fort Stewart and Hunter Army Airfield, Georgia", dated August 2007, prepared by The Environmental Company

** 2005 USEPA NEI Data **does not include** 2280003100 Marine Vessels, Commercial, Residual, Port emissions or 2280003200 Marine Vessels, Commercial, Residual, Underway emissions

The results calculated by the Corps for the entire port are in general agreement with those estimated by EPA in 2002 and 2005 for Ocean-Going Vessels calling at Savannah. Table 5-78 shows the total port air emissions in 2008 for all 22 terminals at the existing -42 foot depth (i.e., baseline or No Action Alternative). Table 6-4, below compares the Total Port Emissions for 2008 (in Table 5-78) to the EPA 2002 NEI and 2005 NEI data for Chatham County. For both the EPA 2002 and 2005 NEI data for Chatham County, the port is a minor contributor of HC, VOC, CO, PM10, PM2.5, and SO2. However, according to the EPA 2002 NEI data for the county, it is a substantial contributor to NOx emissions (about 18.3%). However, as also indicated in Table 6-4, according to the EPA 2005 NEI data, the percent NOx emissions are reduced from 18.3% to 13.5%.

Table 6-4
2008 Port Emissions Comparison (% Percent) to
Chatham County EPA 2002 NEI and EPA 2005 NEI Emissions

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
EPA 2002 NEI							
Port of Savannah (includes all 22 Terminals)	1.9	1.9	1.3	18.3	3.4	9.5	5.4
EPA 2005 NEI							
Port of Savannah (includes all 22 Terminals)	2.0	2.0	1.6	13.5	3.1	7.2	5.1

The District was able to use both the EPA 2002 and 2005 NEI data for Chatham County, Georgia and compare them to the emissions calculated for the 2008 Total Port Emissions shown in Table 5-78. The Corps believes that Table 6-4 provides a good relationship comparing the calculated 2008 Total Port Emissions to both the 2002 and 2005 NEI County data. The expected larger County-wide emissions in 2008 would further reduce the percentage contribution shown for the port.

As indicated in Table 6-7 US EPA Emissions for the Kraft Steam Electric Plant in Port Wentworth, below, this plant discharged about 7,705 tons of SO2 in 2007. The Total Port Emission (2008 values) in Table 6-3, above shows that the SO2 emissions for all 22 terminals in the port was about 1,177 tons (see also Table 5-78). This means that the Kraft Steam Electric Plant discharges more than 6.45 times (7,705 tons SO2/1,177 tons SO2) the amount of SO2 than all 22 terminals in the port.

Emissions from New Work Dredging

The proposed Savannah Harbor Expansion Project would be a major construction project requiring large equipment to be used over a substantial period of time. The emissions expected from the new work dredging for the proposed harbor deepening project were calculated and are shown below compared to the total emissions for the Port and Chatham County.

Table 6-5
Summary of New Work Dredging Emissions (Tons)

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
44-Foot Depth	47	47	445	2,318	54	52	135
45-Foot Depth	53	53	500	2,604	58	56	122
46-Foot Depth	60	60	566	2,947	68	66	165
48-Foot Depth	70	70	671	3,495	81	78	214
% of Total Port (2016)	8.8	8.9	24.5	29.3	21.8	22.4	19.7
% of Chatham County (2002 EPA NEI)	0.4	0.4	0.7	13.6	1.2.	3.6	0.9

NOTE: The percentages use the maximum channel depth being considered (48-Foot Depth Alternative) and EPA's 2002 National Emissions Inventory.

The emissions for the new work dredging would occur over a three-year period, so a direct comparison to yearly totals for the Port and County is not appropriate. The timing of the construction (number of dredges working at the same time) is not firm at this time, so a precise calculation of the emissions per year cannot be made. The percentages shown above assume an equal distribution of the emissions over a three-year construction period. One item to remember is that a good deal of the new work dredging would be performed in the entrance channel. That channel starts roughly 20 miles east of the City center and extends another 19 miles into the ocean. With the prevailing winds being west to east, emissions from dredging the entrance channel would likely not add measurably to emissions from dredging the inner harbor or other emissions in Chatham County.

Emissions from Annual Maintenance Dredging

Figure 6-23 shows the emissions from the maintenance dredging that the Corps performs each year to maintain the authorized Federal Navigation Project. The figure shows that the greatest quantity of emissions are from NOx (270 tons/yr) followed by CO (52 tons/year) and SO2 (20 tons/year).

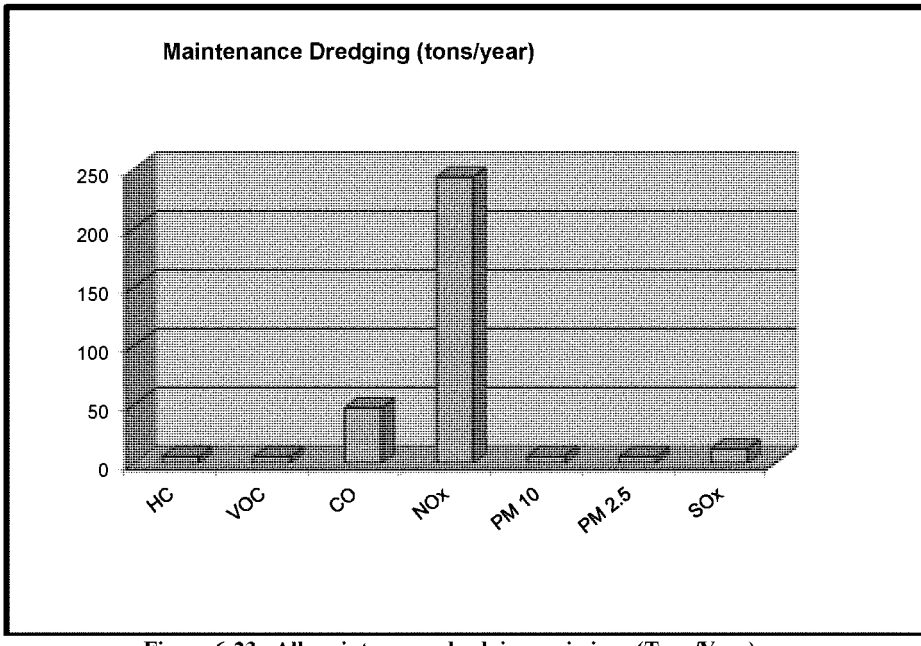


Figure 6-23. All maintenance dredging emissions (Tons/Year).

If one looks at the emissions of Hydrocarbons as being representative of the other pollutants that were evaluated, Figure 6-24 shows that the majority of the emissions come from pipeline dredging that is performed on the inner harbor (as opposed to hopper dredging performed on the entrance channel).

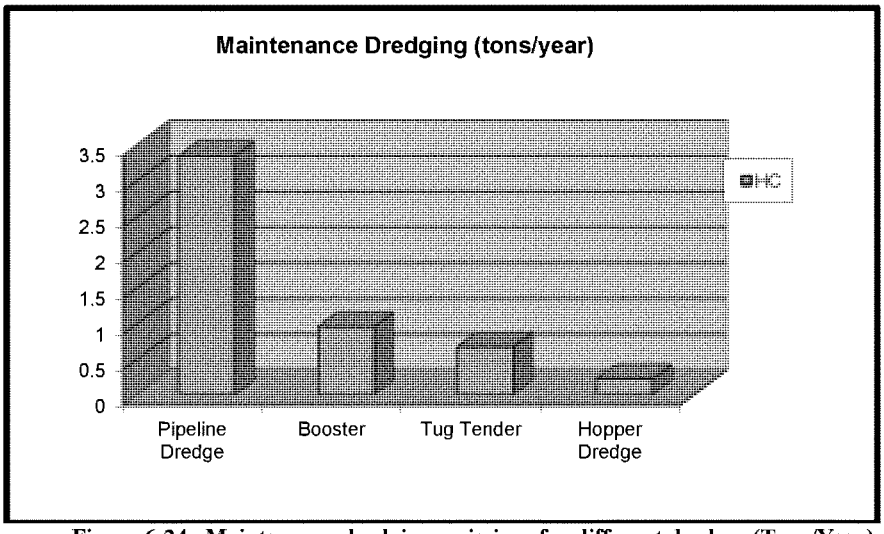


Figure 6-24. Maintenance dredging emissions for different dredges (Tons/Year).

Emissions of Air Toxics

Table 6-6 shows the 28 types of air toxics that are being emitted in Chatham County at the largest quantities. The emission quantities are from the 2002 National Emissions Inventory published by EPA and from the Corps' Savannah Harbor air emission inventory for 2008 (see Table 5-78 for criteria pollutant emission amounts). The quantity of air toxics were calculated using the air toxic ratios taken from the NMIM "SCCToxics" database table, which was provided by US EPA, Office of Transportation and Air Quality Ann Arbor, Michigan. The Corps then multiplied these air toxic ratios by either the 2002 NEI VOC or PM10 emissions and placed the results in Column 5 (2002 EPA NEI Data, Chatham County, Tons/Year) of Table 6-6. The Corps multiplied these same air toxic ratios by the 2008 estimated VOC and PM10 emissions and placed the results in Column 6 in Table 6-6 (Port Air Toxics in 2008).

The Corps calculated emissions of air toxics at the Port of Savannah (includes all 22 terminals, land based operations, dredging, tourist boats, shifts, OGVs, etc.) for the 28 air toxics in the 2008 base year by quantity and compared them to the reported 2002 EPA NEI air toxic emission. To calculate Ethyl Benzene, the Corps multiplied the total VOC emissions in 2008 (see Table 5-78),

which is 352.54 tons times 0.0031 equals 1.09 tons. The total PM10 emissions in 2008 (see Table 5-78) were 229.76 tons. Additionally, the Corps calculated the percent of the 2008 air toxics emissions to the 2002 EPA NEI Chatham County data. All of these quantities are shown below in Table 6-6.

Table 6-6 shows the quantities of air toxic emitted in the County as a whole and the quantity emitted from port-related operations in 2008 (base year). The Corps' air inventory developed information for 2008 that could be compared with the data published by EPA in 2002. Table 6-6 on the following page shows these results. In general, the air toxic values for the port in 2008 are significantly lower than the 2002 values for Chatham County. The reason for this is likely that the Port of Savannah is a small subset of the air emissions in the entire County. The highest portion of the 28 air toxics calculated for 2008 Port Emissions was Phenanthrene. This was about 3.54% of the 2002 USEPA NEI data for Chatham County. The remainder of the 27 air toxics calculated for the 2008 Port Emissions were on average 3% or less of the 2002 USEPA NEI data for Chatham County.

With or without the harbor deepening, the amount of air toxics would increase until the port reaches capacity in 2030 with 6.5 million TEUs. The Corps' projected increases in cargo volumes moving through Savannah may result in approximately a doubling of the quantity of air toxics emitted in the port in 2066 from that released in 2016. For air toxics, these results can be seen in Tables 5-64 through 5-67. If the air toxic emissions in Chatham County remain at their 2002 levels through 2066, the port would still be a small contributor to the County's emissions of air toxics (<4 percent in most cases).

Tables 5-68 through 5-76 show how changes in emissions of air toxics would change at the Garden City Terminal over time with the various depth alternatives. Emissions from Land-Based Equipment would not change with channel depth, because the same number of containers would move through the GCT With and With-out harbor deepening on a given year.

Fewer transits are required from large ships to carry the same amount of cargo when compared to small ships. Therefore, the proposed harbor deepening – which would allow larger vessels to regularly use the harbor – would result in lower emissions of air toxics than would the fleet that can use the present 42-foot deep authorized channel.

Table 6-6
Comparison of Major Air Toxic Emissions in Chatham County (Tons)

	AIR TOXIC PARAMETER		AIR TOXIC RATIOS TAKEN FROM NMIM "SCC TOXICS" DATABASE"	AIR TOXICS For Port In 2008 (TONS / YEAR)	2002 EPA NEI DATA CHATHAM COUNTY (TONS/YEAR)	PERCENT OF 2008 PORT BASE YEAR TO 2002 EPA NEI COUNTY DATA
1	Ethyl Benzene	VOC	0.0031001	1.092907	56.028	1.95%
2	Styrene	VOC	0.00059448	0.209578	10.74	1.95%
3	1,3-Butadiene	VOC	0.0018616	0.656287	33.64	1.95%
4	Acrolein	VOC	0.00303165	1.068776	54.79	1.95%
5	Toluene	VOC	0.014967	5.276454	270.50	1.95%
6	Hexane	VOC	0.0015913	0.560996	28.76	1.95%
7	Anthracene	PM10	0.00000043	0.000099	0.00279	3.54%
8	Propionaldehyde	VOC	0.0118	4.159963	213.26	1.95%
9	Pyrene	PM10	0.0000029	0.000666	0.0188	3.54%
10	Xylene	VOC	0.010582	3.730570	191.25	1.95%
11	Benzo(g,h,i)perylene	PM10	0.00000019	0.000044	0.00123	3.54%
12	Indeno(1,2,3,c,d)pyrene	PM10	0.000000079	0.000018	0.0005	3.54%
13	Benzo(b)fluoranthene	PM10	0.00000049	0.000113	0.0032	3.54%
14	Fluoranthene	PM10	0.000017	0.003906	0.110	3.54%
15	Benzo(k)fluoranthene	PM10	0.00000035	0.000080	0.00227	3.54%
16	Acenaphthylene	PM10	0.000084	0.019300	0.55	3.54%
17	Chrysene	PM10	0.0000019	0.000437	0.0123	3.54%
18	Formaldehyde	VOC	0.118155	41.654271	2135.42	1.95%
19	Benzo(a)pyrene	PM10	0.00000035	0.000080	0.00227	3.54%
20	Dibenzo(a,h)anthracene	PM10	2.9E-09	0.000001	0.188181	3.54%
21	2,2,4-Trimethylpentane	VOC	0.00066	0.232676	11.93	1.95%
22	Benz(a)anthracene	PM10	0.00000071	0.000163	0.0046	3.54%
23	Benzene	VOC	0.020344	7.172058	367.68	1.95%
24	Acetaldehyde	VOC	0.05308	18.712781	959.31	1.95%
25	Acenaphthene	PM10	0.0001	0.022976	0.649	3.54%
26	Phenanthrene	PM10	0.00026	0.059738	1.69	3.54%
27	Fluorene	PM10	0.0001	0.022976	0.65	3.54%
28	Naphthalene	PM10	0.00046	0.105691	2.98	3.54%

Greenhouse Gas Emissions (GHG)

While the majority of greenhouse gas emissions from ships are CO_2, additional GHG emissions include methane (CH_4) and nitrous oxide (N_2O). The EPA 2002 NEI inventory for Chatham County does not include greenhouse gases. However, EPA website at http://camddataandmaps.epa.gov/gdm/index.cfm has the following information on CO_2 being discharged at the Kraft Steam Electric Plant in Port Wentworth, near Savannah, Chatham County Georgia for 2002 and 2007:

Table 6-7
US EPA Air Emissions for the Kraft Steam Electric Plant in Port Wentworth

State	Facility Name	Facility ID (ORISPL)	Stack/Unit/ Pipe ID	Associated Units	Year	Operating Time	# of Months Reported	SO_2 Tons	Avg. NO_x Rate (lb/mmBtu)	NO_x Tons	CO_2 Tons	Heat Input (mmBtu)
GA	Kraft	733	1		2002	7,124	12					3,064,196
GA	Kraft	733	2		2002	6,345	12					2,791,889
GA	Kraft	733	3		2002	6,962	12					6,084,813
GA	Kraft	733	4		2002	2,787	12					1,389,001
GA	Kraft	733	CS001	1, 2, 3, 4	2002	8,533	12	7,189.4	0.51		1,367,644.9	13,329,914
** Site is located at http://camddataandmaps.epa.gov/gdm/index.cfm												
The following information is taken from USEPA Monitoring Location Level Emissions Quick Report** June 12, 2009												
Your query will return data for 1 facilities.												
You specified: Year(s): 2002 Facility(s): Kraft Steam Electric Plant located in Savannah GA												
State	Facility Name	Facility ID (ORISPL)	Stack/Unit/ Pipe ID	Associated Units	Year	Operating Time	# of Months Reported	SO_2 Tons	Avg. NO_x Rate (lb/mmBtu)	NO_x Tons	CO_2 Tons	Heat Input (mmBtu)
GA	Kraft	733	1		2007	7,973	12					4,298,198
GA	Kraft	733	2		2007	7,904	12					3,888,570
GA	Kraft	733	3		2007	7,788	12					7,599,687
GA	Kraft	733	4		2007	647	12					325,600
GA	Kraft	733	CS001	1, 2, 3, 4	2007	8,760	12	7,704.7	0.55		1,653,099.4	16,112,059
** Site is located at http://camddataandmaps.epa.gov/gdm/index.cfm												

From Table 6-7 above, for 2002 and 2007, the Kraft Steam Electric Plant in Port Wentworth, near Savannah, Chatham County, Georgia emitted 1,367,644 and 1,653,099 tons of CO_2, respectively. The Kraft Steam Electric Plant in Port Wentworth is located just upstream of the Garden City Terminal in Chatham County, Georgia.

According to USEPA's Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Ocean Going Vessels, ICF International, Final dated April 2009, on page 2-16, the following information is found:

While the majority of greenhouse gas emissions from ships are CO_2, additional GHG emissions include methane (CH4) and nitrous oxide (N2O). Emission factors for various engine types listed in Table 2-13 are taken from the IVL 2004 update 38. To estimate CO2 equivalents, CH4 emissions should be multiplied by 21 and N2O emissions should be multiplied by 310. Therefore, to estimate CH4 and N20, CO2 should be divided by 21 and 310, respectively. Since C02=CH4 X 21 and CO2=N20 X 310.

Therefore CH4 = CO2/21 and N2O = CO2/310.

On page 3-11 of this same document, it states:

> *In addition to the greenhouse gas emission factors discussed above, it is possible to estimate elemental carbon emission factors from the EPA's SPECIATE4 model for emissions of PM2.5. For diesel harbor craft, the diesel commercial marine vessel (SCC 2280002000) sector is appropriate. That sector is assigned an emission fraction of*

77.12% elemental carbon. That is: EFEC = 77.12% x 97% x EFPM10 after adjusting the PM10 emission factor for fuel sulfur.

Therefore Elemental Carbon = 0.7712 x 0.97 x PM10.

These formulas were used to estimate the GHGs emissions for marine diesel vessels (i.e., OGVs, tugs, tourist boats, pipeline and hopper dredges, and shifts within the harbor) at all depths and years for all 22 terminals in the Port of Savannah. These GHGs estimates are shown in Table 6-8, below.

Comparing the measured 1,653,099 tons of CO_2 air emissions for 2007 at the Kraft Steam Electric Plant in Port Wentworth (which is adjacent to the Garden City Terminal) to the calculated CO_2 for all 22 terminals at the Port of Savannah in Table 6-8, below, the proposed deepened harbor is not a significant source of GHGs in Chatham County.

Table 6-8
Estimated Greenhouse Gases for All Vessels and All Depths

42-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	2,724	131993.04	425.78	6285.38	130.42
2016	4,146	200896.90	648.05	9566.52	198.50
2020	4,713	228371.23	736.68	10874.82	225.65
2025	5,886	285209.64	920.03	13581.41	281.81
2030	7,205	349122.57	1126.20	16624.88	344.96
2066	7,205	349122.57	1126.20	16624.88	344.96

44-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	4,034	268274.58	865.40	12774.98	107.61
2020	4,508	243821.57	786.52	11610.55	102.16
2025	5,601	300310.63	968.74	14300.51	122.02
2030	6,833	371372.78	1197.98	17684.42	146.23
2066	6,833	371372.78	1197.98	17684.42	146.23

45-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	4,010	266678.50	860.25	12698.98	106.97
2020	4,469	241712.20	779.72	11510.10	101.27
2025	5,549	297522.53	959.75	14167.74	120.89
2030	6,760	367405.24	1185.18	17495.49	144.67
2066	6,760	367405.24	1185.18	17495.49	144.67

46-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	3,998	265880.46	857.68	12660.97	106.65
2020	4,451	240738.65	776.58	11463.75	100.87
2025	5,522	296074.86	955.08	14098.80	120.30
2030	6,726	365557.34	1179.22	17407.49	143.94
2066	6,726	365557.34	1179.22	17407.49	143.94

47-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

47-Foot Depth					
48-Foot Depth					
Year	# of Vessels	CO_2	N_20	CH_4	Carbon
2008	NA	NA	NA	NA	NA
2016	3,994	265614.45	856.82	12648.31	106.54
2020	4,442	240251.87	775.01	11440.57	100.66
2025	5,511	295485.07	953.18	14070.72	120.06
2030	6,714	364905.15	1177.11	17376.44	143.68
2066	6,714	364905.15	1177.11	17376.44	143.68

Air Quality Standards

Chatham County is considered by EPA to be in an Attainment area since it meets the National Ambient Air Quality Standards, which are shown in Table 6-9, below:

Table 6-9
National Ambient Air Quality Standards

Pollutant	Primary Standard	Secondary Standard
PM_{10}	150 ug/m3 (daily)	Same
$PM_{2.5}$	15 ug/m3 (annual) 35 ug/m3 (daily)	Same
NO_x	0.053 ppm (annual) 100 ppb (1-hour)	0.053 ppm (annual)
SO_2	75 ppb (1-hour)	0.5 ppm (3-hour)
CO	9 ppm (8-hour) 35 ppm (1-hour)	None
Lead	0.15 ug/m3 (3-month average)	Same
Ozone	0.075 ppm (8-hour)	Same

EPA published information in January 2008 about air quality in Chatham County in its "Latest Findings on National Air Quality, Status and Trends Through 2006". In that document, EPA stated that Savannah's 2006 Ozone level ranged from 0.065 to 0.084 ppm (4^{th} highest daily maximum 8-hour concentration), below the standard of 0.08 ppm. Ground level ozone is formed when NOx and VOC react in the presence of sunlight. That document also reported that ozone levels had improved in Savannah from 2000 to 2006. The summer daily maximum 8-hour ozone concentrations decreased by 0.002 ppm between 2000-2001 (average) and 2005-2006 (average)

(from Figure 12 in EPA's document). For a number of years, EPA has indicated that they may promulgate a new ozone standard. At this time, the Corps does not know when or if this may occur.

EPA also reported a small increase in PM 2.5 concentration from 2000-2006. Figure 14 of that document showed that PM 2.5 had changed -1 to 4 ug/m3 over that period. The average annual PM 2.5 concentrations were in the range of 12.1 to 15 ug/m3, with 66 out of 895 measurements exceeding 15.1 ug/m3. The daily range of PM2.5 was in the range of 16 to 35 ug/m3, with 126 out of 895 measurements (14%) exceeding 35 ug/m3 (Figure 15 of EPA's document).

EPA reported that PM 10 levels for Savannah ranged from 0 to 54 ug/m3 (Figure 21 in EPA's document), with 425 out of 904 measurements exceeding 54 ug/m3.

These values indicate that the air quality is within the standards for Ozone and PM2.5 and well within the standard for PM10.

The State Implementation Plan (SIP) identifies how the State will attain and maintain the primary and secondary NAAQS. Each State is required to have a SIP that describes control measures and strategies that each state will use to attain and maintain the NAAQS. SIP requirements applicable to all areas are provided in Section 110 of the Act. Part D of title I of the Act specifies additional requirements applicable to nonattainment areas. Section 110 and part D describe the elements of a SIP and include, among other things, emission inventories, a monitoring network, an air quality analysis, modeling, attainment demonstrations, enforcement mechanisms, and regulations which have been adopted by the State to attain or maintain NAAQS. EPA has adopted regulatory requirements that describe the procedures for preparing, adopting and submitting SIPs and SIP revisions that are codified in 40 CFR Part 51.

Under CAA Section 176(c), certain Federal actions must be analyzed to determine whether they conform with the applicable SIP(s). However, a Conformity Determination is not required for the SHEP under Section 176(c) because 40 CFR Section 93.153 (b) provides: "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a non-attainment or maintenance area (emphasis added by the writer) caused by a Federal action would equal or exceed any of the rates in paragraphs (b)(1) or (2) of this section." Since both Chatham and Jasper Counties have been designated by the States as attainment areas, a Conformity Determination is not required.

Table 5-78 "Summary of all Pollutants (Tons/Year) for all Vessels and all Land Based Emissions for the 22 Terminals" clearly shows that the air emissions (including greenhouse gases, primarily CO2) at the existing depth (No Action Alternative) of -42 foot depth would be greater than the emissions for the -47/48 foot depth in all years from 2016 to 2066. Table 5-78 also depicts the project future condition analysis that the air emissions for the No Action Alternative (-42 foot depth) would be greater than with a deepened harbor. Additionally, Table 5-78 indicates that since air toxics are ratios of either VOC or PM10, the amount of air toxics discharged by the 22 terminals would be greater for the No Action Alternative than with a deepened harbor. The reason why there would be less air emissions in the deepened harbor is that fewer larger vessels

(more heavily loaded) would be needed to transport the same volume of containers than with the existing depth (No Action Alternative) of -42 foot. This does not mean that larger vessels discharge less air pollutants than smaller vessels; they do not (see EPA 2009). Fewer larger vessels (more heavily loaded) would be needed to transport 6.5 million TEUs in a deepened harbor than with the No Action Alternative. This fact is also reflected in the Commodity and Fleet Forecasts found in the GRR.

Since the proposed harbor deepening is not expected to increase the number of vessels or total cargo moving through the port (when compared to the Without Project Condition), no increases in air emissions would occur as a result of the project. Increases in air emissions at the port are expected over time as a result of growth in demand for goods that move through the port. With or without deepening of the harbor, air emissions at the port are expected to increase. Those increases would occur independent of a harbor deepening project.

The Corps' calculations of 2008 emissions for the Port indicate that the Port was a substantial contributor of NOx (18.3 percent compared to the EPA 2002 NEI and 13.5 percent compared to the EPA 2005 NEI data) emissions in Chatham County (Table 6-4). (It should be noted that some of the emissions the Corps calculated for the Port occur while ships move through the entrance channel located in the ocean east of the coastline.) The Port contributes only minor amounts to emissions of SO2 (5.4 and 5.1 percent compared to the EPA 2002 and 2005 NEI data), PM10 (3.4 and 3.1 percent compared to the EPA 2002 and 2005 NEI data), PM2.5 (9.5 and 7.2 percent compared to the EPA 2002 and 2005 NEI data), HC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), VOC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), and CO (1.3 to 1.6 percent compared to the EPA 2002 and 2005 NEI data).

Emissions of NOx, SO2, and PM2.5 are expected to decrease as terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO2 emissions are expected to decrease as a result of EPA's requirements for use of cleaner fuels. These new standards should substantially reduce SO2 emissions, as the SO2 content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010. For Ocean-Going Vessels, EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NOx emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require Ocean-Going Vessels within 200 miles of the US to use fuel with a maximum of 1% Sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NOx and SO2 emissions in the County should substantially decrease as a result of these new requirements for cleaner fuels.

With these new EPA fuel standards in place for both NOx and SO2, the Port of Savannah will in the future contribute a minor amount of air emissions (including air toxics) when compared to the overall county's emissions. Since, (1) the calculated air emissions for the Future Without Project Condition (i.e., baseline or existing depth of -42 feet) would be greater than with the Proposed Action (i.e., 47-foot depth), and (2) both Chatham County, Georgia and Jasper County,

South Carolina are designated as attainment areas, air quality modeling is not warranted to evaluate the effects of the Proposed Action (i.e., 47-foot depth).

Therefore, over the life of the project (from 2016 to 2066) the proposed deepening of the harbor will not interfere with the area remaining in attainment of the NAAQS under Section 110 of the Clean Air Act.

Ongoing actions that improve air quality – GPA

In 2002, GPA required 1.44 gallons of diesel fuel to process a TEU through the terminal. In FY08, GPA reported it needed 0.89 gallons to move a similar container. GPA encourages the use of freight by rail, which EPA says emits one third the NOx (nitrogen oxides) of other modes of transportation.

GPA continually evaluates methods to reduce diesel consumption and emissions. These actions protect the environment and the local population. Examples include the following:

- GPA has converted the older ship-to-shore cranes to electric and purchased new cranes that run off of electricity. Of the 23 ship to shore cranes, 21 are electric, which avoids the use of 1.9 million gallons of diesel each year. The four new post-panamax cranes that GPA put in service in early 2008 eliminated the use of 400,000 gallons of diesel each year.
- The Garden City Terminal is the largest shipper of refrigerated cargo on the east coast and has installed electric refrigerated container racks which eliminate the use of diesel generators for the refrigerated containers. The use of these racks in place of generators avoids the consumption of nearly 2.4 million gallons of diesel annually.
- In 2008 -- two years ahead of the federal mandate -- GPA completed its conversion of yard cranes, trucks and other equipment to cleaner-burning ultra-low-sulfur diesel (ULSD), cutting emissions by an additional 10 percent.
- In 2010, EPA awarded GPA a Diesel Emissions Reduction Grant to repower 17 rubber tire gantry cranes (RTGs), which is one of the primary types of container handling equipment. By repowering these RTGs, GPA will avoid using 129,000 gallons annually throughout the life of the equipment.
- GPA recently conducted a pilot project on use of a diesel additive in the container handling equipment. The study showed that the additive reduced fuel consumption and lowered emissions. GPA now uses the additive in all container handling equipment. This avoids use of 100,000 gallons of diesel fuel annually.
- The Garden City Terminal has a total of 33 on-road truck container interchange lanes divided between two locations on the terminal, which have processed over 8,200 gate transactions on a single day. GPA's facility master plan includes construction of a third set of gates which would then provide access to the terminal from the east, west and south, thereby spreading out traffic and reducing waiting times at the gates. The dispersal of truck traffic reduces congestion and its accompanying air emissions. GPA expects to implement this improvement within the next 10 years.
- Containers are shipped by rail using the two Intermodal Container Transfer Facilities (rail yards). At those facilities, trains are built for particular destinations as far west as

Chicago. This effort reduces transit times of up to 3 days and avoids central train yard switching of cars, thereby reducing emissions. Moving freight by rail emits three times less NOx and PM than on-road trucks. With the only East Coast ICTFs located on the container terminal, GPA's on-dock rail volumes have increased 135% over the past five years (2008).

- During periods of heavy cargo volumes, GPA coordinates extended gate hours (earlier morning and later evening hours and Saturdays) to decrease on-road and terminal congestion. This improves productivity, reduces truck idling, and decreases diesel emissions.
- Forklifts of 15,500 pound capacity or smaller (86) are now fueled with LP gas, rather than diesel.

As a result of programs GPA implemented throughout the Garden City Terminal, approximately 4.5 million gallons of diesel and the associated emissions are avoided on an annual basis. While GPA has increased the total volume of containers moved, the gallons of diesel per container handled decreased 54% from FY01 to FY10.

The reduction in air emissions in the movement of cargo through the port reduces local and multi-state regional air pollution. The improved air quality benefits the thousands of personnel on GPA terminals and on neighboring industrial sites, as well as those who reside in nearby Georgia and South Carolina communities.

Prior to 2012, all 10 tugs (owned by Moran and Crescent Towing Companies) operating at the Port will be using ULSD fuel (15 ppm Sulfur) and will be "cold ironed" at the dock when not in use.

Ongoing actions that improve air quality - EPA

EPA has issued new standards for diesel fuels that will result in less air pollution. Fuels used in non-road diesel, locomotives, and marine diesel engines transitioned from 5,000 ppm sulfur to 500 ppm in 2007, and will move to ultra low sulfur diesel (ULSD), which is 15 ppm in 2010.

For trucks calling at the Garden City Terminal, the 15 ppm ULSD was used throughout the calculations because EPA indicates that the majority of trucks used the ULSD fuel in 2008. For all other equipment, the calculations include the effects of cleaner fuels on engine emission rates as those fuels become common in the Savannah area.

On March 14, 2007, EPA announced new emission standards for locomotives and marine diesel engines. For locomotives, the regulations apply to all diesel line-haul, passenger, and switch locomotives that operate extensively within the US, including new locomotives and re-manufactured locomotives. That would include the locomotives that service the Garden City Terminal. For marine diesel engines, the regulations apply to new and re-manufactured commercial marine diesel engines above 600 kilowatt (kW) or 800 horsepower (hp) with displacement less than 30 liters per cylinder installed on vessels flagged or registered in the United States. EPA divides marine diesel engines into three categories for the purposes of their standards. Category 1 represents engines up to 7 liters per cylinder displacement. Category 2 includes engines from 7 to 30 liters per cylinder. Finally, Category 3 engines are those at or above 30 liters per cylinder. Category 3 engines are not included in this rule. They are typically used for propulsion on ocean-going vessels and will be addressed in a separate EPA rulemaking.

Marine diesel engines covered by EPA's regulations are used in a variety of applications. Commercial propulsion applications range from fishing and tug boats to Great Lakes freighters. Recreational propulsion applications range from sailboats to super-yachts. Auxiliary power units range from small generator sets to large auxiliary engines on ocean-going vessels. This final group would be of most interest to the port of Savannah. The effect of the rulemaking will be limited, as the marine engine component only applies to vessels flagged or registered in the United States. Most of the vessels that call at Savannah are registered in another country, so these new standards would not apply to them.

The March 2007 rule consists of three parts.

First, there will be new standards for existing locomotives and marine diesel engines when they are remanufactured. They would also apply to newly manufactured locomotives. The standards take effect as soon as certified remanufacture systems are available, as early as 2008.

Second, the rule sets near-term emission standards, referred to as Tier 3 standards, for newly-built locomotive and diesel marine engines. These standards reflect the application of currently available technologies to reduce engine emissions of PM and NOx and phase-in starting in 2009. The rule also creates new idle reduction requirements for new and remanufactured locomotives and establishes a new generation of clean switch locomotives, based on clean non-road diesel engine standards.

Third, the final long-term emissions standards, referred to as Tier 4, apply to newly-built locomotives and marine diesel engines. These standards are based on the application of high-efficiency catalytic after-treatment technology and would phase-in beginning in 2014 for marine diesel engines and 2015 for locomotives. These standards are enabled by the availability of ultra-low sulfur diesel fuel with sulfur content capped at 15 parts per million, which will be available by 2012. These marine Tier 4 engine standards apply only to commercial marine diesel engines above 600 kW (800 hp).

EPA estimates this final rule will result in PM reductions of about 90 percent and NOx reductions of about 80 percent from engines meeting these standards, compared to engines meeting the current standards. The standards would also yield sizeable reductions in emissions of HC, CO, and other air toxics.

On December 18, 2009, EPA finalized emission standards for new marine diesel engines with per-cylinder displacement at or above 30 liters (called Category 3 marine diesel engines) installed on US vessels. These emission standards are equivalent to those adopted in the amendments to Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL Annex VI). The emission standards apply in two stages—near-term standards for newly built engines will apply beginning in 2011; long-term standards requiring an 80 percent reduction in NOx emissions will begin in 2016. EPA also finalized a change to its diesel fuel program that will allow for the production and sale of 1,000 ppm sulfur fuel for use in Category 3 marine vessels. In addition, the new fuel requirements will generally forbid the production and sale of other fuels above 1,000 ppm sulfur for use in most U.S. waters, unless alternative devices, procedures, or compliance methods are used to achieve equivalent emissions reductions. EPA adopted further provisions under the Act to Prevent Pollution from Ships, especially to apply the emission standards to engines covered by MARPOL Annex VI that are not covered by the Clean Air Act, and to require that these additional engines use the specified fuels (or equivalents).

The final regulations also include technical amendments to EPA's motor vehicle and non-road engine regulations; many of these changes involve minor adjustments or corrections to our recently finalized rule for new non-road spark-ignition engines or adjustment to other regulatory provisions to align with this recent final rule.

According to this new standard, OGV within 200 miles of the USA are required to comply with the following:

> Sulfur fuel standards will change in 2012 to 1% or 10,000 ppm S. In 2015 sulfur content will be reduced to 1,000 ppm or 0.10% sulfur. In 2016 NOx will be 3.0 g/kW-hr, no change in PM and SOx (since low sulfur fuel reduces these two pollutants), HC and CO are 2.0 g/kW-hr and 5.0 g/kW-hr respectively. No standards are being developed for CO2.

In 2008, the Pilots in Savannah indicated that OGV are currently using RO with 10,000 ppm sulfur. The current emission inventory uses this 10,000 ppm SO2 standard for 2008 (well before the 2012 deadline). Years 2016, 2020, 2025, 2030, and 2066 have been revised to reflect the new US EPA NOx and Sulfur standard.

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO_2). The new standard will protect public health, including the health of sensitive populations – people with asthma, children and the elderly. EPA set a new 1-hour NO_2 standard at the level of 100 parts per billion (ppb). This level defines the maximum allowable concentration anywhere in an area. It will protect against adverse health effects associated with short-term exposure to NO_x, including respiratory effects that can result in admission to a hospital. In addition to establishing an averaging time and level, EPA also set a new "form" for the standard. The form is the air quality statistic used to determine if an area meets the standard. The form for the 1-hour NO_2 standard is the 3-year average of the 98^{th} percentile of the annual distribution of daily maximum 1-hour average concentrations.

EPA also retained, with no change, the current annual average NO_2 standard of 53 ppb. EPA states that this suite of standards will protect public health by limiting people's exposures to short-term peak concentrations of NO_2 – which primarily occur near major roads – and by limiting community-wide NO_2 concentrations to levels below those that have been linked to respiratory-related emergency department visits and hospital admissions in the United States. To determine compliance with the new standard, EPA established new ambient air monitoring and reporting requirements for NO_2. In urban areas, monitors are required near major roads, as well as in other locations where maximum concentrations are expected.

Additional monitors are required in large urban areas to measure the highest concentrations of NO_2 that occur more broadly across communities. Working with the States, EPA will site a subset of monitors in locations to help protect communities that are susceptible and vulnerable to NO_2-related health effects.

EPA is setting new requirements for the placement of new NO_2 monitors in urban areas. These include:

A. Near Road Monitoring

At least one monitor must be located near a major road in any urban area with a population greater than or equal to 500,000 people. A second monitor is required near another major road in areas with either:

(1) population greater than or equal to 2.5 million people, or
(2) one or more road segment with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles.

These NO_2 monitors must be placed near those road segments ranked with the highest traffic levels by AADT, with consideration given to fleet mix, congestion patterns, terrain, geographic location, and meteorology in identifying locations where the peak concentrations of NO_2 are expected to occur. Monitors must be placed no more than 50 meters (about 164 feet) away from the edge of the nearest traffic lane.

EPA estimates that the new NO_2 monitoring requirements will result in a network of approximately 126 NO_2 monitoring sites near major roads in 102 urban areas.

B. Community-Wide Monitoring

A minimum of one monitor must be placed in any urban area with a population greater than or equal to 1 million people to assess community-wide concentrations. An additional 53 monitoring sites will be required to assess community-wide levels in urban areas. Some NO_2 monitors already in operation may meet the community-wide monitor siting requirements.

EPA expects to identify or designate areas not meeting the new standard, based on the existing community-wide monitoring network, by January 2012. New monitors must begin operating no later than January 1, 2013. When three years of air quality data are available from the new monitoring network, EPA intends to re-designate areas as appropriate. It may be January 1, 2016, before EPA has the required data to re-designate areas as appropriate.

The US Census Bureau defines the Savannah Metropolitan Statistical Area (MSA) as Bryan, Chatham, and Effingham counties. Between 2000 and 2008, the estimated population of the Savannah MSA grew from 293,000 to 334,353 an increase of 14 percent.

According to the Georgia Department of Transportation (GADOT) in 2008, no highways in the Savannah MSA had an AADT count greater or equal to 250,000 vehicles (GADOT 2010).

Ongoing actions that improve air quality – Port of NY/NJ

The Port of New York/New Jersey completed an Emission Inventory Update in 2005 and found that emissions from their Cargo Handling Equipment had dropped, even though the fleet had increased by 19 percent, their average operating hours had increased by 5 percent, and the total number of containers handled increased by 25 percent. The reductions were attributed to a modernization of the fleet and lower sulfur fuels. Their 2005 report explains that EPA found that newer engines produce less pollution, and as they replaced their fleet with newer models, the overall pollution levels would decrease. EPA's data is summarized as follows:

Table 6-10
NONROAD Emission Factors (Grams/HP-Hr)

Engine Tier	Year of Engine	NOx	PM10
Tier 2	2002 – 2004	4.90	0.15
Tier 1	1996 – 2001	6.90	0.25
Base	Pre-1996	10.90	0.49

NOTE: The Base emissions are estimated

Based on this information, engines manufactured today produce roughly half the NOx and PM10 emissions that engines did which were manufactured before 1996. One could expect similar decreases in emissions from Cargo Handling Equipment in Savannah as the terminal operators modernize their equipment and begin to use the cleaner fuels.

Conclusions

Four categories of activities in the Port of Savannah were found to have relatively minor amounts of air emissions (Figures 6-1 and 6-2). Those four consist of (1) internal movement of vessels within the port (Shifts); (2) Maintenance Dredging performed by the Corps; (3) Tourist Boats (Chatham County's shuttle service and two large private tour boats); and operations associated with Liquefied Natural Gas vessels. Those activities do not adversely affect the quality of air in Chatham County or at the Port.

NOx is the pollutant that is emitted in the largest quantities in the port (Figures 6-1 and 6-2). This pollutant comprises roughly 58 percent of the quantity of emissions among the pollutants analyzed (HC, VOC, CO, NOx, PM10, PM2.5 and SO2).

Container vessels are the source of most air emissions among the various types of vessels that call at the port (Figure 6-6). That is to be expected, as the port services more Container vessels than any other vessel type.

Most of the air emissions at the Port result from the deep-draft vessels which call there (Figure 6-11). The tugs which guide those vessels and the land-based operations that handle their cargoes were found to contribute much less air emissions than the vessels or their land-based support operations.

It is apparent from the Corps' Fleet Forecast (Attachment A, April 2011) , that the numbers of vessels expected to call on the Port of Savannah for years 2016, 2020, 2025, 2030, and 2066 will be substantially greater for the existing depth of -42 feet than the maximum proposed depth of -48 feet (see Table 4-3). In 2030, for the -42 and -48 foot depths, the numbers of vessels arriving in Savannah would change from 7,205 to 6,714 respectively. In 2030, the Fleet Forecast estimates 7.3% more vessels arriving in Savannah for the existing depth of - 42 feet than for the maximum proposed depth of -48 foot. More vessels calling on the Port for the existing -42 foot depth during this projected time (i.e., 2016 to 2066) would result in a greater amount of criteria pollutants, air toxics and greenhouse gases being discharged in Chatham County. Those emissions would be reduced by a deeper harbor that would allow a fleet of larger vessels that each carries more cargo. The same cargo volumes could be moved through the port with fewer

container ships. Tables showing the Summary of all Emissions (i.e., Table 5-78) and mentioned throughout this document show this trend.

For the Land-Based Operations at GPA's Garden City Terminal (Figures 6-16 and 6-17), Top lifts were found to produce the most air emissions, followed by Rubber-Tired Gantry Cranes, Jockey Trucks, and Aerial Cranes. The Trucks that bring containers to the port and take them to their US destination were found to be relatively small contributors to the total air emissions. Although Trucks emitted more NOx than other pollutants, they contributed a larger percentage of CO (4.8 percent) to the emissions from the terminal (Table 6-2). Truck emissions comprise less than 5 percent of all air emissions produced by the port.

While containerships are docked and being serviced (referred to as Hotelling) at Garden City Terminal, they contribute less than 12% of the total emissions of the total port emissions (Table 6-1). The emissions while Hotelling represent less than 12% of the emissions from the Garden City Terminal (vessels, tugs, and landside CHE). With the proposed future EPA reductions in both NOx and Sulfur emissions for containerships, this percentage would be further reduced. Therefore, Hotelling is not a major contributor to the port's emissions.

New Work Dredging to deepen the harbor would be a substantial contributor (>10 percent) of the port's emissions of CO and NOx during the four-year construction period (Table 6-5). However, a large portion of those emissions would occur offshore while deepening the entrance channel and are not likely to contribute to air pollution in the City or County.

The Corps' calculations of 2008 emissions for the Port indicate that the Port was a substantial contributor of NOx (18.3 percent compared to the EPA 2002 NEI and 13.5 percent compared to the EPA 2005 NEI data) emissions in Chatham County (Table 6-4). (It should be noted that some of the emissions the Corps calculated for the Port occur while ships move through the entrance channel located in the ocean east of the coastline.) The Port contributes only minor amounts to emissions of SO2 (5.4 and 5.1 percent compared to the EPA 2002 and 2005 NEI data), PM10 (3.4 and 3.1 percent compared to the EPA 2002 and 2005 NEI data), PM2.5 (9.5 and 7.2 percent compared to the EPA 2002 and 2005 NEI data), HC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), VOC (1.9 and 2.0 percent compared to the EPA 2002 and 2005 NEI data), and CO (1.3 to 1.6 percent compared to the EPA 2002 and 2005 NEI data).

The Corps understands that the port and navigation channels are located in both Chatham County, Georgia and Jasper County, South Carolina. The Corps compared the 2008 calculated Port emissions (all 22 terminals) to the combined US EPA NEI data for both Chatham and Jaspers Counties for 2002 and 2005. Table 6-11 shows the comparison.

Table 6-11
Comparison of the 2008 Port Emissions to US EPA NEI data for Chatham County, Georgia and Jasper County, South Carolina for 2002 and 2005.

	HC	VOC	CO	NOx	PM10	PM2.5	SO2
2002 NEI (Tons/Year)							
Jasper County	5,851	5,880	29,028	3,975	4,698	962	993
2005 NEI (Tons/Year)							
Jasper County	4,584	4,607	30,083	3,482	3,331	1,296	655
2002 NEI (Tons/Year)							
Chatham County	18,198	18,289	99,565	32,454	6,782	2,453	23,115
2005 NEI (Tons/Year)							
Chatham County	17,518	17,606	81,948	40,230	7,405	3,104	23,665
Combined Chatham and Jasper Co's							
2002	24,049	24,169	128,593	36,429	11,480	3,415	24,108
2005	22,102	22,213	112,031	43,712	10,736	4,399	24,319
2008 Port Emissions (-42 foot depth) in Tons	348	352	1,394	5,042	230	216	1,177
% 2008 Port Emissions/Combined							
2002 Chatham and Jasper County's	**1.45%**	**1.46%**	**1.08%**	**13.84%**	**2.00%**	**6.33%**	**4.88%**
2005 Chatham and Jasper County's	**1.58%**	**1.59%**	**1.24%**	**11.53%**	**2.14%**	**4.91%**	**4.84%**

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Table 6-11 also indicates that the overall port emissions for all 22 terminals in Savannah are not a significant emitter of criteria pollutants in the project area.

Emissions of NOx, SO2, and PM2.5 are likely to decrease as the terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO2 emissions are expected to decrease as a result of EPA's requirements for use of cleaner fuels. These new standards should substantially reduce SO2 emissions, as the SO2 content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010. For Ocean-Going Vessels, EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NOx emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require OGV within 200 miles of the US to use fuel with a maximum of 1% Sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NOx and SO2 emissions in the County should substantially decrease as a result of these new cleaner fuel requirements.

Comparing the calculated port air toxic emissions in 2008 to EPA's 2002 County-wide air toxic emissions, the Port is not a significant contributor of any air toxics in Chatham County (Table 6-6). The Port contributes minor amounts (less than 5%) of the County's totals for the 28 air toxics that were calculated.

For the 50-year project life, the Port does not appear to be a significant emitter of greenhouse gases (Table 6-6). Port operations contribute less CO2 than the one facility that is included in EPA's public database for Chatham County - the existing coal-fired Kraft Steam Electric Plant in Port Wentworth, Georgia, which has emitted on average over 1.3 million tons per year of CO_2 into the atmosphere since 2002.

More detailed analyses -- such as dispersion analyses to identify "hot spots" of pollution -- were not conducted because the Port is not a major contributor to the overall emissions in the County. In addition, the dispersed nature of many of those "Port" emissions along the 38-mile length of the navigation channel reduces the potential for adverse effects at any given location. At the request of EPA Region 4, the Georgia Ports Authority is separately conducting additional air analyses, including a dispersion analysis, on the present operations at its two terminals in Savannah. The results of that analysis are not yet available.

Future growth in cargo movements and accompanying air emissions are expected at Savannah. With or without the harbor deepening, these air emissions are expected to grow. Those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening. Those higher total emission levels in the future would be lessened if larger container vessels are allowed to regularly call at the port. The expected future growth in total emission levels would be substantially lessened by the recently-mandated use of cleaner fuels.

Any of the proposed harbor deepening alternatives would reduce air emission levels in the Port of Savannah from what would occur with the existing 42-foot navigation channel. The beneficial effect increases with the amount of deepening. Construction of a deeper channel would result in temporary increases in air emissions. However, since those temporary increases would be distributed along the length of the 38-mile channel – almost half of which is in the ocean on the entrance channel -- the overall effects of a harbor deepening project would be beneficial and not warrant mitigation.

Under both the Without and With project conditions, the Corps expects the Garden City Terminal to reach its build-out capacity near 2030 when the total number of TEUs processed through the terminal reaches 6.5 million. That capacity is the maximum number of containers that could reasonably be processed through the Garden City Terminal in a year. That determination includes factors such as the size of the terminal, the number of gates that provide access to the property, the number and size of the berths, the number and size of the container cranes, the number of jockey trucks that move the containers within the terminal, how the containers are stacked within the terminal, and the number of railroads that service the terminal and the frequency of their trains. It is anticipated that without deepening, more vessels will be required to transport the cargo that is expected to move through the port. With deepening, the total number of vessels would decrease as vessels would be able to load more deeply under the improved conditions.

To better understand uncertainties in the level of air emissions that could occur at the Port of Savannah, EPA requested the Corps evaluate alternate scenarios for the number of containers expected to move through the port in the future. In Attachment C, the Corps discusses and evaluates alternative future conditions in the level of air emissions in the Port of Savannah.

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers. Noise, air emissions (including air toxics), and traffic would not be increased as a result of the proposed deepening. Therefore, the proposed harbor deepening would have no adverse landside impacts.

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ATTACHMENT A

Container Fleet Forecast
(April 2011)

Expected Container Vessel Calls (One-way)
Garden City Terminal

2008	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	0	32	1,261	228	1,521

2016	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	134	483	1,171	505	2,293
-44 feet	267	293	1,116	505	2,181
-45 feet	266	292	1,094	505	2,157
-46 feet	265	292	1,084	505	2,145
-47 feet	265	292	1,079	505	2,141
-48-feet	265	292	1,079	505	2,141

2020	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	271	866	778	593	2,509
-44 feet	533	478	700	593	2,304
-45 feet	527	474	671	593	2,265
-46 feet	524	471	658	593	2,247
-47 feet	524	471	649	593	2,238
-48-feet	524	471	649	593	2,238

2025	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	382	1,006	1,122	758	3,267
-44 feet	761	471	992	758	2,982
-45 feet	753	467	952	758	2,930
-46 feet	749	465	932	758	2,903
-47 feet	749	462	924	758	2,892
-48-feet	749	462	924	758	2,892

2030	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

2066	Post-Panamax Gen II	Post-Panamax Gen I	Panamax	Sub-Panamax	Total
-42 feet Baseline	527	1,421	1,196	947	4,092
-44 feet	1,035	672	1,067	947	3,720
-45 feet	1,027	666	1,007	947	3,647
-46 feet	1,021	662	982	947	3,613
-47 feet	1,018	661	975	947	3,601
-48-feet	1,018	661	975	947	3,601

General Cargo and LNG Vessel Fleet Calls for all Depths

YEAR	2008	2016	2020	2025	2030
GENERAL CARGO	1,083	1,733	2,068	2,468	2,946
LNG	120	120	136	151	167
Total	1,203	1,853	2,204	2,619	3,113

Expected Liquefied Natural Gas Vessel Calls (One-Way)
Southern LNG Terminal

Year	Total Vessels	BU SAMRA (266,000 BCM) (17.4%)	AL UWAILA (217,000 BCM) (12.7%)	MERSK ARWA (165,500 BCM) (23.9%)	LUSAIL (145,000 BCM) (23.5%)	BRITISH TRADER (135,000 BCM) (22.5%)
2016	120	21	15	29	28	27
2020	136	24	17	32	32	30
2025	151	26	19	36	35	34
2030	167	29	21	40	39	37

ATTACHMENT B

Emission Calculation Spreadsheets (Available on CD)

ATTACHMENT C

Evaluation of Alternate Future Conditions

Evaluation of Alternate Future Conditions

In their review of the Draft EIS, EPA commented on the uncertainty that surrounds the Corps' projections for the volume of containers expected to move through the port in the future. As with any prediction of the future, there is uncertainty around the resulting numbers. The District predicts consistent growth in the number of containers, based primarily upon expected increases in GDP in the Southeast. That expectation of future growth is independent of whether the harbor is deepened. This approach assumes that a harbor deepening to -47/48 foot depth would not alter the Port of Savannah's competitiveness compared to nearby ports. This approach is the one that the US Army Corps of Engineers typically takes in its evaluations of the feasibility of proposed improvements to container ports. It is a conservative one from which to assess the economic viability of such proposed actions. In this case, it is supported by the Corps' 2006 Multiport Analysis (included as supplemental materials in the GRR Economic Appendix) that found that vessel voyage cost savings resulting from deepening Savannah Harbor would not be sufficient to divert containers from other ports on the basis of least total transportation cost (voyage, port, and hinterland).

For both the **With Project Base Condition** and the **Without Project Base Condition** scenarios (see Tables 1 & 2), the Total Port Capacity would be reached in 2030 with 6.5 million TEUs. After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future. The **With Project Base Condition** scenario includes no change in the Port of Savannah's competitiveness as a result of harbor deepening, which is supported by the conclusion of the Corps' 2006 Multiport Analysis.

To address uncertainty in the level of air emissions that could occur at the Port, EPA requested the Corps evaluate alternate scenarios for the number of containers expected to move through the port in the future.

EPA pointed out that GPA has stated that harbor deepening is required for this port to remain competitive – to keep its present market share. If no deepening occurs, another potential scenario is that the growth in container volume and/or the number of containers decreases for a period of time as shippers use other ports which can efficiently handle the larger, more cost-effective vessels. With that scenario, one could assume that that cargo volume resumes its long term growth rate (that is dependent upon GDP) after a few years of transition. The Corps calculated air emissions for such a scenario of the future, which are found in Table 5-78 in Appendix K. For this **Without Project Reduced Cargo Scenario** (see Table 3), the cargo volumes would be constant for about 10 years after the base year of 2016, then resume growth until the Total Port Capacity of 6.5 million TEUs is reached in 2040 (a later date than 2030 because growth slowed). After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future.

Another scenario of the future is that harbor deepening would result in more goods being moved through this port. For this to occur, the improved transportation efficiencies would result in containers moving through Savannah that would otherwise move through other ports. Savannah would increase its market share and over other ports. Vessel transportation costs are one of

several factors that a shipper considers when he decides which port to use in moving his goods. Those factors include the speed that goods are moved through the port, the process for the goods to clear customs, the security of goods while on the terminal, access to railroads, road congestion near the terminal, trucking or rail distance, and port fees. The 2006 Multiport Analysis does not support this scenario, but the Corps examined it for discussion purposes. For this **With Project Additional Cargo Scenario** (see Table 4, below), additional growth would occur after the harbor is deepened, but it could only continue until the 6.5 million TEU capacity of the Garden City Terminal is reached (in 2025, an earlier date than 2030 due to the faster growth). After the terminal capacity is reached, the container volume and resulting air emissions would stay constant for the future.

The District evaluated the air emission quantities that it calculated for the port to identify the potential range in emissions that could occur under these three scenarios of future conditions. All calculated air emission quantities for the entire port were taken from Table 5-78 in Appendix K Air Emission Inventory. The following tables show the Corps predictions for future emissions in the port under these three alternate scenarios of the future:

(1) Tables 1 and 2 shows the expected emissions in the **With and Without Project Base Scenarios**. The **With and Without Project Base** conditions are the Corps' expectation for the total port emissions with the proposed -47/48 foot and the existing 42-foot channel depth, respectively. The District believes that for both scenarios the port would handle about 2.8 million TEUs in 2016, Port Capacity would be reached in 2030, and air emissions would stay constant from 2030 to 2066. The total air emissions would be lower in the deepened -47/48 foot depth **With Project Base Condition** (when compared to the existing -42 foot depth **Without Project Condition**) because fewer but larger vessels could move the cargo through the port.

(2) Table 3 shows the expected emissions in the **Without Project Reduced Cargo Scenario**. The Corps defines the Reduced Cargo Scenario as being what would occur if the harbor is not deepened (depth remains at -42 foot depth) and shippers move a greater share of their containers through other ports, and cargo decreases (remains constant) for a period of time and then resumes growth until the Total Port Capacity is reached in 2040 with 6.5 million TEUs. Air emissions would stay constant from 2040 to 2066. The analysis is based on about a 10-year delay in the container fleet expected to call at Savannah.

(3) Table 4 shows the expected emissions in the **With Project Additional Cargo Scenario**. The Corps defines the Additional Cargo Scenario as being what would occur if the harbor is deepened to -47/48 foot depth and shippers move a greater share of their containers through Savannah. In this scenario, the deepened port would handle about 2.8 million TEUs in 2016 and would handle an additional 1.2 million TEUs over what was expected for 2025 (6,714 vs. 5,511 TEUs). Port Capacity would be reached in 2025 with 6.5 million TEUs and air emissions stay would constant from that date to 2066.

Tables 1, 2, 3 and 4, as well as Figures 1, 2, 3 and 4, show the calculated air emissions for the Port of Savannah under these alternate future condition scenarios.

As indicated in the tables and figures below, the port emissions are expected to vary over time (in response to GDP growth in the southeast). These analyses also show that the port emissions could vary with the different scenarios of future conditions. More or fewer goods could be moved through the Port of Savannah in response to the decision to deepen the harbor. The District makes the following observations from these four scenarios:

1. Air emissions would be lower in the **With Project Base Condition** (when compared to the **Without Project Condition**) because fewer but larger vessels could move the cargo through the port.

2. Air emissions would initially be greater under the **With Project Additional Cargo** scenario than in the **With Project Base Condition** for the future (both scenarios include a deepened harbor to -47/48 foot depth). The higher total air emissions (tons/year) would continue until the port reaches its landside capacity.

3. Once the total port capacity has been reached for the **Without and With Project Base Condition** in 2030, **With Project Additional Cargo** scenario in 2025, and the **Without Project Reduced Cargo** scenario in 2040, total air emissions for the port would remain constant to the end of the project life in 2066.

Table 1. With Project Base Condition Scenario Air Emissions for the Port of Savannah

Depth -47/48 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	3,994	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	4,442	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025	5,511	756.36	764.17	2,354.17	5,731.20	273.40	258.50	569.82	511,543.41
2030*	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2035	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2040	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

***Total Port Capacity is reached**

Table 2. Without Project Base Condition Scenario Air Emissions for the Port of Savannah

Depth -42 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2020	4,713	663.09	578.86	2,041.34	6,238.08	247.18	233.98	503.08	461,222.15
2025	5,886	806.26	670.16	2,130.17	6,202.50	295.26	279.18	509.67	561,166.22
2030*	7,205	991.74	814.83	2,517.67	6,396.84	353.36	333.77	584.43	684,375.12
2035	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

2040	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12
2066	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	671.22	684,375.12

* Total Port Capacity is reached

Table 3. Without Project Reduced Cargo Scenario Air Emissions for the Port of Savannah

Depth -42 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2020	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2025	4,146	566.82	352.54	1,394.06	7,500.77	235.87	223.90	1,177.49	446,818.70
2030	4,713	663.09	578.86	2,041.34	6,238.08	247.18	233.98	503.08	461,222.15
2035	5,886	806.26	670.16	2,130.17	6,202.50	295.26	279.18	509.67	561,166.22
2040*	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	584.43	684,375.12
2066	7,205	991.74	1,002.19	2,988.15	6,396.84	353.36	333.77	584.43	684,375.12

*Total Port Capacity is reached

Table 4. With Project Additional Cargo Scenario Air Emissions for the Port of Savannah

Depth -47/48 feet									
Year	# of Vessels	HC	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2008	2,724	348.34	352.54	1,394.06	5,042.24	229.76	216.14	1,177.49	258,153.99
2016	3,994	548.72	560.46	1,978.62	7,238.60	227.42	215.90	497.60	427,762.23
2020	4,442	625.68	632.16	2,005.80	5,810.42	230.54	218.22	498.97	423,671.23
2025*	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2030	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2035	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2040	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26
2066	6,714	925.11	934.56	2,776.34	5,867.61	325.13	307.08	651.63	619,878.26

*Total Port Capacity is reached

Figure 1. Comparison of the Calculated Air Emissions (Tons/Year) for Alternate Future Condition Scenarios

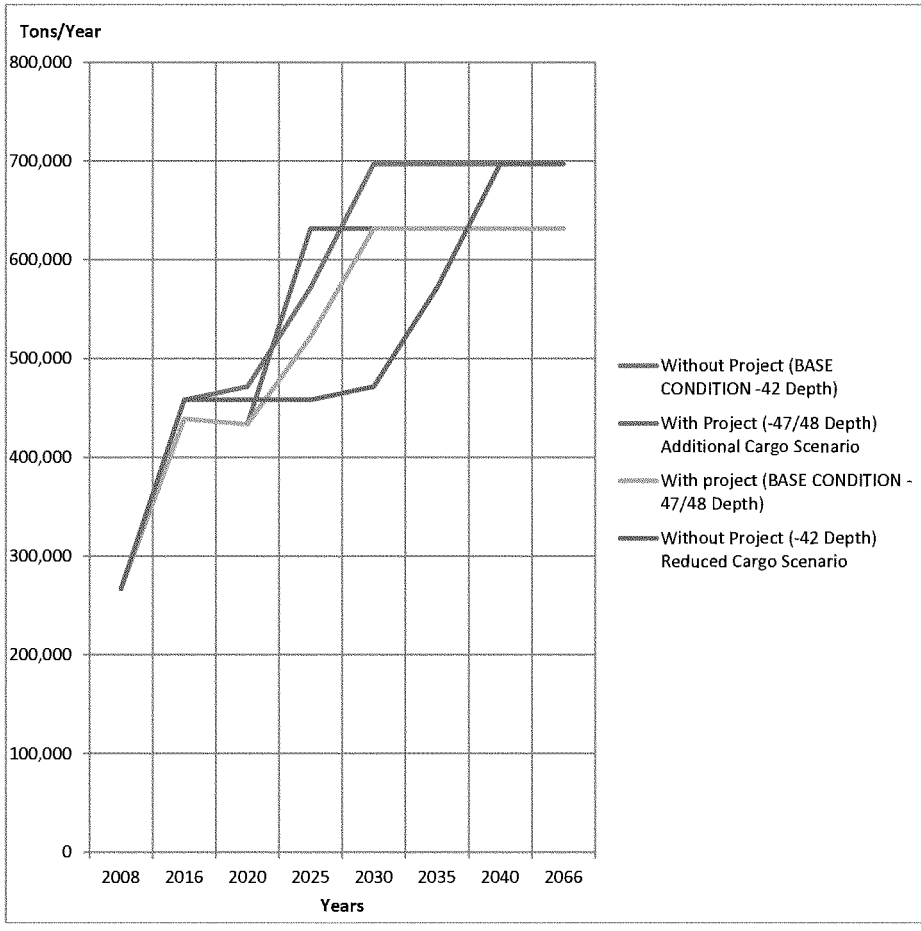


Figure 2. Comparison of the Calculated Air Emissions (Tons/Year): Without Project Base Condition (-42 foot depth) and With Project Base Condition (-47/48 foot depth), 2008 to 2066

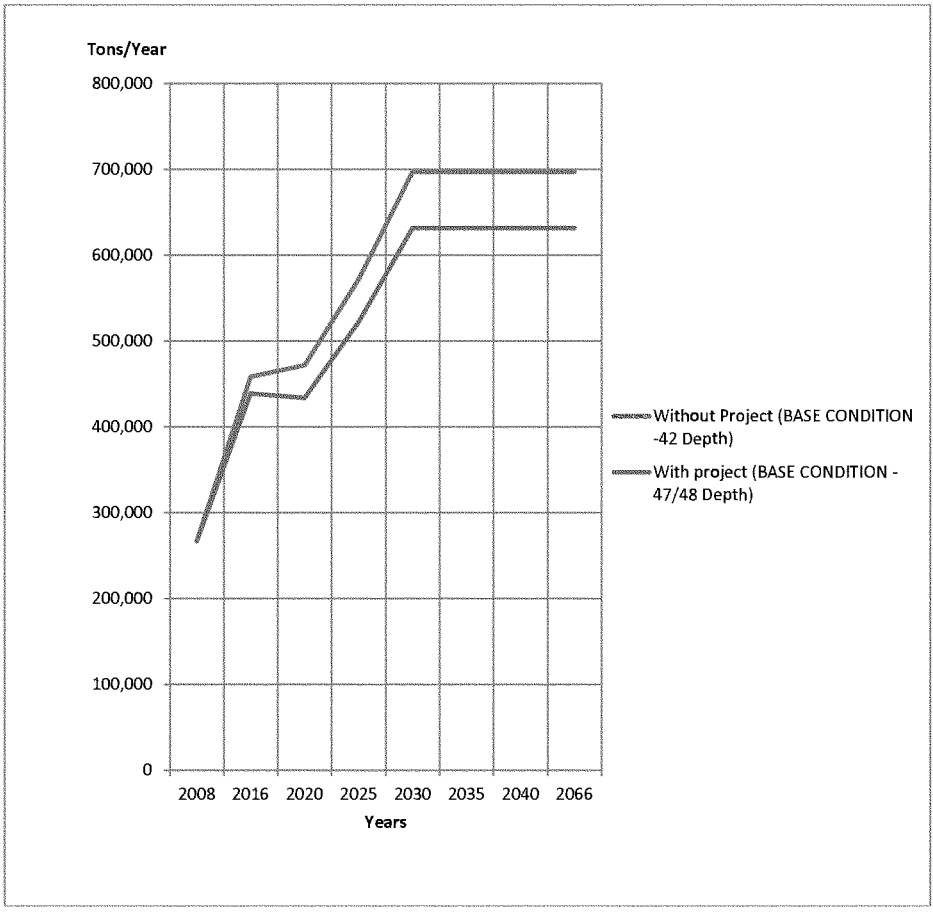


Figure 3. Comparison of the Calculated Air Emissions (Tons/Year): Without Project Base Condition (-42 foot depth) and Without Project Reduced Cargo Scenario (-42 foot depth), 2008 to 2066

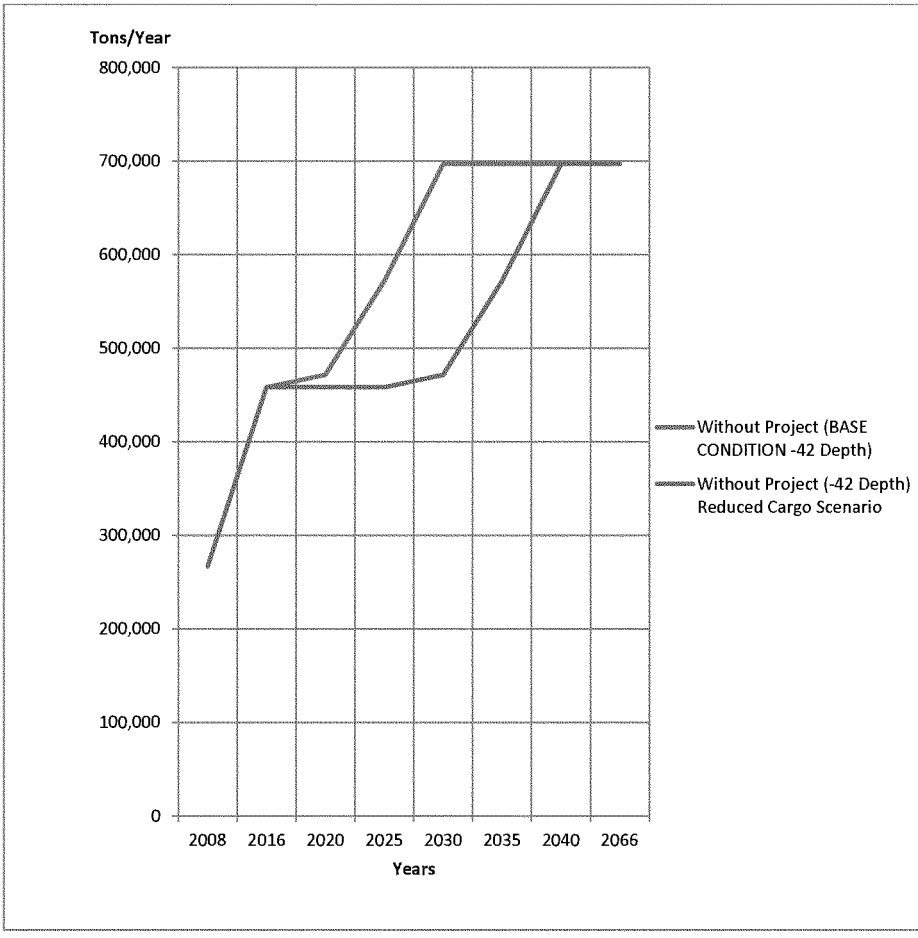
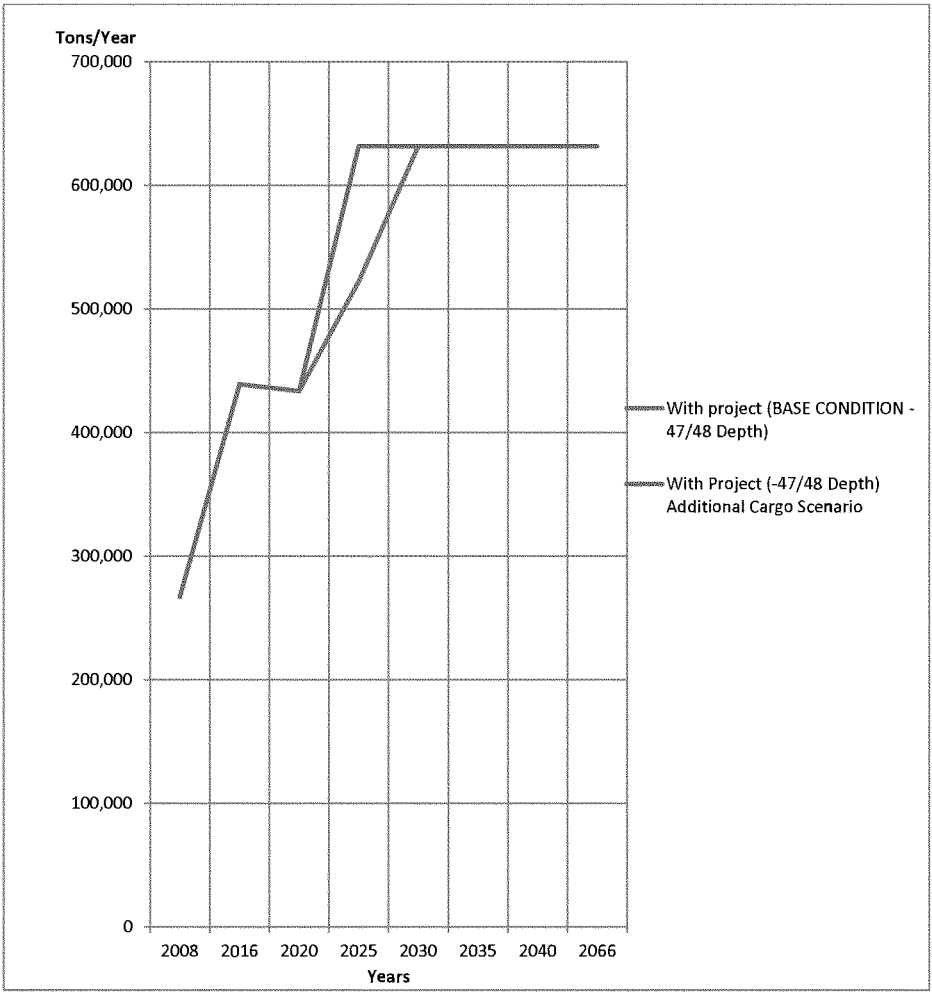


Figure 4. Comparison of the Calculated Air Emissions (Tons/Year): With Project Base Condition (-47/48 foot depth) and With Project Additional Cargo Scenario (-47/48 foot depth), 2008 to 2066



ENVIRONMENTAL IMPACT STATEMENT
APPENDIX L: Cumulative Impacts Analysis

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps of Engineers
Savannah District
South Atlantic Division

Cumulative Impacts Analysis

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SAVANNAH HARBOR EXPANSION PROJECT

CUMULATIVE IMPACTS ANALYSIS

1. Background

The assessment of cumulative impacts in NEPA documents is required by CEQ regulations (CEQ, 1987). According to the CEFQ, a cumulative effect "is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

An assessment of cumulative effects helps one identify the significance of an impact. The assessment sets the stage for determining the importance of the incremental effect produced by a proposed action. When considering significance, one should examine whether the action is related to other actions with individually insignificant, but cumulatively significant impacts. The CEQ regulations state that "significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment." The CEQ produced a handbook titled "Considering Cumulative Effects under the National Environmental Policy Act" to guide agencies in the preparation of cumulative impact analysis.

2. Three Steps of Cumulative Impacts Analysis

As described in the CEQ handbook, the cumulative impact analysis process involves three basic processes:

1. Scoping for cumulative effects
2. Describing the affected environment
3. Determining the environmental consequences

3. Scoping For Cumulative Impacts

An analysis of cumulative effects should include past, present, and future actions and encompass all Federal, non-Federal, and private actions. The analysis should focus on each affected resource, ecosystem, and human community, with the study effort focusing on truly meaningful impacts. As directed by the CEQ handbook, the scoping for potential cumulative effects should include:

1. Identifying the significant potential cumulative effects and defining assessment goals.
2. Establishing the geographic scope of the analysis
3. Establishing the time frame for the analysis

4. Identifying other actions affecting the resources, ecosystems and human communities of concern.

4. Describing the Affected Environment

In describing the affected environment, the CEQ handbook suggests using natural boundaries and focusing on each affected resource, ecosystem, and human community. Consequently this part of the cumulative analysis should include:

1. Characterizing the resources, ecosystems, and human communities identified during scoping in terms of their response to change and capacity to withstand stress
2. Characterizing the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds
3. Defining a baseline condition for the resources, ecosystems and human communities.

5. Determining the Environmental Consequences of Cumulative Impacts

This portion of the cumulative effects analysis addresses additive, countervailing, synergistic effects, looking beyond the life of the action, and addressing the sustainability of resources, ecosystems, and human communities. Consequently, this part of the cumulative analysis should include:

1. Identifying the important cause-and effect relationship relationships between human activities and resources, ecosystems, and human communities
2. Determining the magnitude and significance of cumulative impacts
3. Modifying or adding alternatives to avoid, minimize, or mitigate significant cumulative impacts,
4. Monitoring to determine the cumulative effects of the selected alternative and adapting management measures as required.

6. Scoping for Cumulative Impacts

Scoping for the cumulative impacts associated with the Savannah Harbor Expansion Project (SHEP) was aided by numerous information sources. During the course of the study, various environmental studies were conducted on the harbor and its various resources and ecosystems. These studies included water quality and sediment characterization studies, salinity and dissolved oxygen modeling, fishery studies and other study efforts directed at various resources. Table 1 shows some of the studies conducted in support of the SHEP.

Table 1. Summary of SHEP Modeling Studies

Report	Title	Author	Date
Water Quality Mitigation	*Oxygen Injection Design Report Savannah Harbor Expansion Project*	Tetra Tech, Inc.	October 2010
Model Calibration (EFDC & WASP)	*Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	January 2006
Fishery Impacts	*Habitat Impacts of the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	October 2006
Chloride Model Development (Superseded)	*Savannah Harbor Expansion Project – Chloride Data Analysis and Model Development*	Tetra Tech, Inc.	November 2006
Water Quality Impacts	*Water Quality Impacts of the Savannah Harbor Expansion Project*	Tetra Tech, Inc.	February 2007
Marsh Modeling Report	*Simulations of Water Levels and Salinity in the Rivers and Tidal Marshes in the Vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia*	US Geological Survey	June 2006
Chloride Impacts	*Chloride Impact Evaluation Impacts of Harbor Deepening Only*	USACE Savannah District SAS-EN	February 2007
Hurricane Surge Impacts	*Hurricane Surge Modeling*	USACE Savannah District SAS-EN	September 2005
Chloride Impacts (Superseded)	*Savannah Harbor Expansion Project Evaluation of Chloride Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	December 2007
Fishery Impacts (SNS Impacts Superseded)	*Savannah Harbor Expansion Project Evaluation of Fishery Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	January 2010
Hurricane Surge Impacts	*Savannah Harbor Expansion Project Evaluation of Hurricane Surge Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	December 2007
Wetland Impacts	*Savannah Harbor Expansion Project Evaluation of Marsh/Wetland Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	November 2007

Report	Title	Author	Date
Water Quality Impacts	*Savannah Harbor Expansion Project Evaluation of Water Quality Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts	*Savannah Harbor Expansion Project Mitigation Evaluation for Marsh/Wetland Impacts*	USACE Savannah District SAS-EN	November 2007
Wetland Impacts (Sensitivity Analysis)	*Savannah Harbor Expansion Project Sensitivity Analysis of Proposed Navigation Meeting Areas*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts (Sensitivity Analysis Obsolete)	*Savannah Harbor Expansion Project Sensitivity Analysis of Proposed Sill on Middle River*	USACE Savannah District SAS-EN	September 2009
Wetland Impacts	*Wetland/Marsh Impact Evaluation*	USACE Savannah District SAS-EN	February 2007
Wetland Impacts (Obsolete)	*Savannah Harbor Deepening Project ATM Marsh Succession Model Marsh/Wetland Impact Evaluation*	USACE Mobile District SAM	May 2007
Wetland Impacts (Obsolete)	*Savannah Harbor Deepening Project USGS/USFWS Marsh Succession Model Marsh/Wetland Impact Evaluation*	USACE Mobile District SAM	June 2007
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Adult SNS (Summer) Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS	March 2011
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Adult SNS (Winter) Habitat Impacts with Proposed Mitigation Plan*	USACE Savannah District SAS	March 2011
Fishery Impacts	*Savannah Harbor Expansion Project Evaluation of Juvenile SNS (Winter) Habitat Impacts with Proposed Mitigation*	USACE Savannah District SAS	March 2011
Chloride Model Development	*Chloride Modeling Savannah Harbor Expansion Project*	Tetra Tech, Inc. & Advanced Data Mining Services, LLC	December 2010
Chloride Impacts	*Assessment of Chloride Impact from Savannah Harbor Deepening*	Arthur Freedman Associates, Inc.	April 2011

In addition to scientific data generated from the various studies, the District received input from technical experts from Federal and State resource agencies. Scoping for cumulative impact assessment also benefited from input from the Stakeholder Evaluation Group (SEG), which included others interested in the future of the resources in Savannah Harbor. The cumulative impact analysis was also aided by information contained in the Draft Fish and Wildlife Coordination Act Section 2(b) Report submitted by the US Fish and Wildlife Service's Office of Ecological Services field office in Charleston, SC. This report (November 2008) included input from the National Marine Fisheries Service, the South Carolina Department of Natural Resources, and the Georgia Department of Natural Resources.

7. Identification of Critical Resources or Issues

As discussed above, the CEQ handbook directs that cumulative effect analysis should "Focus on truly meaningful effects". The Savannah Harbor Expansion Project could affect the human environment through several potential avenues. A broad list of potential avenues and items for consideration was developed as a result of the scoping process.

The Cooperating Agencies reviewed that list of items and agreed that the following were the major resources or issues of concern for this project:

- Wetlands
- Fisheries
- Dissolved Oxygen
- Groundwater
- Endangered Species
- Tybee and Nearshore Area

The remainder of this cumulative impact analysis will focus on each of the major resources or issues of concern identified above. For each resource or issue, the analysis will use the following format:

Issue
Geographic scope
Historical basis (baseline condition)
Past actions / stresses
Present condition
Present actions / stresses
Capacity to withstand stress
Future actions / stresses
Incremental impact
Alternatives to avoid, minimize, or mitigate cumulative effects

8. Wetlands

Issue

Wetland concerns addressed in this cumulative impact analysis were divided into three categories. The first concern centers around the Savannah National Wildlife Refuge (SNWR) operated by the US Fish and Wildlife Service. The SNWR withdraws freshwater from Little Back River to assist in the management of diked impoundments for migratory waterfowl. Withdrawal of water with salinity concentrations greater than 0.5 ppt is considered detrimental to their freshwater waterfowl management operations.

The second major wetland concern is the remaining tidal freshwater marsh in the Savannah Harbor estuary. Federal and State natural resource agencies consider tidal freshwater marsh to be of particularly high value because of the plant and animal diversity that it supports. In addition, tidal freshwater marsh is much rarer on a national basis than brackish marsh or saltmarsh.

The third major wetland concern addressed in this cumulative impact analysis is the salt and brackish marsh in the estuary. Industrial development and harbor maintenance (construction of dredged material disposal areas) have impacted much of this resource over time.

A. Savannah National Wildlife Refuge Freshwater Waterfowl Management Operations (Impounded Marshes)

Geographic Scope

The geographic scope of this analysis is the SNWR. The primary purpose of the SNWR is to provide habitat for wintering waterfowl and other migratory birds.

The Refuge lies adjacent to and upstream of Savannah Harbor in Chatham and Effingham Counties, Georgia and Jasper County, South Carolina. The downstream end of the refuge on the Savannah River is located around River Mile 17. The SNWR extends upriver to about River Mile 41, about 14 miles above the I-95 crossing. The SNWR consists of 29,175 acres of palustrine forested wetlands, palustrine and estuarine emergent wetlands, palustrine scrub-shrub wetlands, riverine wetlands, diked waterfowl impoundments (managed wetlands), and uplands. The SNWR obtains freshwater for its diked waterfowl impoundments through freshwater control works that were constructed as part of the Sediment Basin Project in Savannah Harbor. The SNWR obtains its freshwater primarily through the Diversion Canal Intake (water control structure No.1) located on Lucknow Canal just off Little Back River. The water is used to fill the diked waterfowl impoundments (about 5,700 acres) in the fall to provide food and habitat for migratory birds. Figure 1 shows that portion of the SNWR in the immediate study area.

The private lands located east of the SNWR generally known as the Fife and Clydesdale Plantations contain diked impoundments which are primarily used for waterfowl management. The SNWR supplies freshwater through the freshwater control system to these two plantations

because the freshwater control system was constructed to supply a dependable source of freshwater for both the SNWR and these adjacent landowners.

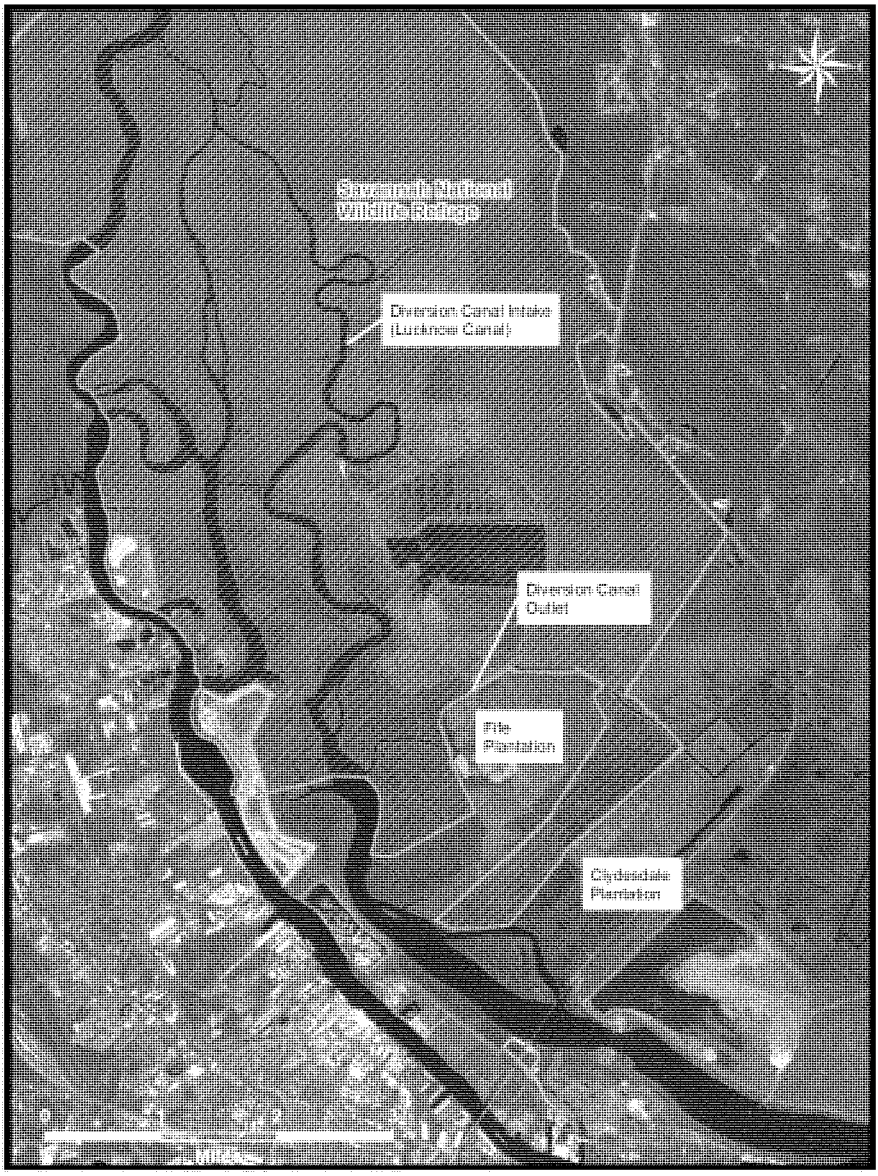

Figure 1. SNWR- SHEP study area.

Historic Basis

On April 6, 1927, Executive Order 4626 established the Savannah River Bird Refuge and set aside 2,352 acres as a preserve and breeding ground for native birds. Executive Order No. 5748 (November 12, 1931) added 207 acres to the Refuge and renamed the area the Savannah River Wildlife Refuge. Executive Order 7391 (June 17, 1936) added 6,527 acres to the Refuge. Presidential Proclamation 2416 (July 30, 1940) renamed it the Savannah National Wildlife Refuge. Much of the Refuge consisted of old rice fields, and the old rice levees form the basis for the current impoundment dikes.

The three Executive Orders cited above provided the initial 9,086 acres of the SNWR. The remaining 20,089 acres comprising the SNWR were purchased using various funds (Duck Stamp Funds, Land and Water Conservation Funds, etc.) with the last purchase being the Solomon tract (887 acres) in 1999.

When the SNWR was established in 1927, the Savannah Harbor Navigation Project was authorized to be maintained to 26 feet MLW, compared to its current authorized depth of 42 feet MLW. In addition, maintenance dredging in Savannah Harbor in 1927 did not include the current practice of allowable overdepth dredging. This practice permits dredging to occur an extra 2-6 feet deeper in critical shoaling areas in the channel to reduce dredging frequency.

Past Actions/Stresses

Since the SNWR began operations in 1927, there have been four harbor deepening projects. In addition, the Sediment Control Works Project was constructed and placed into operation. The Savannah Harbor navigation channel was deepened to 30 feet MLW in 1937 and to 34 MLW in 1958. The navigation channel was then deepened to 38 feet MLW in 1975 and to 42 feet MLW in 1994. All of these deepening projects allowed saltwater to migrate farther upstream. Information supplied in the Fish and Wildlife Coordination Act Section 2(b) Report indicates that the freshwater interface has moved from near the City of Savannah (Mile 14 of Savannah Harbor) in 1940 (30 foot channel) to near the upstream limit of the project (Mile 21.3) just below the Georgia Highway 25 (Houlihan) Bridge (42 foot channel). Figure 2 taken from the November 2008 US Fish and Wildlife Service Draft Fish and Wildlife Coordination Act Report, shows the historical change in the location of the freshwater interface from 1875 to the present.

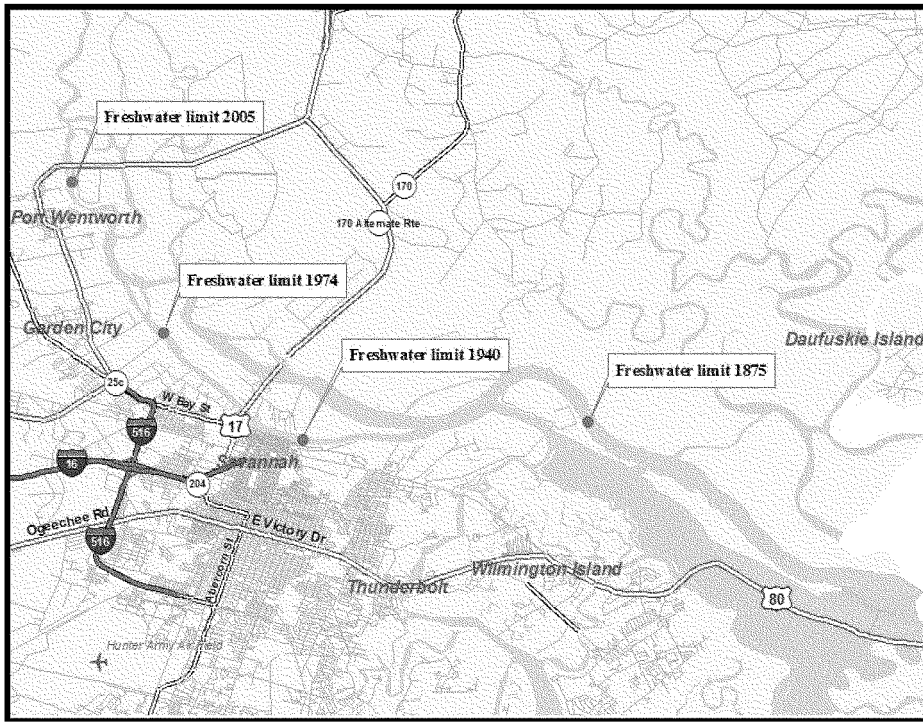

Figure 2. Historical freshwater interface Savannah Harbor.

In addition to the harbor deepening projects described above, the Sediment Control Works Project became operational in 1977 just after completion of the 38 foot channel. The project consisted of a Tide Gate Structure across Back River and a Sediment Basin downstream of the Tidegate. The project also included a drainage canal (New Cut) across Argyle Island which was designed to increase velocities in the navigation channel and thus reduce shoaling. This project was designed to concentrate sedimentation outside the navigation channel in a location (Sediment Basin) close to dredged material disposal areas (CDFs 12A and 12B).

During the design phases of the Sediment Control Works Project and the 38-foot channel in the early 1970s, it became apparent that these projects would have significant impacts on salinity levels in the vicinity of the SNWR. The tide gates would close forcing water through New Cut to Front River. This increased salinity levels in Back River. A Freshwater Control Works Project was, therefore, designed to mitigate for anticipated salinity increases in the vicinity of the SNWR. This system is still used to supply freshwater to the SNWR and the adjacent private

landowners. This Freshwater Control System included various channel improvements in McCoys Cut, Middle River and Little Back River, a main water supply structure just off Little Back River, water control structures and supply canals in the Refuge, and a supply canal to the adjacent landowners.

At the request of the USFWS, one component of the system (cutting off a bend in Little Back River), was not constructed. System maintenance problems caused by higher than anticipated salinity levels in Little Back River caused issues for the SNWR. Personnel at the SNWR complained that they were unable to withdraw freshwater (0.5 or less ppt salinity) during periods of low flows and high tides. Periods of low flows in the Savannah River normally occur during the fall months when the SNWR starts filling their impoundments. The US Fish and Wildlife Service subsequently retrofitted water control structures that rusted and failed after completion of the project.

In addition to problems with the Freshwater Control System, the US Fish and Wildlife Service complained about the impacts of high salinity levels in Little Back River on freshwater marsh and striped bass habitat. As a result, the Tidegate Structure was taken out of operation in March 1991 and New Cut was closed in March 1992 to reduce salinity levels in the vicinity of the SNWR. Taking the Tidegate Structure out of operation and closing New Cut also helped to mitigate any further increases in upstream salinity levels from construction of the 42-foot channel, which was completed in 1994.

Present Condition

The SNWR manages about 5,700 acres of diked impoundments for waterfowl. These impoundments include about 3,000 acres of freshwater pools which include both draw-down pools and permanently flooded pools. The draw-down pools are drained annually between March 15 and May 15 and manipulated to promote growth of emergent waterfowl food plants. These pools are then re-flooded in the fall of each year. The permanent pools remain flooded all year to promote growth of submerged aquatic plants and to provide wood duck brood rearing and alligator habitat. These pools are drained, dried, burned and mowed when undesirable vegetation becomes a problem or productivity of desirable plants decreases.

Currently, salinity levels in Little Back River during average and high flow river conditions are acceptable for the Refuge to withdraw adequate freshwater for their waterfowl management operations. During extreme low flow periods, Refuge staff must still time the flooding of their freshwater pools around the lunar cycle because of high salinity levels. Although conditions at the diversion canal intake permitted fresh water to be withdrawn on most occasions, the physical condition of the system became a problem. The system fell into disrepair characterized by water control structures that either failed or were in the process of failing. Two main structures supply freshwater to the Refuge. The south water control structure was completely out of service as all four of the 48-inch openings failed. Three of the eight pipes in the north water control structure also failed. Thirteen of the interior water control structures which are used to supply water to the individual management units also showed signs of rust and deterioration.

The US Fish and Wildlife Service considers availability of freshwater (salinity less than 0.5 ppt) necessary to maintain maximum use of the SNWR's managed wetlands. Freshwater coastal impoundments produce a greater variety of marsh plants, many of which are desirable duck food, than brackish impoundments. The Service also manages several impoundments to provide high quality feeding habitats for many species of wading birds, including the endangered wood stork. Freshwater impoundments are also managed to provide nesting and feeding habitat for shorebirds, and feeding habitat for neo-tropical migrants.

Present Actions/Stresses

Based on information supplied by the US Fish and Wildlife Service, the Freshwater Control System was in dire need of repair. The November 2008 Fish and Wildlife Coordination Act Report characterized the system as "susceptible to imminent failure". According to the report, loss of the ability to control water levels within the impoundments would subject the Refuge to the ebb and flow of the tides which would result in severe damage to Refuge roads, dikes, and internal water control structures. The Service would also lose the ability to supply fresh water to the adjacent Fife and Clydesdale Plantations.

Savannah District completed a Letter Report in October 2009 that recommended the Corps rehabilitate the water control structures in the Freshwater Control System back to their original condition. The Corps' South Atlantic Division office approved that report on October 16, 2009. Repairs to the Freshwater Control System commenced in 2010 and the repairs on Federal lands were completed in 2011.

Capacity to Withstand Stress

The USFWS must have access to freshwater to properly manage their diked impoundments for migratory waterfowl. There are two potential stresses that could impact their ability to draw freshwater from Little Back River. First, the physical integrity of the Freshwater Control System must be maintained. This was accomplished with completion of the repairs to rehabilitate the system by the Corps in December 2011. Second, any action that would increase upstream salinity levels in Savannah Harbor could affect the USFWS' ability to withdraw freshwater from their intake off Little Back River.

Future Actions/Stresses

Future actions/stresses that could affect the SNWR include construction of the SHEP, construction of a proposed Jasper County Marine Terminal, and sea level rise. The SHEP evaluated various alternative harbor deepening plans which would deepen Savannah Harbor from its authorized depth of 42 feet mean low water to 44, 45, 46, 47, or 48 feet MLW. All of the deepening alternatives would increase salinity levels at the diversion canal entrance (Structure No. 1) without mitigation.

If constructed, a proposed Jasper County Marine Terminal (container) would be located in Jasper County, South Carolina on what is now CDFs 14A and 14B. Although no detailed studies have been conducted relative to this proposed facility, impacts on upstream salinity levels at the

Refuge would probably be minor. If the SHEP is constructed and that channel is determined to be sufficient for the needs of a Jasper County container terminal, no further channel improvements (other than an access channel) would be required to operate that terminal. If the SHEP is not constructed, development of a Jasper County container terminal would require deepening and extension of the entrance channel and deepening of the interior channel to its facility. While the SHEP would involve channel deepening upstream to River Mile 18.8, the proposed Jasper Project would only require a deepened channel to about River Mile 6. Deepening of the harbor to River Mile 6 would not result in a major change in the present location of the saltwater/freshwater interface, and thus the project would not cause a major increase in salinity levels at the SNWR.

Sea level rise could cause a major increase in salinity levels in Little Back River at the SNWR. According to NOAA, the historic sea level rise is 3.05 mm/year. At the request of the resource agencies, the SHEP model studies evaluated a 25-cm and 50-cm rise in sea level over the life of the project (50 years). Looking at a worse case scenario (50-cm rise in sea level over a 50-year period with the existing 42-foot project), model results indicate that salinity levels (10% exceedance) at the SNWR during periods of average flows would be about 0.45 ppt which would increase to 1.52 ppt during low flow periods.

Incremental Impact

The incremental effects of past harbor deepening projects and the resultant increases in upstream salinity levels are readily apparent. The SNWR began operations in 1927 when the authorized navigation channel was 26 feet MLW. In 1940 with an authorized navigation project depth of 30 feet, the freshwater interface moved upstream but remained downstream of the SNWR and was still below the US 17 Bridge. Completion of the 34-foot navigation project resulted in the freshwater interface moving past the US 17 Bridge to GPA's Garden City Terminal. Model predictions for the Sediment Control Project (Tide Gate Structure and Sediment Basin) and deepening the harbor to 38 feet MLW indicated that these projects would cause increased salinity levels in the vicinity off the SNWR. The impacts of the construction of the 38-foot channel on upstream salinity levels were exacerbated by construction and operation of the Sediment Control Works which pushed higher salinity water up Back River into Little Back and Middle Rivers into the SNWR. Consequently, a Freshwater Control System was included in the Sediment Control Works project to mitigate for increased salinities. Salinity levels were higher with the Tidegate operating than anticipated. Consequently the structure was taken out of operation in 1991 and New Cut was closed in 1992 to reduce the upstream movement of higher salinity water into Little Back River.

Today, the freshwater interface is located near the upstream limit of the project just downstream of the Georgia Highway 25 Bridge and upstream of the upper limit of the Savannah Harbor Navigation Project (Mile 21.5). Salinity levels at the SNWR intake are generally within acceptable limits (0.5 ppt or less) because the Tidegate is no longer in operation. Deepening the harbor to 44, 45, 46, 47, or 48 feet MLW would increase salinity levels in the vicinity of the SNWR, thus mitigation would be required to insure that the refuge has access to freshwater.

Alternatives to Avoid, Minimize, or Mitigate Cumulative effects

Increases in upstream salinity levels that would result from deepening the harbor to 44, 45, 46, or 47, or 48 feet were predicted using the Environmental Fluid Dynamics Computer Code (EFDC) model. The EFDC model comprises an advanced three-dimensional surface water modeling system for hydrodynamic and reactive transport simulations of rivers, lakes, reservoirs, wetland systems, estuaries and the coastal ocean.

Based on the modeling results, salinity levels at the SNWR intake would remain within acceptable limits (0.5 ppt or less) during average flows for all alternative depths with no mitigation. The model predicts that salinity levels at the intake would range from 0.1-0.3 ppt for the 44, 45, and 46 foot channels and 0.2-0.4 ppt for the 47 and 48 foot channel without mitigation measures during average flow periods.

However, the model indicates that fresh water would not be available at the SNWR intake during periods of low flow for all alternative channel depths without some form of mitigation. Model predictions indicate that salinity levels at the intake during low flow periods would average 0.7-0.9 ppt for the 44, 45 and 46 foot channels and 0.9-1.1 ppt for the 47 and 48 foot channel without mitigation.

To reduce increases in upstream salinity levels caused by the alternative channel deepening plans, model investigations evaluated various flow and channel modifications. These flow and channel modifications would decrease upstream salinity levels by reducing the flow of higher salinity water into Little Back River and Middle Rivers and increasing the flow of fresh water from the Savannah River into these streams.

For the 44-foot channel, a diversion structure would be constructed at McCoys Cut (the western arm would be closed) to divert more freshwater into Little River and Middle River, and Rifle Cut would be closed to prevent higher salinity water from entering Little Back River. The Tidegate would also be removed and a sill and submerged berm constructed across the mouth of the Sediment Basin to reduce water from Front River with higher salinity levels from entering Back River. This plan was designated Plan 6B (Figure 3).

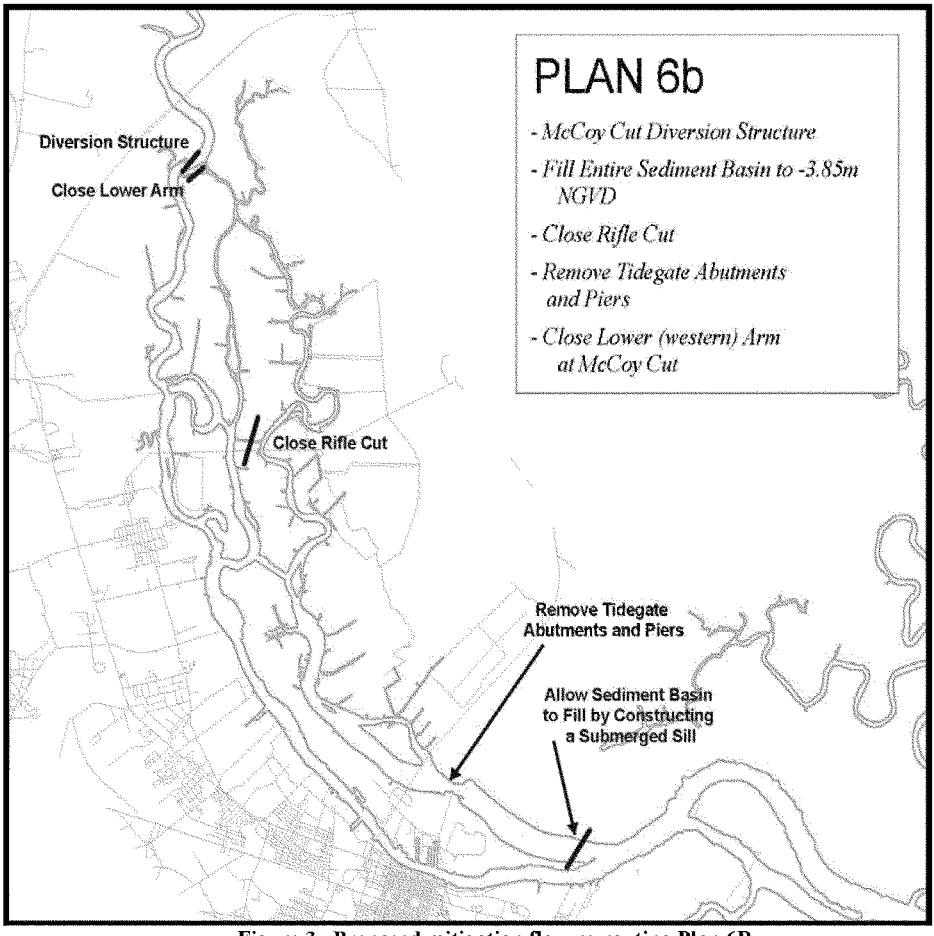

Figure 3. Proposed mitigation flow re-routing Plan 6B.

With mitigation Plan 6B implemented, model predictions indicate that salinity levels at the intake would range from 0.04 ppt during average flow periods to 0.33 ppt during low flow periods which would provide a dependable source of freshwater to the SNWR with the 44-foot project in place.

The proposed mitigation plan (Plan 6A) for the 45, 46, 47, and 48-foot depth alternatives would involve the same features plus the addition of limited channel deepening in McCoys Cut, Little

Back River and Middle River to increase flows of fresh water from the Savannah River into these streams. Figure 4 shows the flow rerouting components of Mitigation Plan 6A.

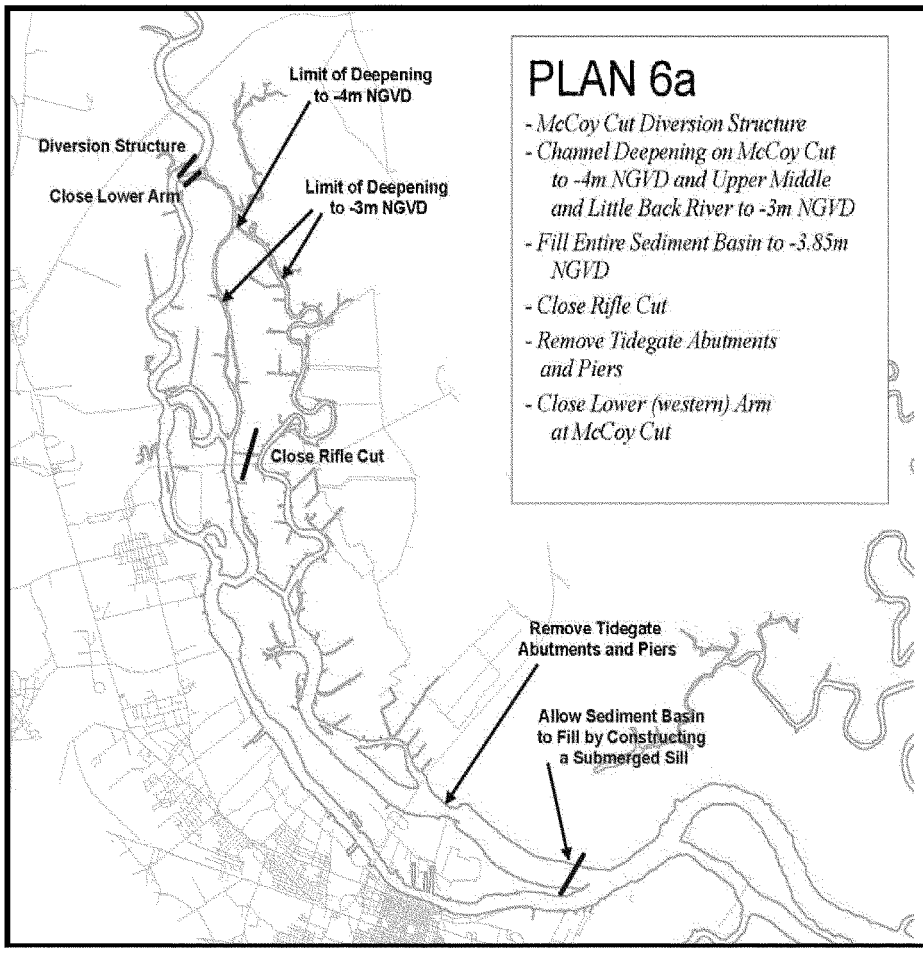

Figure 4. Proposed mitigation flow re-routing Plan 6A.

Model predictions indicate that salinity levels at the intake during periods of average flow would be 0.04 ppt, 0.04 ppt, 0.05ppt and 0.05 ppt for the 45, 46, 47 and 48 foot channels, respectively with mitigation Plan 6A implemented. During periods of low flows, salinity levels at the intake are predicted to be 0.36 ppt, 0.42 ppt, 0.49 ppt and 0.55 ppt for the 45, 46, 47 and 48 foot channel, respectively, with mitigation Plan 6A implemented. Consequently, model predictions indicate that implementation of Mitigation Plan 6A would provide a dependable source of freshwater at the SNWR intake for the 45, 46, and 47 foot projects during low flows.

As discussed above, a predicted rise in sea level may cause a substantial increase in upstream salinity levels in the Savannah estuary. Looking at a high-sea-level-rise scenario (50 cm rise in sea level over a 50-yer period with the existing 42-foot channel), modeling indicates that salinity at the SNWR intake during average flow periods would increase from about 0.02 ppt to 0.11 ppt (50^{th} percentile exceedance).

A rise in sea level with any of the proposed channel deepening alternatives in place would also result in an increase in upstream salinity levels but to a lesser extent because of the mitigation benefits provided by either Plan 6B or 6A. Table 2 shows predicted salinity values at the USFWS intake on Lucknow Canal with both a 25-cm and 50-cm rise in sea level for the existing 42-foot channel and the 44, 45, 46, 47 and 48-foot depth alternatives. The efficiency of Mitigation Plans 6A and 6B in reducing salinity levels at the SNWR intake is apparent from the salinity values shown in Table 2.

Table 2. Predicted Salinity Values in Lucknow Canal

	Existing No Deepening No Mitigation	44 ft Depth & Mitigation Plan 6B	45 ft Depth & Mitigation Plan 6A	46 ft Depth & Mitigation Plan 6A	47 ft Depth & Mitigation Plan 6A	48 ft Depth & Mitigation Plan 6A
Basic Evaluation	0.02/0.14	0.00/0.04	0.00/0.04	0.00/0.04	0.00 / 0.05	0.00/0.05
Sensitivity Analysis #1 (Low Flow)	0.15/0.57	0.05/0.33	0.05/0.036	0.06/0.42	0.08 / 0.49	0.09/0.55
Sensitivity Analysis #2A (25cm Sea Level Rise)	0.05/0.26	0.01/0.08	0.01/0.08	0.01/0.10	0.01 / 0.11	0.01/0.12
Sensitivity Analysis #2B (50cm Sea Level Rise)	0.11/0.45	0.03/0.17	0.03/0.17	0.02/0.19	0.025 / 0.22	0.03/0.24

NOTE: Values reported in 50/10 percent exceedance level (ppt)

B. Tidal Freshwater Marshes

Geographic Scope

The geographic scope of the cumulative impact assessment of tidal freshwater marsh impacts is the Savannah Harbor estuary. More specifically it is the remaining tidal freshwater marsh located in the estuary which occurs from the Interstate Highway 95 crossing of the Savannah River (River Mile 27.5) to near the Georgia Highway 25 bridge (Mile 21.5) Much of the remaining tidal freshwater marsh in the Savannah Harbor estuary is located within the SNWR. Brackish marshes are located downstream of this, to near the International Paper lagoon (River Mile 17). The brackish marshes overlap some of the area covered by the intertidal freshwater marshes, depending on the rainfall that occurred the previous few years. Salt marshes are generally found downstream of River Mile 17.

Historic Basis

The following section includes information from a variety of sources, including Tetra Tech/ US EPA, USFWS, Georgia DNR-EPD, and the Corps. The wetland acreages reported by each organization vary depending on boundary conditions and methods of analysis.

Savannah is a historic city that was settled as a port in 1733. Changes in the landscape that have altered the surrounding wetlands can be traced back to that time. Native American inhabitants did not drastically alter the wetland communities, as did the European settlers.

In the early 1700's, bottomland hardwoods covered most of the freshwater wetlands. Those forests existed downstream to approximately the junction of Back River and the main Savannah River (See Figure 2). That location is based on two factors. The first is the continued discovery of old bald cypress stumps in present saltmarsh, which indicates those areas had previously supported freshwater forest species. Secondly, that location is the downstream extent of successful rice culture, indicating that when those lands were initially cleared the river salinity was consistently below 0.5 ppt (the commonly accepted threshold between fresh and saltwater). Brackish marshes probably extended close to the river mouth, where saltmarsh then occurred. Based on this understanding of the historic wetlands, freshwater wetlands (Cyprus swamps) were the dominant vegetation in the area, while saltmarsh occupied a much narrower range along the coast than is presently observed.

Past Actions / Stresses

The largest single action that adversely affected tidal freshwater wetlands in the estuary was the modification of those wetlands for rice production. In 1752, the prohibition of slavery was lifted in the Savannah colony, resulting in a flourishing production of rice. Slaves cleared expansive wetlands, constructed dikes needed to manage the water in fields, and dug ditches needed to move fresh water to the fields and drain from those fields. These activities became widespread in the estuary, and rice quickly became the most significant crop in Georgia. Following the abolition of slavery in 1863, the profitability of the low country method of rice production declined significantly and rice gradually faded from the local economy.

Exactly how much of the historic freshwater wetlands in Savannah Harbor were bottomland hardwoods versus tidal freshwater marsh is difficult to determine. However, based on historic records, it appears that most of the tidal lowlands in Savannah Harbor were cypress swamps.

After the decline of rice production, some rice fields were reclaimed by nature, some were filled for development, while others remain intact and are managed for wildlife. Hutchinson Island located across from the City of Savannah riverfront was used extensively for rice production. Over time, these fields were filled with dredged sediment to provide areas for both development and upland agricultural pursuits. The managed wetlands in the SNWR were diked and impounded mostly for rice culture in the 18th and 19th centuries, and are now used for fresh water waterfowl management.

Figure 5 shows a model representation of what are believed to be the marshes as they occurred in 1854. This figure (Savannah Harbor Z-Grid Modeling Report, Tetra Tech, Inc. July 2008) was produced during the 2010 development of a revised EPA Draft Total Maximum Daily Load (TMDL) for dissolved oxygen in Savannah Harbor. The BLUE color shows the location of the freshwater marsh, the ORANGE color shows the brackish marsh, and the RED shows the saltmarsh. Based on calculations presented in the modeling report, approximately 8,021 acres of freshwater marsh, 3,467 acres of brackish marsh and 26,092 acres of saltmarsh were present in the Savannah Harbor estuary in 1854.

The US Fish and Wildlife Service presented estimates of the amount of tidal freshwater marsh that existed in the Savannah estuary in the Fish and Wildlife Coordination Act Report. Based on map estimates (Granger 1968), there were about 12,000 acres of tidal freshwater marsh in the Savannah Harbor estuary in 1875. Based on additional map estimates (Lamar 1940), the amount of tidal freshwater marsh present in 1940 had been reduced to about 8,000 acres. Based on estimates presented in the Final Environmental Impact Statement for the Operation and Maintenance of Savannah Harbor (Corps of Engineers, 1975), the amount of tidal freshwater marsh in the estuary in 1974 was about 6,000 acres.

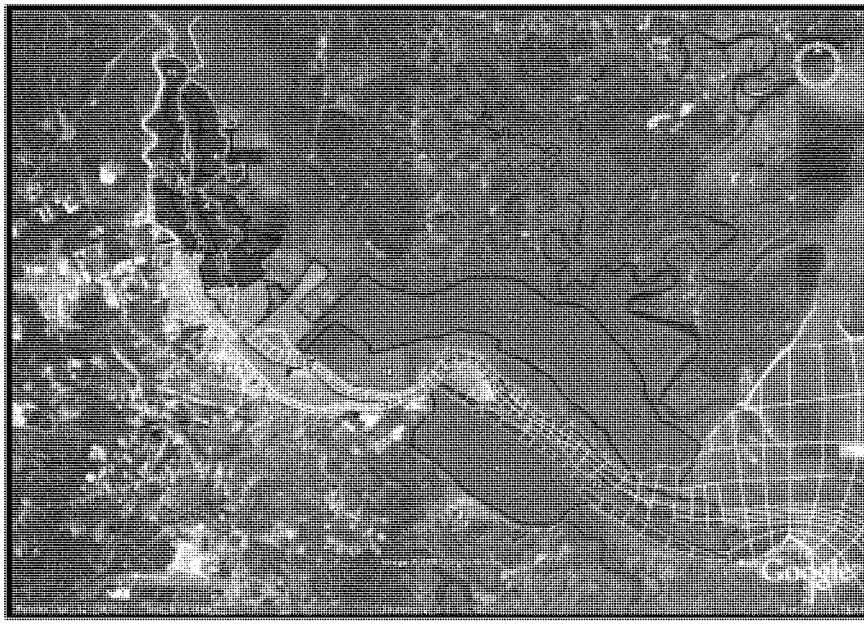

Figure 5. Savannah Harbor marsh distribution in 1854.

Other wetland losses stemmed from increased commercial and industrial development along the Savannah River. Construction of factories, water treatment lagoons, port related facilities, etc. impacted wetland areas along the harbor. The loss of wetlands to commercial and industrial development was greatly reduced by passage of the Clean Water Act in 1972, which gave the US Army Corps of Engineers authority to regulate development in wetlands under Section 404 of the Act.

Fresh water flow downstream to tidal freshwater wetlands was altered by various types of upstream development in the mid-1850s, the Augusta Diversion Dam (City dam) was constructed (RM 208.6). The New Savannah Bluff Lock and Dam was completed in 1939 (RM 188.3). These dams are both relatively small dams that are overtopped each year during high spring flows. The Stevens Creek Dam (RM 209.7), operated by the South Carolina Electric & Gas Corporation, was constructed in 1925. It is somewhat larger and does not get overtopped by flood flows. The larger dams (Hartwell, Richard B. Russell, and J Strom Thurmond) constructed by the Federal government in the upper river for hydropower and flood control purposes were built from 1946 to 1986. Those dams altered the river's hydro-period by reducing flood peaks and raising low flows. These effects were felt all the way down river into the estuary.

Sea level rise has also played a part in the increase in upstream salinity levels and thus the conversion of tidal freshwater marsh into brackish or saltmarsh. A 1995 EPA publication indicates that a historic rate of sea level rise for this area (as measured at the Fort Pulaski gage) is 3 mm/year (0.011 feet/year). The 3 mm/year rate was taken from a NOAA publication titled "Sea Level Variations for the United States, 1855-1986", which quotes the rate at 3.0 mm/year (0.010 feet/year) for the period of 1935 through 1986 at Fort Pulaski and 3.4 mm/year (0.011 feet/year) for the period 1950 through 1986. The standard error in the trend was listed as being 0.3 mm/year (0.00098 feet/year) for the entire series and 0.5 mm/year (0.00164 feet/year) for the period 1950 through 1986. They define the standard error as being the "standard deviation from the line of regression". The 1996 Savannah District Corps of Engineers Annual Survey states that over the 51-year period from 1935 through 1986, mean sea level was observed to rise 0.628 feet at the Fort Pulaski gage (0.012 feet/year). Using that historic rate, sea level may have risen 3.4 feet since the City was settled in 1733.

Loss of wetlands in Savannah Harbor has also occurred from construction and operation of the Savannah Harbor Navigation Project. Direct loss of marsh can be attributed to excavation for channel widening, turning basins and deposition of dredged sediment. Over time, some tidal freshwater marsh has been converted to either brackish or saltmarsh because of increased upstream salinity levels caused by deepening of the harbor.

Maintenance of the navigation channel requires the removal of sediments that continuously settle and accumulate on the river bottom. In the 1900's, those sediments were typically deposited on the marshes that lined the riverbank. This unconfined deposition of sediments resulted in direct wetland losses. Construction of Confined Disposal Facilities (CDFs) starting in the late 1950's began to confine wetland impacts. Sites that would have been affected over time by the deposition of sediments were sealed off from tidal influence to contain the impacts of the sediment placement operation. This action was judged to have a lower total impact than the filling of those wetlands over time, when combined with water quality impacts that would occur from the annual unconfined deposition. Early unconfined deposition of dredged sediment and the later construction of eight CDFs along the harbor and Back River resulted in the loss of about 6,049 acres of wetlands. Most of the marshes affected by CDF construction were brackish or saltmarsh. However, some tidal freshwater marsh was probably impacted by construction of CDFs 2A, 1S and 1N in the upper harbor.

Other construction activities associated with the navigation channel also affected wetlands. Filling the Crosstides area in the upper harbor and other open-water areas between islands resulted in a short-term gain in wetlands. These and other changes were implemented to alter the hydraulics in the harbor by concentrating the river flow in one channel. This would increase the flow in the main shipping channel, thereby reducing the shoaling in that channel and the subsequent maintenance requirements. The changes were effective in producing their goals. However, they also reduced the braided nature of the estuarine river channels, thereby increasing the rate at which sediments were carried out of the river, thereby reducing the delta-building properties (marsh replenishment) of the estuary.

An 1855 hydrographic survey reveals that the lower Savannah River had a controlling depth of about 12 feet before substantial harbor improvements were implemented. Since that time, numerous changes have been implemented to improve the shipping channel. These improvements resulted in the current authorized navigation channel of 42-feet MLW. Deepening, widening, and straightening the original shipping channel made it more efficient for tidal saltwater to move upstream to the upper ends of the estuary. The freshwater interface is now located near the upstream limit (Mile 21.5) of the project.

As discussed in previous paragraphs, construction and operation of the Sediment Control Works Project also impacted tidal freshwater marshes in the SNWR. Although the project included a Freshwater Control System to provide freshwater to the SNWR and to offset anticipated salinity increases in Little Back and Middle Rivers, salinity levels in these streams were higher than expected. Consequently, the Tidegate was taken out of operation in 1991 and New Cut closed in 1992. Since these actions were taken, the US Fish and Wildlife Service has observed some conversion of brackish marsh back to tidal freshwater marsh.

Present Condition

Tidal freshwater wetlands (palustrine emergent wetlands) cover much of the SNWR in the vicinity of the harbor, and in contrast to the managed wetlands are flooded twice daily by tidal action. These marshes were either never diked or the dikes constructed for rice culture have eroded to marsh elevation allowing tidal flooding (USFWS, 2008). As discussed previously, the freshwater interface in Savannah Harbor has moved upstream over time and is currently considered to be located just downstream of the Georgia Highway 25 Bridge (Houlihan Bridge) near the upper end of the Savannah Harbor Navigation Project (Mile 21.5). Since 0.5 ppt salinity is the threshold between freshwater and brackish marsh, GA Highway 25 is the present separation between these two marsh types.

Various studies have been conducted relating to classifying marsh plant communities in the Savannah Harbor estuary and the SNWR. The results of those studies have not always agreed.

Figure 6 shows a model representation (Savannah Harbor Water Quality Model Update, Tetra Tech Inc., April 2010) of existing marshes (Figure 6). The BLUE color reportedly shows the location of the freshwater marsh, the ORANGE color shows the brackish marsh, and the RED shows the saltmarsh. Using this information, the largest percentage change since the 1850s is the loss of freshwater marsh. Saltmarsh has advanced upriver of the Talmadge (US Highway 17) Bridge.

Table 3 shows the changes in marshes that appeared to have occurred in the lower estuary over a 145-year period.

Table 3. Marsh Acreage Savannah Harbor 1999 (GA DNR-EPD)
Marsh Distribution
(GA DNR-EPD, 2008)

Marsh Type	1854	1999
Freshwater	8,021	2,118
Brackish	3,467	5,903
Saltmarsh	26,092	23,510

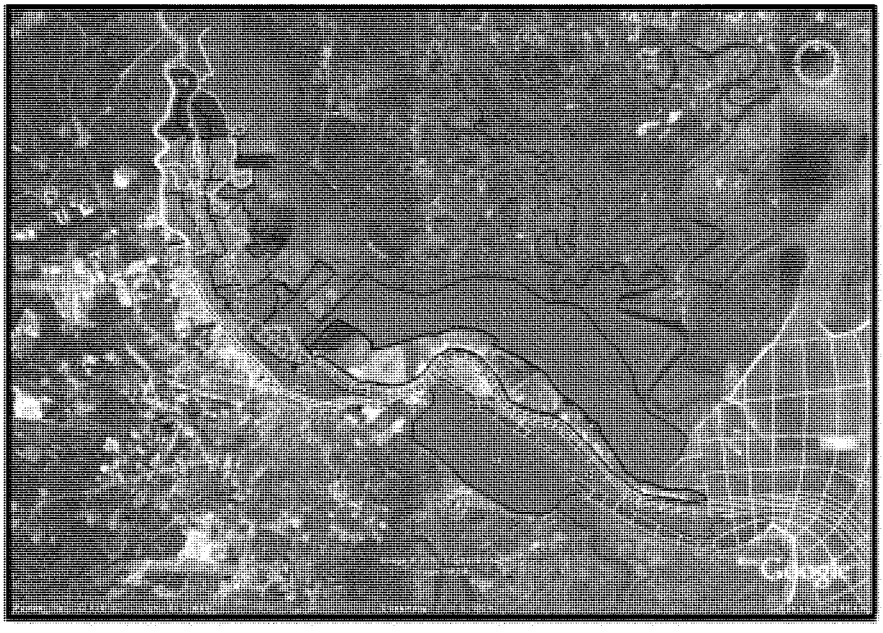

Figure 6. Savannah Harbor existing marsh distribution.

Several studies were conducted during the SHEP to establish baseline conditions in regards to the amount of tidal freshwater marsh remaining in the estuary. Both Applied Technology and Management (March 2003) and USFWS (Welch and Kitchens 2006) conducted studies to classify the various wetland communities in the study area (I-95 Bridge to mouth of Back River). Using a marsh succession model, the USFWS determined that wetlands in this area are

characterized by about 3,269 acres of tidal freshwater marsh, 3,082 acres of brackish marsh, and 2,506 acres of saltmarsh (Welch and Kitchens 2006).

As discussed in previous paragraphs, the EFDC model was used during the SHEP study to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where marsh salinity contour lines are extrapolated from the river into the adjacent marsh areas. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. Using this method and river salinities predicted by the EFDC model, the following distribution of wetlands between I-95 and the mouth of Back River were calculated as shown in Table 4:

Table 4. Marsh Distribution EFDC Model
Marsh Distribution
Average River Flows

Marsh Type	Acreage
Freshwater	4,072
Brackish	2,253
Saltmarsh	2,506

SHEP study participants agreed that this marsh distribution acreage would be used as the baseline for the impact assessment of tidal freshwater marsh losses that could be caused by any of the harbor deepening alternatives under consideration.

Present Actions / Stresses

The remaining tidal freshwater marshes in the upper part of the Savannah River estuary are protected from direct development activity. The vast majority of tidal freshwater marshes are located in the SNWR. Those areas of tidal freshwater marsh outside of the SNWR could be filled after obtaining a Department of the Army Permit; such a permit would require mitigation for these impacts.

The primary stress to existing tidal freshwater marsh is the effects of prolonged droughts. As less freshwater enters the estuary, more saline waters can move further upstream. As a result, tidal freshwater marsh species become less able to compete with the more brackish marsh species of marsh resulting in loss of tidal freshwater marsh. An example of the potential effects of drought on tidal freshwater marsh can be seen in the results of the SHEP marsh impact studies. Modeling efforts indicate that about 4,072 acres of tidal freshwater marsh can be found

in the study area during non-drought periods (average flows). However, the acreage of tidal freshwater marsh would drop to about 2,200 river acres during periods of drought (low flows).

Capacity to Withstand Stress

Tidal freshwater marshes exist in a very specific environment and are greatly controlled by ground elevation, river and tidal flows, and salinity levels. Maintaining salinity levels that are 0.5 ppt or less is critical to their survival. Droughts will continue to periodically occur, adversely impacting the remaining tidal freshwater marsh areas in the Savannah River estuary. However, as normal flow conditions return, tidal freshwater marsh species have the opportunity to out compete brackish marsh species, allowing the freshwater vegetation to recover. Tidal freshwater marshes will also be affected in the future as upstream salinity levels increase due to sea level rise. Because of their very specific habitat requirements (salinity of 0.5 ppt or less), tidal freshwater marsh has very little capacity to withstand the stress of increased salinity levels.

Future Actions / Stresses

Future potential stresses to tidal freshwater marsh include sea level rise, extended droughts and increased withdrawals of surface water from the Savannah River, and harbor development projects, such as the SHEP. EPA expects sea level rise to occur at least at the rate in the US that has been measured in the recent past. A 1995 EPA publication titled "The Probability of Sea Level Rise" states that the historic rate of rise at the Fort Pulaski gage is +3 mm/yr. This additional rise in sea level will result in the further conversion of freshwater wetlands to brackish marsh, and brackish marsh to saltmarsh. The results of the modeling conducted during the SHEP show the potential effects of a 25-cm rise in sea level and a 50-cm rise in sea level. With a 25-cm rise in sea level (surface salinity-50% exceedance values) and the existing 42-foot navigation channel, the estimated 4,072 acres of tidal freshwater marsh would be reduced to about 3,507 acres. With a 50-cm rise in sea level (surface salinity-50% exceedance values) and the 42-foot channel, the acreage of tidal freshwater marsh would be reduced to about 2,809 acres. Thus, a 50-cm increase in sea level would result in the loss of 31% of the remaining tidal freshwater marsh.

The effects of drought conditions on tidal freshwater marsh could increase in the future. Groundwater resources have become overused along the coast, as demands exceed the supply in Chatham County. State water resource managers have capped the total volume of water that can be withdrawn from the main water-bearing aquifer. As the population grows along the coast leading to an increase in water demands, there is increasing pressure to obtain additional M&I water from surface water sources. Savannah River is the prime target for that supply, as it is the only large river with a dependable flow during the summer. When these additional withdrawals waters from the Savannah River occur, less water will reach the estuary to keep out the salinity intrusion during droughts. This will stress the freshwater and brackish marshes the worst, possibly leading to their conversion to brackish marshes and saltmarsh.

The Georgia Power Company has begun to obtain the permits to expand the Plant Vogtle nuclear facility near Augusta, Georgia. The plan is to double the electrical generating capacity of the facility by constructing and operating two additional nuclear power units. Georgia Power's

expansion would withdraw approximately 0.7% of the river during average flow conditions (8,830 cfs). This equates to a withdrawal of roughly 62 cfs. At the maximum plant pumping rate and drought river flows of 2,000 cfs, the intake structure would withdraw 3.4% of the river. The Corps discharges water from its reservoirs at a 3,600 cfs rate during severe droughts, so the 2,000 cfs river flow rate is a conservative one to use in an analysis. During the recent drought-of-record, the Corps released 3,600 cfs from the dams and the flow entering in the estuary reached a low of about 4,340 cfs. At the maximum removal rate of 93 cfs, construction and operation of the additional two units would result in the removal of 2.1% of the lowest recently recorded river flow. Removal of that percentage, which is within the range of error for the model predictions, would likely not result in substantial changes in salinity levels and wetland vegetation in the estuary.

Similarly, the Savannah River has been identified as a potential source of drinking water for the Atlanta region. Removal of water from the Savannah River basin for use in Atlanta and subsequent discharge to other river basins would be considered an inter-basin transfer. Such an action would have to be evaluated and approved by the Georgia DNR Environmental Protection Division. They would consider potential impacts on the ecology of the Savannah River, including wetlands in the estuary. Identifiable impacts in the estuary could occur if large volumes of water were removed from the Savannah River basin. The Georgia Governor's Water Contingency Planning Task Force rejected the concept of removing water from the Savannah River Basin to meet Atlanta's water supply needs in its December 2009 report, so at this point that action is considered speculative.

The remaining tidal freshwater marshes in the Savannah Harbor estuary are for the most part protected from port-related development such as warehouses, distribution centers, roads etc. since most of these wetlands are located in the SNWR. However, there are two known proposed port improvement projects (Jasper County Marine Terminal and the SHEP) which could impact tidal freshwater marshes by causing an upstream movement of saltwater from channel improvements.

As previously discussed, the potential exists that a container terminal in Jasper County could be constructed in what is now CDFs 14A and 14B, which are located just upstream of the Fields Cut intersection with Savannah Harbor (about River Mile 6). Although no detailed plans for this facility have been presented, its developers have stated that construction of this terminal would require a similar channel depth to that proposed for SHEP. If SHEP is constructed and that channel depth is determined to be adequate for a Jasper County terminal, then no additional channel improvements (other than an access channel) would be required. If SHEP is not constructed, a Jasper terminal would deepen the entrance channel and the interior channel up to about River Mile 6. If the navigation channel were deepened for a Jasper terminal, that deepening would likely have no direct impacts on the remaining tidal freshwater marsh in the Savannah Harbor estuary. This statement is based on the determination that construction of channel improvements to River Mile 6 (as compared to River Mile 18.8 for SHEP) would have very little impact on the upstream movement of the saltwater/freshwater interface (currently located at about River Mile 21.5).

Construction of any of the channel alternatives considered for the SHEP would further impact tidal freshwater marshes as described below.

Incremental impact

As previously discussed, many different activities have contributed to the decline of freshwater wetlands in the Savannah Harbor estuary including rice field construction, harbor construction and maintenance, construction of managed wetlands, and industrial and municipal development. The amount of tidal freshwater marsh has been reduced to approximately 4,072 acres (SHEP model estimates). In addition to the effects of sea level rise described above, the proposed SHEP presents the greatest threat to further reductions in tidal freshwater marsh in the Savannah estuary.

Model predictions indicate that deepening the harbor to 44, 45, 46, 47, or 48-feet without mitigation would result in the conversion of 469, 967, 1,057, 1,177, and 1,212 acres of tidal freshwater marsh, respectively (average flow, no sea level rise) to brackish marsh. These numbers would increase with a rise in sea level.

Alternatives to Mitigate for Cumulative Effects

If any of the channel deepening alternatives is implemented, totally avoiding increases in upstream salinity levels, and thus, impacts to tidal freshwater marsh would not be possible. However, the projected increases in upstream salinities can be greatly minimized by reducing the amount of salt water entering Little Back River and Middle River, and simultaneously increasing the amount of freshwater entering these streams.

As discussed previously, model studies were conducted to determine various ways to reduce the upstream movement of salinities that would result from deepening the harbor. Model studies were used to evaluate various hydraulic modifications that could be implemented in Back River, Little Back River, and Middle River to reduce higher salinity levels, and thus, impacts to tidal freshwater marsh. As a result of these model studies, Plan 6B (See Figure 3) was developed for the 44-foot project and Plan 6A (See Figure 4) was developed for the 45, 46, 47, and 48-foot projects to minimize the anticipated increase in upstream salinity levels. Plan 6B involves construction of a submerged berm in Back River and partially filling in the Sediment Basin with dredged material, removal of the Tidegate, closing Rifle Cut which links Little Back River and Middle River, construction of a diversion structure at McCoy Cut, and closure of the lower arm of McCoy Cut. This plan would result in additional freshwater entering the Back River system at McCoys Cut without exiting through the lower arm and flowing downstream through Middle, Back, and Little Back Rivers. It also limits saltwater intrusion to the Back River area through the Sediment Basin and Rifle Cut. Plan 6a involves the same modifications and adds channel deepening at McCoys Cut and in upper Middle River and Little Back River. The channel deepening increases the volume of freshwater flows entering the Back River system at McCoys Cut and flowing downstream through Middle, Back, and Little Back Rivers.

Table 5 shows the estimated marsh acreages for various salinity levels for the Without Project Condition and the five deepening alternatives considered (44-, 45-, 46-, 47-, and 48–foot depths) under alternate scenarios for river flow and sea level rise.

Table 5. Estimated Marsh Acreages

Salinity range for Basic Evaluation	Existing No Deepening No Mitigation	44 ft Depth & Mitigation Plan 6B	45 ft Depth & Mitigation Plan 6A	46 ft Depth & Mitigation Plan 6A	47 ft Depth & Mitigation Plan 6A	48 ft Depth & Mitigation Plan 6A
0.0 – 0.5 ppt	4072	4394	4040	3871	3849	3735
0.6 – 1.0 ppt	864	1137	1781	1650	1641	1340
1.1 – 2.0 ppt	555	749	588	862	889	1191
2.1 – 4.0 ppt	834	855	745	700	687	790
>4.0 ppt	2506	1698	1678	1749	1766	1776
Salinity Range for Sensitivity Analysis #1 (Low Flow)	**Existing No Deepening No Mitigation**	**44 ft Depth & Mitigation Plan 6B**	**45 ft Depth & Mitigation Plan 6A**	**46 ft Depth & Mitigation Plan 6A**	**47 ft Depth & Mitigation Plan 6A**	**48 ft Depth & Mitigation Plan 6A**
0.0 – 0.5 ppt	2208	3128	3111	2886	-	2570
0.6 – 1.0 ppt	767	459	674	825	-	845
1.1 – 2.0 ppt	1322	1342	981	822	-	786
2.1 – 4.0 ppt	1076	1564	1848	2009	-	2236
>4.0 ppt	3458	2339	2218	2291	-	2394
Salinity Range for Sensitivity Analysis #2A (25cm Sea Level Rise)	**Existing No Deepening No Mitigation**	**44 ft Depth & Mitigation Plan 6B**	**45 ft Depth & Mitigation Plan 6A**	**46 ft Depth & Mitigation Plan 6A**	**47 ft Depth & Mitigation Plan 6A**	**48 ft Depth & Mitigation Plan 6A**
0.0 – 0.5 ppt	3507	3659	3740	3594	-	3536
0.6 – 1.0 ppt	1118	1401	1500	1400	-	713
1.1 – 2.0 ppt	5551	972	1098	1283	-	1790
2.1 – 4.0 ppt	969	1000	758	796	-	977
>4.0 ppt	2687	1799	1737	1760	-	1815
Salinity Range for Sensitivity Analysis #2B (50cm Sea Level Rise)	**Existing No Deepening No Mitigation**	**44 ft Depth & Mitigation Plan 6B**	**45 ft Depth & Mitigation Plan 6A**	**46 ft Depth & Mitigation Plan 6A**	**47 ft Depth & Mitigation Plan 6A**	**48 ft Depth & Mitigation Plan 6A**
0.0 – 0.5 ppt	2809	3462	3554	3512	-	3297
0.6 – 1.0 ppt	1255	1099	793	484	-	558
1.1 – 2.0 ppt	927	1305	1641	1909	-	1874
2.1 – 4.0 ppt	977	785	988	1139	-	896
>4.0 ppt	2864	2181	1855	1787	-	2208

Table 5 includes four different scenarios; the basic evaluation (average flow, no sea level rise); Sensitivity Analysis #1 (low flow, no sea level rise); Sensitivity Analysis #2A (average flow, 25 cm rise in sea level); and Sensitivity Analysis #2B (average flow, 50 cm rise in sea level). The Basic analysis is used for purposes of mitigation determination because it best reflects the most likely future condition, particularly in the early years after a deepening project has been implemented. Because the ICT had already agreed the basic evaluation was the most likely future condition, sensitivity analyses were not run for the 47-foot alternative, an alternative that was examined later in the study process.

According to the estimated marsh salinity acreage impact analysis, construction of the 44-foot channel with Mitigation Plan 6B would result in a net increase in the amount of tidal freshwater marsh by about 322 acres. Construction of the 45, 46, 47, and 48-foot channels with Mitigation Plan 6A would result in the conversion of 32, 201, 223, and 337 acres of tidal freshwater marsh, respectively to brackish marsh.

From a sea level rise perspective (both 25 cm and 50 cm), the estimated marsh salinity acreage impacts shown in Table 5 indicate that there would be more tidal freshwater marsh remaining with any of the channel deepening alternatives (with mitigation) than with the existing 42-channel (without project condition). This can be attributed to the mitigation plans which reduce the amount of saltwater intrusion into these streams and increase freshwater inflow.

Freshwater marsh in the SNWR would be negatively impacted for the 45, 46, 47, and 48-foot channels even with implementation of mitigation Plan 6A. Consequently, it became apparent that some other form of mitigation would be required to compensate for the remaining anticipated effects to 32, 201, 223, and 337 acres of tidal freshwater marsh associated with the 45, 46, 47-foot and 48-foot channels, respectively.

The conversion of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 45, 46, 47 or 48 feet. It is important to note that the ecological values of the impacted acres of freshwater wetlands would not be completely lost. Instead, those acres would convert to brackish marsh. The Corps' calculation of the number of acres of freshwater wetland that have the potential to convert to brackish marsh is based on a shift in the location of 0.5 ppt salinity, a traditional rule-of-thumb for differentiating between freshwater marsh and brackish marsh. However, data reported in the literature for Savannah Harbor suggest that a shift in vegetation (from freshwater marsh to brackish marsh) in this estuary does not occur until salinity concentrations approach 2.5 ppt (Latham et al., 1994). Even at oligohaline marsh sites with average salinity concentration of 2.1 ppt, a discriminant function (DF) analysis revealed that only 47% of cases resulted in the correct pairing of environmental variables with vegetative species composition and dominance. At those same oligohaline sites, 37% of the vegetative species composition and dominance were more closely aligned with a freshwater classification (Latham et al., 1994).

Deepening the harbor to 45, 46, 47 or 48 feet would result in a conversion of the dominant vegetative species typically observed in freshwater marsh (freshwater to brackish marsh scenario). It is important to note that many of the emergent plant species associated with freshwater marsh systems would still be readily observed in environments that have been defined

as brackish marsh (Latham et. al., 1994). However, the overall basic wetland functions typically associated with these systems would not change. A comparison of potential changes in elements of wetland function for the conversion of tidal freshwater to brackish marsh is provided in the following table.

Table 6. Changes in Wetland Function as a Result of Wetland Conversion

Elements of Wetland Function	Freshwater to Brackish Marsh	Saltmarsh to Brackish Marsh
Water Purification	Negligible	Negligible
Flood Protection	Negligible	Negligible
Shoreline Stabilization	Negligible	Negligible
Groundwater Recharge	Negligible	Negligible
Streamflow Maintenance	Negligible	Negligible
Retention of Particles	Negligible	Negligible
Surface Water Storage	Negligible	Negligible
Subsurface Storage	Negligible	Negligible
Nutrient Cycling	Negligible	Negligible
Values to Society	Negligible	Negligible
Fish and Wildlife Habitat	Minor Adverse	Negligible

Negligible Effect – the effect on the resource would be at the lowest levels of detection, barely measurable, with no perceptible consequences, either adverse or beneficial, to the resource.

Minor Adverse Effect – the effect on the resource is measurable or perceptible, but it is slight.

Adverse Effect: the action is contrary to the interest or welfare of the resource; a harmful or unfavorable result

As illustrated in the table above, the only adverse effect the project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. The USACE recognizes that a comparison of fish and wildlife habitat between freshwater and brackish marsh systems yields fewer similarities. However, the conversion in fish and wildlife habitat will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation after deepening in wetland areas that would be classified as brackish marsh. For additional information pertaining to the functional assessment, please see Section VII of EIS Appendix C -- Consideration of Final Compensatory Mitigation Rule.

Since there would be a minor adverse effect to the fish and wildlife habitat function in tidal freshwater wetlands if the SHEP is implemented, an assessment was conducted to determine how to best mitigate for that impact. Once the extent of the impacts to wetlands was known, the

Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs. No sites could be identified where tidal freshwater restoration or creation was feasible. Consequently, the acquisition and preservation of lands that would be ecologically significant to the Savannah National Wildlife Refuge was determined to be appropriate mitigation.

The Corps completed its initial assessment of properties in the SNWR's Acquisition Plan to determine potential properties that could meet the wetland mitigation needs of the SHEP. This assessment (Consideration of 2008 USEPA/USACE Mitigation Rule) is in Appendix C. The lands proposed for preservation consist of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain estuarine emergent wetland characteristics. Thus, the acquisition and preservation of wetland and upland buffer would provide a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of freshwater to brackish marsh conversion. Acquisition requirements for the 45, 46, 47 and 48-foot channel depths are 1,643, 2,188, 2,245, and 2,683 acres, respectively.

C. Saltmarsh and Brackish Marsh

The third wetland concern addressed in this cumulative impact analysis is the brackish and saltwater wetlands in the Savannah Harbor estuary.

Geographic Scope

The geographic scope of this analysis is the Savannah River estuary. Considering existing salinity regimes and average river flows, brackish marsh in the Savannah Harbor estuary exists from just above the upstream limit of the Navigation Project (River Mile 21.5 to about River Mile 17) at the International Paper Company waste water treatment lagoon. Saltmarsh constitutes the majority of wetlands from River Mile 17 to the sea.

Historic

From a state wide perspective, coastal wetlands along the coastline comprise about 700,000 acres or 13% of the 5,298,200 acres of wetland areas found in the State of Georgia (Georgia-Wetland Research). As discussed in previous paragraphs, about 26,090 acres of saltmarsh, and 3,467 acres of brackish marsh existed in the Savannah River estuary in 1854.

Past Actions/Stresses

As discussed in previous paragraphs, major actions contributing to marsh decline in the Savannah River estuary center around agriculture (rice production), construction of various harbor improvements (channel deepening, channel widening, turning basin construction, construction of the CDFs, etc.) necessary to maintain the project, and sea level rise.

Construction of CDFs resulted in the loss of over 6,000 acres of wetlands. Industrial and commercial development such as the construction of large wastewater treatment lagoons, roads, warehouses, distribution centers, etc. have also contributed to wetland losses in the harbor.

Present Condition

The amount of saltmarsh in the Savannah estuary appears to have declined from about 26,090 acres in 1854 to about 23,510 acres in 1999. The amount of brackish marsh in the estuary has actually increased from about 3,467 acres in 1854 to about 5,903 acres in 1999. The decline in saltmarsh would probably be greater if not for sea level rise and the increased upstream salinity levels caused by past harbor modifications. The increases in upstream salinities have caused freshwater and brackish marshes to be replaced by more saline marsh types. The increase in the amount of brackish marsh can also be attributed to the increase in salinity levels in the upper portions of the harbor.

Present Actions/Stresses

Development remains the primary threat to brackish and salt wetlands in Savannah Harbor. All marsh in the Savannah estuary is protected from development by the provisions of Section 404 of the Clean Water Act. Anyone who wishes to impact wetlands associated with development must apply for a Section 404 Permit from the US Army Corps of Engineers. As part of the permit process, the applicant must show through a detailed analysis that there is no practicable alternative to impacting wetlands. When wetland impacts cannot be avoided, the applicant must show what actions they will take to minimize those impacts and mitigate remaining wetland losses. In-kind mitigation (at a ratio of approximately 2:1) within the same watershed is required. Purchase of credits from a mitigation bank is the preferred method of compensatory mitigation. However, no commercial mitigation banks are presently operating near Savannah for brackish or saltmarsh wetlands.

As port development has increased, the Savannah District Corps of Engineers Regulatory Office has observed an increase in Section 404 permits for facilities (warehouses, distribution centers, etc.) which support port operations. Those who have obtained permits have been required to avoid wetland impacts where practicable and to provide in-kind mitigation where wetland losses are unavoidable.

Most of the permits that have been issued in the lower Savannah River Basin involve activities in non-tidal wetlands. Information from the Savannah District and Charleston District Regulatory data bases from 1990-2005 indicate that 1,197 acres of impacts have been permitted in non-tidal wetlands in the six counties (Chatham GA, Effingham GA, Screven, GA, Allendale, SC, Hampton, SC, Jasper, SC) that are at least partially in the lower Savannah River Basin. Approximately 6,300 acres of mitigation were required for these impacts.

Department of the Army Permits for activities in tidal (brackish and salt) wetlands are more difficult to obtain and mitigation is difficult because of the scarcity of saltmarsh mitigation banks and opportunities to restore saltwater marsh. According to the Savannah District Regulatory

database, 17.5 acres of tidal marsh fills have been authorized in coastal Georgia over the last 10 years. Mitigation for these impacts has been at a ratio of approximately 2:1.

The US Army Corps of Engineers does not issue itself a Section 404 Permit when a Federal navigation project impacts wetlands. However, the agency is responsible for following the Section 404 permit procedures including avoiding wetland impacts where possible, minimizing impacts to the maximum extent practicable and providing mitigation for any remaining wetland losses.

Capacity to Withstand Stress

The States of Georgia and South Carolina still contain large expanses of saltmarsh and brackish marsh. However, past development actions have greatly impacted these resources. Although there are large amounts of saltmarsh and brackish marsh remaining in coastal Georgia and South Carolina, including the Savannah River estuary, the philosophy of the Corps of Engineers and state wetland protection programs is a "no net loss" wetland policy.

Future Actions/Stresses

Harbor improvements and development remain the most likely actions to adversely affect the salt and brackish marshes remaining in the Savannah River estuary. The only known, major harbor improvements that may occur in Savannah Harbor are construction of a container terminal in Jasper County and the SHEP.

Although no formal detailed plans for a Jasper County terminal are available, some conceptual plans for a facility have been presented over the years by various organizations. The most recent plan, presented by the Joint Project Office, was for a Jasper County container terminal located in what is now CDFs 14A and 14B. Although the Corps does not own those tracts in title, it maintains dredged material disposal easements in CDF 14A (728 acres) and CDF 14B (725 acres). At one time, these areas were saltmarsh. However, the construction of containment dikes and the deposition of dredged material into these areas removed these marshes from tidal influence, and much of the marsh vegetation is now gone.

Construction of a Jasper County terminal would require typical facilities associated with a marine container terminal, i.e., berths, docks, operation and maintenance facilities, container yard, parking, etc. Based on the conceptual plans, the construction of a terminal may be able to avoid significant wetland impacts resulting from construction of these facilities by staying within the footprints of CDFs 14A and 14B.

Construction of the required road and rail infrastructure would have the potential to impact extensive wetlands. Rail infrastructure would be required from the existing rail line to the Jasper site (about 7.5 miles) over marsh areas. Road access to the site from US Highway 17 (probably a four-lane road) would involve the construction of about 5.7 miles of new roadway. Impacts to wetlands resulting from construction of this road may be able to be minimized by building the road along the front and rear dikes of CDFs 12A, 12B, 13A and 13B. Improvements to US Highway 17 may also be required because of the anticipated truck volume expected at the

facility. Such improvements could impact wetlands that are adjacent to and cross the highway. Wetland impacts would require a Section 10 and Section 404 Permit from the US Army Corps of Engineers (Charleston District) and a Critical Zone Permit from the Office of Coastal Resource Management in the South Carolina Department of Health and Environmental Control. Issuance of these permits would include appropriate mitigation measures to offset any wetland losses associated with the project.

Use of CDFs 14A and 14B for a container terminal would require the development of a sediment storage capacity replacement plan to compensate for the loss CDFs 14A and 14B. In accordance with the Project Cooperation Agreement for Savannah Harbor, the Local Sponsor (Georgia Department of Transportation) is required to present an acceptable alternative to the loss of disposal area capacity. The Corps would not release the existing dredged material disposal easements until the Federal Government is "made whole" with respect to dredged material disposal capacity for Savannah Harbor. Although not likely, the replacement of this loss of disposal capacity could further impact wetlands if the new disposal sites are located in such areas. In view of wetland protection laws and mitigation requirements for wetland losses, it is doubtful that environmental approvals could be obtained to construct new disposal sites completely in wetlands.

Construction of the SHEP would result in the loss of 15.68 acres of brackish marsh regardless of which alternative channel depth was constructed. Approximately 3.0 acres of brackish marsh would be excavated due to the enlargement of the Kings Island Turning Basin, and approximately 4.2 acres of brackish marsh would be lost from excavation requirements of the project. Approximately 8.48 acres of brackish marsh would be lost as a result of excavation required to remove the Tidegate structure end walls. Additional impacts to brackish marsh and saltmarsh would occur as a result of SHEP-induced salinity changes. Brackish marsh would increase in acreage, while saltmarsh would decrease through conversion to brackish marsh. These impacts are fully described in Section 5 and Appendix C of the EIS.

Incremental Impact

The SHEP would result in the loss of 15.68 acres of brackish marsh. When compared to the total amount of brackish marsh in the Savannah Harbor estuary, this marsh loss might seem insignificant. However, it is the incremental impact of many small losses over time that can lead to significant adverse impacts to a resource. Consequently, the SHEP will mitigate for these marsh impacts.

Saltmarsh would also be impacted by the flow routing since more freshwater would be introduced into Little Back and Middle Rivers, causing some areas of saltmarsh to shift to more brackish species. Predictions indicate that approximately 828, 757, 740, and 730 acres of saltmarsh would be converted to brackish marsh for the 45, 46, 47, and 48-foot projects, respectively. As previously discussed, the Corps used the EFDC model to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary, as well as predicting how these species would change with the various channel deepening alternatives, was

accomplished using a method where riverine surface salinity levels are extrapolated across the adjacent marshes. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.5-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh.

The results of the functional assessment concluded that the differentiation between salt marsh and brackish marsh recommended by the Wetland Interagency Coordination Team (ICT) and used in the EIS was somewhat constrained. The salinity range used in the SHEP to differentiate between brackish marsh (0.6-4 ppt) and salt marsh (> 4ppt) was restrictive, given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt) which occur within the area of potential effect, also supports those findings. The EFDC value for saltmarsh (> 4.0 ppt) is approximately 2.5 times less than that reported by NOAA (2010). Additionally, the NOAA (2010) range for brackish marsh includes areas determined by the EFDC model to be saltmarsh. When considering values reported in the literature, the acreage of saltmarsh conversion which was calculated using the EFDC model is a very inclusive value and includes existing vegetative areas that would not transition to brackish marsh flowing deepening because these areas currently exist within the salinity range of a brackish marsh (0.5-10 ppt). Thus, the salinity range used to quantify salt marsh in the area of potential effect (i.e., > 4 ppt) over estimated the amount of saltmarsh in the system and under estimated the amount of brackish marsh. As such, the described conversion of salt marsh to brackish marsh, which would occur as a result of harbor deepening, would likely be much less if one takes into account vegetative characteristics for wetland environments with associated salinities that are more commonly associated with a brackish marsh (i.e., range between 0.5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, Savannah District concluded that the conversion of saltmarsh to brackish marsh if the harbor is deepened t is conservative, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah. That said, the District was inclusive in its assessment of the potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts. Also, as shown in Table 6 above, changes in wetland functions when saltmarsh is converted to brackish marsh are negligible.

Mitigation - Brackish Marsh

As discussed above, the Corps of Engineers must go through the same procedures as a Section 404 permit applicant even thought the agency does not issue itself a permit. The SHEP was able to avoid significant impacts to saltmarsh and brackish marsh by not moving the channel side slopes. The improvements to the Kings Island Turning Basin, the excavation requirements of the project, and the removal of the Tidegate end walls are unavoidable requirements of deepening the harbor with any of the depth alternatives. Consequently, the SHEP must provide mitigation

for the loss of 15.68 acres of brackish marsh. The resource agencies have requested in-kind restoration for the loss of these estuarine emergent wetlands.

To mitigate for the anticipated wetland losses, the SHEP would restore marsh in Disposal Area 1-S located on Onslow Island adjacent to Middle River. This disposal area has not been used in at least 20 years. Approximately 40.3 acres of dredged sediment deposits in Disposal Area 1S would be graded down to the original marsh elevation to allow tidal interchange to occur. Over time, this site would be expected to re-vegetate with estuarine emergent wetlands (brackish marsh). Using Corps of Engineers Regulatory Guidance, approximately 28.8 acres of marsh restoration would be required to satisfy SHEP wetland mitigation requirements. Therefore marsh restoration at this site would provide more mitigation than is required for the project.

Monitoring

The SHEP includes a Monitoring Plan and Adaptive Management Plan. The monitoring program would involve pre-construction, construction, and post-construction studies to determine actual project impacts in the field, as well as to develop any changes to the mitigation measures that might be necessary. The Adaptive Management Plan would permit modifications to be made to the various mitigation features of the project if required.

The wetland monitoring would focus on project impacts to tidal wetlands and the success of the marsh restoration efforts in Disposal Area 1S. In regards to the wetland impacts of the project, the SHEP includes the following monitoring activities:

Pre-construction Monitoring

Monitoring of 12 Marsh Sites. This would include sampling over two seasons and involve six of the seven sites that were evaluated during a 2000-2001 study conducted by the USFWS to define the environmental factors that determine plant distribution. In addition, six new marsh study areas would be added. The six new marsh locations were chosen to expand monitoring in highly sensitive marshes, in areas where significant changes are possible under a variety of scenarios, and to monitor community shifts both vertically (up and down river) and laterally (interior versus exterior). In addition to monitoring the distribution and density of wetland vegetation, continuous recording stations would be established at the 12 sites which would record water surface elevation, specific conductance of surface waters that flood the marsh, and specific conductance of waters in the root zone, and water depth every 30 minutes.

Monitoring During Construction

The same monitoring activities at the 12 marsh sites described above would be continued throughout the construction process, which is estimated to take 4 years.

Post-Construction Monitoring

The twelve wetland monitoring sites would continue to be monitored for ten years after project construction including measuring marsh salinities continuously and sampling vegetation twice a year.

At the end of the ten years of Post-Construction Monitoring of the 12 marsh sites, the data could then be compared to the data gathered during the pre-construction and construction period monitoring to determine project impacts to tidal marshes. The hydrodynamic and water quality models would also be used in conjunction with the field data that is collected to evaluate how the project is performing and the adequacy of the mitigation features. Even though the potential impacts of the project were evaluated under a range of conditions, the conditions that are experienced after construction are likely to be somewhat different than those evaluated in the feasibility phase of the project. Consequently, the hydrodynamic and water quality models would be used to permit an evaluation to be made of project performance under the actual conditions that occur after construction is complete. The performance of the hydrodynamic and water quality models would be assessed and the models recalibrated, if necessary. This would occur once during pre-construction monitoring and twice during post-construction monitoring. The objective of this model assessment is to improve the model accuracy to the maximum extent possible. Since post-construction field data would be available, the additional data should increase the accuracy of the models. At the end of this model assessment, the range of the models' uncertainty would be established based on the models' new accuracy limitations.

The Corps and the natural resource agencies would use the models after the post-construction assessment/calibration to evaluate the performance of the project and its mitigation features. Model runs would be conducted using conditions measured in the field and the results compared to monitoring data for the parameter being evaluated. In the case of tidal wetlands, salinity data gathered from the 8 continuous hydrologic and hydraulic recorders would be used with the models to evaluate project impacts. Data would also be available from the 12 continuous recording stations established at the marsh monitoring sites.

Monitoring of the marsh restoration site in Disposal Area 1-S would be conducted for seven years. A reference site would be identified to allow comparison to the restored area in Disposal Site 1S. Juvenile Spartina alterniflora would be planted if the site does not have 90% coverage compared to the reference site. Should the restored marsh not meet this success criterion, the ICT would identify/recommend corrective actions, including planting requirements and associated sprig densities. The need for corrective action(s) would be determined annually with agency involvement/concurrence.

The marsh restoration site in Disposal Area 1S would also be monitored for the presence of invasive species. An invasive species removal plan would be developed and implemented if needed.

9. Fisheries

Issue

The second major issue addressed in this cumulative impact analysis is fisheries. Over time, fishery resources in the basin in the estuary have been significantly degraded by various activities in the estuary as well as upstream activities that have altered flows and blocked fish migration. Harbor improvements and maintenance activities have resulted in significant changes over time. The estuary has become saltier; the flows of the river confined to fewer channels with higher average velocity; and wetlands have been filled, directly eliminating some habitats and reducing access to others. These changes have undoubtedly resulted in significant changes in the habitat value of the estuary to fishery resources.

Early in the study process, fishery experts from the NMFS, USFWS, GA DNR, and SC DNR agreed that the SHEP needed to directly evaluate potential impacts to the following species, as they would represent the most important fishery guilds that occur within the estuary and are relatively sensitive to the types of water quality changes expected to result from harbor deepening:

- Striped bass
- Shortnose sturgeon
- Southern flounder
- American shad

Shortnose sturgeon are discussed in the Endangered Species section of this Cumulative Effects Assessment.

Geographic Scope

The primary concern is for fishery communities that could be affected by changes that may result from deepening the harbor. Direct changes in habitat would occur within the existing navigation channel, while secondary effects would extend beyond those boundaries. The secondary effects would include areas where changes in hydrodynamics or water quality occur as a result of the project, such as any additional intrusion of salinity further into the estuary. The secondary effects would also include biological effects if physical changes within the river reduced the survivability of an estuarine life stage of a species. In that case, the effects of the impact could be felt throughout the entire geographic range of the affected species' population, as population levels could diminish throughout that range.

Since the Savannah River estuary supports fish species that move to upriver portions of the basin, as well as into the ocean and to other drainage basins, the geographic extent of the potential effects of the proposed project on fishery resources is quite large. However, since habitats used by Savannah River fisheries in other basins and in the ocean are not as much at risk as are habitats in the Savannah River, this Cumulative Effects Analysis will discuss only the estuary and the upriver portion of the basin that is available to migrating fish. The upper limit would be the J. Strom Thurmond Dam at River Mile 237.7.

The spawning habitat of Striped bass and American shad has been severely impacted by past activities in the Savannah River Basin. Over-fishing in Atlantic coastal states resulted in diminished populations of Southern flounder in the early 1990s. However, management regulations were implemented and populations of Southern flounder are no longer stressed. Consequently, much of the discussion in this section of the analysis is devoted to Striped bass and American shad.

Historic

Prior to construction of dams and intense exploitation of fisheries during the late 19th and early 20th centuries, the Savannah River and its tributaries supported large populations of diadromous fish species including Atlantic sturgeon *(Acipenser oxyrinchus),* Shortnose sturgeon *(Acipenser brevirostrum),* Striped bass *(Morone saxatilis),* American shad *(Alosa sappisissima),*Blueback herring *(Alosa aestivalis)* and American eel *(Anguilla rostrata).*

Prior to mainstream impoundment, shoals existed in the Savannah River from the city of Augusta upstream to the mouth of the Tugaloo River, a distance of approximately 177 km (Brown, 1988). Shoals typically harbor high species richness of fishes and mussels, owing in part to the complexity of habitats within them (USFWS, 2003). Striped bass and alosines ascended beyond the fall line to the Piedmont region of Georgia, South Carolina, and North Carolina. Some anadromous species annually migrated to the headwaters through the 49-mile long Tugaloo River to Tallulah Falls, Georgia, located on the Tallulah River about 10 miles upstream of the convergence of the Tallulah and Chattooga Rivers (Stevenson 1899, as cited by Mansueti and Kolb, 1953).

Although the size of diadromous fish populations in the Savannah River prior to exploitation and dam construction cannot be reliably determined, it is likely that annual migratory spawning populations of shad and herring numbered in the tens of millions (personal communication, NMFS).

Past Actions/Stresses

Historical accounts of the Savannah River fishery indicate that large declines in populations of shad and herring began in the late 1700s. Much of this population decline can be traced to overexploitation of the resource and the blockage of tributary rivers by gristmill dams. Large scale-land clearing for agricultural with the subsequent increased sediment load to the river also was a significant factor in the decline of fish populations.

Three major Federal projects (Hartwell, Richard B. Russell, and J. Strom Thurmond) were constructed in the upper Savannah River Basin for flood control and hydropower. These projects were started in the late 1950s and completed in the early 1980s. Below these projects at the City Of Augusta are three additional dams. The Augusta Diversion Dam was completed in the mid-1850s, Stevens Creek Dam was completed in 1925, and New Savannah Bluff Lock and Dam in 1939. Figure 7 from the Draft Fish and Wildlife Coordination Act Report for the Savannah River Basin Comprehensive Study shows the location of the J Strom Thurmond Project and the three dams located below it.

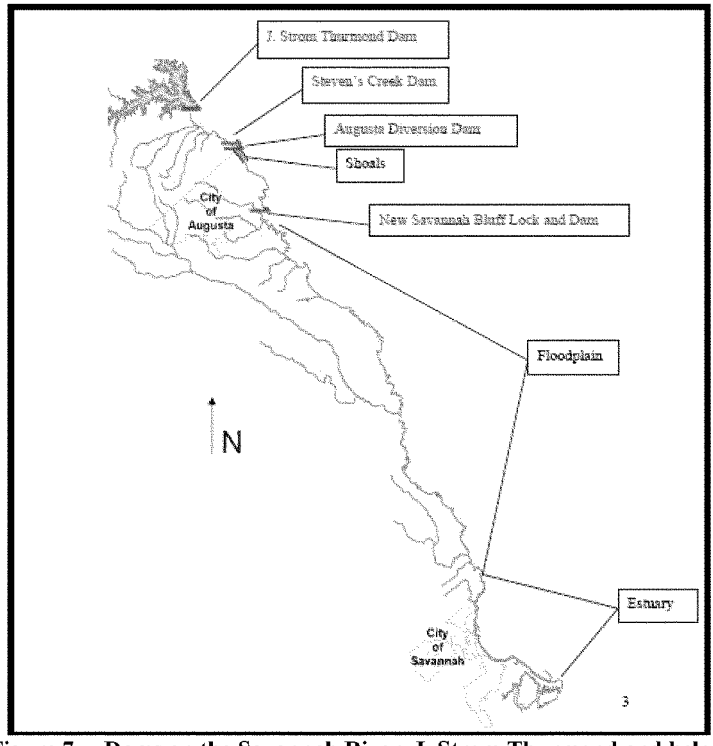

Figure 7. Dams on the Savannah River, J. Strom Thurmond and below

Dam and reservoir construction converted or blocked access to approximately half of the 384 miles of historical anadromous fish spawning and nursery habitat of the Savannah River. Practically 90 percent of the high quality anadromous fish spawning habitat (rapids complex: boulder, bedrock, cobble and gravel substrate) has been blocked or inundated by large reservoirs above the Augusta Diversion Dam. This may be even more significant since the majority of habitat that is no longer accessible was probably the most highly used, especially for the American shad. The NMFS estimates that 90 to 95 percent of the quality spawning habitat for rapids-dependent anadromous species has been lost. As shown in Figure 7, the only shoals remaining on the Savannah River is a small stretch (7.2 km) located below the Augusta Diversion Canal.

The New Savannah Bluff Lock and Dam was part of the Savannah River Below Augusta Navigation Project. In addition to the lock and dam, the project provided for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (Mile 21.3) to the head of navigation just below the 13th Street Bridge in Augusta, Georgia (Mile 202.2), a distance of 180.9 miles. Channel modifications including deepening, widening, snagging, construction of bend cutoffs (channel straightening) and construction of pile dikes to maintain the 9-foot depth.

This project has not been maintained since 1979. However, the bend cutoffs effectively removed large channel segments from the river at low flow periods (USFWS, 1996). The cutoff bends have accumulated sediment and organic matter since they were constructed in the late 1950s and early 1960s. Most of the cutoff bends have been substantially reduced in volume and surface area and some have completely filled with sediment reducing fish habitat during normal summer flow conditions. The USFWS considers these river bends to be biologically significant.

In addition to loss of riverine habitat, much of the fishery habitat in the Savannah River estuary has also been lost or adversely affected. Agricultural and industrial development has resulted in the loss of much of the historical fishery habitat. As previously discussed, many of the bottomland hardwood forests were converted to rice fields. Industrial development along the harbor has resulted in the filling of tidal wetlands.

Prior to passage of the Clean Water Act Amendments in 1972, Savannah Harbor was characterized by numerous unregulated discharges of various types of industrial wastewater as well as untreated municipal sanitary waste. The harbor was subject to low dissolved oxygen levels which severely restricted suitable habitat for many fish species.

Construction and operation of the Savannah Harbor Navigation Project has also had significant effects on fishery habitat. River flow through the estuary was originally distributed through several braided channels. That pattern has been significantly altered, with the majority of the flows now being confined to Front River. Those alterations included closing many of the connections between the braided channels. The concentration of flow has increased velocities in Front River. These actions have occurred in conjunction with deepening of the navigation channel from a roughly natural 12-foot deep river to the present authorized 42-foot channel. Deepening the harbor has allowed salt waters to move further up the estuary, altering the composition of wetlands along the river. Deepening the channel has also exacerbated naturally low dissolved oxygen levels in the summer months. Periodic removal of sediments from the channel reduces the benthic community within the shipping channel. Disposal of the dredged sediment has resulted in the loss of fishery habitat where approximately 6,000 acres of wetlands have been converted into diked disposal areas adjacent to the harbor.

Construction of the Sediment Control Works Project (Tidegate and Sediment Basin) impacted fishery habitat in the estuary, especially for the Striped bass. Studies in the early 1960s and 1970s indicated that the primary spawning area for Striped bass in the Savannah River system was the tidal freshwater zone located in Little Back River adjacent to the SNWR. Studies by Van Den Avyle et al. indicate that production of Striped bass eggs in the Savannah River estuary declined by about 95 percent between 1977 (when the Tidegate was put into operation) and 1989. Operation of the Tidegate Structure increased salinity levels in Striped bass spawning grounds and altered current velocities and pathways of water movement in the middle and lower estuary. Essentially, most Striped bass eggs spawned in the Savannah River estuary were transported downstream beyond Hutchinson Island into areas with toxic salinity levels (10 ppt or greater) within 30 to 48 hours of being spawned. Striped bass eggs hatch within 40 to 60 hours post spawning and thus the larvae were exposed to toxic salinity levels before they became strong enough to swim out of the area.

Present Condition

The Savannah River Estuary is one of the largest marsh ecosystems on the Atlantic Coast. The estuary encompasses about 290,000 acres and includes the 29,000-acre Savannah National Wildlife Refuge in the upper estuary near the freshwater/saltwater tidal interface. The Savannah River Estuary is a dynamic system characterized by high tidal fluctuation 6-7 feet, which causes spatial shifts in various salinity-defined habitats. Changes in habitat in many areas occur every six hours (high vs. low tide), and seasonal changes in river discharge also influence these habitats.

Significant progress has occurred throughout the basin to reduce or eliminate over-fishing, pollution and poor water quality.

The Clean Water Act was originally enacted in 1948 as the Water Pollution Control Act. The Act has been amended several times, with major revisions being made in 1972 and 1977. The 1972 amendment established a national goal of eliminating all pollutant discharges by 1985, with an interim goal of making the waters safe for fish, shellfish, wildlife and people by 1983. The Act established a number of regulatory programs and provides standards of enforcement. Water quality in Savannah Harbor has significantly improved from the 1970s.

Much of the tidal brackish and freshwater marsh is protected within the SNWR. Other wetlands in the estuary are protected from development by Section 404 of the Clean Water Act. Any party wishing to discharge dredged or fill material into wetlands must obtain a Section 404 permit from the US Army Corps of Engineers.

The Endangered Species Act was originally enacted in 1973 to conserve, protect, and propagate species that are at risk of becoming extinct. The law reflected a national desire to protect threatened species and increased the protection for specific identified species. It also established a policy that all Federal departments and agencies seek to conserve threatened and endangered species and use their authorities to further the goals of the Act. Federal action agencies must coordinate their activities with the US Fish and Wildlife Service and the National Marine Fisheries Service. This coordination and the law requiring it have resulted in the protection of fish species and populations whose future existence are threatened. The Shortnose sturgeon is the only endangered fish in the Savannah Harbor estuary.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) was originally enacted in 1990. The act is intended to conserve and manage the fishery resources found off the coasts of the US, the anadromous species, and the Continental Shelf fishery resources of the US. The Act ensures consideration of the effects of proposed Federal actions on estuarine and coastal fish habitats. The Act requires Federal action agencies to consult with NOAA Fisheries if a proposed action may adversely affect Essential Fish Habitat (EFH). The MSA provides for regional Fishery Management Councils and requires these Councils to develop Fishery Management Plans for marine and anadromous fish species that are fished in waters from 3 to 200 miles offshore. The Councils designate EFH in the management plans, minimize adverse effects on EFH from fishing, and identify other actions to encourage the conservation and enhancement of EFH. The South Atlantic Fishery Management Council (SAFMC) has developed the EFH requirements for some of the fishery management plans prepared by the

Atlantic States Marine Fisheries Commission. EFH has been designated for red drum, summer flounder, white shrimp and brown shrimp, all of which reside in the Savannah River estuary.

Although the Atlantic States Marine Fisheries Commission has prepared fishery management plans for American shad, Blueback herring, and Atlantic sturgeon, the SAFMC has not yet prepared their regional fishery management plans, so EFH has not been designated for those diadromous species. However, diadromous species such as American shad and other alosids are recognized as vital components of the prey base for essentially all managed predacious fish species and are significant components of fishery landings (South Atlantic Fishery Management Council, 1998 – Final Habitat Plan for South Atlantic Region).

The positive impacts of passage and implementation of these various water quality laws are evidenced by the fisheries present in the Savannah River estuary.

Several studies have been conducted to characterize fisheries in the Savannah Harbor estuary. As part of SHEP, the University of Georgia conducted a study for the Georgia Ports Authority in 2000-2002 titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary". The study found that the estuary supports a diverse and abundant fish community that is dependent on the availability of specific salinity-defined habitat zones. The study identified fish from 91 species and 42 families within the salinity-defined habitats. Most of the fish abundance was comprised of relatively few species, but these species were important to commercial and recreational fisheries. Twenty-three species caught in samples (including the six most abundant) were protected species with Fishery Management Plans and comprised over 90 % of the total catch.

Most members of the fish community seemed to be estuarine generalists capable of tolerating a wide range of salinities (1.0-15.0 ‰). A smaller subset of the assemblage can be characterized as marine species whose distribution was limited to areas with higher salinities (> 10 ‰); these species occasionally invade the estuaries as the salt wedge moves inland during periods of low river discharge. The smallest component of the fish community in the estuary was the obligate freshwater species and those that could not tolerate salinities above 5.0 ‰.

Seasonal changes in abundance and diversity were evident and exceeded differences observed within a given season. The most important low-salinity period seemed to be late winter/early spring, and river discharge seemed to dominate the habitats during that time. Fish density and species richness were low in the fall; while almost all species declined in abundance and many species disappeared from sample reaches during that season. In the winter and early spring, drum and flatfish density and richness increased in low salinity habitats and were followed by clupeids and gobies in spring and early-summer. In the summer, the number of invading marine opportunist species increased, but the abundances of most of these species were low. Bay anchovy dominated fish abundance in the summer in the estuary, but the presence of all species made summer (especially in mesohaline habitat) the most abundant and speciose season both of the study years. Spatial trends in fish abundance were less evident than temporal trends. Definite peaks in abundance occurred for numerous species in low-salinity habitat, and for two species in high-salinity habitat. Atlantic croaker, Atlantic menhaden, and Southern flounder larvae seemed to use oligohaline and tidal freshwater habitats in the winter and spring. High

river discharge probably is important to provide spatially-broad, low-salinity, tidal habitat. Increases in salinity might affect larval survival, but to what extent is unknown.

The South Carolina Department of Natural Resources conducted a parallel study in 2000-2002 also titled "Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary". A total of 85 species were identified. The most abundant species in the gillnet samples included longnose gar, Atlantic menhaden, and channel catfish. In trawl collections, the dominant species included star drum, white shrimp, Atlantic croaker, spot, bay anchovy, and Atlantic menhaden. Commercially- and recreationally-important species encountered were white shrimp, brown shrimp, blue crab, summer and southern flounders, red drum, spotted sea trout, striped bass, channel and white catfish, and weakfish. Protected species encountered included the Atlantic sturgeon and the Shortnose sturgeon. SC DNR stated that the estuary apparently plays an important role in the development and sustainability of many of these species. Dissolved oxygen levels were observed below 4 mg/L, a level that is considered critically low for many species.

SC DNR stated that despite extensive anthropogenic modifications and ongoing water quality (i.e., low dissolved oxygen) concerns, the lower Savannah River continues to function as a valuable, productive estuary. Rather than multiple discrete ecological communities in different portions of the estuary, the species composition appears to consist of a gradient structured by, among other parameters, salinity. The use of the estuary as a nursery habitat for many ecologically, recreationally, and commercially important species is apparent, including imperiled species such as the Atlantic sturgeon and the endangered Shortnose sturgeon. The scarcity of certain valuable species, such as Spotted sea trout, Red drum, and Striped bass, relative to other estuaries in the region suggests that the nursery (and perhaps other) functions of the estuary may have already been compromised to some degree. For example, much of what was once intertidal polyhaline/mesohaline marsh with dendritic creeks has now been either filled or used for deposition of dredged sediments. Further compression of this nursery habitat by saltwater intrusion, whether caused by continued low flows, sea level rise, or harbor deepening could exacerbate this problem.

It also appears that successful Striped bass natural reproduction has improved in the lower Savannah River. The Georgia DNR-WRD conducted a stocking program in the lower Savannah River from 1989-2002. Studies by Weyers (2003) reported that Striped bass larvae were collected in 2001-2002 ichthyoplankton samples from freshwater and low salinity habitats, thus indicating successful reproduction in the estuary. Collins et al. (2002) reported collecting a high proportion of juvenile Striped bass smaller than those stocked by the Georgia DNR, indicating natural reproduction. The Georgia DNR-WRD conducts regular Striped bass sampling using electrofishing. They have collected Striped bass spawned in 2003 and 2004 and the number of Striped bass age two years or more caught per hour has increased from two or less in the mid-1990s to more than 12 in mid-2000s. Limited recreational fishing is now allowed for this species. Maintenance of acceptable salinity limits in their spawning grounds has been demonstrated as critical to their ability to successfully spawn.

Although many of the past stresses on Striped bass and American shad have been removed, populations of these species still suffer from loss of spawning habitat. Most major rivers along

the Atlantic coast have historically supported distinct spawning stocks of American Shad (NMFS, 2006). Stock abundances of American Shad are significantly below the historic levels of the early 20th century. Atlantic coast commercial landings have declined from over 22,000 metric tons in 1896 to between 100 and 1,000 metric tons annually since 1996 (NOAA, 2006). This reduction in landings is attributed to habitat loss and over-fishing. American shad are managed by the Atlantic States Marine Fisheries Commission under a Fisheries Management Plan for American shad and river herring. This plan was implemented in 1985 to facilitate cooperative management and stock restoration between the states. Restoration efforts involved habitat improvement, fish passage, stocking, and transfer programs. To prevent over-fishing, the traditional method of harvesting American shad by gillnets in a coastal intercept fishery was phased out between 2000 and 2004.

Coastal migratory stocks of Striped bass (Atlantic striped bass) are managed under a fishery management plan developed by the Atlantic States Marine Fisheries Commission under the authority of the Striped Bass Conservation Act. This legislation was passed in 1981 in response to declines in commercial Striped bass harvest and the perceived decline in production of juvenile Striped bass. The Savannah River population of Striped bass is considered riverine (spend their lives in the Savannah River) in contrast to the Atlantic striped bass which is anadramous (lives in the ocean, spawns in freshwater).

Southern flounder have not suffered the same habitat losses as the American Shad and the striped bass populations in the Savannah River. However, populations of this species have suffered from over-fishing in the past. Over-fishing resulted in the Atlantic States Marine Fisheries Commission reducing the creel limit for this species in the Atlantic coastal states as appropriate. Populations of this species have since recovered.

Present Actions/Stresses

The last major obstacle in restoring diadromous fish runs in the Savannah River is reducing the impacts of the upstream dams. These structures physically and biologically fragment river systems and alter river flows, bedload movements, water chemistry and aquatic habitat. They restrict or prevent the upstream and downstream passage of migratory fish, effectively isolating these populations from critical spawning and nursery habitats. The only remaining shoal habitat in the Savannah River is a 7.2 km reach extending downstream of the Augusta City Dam.

In 1994, the USFWS, NOAA Fisheries, SC DNR, and the GA DNR completed development of a plan to restore access to a portion of historical anadromous fish spawning habitat in the Savannah River. The plan was filed by the Service on behalf of the resource agencies in 1994, and was adopted by the Federal Energy Regulatory Commission (FERC) as a Comprehensive Plan pursuant to Section 10(a)(2) of the Federal Power Act. The plan is a guide for resource agency efforts and would restore access to approximately 35 miles of spawning and maturation habitat. The plan includes the following elements: (1) reliable passage of anadromous fish at the New Savannah Bluff Lock and Dam; (2) the design and implementation of an upstream fish passage mechanism and safe downstream (out-migrant) passage at the Augusta Diversion Dam; (3) the design and implementation of an upstream fish passage mechanism and safe downstream

(out-migrant) passage at the Stevens Creek Dam; and (4) improvement of poor dissolved oxygen releases from the J. Strom Thurmond Dam during the summer months.

Three of the four elements of the plan to restore access to the 35 miles of the Savannah River between New Savannah Bluff Lock and Dam and J Strom Thurmond Dam are in place. In 2004, the NMFS and USFWS sent the Federal Energy Regulatory Commission (FERC) a joint prescription for fish passage at the Augusta Diversion Dam as well as minimum flow requirements necessary over the Augusta Shoals in regards to the proposed re-licensing of the Diversion Dam. When FERC issued the license for the Stevens Creek Hydropower Project in 1995, it reserved authority for the USFWS to prescribe a fishway at that project once upstream passage was achieved at the Augusta Diversion Dam. The Corps of Engineers began replacement of turbines at the Thurmond Dam in 2002 with new auto-venting turbines. Installation of the new units was completed in 2006. Since the new turbines have been used, dissolved oxygen levels in the summer discharges have increased, greatly improving fishery habitats in the 17-mile reach between Thurmond Dam and the Augusta Diversion Dam.

While plans are in place to provide fish passage at the Augusta Diversion Dam and the Stevens Creek Hydroelectric Project and dissolved oxygen concentrations have been improved below J. Strom Thurmond Dam, there is no need to require implementation of fish passage facilities at these two upstream dams until fish passage is achieved at the New Savannah Bluff Lock and Dam. Two fish passage measures have been attempted at New Savannah Bluff Lock and Dam with very limited success.

A pulse of water was released from J. Strom Thurmond Dam during the spawning season to overtop the spill gates at New Savannah Bluff Lock and Dam to allow opportunity for fish to pass over the dam. This method of fish passage proved ineffective. More than likely, the cold water released from Thurmond Dam may have cooled the water to the point where the fish were no longer inclined to spawn. Also, it is doubtful, that a benthic dwelling fish such as the Shortnose sturgeon would have been able to negotiate the 8-foot support walls at the bottom of the dam.

The New Savannah Bluff Lock and Dam is currently operated by the City of Augusta. A provision of their lease with the US Government requires that they lock fish through the dam twice a week during the spring spawning season. Some limited transmitter studies have been conducted to determine if fish are successfully locked through. Apparently, there is little movement of fish through the lock.

Capacity to Withstand Stress

It is obvious from studies that have been conducted that populations of American shad are already severely stressed. Steps have been taken to reduce fishing pressure on this species. However, loss of traditional spawning habitat will continue to limit population recovery for this species.

Populations of Striped bass in the Savannah River are predominantly riverine, meaning they remain in the Savannah River year round, unlike anadromous populations species of Striped bass

which live in the ocean and return to freshwater only to spawn. Survival of the Savannah River population is dependent on access to suitable spawning grounds in the upper estuary. This species has shown signs of recovery since the Tidegate structure was taken out of operation in 1991 and New Cut closed in 1992. These two actions helped to restore acceptable salinity levels in Striped bass spawning grounds in the estuary. This species has recovered to the point that limited recreational fishing is now permitted. Continued propagation of this population is dependent on maintaining acceptable salinity levels in spawning areas.

Populations of Southern flounder have experienced stress due to over-fishing. Steps have been taken to reduce fishing pressure to allow this species to recover to more acceptable levels.

Future Actions/stresses

The impacts of dams on spawning habitat for diadromous species such as American shad will continue to contribute to low population numbers. Harbor improvement projects also have the potential to impact American shad, Striped bass, and Southern flounder populations. The only two potential harbor improvement projects known at this time are the SHEP and the Jasper County Marine Terminal.

The SHEP will impact habitat for the American shad, Striped bass and Southern flounder. Most of these impacts are centered on predicted impacts to the existing salinity and dissolved oxygen regimes caused by deepening the harbor. Implementation of any of the channel deepening alternatives would also result in the loss of 15.68 acres of fishery habitat (15.68 acres of brackish marsh).

As previously discussed, a marine terminal has been proposed for Jasper County, South Carolina. If that project is constructed, it would require deepening and extending the Savannah Harbor entrance channel and deepening the inner harbor navigation channel to the terminal site which is located at about River Mile 6. If the SHEP is constructed, no further dredging of the navigation channel would be required to support such a facility. If the SHEP is not constructed, deepening the navigation channel to River Mile 6 for a Jasper terminal would be expected to have only minimal impacts on the salinity and dissolved regimes in Savannah Harbor. Consequently, construction of a Jasper County container terminal would not be expected to adversely affect upstream habitat of species such as the Striped bass. Construction of a Jasper facility could adversely affect fish habitat due to marsh impacts resulting from road and rail infrastructure requirements. The exact extent of any marsh impacts as a result of the construction of this facility cannot be accurately predicted at this time because the project is in the conceptual stage.

The Corps manages three reservoirs upstream on the Savannah River. Periodically, the Corps makes revisions to the drought contingency plan for those reservoirs. The impacts from those revisions are evaluated and approved before changes are implemented. The revisions would only be implemented if they were found to be acceptable to fishery resources located downstream of the reservoirs.

Incremental Impact

Based on information presented in this analysis, it is obvious that incremental loss of upstream habitat and spawning areas has significantly impacted populations of American shad. Remaining populations of American shad undergo seasonal migrations moving from the ocean into southern rivers beginning in January. Past harbor improvements and sea level rise have raised salinity levels in the upper part of the Savannah estuary and limited Striped bass spawning habitat. Populations of Southern flounder on the Atlantic coast have recovered from past over-fishing. This species does not appear to have suffered from loss of traditional habitat.
NOAA fisheries resource management goals and objectives for the SHEP can be summarized as follows:

- **Conserve Species**. Avoid further declines and/or extinction and foster long-term survival and recovery of Savannah River Basin American shad, river herring, Striped bass, American eel, Atlantic sturgeon, and Shortnose sturgeon.

- **Riverine, Estuarine, and Marine Ecosystems.** Conserve the estuarine ecosystem and the vital link between the river and the marine environment, and the contribution to marine health provided by diadromous species.

- **Balance the Life Cycle Needs of Other Species.** Ensure that diadromous fish conservation measures are balanced with the management and conservation needs of other native fish and wildlife species.

- **Support Sustainable Recreational and Commercial Fisheries.** Provide for adequate fish passage; preservation of Essential Fish Habitats for Red drum, Summer flounder, White shrimp, and Brown shrimp; and support American shad and other alosids as vital components of the prey base of essentially all Federally-managed predacious fish species, and to a healthy estuarine and marine ecosystem.

To identify potential impacts to the Striped bass from harbor deepening, an interagency team developed criteria to describe acceptable habitat for Striped bass in the Savannah River. Criteria were developed for spawning, egg and larval habitat. Hydrodynamic and dissolved oxygen models were used to identify changes in salinity, dissolved oxygen, and velocity. The team identified the conditions under which the hydrodynamic and dissolved oxygen models would be run to identify potential impacts to those habitats. Average river flows were determined to be the most representative of conditions that would be experienced over the long-term. For the Striped bass, additional runs were made with high (80% exceedance) and low (20% exceedance) river flows to ensure unusual impacts would not develop during those less-typical years. Fish habitat modeling was used to identify areas in the harbor where suitable habitat exists as well as how that habitat would change under the various harbor deepening alternatives. A similar approach was used for American shad, Southern flounder, and Shortnose sturgeon.

Table 7 is a summary of project-related fishery impacts without mitigation. All of the deepening plans have a negative impact on striped bass spawning, eggs, and larvae habitat, with construction of the 48-foot channel resulting in the greatest impacts. Most of the negative impacts are centered on increases in salinity levels in the spawning grounds and downstream areas.

Table 7. Predicted Fishery Impacts Without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Dissolved Oxygen	Reductions at mid-depth and bottom	Same effect, but greater amount	Same effect, but greater amount	Same effect, But greater amount	Same effect, but greater amount
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (-45.0 acres)	- 6.4 % (-89.0 acres)	- 9.5 % (-132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %

As shown in Table 7, the various deepening alternatives do not impact American shad habitat. Southern flounder habitat would be negatively impacted by all the harbor deepening alternatives except for the 48-foot channel. In addition to project-related fishery impacts, approximately 15.68 acres of brackish marsh would be lost as a result of the construction of bend wideners, removal of the Tidegate and expansion of the Kings Island Turning Basin. These wetlands are considered important habitat for the Striped bass, American shad and Southern flounder. The reader needs to remember that the table above shows the impacts PRIOR to inclusion of the project's mitigation features. The effects WITH the mitigation features are described in the following pages.

Alternatives to Mitigate for Cumulative Effects

Based on the project-related fishery impacts model studies, it is apparent that mitigation measures are warranted to reduce impacts to salinity and dissolved oxygen levels that would

occur as a result of implementing any of the various harbor deepening alternatives. Also, mitigation is warranted to offset the unavoidable loss of 15.68 acres of emergent wetlands.

From a broad perspective, general mitigation objectives for fishery impacts in the Savannah River can be described as:

- Removing impediments to spawning migrations of diadromous species to sustain those recreational and commercial fish populations.

- Restoring historic spawning areas of diadromous species within the Savannah River to foster the long-term survival and recovery of those species.

- Enhancing Essential Fish Habitats of Federally-managed species by constructing oyster reefs along tidal rivers.

- Restoring access to wetlands in the estuary through restoration of previous saltmarsh areas to improve the sustainability of estuarine-dependent species.

- Restoring conditions in the estuary that are favorable to spawning of Striped bass to support the recovery of that species.

- Enhancing habitats by reducing salinities in portions of Back and Middle Rivers through closing of cuts that allow higher salinity water to enter areas with otherwise lower levels of salinity.

- Enhancing habitats by reducing salinities or modifying velocities in specific estuarine waters through modifying flows into Back and Middle Rivers.

With these general objectives in mind, specific mitigation plans were developed to offset the predicted adverse impacts associated with the harbor deepening alternatives under consideration. As previously discussed, Mitigation Plans 6A and 6B were developed to minimize predicted increases in upstream salinity levels that would be caused by construction of the deeper channels.

Plan 6B would be implemented to offset expected salinity increases associated with construction of the 44-foot channel. This plan consists of constructing a diversion structure at McCoy Cut, as well as closing the lower arm; closing Rifle Cut; removing the Tidegate, and constructing a broad berm and a submerged rock sill across the mouth of the Sediment Basin; and placing dredged material behind the berm to partially fill in the basin. Plan 6A would be used to offset the predicted salinity increases associated with the 45, 46, 47, and 48-foot channels. It includes the same provisions, but also includes deepening the channels in McCoys Cut, Middle River and Little Back River.

Studies were conducted to determine the most effective way to minimize decreases in dissolved oxygen levels that would result from constructing the various channel deepening alternatives. These studies indicate that an oxygen injection system would be the most efficient means to

increase dissolved oxygen levels in harbor. A system using Speece Cones was designed for use in Savannah Harbor. Further model studies revealed that three oxygen injection locations would be required for the SHEP. One oxygen injection site would be located in the Savannah River near Georgia Pacific and the other two sites would be located on Hutchinson Island with injection into the Front and Back Rivers (Figure 8).

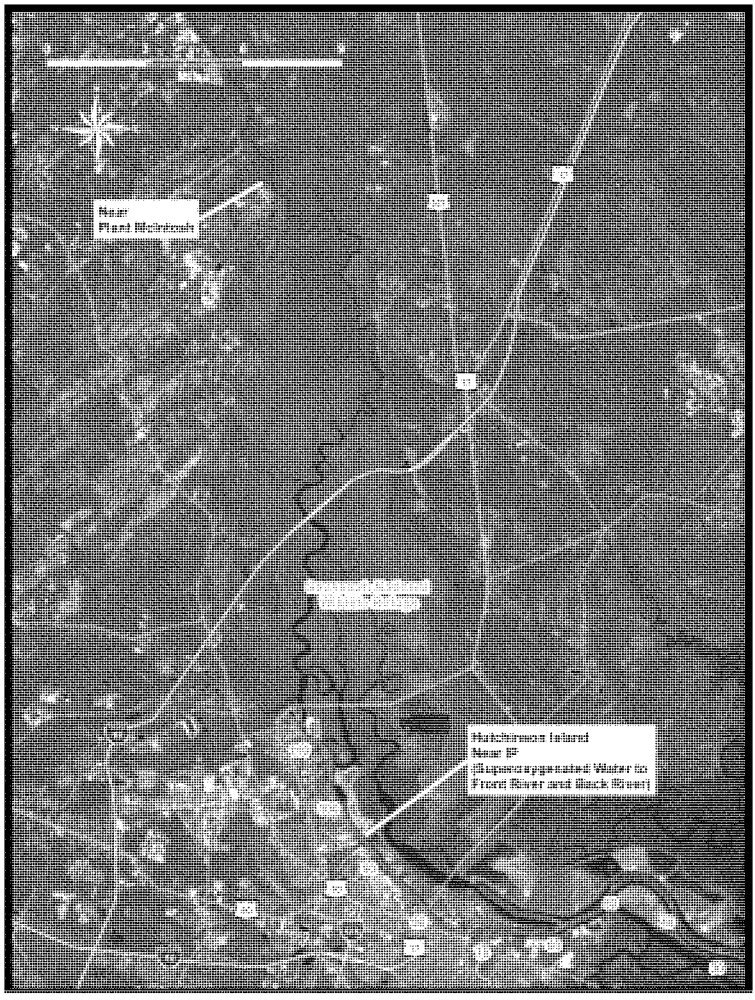

Figure 8. Location of speece cones systems for oxygen injection.

Table 8 shows the summary of predicted project-related fishery impacts for the 44, 45, 46, 47 and 48-foot channels with Mitigation Plan 6A or 6B implemented and with injection of dissolved oxygen.

Table 8. Predicted Fishery Impacts With Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Salinity	Move further into estuary up Front River	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount	Same effect, but greater amount
Dissolved Oxygen	Minor net improvement	Same	Same	Same	Same
Fisheries	Loss (-) or Gain (+) of Acceptable Habitat				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	- 4.6 % (-179.0 acres)	-6.2% (-240.0 acres)	-6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+ 19.0 % (+ 260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	+6.5 % (+89.0 acres)	-+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	-6.7 % (-220.0 acres)	-7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6 % (-251.0 acres)	-11.5 (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0acres)	+ 54.2 % (+1014.0acres)	+ 57.3 % (+1072.0acres)	+57.3 % (+1072.0acres)	+ 52.9 % (+989.0 acres)

Although the mitigation measures reduce the amount of Striped bass spawning habitat that would be lost from implementing any of the harbor deepening alternatives, there would still be a loss of spawning habitat ranging from 30.0 acres (-2.9%) with the 44-foot channel to 167.0 acres (-16.1%) with the 48-foot channel.

Implementation of the mitigation plan would eliminate adverse impacts to Striped bass egg habitat with the 46-foot channel and increase egg habitat by about 87.0 acres (-5.2%) with the 45-foot channel. However, approximately 157.0 acres (-9.4%) of egg habitat would be lost with the 44-foot channel and 181.0 acres (-10.8%) lost with the 48-foot channel.

With the mitigation plans in place, Striped bass larvae habitat would increase by about 9.5 acres (1.7 acres) with the 45-foot channel and about 31.5 acres (5.6%) with the 46-foot channel. Striped bass larvae habitat would be reduced for the 44-foot channel (31.5 acres-5.6%) and the 48-foot channel 19.5 acres-3.5%) even with mitigation.

Predictions regarding impacts to American shad habitat with the mitigation plans in place indicate there would be losses of 0.2% for the winter and spring months for all of the deepening plans under consideration.

Southern flounder habitat would be significantly increased for any of the alternative deepening plans with mitigation. Specifically, Southern flounder habitat for the 44, 45, 46, 47 and 48-foot depth alternatives increases by 1387 acres (+74.1%); 1014 acres (+54.2%); 1072 acres (+57.3%); 1072 acres (+57.3%); and 989 acres (+52.9%); respectively.

The remaining adverse impacts to Striped bass habitat with the channel modification and dissolved oxygen mitigation features in place were deemed sufficient enough to warrant consideration of additional mitigation. Additional structural modifications, such as timber or rock flow diverters were analyzed, but no measure could be identified that would improve habitat over the range of river flows that occur. The SHEP study team could not identify any other measures that could be implemented to restore or enhance Striped bass habitat in the basin. Consequently, implementation of a stocking program was deemed to be the most effective means of mitigating for the remaining loss of Striped bass habitat associated with each alternative deepening plan. As discussed in previous paragraphs, the Wildlife Resources Division of the Georgia Department of Natural Resources conducted a successful Striped bass stocking plan in the Savannah River estuary in the 1990s.

Determining the appropriate level of stocking was accomplished by the SHEP study team in coordination with the Georgia DNR-WRD. Most of the concern centers around salinity levels in spawning and early life stage habitats before the fish are mature enough (2 months) to find habitats with suitable salinity conditions. Consequently, stocking young of the year would be sufficient to meet this need. The Georgia DNR-WRD hatchery in Richmond Hill, Georgia produces that phase of fish each year. The project would fund a portion of the costs of WRD's operations in the same percentage as the project impacts to the Striped bass habitats. Modeling indicates the following losses from the deepening alternatives (Table 9).

Table 9. Combined Adverse Impact for Striped Bass

CHANNEL DEPTH ALTERNATIVE	SPAWNING 50% Flows	EGGS 50% Flows	LARVAE 50% Flows	COMBINED ADVERSE IMPACT
44-FOOT	-2.9 %	-9.4 %	-5.6 %	17.0 %
45-FOOT	-9.2 %	5.2 %	1.7 %	2.9 %
46-FOOT	-10.0 %	-0.0 %	5.6 %	5.0 %
47-FOOT	-11.1 %	-5.0 %	-13.5 %	26.9 %
48-FOOT	-16.1 %	-10.8 %	-3.5 %	27.8 %

With that combined adverse impact value and the costs of a complete stocking program, one can calculate the compensation required to mitigate for each depth alternative. The GA DNR-WRD provided information on the costs to rehabilitate and operate some of GA DNR-WRD's facilities at their Richmond Hill hatchery to conduct a Striped bass stocking program capable of producing

40,000 Phase II fish each year. The costs included initial expenses of $3.1 million, annual expenses of $203,000 to operate the program, and recurring costs of between $30,000 and $50,000 for equipment replacement. The Corps used those values and calculated them to represent an annualized cost of roughly $504,000 for a complete Striped bass stocking program. Based on that average annual value, the following compensation would be required:

Table 10. Annual Funding Levels for Striped Bass

CHANNEL DEPTH ALTERNATIVE	COMBINED ADVERSE IMPACT	ANNUAL PROGRAM FUNDING
44-FOOT	17.0 %	$85,383
45-FOOT	2.9 %	$14,461
46-FOOT	5.0 %	$25,039
47-FOOT	26.9 %	$135,348
48-FOOT	27.8 %	$139,908

Monitoring

An evaluation of the impacts of the SHEP on Striped bass habitat would be conducted during years 2, 4, and 9 of the Post-Construction Monitoring. The data from the 8 continuous hydrologic and hydraulic recorders would be used with the updated hydrodynamic and water quality models to assess project impacts to Striped bass habitat. This analysis would determine if impacts to Striped bass habitat are beyond those expected, and if so, what additional mitigation might be warranted.

10. Dissolved Oxygen

Issue

The third major issue evaluated in this cumulative impact analysis is the dissolved oxygen regime in Savannah Harbor. Although water quality in the Savannah Harbor estuary is generally good, the harbor is characterized by low dissolved oxygen levels in the summer months.

Geographic scope

The primary area of concern for dissolved oxygen is the Savannah River estuary. More specifically, it is the portion of the Savannah River between Fort Pulaski (River Mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 27.4). This section of the Savannah River estuary is the area that would be affected by the SHEP. Evaluation of impacts to the dissolved oxygen regime is critical, because this segment of the river is on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen.

Historic

Dissolved oxygen levels in the harbor have changed over the years. When Savannah was originally settled, presumably the quality of the water in the river was good. Early writings commonly refer to the rivers supporting substantial fisheries and the settlers benefiting greatly from those resources. After the city became highly industrialized, the river received substantial volumes of untreated industrial and municipal waste. Water quality in the Savannah Harbor estuary was further degraded because of similar unregulated discharges from upstream municipalities and industries located in the Augusta, Georgia area.

Water quality decreased in this river in the 1900s as it did in many others across the country. In the early 1970's, concerns were raised and Congress passed laws to protect and improve water quality. The Clean Water Act Amendments provided the authorization for the establishment of the National Pollutant Discharge Elimination System (NPDES) which now regulates point source discharges. It is generally acknowledged that the quality of the water in Savannah Harbor is much better now than it was before point source discharge controls were instituted.

In addition to the changes that have occurred over time, changes also occur on a seasonal and even hourly basis. The seasonal changes result from varying flow volumes down the Savannah River (summer and fall low flows, etc.). The hourly variation is cause by the large diurnal tide.

Since the issue of water quality is so driven by data – by knowing the actual concentrations of specific chemicals at specific locations and points in time – there is not a great deal of value discussing water quality in detail unless specific data is available. In addition, since water quality in the harbor is -- at a minimum not degrading – but likely to be stable or improving as tighter discharge standards are instituted and new industrial controls implemented, the present day conditions will be used as the baseline for this analysis. This approach is the most useful because of the availability of data to assess the impacts of any changes to the current baseline conditions. Discussions can still be included in a qualitative way about conditions that existed previously.

Past Actions / Stresses

Past actions that have degraded water quality in the Savannah estuary are numerous and include both upstream activities as well as development in the estuary. From an upstream perspective, massive clearing of land for agricultural purposes and large scale timber harvesting were heavy contributors to the silt load in the river. As the use of fertilizers, herbicides and pesticides became more prevalent, non-point sources of pollution became a major factor in water quality degradation. As development grew around the City of Augusta, unregulated discharges from industries and municipalities contributed to the water quality problems in Savannah Harbor. Construction of upstream dams further aggravated water quality problems by reducing peak flows. The more dependable flows from the dams increased the average water from the river for municipal water supply systems and industrial process water further detracted from the ability of the river to handle waste loads.

Some of the water quality issues in the Savannah Harbor can be traced to the growth of the City of Savannah and extensive industrial development adjacent to the river. Untreated municipal and industrial waste was discharged into the river up until the late 1960s. After pollution control laws were passed in the early 1970's, municipal and industrial treatment facilities were constructed that reduced the pollution loads discharged into the river.

As more water quality data was gathered and stresses to water quality became better understood, the States of Georgia and South Carolina issued standards for dissolved oxygen and as other parameters to protect aquatic life in the Savannah River and its estuary. These standards formed the basis for the states' decisions on whether to allow certain activities to occur that could damage water quality or aquatic life.

The Savannah estuary is similar to other nearby tidal creeks and rivers in that it suffers from low water quality during the summer months. The warmer temperatures coupled with the high organic loads from adjacent tidal marshes lead to substantial decreases in dissolved oxygen levels. This phenomenon is seen in both natural and deepened rivers, and is not dependant on the existence of adjacent development with its point sources discharges. Recent studies conducted by Georgia DNR-EPD concluded that the estuary could not meet the State's standards for dissolved oxygen during the summer even if all point source discharges were removed from the basin.

The operation and maintenance of the Savannah Harbor Navigation Project has contributed to degradation of water quality conditions in Savannah Harbor. The harbor has been deepened from about 12 feet MLW in the mid 1850s to its current authorized depth of 42 feet mean low water. As the channel became deeper, it became more difficult for dissolved oxygen to diffuse the greater distance down to the bottom of the channel. This reduced the average dissolved oxygen levels in the water column near the bottom of the river during the summer months.

Maintenance of the navigation channel is performed on essentially an annual basis. Dredges, typically hydraulic cutterhead dredges in the inner harbor, are used to remove sediments that have settled within the authorized channel dimensions. Sediments removed from the river are placed in upland confined disposal facilities. This operation re-suspends a small volume of sediments into the water column. The re-suspension of these sediments can cause dissolved oxygen levels to drop. Monitoring indicates that the effects of this resuspension on dissolved oxygen levels are small, temporary, and localized.

In addition to the large-scale channel deepening, two segments of the harbor were deepened equal to or beyond the depth of the navigation channel. The Sediment Basin was designed (operating in conjunction with the Tide Gate structure) to trap sediments that would normally settle in the navigation channel. The Sediment Basin was constructed adjacent to CDFs 12A and12B so the material could be easily removed and deposited into these two disposal sites. The tide gates have been taken out of operation causing the Sediment Basin to functions at a lower level of efficiency. However, the basin still provides an area of relatively low current in which suspended sediments readily settle out from the water column. The high sediment deposition rate in the basin and the annual maintenance period lead to large depths of fine-grained sediment residing in that location for an extended period of time. Those conditions lead to large sediment

oxygen demands, with resulting low dissolved oxygen levels typically occurring within the basin during the summer months.

The Kings Island Turning Basin was deepened in 1997 by 6 feet to produce an 8-foot deep advance maintenance section. As with the Sediment Basin, this area also experiences high deposition of fine-grained sediments and is maintained annually. Low dissolved oxygen levels regularly occur within the basin during the summer.

Maintenance of berths along the length of the harbor is commonly performed through agitation dredging, where the sediments are moved from the berth by dragging them into the main river. These sediments can then be removed during the maintenance dredging of the navigation channel. This procedure re-suspends sediments in the water column, to some degree, and causes dissolved oxygen levels to drop. Detailed studies were conducted on this procedure in 1993 and 2002. Those studies documented the level of these effects and found them to be localized in extent and temporary in duration. Overall, the studies revealed that this procedure does not degrade the quality of the river to unacceptable levels. This procedure is not performed when background dissolved oxygen levels in the river are at or below Georgia water quality standards.

Present Condition

Water quality in the harbor is generally good as evidenced by its water use classification (Coastal Fishing). However, low levels of dissolved oxygen are experienced during the summer months as result of several factors. The dissolved oxygen levels can drop to concentrations that do not adequately support aquatic life.

The designated water use classification for the Savannah River from Fort Pulaski to the Seaboard Coastline Railroad Bridge is Coastal Fishing. This segment of the river failed to meet the dissolved oxygen criterion that the State established for the Coastal Fishing water quality use designation based on data collected in the summers of 1997 and 1999 (EPA 2006). Therefore, the State identified it in its Section 303(d) list of impaired waters.

In 1989, the US Environmental Protection Agency disapproved the State of Georgia's dissolved oxygen criteria as not protective of coastal fishing aquatic life. EPA believed the criteria were under-protective of aquatic species in the upper part of the water column and over-protective of aquatic species in the lower part of the water column. EPA went on to state that a concentration of 3 mg/l of DO in the lower part of the water column cannot be obtained without oxygen injection even if all discharges of oxygen demanding wastes were removed. Even though the criterion was disapproved, the EPA allowed them to remain in effect until a replacement criterion could be adopted.

Subsequently, a consent decree was established in Sierra Club v. EPA (Civil Action No. 94CV-2501-MHS (N.D.G.A.) which required the Georgia DNR-Environmental Protection Division or the EPA to propose Total Maximum Daily Loads (TMDLs) for waterbodies identified as impaired on the 2002 Section 303(d) list in the Savannah and Ogeechee River Basins. In response to the consent decree obligation, EPA established a TMDL in 2006 for dissolved oxygen for the Savannah Harbor from Fort Pulaski to the Seaboard Coastline Railroad Bridge.

The TMDL assessment took into consideration the known potential sources of pollution of concern in the watershed, including point source discharges regulated under the NPDES program, non-point sources, other sources of pollution, and background levels of pollutants in the waterbody.

Permitted point source discharges in both Savannah and Augusta that contribute to the oxygen demanding load were identified and taken into account. The vast majority of non-point sources of oxygen demanding substances was determined to be from natural background sources including detritus transported downstream in the river, detritus from marsh areas flowing directly into the harbor, and tidally transported detritus from the ocean. The assessment also established the critical segment of the Savannah Harbor system which is the segment with the lowest daily dissolved oxygen levels. This segment was determined to be a five mile segment around the Sediment Basin (Mile 9.3-14.3).

Based on this analysis, the EPA determined that Savannah Harbor cannot accept any discharges of oxygen demanding substances and still attain the applicable criterion during critical periods. The Georgia DNR Environmental Protection Division considers appropriate critical conditions to represent the event that would occur once in ten years on the average or less often. The TMDL established by EPA for Savannah Harbor established a 100% reduction of oxygen-demanding substances from all continuous NPDES-regulated discharges in the watershed (from the Thurmond Dam near Augusta, Georgia to the Savannah Harbor) in order to attain the existing, applicable site-specific criterion. However, the EPA further noted that even if this TMDL were fully implemented, a concentration of 3mg/l dissolved oxygen in the lower part of the water column cannot be obtained without injecting oxygen into Savannah Harbor.

The State of Georgia has since revised the dissolved oxygen standard for streams designated as Coastal Fishing. The revised standard is "A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times. If it is determined that the "natural condition" in the waterbody is less than the values stated above, then the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/L deficit from the "natural" dissolved oxygen value. Up to a 10% deficit will be allowed if it is demonstrated that resident aquatic species shall not be adversely affected."

EPA published a Revised Draft TMDL for dissolved oxygen in Savannah Harbor in April 2010. This TMDL requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand (UOD) to about 130,000 lbs per day.

Present Actions/Stresses

The present stresses on dissolved oxygen levels in Savannah Harbor continue to be point source discharges of oxygen demanding substances from sources between J Strom Thurmond Dam and Savannah Harbor and non-point sources, including loads from the river upstream of the harbor, the marsh and the ocean Table 11 (taken from the EPA Revised Draft TMDL for Savannah Harbor for Dissolved Oxygen, April 2010) shows the NPDES permitted dischargers to the

Savannah River from the Augusta, Georgia area through Savannah Harbor and their permitted wasteloads.
]

Table 11. NPDES-Permitted Dischargers for the Savannah River

Table 6 NPDES Permitted Dischargers BOD5 and Ammonia Loads to River Facility Name	Receiving Water	Permit Number	Effluent Flow Rate (MGD)	BOD5 (mg/L)	Ammonia (mg/L)	BOD5 (lbs/day)	Ammonia (lbs/day)
Aiken PSA/Horse Creek WWTF	River	SC0024457	26	30	11	6,505	2,385
Allendale	River	SC0039918	4	25	20	834	667
Augusta -James B. Messerly WPCP	River	GA0037621	46	30	17	11,534	6,690
Clariant Corp/Martin Plant	River	SC0042803	--	--	--	564	2,000
Columbia County - Crawford Creek WPCP	River	GA0031984	2	12	1	150	15

The summary of the Ultimate Oxygen Demand (UOD) loads from NPDES Dischargers to the Savannah Harbor and River System is listed in Table 12.

Table 12. Summary of the Permitted UOD Loads for the Harbor and the River Receiving Water

	CBODu (lbs/day)	NBODu (lbs/day)	UOD (lbs/day)
Harbor	300,551	32,407	332,958
River	204,491	63,899	268,390
TOTAL	505,042	96,306	601,347

As discussed above, the EPA has issued a Revised Draft TMDL for dissolved oxygen for Savannah Harbor. This TMDL directs a reduction in the UOD loads to the Savannah River from about 600,000 lbs/day to 130,000 lbs/day.

As discussed previously, construction of the Savannah Harbor Navigation Project has also contributed to the depression of dissolved oxygen levels in the harbor. Model results from the EPA TMDL study for Savannah Harbor indicate that the Savannah Harbor Navigation Project has resulted in a 1mg/l depression of dissolved oxygen in the upper water column. This estimate

was obtained by using a model to estimate dissolved oxygen levels using the 1854 bathymetry and then comparing those to current dissolved oxygen levels with the 42-foot navigation channel.

Annual maintenance dredging also contributes to temporary and localized depressed dissolved oxygen conditions in Savannah Harbor. Prior to dredging being initiated in the summer months, monitoring is performed to determine the levels of dissolved oxygen in the river. If the background levels are near or below Georgia water quality standards, the dredging is not performed unless a waiver is obtained from the state. This ensures that activities will not be conducted which would further exacerbate stressful conditions for aquatic life.

Capacity to Withstand Stress

The dissolved oxygen regime in Savannah Harbor is stressed during summer months. The existing criteria for dissolved oxygen in the lower part of the water column cannot be met during critical periods. The EPA has issued a Revised Draft TMDL for Savannah Harbor for dissolved oxygen. From a dissolved oxygen standpoint, Savannah Harbor has reached its capacity to withstand any additional stresses.

Future Actions/Stresses

Point-and non-point source, thermal and stormwater discharges will continue to occur, reducing levels of dissolved oxygen in the estuarine waters. As the Revised TMDL for Savannah Harbor is implemented, UOD loading to the Savannah Harbor estuary will be significantly reduced, and the dissolved oxygen regime should be greatly improved.

The continued maintenance of the Savannah Harbor Navigation Project as well as future harbor development projects could also impact the dissolved oxygen regime in Savannah Harbor. Potential future harbor development projects include the SHEP and a container terminal in Jasper County.

Conceptual plans have been developed for a Jasper County container terminal located in what is now CDFS 14A and 14B. This terminal would require similar channel improvements as the SHEP including deepening and extending the Savannah Harbor Entrance Channel and deepening of the inner harbor channel to the facility. Consequently, construction of a terminal could impact the dissolved oxygen regime in Savannah Harbor. If the SHEP is constructed prior to a Jasper County terminal, no additional entrance channel or inner harbor channel dredging would be required. Some dredging would be required to provide a channel between this facility and the navigation channel and to construct the container ship berths. This dredging would be minor in nature and the effects on the dissolved oxygen regime would be negligible and temporary. If the SHEP is not constructed, dredging would be required to make the required improvements in the entrance channel and to deepen the inner harbor channel to River Mile 6 where the Jasper facility would be located. Deepening the Savannah Harbor channel to River Mile 6 would be expected to have only negligible effects on the dissolved oxygen regime in the harbor.

A Jasper County container terminal could require periodic maintenance dredging for the container ship berths and the access channel to the Savannah Harbor Navigation Channel. The

effects of periodic maintenance dredging for this facility on the dissolved oxygen regime in the harbor would be expected to be minor and temporary.
The Savannah Harbor Navigation Project will continue to be maintained at its authorized depth of 42 feet MLW. Dredging and disposal operations have a minimal short-term effect on dissolved oxygen levels in the harbor.

The other known potential additional stress to the dissolved oxygen regime in Savannah Harbor is the SHEP.

Incremental Impact

Many facets of a harbor deepening project have the potential to adversely affect the water quality regime. From a construction perspective, the dredging and disposal of sediments alters turbidity and dissolved oxygen, thereby potentially impairing water quality. However, the studies that were conducted to analyze the impacts associated with the SHEP indicate that dredging and sediment placement activities will not have major impacts on the water quality regime in the estuary. These findings are presented in Chapter 5 of the EIS.

Harbor deepening would have substantial effects on the salinity regime in the estuary. Increases in upstream salinity levels would adversely affect tidal freshwater marsh and fishery habitat. These types of impacts and the methods to ameliorate those impacts have been previously discussed in this cumulative impact analysis and in Chapter 5 of the EIS.

The remaining water quality issue is the effects of harbor deepening on the dissolved oxygen regime. Model studies indicate that all of the channel deepening alternatives under consideration would decrease dissolved oxygen levels without mitigation. Degradation of the dissolved oxygen regime in Savannah Harbor has the potential to adversely affect numerous aquatic species.

Dissolved oxygen concerns relating to harbor deepening can be divided into three issues: (1) as the channel depth increases, the ability of oxygen to reach the river bottom decreases, causing lower average concentrations of dissolved oxygen at the bottom, (2) as the channel prism enlarges, additional saltwater is moved to the upper portions of the harbor and into the estuary, decreasing the ability of those waters to accept oxygen from the air, and (3) as the channel prism enlarges, the average velocity decreases, reducing the mixing of oxygen throughout the water column. If dissolved oxygen concentrations decrease to unacceptable levels, it could have deleterious effects on fish and other aquatic organisms. Lower dissolved oxygen concentrations also reduce the ability of the estuary to handle the point- and non-point source loads of pollutants entering the estuary.

The SHEP is evaluating five deepening plans which would deepen the harbor to 44, 45, 46, 47 or 48 feet MLW. Implementation of any of these harbor deepening plans could cause negative impacts to the dissolved oxygen regime if not mitigated.

Two models were used during the SHEP to evaluate the impacts of the harbor deepening alternatives on the dissolved oxygen regime in Savannah Harbor. The Environmental Dynamics

Code (EFDC) model was used to develop the hydrodynamic data and then linked to the Water Quality Analysis Simulation Program Version 7.0 (WASP7) to predict dissolved oxygen concentrations. Evaluations were conducted based on average (August 1997) and drought (August 1999) river flow conditions. The study evaluated 26 spatial zones within the estuary and they extended from Clyo, Georgia (61 miles above Fort Pulaski) to the Atlantic Ocean (17 miles offshore from Fort Pulaski). Figure 9 shows the 26 zones, which include 11 zones for Front River (FR), 6 zones for Middle River(MR), 3 zones for Back River (BR), 3 zones for Little Back River (LBR), 2 zones for South Channel (SC), and 1 zone for the Savannah River (SR). The South Carolina standards for dissolved oxygen were used to evaluate the severity of impacts, because they were the most restrictive at the time of the study (daily average of 5mg/l, with an instantaneous minimum of 4.0 mg/l, applied throughout the water column).

From a general perspective, the model shows that harbor deepening without mitigation would result in insignificant (1-2%) increases in the percentage of dissolved oxygen in the harbor's waters with violations of existing dissolved oxygen standards. There would be upstream shifts of lower dissolved oxygen zones in bottom and surface layers of the estuary as the channel deepening increases in magnitude. The studies also indicate that deteriorations of the lowest dissolved oxygen values along critical cells (the cell with the lowest dissolved oxygen concentrations during specified simulation period) of major parts of the estuary increase proportionately to the amount of deepening.

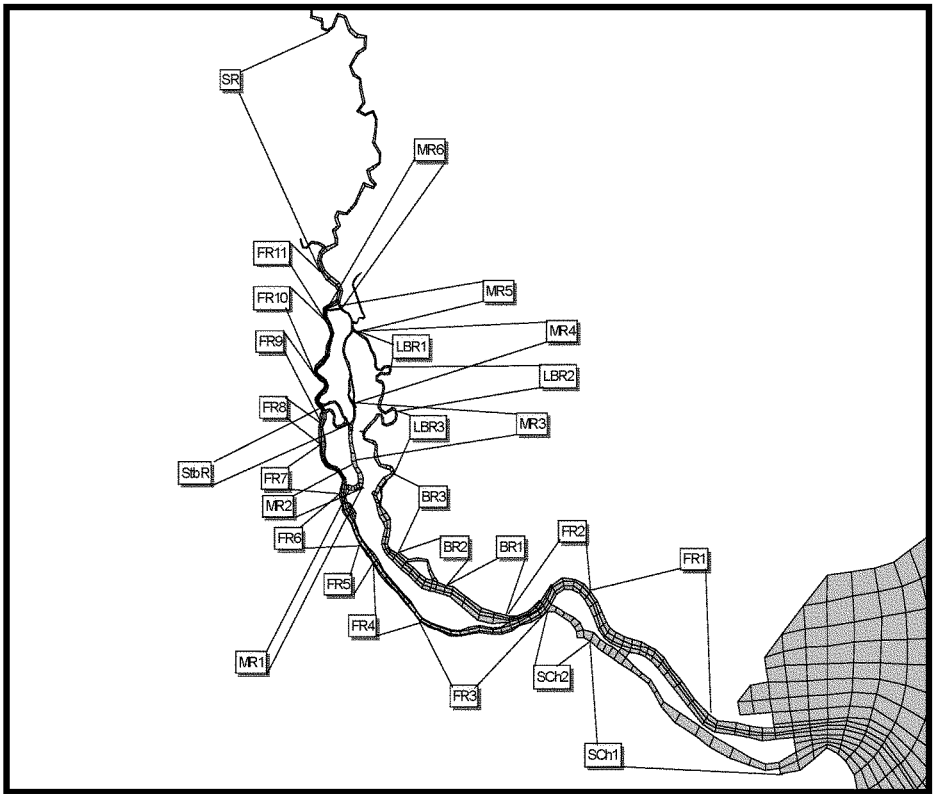

Figure 9. 26 Spatial Zones-SHEP Dissolved Oxygen Study

NOTE: The following data show dissolved oxygen levels without mitigation for D.O., but with the flow re-routing components of the harbor deepening alternatives. These data also reflect conditions in the bottom half of the water column (i.e., bottom 3 layers of the 6-layer model), where dissolved oxygen levels are lower. For the data shown in Tables 13-17, the Corps identified a decrease in dissolved oxygen as substantial when values reported in the 10%-tile Project Baseline Difference category were reduced by 0.25 mg/l.

Table 13 shows the predictions for the dissolved oxygen regime deterioration for the 48-foot channel project (1999 drought conditions). The most dissolved oxygen deterioration would occur with the 48-foot channel project. Critical cells of Front River Zones FR6, FR-7, FR8 and FR11, Middle River Zone MR1, as well as critical cells in Back River Zones BR1, BR2 and BR3

show a substantial decrease in dissolved oxygen levels, while dissolved oxygen would increase in Front River Zones FR2, FR3, FR4, FR5, FR9, FR10, Middle River Zones MR 2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

Table 13. Predicted Dissolved Oxygen Decreases: 48-foot Channel (No Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.8	0.5	0.0	0.0	-0.7	-0.9	-2.2	-2.4	-3.0
FR2	-0.8	8.5	8.8	7.4	5.6	4.4	3.4	3.5	-2.2
FR3	4.5	2.6	2.9	2.2	-0.5	-2.9	-5.7	-2.9	-4.7
FR4	5.1	3.8	2.9	1.1	-0.8	-5.0	-9.6	-8.0	-1.9
FR5	4.6	4.2	2.7	0.8	-1.2	-8.1	-13.9	-11.6	-10.0
FR6	1.7	1.1	-0.5	-0.3	-3.3	-10.8	-14.1	-11.6	-9.7
FR7	-4.5	-3.2	-3.1	-6.6	-11.9	-21.4	-11.7	-5.5	-3.1
FR8	-7.4	-8.0	-11.0	-15.0	-11.5	-7.2	-5.4	-4.2	-5.8
FR9	6.4	11.3	6.5	5.2	1.3	0.6	1.0	2.0	4.2
FR10	8.8	5.4	5.9	4.3	-0.2	-1.6	-1.3	-2.3	-0.8
FR11	0.2	-2.6	-2.4	-2.3	-0.2	0.0	-1.4	0.3	-2.8
MR1	-5.5	-5.3	-5.6	-5.9	-5.5	-9.1	-8.6	-8.1	-4.2
MR2	4.2	4.4	3.0	0.9	-2.4	-6.8	-5.2	-4.8	-4.8
MR3	12.8	10.6	11.9	10.6	9.2	3.0	-6.0	-7.3	-9.1
MR4	11.6	10.2	10.5	8.5	9.6	9.0	10.9	10.7	11.1
MR5	47.7	35.8	29.5	26.6	7.8	-0.6	-0.8	-1.6	-1.3
MR6	191.0	153.0	114.0	89.2	23.0	13.9	9.1	6.4	4.0
LBR1	14.0	10.8	7.6	7.2	7.0	8.2	5.9	6.2	3.6
LBR2	16.3	18.1	18.1	18.6	17.4	17.4	16.4	17.1	10.9
LBR3	-13.5	-19.5	-19.4	-18.0	-15.8	-16.0	-18.9	-21.2	-21.8
BR1	-43.5	-35.4	-23.3	-7.0	3.4	12.3	12.0	11.3	10.8
BR2	-40.7	-33.1	-29.7	-23.2	-13.9	-3.1	2.2	3.2	4.2
BR3	-41.8	-38.1	-38.9	-36.8	-32.9	-24.5	-15.5	-13.5	-11.1
SCh1	-7.1	-0.8	1.2	1.9	4.5	17.9	13.6	14.7	11.5
SCh2	-0.8	-2.6	-2.1	-1.0	-0.7	-1.1	-1.3	-1.5	-2.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-4.7	2.1	-0.9	0.4	-1.8	-3.1	-3.2	-3.9	-3.2

Table 14 shows the predictions for the dissolved oxygen regime deterioration of the 47-channel project. For the 47-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zone FR7, FR8, FR11, Middle River Zone MR1, Little Back River Zone LBR3, and Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR1, FR2, FR3, FR4, FR5, FR9, F10, Middle River Zones MR2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

Table 14. Predicted Dissolved Oxygen Decreases: 47-foot Channel (No Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.5	0.5	0.3	0.2	-0.7	-0.9	-1.8	-1.9	-1.9
FR2	-2.8	7.9	8.6	6.9	5.6	4.4	3.6	3.8	-2.4
FR3	4.5	2.3	2.6	1.9	-0.3	-2.4	-4.6	-0.2	-2.9
FR4	5.1	3.5	2.6	0.8	-0.5	-4.5	-8.2	-6.0	0.6
FR5	4.6	3.1	1.4	0.0	-2.2	-11.3	-12.2	-11.8	-10.4
FR6	2.0	1.6	0.0	0.3	-2.9	-9.2	-11.7	-9.9	-8.1
FR7	-4.3	-2.7	-2.9	-6.4	-11.3	-18.7	-7.7	-4.3	-2.8
FR8	-6.5	-6.9	-10.2	-14.0	-9.0	-5.8	-4.9	-4.0	-5.6
FR9	1.1	6.2	2.9	5.5	1.9	1.7	2.5	3.0	2.5
FR10	8.8	5.4	5.7	4.3	-0.3	-1.7	-1.3	-2.3	-0.8
FR11	0.2	-2.3	-2.4	-2.5	-0.2	0.0	-1.4	0.3	-2.7
MR1	-4.7	-4.6	-5.4	-5.1	-5.0	-8.3	-7.6	-6.7	-3.7
MR2	4.5	5.1	3.5	0.0	-4.2	-7.5	-5.9	-5.5	-1.7
MR3	12.8	11.1	12.2	11.1	9.6	3.8	-5.5	-6.6	-8.1
MR4	12.1	10.2	11.2	8.7	9.8	8.8	10.5	10.5	11.1
MR5	47.7	36.3	29.5	26.6	7.8	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	13.7	10.8	7.8	7.2	6.8	8.0	5.9	6.2	3.4
LBR2	21.5	18.4	18.1	18.3	17.4	17.2	16.4	16.7	10.7
LBR3	-12.2	-18.9	-18.5	-17.4	-15.3	-16.0	-18.7	-21.6	-22.6
BR1	-46.3	-38.7	-26.5	-8.1	2.9	11.9	12.4	11.8	11.0
BR2	-43.6	-36.8	-32.5	-25.4	-15.2	-4.2	0.8	2.4	4.5
BR3	-44.6	-41.3	-41.9	-39.4	-35.3	-27.4	-17.3	-15.5	-13.1
SCh1	-4.0	-2.9	0.8	3.4	1.7	-4.5	-3.8	-3.2	-5.9
SCh2	-1.4	-2.6	-2.1	-1.0	-0.7	-1.1	-0.7	-1.3	-1.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-2.6	1.9	0.2	1.2	-0.5	-2.4	-2.6	-2.9	-2.8

Table 15 shows the predictions for the dissolved oxygen regime deterioration of the 46-channel project. For the 46-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zone FR1, FR8, FR9, FR11, Middle River Zone MR 1, Little Back River Zone LBR3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2, FR3, FR4, FR5, FR6, FR7, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6 and Lower Back River Zones LBR1 and LBR2.

Table 15. Predicted Dissolved Oxygen Decreases: 46-foot Channel (No Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.5	-0.3	-0.5	0.0	-0.7	-0.5	-1.5	-1.5	-2.1
FR2	-5.1	7.4	7.8	6.9	5.6	4.7	3.6	3.8	-2.0
FR3	3.9	1.7	2.3	1.9	0.0	-1.7	-2.8	2.0	-2.0
FR4	3.6	2.9	2.3	0.8	-0.5	-4.0	-6.9	-3.7	2.1
FR5	4.1	3.1	2.2	0.8	-1.0	-6.4	-9.9	-6.9	-5.8
FR6	2.3	1.6	0.3	0.8	-2.1	-7.5	-8.1	-6.7	-5.2
FR7	6.0	7.4	8.7	8.2	10.5	-0.3	1.0	1.7	9.4
FR8	-5.1	-6.3	-9.0	-12.4	-7.4	-4.5	-3.7	-3.2	-4.6
FR9	-6.1	-7.4	-10.2	-11.9	-6.9	-3.2	-2.8	-3.6	-2.5
FR10	8.8	5.4	5.5	4.5	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.8	-2.4	-2.5	0.0	0.0	-1.4	0.3	-2.8
MR1	-4.0	-4.1	-4.3	-4.2	-4.0	-7.8	-5.9	-5.4	-2.1
MR2	5.2	5.3	3.5	1.5	-1.4	-5.3	-3.7	-2.9	-3.3
MR3	14.1	10.3	11.4	11.5	9.2	3.2	-6.2	-8.4	-9.6
MR4	12.4	10.4	11.2	9.2	9.8	9.2	10.5	10.3	10.9
MR5	47.7	36.3	29.0	26.6	7.6	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	12.6	10.6	8.0	7.0	6.8	8.0	5.9	6.3	3.2
LBR2	0.0	17.9	17.9	18.6	17.4	17.0	16.4	16.9	10.7
LBR3	-10.8	-18.9	-18.2	-16.9	-15.3	-16.0	-19.1	-21.4	-22.2
BR1	-48.6	-42.7	-29.9	-10.0	1.8	11.4	12.4	12.0	11.0
BR2	-48.6	-40.4	-36.4	-27.7	-16.1	-5.1	0.3	2.1	4.2
BR3	-47.7	-44.2	-43.7	-40.8	-36.4	-29.5	-19.1	-16.5	-14.8
SCh1	-5.3	-3.7	1.6	3.0	1.0	-4.2	-4.9	-2.6	-4.2
SCh2	-0.6	-1.1	-1.3	-1.2	-1.0	-1.1	-1.1	-0.9	-0.9
SR	-0.2	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-0.8	2.6	1.3	2.0	-0.5	-1.3	-2.0	-2.4	-2.8

Table 16 shows the predictions for dissolved oxygen regime deterioration for the 45-foot channel. For the 45-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR7, FR8, FR9, and FR11, Middle River Zone MR 1, Little Back River Zone LRB3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2, FR3, FR4, FR5, FR6, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6 and Lower Back River Zones LBR1 and LBR2.

Table 16. Predicted Dissolved Oxygen Decreases: 45-foot Channel (No Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.8	0.0	0.0	0.2	-0.5	-0.5	-0.9	-1.1	-1.5
FR2	-7.9	7.9	8.3	6.9	5.9	4.7	4.0	4.0	-1.8
FR3	3.9	1.7	2.3	3.0	0.5	-0.7	-2.0	2.4	-1.3
FR4	3.6	2.3	2.3	2.1	0.8	-1.9	-3.6	0.8	3.0
FR5	4.1	2.5	0.8	0.0	-1.7	-11.5	-8.4	-7.6	-6.7
FR6	2.3	2.2	0.8	1.5	-1.0	-4.8	-4.5	-4.3	-2.4
FR7	-3.0	-1.7	-2.4	-4.5	-8.2	-11.8	-3.4	-2.5	-1.9
FR8	-4.5	-5.4	-7.6	-10.2	-5.1	-3.6	-3.6	-2.5	-3.5
FR9	-5.3	-6.4	-8.8	-9.8	-5.4	-2.4	-2.3	-3.6	-2.5
FR10	8.8	5.4	5.5	4.3	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.3	-2.4	-2.5	0.0	0.0	-1.4	0.2	-2.7
MR1	-3.1	-3.2	-3.4	-3.4	-3.0	-6.4	-4.3	-3.5	-1.3
MR2	5.2	5.6	4.0	1.7	-0.8	-4.2	-2.8	-1.9	-2.8
MR3	13.9	12.1	12.4	11.5	10.3	4.6	-4.1	-4.9	-7.2
MR4	13.2	10.4	11.7	9.2	9.8	8.8	10.5	10.3	10.8
MR5	48.3	37.3	29.0	25.9	7.6	-0.6	-0.6	-1.6	-1.1
MR6	191.0	153.8	114.6	89.2	23.0	13.7	9.0	6.4	4.0
LBR1	12.3	10.8	8.2	7.0	6.6	7.8	5.7	6.2	3.1
LBR2	21.5	18.7	18.1	18.6	17.1	17.2	16.4	17.3	23.5
LBR3	-10.1	-17.7	-17.6	-16.9	-14.8	-15.5	-18.7	-21.4	-22.2
BR1	-53.0	-46.3	-33.7	-11.4	1.6	10.9	12.9	12.0	11.7
BR2	-51.4	-41.5	-38.1	-30.5	-17.6	-5.9	-0.3	1.6	3.1
BR3	-52.6	-47.1	-46.4	-42.5	-38.6	-31.6	-20.6	-18.5	-15.5
SCh1	-7.1	1.2	0.0	2.2	7.3	19.7	16.0	15.5	12.0
SCh2	0.0	-1.1	-0.5	-0.7	-0.5	-0.9	-0.9	-0.9	-0.4
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	2.3	3.8	2.4	2.4	-0.2	-1.0	-1.7	-2.0	-1.6

Table 17 shows the predictions for the dissolved oxygen regime deterioration of the 44-foot channel project. For the 44-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR1, FR5, FR6, FR7, FR8, FR11, Middle River Zones MR1 and MR5, Lower Back River Zone LBR 3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2, FR3, FR4, FR9, FR10, Middle River Zones MR2, MR3, MR4, MR6, Lower Back River Zones LBR1 and LBR2 and Back River Zones BR1, BR2, and BR3. The changes in dissolved oxygen profiles for the 44-foot depth alternative are considerably different from the other alternatives since the flow rerouting components are different with this channel depth alternative.

Table 17. Predicted Dissolved Oxygen Decreases: 44-Foot Channel (No Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	-0.3	-0.8	-1.0	-0.5	-0.7	-0.2	-0.9	-0.4	-1.3
FR2	-9.0	7.4	7.0	6.4	5.9	4.9	4.0	4.4	-1.8
FR3	3.0	0.9	1.4	2.4	0.8	0.0	1.3	3.9	-0.2
FR4	3.3	1.7	2.0	1.3	0.5	-1.9	-2.9	-1.8	0.9
FR5	3.2	1.7	-0.5	-0.8	-2.7	-11.1	-7.0	-6.0	-4.9
FR6	1.4	0.3	-1.1	0.5	-1.9	-6.0	-4.0	-2.9	-1.7
FR7	-2.5	-1.7	-1.9	-3.9	-7.2	-6.7	-2.6	-2.2	-1.5
FR8	-3.6	-4.1	-6.3	-8.5	-3.1	-2.0	-2.8	-2.5	-3.5
FR9	7.0	14.0	10.0	9.1	3.4	2.4	3.2	2.7	2.4
FR10	7.0	4.8	4.0	3.0	-1.0	-2.6	-1.6	-3.6	-1.1
FR11	-13.9	-12.8	-11.6	-9.0	-0.7	-1.1	-2.2	-1.7	-4.1
MR1	-2.6	-2.5	-2.5	-2.8	-2.6	-6.0	-2.6	-1.9	-0.6
MR2	3.7	4.1	2.1	0.4	-2.6	-4.2	-1.6	-1.0	-1.5
MR3	11.4	7.7	9.6	8.2	6.7	1.6	-7.4	-8.4	-9.6
MR4	-0.8	16.2	19.5	19.0	19.0	18.3	20.2	21.4	24.7
MR5	-6.0	-23.5	-24.5	-16.4	0.8	-1.9	-1.7	-2.5	-2.0
MR6	157.3	134.9	104.7	86.0	21.2	12.4	8.4	5.8	3.4
LBR1	-10.9	-3.4	1.7	2.3	1.5	2.7	1.8	2.3	0.6
LBR2	3.8	6.5	6.0	6.0	5.9	5.9	5.0	6.4	8.4
LBR3	-39.6	-41.2	-40.8	-35.1	-30.4	-28.8	-29.8	-30.7	-32.0
BR1	-70.5	-57.6	-49.1	-32.9	-19.1	-3.7	-3.3	-3.5	-3.1
BR2	-79.0	-72.1	-64.3	-46.9	-33.3	-29.1	-24.0	-21.4	-19.1
BR3	-75.6	-68.3	-66.6	-60.3	-54.8	-41.6	-28.8	-24.8	-22.3
SCh1	-3.1	-1.7	0.4	0.7	1.0	-3.0	-3.5	-1.6	-3.9
SCh2	0.0	-1.1	-0.8	-0.7	-0.5	-0.9	-0.9	-0.9	0.0
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	5.7	5.7	3.5	3.2	0.4	-0.6	-1.4	-1.1	-0.9

Model scenarios were also run for average flow conditions (1997). The deterioration of the dissolved oxygen regime is not as pronounced as for drought conditions, and most of the major decreases in dissolved oxygen levels are predicted to be in the critical cells of Front River Zones FR7, FR8 and FR9.

Alternatives to Mitigate for Cumulative Effects

As discussed in previous sections of this analysis, Mitigation Plan 6B would be implemented with the 44-foot channel project to help offset expected increases in upstream salinity levels while Mitigation Plan 6A would be used for the 45, 46, 47 and 48-foot channel projects. Basically, these plans reduce the anticipated increase in salinity levels by reducing salt water flows into Back, Little Back River, and Middle Rivers, while providing more freshwater inflow to these streams. While increasing freshwater into these streams would reduce salinity levels and thus improve dissolved oxygen levels, the increase in dissolved oxygen levels would not be sufficient to offset the expected impacts. Also, Mitigation Plans 6B and 6A would not help to ameliorate predicted adverse effects to the dissolved oxygen regime in Front River. Consequently, an additional mitigation measure was required to offset expected decreases in dissolved oxygen levels that would result from the harbor deepening plans.

An evaluation of mitigation alternatives with respect to the dissolved oxygen regime revealed that injection of oxygen into the river was the most efficient and feasible means to mitigate for adverse effects to the dissolved oxygen regime in Savannah Harbor. Further investigations indicated that use of the Speece Cone would be the most appropriate method to mitigate impacts associated with harbor deepening. This device was originally used to add oxygen to the bottom of lakes to enhance downstream fisheries. Basically, the technology involves super-oxygenating a portion of the river water and then reintroducing it back into the river, where it mixes with and is diluted by the main flow.

The SHEP models were further used to determine the quantities of oxygen that would be needed and the locations of the dissolved oxygen facilities for each harbor deepening alternative. Two evaluations were conducted. The first investigation was to determine how much oxygen would be required to meet the existing dissolved oxygen levels for the five harbor deepening plans under consideration. The conditions of August 1997 (average flow year) were selected as the flow and meteorological conditions for this evaluation. An average flow year was selected over the drought year (1999) because there would be a greater amount of oxygen needed to treat the increased volume of water that would occur in an average flow year.

Table 18 shows a summary of dissolved oxygen loads and costs associated with mitigation for each of the alternative channel depths under consideration. As expected, the requirements for the 48-foot channel are substantially greater than those for the 44-channel. The costs for operating the oxygen injection systems are based on their continued operation for a period of 4 months per year. The operation period could vary depending on actual conditions from year to year.

Table 18. Dissolved Oxygen Needs To Meet Existing Dissolved Oxygen Levels

Scenario Description	D.O. Discharge Location	Cell (I,J,K) Coordinates	Load (kg/day)	Sum 1000 kg/day	Volume mitigation (%) for the percentiles 5%	10%	25%	50%
Plan 6A	IP (FR)	14, 66, 6	7000					
6 ft deepening	IP (BR)	31,70, 6	2000	18000	97.9	97.8	98.1	97.3
(GP+IP_13m)	Georgia-Pacific	14, 171, 6	9000					
Plan 6A	IP (FR)	14, 66, 6	3000					
5 ft deepening	IP (BR)	31,70, 6	2000	16000	98.2	97.5	97.9	97.3
(5F-5m)	Georgia-Pacific	14, 171, 6	11000					
Plan 6A	IP (FR)	14, 66, 6	2000					
4 ft deepening	IP (BR)	31,70, 6	2000	14000	97.6	97.2	97.4	97.7
(4F-3m)	Georgia-Pacific	14, 171, 6	10000					
Plan 6A	IP (FR)	14, 66, 6	1000					
3 ft deepening	IP (BR)	31,70, 6	2000	13000	98.1	97.4	97.7	98.5
(3F-3m)	Georgia-Pacific	14, 171, 6	10000					
Plan 6B	IP (FR)	14, 66, 6	1000					
2 ft deepening	IP (BR)	31,70, 6	4000	15000	97.2	97.3	97.6	97.8
(2B-6m)	Georgia-Pacific	14, 171, 6	10000					

Study investigations indicate that oxygen would have to be injected at three locations. All three injection locations (near Georgia Power's Plant McIntosh, Hutchinson Island – west, Hutchinson Island –east) would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend into the authorized navigation channel. The systems would be operated to provide the needed amount of oxygen for that depth alternative during the months of July, August, and September. The Corps would begin to operate the systems on 15 June to allow the dissolved oxygen to be fully distributed throughout the estuary by 1 July.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the injection site increases. Removing the incremental adverse project effect at a great distance from an injection site requires large amounts of oxygen. This becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity (and cost) of maintaining numerous systems also increases. The oxygen injection system configuration is designed to remove the incremental effect of a deeper channel in 97 percent of the cells in the hydrodynamic model. The minor impact at distances away from the injection location is balanced by the higher dissolved oxygen levels that would occur close to where the oxygen is added. The Corps believes the 97 percent level of performance recognizes both the higher dissolved oxygen levels close to the injection sites and the limitations of the model at distinguishing small differences between different run conditions.

Monitoring

Extensive monitoring would be conducted to verify model predictions relative to both post-deepening dissolved oxygen concentrations and oxygen injection needs. The mitigation plan includes ten years of Post-Construction data to be collected from the 8 continuous hydrologic and hydraulic data recorders. The dissolved oxygen data collected in the field would be used with the updated hydrodynamic and water quality models to evaluate how the oxygen injection systems are performing with respect to removing the incremental effects of the project on the dissolved oxygen regime in Savannah Harbor.

The monitoring program for the oxygen injection system also includes a Transfer Efficiency Study which would be conducted after the systems become operational. This study would identify the efficiency at which the systems add oxygen to estuarine waters. This efficiency rate would be used to determine how the systems should be operated to add the amount of oxygen determined by the modeling to be needed to compensate for the impacts of the SHEP.

11. Groundwater

Issue

The potential for additional saltwater to enter the Upper Floridan aquifer is the next major concern addressed in this cumulative impact analysis. The Upper Floridan aquifer is the primary source of groundwater for Chatham County, Georgia as well as other areas of Coastal Georgia and South Carolina

Geographic Scope and Geological Setting

The Floridan aquifer system underlies parts of Alabama, Georgia, South Carolina, and Florida and supplies approximately 50% of the groundwater in Georgia (Kressler et. al., 2001). The aquifer system is divided into two main aquifers: the Upper Floridan and Lower Floridan. Within Chatham County and the study area, the Upper Floridan aquifer is the primary source of ground-water. The immediate area of concern is the project area where the dredging for harbor deepening would occur which is from Mile 18.8 (Kings Island Turning Basin) of Savannah Harbor to what would be about Mile 18.6 of the bar channel.

Eastern Chatham County is underlain by approximately 2,000 feet of sedimentary Coastal Plain sediments ranging in age from Holocene to Cretaceous (Miller, 1986). From land surface to a depth of about 500 feet, the sediments (in descending order) are described as Pleistocene-Recent (surficial aquifer), Upper and Middle Miocene (the upper confining unit of the aquifer), and Late and Early Oligocene (Upper Floridan aquifer).

The Pleistocene Recent unit contains fluvial sands, silts and clays that overlie the Miocene unit. These sediments, typically about 60 to 75 feet thick but locally as much as 130 feet thick, contain mainly low-permeability confining beds but contain thin permeable sands in some areas.

Groundwater within these sands occurs under both water table (unconfined) and artesian (confined) conditions, and the elevation of the water table is typically higher than the heads of underlying aquifers. Daily withdrawals of ground-water from this surficial aquifer are estimated to be 120,000-855,000 gallons per day in the Savannah area (Clark et al., 1990).

The Miocene unit (confining unit of the Upper Floridan aquifer) consists of green-colored clays, silts, clayey silts, and sandy or silty clays. The top of the Miocene unit in the study area occurs at an average depth of -45 feet MLW, and its thickness ranges from less than 30 feet near the Tybee high (an anticlinal structure along the navigation channel between Stations 20+000 and -23+000B) to 160 feet near downtown Savannah.

The Oligocene unit (the uppermost unit of the Floridan aquifer) is composed of limestone. The elevation of the top of the Oligocene unit ranges from -95 feet MLW near the Tybee high to about - 200 feet MLW near downtown Savannah. Consequently, the Tybee high is the feature of most concern since the top of the Miocene confining unit and the Oligocene unit is nearest the land surface.

Historic

Prior to industrial and agricultural development, the flow system was considered steady state. Recharge was equal to natural discharge (artesian springs, streams, etc.), and ground water levels showed little fluctuation.

Past Actions/Stresses

Since the 1800s, increasing withdrawals of water from the Upper Floridan aquifer to support development in the coastal region have caused a cone of depression to form in the Savannah area and lowered the water level in the aquifer to as much as 100 feet below sea level (Peck et al., 1999). Consequently, this has resulted in an unbalance of recharge and discharge rates. The increased pumping has lowered water levels, induced additional recharge and reduced natural discharge, and increased total flow through the system (Krause and Randolph, 1989).

The long-term pumping of the Upper Floridan aquifer in the Savannah area and surrounding coastal areas has lowered groundwater levels and reversed the seaward hydraulic gradient that existed before development (Garza and Krause, 1996; Krause and Randolph, 1989). Figure 10 illustrates the effects of long-term pumping. The increased withdrawal of water from the Upper Floridan aquifer has resulted in radial flow toward the center of pumping and a cone of depression beneath Savannah.

This reversal in hydraulic gradient has resulted in lateral encroachment of seawater that has been observed in two ways. First, lateral encroachment is expressed by the westward movement of the freshwater/saltwater interface toward the center of pumping (Savannah). Second, lateral encroachment is seen at Port Royal Sound in South Carolina where the confining unit is completely absent and the aquifer is directly overlain by saltwater. Saltwater enters the aquifer and moves southward (laterally) toward the center of pumping. This effect has been well

documented as elevated chloride levels in Floridan wells at the north end of Hilton Head, South Carolina (Smith, 1988; Ransom et al., 2006).

Sustained pumping in the Savannah area has also resulted in a downward hydraulic gradient and induced significant head differences between the surficial aquifer and the confined Upper Floridan aquifer (Clark et al., 1990). This effect has resulted in the downward intrusion of water through the Miocene into the aquifer. The Savannah District US Army Corps of Engineers (1998) and Clark (1999) documented downward hydraulic gradients through the upper confining unit at four well locations in the Savannah area. These studies indicate that downward leakage of water through the confining unit contributes a significant amount of water to the flow system.

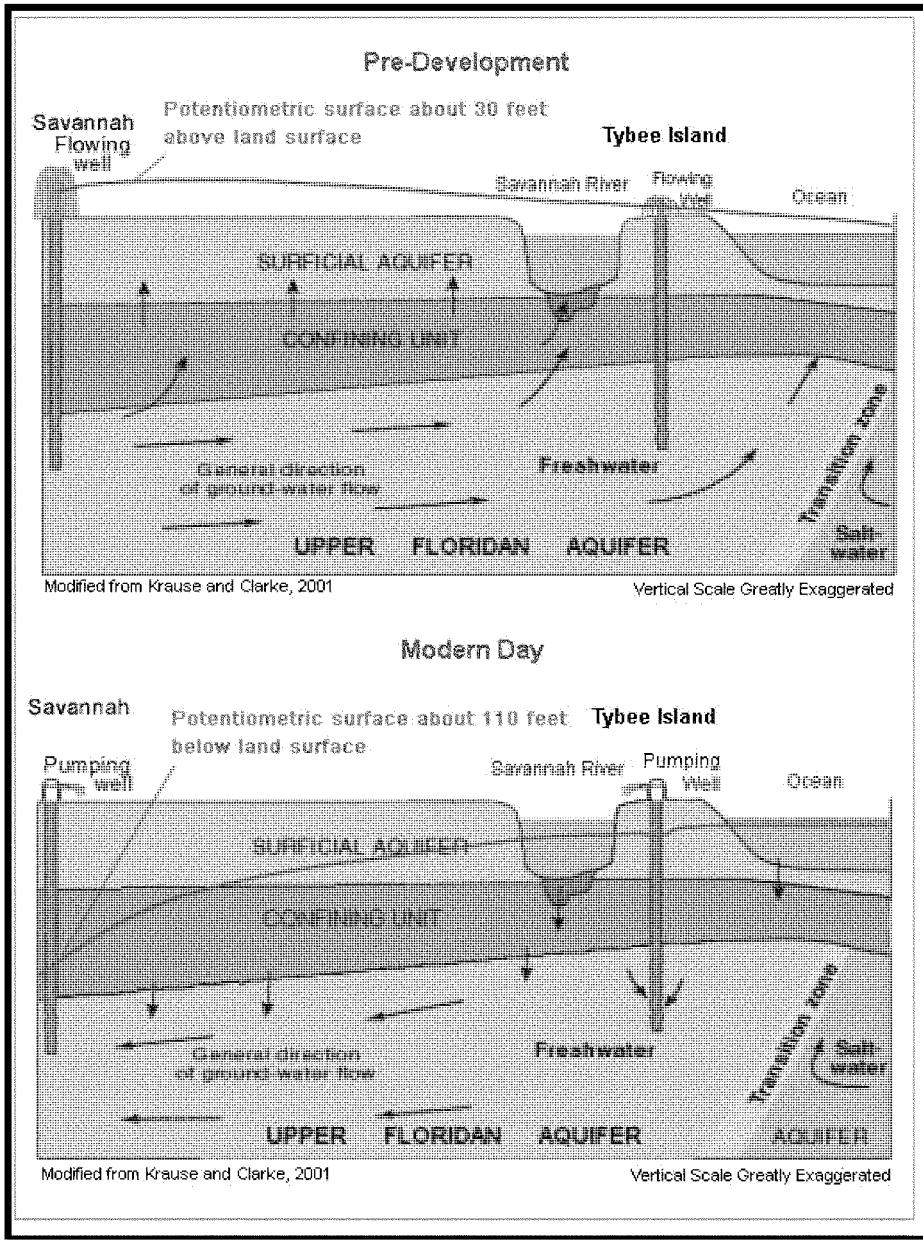

Figure 10. Pre-development and present ground-water flows.

Improvements (deepening) and maintenance of the Savannah Harbor Navigation Project have also had some impact on the downward migration of water through the confining unit into the aquifer. Channel dredging has removed portions of the Pleistocene sands and Miocene clays that reside above the upper Floridan aquifer. The Miocene is exposed in some portions of the bottom of the navigation channel. Significant exposure of the Miocene in the navigation channel is a fairly recent event. GIS studies conducted as part of the SHEP indicate that exposure of large stretches of Miocene along the Bight Channel (Elba Island) and near the Kings Island Turning Basin appeared to have occurred between 1992 and 1998. Completion of the dredging of the existing 42-foot channel in 1994 may at least partially explain this observation.

Present Conditions

The upper Floridan aquifer serves as the most important source of ground water in the study area, providing some 82 million gallons per day (MGD) of ground water in Chatham County. This withdrawal rate is down from a maximum of 88 MGD in 1990 due to a reduction in industrial pumping. This pumping has created a cone of depression, greatly reducing or eliminating the artesian pressure that had previously existed in the Savannah area. Previous studies indicate that a withdrawal of 82 MGD at Savannah produces about a 90-foot drop in head in the upper Floridan aquifer. Lowering of the artesian pressure has resulted in a landward movement of the saltwater/freshwater interface in this aquifer (saltwater intrusion).

Depressed groundwater heads in the Upper Floridan aquifer due to Savannah area pumping also induce downward flow of water through the Miocene to the aquifer. The downward leakage of water through the confining unit contributes a significant amount of water to the flow system in the area. The leakage has been estimated to represent nearly half the water budget for the Savannah area, or 40 MGD (Garza and Krause, 1996). Some of this downward flow of water is saltwater. Thus, these vertical head gradients are the dominant forces that cause the downward movement of saltwater through the Miocene confining unit.

Pumping of groundwater from the upper Floridan aquifer is expected to continue in the future. In Chatham County, this water is used for municipal and industrial purposes. Demands for this water are expected to increase as the population of the County grows.

The GA DNR-EPD "Interim Strategy for Managing Salt Water Intrusion in the Upper Floridan Aquifer of Southeast Georgia" (1997 – 2005) called for reducing total permitted volumes for pumping in Chatham County from the upper Floridan aquifer by 10 MGD. This policy was implemented. While this action limits the permitted level of withdrawals -- not necessarily the amount actually being withdrawn, it effectively caps groundwater use rates at 1997 levels. By the summer of 2001, GA DNR-EPD had fully allocated the 36 MGD of groundwater that was available for permitting. Since then, they have issued no new permits for withdrawal in this area.

Another component of the Interim Strategy is that GA DNR-EPD will not issue any new withdrawal permits for the upper Floridan aquifer in Chatham County and the southern portions of Bryan and Effingham Counties – the counties located westward and immediately adjacent to Chatham County.

The Coastal Sound Science Initiative (CSSI) was initiated by the GA DNR-EPD in 1998. This was the second stage of the interim strategy. It included an array of scientific and engineering investigations intended to generate the information and data required to develop a more well-founded plan for managing saltwater intrusion in the 24 coastal Georgia counties under the interim plan. Three sub-regions were established for purposes of implementing region specific policies and permitting requirements to stop saltwater intrusion, manage wastewater and implement water conservation and reuse practices.

Chatham, Bryan, and Liberty Counties, as well as the portion of Effingham County south of Georgia Highway 119, were included in Sub-region-1. The primary management tool for the revised plan involves no net increases in Upper Floridan aquifer withdrawals above amounts withdrawn in 2004 and a reduction in actual withdrawals by least an additional 5 MGD at the end of 2008. This plan also included water conservation and reuse and a move towards diversification of resources (a blend of surface and ground-water sources versus ground-water only).

In 2004, GA DNR-EPD modified the interim strategy by stating that it would not approve any new groundwater pumping (from any aquifer) in the capped area where surface water is reasonably available. Elsewhere, aquifers other than the upper Floridan are still available for permitting. More recently, work from the CSSI has been integrated into the development of the State Water Plan.

As discussed above, construction and maintenance of the Savannah Harbor navigation project has also contributed to the downward migration of water through the confining layer to the aquifer. The Miocene is exposed in some portions of the navigation channel. GIS analysis conducted as part of the SHEP studies indicate that approximately 5 feet of confining material has been removed from some portions of the navigation channel. Underneath the navigation channel, the overall thickness of the confining unit ranges from about 30 feet thick near the Tybee high to over 150 feet thick near downtown Savannah. GIS analysis of the removal of confining material through time and groundwater model studies conducted during SHEP studies indicate that historic dredging has probably had minimal influence on the rate of saltwater intrusion.

SHEP studies also identified eight significant paleochannels that had incised deeply into the Miocene confining layer between Stations 30+000 and Stations -30+000B. Table 19 shows the Paleochannel (described as Relic Cut and Fill (RCCF)) locations and formation elevations. RCCF 4 located near Station 9 is the area of the navigation channel with the minimum thickness (26 feet) of Miocene confining material underlying the navigation channel.

Table 19. Paleochannel Locations and Elevations

Feature Designation	Location (River Station)	Elevation of Paleochannel Miocene Contact at Maximum Incision Depth (ft MLW)	Average Elevation of Miocene/Oligocene Contact (ft MLW)	Minimum Thickness of Miocene Confining Layer (ft)
RCCF 1	22+000	-80	-116	36
RCCF 2	20+000	-64	-116	55
RCCF 3	15+000	-74	-112	42
RCCF 4	9+000	-83	-108	26
RCCF 5	1+500	-70	-107	38
RCCF 6	-3+000	-70	-98	28
RCCF 7	-11+000	-67	-99	34
RCCF 8	-21+000	-73	-110	36

Analysis conducted during the SHEP studies indicate that the Savannah Harbor project area is not likely characterized by joints or fractures which could serve as pathways for enhanced downward flow. The absence of observable vertical joints in Miocene-aged surface exposures and subsurface cores of the Miocene show no evidence of joints or fractures. Also, there is no historical evidence (springs, etc) of joints or fractures in the area. These findings support the conclusion that fracture or joints are not a factor in the hydraulics of the confining layer in the Savannah area. If joints or fractures existed in the past, the in-situ conditions (-42 feet MLW and under considerable lithostatic pressure, considerable clay content and plasticity) would not allow joints or fractures to remain in the Miocene indefinitely.

Capacity to Withstand Stress

Users of groundwater in coastal Georgia (and adjacent South Carolina and Florida), to varying degrees, contribute to saltwater intrusion in the upper Floridan aquifer in coastal Georgia. In order to minimize further degradation of the Floridan aquifer, the GA DNR-EPD has capped the total withdrawal of groundwater from the aquifer. The restrictions on withdrawal of groundwater illustrate the importance of preventing or minimizing any additional activities that would increase the chloride content in the Upper Floridan aquifer.

Future Actions / Stresses

Increases in population levels are expected to result in demand for greater volumes of treated water. For growth to continue, government officials must either provide more water or re-use the water that is already withdrawn.

Increases in the volumes of water permitted to be withdrawn from the upper Floridan aquifer in Chatham County is not expected, since GA DNR-EPD has capped the total withdrawal volume for the county. Therefore, the cone of depression near Savannah and saltwater intrusion near Tybee Island are not expected to rapidly worsen.

Re-use of water is relatively low in the coastal region, with that re-use concentrated mainly in the pulp and paper production and electrical power production industries. Re-use is higher in South Carolina and Florida. Some golf course irrigation occurs in coastal Georgia using treated effluents, but the level of that re-use is relatively low. Any re-use of water that has already served the intended use reduces the demand on new sources.

GA DNR-EPD indicates that there appear to be more water conservation opportunities in the fields of agriculture (irrigation) than the field of public water supply. They believe there are limited water conservation opportunities in the pulp and paper industries.

The lowering of the water level in the Floridan aquifer has reversed the natural pre-development flow of ground-water from the aquifer upward through the confining layer to a downward flow of water from above through the confining layer and toward the center of pumping for in Savannah. Since much of the area within the drawdown cone of depression is overlain by saltwater, chloride levels in the Upper Floridan aquifer in the Savannah area are expected to increase.

Harbor channel improvements also have the potential to affect saltwater intrusion into the aquifer. Potential harbor channel improvement projects include the SHEP and a Jasper County container terminal in what are now CDFs 14A and 14B at about River Mile 6. A Jasper County terminal could have similar dredging requirements in the entrance channel as the SHEP. Construction of a Jasper County terminal would not be expected to exacerbate the movement of chlorides through the Miocene into the Upper Floridan aquifer.

The SHEP has the potential to impact chloride levels in the Upper Floridan aquifer. The concern is that excavation required to deepen the harbor would allow saltwater to enter that freshwater aquifer, degrading its quality and rendering it unacceptable for drinking purposes. The EPA has established drinking water standards of 500 mg/l for total dissolved solids and 250 mg/l for the chloride ion. Water having chloride levels of less than 250 mg/l is considered safe and palatable to drink. This potential impact to the aquifer from channel deepening could occur in three different ways:

1. Deepening of the channel would require removal of the some of the aquifer's protective layer (Miocene cap). Since most of the water over the Miocene layer in the navigation channel is saltwater, this could result in saltwater intrusion into the aquifer.

2. Removal of sediments from paleochannels (former Pleistocene-age stream channels that have eroded into the Miocene cap) would increase the potential for saltwater intrusion into the aquifer. These areas generally represent those portions of the navigation channel with the minimum thickness of the confining layer over the aquifer. SHEP studies indentified eight significant RCCFs where the thickness of the remaining Miocene layer ranges from 26 feet to 55 feet.
3. Water with increased salinity levels could enter the aquifer via fracture or joints in the Miocene cap.

Incremental Impact

The incremental impact of long-term groundwater withdrawals on chloride levels in the Floridan aquifer has been well documented. Water levels in the aquifer have dropped to the point where both lateral and vertical intrusion of saltwater occurs. Using year 2000 pumping rates, SHEP model studies predict that this rate of pumping will cause total breakthrough of seawater to occur regardless of any channel deepening at some downstream locations in approximately 100—300 years depending on hydraulic conductivity of the confining layer. The GA DNR-EPD is aware of this possibility and has taken steps to reduce groundwater pumping that affects the Upper Floridan aquifer. The GA DNR-EPD is also conducting additional studies to determine what other steps can be taken to prevent further degradation of the Upper Floridan aquifer.

Although not as severe as massive pumping of groundwater, the Savannah Harbor Navigation project has had some impacts on chloride levels in the Upper Floridan aquifer. Construction and maintenance of the existing deep-draft navigation channel has not contributed to the cone of depression or loss of artesian pressure that has resulted in both lateral and downward intrusion of saltwater into the aquifer. However, GIS analysis conducted during the SHEP studies indicate that about 5 feet of the confining layer that protects the aquifer has been removed by project improvements and maintenance in some reaches of the channel. The removal of 5 foot of confining materials would make it easier for water to move downward through the Miocene into the aquifer. Since most of the navigation channel is saltwater, this could increase chloride levels in the aquifer. However, GIS analysis of confining material through time and groundwater model studies indicate that historical dredging has probably had minimal influence on the rate of saltwater intrusion.

Initial studies (1998 Potential Groundwater Impacts for the Savannah Harbor Expansion Feasibility Study) to evaluate the impacts of harbor deepening on the aquifer were conducted in support of the Tier I EIS. Following the release of that report, the SHEP study group developed a study plan to address additional issues relating to the aquifer. The primary objective of the additional study plan was to further evaluate potential impacts of harbor deepening on chloride levels in the aquifer. The 48-foot channel was selected to be analyzed since it would represent the worst case scenario. Deepening the channel to 48 feet would impact materials between -42 feet and -58 feet MLW which are comprised primarily of Miocene sediments. Consequently, the study focused on the Miocene layer (confining layer) along the navigation channel, especially from Fields Cut (Mile 5.0) to approximately two miles offshore of Tybee Island, where the confining layer naturally thins and RCCFs have incised into the confining layer.

Additional studies conducted during the SHEP relating to impacts on the aquifer included six major tasks which were: seismic surveys, land and marine drilling that incorporated porewater and hydraulic testing, development of a groundwater model, determining the feasibility of conducting an aquitard test, and incorporating data (past and present) into a comprehensive Geographic Information System.

The porewater data obtained from the additional studies indicate that, as expected, seawater is moving downward through the Miocene confining layer toward the Oligocene limestone (Upper Floridian aquifer), and, in some locations, low concentrations of chlorides appear to have migrated entirely through the confining layer and into the limestone. Chloride concentrations in the Miocene decrease with depth from top to bottom. Chloride concentrations ranged from a high of 20,000 mg/l near the top of the layer to a low of 15 mg/l near the bottom of the layer.

The results of the three-dimensional model runs indicate that the expected increase in the downward flow of saline water from the area underlying the navigation channel due to channel deepening would be very low. The area that would have to be dredged to deepen the channel to 48 feet MLW accounts for a total downward flow between 50 to 250 gallons per minute depending on the hydraulic conductivity assigned to the confining unit. Dredging the navigation channel to 48 foot MLW increases the downward flow between 2-7 gallons per minute which translates to a 3-4 % increase. This contribution is negligible when compared to groundwater production in the Savannah area from the aquifer which is about 80 million gallons per day (55,555 gallons per minute). The results of this analysis represent only the contribution from the river and the navigation channel. Other water sources (salt marshes, offshore) were not simulated in order to determine the explicit impacts of dredging.

The potential for increased saltwater intrusion into the aquifer is less in the upstream areas of the harbor where surface water quality modeling predicts minimum increases in chloride concentrations. The location of the maximum head gradient, i.e., the center of the cone of depression (Savannah), would seem to be the area that would pose the greatest potential for enhanced saltwater leakage through the confining layer. However, the porewater data and the model results show that the thickness of the confining unit (>100 feet) and the lower salinity of the river water in the upper harbor minimize potential adverse impacts to the aquifer and production wells located in and around Savannah.

The three-dimensional model was used to simulate chloride concentrations in the Upper Floridan aquifer for the years 2000, 2050, and 2200 for both dredging and no dredging scenarios. In the year 2200 (based on the year 2000 pumping rates); the upstream chloride concentrations in the Upper Floridan aquifer beneath the river were predicted to be 0 mg/l for low-value hydraulic conductivity simulations and up to 100 mg/l for the mid-range hydraulic conductivity simulations. The difference between simulated chloride conditions in the top of the Floridan aquifer between the dredging and the no dredging scenarios were minor.

The downstream areas, however, specifically near the Tybee high, showed a gradual increase in chloride concentrations in the Upper Floridan aquifer. Chloride levels directly beneath the river approached 500 mg/l after 200 years for the low-value hydraulic conductivity simulations. For the mid-range hydraulic conductivity simulations, total breakthrough (when simulated chloride

concentrations in the top 50 to 60 feet of the upper Floridan aquifer initially exceed 250 mg/l) occurred after approximately 100 years. The enhanced salt-water intrusion in this area is attributed to the induced negative head gradient from pumping in Savannah, the high salinity of the overlying water with minimal freshwater input from the Savannah River, the naturally thin confining layer (40-60 feet), and the paleochannels that have further removed Miocene material. The model results show that harbor deepening would have little effect on this process.

Dredging in the areas where the eight significant RCCFs were documented would have only minor impacts on the downward movement of chlorides through the confining unit into the aquifer. Groundwater model results indicate that any additional contribution of chloride by the paleochannels is negligible when compared to the total contribution from other adjacent saltwater sources outside paleochannels along the river bottom. The impacts of dredging in the sediments within the paleochannels were small when compared to the impacts of dredging elsewhere in the channel where the Miocene confining unit is impacted. The bottom of the paleochannels represents the areas of minimum thickness of the Miocene confining area in the harbor. Dredging would not be required at these depths.

Alternatives to Mitigate for Cumulative Effects

There are no known, practical means to remedy the saltwater intrusion that has occurred in the Upper Floridan aquifer from past groundwater pumping practices. However, as discussed in previous paragraphs, GADNR-EPD is very proactive in taking actions to halt the intrusion of additional saltwater into the aquifer as a result of ground-water withdrawal.

The proposed deepening of the Savannah Harbor Navigation Project raised concerns about the potential for additional saltwater to enter the aquifer through removal of a portion of the Miocene confining unit or through the paleochannels that cross portions of the channel. SHEP Tier II studies (using the 48-foot channel) show that the predicted increases in salinity levels in the harbor or the reduced thickness of the confining layer due to dredging will not significantly affect the timing of the breakthrough of chlorides along the navigation channel in the Upper Floridan aquifer. Study results also indicate that the proposed dredging would have minimal impacts on water quality in production wells that tap the Upper Floridan aquifer in and around the City of Savannah. No mitigation actions are proposed for the minimal impacts identified to chloride levels in the aquifer. However, monitoring would be conducted to confirm model predictions.

Monitoring

As a condition to the Georgia Section 401 Water Quality Certification for the SHEP, the Georgia DNR-EPD requested a detailed monitoring plan for early detection of potential chloride migration into the aquifer. Monitoring of chloride levels in the Upper Floridan aquifer must be conducted along critical groundwater flow paths to ensure there the SHEP does not result in the significant migration of chlorides downward through the confining layer that could move towards production wells in the Savannah area. The monitoring would involve the establishment of sentry wells along critical groundwater flow paths. These wells would be installed near the top of the aquifer to monitor downward migration of chlorides through the confining unit and

deeper in the aquifer to monitor how horizontal flow of freshwater within the aquifer mixes with and dilutes the chloride. The sentry wells are to be located west of exploratory borings SHE-11 and SHE-13 and on Cockspur Island near Fort Pulaski.

Monitoring wells would also be established upgradient of critical groundwater flow paths to provide information on background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Background wells would be established near the top of the aquifer and deeper in the aquifer to establish background chloride concentrations. Annual monitoring of these wells would be required for the life of the project, and differences in the long-term trends of chloride concentrations in the sentry and background wells used to evaluate impacts of SHEP from impacts of groundwater withdrawal on chloride concentrations in the aquifer.

Groundwater monitoring also includes the establishment of benchmark chloride concentrations for each sentry well. The benchmark chloride concentrations must protect the Savannah area production wells which include industrial, commercial, municipal, agricultural, and other un-permitted wells. Mitigation would be required if sampling of monitoring wells indicates that the Savannah area production wells may be affected by downward migration of chloride confining unit as a result of SHEP dredging activities.

12. Endangered Species

Issue

Endangered species in Savannah Harbor was another resource that the Corps decided to address in the cumulative impact analysis for the project. More specifically, the Corps felt that Shortnose sturgeon be considered in the analysis of cumulative impacts.

As required by the Endangered Species Act, the Corps prepared a Biological Assessment of Threatened and Endangered Species (BATES) for the SHEP. Protected species that reside in the area were identified in the Biological Assessment of Threatened and Endangered Species (BATES) which is included in the EIS as Appendix B. North American right whales, humpback whales, sperm whales, leatherback turtles, loggerhead turtles, Kemp's ridley turtles, hawksbill turtles, green sea turtles, West Indian manatee and Shortnose sturgeon are species that are protected by Federal law that are commonly thought of as being at risk from harbor operations. The potential impacts of harbor deepening on these species are addressed in the BATES. Based on evaluations conducted in the BATES, a determination was made that harbor deepening "may affect but is not likely to adversely affect" these species. This finding was subject to review by the US Fish and Wildlife Service and the National Marine Fisheries Service. The USFWS has issued a letter of concurrence with the BATES' findings with respect to those species for which they have responsibility. The National Marine Fisheries Service has submitted the results of their review of the BATES in a Biological Opinion (BO). Both the USFWS Report and the BO are included in this document in Appendix Z.

The potential impacts to the endangered species identified in the BATES. . In view of the past adverse incremental impacts to Shortnose sturgeon habitat and the small population of these species remaining in the Savannah River, an analysis of further potential cumulative adverse impacts that could be caused by harbor deepening was deemed appropriate.

Geographic Scope

The Shortnose sturgeon is an anadromous species restricted to the east coast of North America. They have been recorded from New Brunswick to northern Florida. Throughout its range, Shortnose sturgeon occur in rivers, estuaries, and the sea. However, Shortnose sturgeon prefer lower salinity than pure seawater, typically in the range of 30-31 ppt (Holland and Yelverton 1973: Dadswell et al. 1984). The greatest abundance of this species is found throughout most of the year in the lower portions of the estuary of their respective river.

The NMFS considers Shortnose sturgeon from different river systems to be reproductively isolated, with the loss of a single Shortnose sturgeon population segment possibly risking the permanent loss of unique genetic information that is critical to the survival and recovery of the entire species. Therefore, the NMFS manages each Shortnose sturgeon population as a distinct population segment for the purposes of the ESA. Under this policy, actions that could adversely affect a Distinct Population Segment are evaluated in terms of their potential to jeopardize the continued existence of an individual population segment (as opposed to the existence of Shortnose sturgeon range wide). Shortnose sturgeon residing in the Savannah River have been found in nearby river systems, so some movement between sturgeon populations does occur in this area.

NMFS has divided the Shortnose sturgeon populations into 19 management units based on presumed reproductive isolation (Center for Biological Diversity, 2009). Seven large populations (>= 1,000 fish) are located in the Saint John River (New Brunswick), Kennebec System Maine, Connecticut River (Connecticut and Massachusetts), Hudson River, New York, Delaware River (Delaware, New Jersey, and Pennsylvania), Savannah River and Altamaha River ,Georgia. Two small populations (< 1,000 fish) are located in Winyah Bay, South Carolina and Ogeechee River, Georgia. Ten very small populations (< 100 fish) are located in Penobscot Maine; Merrimack River, Massachusetts; Chesapeake Bay (Maryland and Virginia); Cape Fear River, North Carolina; Santee River, South Carolina; Cooper River, South Carolina; "ACE Basin", South Carolina; Satilla River, Georgia; St. Mary's River, Florida; and St. Johns River, Florida.

Since the NMFS considers the Savannah River Shortnose sturgeon to be a distinct population based on reproductive isolation, the Savannah River will be the geographic scope of this analysis. Although Shortnose sturgeon are an anadromous species of fish, Shortnose sturgeon in the Savannah River appear to be primarily riverine.

Historic

There is no estimate of the historical population size of Shortnose sturgeon (NOAA Fisheries, Office of Protected Resources, 2009). Atlantic and Shortnose sturgeon fisheries began with native American Indians prior to the arrival of European settlers. Colonist's records indicate exports of sturgeons to Europe as early as 1628 (NOAA, 2009). Shortnose sturgeon were rarely the target of commercial fisheries and were taken primarily as incidental by-catch in other fisheries (NOAA, 2009). The USFWS placed the Shortnose sturgeon on the endangered species list in 1967. The Shortnose Sturgeon Final Recovery Plan was completed in 1998.

Shoals in the Savannah River served as prime spawning habitat for the Shortnose sturgeon in this basin. Prior to mainstream impoundment by dams, shoals existed in the Savannah River from Augusta, Georgia upstream to the mouth of the Tugaloo River (177 miles). Some anadromous species continued up the Tugaloo River for another 49 miles to the headwaters at Tallulah Falls, Georgia.

Shortnose sturgeon were first studied in the Savannah River system in the mid-1970's (Dadswell et al. 1984). During 1984-1992, over 600 adults were collected by shad fishermen and researchers using gillnets and trammel nets (Collins and Smith 1993). The ratio of adults to juveniles in this study was very high, indicating that recruitment is low in the river (Smith et al. 1992). No reliable adult population estimates were calculated since not all basic assumptions were met (M. Collins, South Carolina Department of Natural Resources, personal communication).

A 1991 study indicates that two probable spawning sites for sturgeon are from River Mile 112 to 119 and from River Mile 172 to 174 (Hall et al., 1991). The study also found juvenile Shortnose sturgeon in the upper end of the harbor, particularly the Kings Island Turning Basin (River Mile 18.9). The criteria the fish used to choose that location were not fully understood, as that area regularly experiences low levels of dissolved oxygen in the summer.

Between 1984 and 1992, approximately 97,000 Shortnose sturgeon (19% tagged) of various sizes were stocked in the Savannah River to evaluate the potential for Shortnose sturgeon stock enhancement (Smith and Jenkins 1991). Subsequent investigation showed that stocked fish were at large for an average of 416 days and comprised 41 % of all juvenile sturgeon collected (Smith et al. 1995).

Surveys of the 1999-2000 population indicated many more adults than in 1992 which was attributed to stocked fish. There was little evidence of reproduction. The 1999 population in the Savannah River was estimated at 3,000 fish.

Past Actions/Stresses

Construction of mainstream dams on the Savannah has blocked access to traditional Shortnose sturgeon spawning grounds in shoal areas located above Augusta, Georgia. Over-fishing, starting in colonial times and continuing into the 1950s, also contributed to population declines of this species. Although the Shortnose sturgeon was rarely a targeted fishery, many were taken as a byproduct of other fisheries such as Atlantic sturgeon and American shad.

Access to traditional spawning grounds is now blocked by a series of six dams with the New Savannah Bluff Lock and Dam below Augusta, Georgia being the first obstacle to traditional spawning grounds. Dam and reservoir construction converted or blocked access to approximately half of 384 miles of historical anadromous fish spawning and nursery habitat of the Savannah River. Practically 90 percent of the high quality anadromous fish spawning habitat (rapids complex: boulder, bedrock, cobble and gravel substrate) has been blocked or inundated by large reservoirs above the Augusta Diversion Dam. The majority of the habitat that is no longer accessible was the most heavily used. The NMFS estimates that 90 to 95 percent of the quality spawning habitat for rapids-dependent anadromous species has been lost. As previously shown in Figure 7, the only shoals remaining on the Savannah River consists of a small 7.2 km stretch located below the Augusta Diversion Dam.

In addition to the loss of traditional upstream spawning habitat, riverine habitat below the dams has been affected by contaminants from both point source discharges and non-point sources (urban and agricultural run-off, timber harvesting, etc.). In lieu of natural flows, flow in the river is now controlled by releases from J. Strom Thurmond Dam.

Construction of the Savannah River Below Augusta Navigation Project also affected spawning habitat below the dams. The project provides for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (Mile 21.3) to just below Augusta, Georgia (Mile 202.2), a distance of 180.9 miles. Channel modifications included channel dredging, widening, snagging, construction of bend cutoffs (Channel straightening) and construction of pile dikes. This project has not been maintained since 1979. The cutoff bends have accumulated sediment and organic matter since they were constructed in the late 1950s and the early 1960s. Most of the cutoff bends (there are 40 such bends along the project) have been substantially reduced in volume and surface area and some have completely filled with sediment, reducing fish habitat during normal summer flow conditions. The USFWS considers these river bends to be biologically significant.

The estuarine habitat of Shortnose sturgeon in the Savannah Basin has also been extensively modified. A significant amount of wetland habitat has been lost to agriculture, industrial development, and from dredged material disposal operations associated with the construction and maintenance of the Savannah Harbor Navigation Project. Water quality has been altered by non-point and point-source discharges as well as harbor modifications. Harbor construction and maintenance has had major impacts on the dissolved oxygen and salinity regimes in the estuary.

Present Condition

The present population of Shortnose sturgeon in the Savannah River is unknown. The 1999 population was estimated to be 3,000 fish. The fish are readily found by resource agencies when sampling is specifically targeted for them. Although the Savannah River Shortnose population is considered to be improving since the species was placed on the endangered species list in 1967, the apparent low level of recruitment remains a major concern.

Shortnose sturgeon are found in the Savannah River estuary throughout the year within the area from about River Mile 17.5 to 31.7. Juvenile and adult Shortnose sturgeon use the area located about 1-3 miles above the freshwater interface throughout the year as a feeding ground. During the summer, this species tends to use deep holes at or just above the freshwater interface.

In a recent study of Shortnose sturgeon on the Savannah River conducted by the SCDNR, all juveniles were found upriver of the Kings Island Turning Basin (Mile 18.8). Juvenile sturgeon were found just downstream of the Houlihan Bridge (Mile 21.5) during the spring. During the winter months, they were found just inside the mouth of Middle River (River Mile 19.4) in a deep hole just downriver of New Cut. The small size of the fish captured in Middle River suggests that this location is an important nursery area for juvenile Shortnose sturgeon. The juveniles moved upriver (Mile 29.5) during the summer months.

Adults were found throughout the estuary, extending from River Mile 3.4 to 30.4. They also exhibited an upstream movement during the warmer summer months. The species' general pattern of seasonal movement appears to involve an upstream migration from late January through March when water temperatures range from 9 C to 12 C. Two probable spawning sites for Shortnose sturgeon are from River Mile 112 to River Mile 119 and River Mile 172 to 174 (Hall et al, 1991). Spawning fish begin moving back downstream in March, returning to the estuary area of the river in late May.

Present Actions / Stresses

The Recovery Plan lists habitat degradation or loss, and mortality as being the principal threats to the species' survival.

Habitat degradation or loss on the Savannah River is mainly attributable to the construction of upstream dams. These dams prevent Shortnose sturgeon from using traditional upstream spawning habitat. An inability to move above dams and use potentially beneficial spawning habitats may restrict the size of the Savannah River population.

Hydroelectric dams may also affect Shortnose sturgeon habitat by altering river flows or temperatures necessary for successful spawning and/or migration. The major dams on the main stem of the Savannah River – Hartwell, Richard B. Russell, and Thurmond Dams – substantially alter river flows and temperatures. Since sturgeon require adequate river flows and water temperatures for spawning, alterations that dam operations pose on a river's natural flow pattern (including increased or reduced discharges) can be detrimental to sturgeon reproductive success. Shortnose sturgeon are known to spawn downstream of the New Savannah Bluff Lock and Dam.

New Savannah Bluff is located some distance downstream of the last of the major dams on the river, and discharges from New Savannah Bluff are evened out quite a bit from the peaking characteristics of the flows that leave Thurmond Dam.

Construction and maintenance of the Savannah Harbor Navigation Project also affects Shortnose sturgeon habitat in the estuary. The navigation channel allows salinity to move further into the estuary and decreases dissolved oxygen concentrations in the harbor.

Loss of cool water habitat for Shortnose sturgeon during the summer months may also be a problem. During summer months, especially in southern rivers, Shortnose sturgeon must cope with the physiological stress of water temperatures that often exceed 28°C. Flournoy et al. (1992) suspected that during these periods, Shortnose sturgeon congregate in river regions that support conditions that relieve physiological stress. In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flournoy et al. 1992; Rogers and Weber 1994; Weber 1996). Gulf sturgeon are reported to fast at high water temperatures and occupy river reaches of the Suwannee River (Florida) near flowing spring heads (Mason and Clugston 1993). Flournoy et al. (1992) suggest that in the Altamaha River, Shortnose sturgeon also seek deep, artesian spring-fed habitats that provide thermal refuge. Although a relatively new finding, the loss and/or manipulation of these discrete habitats may limit or be limiting population survival, particularly in southern river systems. For instance, Krause and Randolph (1989) report that subterranean aquifers are severely depleted in the Savannah and Ogeechee Rivers (Georgia) and Satilla and St Mary's Rivers (Florida). Other portions of the EIS for this project discuss how excess pumping of groundwater has decreased or eliminated the historic artesian springs in the Savannah area.

Shortnose sturgeon mortality can be caused by numerous factors. The USFWS identified over-harvesting in commercial fisheries as one of two primary reasons for initially listing Shortnose sturgeon as endangered. Directed harvest of Shortnose sturgeon is prohibited by the ESA. However, Shortnose sturgeon are taken incidentally by shad fishermen on the Savannah River. Collins et al. (1996) reported that the shad gillnet fishery accounted for 83% of Shortnose sturgeon take in Georgia coastal fisheries.

In most cases, these fish are returned to the river, presumably unharmed. However, Moser and Ross (1993) found that captures of Shortnose sturgeon in commercial shad nets disrupted spawning migrations in the Cape Fear River, and Weber (1996) reported that these incidental captures caused abandonment of spawning migrations in the Ogeechee River, Georgia. Incidental take of Shortnose sturgeon by American shad fisherman has been greatly reduced. The traditional method of harvesting American shad by gillnets in a coastal intercept fishery was phased out between 2000 and 2004.

Contaminants can also contribute to Shortnose sturgeon mortality. Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life. These impacts can include production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sindermann 1994). Ultimately, toxins introduced to the water column become associated

with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Point-source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) may also contribute to impacts stemming from poor water quality. Compounds associated with discharges, including metals, dioxin, dissolved solids, phenols, and hydrocarbons, can alter the pH of receiving waters, which may lead to mortality, alterations in fish behavior, deformations, and reduced egg production and survival (Heath 1987). Dioxins and furans were detected in ovarian tissues of Shortnose sturgeon collected in the Sampit River/Winyah Bay ecosystem (South Carolina). Pulp mill, silvicultural, agricultural and sewer discharges which contain elevated temperatures or high biological demand can reduce dissolved oxygen levels. Low dissolved oxygen levels (below 5 ppm) are known to be stressful to aquatic life and, presumably, sturgeon are adversely affected by levels below this limit. Research indicates that juvenile Shortnose sturgeon experience relatively high mortality (86 %) when exposed to dissolved oxygen concentrations of 2.5 mg/l. Older sturgeon (> 100 days) could tolerate dissolved oxygen concentrations of 2.5 mg/l with < 20 % mortality, indicating an increased tolerance for lowered oxygen levels by older fish. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C. At these temperatures, concomitant low levels of dissolved oxygen may be lethal. In Georgia, several rivers exhibit low oxygen levels (< 2.5 mg/l) during the summer at the saltwater/freshwater interface, an area that normally aggregates both juveniles and adults.

Although there are numerous point source discharges into the Savannah River from the Augusta and Savannah areas, water quality in the river is generally considered good. The water use classification for the Savannah River from Augusta (Mile 202) to the US Highway 301 Bridge (Mile 129) is fishing. Dissolved oxygen requirements provide for a daily average of 5.0 mg/l and no less than 4.0 mg/l at all times for waters supporting warm water species of fish. In regard to point source discharges, at no time can the receiving waters be increased more than 5 degrees Fahrenheit.

The stretch of the Savannah River from the US 301 Bridge to the Seaboard Coastline Railroad Bridge (Mile 27.4) is classified as Drinking Water. Dissolved oxygen and temperature requirements are the same as for those waters classified as Fishing.

The portion of the Savannah River between the Seaboard Coastline Railroad Bridge and Fort Pulaski (Mile 0.0) is classified as Coastal Fishing. Dissolved oxygen requirements provide for a daily average of 5.0 mg/l and no less than 4.0 mg/l at all times. If it is determined that the "natural condition" in the waterbody is less than the values stated above, then the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/l deficit from the "natural" dissolved oxygen value. Up to a 10% deficit is allowed if it can be demonstrated that resident aquatic life shall not be adversely affected. Since this stretch of the river is in an estuary, the temperature of the receiving waters cannot be raised more than 1.5 degrees F.

Although the section of the Savannah River between the Seaboard Coastline Railroad Bridge and Fort Pulaski generally meets the standards for waters classified as Coastal Fishing, it is on the

State of Georgia's Section 303 (d) list of impaired waters because of recurring low levels of dissolved oxygen.

Shortnose sturgeon are also susceptible to impingement on cooling water intake screens. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. Without better data on current population sizes, it is not possible to assess the extent to which power plant impacts adversely affect a given sturgeon population.

Dredging operations have the potential to cause Shortnose sturgeon mortality as well. Maintenance dredging of Federal navigation channels can adversely affect or jeopardize Shortnose sturgeon populations. In particular, hopper dredges can lethally harm sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. NMFS observers documented the take of one Atlantic sturgeon in a hopper dredge operating in King's Bay, Georgia (C. Slay, New England Aquarium, personal communication). In addition to direct effects, dredging operations may also impact Shortnose sturgeon by destroying benthic feeding areas or disrupting spawning migrations.

In addition to hydraulic hopper dredging, other dredging methods may also adversely affect sturgeon. Atlantic sturgeon have been killed in both hydraulic pipeline and bucket-and-barge operations.

Maintenance of the Savannah Harbor Navigation Project is believed to have only minimal impacts on Shortnose sturgeon in Savannah Harbor. Maintenance dredging is performed well downstream of known Shortnose sturgeon spawning habitat. Maintenance dredging operations are also downstream of areas where juvenile Shortnose sturgeon have been most recently observed. Adult Shortnose sturgeon are capable of avoiding maintenance dredging activities. There have been no observed instances of Shortnose sturgeon mortality associated with either hydraulic pipeline or hopper dredges working in Savannah Harbor. See Appendix B for the full discussion of potential impacts of dredging to Shortnose sturgeon.

Capacity to Withstand Stress

The capacity of the Shortnose sturgeon population in the Savannah River to withstand stress is unknown, as the population size, population distribution, and any critical habitats are unknown. However, these fish are mobile and recent studies indicate that they move to sites with more favorable conditions during the warmer summer months. This reveals at least some ability to move from preferred areas to locations that provide less favorable, but acceptable conditions. The biological cost of such relocation -- whether it stem from considerations such as fewer available food resources or crowding into smaller suitable habitats -- on specific individuals and its long-term effect on the entire population are unknown. But the total number of this species in the Savannah River is believed to be relatively small. Loss of a single well-used habitat could have major and/or long term effects on the survivability of this population. In the same way, restoration or enhancement of a single previously-valuable habitat could greatly aid in the recovery of this population segment.

Future Actions / Stresses

The long-term recovery objective for the Shortnose sturgeon is to recover all discrete population segments to levels of abundance at which they no longer require protection under the ESA. Establishing the population size thresholds in the Savannah River is a Priority 1 recovery task. To achieve and preserve the minimum population size for this population segment, essential habitats must be identified and maintained, and mortality must be monitored and minimized. Accordingly, other key recovery tasks are to define essential habitat characteristics, assess mortality factors, and protect Shortnose sturgeon through applicable federal and state regulations.

Factors identified in previous paragraphs that may adversely affect sturgeon in the Savannah River include the paucity of adequate spawning habitat, operation of hydroelectric dams and power plants, discharges of contaminants and maintenance dredging operations. Additionally harbor channel improvement projects have the potential to affect Shortnose Sturgeon and their habitat. Potential harbor improvement projects include the SHEP and a Jasper County container terminal.

Incremental Impact

Although studies on loss of Shortnose habitat and mortality factors in the Savannah River are somewhat limited, it is clear that protection of existing habitat is important to the survival of this population. Spawning habitat appears to be limited to a few areas between River Mile 112 to just below New Savannah Bluff Lock (about River Mile 215). Although classified as anadromous, the Shortnose sturgeon in the Savannah River are riverine. Other than the spring spawning migration, these fish appear to spend their entire life cycle in the Savannah River estuary. Juvenile Shortnose sturgeon spend most of the early part of their lives just above the freshwater interface. As juveniles grow into adults, they become more tolerant of low dissolved oxygen concentrations and higher salinities and venture well down into the estuary, with adults being recorded downstream as far as River Mile 3.4. Although no portion of the Savannah River estuary has been declared official critical habitat under the Endangered Species Act, the importance of preserving existing habitat in this basin is obvious.

Many measures have been implemented to protect the Shortnose sturgeon as well as other aquatic and marine life in the Savannah River estuary.

Over-fishing of Shortnose sturgeon has been eliminated as a causative factor in the decline of the Savannah River Shortnose sturgeon population. The Shortnose sturgeon has been on the endangered species list since 1967, and it is illegal to kill or possess this species. The phasing out of the traditional method of catching American shad (gillnets in a coastal intercept fishery) has greatly reduced the number of Shortnose sturgeon inadvertently caught by Shad fisherman. In turn, this has greatly reduced the interruption of Shortnose sturgeon migrations in the late winter and early fall.

Point source discharges in the Savannah River are regulated under the NPDES program by the GA DNR-EPD in coordination with the US EPA. Since the NPDES is a Federally-mandated program, all permits issued under the program are subject to review per the provisions of the Endangered Species Act.

As discussed in the section on dissolved oxygen, EPA established a TMDL for the Savannah River to improve dissolved oxygen conditions in the Savannah Harbor. The TMDL requires a reduction in oxygen demanding substances (over time as the various NPDES permits come up for renewal) in point source discharges. This impacts NPDES permit holders in the Augusta, Georgia area, as well, since their waste loads contribute to the dissolved oxygen deficiencies in Savannah Harbor. This is but one example of how implementation and management of the NPDES program protects aquatic life, including the Shortnose sturgeon from adverse cumulative effects from the discharge of pollutants.

Dam construction, removal and re-licensing actions are also subject to review for compliance with the provisions of the Endangered Species Act and other Federal laws protecting fish and wildlife through the approval process of the Federal Energy Regulatory Commission (FERC). There are no imminent plans for any dam construction or removal on the Savannah River. However, re-licensing actions have provided opportunity for input from Federal and state natural resource agencies concerning reducing the cumulative adverse effects of existing projects on aquatic habitat.

Power plant construction and operation is also regulated by FERC. Physical structures necessary to operate the plants such as intake and outfall structures require a Department of the Army Permit from the US Army Corps of Engineers. As such, power plant construction and operation are subject to the provisions of the Endangered Species Act. Water intakes and any associated potential Shortnose sturgeon entrainment issues would be reviewed by the USFWS and the NMFS, to determine what avoidance or mitigation measures would be required.

Dredging operations in the Savannah River also have the potential to impact Shortnose sturgeon. Any non-Federal dredging on the Savannah River requires a Department of the Army Permit from the US Army Corps of Engineers. The Corps of Engineers' permit review process includes full and close coordination with the USFWS and the NMFS to determine potential effects of any proposed dredging on endangered species.

The annual maintenance dredging of the Savannah Harbor Navigation Project has been evaluated for impacts to endangered and threatened species through various documents including a BATES. It has been concluded that maintenance of the harbor has very little impact on the Shortnose sturgeon. Dredging required to maintain authorized project depths is conducted well downstream of known Shortnose sturgeon spawning areas and below juvenile Shortnose habitat that is located just above the freshwater interface.

There are no current restrictions on maintenance dredging activities specifically relating to protection of the Shortnose sturgeon. Turtle observers on hopper dredges that maintain the bar channel are required to report any Shortnose sturgeon that are entrained by the dredge, in

addition to sea turtle entrainment. There have been no reported cases of Shortnose sturgeon entrainment in the Savannah Harbor Entrance Channel.

Dredging is not conducted when dissolved oxygen levels are below State standards unless a waiver is obtained from the Georgia DNR-EPD. This restriction protects both Shortnose sturgeon and other aquatic and marine life in the harbor.

There are two potential major dredging projects that could occur in Savannah Harbor.

A. Conceptual plans have been developed to construct a major container terminal in Jasper County, South Carolina. The facility would be located on what are now CDFs 14A and 14B. Channel deepening would be required in the entrance channel and in the inner harbor navigation channel to about River Mile 6.0. This dredging would be well below known Shortnose sturgeon spawning grounds and juvenile Shortnose sturgeon habitat, but includes locations where adult Shortnose sturgeon have recently been found. Since the project would require dredging only to about River Mile 6.0, the anticipated effects on upstream dissolved oxygen and salinity levels would be minimal. Construction of this facility would require appropriate Department of the Army Permits which would be subject to review to determine compliance with the provisions of the Endangered Species Act.

B. The SHEP also has the potential to impact the Shortnose sturgeon. Impacts could vary from direct, short-term impacts from dredging and disposal operations to more long-term impacts caused by loss of habitat.

Potential impacts to the Shortnose sturgeon resulting from dredging and disposal of the dredged sediment are evaluated in Chapter 5 of the EIS and the BATES. All dredging and sediment placement activities would be conducted well below Shortnose sturgeon spawning grounds and downstream of juvenile habitat which is near the freshwater interface. Construction activities would be carried out in accordance with any special provisions directed by the NMFS in the BO. The dredging and sediment placement activities are expected to have only minor impacts on the Shortnose sturgeon.

Model studies conducting during the SHEP indicate that harbor deepening could adversely impact Shortnose sturgeon habitat. More specifically, harbor deepening would adversely impact adult and juvenile winter Shortnose sturgeon habitat in the upper harbor because of increases in salinity levels. However, the proposed harbor deepening is expected to improve Shortnose sturgeon summer habitat through increases in dissolved oxygen concentrations.

Fishery habitat modeling was conducted involving model runs developed around important times for several life cycle stages of the Shortnose sturgeon. Since spawning occurs well upstream of Savannah Harbor, the impacts of harbor deepening were not evaluated with respect to egg and larvae habitat. The impacts of harbor deepening on juvenile and adult Shortnose sturgeon were evaluated. Habitat suitability criteria were developed by the SHEP Fisheries Interagency Coordination Team. EFDC model runs were used to predict hydrodynamics and salinity and WASP model runs were used to predict dissolved oxygen levels. The Post-Processor Habitat

Analysis Module combined the output from the EFDC and WASP models to determine habitat suitability based on criteria for each life stage and time of year.
Table 20 summarizes the results of the model runs for project impacts on winter and summer habitat for adult Shortnose sturgeon and winter habitat for juveniles without mitigation. As would be expected, the volume of suitable habitat for Shortnose sturgeon (without mitigation) decreases as harbor deepening increases. Reductions in the volume of juvenile Shortnose sturgeon winter habitat are the most noticeably affected and range from -5.0% with the 44-foot channel to -21.61% for the 48-foot channel. Decreases in adult Shortnose sturgeon winter habitat ranged from -0.5% for the 44-foot channel to -1.1% for the 48-foot channel while decreases in adult Shortnose summer habitat ranged from -3.2% for the 44-foot project to -15.80% for the 48-foot channel.

Table 20. Summary of Project-Related Impacts Without Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
	Loss (-) of Acceptable Habitat				
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)

Again, this table presents the impacts that could be expected if mitigation is not included in the project.

Alternatives to Mitigate for Cumulative Effects

The factors causing the historic decline of the Shortnose sturgeon population in the Savannah River have been discussed in previous paragraphs. Loss of access to traditional spawning areas in upstream shoal areas is a major factor in the decline of the species. Despite the stocking of 97,000 juvenile Shortnose sturgeon, no major reproduction trends have been observed.

There is opportunity to restore access to 35 miles of spawning habitat between the New Savannah Bluff Lock and Dam and J. Strom Thurmond Dam. The USFWS and NOAA (fisheries) in conjunction with the state natural resource agencies developed a plan to restore access to a portion of historical anadromous fish spawning habitat in the Savannah River. The plan was filed by the USFWS on behalf of the State resource agencies in 1994 and was adopted by FERC as a Comprehensive Plan pursuant to Section 10(a)(2) of the Federal Power Act. If implemented, the plan would restore access to approximately 35 miles of anadromous fish spawning and maturation habitat between New Savannah Bluff Lock and Dam and J. Strom Thurmond Dam. The plan contains four major provisions: (1) reliable passage of anadromous fish at the New Savannah Bluff Lock and Dam; (2) design and implementation of an upstream passage mechanism and safe downstream (out-migrant) passage at the Augusta Diversion Dam; (3) design and implementation of an upstream fish passage mechanism and safe downstream

passage at the Stevens Creek Dam; and (4) improvement of poor dissolved oxygen releases from the J. Strom Thurmond Dam during the summer months.

The Cops has attempted two fish passage methods at New Savannah Bluff Lock and Dam. Flows from J. Strom Thurmond were increased to overtop the spill gates during the spawning season. This method of fish passage proved ineffective for Shortnose sturgeon. More than likely, the cold water released from Thurmond Dam may have cooled the water at the dam to the point where fish were no longer induced to spawn. Also, it is doubtful that Shortnose sturgeon were able to negotiate the 8-foot high support walls at the bottom of the dam.

The New Savannah Bluff Lock and Dam is currently operated by the City of Augusta. As a requirement of their lease, the Corps requires the County to lock fish through twice a week during spawning season. Some limited transmitter studies have been conducted to determine if fish are successfully locked through. Apparently, there is very little movement of fish through the lock. Again, the 8-foot high supporting walls of the New Savannah Block and Dam probably deter any meaningful use of the lock by Shortnose sturgeon.

In 2004, the NMFS and the USFWS sent FERC a plan for fish passage at the Augusta Diversion Dam (the next dam upstream of the New Savannah Bluff Lock and Dam) including minimum flow requirements over the Augusta Shoals. This plan was sent in response to the proposed re-licensing of the dam.

When FERC re-licensed the Stevens Creek Dam in 1995, it reserved authority for the USFWS to prescribe a fishway once upstream passage was achieved at the Augusta Diversion Dam.

Measures to provide fish passage facilities at both the Augusta Diversion Dam and the Stevens Creek Dam are in place. However, construction of such devices at these two facilities is not warranted until dependable fish passage is provided at New Savannah Bluff Lock and Dam. Based on previous fish passage attempts at New Savannah Bluff Lock and Dam, it is obvious that some type of fish passage structure specifically designed for Shortnose sturgeon would be required.

Removal of the New Savannah Bluff Lock and Dam would provide even more benefit than a fish passage device. However, loss of the pool area behind the structure could adversely affect recreation activities and water withdrawal for industrial users in the Augusta, Georgia area.

In regards to the fourth element of the plan, the Corps began replacing turbines at J. Strom Thurmond Dam with auto-venting in 2002 and completed that construction in 2006. Dissolved oxygen concentrations in the releases from the dam have increased, enhancing downstream fishery habitat. Further increases are expected when the Corps begins injecting oxygen in Thurmond Lake. Construction of those facilities at Modoc, South Carolina is now underway and is scheduled to be complete in 2011.

There are additional opportunities to enhance Shortnose sturgeon habitat below the New Savannah Bluff Lock and Dam. As discussed previously, construction of the Savannah River Below Augusta Navigation Project involved various navigation cuts to straighten the channel,

leaving the old river channel as an oxbow. The project has not been maintained since 1979. Depletion of the natural flow through these cutoff bends has led to rapid deposition of silt and organic material in the bends. This deposition of sediment has also resulted in lower flows to creeks originating in the bends that are the water source for adjacent forested wetlands.

The Lower Savannah River Basin Environmental Restoration Reconnaissance Report completed by the Savannah District in 1992 investigated 40 navigation cuts along the Savannah River. The report concluded that there are feasible environmental restoration solutions with a Federal interest at 26 of those sites. The Lower Savannah River Basin Environmental Restoration Study was completed in 1996 and which resulted in restored flows into Bear Creek at Cut #3 as well as Mill Creek. This particular project was more designed to increase flows to Bear Creek and Mill Creek and thus provide additional water to bottomland hardwoods, rather than restoring fishery habitat in Cut #3. However, there may be more opportunity to provide additional Shortnose sturgeon habitat at the other 25 navigation cuts. This type of project falls under the US Army Corps of Engineers' Environmental Restoration Program, and a non-Federal project sponsor would be required.

In addition to these mitigation features which could be to used offset the effects of past incremental impacts to Shortnose sturgeon habitat in the Savannah River, mitigation would be required to ameliorate predicted adverse impacts to Shortnose sturgeon habitat from the proposed harbor deepening. Deepening would increase upstream salinity levels and decrease dissolved oxygen levels, which would adversely affect both adult and juvenile Shortnose sturgeon habitat.

As discussed in previous paragraphs, two mitigation plans (Plans 6B and 6A) were developed to offset anticipated upstream increases in salinity levels and decreases in dissolved oxygen concentrations from harbor deepening. These plans basically would increase flows in Middle, Back and Little Rivers to reduce salinity levels. Oxygen would be added at three locations on the Savannah River. Table 21 summarizes impacts to adult and juvenile Shortnose sturgeon habitat with either Mitigation Plan 6B or 6A in place along with the injection of dissolved oxygen.

Table 21. Summary of Project-Related Impacts With Mitigation

	DEPTH ALTERNATIVES				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
	Loss (-) or Gain (+) of Acceptable Habitat				
- Shortnose sturgeon adult (January)	-3.9 % (-153.0 acres)	- 4.6 % (179.0 acres)	-6.2% (-240.0 acres)	-6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+ 19.0 % (+ 260.0 acres)	+9.8 % (+134.0 acres)	+7.3 % (+100.0 acres)	+6.5 % (+89.0 acres)	+2.8 % (+39.0 acres)
- Shortnose sturgeon juvenile (January)	-6.7 % (-220.0 acres)	-7.0 % (-231.0 acres)	-7.3 % (-238 acres)	-7.6 % (-251.0 acres)	-11.5 % (-376.0 acres)

With the mitigation features in place, there is a loss of adult Shortnose sturgeon winter habitat for all channel depth alternatives due to increased salinity levels. However, there would be a significant increase in Shortnose sturgeon adult summer habitat because of the injection of

oxygen during the summer months when dissolved oxygen levels are low. With the exception of the 44-foot project, the mitigation features minimize the adverse effects of channel deepening on juvenile Shortnose sturgeon winter habitat.

Since implementation of either Mitigation Plan 6B or 6A with oxygen injection would not totally mitigate for loss of Shortnose sturgeon habitat, an attempt was made to identify measures that could be used in the estuary to restore sturgeon habitat or enhance existing habitats. No such measures could be identified by the SHEP study team or the natural resource agencies. The habitat suitability analysis indicates that the reduction in volume of acceptable habitat is mainly due to increases in salinity levels in areas that currently provide suitable habitat. The fish could adapt by moving upstream to areas with lower salinity levels. The Corps investigated the bottom substrate that exists in the Savannah River from its junction with Middle River (River Mile 19.7) to the Interstate 95 Bridge (River Mile 27.8). That reach of the river is where Shortnose sturgeon are expected to go if habitat conditions are unacceptable lower in the estuary. The reach is also where Shortnose sturgeon have been observed during the summer when dissolved oxygen levels decrease in the harbor. Sandy substrates are known to support substantial and diverse benthic communities, while silty substrates generally do not support viable benthic communities. Dial-Cordy (2010) found this section of the river to possess predominantly sand substrates (94% of total area). Therefore, this 8.1-mile reach just upstream of the 42-foot depth draft harbor is believed to provide sufficient benthic feeding habitat for the relatively small number of Shortnose sturgeon that presently exist in this population. However, the SHEP Fisheries Interagency Coordination Team believed that additional mitigation was warranted for the loss of Shortnose sturgeon habitat.

Consequently, the Corps began to evaluate other means to improve Shortnose sturgeon habitat including upstream spawning habitat. The Corps acknowledged that removal of the lowest dam on the river, the New Savannah Bluff Lock and Dam (NSBL&D) at Augusta, Georgia, would be the preferred method to allow sturgeon and other anadromous fish to access upstream habitat. The Corps also acknowledged that removal of the lock and dam would benefit the ecosystem. The Corps had proposed such an action in 1999, but local governments opposed it, citing adverse impacts to recreational uses of the pool upstream of the dam. In response, the Corps proposed rehabilitating the structure and adding a fishway to allow fish to move pass the structure. In 2000, Congress authorized construction and operating a fishway at NSBL&D as part of a lock and dam rehabilitation project. That project has not been funded. Coordination with local governments indicates they continue to oppose removal of the structure. Consequently, removal of the New Savannah Bluff Lock and Dam is not a feasible mitigation alternative for the following reasons:

1) The lock and dam is a Congressionally-authorized project; therefore, the Corps is obligated to maintain the project as Congress provides funding for such actions.

2) The current authorization language (WRDA 2000), amended in Omnibus Act 2001 calls for repair and rehabilitation of the lock and dam structure, construction of a fish passage, and conveyance of Lock and Dam to the City of North Augusta.

3) Removal of the structure would adversely impact the freshwater supply of eight major users.

Since removal of the NSBL&D is not feasible, the Corps suggested that a fish bypass structure be considered as mitigation feature for the SHEP impacts to Shortnose sturgeon habitat. A fishway around the structure would allow migrating fish to move past the dam and allow Shortnose sturgeon to access historic spawning areas at the Augusta Shoals. The structure would also open up the river to American shad and other anadromous fish species, thereby helping those populations. There is also evidence that some of the Savannah Harbor Striped bass population spawn in upstream areas near the fall line which could also benefit from the fishway.

The previously approved horseshoe rock ramp design was proposed as a means of allowing Shortnose sturgeon and other anadromous species of fish to move pass the NSBL&D during spawning season. The fishway would be located around the South Carolina abutment of the dam. It would be designed to operate continuously and pass 600 cubic feet per second (CFS) during low flow conditions (95% exceedance). The 600 CFS minimum attraction flow is 5 percent of the mean river flow during upstream spawning migration period of February through June. Higher attraction flows are probably better, but Parasiewicz et al. 1998 indicated that 5% of the river flow should be an adequate attraction flow for most fish. The fishway would pass higher flows when the river flows are higher. Flows in the fishway are designed to be self-regulating over a two-foot headwater variation, including a range of river flows from 3,600 to 20,000 CFS. The horseshoe rock ramp would have roughly a 75-foot width across the base and use boulder weirs at approximately a 25-foot spacing. There would be roughly a 9-inch drop per weir along the length of the fishway. The water depth would range between 3.5 and 5.5 feet in the fishway.

In June 2007, representatives of the resource agencies confirmed that the fishway appears to be the only measure within the basin to effectively compensate for the predicted loss in Shortnose sturgeon habitats. The Corps conducted a preliminary review of the 2001 fishway design and confirmed that conditions had not changed that would reduce its effectiveness or implementability. Also, in 2010, the Corps consulted the Federal and State regional natural resource agencies to determine if the state-of-the-art had advanced substantially since the design was completed for the fish passage structure at the NSBL&D. No fishery experts in the natural resource agencies identified any specific change to the proposed design that should be made as a result of recent documented fish passage research. The rock ramp design was provided to the cost estimators, who updated the cost for constructing the fishway. That fishway was added as a feature of the mitigation plan at an estimated ROM cost of $4.3 million (2006 price levels).

A horseshoe rock ramp bypass design was presented in the DEIS. The horseshoe rock ramp bypass design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages. The horseshoe rock ramp bypass was designed to capture 5 percent of the river flow. Based on some of the comments received on the EIS, some of the agencies believe the bypass would need to carry more of the river flow to successfully pass Shortnose sturgeon.

Consequently, the Corps convened an interagency workshop on April 25-27 2011 to discuss and evaluate mitigation options available. Numerous options were evaluated in regards to fish passage at the NSBL&D. Using the input from the agencies at the workshop, the Corps screened the potential fish passage options and prepared preliminary designs for three fish passage

alternatives: (1) Full River Rock Ramp, (2) Off-Channel Rock Ramp, and (3) Hybrid Rock Ramp. Although not specifically considered at the interagency workshop, the Corps considers the Off-Channel Rock Ramp to be a variation of the Full River and Hybrid Rock Ramp designs since they would all transport roughly the same amount of water for Shortnose sturgeon to use while moving through that location of the river. These alternatives differ by their location across the channel's cross-section. Once upstream passage occurs, successful downstream passage is critical to ensure the adult breeding population can return to its traditional foraging habitats in the estuary. For all three alternatives, a rock ramp would be constructed to allow Shortnose sturgeon to swim to the upstream pool. In each design, large boulders would be used to create pools with local areas of lower velocities. All three designs would also accommodate the larger Atlantic sturgeon and readily pass other anadromous species, such as American Shad and Striped bass.

Table 22 shows a comparison of three designs. The Full River Rock Ramp would capture all of the river flow (up to 10,000 cfs) 73% of the time from February-June which is the Shortnose sturgeon spawning season. Flows over 10,000 cfs would flow through the flood bypass channel and the ramp. The Off-Channel Rock Ramp Design would capture all of the river flow (up to 8,000 cfs) 64% of the time from February-June while the Hybrid Rock Ramp Design would capture all of the river flow (up to 9,000 cfs) 70% of the time. Since all three designs would achieve the objective of Shortnose sturgeon passage at the NSBL&D, the Off-Channel Rock Ramp Design was selected as the preferred design because it is the most cost effective. Figure 11 shows the initial design for the Off-Channel Rock Ramp. A complete discussion of the analysis of fish passage alternatives at NSBL&D can be found in Appendix C.

Table 22. Comparisons of Potential Fishway Designs at NSBL&D

Parameter	Full River Rock Ramp	Off-Channel Rock Ramp	Hybrid Rock Ramp
100% of flow through ramp up to X cfs	10,000 cfs	8,000 cfs	9,000 cfs
Crest elevation of Rock Ramp	109 ft	109 ft	109.5 ft
Number of gates operational	0	5	3
Modification to existing Lock & Dam structure	Major	Minor	Moderate
Modification to existing Lock & Dam project	Major	Minor	Moderate
Percent of time ramp captures all of river flow (February - June)	73%	64%	70%
Effectiveness in fish passage (Upstream)	90%	75%	80%
Effectiveness in fish passage (Downstream)	100%	85%	90%
Effectiveness in fish passage (Overall)	Acceptable	Acceptable	Acceptable
ROM cost	$100 mil	$32 mil	$41 mil
Cost Effectiveness (Cost /% SNS passage effectiveness)	$1,050,000	$325,000	$480,000

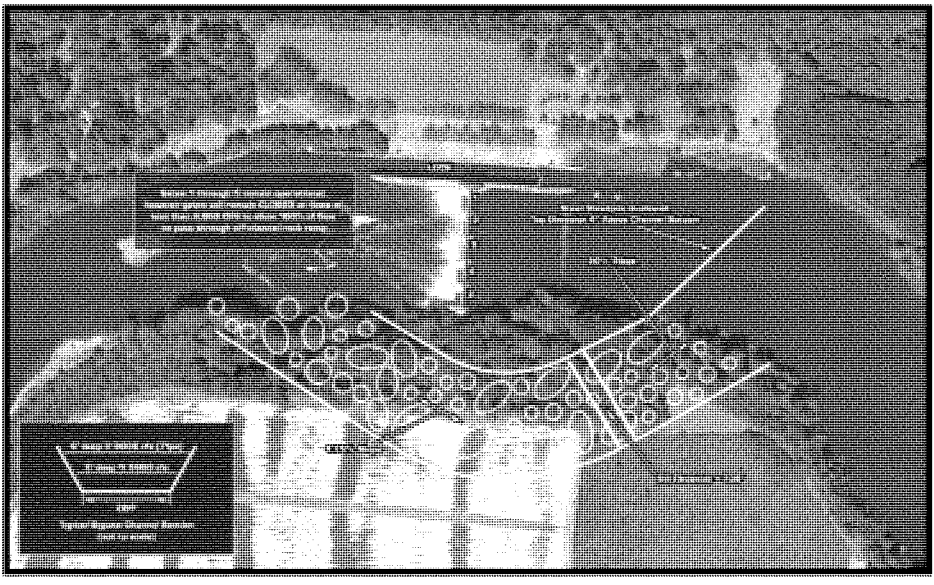

Figure 11. Conceptual design of off-channel rock ramp

Construction of the Off-Channel Rock Ramp fish bypass would provide access to the historic spawning area at the Augusta Shoals. Monitoring would be performed to ensure the success of the structure in providing dependable upstream fish passage. If the results of the monitoring indicate that the fishway provides dependable fish passage, this could trigger the construction of fish passage structures at both the Augusta Diversion Dam and Stevens Creek Dam. In this event, access would be provided to traditional spawning grounds from the New Savannah Bluff Lock and Dam to the base of the J. Strom Thurmond Dam (about 35 miles). If successful, this mitigation measure would meet one of the criteria in the Shortnose sturgeon Recovery Plan, which is to rehabilitate Shortnose sturgeon populations and habitats. Providing access to traditional spawning areas would expand the sturgeon spawning area and, thereby, enhance the potential for reproduction and recruitment of Shortnose sturgeon in the Savannah River.

Monitoring

The monitoring plan for the SHEP includes two specific studies to address the impacts of the project on Shortnose sturgeon. These studies include a study to determine the distribution of Shortnose sturgeon in the Savannah Harbor estuary, and a study to evaluate Shortnose sturgeon passage at the NSBL&D.

The distribution of Shortnose Sturgeon in the Savannah Harbor estuary would be studied during the one-year of pre-construction monitoring and the four years of monitoring during construction to provide background data. This monitoring would include capturing, tagging and tracking both juvenile and adult sturgeon. Water quality would be measured and documented where the sturgeon are captured and later found. Monitoring would be performed each season. The study area would include Front, Middle, and Back Rivers. The bottom substrate would be identified when fish are found to intensively use a specific area. Water quality data would also be collected at receiver location.

The study of Shortnose sturgeon distribution in the Savannah Harbor estuary would be conducted during years 1-5 of the Post-Construction Monitoring and again in year 9. The data collected from this effort would then be compared to the data collected during the Pre-construction and Construction Monitoring to determine if there have been any changes in the distribution of Shortnose sturgeon, and if so, how those changes in distribution might be attributable to the project. Field data (salinity, dissolved oxygen) would also be used with the updated hydrodynamic and water quality models to assess the impacts of the project on Shortnose sturgeon habitat.

The second study would involve an assessment of Shortnose sturgeon distribution at the NSBL&D. This study would also focus on fish passage at the NSBL&D after construction of the fishway. The movement of fish at the NSBL&D would be monitored for one year (during the Pre-Construction studies). The monitoring would include capturing, tagging, and tracking Shortnose sturgeon and possibly other representative species of the NSBL&D area fish community (Striped bass, Robust redhorse, and American Shad). Based on availability, up to 25 Shortnose sturgeon (and a total of 75 fish) would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be captured within 1 km of the dam by electrofishing, hook and line, or gill net.

The fish would be monitored continuously in the vicinity of the NSBL&D using a fixed station radio receiver. In addition, the river would be searched weekly during migration season between the dam and the Jackson, SC landing and the Augusta Diversion Dam for fish with transmitters. On a monthly basis, the Savannah River would be searched from the Savannah Harbor Kings Island Turning Basin to the NSBL&D, and above to the Augusta Diversion Dam. When located, species identification, number, and location would be recorded. Temperature would be recorded several times daily using temperature loggers established at fixed locations at NSBL&D, 1, 10, 50, 100 and 200 km below the dam, and 1 km above the dam. Dissolved oxygen concentration, turbidity, and river stage at NSBL&D would be recorded at least weekly. Dam discharge would be recorded daily.

This study would be conducted again during years 1-5 and year 9 of the Post-Construction Monitoring. However, this part of the study would include the installation and use of a series of infrared video cameras to monitor fish movement within the fish bypass structure. The system would operate continuously and collect images of fish at the upper end of the passage facility. The recorded video would be reviewed to determine the species composition, fish orientation (upstream versus downstream) and abundance. The results of this study would be used to

determine the success of the fish passage study and whether further mitigation might be warranted for the Shortnose sturgeon.

It should be noted that construction and operation of a fish bypass at NSBL&D would adversely affect the economic feasibility of generating hydropower at that location, should some entity desire to do that in the future. With the proposed bypass design, most of the flow would pass around the dam through the bypass, resulting in little flow being available to generate power by passing the dam.

Findings of the BO

As previously discussed, the Corps prepared a BATES which evaluated the impacts of the SHEP on threatened and endangered species. In regards to the Shortnose sturgeon, the BATES concluded that construction of the SHEP may affect but is not likely to adversely affect the Shortnose sturgeon. However, the BO prepared by the NMFS determined that construction of the SHEP would likely adversely affect the Shortnose sturgeon.

The "likely to adversely affect" determination for Shortnose sturgeon is primarily based on adverse effects (increase in salinity) to important estuarine foraging winter habitats for both juvenile and adult fish. While the NMFS expects these effects to be sub-lethal for individual sturgeon of the existing population, these effects could reduce the Savannah River's overall carrying capacity and ability to provide optimal habitat for the Shortnose sturgeon to forage. The NMFS believes that both adults and juveniles will move to suitable habitats further upriver once the SHEP is constructed. However, the NMFS also points out that there may be a transitional period as the habitat adjusts to the new, higher salinity. They expect sturgeon to use these areas for foraging once their prey have colonized and stabilized to the new environmental conditions. The NMFS also determined that construction of the SHEP would not likely cause a long-term reduction in reproduction. There may be a reduction (1-2 years, maybe longer) in spawning due to lack of fitness of spawning adults resulting from lower foraging success during the transitional period as the habitat adjusts to a new, higher salinity. However, the NMFS expects that construction of the fish passage facility at the NSBL&D will result in the addition of 20 miles of spawning habitat that is expected to increase spawning activity over the long-term. Based on these determinations, the NMFS concluded that construction of the SHEP is not likely to jeopardize the survival and recovery of the Shortnose sturgeon in the Savannah River.

For sturgeon, the BO includes five Reasonable and Prudent Measures that must be implemented for the Corps to be exempt from the provisions of Section 9 of the ESA. These five Reasonable and Prudent Measures and the terms and conditions to implement those measures are as follows:

1. Implement Safe and Effective Fish Passage in a Timely Manner.

    a. Develop a plan for safe and effective fish passage. The plans shall be coordinated with the NMFS, USFWS, SCDNR, and GADNR. The COE shall conduct a comparison analysis of the performance of existing rock ramps located in other parts of the country with similar characteristics to the proposed New Savannah Bluff Lock and Dam fish passage conditions to review information on the spatial variation of velocities across the

width of rock ramp designs. The COE will coordinate the results of that effort with the natural resource agencies within 6 months of receiving all of the environmental approvals to implement the project. The goal of the fish passage alternative is to achieve at least 75 percent upstream passage effectiveness for both Shortnose and Atlantic sturgeon, at least 85 percent downstream passage effectiveness, and cause no serious injury to sturgeon that come into contact with the passage or dam structures. The fish passage would maintain velocities comparable to those found in the upstream habitat that the sturgeon are expected to access upon completion of the fish passage facility.

b. Fish passage construction shall commence prior to or concurrently with inner harbor dredging and be complete within two years.

c. The COE shall purchase any additional land necessary for the fish passage and for an access road to the site. The land acquisition process must be initiated prior to, or concurrent with, commencement of entrance channel dredging.

d. To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam shall occur during the late winter/spring period and early summer larval period between February 1 and May 31 of any year.

e. The COE shall adhere to protective measures during construction of the fish passage including appropriate erosion and turbidity controls. Additionally, the Corps will ensure passage throughout the habitat. Adequate pathways must be provided at all times so that fish can migrate between foraging habitat and spawning habitat; no blocking of the channel is allowed. Normal water flows must be maintained throughout the construction areas. The COE shall not reduce flows during the spring/early summer to aid in the construction of the fish passage.

f. The COE shall develop a Monitoring and Adaptive Management Plan specifically for the fish passage that will, to the maximum extent practicable, ensure the performance criteria will be achieved. The plan will also identify triggers for passage modification. Post-construction monitoring shall be designed and conducted to assess the effectiveness of the fish passage in safely passing sturgeon upstream and downstream. The COE shall consult with the NMFS and the other natural resource agencies to complete the plan within 6 months of receiving all environmental approvals to implement the project. If it is determined that sturgeon are not safely and effectively passing upstream and downstream through the fish passage, measures shall be taken to rectify the problem.

2. Protective Measures for Sturgeon during Construction in the SHEP Project Area.

a. The construction of the diversion structure associated with the flow re-routing modifications shall be conducted between May 15 and November 1 while most sturgeon are congregated upstream of the construction area.

b. During construction of the various flow diversion measures, the COE will adhere to appropriate erosion and turbidity controls. No blocking of the channel is allowed, except where included as part of the flow re-routing modifications.

3. Ensure Appropriate Monitoring and Adaptive Management Within the Lower Savannah River Project Area. A comprehensive monitoring and adaptive management plan shall be developed for assessing project impacts associated with the deepening, the flow-re-routing modifications, the injection of oxygen, the fish passage and for implementing corrective actions. The plan shall identify success criteria and triggers. The plan shall be completed within 6 months of receiving all environmental approvals to implement the project. The Plan shall include monitoring to determine whether the predicted amount of habitat loss is being exceeded. If the monitoring indicates habitat loss to any species within NMFS' ESA authority is being exceeded, this will trigger re-initiation of consultation with the NMFS.

4. Ensure Appropriate Dissolved Oxygen Levels. Monitoring and adaptive management for dissolved oxygen levels shall ensure that the dissolved oxygen systems perform as expected to offset harbor deepening impacts and ensure the amount of suitable habitat as predicted in the modeling of the three-level summer habitat suitability criteria for sturgeon are not reduced. If dissolved oxygen excursions below minimum levels in the modeled river cells are longer in duration than specified in the criteria, corrective action (increasing or adjusting the operation of the Speece cones, cessation of dredging in the area of concern, etc.) will be taken immediately. If short-term response is not practicable, solutions shall be implemented as soon as possible, and not later than July 1, following identification of the poor oxygen levels.

5. Tissue Sampling, Tags and Reporting Take. A tissue sample shall be taken of any sturgeon handled or stranded. All sturgeon encountered shall be scanned for a PIT tag. If a lethal take occurs, the COE shall arrange for containment analysis of the carcass. Sonic tags, or some other state-of-the-art tracing device shall be placed on sturgeon captured during relocation trawling, or alive by the hopper dredge by NMFS-approved personnel only. Observer reports of incidental take by hopper dredges and relocation trawls will be reported to the NMFS' Southeast Regional Office.

The BO submitted by the NMFS is included in this document as Appendix Z.

13. Tybee and Nearshore Area

Issue

Questions have existed for many years on whether construction and maintenance of the Savannah Harbor Navigation Project, especially the entrance channel portion, plays a major role in beach erosion on Tybee Island. A study completed in 2008, "Impact of Savannah Harbor Deep Draft Navigation Channel on Tybee Island Shelf and Shoreline" confirmed that the entrance channel and the two large jetties near the mouth of the harbor has disrupted the north to south movement of sediment across the channel. The major impacts of this disruption are loss of sand from the Tybee shelf which would be available to move towards Tybee Island and subsequent erosion of the Tybee shoreline.

During the SHEP study, additional concerns surfaced concerning possible impacts that harbor deepening might have on this condition, including the potential for further adverse, incremental impacts on the Tybee Island sand budget.

Geographic scope

The primary area of concern is the ocean shoreline of Tybee Island. This area must also be placed in the larger context of changes to the nearshore sand sharing system because this system has a major impact on whether a shoreline is eroding or accreting. The Corps of Engineers typically examines potential impacts from its proposed projects for 10 miles along each direction of a coast. Hydraulic modeling indicates that such a distance is more than adequate to identify potential impacts from the Savannah Harbor Navigation Project. Figure 10 shows the geographic area of this analysis which is bounded by Hilton Head Island, South Carolina to the north and Little Tybee Island to the south.

Historic

When the City of Savannah was founded in 1733, the controlling depth across the bar was about 13 feet at low water. Black (1893) states that prior to 1763, the depth on Tybee Knoll (located 1/2 mile east of Fort Pulaski) was 15 feet, and a good, clear channel was reported as far upriver as Savannah. Review of the 1855 survey conducted by the U.S. Coast Survey shows controlling depths of 15 feet MLW over Tybee Knoll and 13 feet near Oyster Bed Island.

In the 1800s, Congress authorized Savannah Harbor as a Federal navigation project. The first obstruction in the navigation channel was two and a half miles above Tybee Point (one half mile off Fort Pulaski), which was referred to as the "Knoll." The USACE Annual Report of the Chief of Engineers indicates that dredging in this area began in 1873.

As part of the Federal project, two 12,000-foot long jetties were constructed at the mouth of the Savannah River entrance to stabilize the two river channels (Savannah River and South Channel) and stabilize their associated sand bars. The North Jetty (Oyster Bed Jetty) was completed in 1890 and the South Jetty was completed in 1896 (Cockspur Jetty) (Sargent 1988). Additionally,

a submerged offshore breakwater was completed at the south end of Barrett Shoals in 1897 to provide a shelter for vessels entering Tybee Roads.

Records indicate that the first significant dredging of the entrance channel occurred in 1910 when 1,640,000 cubic yards of sediment were removed from the ocean bar, Tybee Roads, Tybee Knoll and near Quarantine Station (Oyster Bed Island). The navigation channel of Savannah Harbor was deepened to 22 feet MLW in 1902, to 26 feet MLW in 1912, to 30 feet MLW in 1936, to 34 feet MLW in 1945, to 38 feet MLW in 1972 and to 42 feet MLW in 1994. It should be noted these depths are the authorized depths of the inner harbor channel. The entrance or bar channel depth is two feet deeper.

A general north to south littoral drift exists along the Georgia coast. Tybee Island is located directly down-drift of the Savannah Harbor entrance channel. The island has experienced shoreline recession especially along the north-south oriented oceanfront between 1st Street and 6th Street. Historical maps and information indicate that the erosion of the shoreline on Tybee Island is linked to deepening of the navigation channel and construction of the two large jetties at the mouth of the river.

The shoreline positions of Tybee Island were mapped in studies by Oertel et al. (1985) and Griffin and Henry (1984). Based on analysis of beach ridge formations, Oertel hypothesized that prior to 1854, the ocean shoreline of Tybee Island was characterized by significant periods of accretion. The regularly-spaced dune ridges on the southern end of the island suggest that accretion was continuous over the recent past. Development of the north end of the island was apparently much more irregular, as indicated by the truncations between beach ridge sets. The shoreline positions illustrate two major trends in shoreline evolution: net accretion between 1859-63 and 1900, and net erosion between 1900 and the present.

Between 1900 and 1920, the shoreline shows rapid erosion. Griffin and Henry (1984) observed the erosion between the 1913 and 1925 shorelines and hypothesized that because this atypical erosion took place prior to dam construction, adoption of soil conservation practices, and occurred during a period in which the majority of other island systems in Georgia were rapidly accreting, the losses may be related to the dredging activities initiated in 1919. Maps showing the shoreline location in 1920 indicate that this erosion occurred too soon to be caused by navigational dredging conducted in 1919 and later. However, substantial dredging in the harbor had occurred between the 1890s and 1920, indicating that dredging may have contributed to some degree to erosion of the Tybee Island shoreline.

Shore protection structures were constructed at various places along the beach starting in 1912, with varying degrees of success. However, the beach continued to erode. By the late 1960s, the MHW shoreline had eroded to the seawall at the northern end of the island and use of the beach was restricted to periods of low water.

Shore protection operations involving beach nourishment started in 1975 as authorized by the Tybee Island Shoreline Protection Act of 1974. The most recent shore protection efforts include placing sand on the beach five times between 1986-2009, construction of an 800-foot long north terminal groin in 1975 to trap sand that is being transported north, a 600-foot long south terminal

groin completed in 1987 to trap and hold fill sand on the southern end of Tybee Island, and two additional T-head groins and an L-head groin further to the south in 1994 to retain sand at the very southern end of the island.

Past actions / stresses

The Corps conducted a study in 2007 to determine if the Savannah Harbor Navigation Project is adversely impacting or has in the past adversely affected the shores of Tybee Island. The study was conducted by the Savannah District in cooperation with the City of Tybee Island. The study was completed and the results of the study were presented in a report "Impact of Savannah Harbor Deep Draft Navigation Project on Tybee Island Shelf and Shoreline" (April 2008).

The study included both numerical modeling and sediment budget components. The modeling included waves, currents, water levels, and sediment transport rates for pre-project bathymetry and post-project bathymetry. The model output was used to identify sediment pathways and changes to wave, current, and sediment transport patterns resulting from the existing navigation project. Sediment budgets were developed for pre-project and post-project conditions. The sediment budget was used as an accounting of sediment transport pathways and magnitudes in the pre-and post- project time periods. Sediment budgets were developed for the period 1854-1897 and 1897-2007. Bathymetry changes were calculated over both of these time periods.

Figure 12 shows the study area. The main barrier islands to the north of the Savannah Harbor entrance channel are Hilton Head, Daufuskie and Turtle. Cockspur Island separates the main navigation channel from the South Channel of the Savannah River. Tybee Island is located to the south of the Savannah Harbor entrance channel. Islands south of Tybee Island include Little Tybee and Wassaw.

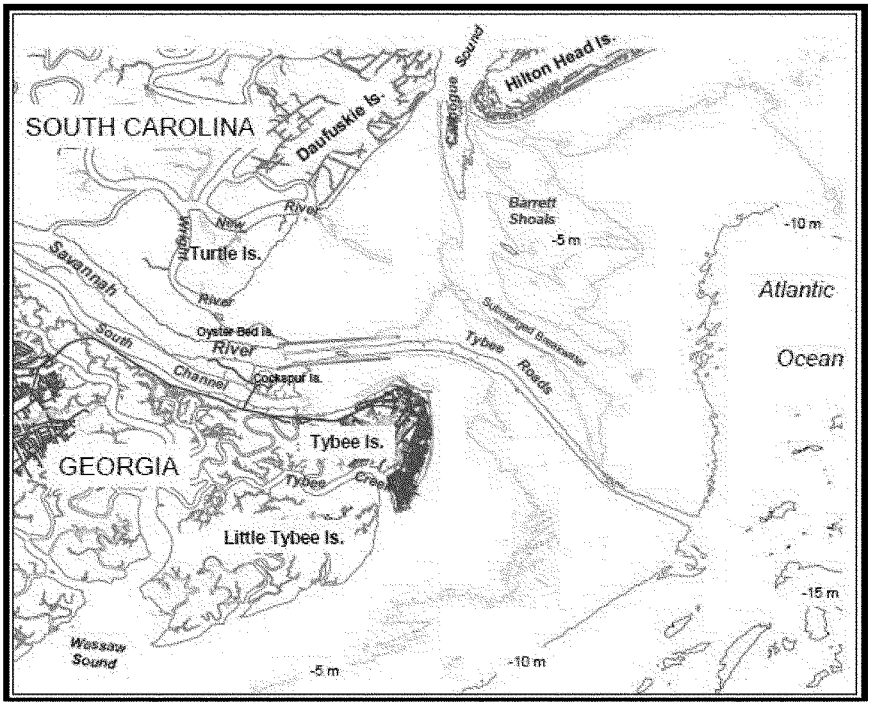

Figure 12. Tybee Island study area.

The post-project bathymetry change showed a pattern of ebb shoal deflation on the Tybee shelf, which is a typical consequence of removing sediment from the nearshore sand sharing system. The ebb shoal deflation is a direct result of the disruption of normal sediment pathways across the navigation channel. The magnitude (historical average of approximately 700,000 cubic yards) and frequency (annual) of maintenance dredging in the entrance channel indicates that the bar channel is an efficient trap for wave-and current-induced sediment transport. Ebb shoal deflation results in the loss of sand from the Tybee shelf and in shoreline change on Tybee Island.

The Tybee shelf is part of a large ebb shoal complex associated with the Savannah River inlet. Ebb shoals form as a balance of sediment that is jetted out of an inlet by offshore (ebb) currents and sediment that is returned to the inlet by onshore (flood) currents and waves. These ebb shoals are the pathway for sediment to travel around an inlet to the down-drift beaches (Tybee Island) as well as up-drift beaches (Oyster Bed Island) during periods of reversal in sediment transport direction. Disruption of these pathways and deflation of the ebb shoal lead to erosion of the down-drift (and possibly up-drift) beaches because natural sand bypassing around the inlet is interrupted.

Prior to construction of the project, transport patterns showed recirculation onto the Tybee shelf from the margins of the South Channel. This compares to post-project conditions where sediment transport is directed north along the Tybee shoal and toward the Tybee Knoll Channel, with very little re-circulating to the Tybee Island shelf. With project conditions also show more of a tendency for offshore transport on the outer edges of the Tybee island shelf. In general, the project does not change the magnitudes of transport, but the pathways.

The most significant change in the calculated circulation pattern was the increase in current speed through the navigation channel. The South Channel of the Savannah River entrance hugged the north end of Tybee Island in 1854, and there was a circulation cell that was centered on the south side of the channel. This circulation cell would naturally circulate sediment onto the Tybee shelf. With the existing project, the circulation cell is shifted north to the south edge of the Tybee Knolls Channel. It has the potential to push sand off the Tybee Island shelf and into the north Tybee shoal. Current magnitudes tended to increase for the existing bathymetry on the north end of Tybee Island. Tidal and storm surge levels are not significantly impacted by the existing navigation project.

Deepening the bathymetry in front of the Tybee Island shoreline allows larger waves to propagate closer to shore. The maximum increase in wave heights is on the northern end of the island. The average increase in wave height is 0.5 meters during a simulated hurricane, 0.25-0.5 meters for a stormy month, with no increase observed for a fair weather month.

Sediment pathways were further evaluated through the sediment budget. The sediment budget was developed based on historical volume changes in five sediment budget cells (Barrett Shoals Platform, Breakwater shoal, etc.), shoreline change rates on Tybee Island, beach nourishment volumes, dredging volumes, pathways, and relative rates provided by the numerical sediment transport modeling.

Post-project sediment budget analysis shows only pathways leaving the Tybee Island Shoal (with the exception of the beach nourishment actions). Consequently, the Tybee Island Shoal and shoreline can only be losing sand. Some of the erosion experienced on the shoal and shoreline is part of the natural process, since there was deflation of the Tybee Island Shoal and shoreline erosion prior to construction of the project. The primary difference in the pre-and post-project budgets for the Tybee Island Shoal is the loss of bypassing from Barrett Shoals across the entrance channel. Channel dredging cuts off the natural bypassing mechanism. Deposition of those sediments outside the nearshore sand sharing system effectively removes those sediments from Tybee's natural renourishment processes. Construction of jetties and channel dredging generally cause deflation of the ebb shoal and eventual down-drift erosion.

The impact of the Savannah Harbor Navigation Project on the Tybee Island Beach is evaluated as the difference in volume loss rates (post-project minus pre-project) for the Tybee Island shelf cell of the sediment budget plus the estimated shoreline change (erosion) rate (converted to a volume). The estimated combined shelf and shoreline impact at Tybee Island was calculated to be 78.5%. This means that an estimated 78.5% of the reduction in sand volume on the Tybee shelf and shoreline is due to the existing navigation project. The remainder of the erosion is attributed to natural processes. In volumetric terms, the volume change rate for the Tybee Island

shelf and shoreline due to the existing project is approximately 227,000 cubic meters (297,000 cubic yards) of sand per year. The reduction in sand volume has mainly occurred on the Tybee shelf, with both losses of sand on the Tybee beaches (northern end) and gains (southern end). The reduction of sand bypassing from the north to the Tybee shelf is estimated at -207,000 cubic meters/year.

From a general study area standpoint, the volume change rates north of the entrance channel (Barrett Shoals, Calibogue Sound, Breakwater Lee, Daufuskie and Turtle Island Shelves) have changed from -76,000 cubic meters/year to +76,000 cubic meters, indicating the impact north of the channel is net accretion. Similarly, the net volume change rate south of the channel has changed from +101,000 cubic meters/year to -220,000 cubic meters/year (north Tybee shoal and Tybee Island shelf) indicating net erosion.

Sea level rise would have affected both the location and rate of wave-induced erosion of the Tybee shoreline. As the sea level has increased the depth of water in the nearshore area would have increased, allowing waves to break closer to the shoreline, thereby increasing the shoreline erosion rate. As the sea level increased, the location of the natural long-term erosion would move landward, closer to any man-made structures located along the shoreline.

Present Condition

The present Federal Navigation Project includes an entrance channel that is approximately 11.4 miles long. The entrance channel is maintained at 44-feet deep and 600-feet wide for the first 8.7 miles and 42-feet deep and 500 feet wide for the remaining 2.7 miles. A rock jetty along each side of the channel at the river entrance confines the tidal flows.

Analysis of the 1999 After Dredging and 2000 Before Dredging entrance channel surveys shows the major sedimentation areas are: (1) the north side of the seaward bend of the channel where it intercepts sediments from Barrett Shoals (Stations –29+000(B) to –41+500(B)), and (2) closer to the inlet on the southern side of the channel (Stations –24+000(B) to –32+000(B)).

Approximately 1,000,000 cubic yards of O&M sediment (mostly sand) are removed from the bar channel on an annual basis. Those sediments from the entrance channel are typically removed by hopper dredge and taken to the Offshore Dredged Material Disposal Site (ODMDS). The ODMDS was designated and approved by the US EPA in 1987. The 4.26 square mile site is located about 3.7 nautical miles east of the coastline and about 0.25 nautical miles south of the entrance channel (Figure 11).

In addition to the ODMDS, there are other areas available to be used for placement of maintenance dredged sediment from the bar channel which were approved as part of the LTMS process. These placement areas include sites in the nearshore off Tybee Island and sites located just south of the entrance channel for construction of submerged feeder berms. Placing dredged sediment at these sites would provide the opportunity for the material to eventually move towards Tybee Island Beach as a result of wave action. If constructed, the berms created at these sites would also serve as a protective barrier to the beach since waves would expend energy moving sediment from the berms before the waves reach the beach.

To date, two of the sites designed for submerged feeder berm construction adjacent to the entrance channel have been used. Generally, the sites are too shallow for use of a conventional hopper dredge. A conventional hopper dredge could be used if it was equipped with pump-out capability so that it could pump the sediment directly to the site. Since this would greatly increase dredging costs, sites with the shallow depths would more than likely only be used in those instances when the entrance channel is maintained by hydraulic pipeline dredge since this type of dredge could place the sediment directly into the sites. A hydraulic pipeline dredge would be used to maintain the entrance channel only in those instances when a hopper dredge could not normally be used. An example of this type of situation is the eight month period out of the year when hopper dredging is prohibited in the entrance channel due to the presence of endangered sea turtles.

The LTMS also authorized suitable maintenance material from the Savannah Harbor Navigation Project to be placed directly on the beach at Tybee Island. However, most of the material removed during maintenance dredging operations in the entrance channel is not suitable for direct placement on the beach. From a beach compatibility standpoint, sediment removed from the entrance channel averages about 13 percent fines, which is more suitable for nearshore placement than direct placement on the beach. However, hopper dredges must have pump-out capability to put material into the nearshore off Tybee Island or directly on the beach. This type of placement operation greatly increases project costs.

The "Base Plan" for Savannah Harbor as defined in Corps of Engineers policy is the dredged material placement alternative or alternatives identified by the Corps which represent the least costly alternatives consistent with sound engineering practices and meeting the appropriate environmental standards. The Base Plan for the maintenance of Savannah Harbor entrance channel is to place the material into the ODMDS or Site 2 and Site 3 (See Figure 11 below) just south of the entrance channel. If placement at alternate locations is found to be more desirable for environmental or other reasons but would be more costly than the Base Plan, it can be pursued with appropriate cost sharing.

Erosion of the Tybee Island shoreline continues to be a problem. The initial shore protection measure involving placement of sand on the Tybee beaches was completed in 1975. Four other sand placements occurred from 1986-2009. The latest placement of sand on the Tybee Beaches was completed in 2009 and involved placing about 1.25 million cubic yards of sediment.

Present Actions / Stresses

As determined in the ERDC report, existing conditions are characterized by deflation of the Tybee Island shelf and erosion of the north end of Tybee Island. The current entrance channel (including the entrance channel jetties) causes a pattern of ebb shoal deflation on the Tybee Shelf and appears to be nearly a complete littoral sink for any sediment moving from north to south along the Tybee shelf. These studies estimated that the combined shelf and shoreline impact at Tybee Island to be 78.5%. This means that an estimated 78.5% of the reduction in sand volume on the Tybee Island shelf and shoreline can be attributed to the existing project with the remainder of the erosion attributed to natural processes.

The major sedimentation areas on the entrance channel are: (1) the north side of the seaward bend of the channel where it intercepts sediments from Barrett Shoals (Stations –29+000(B) to –41+500(B)), and (2) closer to the inlet on the southern side of the channel (Stations –24+000(B) to –32+000(B)).

Periodic removal of sediments to maintain adequate depths in the navigation channel will continue. Since hopper dredges are the lowest cost equipment available to perform channel maintenance, deposition of the excavated sediments is likely to continue to be in the ODMDS or Sites 2 and 3. Such placement removes those sediments from the nearshore sand sharing system of the inlet and Tybee Island.

As stated above, an estimated 78.5% of the reduction in sand volume on the Tybee Island shelf and shoreline can be attributed to the existing project. Any mitigation for this effect would be the responsibility of the existing Savannah Harbor Navigation Project.

To obtain mitigation for these impacts to the shoreline and shelf of Tybee Island due to operation of the Savannah Harbor Navigation Project, the Corps must follow the civil works planning process as outlined in ER 1105-2-100. A specifically authorized study, known as the Tybee Channel Impacts Study, provides the authorization for the Corps to study the impacts (Phase I) and determine appropriate mitigation measures (Phase II). Phase I of the study was completed in 2008. The Corps was working with the City of Tybee as recently as 2010 to continue with Phase II of the study, however, the City of Tybee Island has indicated they did not have a source of matching funds required to continue the study as the non-Federal cost-sharing partner. Should the City of Tybee find a source of matching funds, the cost-shared study could be resumed. Under the normal civil works process, a feasibility report, Record of Decision, and Chief's Report must be completed. The Chief's Report would be provided to Congress, who could then authorize the Corps to implement mitigation measures.

Capacity to Withstand Stress

Construction and maintenance of the Savannah Harbor Navigation Project impacts the Tybee Island nearshore area and the beaches. In addition to the effects of the navigation channel, natural coastal processes (waves, storms, etc) also contribute to the erosion of the Tybee Beaches. Shore protection (beach nourishment) has been required five times between 1986 and 2009. Based on the current erosion characteristics of the north end of Tybee Beach, this resource has little capacity to withstand further stress.

Future Actions / Stresses

Maintenance of the Savannah Harbor Navigation Channel will continue. As discussed in previous paragraphs, construction and maintenance of the project is a major factor in depletion of the sand budget for the Tybee shelf and the erosion of the Tybee beaches.

Sediments removed during periodic maintenance of the entrance channel would likely continue to be deposited in the ODMDS or Sites 2 and 3. Placement in the ODMDS removes those

sediments from the nearshore sand sharing system of the inlet and Tybee Island. The sediments may still be available in the sand sharing system on a larger geographic scale.

Periodic renourishment of the Tybee Island shoreline is expected to continue. This should keep the ocean shoreline between the north and south groin relatively stable, keeping the shoreline away from the seawall and adjacent oceanfront properties. Sediments are likely to continue to be borrowed from the nearshore area off the southern end of the island. That general area was used in recent nourishments and contains sediments that are suitable for this purpose.

Natural processes will also continue to erode the Tybee beaches. These processes include wind and wave and current action, especially during certain types of storm events.

Sea level is expected to continue to rise in the future. This would have similar effects as in the past, where both the location and rate of wave-induced erosion of the Tybee shoreline could increase. This could lead to an increase in the rate of shoreline erosion and concern about its potential effects on man-made structures located along the shoreline.

Concern has also been raised about the potential for harbor deepening to further exacerbate erosion of the Tybee Island beaches. If constructed, the harbor deepening project would involve deepening the entrance channel from its existing authorized depth of -44 feet MLW to -49 feet MLW.

Likewise, construction of a Jasper County container terminal could have similar concerns in regard to Tybee Island. Although no detailed plans are available for that project, it is assumed the entrance channel dredging requirements would be comparable to that for the SHEP since similar vessels would use both facilities.

Incremental Impact

The incremental impact of the Savannah Harbor Navigation Project on the Tybee Island beaches has been discussed in previous paragraphs. In order to address the concern that harbor deepening could have adverse effects on the erosion of the Tybee Island beaches, the Corps conducted studies during the SHEP to address that potential issue.

Channel maintenance volumes are not expected to increase for the entrance channel between Stations 0+000 and -60+000B. Some increase in dredging volume would result from extending the channel from Stations -60+000B to -97+680B. However, based on sedimentation patterns in the existing entrance channel, the sedimentation in that additional offshore channel length is expected to be comparatively small.

The current navigation channel appears to be a nearly a complete sink for any sediment moving from north to south along the shelf (suggested by pre- and post-dredging surveys and the consistency of dredging volumes following past deepening projects). Placement of dredged O&M sediment, back in the nearshore zone of Tybee Island would be a means for restoring this supply of sand to the Tybee beach system.

ERDC evaluated the impact of the proposed deepening of the Savannah Harbor navigation channel. They conducted bathymetry and volume change analyses to obtain the historical perspective of the Savannah nearshore evolution. They also performed numerical modeling of circulation, waves, and sediment transport to compare pre- and post-deepening of the channel impacts on the coastal processes.

The GTRAN modeling reflects conditions in deeper water where waves tend to agitate and suspend sediment and currents tend to move the sediment, not the shallow surf zone region along the Tybee Island shoreline. The very shallow nearshore region is much more wave dominated than the offshore region for which GTRAN was applied. ERDC did not conduct shoreline change modeling of the inner surf zone region, but the minor changes in the nearshore wave results indicate that the proposed deepening would have little impact on the shoreline.

The circulation and wave modeling indicate very small changes associated with the proposed deepening. The GTRAN results provide insight about what the proposed deepening would do in terms of sediment transport regime, which is expected to be similar to that of past harbor deepening projects. GTRAN results for the existing condition and the with-deepened-channel condition indicate that the additional channel deepening will not change the general overall pattern of sediment transport in the region. The most noticeable changes were computed in the channel.

Transport in the Tybee Knoll Bar Channel reach showed decreases in magnitude for all four of the typical months of simulation, but conditions remain strongly ebb-dominant. The magnitude of change was greatest in this reach (15-20 percent), compared to changes throughout the rest of the system (changes elsewhere were generally quite small, several percent). Some small increases to shoaling rates in this reach of the channel might be expected in light of these decreases in flow, but gradients in transport (which dictate accumulation rates) do not appear to be altered very much.

Transport in the Tybee Roads Channel reach consistently shows increases for each of the typical months, but only very slight increases (a few percent). No significant changes in sedimentation are expected in this reach of the navigation channel. Transport rates increase in this portion of the channel for a hurricane event (simulations used a re-tracked Hurricane Hugo) (about a factor of 2 greater), as they do for all sections of the main channel. Transport remains strongly ebb dominant in this reach.

In the Tybee Range Channel reach (the outer limits of the navigation channel), changes in transport rate would also be very small. The deepening would increase rates for one month, show zero change for one, and show slight decreases for two of the months. All increases or decreases are small (a few percent). For re-tracked Hurricane Hugo, the deepening would increase transport by about 20%, compared to a factor of 2 in the other channel reaches. This section of channel remains ebb-dominant. These changes do not suggest any significant changes in channel shoaling and they suggest that the channel region will remain strongly ebb-dominant in terms of sediment transport direction.

Average transport within the Tybee Island Shelf region consistently shows slight increases or no change for each of the four typical months, and an increase for the extreme event. No decreases were computed. Patterns appear unchanged and the net direction of movement appears to remain to the northwest. Slight increases suggest a tendency for sediment to be transported from the shelf region to the northwest at a higher rate. This would be consistent with the hypothesized model for how sand has been moving to the northwest in response to initial project construction and subsequent deepening. The proposed deepening seems to produce a result consistent with that hypothesis. However, the magnitudes of change are quite small, in the range from 0 to 2 percent for all months and even for the extreme hurricane event. Zero change was computed for two of the four months. Computations show that channel deepening would have negligible effect on the Tybee Island Shelf.

For the North Tybee Shoal region, computations show a consistent decrease in transport rate for all four months, about 5 percent or less; however, for the extreme hurricane event transport rates are increased by about 40%. These changes suggest that sediment being transported into the North Tybee Shoal region will have less of a tendency to leave the region, but this is more dictated by changes to the transport gradients. Such a trend would be consistent with historic accumulation of sediment in these shoals.

The ERDC report concluded that the existing navigation channel essentially acts as a complete littoral sink. As such, construction of SHEP will not cause additional impacts to the littoral supply downdrift of the navigation channel. In summary, the proposed harbor deepening alternatives are expected to produce minimal adverse impacts to the nearshore area or the Tybee Island shoreline.

Alternatives to Mitigate for Cumulative Effects

Substantial changes have occurred over time in the sediment transport patterns at the Savannah River entrance. Construction of the jetties and deepening of the navigation channel have concentrated ebb tidal flows through the center of the inlet. The increased tidal velocities push sediments that would deposit at the inlet further out into the ocean.

The changes that have occurred over time along Tybee Island have primarily been located offshore. The island's ocean shoreline has been relatively stable, advancing in some areas, eroding in others, and structurally protected or nourished along the majority of its length. However, the subaqueous platform offshore of Tybee has deflated and deepened somewhat, increasing the wave climate that reaches the shoreline.

Maintenance of the navigation channel and the subsequent deposition of those sediments at the ODMDS remove sediments from the nearshore sand sharing system. The current navigation channel appears to be nearly a complete sink for any sediment moving from north to south along the shelf (suggested by pre- and post-dredging surveys and the consistency of dredging volumes following channel deepening). Mitigation to date has included construction of various groin structures and beach re-nourishment.

Additional mitigation could be achieved by placing dredged sediment back into the nearshore zone of Tybee Island to restore the supply of sand to the Tybee beach system. Suitable sediment removed during normal maintenance of the entrance channel could be placed in the nearshore area off Tybee Island to construct feeder berms. This would function as a form of sand bypassing and could (1) restore depths in the nearshore area off of Tybee Island, (2) create and maintain submerged berms, or (3) create and maintain emergent islands. Re-inflating the nearshore platform, the submerged berms, and the emergent islands could reduce the wave climate experienced at the beach.

Provisions were included in the LTMS for the use of such sites. Site 2 Extension, MLW 500, MLW 200, and ERDC Nearshore (Figure 11) provide sites for the construction of feeder berms. Suitable sediment from the entrance channel could be placed into these sites providing opportunity for these sediments to be subsequently dispersed as part of the sand sharing system for the Tybee Island beaches. However, use of these sites in most cases would be more expensive than present maintenance practices. The increased costs of using these sites on a routine basis would have to be borne by a non-Federal sponsor.

If constructed, the SHEP would provide an opportunity to place suitable new work sediments in the sand sharing system for Tybee Island. Using the concepts developed in the LTMS, plans for the harbor deepening project included the use of nearshore sites for suitable material from the entrance channel that could benefit the Tybee Island beaches. Suitable material is generally defined as material with a fines content of less than 20 percent. Figure 11 shows the sites that were proposed for placement of suitable dredged sediment from deepening and extending the entrance channel.

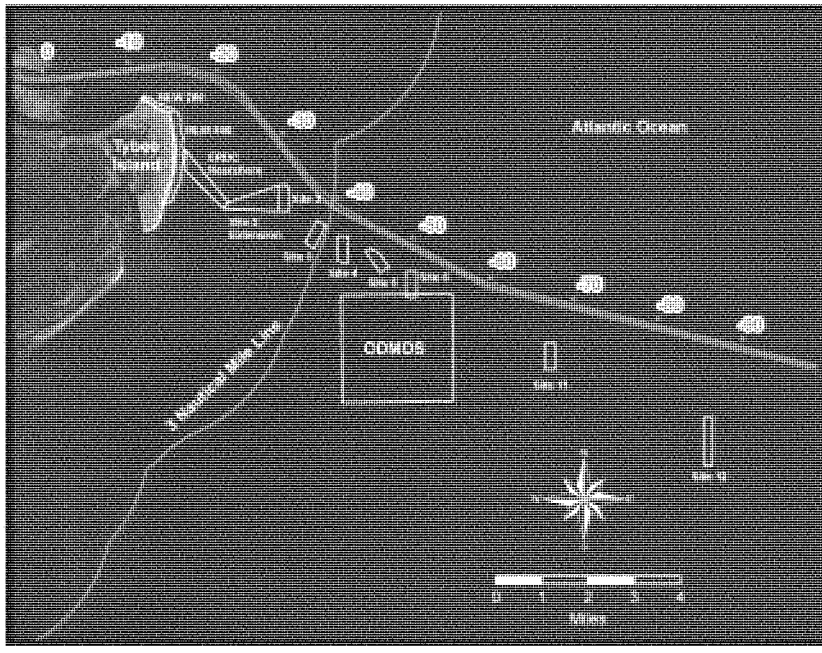

Figure 13. Savannah Harbor Deepening Offshore Disposal and Nearshore Placement Sites as Initially Proposed

Two of the sites would involve placement of suitable dredged sediments close to the beach. MLW 200 would be located northwest of the North Groin on Tybee Island. Sediment would be deposited at the mean low water (MLW) line and allowed to mound up to mean seal level (MSL) or mid-tide. When filled to capacity, this site has a capacity of 217,000 cubic yards creating a mid-tide berm about 200-feet wide and 3,200 feet long. Site MLW 500 would be located south of the North Groin on Tybee Island. Sediment would be deposited at the MLW line and allowed to mound up to MSL or mid-tide. This site has a capacity of 1,896,000 cubic yards which would create a berm about 500-feet wide and 11,000 feet long.

Three of the sites designated to receive suitable dredged material from deepening of the entrance channel would be located in nearshore areas east of the beach. ERDC Nearshore would be located below the MLW contour. When filled to capacity (1,165,000 cubic yards), the top elevation of the site would be -5 feet MLW so as not to interfere with boaters while still providing opportunity for movement of sediment towards the shoreline through wave action. Site 2 would be located below the MLW contour east of the southern end of the beach. At total capacity (3,225,000 cubic yards), the top elevation of the site would be +8 feet MLW permitting it to serve as bird and shallow water and shoreline fish habitat as well. Site 2 extension would

extend from Site 2 to below the ERDC nearshore site. When filled to capacity (4,251,000 cubic yards) the top elevation of the placement would be at -5 feet MLW.

The remaining placement sites initially proposed to receive new work dredged sediments are four sites (Sites 3-6) just south of the entrance channel designed for submerged berm construction previously approved during the LTMS. The other two sites are designated Sites 11 and 12 and which were to be used to place suitable material from the outer most portions of the entrance channel. Placement of material at those two sites would not help the sand budget for Tybee Island Beach, but use of these sites would provide additional fish habitat.

Based on DEIS review comments received from the Georgia Department of Natural Resources, Coastal Resources Division and the City of Tybee Island, the use of these nearshore dredged material placement sites has been removed from the project. The City of Tybee Island and the CRD are concerned that the sediments that would have been placed in these sites are not of beach quality. Consequently, sediments that would have been placed in these nearshore sites (As well as Sites 11 and 12) would, instead, be deposited in the Jones/Oysterbed CDF or the ODMDS. Additionally, the EPA has indicated that any site beyond the 3-mile line is considered an ocean dredged material disposal site. Consequently, Sites 4, 5, 6, 11, and 12 would have to be evaluated using Section 103 (MPRSA) criteria and site designation approval requested from the EPA.

In addition to the SHEP, conceptual plans for a Jasper County container terminal have been developed. This facility may be located in what is now CDFs 14A and 14B at about River Mile 6. Dredging requirements for this facility would be similar to the SHEP project with the exception that improvements to the inner harbor channel would only be required to River Mile 6. As with the SHEP, the main potential for impacts to the Tybee Island Beach would be associated with the entrance channel deepening, widening, and extension. Since entrance channel improvement requirements are similar for the two projects, construction of a Jasper County terminal would have very little impact on either the Tybee Shelf or the Tybee Island Beach.

ENVIRONMENTAL IMPACT STATEMENT
APPENDIX M: Sediment Quality Evaluation

SAVANNAH HARBOR EXPANSION PROJECT

Chatham County, Georgia and Jasper County, South Carolina

January 2012

(Revised July 2012)

US Army Corps
of Engineers
Savannah District
South Atlantic Division

Sediment Quality Evaluation

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Savannah Harbor Expansion Project

Sediment Quality Evaluation

Executive Summary

Savannah District has prepared a sediment quality evaluation assessing potential contaminant impacts associated with the proposed Savannah Harbor Expansion Project (SHEP). The evaluation also establishes whether management actions need to be taken to ensure the proposed placement of project sediments within the dredged material containment areas (DMCAs) would occur in a manner protective of human health and the environment. The evaluation followed tiered approach guidance prepared jointly by the US Army Corps of Engineers and the US Environmental Protection Agency.

The evaluation reviewed and summarized the findings of a number of sediment quality investigations/assessments performed for the SHEP. The effort began with a broad look at potential contaminants and used the tiered approach to identity potential contaminants of concern for the project sediments.

In 1997, sediment core samples were collected and examined for sediment physical and chemical properties. The sampling area covered the entire area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients.

The evaluation found that most of the sediments provided no reason for concern over potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified.

One issue involved sediments near the old RACON Tower site. Subsequent sampling conducted in 2005 revealed that sediments at that location do not pose potential for contaminant-related environmental impacts.

The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAHs and phenols, especially achieved detection limits, were adequate for comparison to screening criteria. This issue was addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there was no potential sediment contaminant concerns related to pesticides, PAHs, phenols, or metals other than cadmium.

The final issue involved the concentration and distribution of cadmium within the new work sediments. Sampling was conducted in 2005 to address this issue. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be

excavated during the SHEP dredging. Evaluation of the laboratory results could not rule out the potential for adverse impacts from sediments with elevated cadmium levels in some reaches of the channel.

Therefore, additional sampling and detailed analyses were conducted in 2007. The potential pathways by which cadmium might enter the environment were evaluated. Pathways of particular concern were identified to be exposure of cadmium-containing clays within the channel with subsequent movement of cadmium into the river ecosystem, and potential environmental impacts associated with placement of cadmium-containing sediments within the DMCAs.

The detailed Tier III studies in 2007 included the following:

- Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
- Side scan sonar survey to identify and map bottom characteristics in the channel;
- Benthic community assessment;
- Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);
- Collecting dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
- Compositing and processing sediment cores to create "high cadmium" and "low cadmium" composite samples for further testing;
- Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
- Analytical testing of porewater and SLRP samples at the high cadmium locations only;
- Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and
- Risk evaluation and report preparation.

These studies found that sediments with a minimum cadmium concentration of about 29.8 ppm could potentially produce environmental impacts to birds feeding 100 percent of the time in these sediments. These studies also found when these wet sediments are dried, cadmium becomes much more mobile, with cadmium concentrations as low as 14 ppm potentially causing environmental impacts.

The evaluations concluded that SHEP project sediments from Stations +90+000 to +80+125, +57+000 to 51+000, and +45+000 to +6+375 (found to contain layers averaging 14 ppm cadmium or greater) should be isolated within the DMCAs and covered with other new work sediment to ensure they are not exposed to the environment. This procedure would ensure the sediments stay moist and are not relocated for use as dike raising materials, since that action would cause the sediments to dry and the cadmium to become mobile. Sediments from other reaches, including the bar channel, averaged from <1 to <5 ppm cadmium and were found to present minimal risk to the environment and therefore not require special management when placed in a

DMCA. The results of these assessments show there should be no contaminant-related concerns associated with placement of bar channel sediments in the nearshore. However, placement of dredged material into the nearshore sites has been removed from the project. .

Sediment Quality Evaluation

Savannah Harbor Expansion Project (SHEP)

1.0 Introduction

This sediment quality evaluation was conducted to assess potential contaminant-related impacts associated with the proposed Savannah Harbor Expansion Project (SHEP). This evaluation considers sediments to be removed throughout the entire extent of the project and proposed sediment placement alternatives, and determines whether management actions need to be taken to place those sediments within the dredged material containment areas (DMCAs)/dredged material confined disposal facilities (CDFs) under the jurisdiction of the Savannah District of the US Army Corps of Engineers to ensure protection of human health and the environment. This report follows tiered approach guidance contained in the *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (UTM) prepared jointly by the US Army Corps of Engineers and the US Environmental Protection Agency (USACE 2003).

This evaluation reviews and summarizes the findings of a number of sediment quality investigations/assessments performed for the SHEP. These investigations/assessments include:

1. Sediment sampling in 1997 by ATM (Applied Technology and Management). Dredged Material Environmental Effects Evaluation, Savannah Harbor Deepening. Prepared by Applied Technology and Management, Inc., for the Georgia Ports Authority, Final Draft, April 22, 1998 (ATM, 1998).

2. 2005 sampling by CESAS, including grab samples at the RACON tower site, and channel cores divided into 2-ft lifts.

3. TCLP procedures conducted on archived 2005 samples (contracted out by CESAS-EN in 2006).

4. Savannah Harbor Expansion Dredged Material Evaluation, Phase 1, Draft. CESAM-PD-EC, February 2006, PD-EC 2006a.

5. Savannah Harbor Expansion Dredged Material Evaluation Screening Analysis to Evaluate Potential Environmental Impacts of Cadmium. ERDC, July 06

6. Conceptual Model developed by CESAM-PD-EC in 2006, PD-EC, 2006b.

7. Ecological Risk Assessment by CENWO-HX-S, June 2006.

8. Human Health Risk Assessment by CENWO-HX-S, 2006.

9. Assessment of Wet Sediment Leachate and Potential Groundwater Interactions within Confined Disposal Facilities, Potential for Wet Sediments to Impact the Upper Floridan Aquifer, CESAS-EN-GG, 2 Aug 06.

10. Sediment Quality Evaluation Phase II – Cadmium, for Savannah Harbor Expansion Project, CESAM-PD-EC, 1 Sept 06, PD-EC 2006c, and 7 Sep 2006 Addendum, PD-EC 2006d.

11. Results of pore water analyses on two samples taken from the high cadmium stations (Stations +26+000 and +26+500) 2006 and analyzed by USGS, USGS Memorandum, 27 March 2007.

12. 2007 sampling by EA (EA Engineering, Science, and Technology). Savannah Harbor Expansion Project Phase II Sediment Evaluation, Savannah, GA. Prepared for the U.S. Army Corps of Engineers, Savannah District by EA Engineering, Science, and Technology, Sparks, MD, January 2008 (EA, 2008).

These studies began with a broad look at potential contaminants and used the tiered approach to identity contaminants of concern for the Savannah Harbor Expansion Project (SHEP). Cadmium was identified as the only contaminant of concern and was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. All of the potential pathways by which cadmium might enter the environment were evaluated. Pathways of particular concern were identified to be exposure of cadmium containing clays within the channel with subsequent movement of cadmium into the river ecosystem, and potential environmental impacts associated with placement of cadmium containing sediments within the DMCAs/CDFs. Primary potential DMCA impacts were identified to be worker exposure, leachate and groundwater impacts, and movement of cadmium to wildlife that inhabit the confined disposal facilities.

The potential availability of cadmium and conditions under which cadmium might be released from the clay substrate were found to be determinate factors driving potential environmental impacts. When the Miocene clays are in a wet environment, release of cadmium was found to be minimal. Therefore, risks to the river aquatic ecosystem are expected to be minimal and risks to the aquatic environment within the DMCAs are expected to be minimal with the exception of birds feeding 100 percent of the time within a DMCA. Movement of cadmium to groundwater is also expected to be minimal. Cadmium was found to be much more available in dried and oxidized sediment, conditions expected to occur if the sediments are placed in a DMCA, allowed to dry, and later used to raise dikes in the manner of the District's normal maintenance operations.

Potential environmental risks associated with sediments containing about 4.6 ppm cadmium were found to be minimal, whereas potential impacts associated with dried sediments containing about 14 ppm cadmium could not be discounted.

Therefore, it is recommended that SHEP new work sediments from Stations +90+000 to +80+125, +57+000 to 51+000, and +45+000 to +6+375 (found to contain layers averaging 14 ppm cadmium or greater) be isolated within the DMCAs and covered with sediment in a manner that will ensure they are not exposed to the environment. This procedure would ensure the sediments stay isolated and are not relocated for subsequent use as dike raising materials. Such sediments placed on the dikes would be expected to dry and the cadmium become mobile. Sediments from other reaches (averaging from <1 to <5 ppm cadmium) are found to present minimal risk to the environment and do not require special management.

The remainder of this evaluation reviews data and evaluations from the above mentioned reports, describes the process by which contaminants of concern were narrowed to cadmium, and presents justification for the recommended management technique.

2.0 Background: Determination of Contaminants of Concern

2.1 Radiological Screening

The project area is located downstream from the Savannah River Site, where radioactive materials are processed. Releases of radioactive materials from the site have been documented over the years, raising concern as to whether such releases could cause accumulation of these materials within the sediments that are to be removed from the project area. The likelihood of this occurring has been considered improbable; nevertheless, a decision was made to screen selected sediment samples that were collected during the 2002 investigations for gross radioactivity.

All results were measured in milli-Rems per hour (mRem/hr). Background values varied between 0.01 and 0.03 mRem/hr. Values from the sediment samples ranged from 0.02 to 0.04 mRem/hr. These results are consistent with background values, with only a few samples exhibiting an increase of 0.01 mRem/hr over the background range. The slight increase in some samples was expected, as the soils encountered are known to contain phosphatic and glauconitic minerals, along with other clays, that exhibit naturally-occurring radiation levels above background. The results are two magnitudes below acceptable action levels approved by OSHA and the EPA that range between 1 mRem/hr and 5mRem/hr. Based on these results, it is believed that the levels of gross radioactivity measured in the samples is naturally occurring and poses no hazard to the environment. The complete report is included as part of the *Dredged Material Physical Analysis Report* included in the Engineering Investigations Supplemental Materials C.2.4.c.

2.2 Phase 1, Tier 1 EIS

In 1997, as part of the Tier 1 EIS process, approximately 31 sediment core samples for sediment physical and chemical evaluation were taken from the channel and bend widener new work material and most of the core samples contained sufficient sediment for analyses. The sampling area covered the entire area proposed for harbor deepening at that time. It extended from deep water in the ocean (Station -60+000B) to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients. Results of these investigations were reported as part of the 1998 Tier I EIS for the Expansion Project and the April 23, 1998 "Dredged Material Environmental Effects Evaluation, Savannah Harbor Deepening", prepared by ATM for the Georgia Ports Authority (ATM, 1998). That study also included a review of previous sediment testing in Savannah Harbor. The results for metals from that study are shown in Tables 1 to 4, below. Table 5 shows relevant marine sediment screening criteria.

Table 1. Metal Sediment Concentrations Kings Island (Station +103) to Talmadge Bridge (Station +79) Sampled 1997, dry wt.mg/kg (ATM, 1998)

Sample No.	103NW	T01NW	095NW	090NW	085NW	080NW	W01NW	W02NW
Stations *	103	99.5	95	90	85	80	102.5	88.2
Aluminum	16000	6410	6860	22500	6050	6070	1930	7750
Iron	25600	16000	14600	21200	12700	9530	6240	11300
Antimony	<4.8	<3.2	<2.7	<3.8	<2.9	<2.9	<3.8	<2.6
Arsenic	10	5	3	9.9	5.3	1.6	<1.9	2.7
Beryllium	<1.2	<0.79	<0.68	1.3	<0.72	<0.74	<0.94	<0.66
Cadmium	*<0.7*	0.7	<0.4	8.5	5.5	5.1	<0.6	<0.4
Chromium	39.6	22.7	19.9	*162*	33.7	36.3	4.8	13.4
Copper	14.7	12.2	8.3	16.6	6.3	3.8	<4.7	6.1
Lead	15.8	5.6	3.1	5.8	3	2.3	2.1	7.8
Manganese	808	223	148	189	413	361	233	160
Mercury(7471)	0.07	<0.016	<0.014	<0.019	<0.014	<0.015	0.02	0.1
Nickel	12	13.8	10.8	*30.8*	11.2	7.4	<2.8	4
Selenium	<2.4	<1.65	<1.4	<2.2	<1.4	<1.5	<1.9	<1.3
Silver	<0.48	<0.32	<0.27	<0.38	<0.29	<0.29	<0.38	<0.26
Thallium	<0.48	<0.32	<0.27	<0.38	<0.29	<0.29	<0.26	<0.26
Zinc	72.2	44.4	34.4	95.3	49.3	34.5	10.4	20.2

* Stations in 1000's feet above Station 0+000.

Table 2. Metal Sediment Concentrations Talmadge Bridge (Station +79) to Elba Island (Station +50) Sampled 1997, dry wt. mg/kg (ATM, 1998)

Sample No.	075NW	W03NW	W04NW	C07NW	W05NW	W06NW
Station*	75	77	71	65	54	50.8
Aluminum	4200	26700	21500	17200	10300	15100
Iron	8400	32200	30700	17100	14400	21500
Antimony	<3.2	<5.1	<5.9	<3.4	<4.2	<4.3
Arsenic	3.6	*15.8*	*14.5*	*9.5*	*7.8*	*10.4*
Beryllium	<0.81	<1.3	<1.5	<0.94	<1.00	<1.1
Cadmium	<0.5	*<0.8*	<0.9	4.7	2.5	<0.7
Chromium	12.3	51.1	15.6	*63.6*	24.2	33.8
Copper	4.5	17.5	14.6	11.9	6.3	11.5
Lead	7.2	24.5	20.1	12.5	8.1	16.6
Manganese	311	860	998	338	376	426
Mercury(7471)	0.02	<0.26	<0.029	<0.017	0.03	0.05
Nickel	4.1	15.9	13.2	15.9	6.9	9.1
Selenium	<1.6	<2.6	<2.9	<1.7	<2.1	<2.2
Silver	<0.32	<0.51	<0.59	<0.34	<0.42	<0.43
Thallium(7841)	<0.32	<0.51	<0.59	<0.34	<0.42	<0.43
Zinc	26.4	90.7	80.3	13.6	43.6	45.2

* Stations in 1000's feet above Station 0+000.

Table 3. Metal Concentrations Elba Island (Station +50) to Mouth of Harbor (Station 0+000) (ATM, 1998)

Sample No.	W07NW	045NW	W08NW	W09NW	015NW	W10NW	005NW
Stations*	46.2	45	35.2	29.2	15	10.6	5
Aluminum	5520	1100	13600	13100	8220	3390	2290
Iron	11500	8370	20500	17500	16600	6650	4030
Antimony	<3.2	<2.4	<4.5	<3.4	<3.4	<3.1	<2.6
Arsenic	5.7	3.7	*11.4*	9.9	7	4.1	2.9
Beryllium	<0.81	<0.59	<1.1	<1.0	1.1	<0.77	<0.65
Cadmium	<0.5	<0.4	*<1.1*	*<0.9*	*<0.9*	<0.5	0.48
Chromium	15.1	4.8	32.6	29.4	23.6	9.6	17.9
Copper	<4.0	<2.9	9.2	9	5.9	<3.8	<3.2
Lead	5.4	1.2	14.9	11.2	10	4.2	1.9
Manganese	275	38.4	488	252	297	140	58.9
Mercury(7471)	<0.016	0.01	0.13	<0.017	<0.017	<0.015	<0.013
Nickel	4.3	3.4	9	10.3	9	2.3	5
Selenium	<1.6	<1.2	<2.3	<1.7	<1.7	<1.5	<12.3
Silver	<0.32	<0.24	<0.45	<0.34	<0.34	<0.31	<0.26
Thallium(7841)	<0.32	<0.24	<0.45	<0.34	<0.34	<0.31	<0.26
Zinc	18.5	9.6	42.1	69.5	36.4	13.6	12.6

* Stations in 1000's feet above Station 0+000.

Table 4. Metal Concentrations in the Bar Channel (ATM, 1998)

Sample No.	005NW	015NW	W01NW	W02NW	035NW	075NW
Stations*	-5	-15	-19	-39.5	-35	-75
Aluminum	2510	2780	11300	1200	3020	3830
Iron	2600	2840	18100	2910	4600	3650
Antimony	<2.7	<2.7	<3.1	<2.5	<2.7	<2.6
Arsenic	3.3	3.4	*8.7*	3.6	6.4	12
Beryllium	<0.67	<0.68	<0.78	<0.62	<0.68	<0.64
Cadmium	0.68	*1.5*	<0.5	<0.4	<0.4	**24.3**
Chromium	20.2	39.4	20	7.1	9.2	35.9
Copper	3.9	5.6	8.1	<3.1	<3.4	5.5
Lead	1.3	1.7	11.3	1.8	2.9	2.3
Manganese	25.2	13.9	436	33.6	63	38.4
Mercury(7471)	<0.013	<0.014	0.04	<0.012	<0.014	0.04
Nickel	6.8	8.9	5.9	1.9	3.1	9
Selenium	<1.3	<1.4	<1.6	<1.2	<1.4	<1.3
Silver	<0.27	<0.27	<0.31	<0.25	<0.27	<0.26
Thallium(7841)	<0.27	<0.27	<0.31	<0.25	<0.27	<0.27
Zinc	12.2	16.3	26.3	8	10.1	51.4

* Stations in 1000's feet above Station 0+000.

Table 5. Sediment Screening Criteria (mg/kg), from Buchman, 1999

	TEL	ERL	ERM	AET
Aluminum				1800
Iron				220000
Antimony				9.3
Arsenic	7.2	8.2	70	35
Beryllium				
Cadmium	0.68	1.2	9.6	3
Chromium	52.3	81	370	62
Copper	18.7	34	270	390
Lead	30.2	46.7	218	400
Manganese				260000
Mercury(7471)	0.13	0.15	0.71	0.41
Nickel	15.9	20.9	51.6	110
Selenium				1
Silver	0.73	1	3.7	3.1
Thallium(7841)				
Zinc	124	150	410	410

The following paragraphs contain summaries of findings that were made based on the above 1997 data and data obtained more recently. Most metals were eliminated as potential contaminants of concern after comparing the observed sediment levels to sediment screening criteria (Table 5). The only metal found to be of concern at that time was potential cadmium contamination at the old RACON tower site. Therefore, cadmium was the only heavy metal that was included in the 2005 confirmatory testing. The following paragraphs describe the metals most likely to be considered potential

contaminants of concern and the findings and conclusions eliminating them from further consideration.

2.2.1 Arsenic

The 1997 sampling found some new work sediments would be expected to contain arsenic above possible effects sediment screening levels, but below probable effects levels. However, average concentrations in the new work sediments are expected to be below screening levels. Furthermore, the observed levels are similar to levels observed in maintenance sediments (1.7 to 17 ppm) and the harbor reference area (14 ppm)(ENSR, 2003). No additional environmental impacts are expected due to new work sediment arsenic levels and no additional evaluation is warranted.

2.2.2 Chromium

This metal was found above possible effect sediment screening levels, but below probable effects levels for only one 1997 sample. Therefore, the 1997 sampling results were considered to indicate the potential for environmental effects was minimal. However, some additional investigation of chromium was continued in later studies to confirm this. For example, consideration is warranted of how easily it might be released from the sediment to the environment. Such an assessment would guide one's expectation of environmental impacts. If the majority of the element is tightly bound within the sediment, the potential for environmental impact should be minimal. EA (2008) conducted sequential extraction procedures (SEP) to estimate how tightly chromium is bound to the new work sediments. The low cadmium composite found chromium at 134 and 139 ppm. SEP analyses found 92.1 and 91.9 percent existed in the sulfide and residual fractions. The chromium is considered to be tightly bound when it exists in these fractions. The high cadmium composite found chromium at 126 and 146 ppm. SEP analyses of the high cadmium sediments found 91.1 and 89.1 percent existed in the sulfide and residual fractions. These percentages are even higher in the dried soil. These data indicate chromium would not be available or expected to produce adverse environmental impacts. No further investigation of chromium is warranted.

2.2.3 Manganese

In the 1997 sampling, this metal was found below sediment screening levels (AET, Buchman, 1999). Because of its low potential for bioaccumulation, manganese is not expected to cause environmental impacts. However, additional study of the potential availability of manganese in new work sediments was performed by EA (2008). SEP procedures conducted by EA found 16 to 32 percent of manganese is either in the sulfide or residual fractions. These percentages are about the same for dried soil (27-28 percent). The low Cd sediment showed 10-12 percent of manganese in the exchangeable fraction. The high Cd sediment showed only 4-5 percent in the exchangeable fraction. The dried soils showed 10-20 percent in the exchangeable fraction. These data indicate that some manganese would be expected to be available in both aquatic and upland environments. However, because of its low potential for bioaccumulation, potential environmental

impacts are expected to be minimal, so no further consideration of manganese is warranted.

2.2.4 Nickel

This metal was found above no effect sediment screening levels, but below probable effects levels, in only one 1997 sample. As in the case of the other metals found above no effects screening criteria during the 1997 sampling, EA (2008) conducted SEP procedures for nickel. The SEP procedures conducted by EA (2008) found 48 to 54 percent of nickel in the wet sediment and dried soil is either in the sulfide or residual fractions. These data indicate at least half of the sediment/soil nickel would not be available to aquatic life or upland plants. However, because of its potential to bioaccumulate, nickel was included in the bioaccumulation and plant uptake studies.

The bioaccumulation study found both *Macoma* and *Nereis* accumulated nickel and produced wet weight tissue nickel concentrations of 0.48 to 0.69 ppm. These results were significantly higher than reference. These results are discussed in Sections 4.2.5 and 4.3.1.5. These results are below the lowest NOAEL in the ERED vertebrate database except for a frog (2.0 mg/kg wet wt. for the Rainbow Trout). The highest sediment nickel concentration was 30.8 mg/kg and the inner harbor sample average was 11.6 mg/kg. The Terrestrial Toxicity Database (USACHPPM, chppm-www.apgea.army.mil) shows a lowest tissue NOAEL of 63 mg/kg and 35 ppm soil concentration as a concentration below which adverse effects should not occur. These data are thought to show minimal environmental concern regarding potential environmental impacts associated with nickel concentrations in the proposed new work sediments.

2.2.5 Zinc

The 1997 study found zinc below no effect screening criteria. However, because zinc was found above no effect screening criteria in the high cadmium composite, EA (2008) also conducted SEP procedures for zinc on the new work composites. Exchangeable and carbonate fractions are the most available fractions in an aquatic state. As Tables 6 and 7, show, the amount of zinc in these fractions is small, indicating little environmental concern for zinc in an aquatic environment. When sediments oxidize, the hydroxide and organic fractions can become available. The washed and dried sediments showed a loss of zinc from the hydroxide fraction, and an increase in the exchangeable and carbonate fractions. These data indicate zinc is unlikely to become available to aquatic life but could become a little more available under some oxidizing conditions. The aquatic bioaccumulation study found that *Macoma* accumulated zinc at concentrations slightly above reference. *Macoma* in the low sediment composite showed zinc concentrations of 10.2 ppm, which was significantly higher than the 9.32 ppm found in organisms grown in the reference sediment (EA, 2008, Table 8-7). This minimal difference shows that new work sediments are unlikely to produce any additional environmental impacts related to zinc in an aquatic environment. The plant uptake study found zinc did bioaccumulate in plants under oxidizing conditions. The Terrestrial Toxicity Database (USACHPPM) lists for zinc 140 mg/kg as a soil concentration below which adverse effects should not occur

and a lowest NOAEL of 100 mg/kg. Table 6 shows zinc levels associated with the sediments containing elevated levels of cadmium. These results indicate a potential concern for possible effects of zinc associated with sediments containing elevated cadmium levels when placed in a dry environment. The results of potential plant uptake of zinc are discussed at Section 4.3.1.5.

2.2.6 Selenium

The 1997 sampling found no detection of selenium in the new work sediments, but showed MDLs for selenium above published possible effects criteria (Apparent Effects Threshold = 1 mg/kg). Previous O&M sampling has found selenium to be non-detectable with MDLs ranging from 0.83 to 1.0 mg/kg (ENSR, 2003). Because selenium has not been found in O&M sediments and the achieved MDLs for the new work sediments were not greatly above 1 mg/kg (in the range of 1.2 to 2.4 mg/kg), the potential for environmental effects was deemed minimal. Selenium was tested for in the river water and elutriate samples. Dissolved concentrations were similar to the river water concentrations, thus confirming the potential for selenium environmental impacts to be minimal.

Table 6. Zinc Sediment Concentrations from SEP Fractions (EA, 2008), mg/kg

	Exchange-able	Carbon-ate	Organic	Hydrox-ide	Sulfide	Residual	Total*1	Total*2	Total*3
High Cd Comp	0.65	3.8	35.8	121	31.8	10.7	191	130	163.5
High Cd Comp Dup	0.7	3.3	33.8	119	29.2	11.1	210	164	159.3
High Cd Comp Wash/Dry	1.9	5.6	31.9	114	70.7	13.1	219	171	197.8
Low Cd Comp	0.75	3.8	22.7	71.7	31.4	15.4	146	100	117.9
Low Cd Comp Dup	0.75	3.8	23.7	71.2	33.6	13.1	146	92.1	117.9
Low Cd Comp Wash/Dry	1.4	5.7	22.9	59.5	37	8.5	132	93.1	105

*1 Microwave digestion

*2 Total standard digestion

*3 Total relatively unavailable (hydroxide, sulfide, residual) (microwave digestion)

Table 7. Zinc, Percentages from SEP Fractions (EA, 2008), mg/kg

	Exchange-able	Carbon-ate	Organic	Hydroxide	Sulfide	Residual	Total*
High Cd Comp	0.3	1.9	17.6	59.4	15.6	5.30	80.2
High Cd Comp Dup	0.4	1.7	17.1	60.4	14.8	5.6	80.8
High Cd Comp Wash/Dry	0.8	2.4	13.4	48.1	29.8	5.5	83.4
Low Cd Comp	0.5	2.6	15.6	49.0	21.6	10.6	81.2
Low Cd Comp Dup	0.5	2.6	16.2	48.7	23.0	9.0	80.7
Low Cd Comp Wash/Dry	1.0	4.2	17.0	44.1	27.4	6.3	77.8

* Total relatively unavailable (hydroxide, sulfide, and residual fractions)

2.2.7 Cadmium

During the 1997 sampling, cadmium was detected between ERLs and ERMs at several inner harbor stations and above ERM at a station near the old RACON tower site (-75+000). It was determined that cadmium warranted additional investigation through the Phase 2 verification sampling. Additional investigations are covered at Sections 2.3.2.1 and 3.0.

2.2.8 Other Potential Contaminants of Concern

2.2.8.1 PCBs. The 1997 sampling (ATM 1998) found total PCBs were below available no effect sediment screening criteria and therefore of no environmental concern. No further investigation of PCBs was warranted.

2.2.8.2 Pesticides. In the 1997 sampling, observed pesticide levels were found to be below available screening criteria. However, questions existed about attained detection limits. Further analysis or documentation was needed, see Section 2.3.3.3.

2.2.8.3 Phenols. In the 1997 sampling, phenolic compounds were not detected, but some detection limits were above available sediment screening criteria. Further analysis or documentation was needed, see Section 2.3.3.1.

2.2.8.4 PAHs. In the 1997 sampling, one bend widener sample showed some PAHs above threshold effects screening criteria, but below probable effects levels. Unacceptable adverse effects were determined to be unlikely because only a few PAHs were observed above the effects thresholds and the observed concentrations were relatively low. Additional sampling (verification samples) was planned to more clearly

define the sediment levels of these parameters and their potential for environmental impact. PAHs and cadmium were detected in a sample taken at about Station 75+000 near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996. Additional sampling at the RACON tower site and sediment testing was planned to clearly determine whether concentrations of cadmium and PAHs in this area would impact the Expansion Project, see Section 2.3.3.2.

2.2.8.5 Dioxins. The 1997 sampling (ATM 1998) found 2378 PCDD/PCDF dioxin congeners in new work sediments. Since calculated TBPs (theoretical bioaccumulation potentials) were less than reference values, there was no reason for environmental concern. No further investigation of dioxins was warranted.

2.2.8.6 Organotins. The 1997 sampling (ATM 1998) detected low levels of butyltins throughout the harbor. Other studies (see ATM, 1998) showed conflicting results, so additional testing of these parameters was planned through the Phase 2 verification sampling. EA reviewed existing project data on butyltins and concluded "it is not expected that there are any risks associated with any exposure to the sediment, or to soil should the sediment be utilized for upland placement" (EA, 2007). No further investigation of butyltins was warranted.

2.2.8.7 Petroleum Hydrocarbons. The 1997 sampling (ATM 1998) detected total recoverable petroleum hydrocarbons at levels ranging from <10 ppm to 70 ppm. These levels were considered minor, but warranted additional investigation through the Phase 2 verification sampling, see Section 2.3.2.2.

2.2.8.8 Cyanide. The ATM sampling in 1997 found no detection of cyanide in any sediment samples or elutriates. Detection limits ranged from 1.2 to 2.9 mg/kg for the sediment samples and 0.01 mg/L for the elutriates. No further investigation of cyanide was warranted.

2.2.8.9 Nutrients. Nutrients were not considered to present an environmental hazard and additional evaluation was not performed.

2.3 SHEP Phase 2 Testing

2.3.1 Goals

Results of the first set of sediment sampling and analysis (1997) for the Expansion Project left open some questions concerning the potential for contaminant-related impacts associated with the proposed dredging and dredged material placement.

One set of questions involved the old RACON Tower site. Do the sediments around the old RACON Tower site pose a potential for environmental impacts due to the proposed Expansion dredging? The 2005 sampling included twenty grab samples taken in the RACON Tower area to answer that question. These samples were analyzed for cadmium and PAHs.

The second set of questions pertained mostly to whether the sediment chemistry data, especially achieved detection limits, were adequate for comparison to screening criteria. To address this set of questions, the 2005 sampling included six confirmatory samples spread along the length of the channel to be analyzed for pesticides, PAHs, and phenols.

As a result of sampling and testing unrelated to the SHEP but which occurred after the 1998 evaluation, additional questions arose concerning the concentration and distribution of cadmium within the new work sediments (these questions are addressed in Section 3.0). To address this issue, the 2005 sampling included collection of approximately 350 samples for cadmium analysis taken at 2-ft intervals from 45 cores distributed throughout the harbor, but concentrating in areas believed to contain Miocene clays. Sampling intervals (measured from MLW) were assigned letter designations as follows: -42 ft to -44 ft (a), -44 ft to -46 ft (b), -46 ft to -48 ft (c), -48 ft to -50 ft (d), -50 ft to -52 ft (e), -52 ft to -54 ft (f), -54 ft to -56 ft (g), -56 ft to -57 ft (h). A subset of these samples was subjected to both standard extraction and total digestion techniques to determine if the cadmium was tightly bound to the sediment. Should these analyses show cadmium exists in the new work sediments at levels of concern, additional testing would have to be performed at a later time to address specific environmental concerns associated with the specific dredged material placement options under consideration.

In addition, since the Tier 1 EIS was written, the depth of potential impact of a hydraulic cutterhead dredge was clarified. In general, a cutterhead dredge usually disturbs and mixes sediment below the level it is capable of removing. In the case of a large cutterhead dredge, this disturbance depth can be 3 to 4 feet below the final channel depth that is actually attained, depending on the size of the dredge. To account for this increased disturbance depth, the target depth for all core samples for the Phase 2 (2005) sediment sampling and analysis was 3 feet below the expected removal depth (see Table 8, below). For example, the core depth would be the authorized depth, plus 2 feet of overdepth, any additional amount of Advance Maintenance, and 3 feet of disturbance depth. Table 9 shows the difference between the core depths achieved by the 1997 sampling and the calculated disturbance depth. The failure to reach disturbance depth in 1997 would be corrected in the next round of testing.

Table 8. Channel Depths (in feet MLW)

STATION (1000 FT)	AUTH DEPTH	ADV MAINT	ALLOW OVER-DEPTH	SEDIMENT REMOVAL DEPTH	DISTURBANCE DEPTH*1	TOTAL O&M DREDGING DEPTH*2
112.5 to 105.5	30	2	2	34	3	37
105.5 to 103	36	2	2	40	3	43
103 to 102	42	0	2	44	3	47
102 to 70	42	2	2	46	3	49
70 to 37	42	4	2	48	3	51
37 to 35	42	6	2	50	3	53
35 to 26	42	4	2	48	3	51
26 to 0	42	2	2	46	3	49
0 to 14B	42	2	2	46	3	49
14B to 60B	44	0	2	46	3	49
24B to 32B south ½	44	2	2	48	3	51
29B to 41.5B [3]	44	100-ft widener	2	46	3	49
Oysterbed Island Turning Basin	40	0	2	42	3	45
Fig I TB	34	4	2	40	3	43
Marsh I TB	34	0	2	36	3	39
Kings I TB	42	8	2	52	3	55
Argyle I TB	30	0	2	32	3	35
Port W TB	30	0	2	32	3	35
Sediment Basin: 0 to 2+000	38	0	2	40	3	43
Sediment Basin: 2+000 to 13.3	40	0	2	42	3	45

NOTES:
*1 Depth below the intake of a cutterhead hydraulic dredge but which the cutterhead disturbs during dredging.
*2 Total Dredging depth includes the depth that is disturbed by a cutterhead dredge. This is deeper than the depth to which sediment is actually removed, as it includes the disturbance depth.
*3 These advance maintenance sections are currently under environmental review and do not presently have environmental clearances. CESAD approved an additional advance maintenance feature in the entrance channel in June 2003 that would be located between Stations -24+000(B) to -41+500(B). It has not yet been implemented, but CESAS is seeking funds for the initial construction.

Table 9. 1997 Sampling Depths (ATM 1998)

Harbor Location	Sample	Station* (1000 feet)	Penetration	Core Depth	Disturbance Depth*
SHIH	103NW	103	4	-45.9	-53
SHIH	W01NW	102.5	9.5	-33	-53
SHIH	T01NW	99.5	2	-43	-55
SHIH	095NW	95	8	-52.7	-55
SHIH	090NW	90	3	-47.8	-55
SHIH	085NW	85	7	-52.4	-55
SHIH	080NW	80	4.5	-48.2	-55
SHIH	W02NW	88.2	11	-31.8	-55
SHIH	075NW	75	11	-51.1	-55
SHIH	W03NW	77	11	-42.1	-55
SHIH	W04NW	71	12	-47.1	-55
SHIH	C07NW	"25 to 65"	"2.5 to 5"	"-43 to-49"	"-57 to-59"
SHIH	W05NW	54	5	-42.2	-57
SHIH	W06NW	50.8	12	-38.3	-57
SHIH	W07NW	46.2	10	-19.4	-57
SHIH	045NW	45	3	-47.4	-57
SHIH	W08NW	35.2	12	-40.1	-59
SHIH	W09NW	29.2	11	-31.1	-57
SHIH	015NW	15	6	-49.3	-55
SHIH	005NW	5	12	-55.1	-55
SHIH	W10NW	10.6		-42.3	-55
SHBC	005NW	-5		-44.2	-55
SHBC	015NW	-15		-48.8	-55
SHBC	W01NW	-19		-40.2	-55
SHBC	W02NW	-39.5		-43.3	-57
SHBC	035NW	-35		-50.9	-55

* For a 6-foot deepening.

2.3.2 RACON Tower Testing Results

The Tier I Expansion sampling (1997) collected sediment near the RACON/light tower site at Station -75+000 in the bar channel. Cadmium and low molecular weight (LMW) PAH compounds were detected in that sediment, presumably from a fuel, battery, and paint lacquer spill that occurred in November 1996. While the PAH compounds that were encountered were not found at concentrations normally associated with benthic effects, the cadmium concentration was detected above probable effects levels (ATM, 2004, p. 5). To further investigate the potential for environmental impacts from dredging in this area during the proposed Expansion Project, additional grab samples were taken in the vicinity of the site and analyzed for PAHs and cadmium.

2.3.2.1 Cadmium. In the second round of testing, twenty sediment samples were taken in a circular area at distances of 300 to 1500 meters from the old RACON tower site and analyzed for cadmium to define the distribution of cadmium in the area. No cadmium was detected in any of the samples, with the MDL at 0.30 ppm or less. These samples were also analyzed for aluminum and iron. Aluminum values ranged from about 600 to 4500 ppm, with the lowest values found mostly to the south of the tower near the

channel. Iron values ranged from about 560 to 1850 ppm, with the highest values mostly to the NE and SW of the tower site. These data indicate no environmental concerns related to metal concentrations near the RACON tower site.

2.3.2.2 PAHs. PAH's were analyzed in four samples taken at 300 meters from the tower site along N, S, E, and W radii. Low molecular weight totals for detected PAHs ranged from 2.4 to 3.6 ppb. High molecular weight totals for detected PAHs ranged from 0.07 to 6.7 ppb, except for the sample taken 300m east of the tower site, which showed a high molecular weight PAH total of 23.6 ppb. These observed values are well below TELs (Threshold Effects Levels) for both low molecular weight PAHs (311.7 ppb) and high molecular weight PAHs (655.34 ppb).

These data show no contaminants in the area of the RACON tower site at levels of concern and no additional investigations at the site by the Savannah Harbor Expansion Project are warranted. Available evidence indicates that sediments in the vicinity of the RACON tower site do not pose any environmental concerns related to the proposed Expansion Project work.

2.3.3 Confirmatory Sampling

This section reviews the list of potential contaminants of concern remaining after the Phase 1 sampling in 1997 and the results of the six Phase 2 confirmatory samples taken in 2005, and presents findings which eliminated concern for all contaminants except cadmium. The discussion is presented by contaminant.

2.3.3.1 Phenols. The 1997 sampling (ATM 1998) detected no phenols, but some detection limits were above no effects sediment screening criteria. Therefore, analysis for phenols was included for the six confirmatory samples taken during the 2005 sampling. No phenols were detected. Five of the samples achieved very low MDLs (0.2 to2.6 ug/kg). The other sample (bar channel sample at Station -63+000) showed higher MDLs (from 1 to 13 ug/kg). These MDL's were all below marine sediment screening criteria except for 2, 4, 5 trichlorophenol in the bar channel Station -63+000 sample, where the MDL of 7.23 ug/kg exceeded the AET of 3 ug/kg. The lowest and highest MDL's achieved for the six samples are listed in the table below. These results indicate minimal concern for potential environmental effects due to phenols and further investigation of phenols was judged to not be warranted.

Table 10. Confirmatory Sampling Phenol Results for All Samples (SH083+000 (A+B), SH065+000 (D), SH025+282(B), SHBC027+000(C), SHBC045+000 (B), SHBC063+000 (F))

ANALYTE	RESULT	LOWEST MDL	HIGHEST MDL	AET*	UNITS
4-Chloro-3-methylphenol	U	0.389	2.07		µg/kg
2,4,6-Trichlorophenol	U	1.07	5.68	6	µg/kg
2,6-Dichlorophenol	U	0.565	3.01		µg/kg
2,4-Dichlorophenol	U	0.565	3.01	5	µg/kg
2-Nitrophenol	U	0.560	2.98		µg/kg
3-Methylphenol (m-Cresol)	U	0.493	2.63		µg/kg
4-Methylphenol (p-Cresol)	U	0.493	2.63	100	µg/kg
2,4-Dimethylphenol	U	0.418	2.22	18	µg/kg
2-Methylphenol (o-Cresol)	U	0.237	1.26	8	µg/kg
Phenol	U	0.190	1.01	130	µg/kg
4-Nitrophenol	U	1.28	6.82		µg/kg
2,4,5-Trichlorophenol	U	1.36	**7.23**	3	µg/kg
2-Methyl-4,6-dinitrophenol	U	1.59	8.46		µg/kg
2-Chlorophenol	U	0.195	1.04	8	µg/kg
Pentachlorophenol	U	1.42	7.55	17	µg/kg
2,4-Dinitrophenol	U	2.65	13.4		µg/kg

* Buchman, 1999.

2.3.3.2 PAHs. The 1997 sampling (ATM 1998) found one bend widener sample above sediment threshold effects screening criteria. PAHs were also detected in one sample taken at about Station -75+000 near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996.

PAHs were analyzed during the 2005 "confirmatory" sampling (Tables 11 and 12). Neither the low molecular weight totals nor the high molecular weight totals approached threshold effects levels. These results indicate no concern for potential environmental effects due to PAHs and no further investigation of PAHs occurred related to the confirmatory sampling.

Table 11. PAHs Upper Harbor 2005 Testing (ppb (ug/kg))

	SH083+000 (A+B)			SH065+000 (D)			SH025+282 (B)			SH025+282 (Z)	
Analyte	Result	MDL		Result	MDL		Result	MDL		Result	MDL
1-Methylnaphthalene	0.81	0.55	J	1.10	0.58	J	0.39	0.32	J	0.72	0.31
2-Methylnaphthalene	1.20	0.75	J	1.60	0.78	J	0.66	0.43	J	1.10	0.42
Acenaphthene	1.30	0.36	J	7.80	0.37			0.20	U	0.30	0.20
Acenaphthylene	2.00	0.49	J	4.20	0.51	J		0.28	U	0.54	0.27
Anthracene	4.50	0.49	J	7.20	0.51			0.28	U	0.27	0.27
Benz(a)anthracene	12.00	0.36		21.00	0.37		0.28	0.20	J	0.24	0.20
Benzo(a)pyrene	13.00	0.49		19.00	0.51		0.59	0.28	J	0.27	0.27
Benzo(b)fluoranthene	17.00	1.10		20.00	1.20		0.60	0.60	J	0.87	0.59
Benzo(g,h,i)perylene	10.00	0.51		13.00	0.53		0.45	0.29	J	0.29	0.29
Benzo(k)fluoranthene	15.00	0.73		20.00	0.76		0.49	0.42	J	0.41	0.41
Chrysene	17.00	0.90		22.00	0.95			0.51	U	1.50	0.50
Dibenz(a,h)anthracene	2.30	0.58	J	3.10	0.60	J		0.33	U	0.32	0.32
Fluoranthene	40.00	0.75		54.00	0.78		1.20	0.43	J	5.00	0.42
Fluorene	1.50	0.42	J	4.70	0.44	J		0.24	U	0.66	0.24
Indeno(1,2,3-cd)pyrene	13.00	0.53		17.00	0.56		0.45	0.30	J	0.33	0.30
Naphthalene	5.60	0.75		6.10	0.78		4.40	0.43	J	3.70	0.42
Phenanthrene	8.80	0.73		12.00	0.76		0.44	0.42	J	5.40	0.41
Pyrene	38.00	0.79		45.00	0.83		1.20	0.45	J	2.20	0.44
LMW TOTAL, TEL=311	25.71			44.70			5.89			12.69	
HMW TOTAL, TEL=655	177.30			234.10			5.26			11.43	

Table 12. PAHs Bar Channel 2005 Testing (ppb (ug/kg)

		SHBC -27+ 000(C)		SHBC -45+ 000(B)		SHBC -63+ 000(F)		
Analyte		MDL	Flag	MDL	Flag	Result	MDL	Flag
1-Methylnaphthalene	L	0.340	U	0.310	U	0.340	0.320	J
2-Methylnaphthalene	L	0.460	U	0.420	U	0.470	0.440	J
Acenaphthene	L	0.220	U	0.200	U		0.210	U
Acenaphthylene	L	0.300	U	0.270	U		0.280	U
Anthracene	L	0.300	U	0.270	U		0.280	U
Benz(a)anthracene	H	0.220	U	0.200	U	1.000	0.210	J
Benzo(a)pyrene	H	0.300	U	0.270	U	0.780	0.280	J
Benzo(b)fluoranthene	H	0.640	U	0.590	U	1.100	0.610	J
Benzo(g,h,i)perylene	H	0.310	U	0.280	U	0.700	0.300	J
Benzo(k)fluoranthene	H	0.440	U	0.400	U	0.810	0.420	J
Chrysene	H	0.550	U	0.500	U	0.990	0.530	J
Dibenz(a,h)anthracene	H	0.350	U	0.320	U		0.330	U
Fluoranthene	H	0.460	U	0.420	U	2.000	0.440	J
Fluorene	L	0.260	U	0.230	U		0.250	U
Indeno(1,2,3-cd)pyrene	H	0.320	U	0.300	U	0.650	0.310	J
Naphthalene	L	0.460	U	0.420	U	1.000	0.440	J
Phenanthrene	L	0.440	U	0.400	U	0.580	0.420	J
Pyrene	H	0.480	U	0.440	U	1.500	0.460	J
LMW TOTAL, TEL=311						2.39		
HMW TOTAL, TEL=655						9.53		

2.3.3.3 Pesticides. The 1997 sampling (ATM 1998) found pesticides were below potential effects screening criteria and therefore of no environmental concern. However, pesticides results in the 1997 sampling often had somewhat elevated reporting limits. These results also showed scattered low concentrations of several pesticides (see Table 13, below). Therefore, analysis of pesticide concentrations was added to the confirmatory sampling.

The confirmatory sampling (Tables 14 and 15, below) shows detection of only two pesticides, beta-BHC (5.554 ug/kg) in the upper harbor sample at Station 83+000, and gamma-BHC (lindane) (2.109 ug/kg) in the upper harbor sample at Station 65+000. Buchman (1999) does not list screening criteria for beta-BHC. ATM (2004) lists a consensus Threshold Effects Level (TEC) for beta-BHC of 5.1 ug/kg. Since this level was observed in only one sample, this substance is not expected to be widespread and project sediments would be expected to average much less than this screening value. Therefore, no environmental impacts are expected due to beta-BHC.

Buchman lists lindane at a TEL of 0.32 ug/kg and a PEL of 0.99 ug/kg. ATM (2004) lists a consensus TEC for gamma-BHC (lindane) of 0.80 ug/kg. The observed level of lindane at Station 83+000 is above these screening levels. However, the observed level (2.109 ug/kg) is less than one of the reference values (3.989 ug/kg). Moreover, since this level was observed in only one sample, this substance is not expected to be widespread and the overall project sediments would be expected to average much less than the screening values. Therefore, no environmental impacts are expected due to gamma-BHC (lindane).

Table 13. Pesticides Detected in New Work Sediments during 1997 Sampling (all detections J flagged) ppb (ug/kg)

SAMPLE	SHIH W03NW	SHIH 075NW	SHIH W05NW	SHIH W06NW	SHBC 035NW	SHBC 075NW	SHIH R02
Station #	+77+100	+75+000	+54+000	+50+800	-35+000	-75+000	Reference
Aldrin	0.50	0.125	U	0.15	U	U	U
4,4` DDE	U	U	U	0.71	U	U	U
4,4` DDT	U	0.33	U	U	U	U	U
Dieldrin	U	0.16	U	U	0.12	0.10	0.13
Endrin	U	0.39	0.24	0.29	U	U	0.085
Endrin aldehyde	U	0.25	U	U	U	U	U
Heptachlor	U	0.13	U	U	U	U	U

Table 14. Pesticides Upper Harbor 2005 Testing

		SH083 + 000 (A+B)		SH065 + 000 (D)		SH025 + 282 (B)	
ANALYTE	UNITS	RESULT	MDL	RESULT	MDL	RESULT	MDL
2,4'-DDD	µg/kg	U	1.460	U	1.450	U	0.404
2,4'-DDE	µg/kg	U	1.460	U	1.450	U	0.404
2,4'-DDT	µg/kg	U	1.460	U	1.450	U	0.404
4,4'-DDD	µg/kg	U	4.850	U	4.830	U	1.340
4,4'-DDE	µg/kg	U	4.850	U	4.830	U	1.340
4,4'-DDT	µg/kg	U	4.850	U	4.830	U	1.340
Aldrin	µg/kg	U	0.485	U	0.483	U	0.067
alpha-BHC	µg/kg	U	0.097	U	0.097	U	0.067
alpha-Chlordane	µg/kg	U	0.097	U	0.097	U	0.067
Beta-BHC	µg/kg	**5.554**	0.485	U	0.483	U	0.067
Chlordane (Technical)	µg/kg	U	3.880	U	3.870	U	1.610
cis-Nonachlor	µg/kg	U	0.058	U	0.058	U	0.040
delta-BHC	µg/kg	U	0.485	U	0.483	U	0.067
Dieldrin	µg/kg	U	0.194	U	0.193	U	0.134
Endosulfan I	µg/kg	U	0.097	U	0.097	U	0.067
Endosulfan II	µg/kg	U	0.194	U	0.193	U	0.134
Endosulfan sulfate	µg/kg	U	0.194	U	0.193	U	0.134
Endrin	µg/kg	U	0.194	U	0.193	U	0.134
Endrin aldehyde	µg/kg	U	0.194	U	0.193	U	0.134
Endrin ketone	µg/kg	U	0.194	U	0.193	U	0.134
gamma-BHC (Lindane)	µg/kg	U	0.485	**2.109**	0.483	U	0.067
gamma-Chlordane	µg/kg	U	0.097	U	0.097	U	0.067
Heptachlor	µg/kg	U	0.485	U	0.483	U	0.067
Heptachlor epoxide	µg/kg	U	0.097	U	0.097	U	0.067
Hexachlorobenzene	µg/kg	U	0.058	U	0.058	U	0.040
Methoxychlor	µg/kg	U	0.970	U	0.967	U	6.710
Mirex	µg/kg	U	0.058	U	0.058	U	0.404
Oxychlordane	µg/kg	U	0.058	U	0.058	U	0.040
Toxaphene	µg/kg	U	3.880	U	3.870	U	1.610

Table 15. Pesticides Bar Channel 2005 Testing

		SHBC027+000(C)		SHBC045+000 (B)		SHBC063+000 (F)	
ANALYTE	UNITS	'RESULT	'MDL	'RESULT	'MDL	'RESULT	'MDL
2,4'-DDD	µg/kg	U	0.460	U	0.069	U	1.400
2,4'-DDE	µg/kg	U	0.460	U	0.069	U	1.400
2,4'-DDT	µg/kg	U	0.460	U	0.069	U	1.400
4,4'-DDD	µg/kg	U	1.530	U	0.139	U	2.810
4,4'-DDE	µg/kg	U	1.530	U	0.139	U	2.810
4,4'-DDT	µg/kg	U	1.530	U	0.139	U	2.810
Aldrin	µg/kg	U	0.077	U	0.069	U	0.070
Alpha-BHC	µg/kg	U	0.077	U	0.069	U	0.070
Alpha-Chlordane	µg/kg	U	0.077	U	0.069	U	0.070
beta-BHC	µg/kg	U	0.077	U	0.069	U	0.070
Chlordane (Technical)	µg/kg	U	1.840	U	1.660	U	1.400
cis-Nonachlor	µg/kg	U	0.046	U	0.069	U	0.070
Delta-BHC	µg/kg	U	0.077	U	0.069	U	0.070
Dieldrin	µg/kg	U	0.153	U	0.139	U	0.140
Endosulfan I	µg/kg	U	0.077	U	0.069	U	0.070
Endosulfan II	µg/kg	U	0.153	U	0.139	U	0.140
Endosulfan sulfate	µg/kg	U	0.153	U	0.139	U	0.140
Endrin	µg/kg	U	0.153	U	0.139	U	2.810
Endrin aldehyde	µg/kg	U	0.153	U	0.139	U	2.810
Endrin ketone	µg/kg	U	0.153	U	0.139	U	2.810
gamma-BHC (Lindane)	µg/kg	U	0.077	U	0.069	U	0.070
gamma-Chlordane	µg/kg	U	0.077	U	0.069	U	0.070
Heptachlor	µg/kg	U	0.766	U	0.069	U	0.070
Heptachlor epoxide	µg/kg	U	0.077	U	0.069	U	0.070
Hexachlorobenzene	µg/kg	U	0.046	U	0.069	U	0.070
Methoxychlor	µg/kg	U	7.660	U	0.693	U	0.702
Mirex	µg/kg	U	0.460	U	0.069	U	0.070
Oxychlordane	µg/kg	U	0.046	U	0.069	U	0.070
Toxaphene	µg/kg	U	1.840	U	1.660	U	1.400

Pesticide levels in the reference samples taken during confirmatory sampling were either non-detect or very low. The three outer reference samples showed no detection of pesticides. Each sample is listed below, along with the range of detection limits. All values are ug/kg dry wt.(ppb).

SHRF OU (0.153 to 6.14, 30.7 for methoxychlor)
SHRF MD (0.159 to 7.65)
SHRF IN (0.173 to 4.16)

The three inner reference samples showed mostly no detection of pesticides, except for two samples that showed small amounts of gamma-BHC (lindane). Each sample is listed

below, along with the range of detection limits, and values for lindane. All values are ug/kg dry wt.(ppb).

SHWRF 01 (0.1112 to 4.48), lindane = 3.989.
SHWRF 02 (0.099 to 1.980), lindane = 0.268J
SHWRF 03 (0.188 to 7.540, 37.7 for methoxychlor), lindane = <3.770(U)

In summary, very low levels of a number of pesticides have been detected in Savannah Harbor sediments in scattered parts of the harbor from time to time. This is also true for sediments from the Savannah Harbor reference areas. Environmental effects due to these low levels are expected to be minimal and no contaminant related impacts from pesticides would be expected due to the proposed Savannah Harbor dredging and dredged material placement.

2.3.3.4 Metals. The 1997 sampling (ATM 1998) found some metals (cadmium, chromium, manganese, nickel, zinc) occurred in new work sediments above no effect sediment screening levels, but below probable effects levels. The one exception was the discovery of cadmium at Station -75+000 near the RACON Tower spill (discussed above). These data overall indicate little potential for sediment contaminant-related environmental impacts due to proposed new work channel dredging or dredged material placement. Elimination of other metals as contaminants of concern is covered above in Section 2.2. However, subsequent unrelated testing indicated the potential for cadmium to occur in new work sediments above probable effects sediment screening criteria. These results led to the decision to identify cadmium as a contaminant of concern warranting additional investigation during the Phase 2 sampling. The identification of cadmium as a contaminant of concern is discussed in detail in Section 3.0.

3.0 Identification of Cadmium as a Contaminant of Concern

In February 2006, Savannah District completed an evaluation of sediments that may be excavated to deepen the Savannah Harbor Navigation Project as part of the Savannah Harbor Expansion Project. That evaluation reviewed the information obtained on the physical and chemical properties of the sediments that may be removed by the Expansion Project. That information included results of the 1997 and 2005 sampling. The evaluation concluded that: (1) there is sufficient reason to believe that cadmium is a contaminant of concern (COC) in the proposed SH Expansion Project since it occurs above concentrations of potential concern (available sediment screening criteria) in portions of the proposed dredge material, and (2) this warrants a more detailed evaluation of potential COC (cadmium) effects both inside and outside the DMCAs (Savannah Harbor Expansion Dredged Material Evaluation, Phase 1, PD-EC, 2006a). The process leading up to the decision to conduct further testing and risk evaluation is described below.

3.1 1997 Sediment Sampling

The first observation of cadmium in harbor sediments at levels of concern was in 1997. The following table (Table 16) contains a list of the ten sediment samples collected in 1997 during the Tier 1 studies in which cadmium was detected. The other approximately 18 new work samples showed no detection of cadmium. Using marine sediment screening levels (Buchman, 1999), some of these values were above the Threshold Effects Level (TEL) of 0.676 ppm (mg/kg), Effects Range Low (ERL) of 1.2 ppm (mg/kg), and Probable Effects Level (PEL) of 4.2 ppm (mg/kg). However, none were above the Effects Range Median (ERM) of 9.6 mg/kg, except for the sample taken near the RACON tower (SHBC075NW). These data indicated little overall concern for potential environmental impacts due to expected average cadmium concentrations in the Expansion sediments, but did warrant additional investigation of the RACON tower site.

Table 16. Cadmium Levels Detected during 1997 Sediment Testing for Savannah Harbor Expansion*

Sample Designation	Sample Number	Cadmium Concentration (mg/kg)
SHIHT01NW	76256-3	0.7
SHIH090NW	76256-6	8.5
SHIH085NW	76256-1	5.5
SHIH080NW	76256-2	5.1
SHIHC07NW Composite	76415-20	4.7
SHIHW05NW	76415-8	2.5
SHIH005NW	76415-5	0.48
SHBC005NW	76415-3	0.68
SHBC015NW	76415-10	1.5
SHBC075NW (Archive)	76415A-1	14
SHBC075NW	76415-1	24.3

* Samples taken in October and November, 1997

3.2 Savannah Harbor Advance Maintenance Widener

At approximately the same time in 1997, sediment testing and evaluation was conducted for an unrelated proposed action in the harbor. The testing was conducted in September 1997, as part of an environmental assessment of a proposed advance maintenance widener. Sediment samples were collected between Stations +35+000 and +37+000 (Area 1) and between Stations 0+000 and -14+000 (Area 2) (GEL, 1997).

Two cores, one to -45 feet MLW and one to -46.5 feet MLW were composited for the Area 1 NW (new work) sample. The two cores were taken from Stations 37+100 and 36+100. Four cores (to -45 to -47 feet MLW) were taken in the bar channel from Stations -5+300 to -12+500 for the Area 2 new work sample. The Area 1 new work sample showed a cadmium level of 6.96 mg/kg. The Area 2 new work sample showed cadmium at a level of 0.939 mg/kg. Since the observed cadmium level in the sediments in the Area 1 new work sample (Stations 37+100 to 36+000) was less than the ERM value of 9.6 mg/kg and the relatively small amount of new work sediment would be expected to mix with overlying O&M sediment during the dredging process, the potential for cadmium-related impacts from the dredging and disposal within a DMCA was considered minimal and no additional evaluation was performed.

3.3 Southern LNG Proposed Turning Basin, November 2000 (ATM, 2000)

As part of the dredged material evaluation for a turning basin to be constructed by Southern LNG in the Savannah River adjacent to the navigation channel, three berth cores and three turning basin cores were collected and analyzed for contaminants in November 2000. The berth cores returned cadmium values of 4.94 mg/kg, 3.79 mg/kg, and 13.1 mg/kg. The turning basin cores returned cadmium values of <0.17, <0.40, and 11.4 mg/kg. Since the observed level of cadmium in some of the cores was above the ERM value of 9.6, additional testing was conducted by Southern LNG to more clearly identify the location and extent of cadmium concentrations above the ERM value of 9.6 mg/kg.

3.4 Southern LNG Proposed Turning Basin, Sampling February 2001 (ATM, 2001), SLNG(2001)

In a second round of sediment sampling and evaluation for the proposed turning basin, ATM developed a sampling and analysis plan for Southern LNG in which five cores were collected in February 2001, divided into 2.5 foot sections and analyzed for cadmium. Observed cadmium concentrations by elevation are shown in the following Table 17 in mg/kg dry wt. This work showed that elevated cadmium levels existed in the deeper new work sediments. In subsequent negotiations between the District and Southern LNG, it was determined that sediment below -35 feet MLW on the South Carolina side of the Federal Project would be placed in the applicant's DMCA, as well as sediment below -45 ft MLW on the Georgia side of the Federal Project. Their data showed that sediments above -35 ft MLW that were destined for a Federal Project DMCA would be expected to contain <4.12 mg/kg cadmium and that sediment above -45 ft MLW on the Georgia side and also destined for a Federal Project DMCA would be expected to contain 6.7 mg/kg cadmium or less. The applicant further indicated that sediments deposited within their DMCA (on Elba Island) and containing 12.8 to 83 mg/kg cadmium would be maintained "in as dry as possible a state so as not to create an attractive nuisance for shorebirds".

Table 17. Southern LNG Turning Basin - Cadmium Sediment Core Concentrations by Elevation (ATM, 2001)(mg/kg dry wt)

Approximate						
Top Elevation of Cores –MLW (ft)	Bottom Elevation of Cores -MLW (ft)	Core VC-1	Core VC-2	Core VC-4	Core VC-6	Core VC-7
		Stations (feet)				
		40+000	38+000	38+750	39+000	37+000
31	34	0.7		1.2		4.1
33.5	36.5	0.9				13.7
36	39.5	1.2			1.57	17.1
38.5	42	1.7		29.6	1.1	17.3
41	44.5	1.8	1	30.9	2	14
43.5	47	5.4	1.6		6.7	14.1
46	49.5	24.1	1.6		24.2	83
48.5	52	24.5	23.7		27.9	

3.5 Implications of Southern LNG Sediment Findings for SHEP Sediment Testing and Evaluation

Results of the 2001 sediment sampling program by ATM at Southern LNG suggested that elevated cadmium levels might be associated with a clay layer described as Miocene Unit A. ATM analyzed geotechnical boring data from the harbor to predict where this layer might be encountered during the Expansion Project. The goal of the proposed sampling plan was to characterize the potential distribution and concentration of cadmium in the proposed Expansion new work sediments. Due to the unknown nature of the distribution and concentration of cadmium within the Federal Project and the lack of funds for a more comprehensive set of analyses, it was determined that the second round of sediment testing (Phase 2) would consist of only physical and chemical testing. The testing would include two different metals extraction procedures to assess whether the cadmium was tightly bound to the sediments and thus unavailable for potential environmental impacts. If cadmium were found to be tightly bound to the sediment matrix, that finding would be good evidence to expect cadmium would not be released to plants, animals, or water when the sediments were placed in a DMCA. It could then be concluded that sediment concentrations of cadmium above the ERM level would not pose significant potential for environmental impact when placed in a DMCA.

3.6 Phase 2 Sediment Sampling for Cadmium Concentrations by Depth

Sampling in 2005 collected approximately 350 sediment samples at 2-foot intervals from 45 cores distributed throughout the harbor, but concentrating in areas believed to contain Miocene clays. These samples were also analyzed for aluminum, iron, TOC (total organic carbon) and acid volatile sulfides.

Material existed above -46 feet MLW at only a few stations.. Cores of that material represented O&M sediments that accumulate within the channel regularly and are the impetus for the annual maintenance dredging of the navigation channel. These O&M samples all showed cadmium levels of about 2 ppm or less.

The most down-river station in the harbor found with elevated cadmium is Station 10+000, where cadmium shows up at 19.2 ppm in the -46 to -48 foot layer. This layer also showed cadmium at concentrations of about 10 to 20 ppm between Stations 28+000 and 36+000. The next upriver sampling location is Station 24+000, where high levels of cadmium (58 – 62 ppm) were found only at depth (in the -54 to -57 foot interval). The next few upriver stations (to Station 26+000) show high cadmium concentrations (40 ppm) in the -48 to -50 foot layer, with deeper layers increasing in cadmium concentration up to 70 ppm in the -54 to -56 foot layer. The deepest interval (-56 to -57 foot) showed less cadmium (30 to 7 ppm) in a decreasing trend with depth while moving upstream to Station 28+000. This cyclical pattern of increasing then decreasing cadmium concentrations is repeated four or five times as one examines sampling Stations, moving upstream (see Figures 1-4, below).

Proceeding upstream, cadmium concentrations show a pattern of generally decreasing peaks and lows that is reflected in each of the 2-foot layers. This pattern shows decreasing peaks and wider intervals between peaks proceeding upstream. The pattern deteriorates somewhat in the deepest layer (either -56 to -57-foot, or -56 to -58-foot), although less data exist for these intervals. At some stations the peak concentrations tend to decrease with depth, while other stations show lower concentrations at the surface and higher concentrations at depth.

Station 32+000 shows very low cadmium concentrations (1 ppm or less) throughout the sediment column (down to -57 feet MLW). Proceeding upstream from Stations 32+000 to 40+000 there is another spike in cadmium concentrations between Stations 34+000 to 36+000, with the -48 to -50 foot layer showing a lower peak concentration (12 ppm) than the deeper layers (about 20 ppm).

The cyclical nature of the data suggest the layers containing cadmium may show a wave-like pattern, with the more inland sediments exhibiting decreasing cadmium concentrations. Data from four depth intervals presented in the following four figures show the cyclical nature of cadmium concentrations in the harbor sediments.

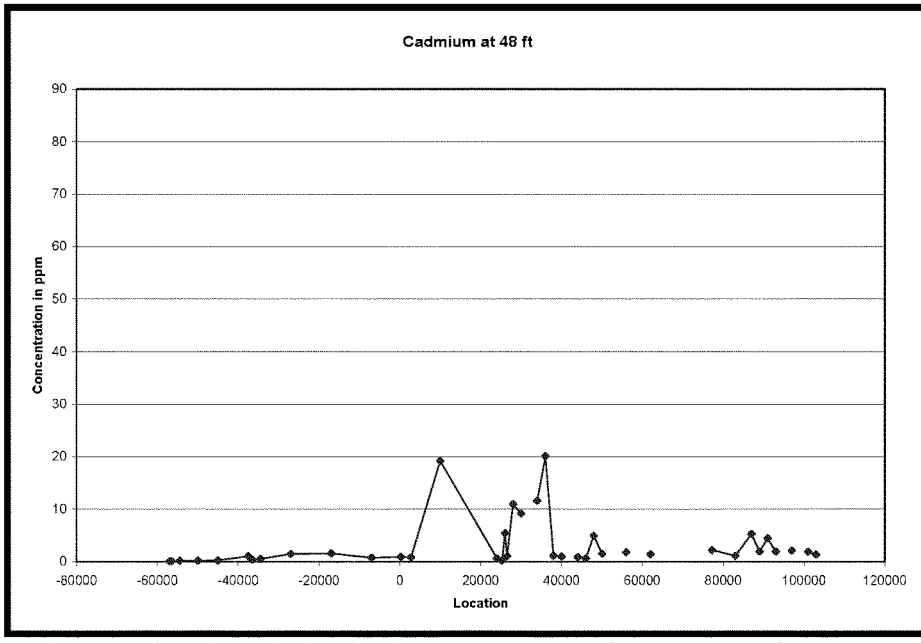

Figure 1. Cadmium distribution in the core segment from -46 to -48 feet MLW, 2005 sampling.

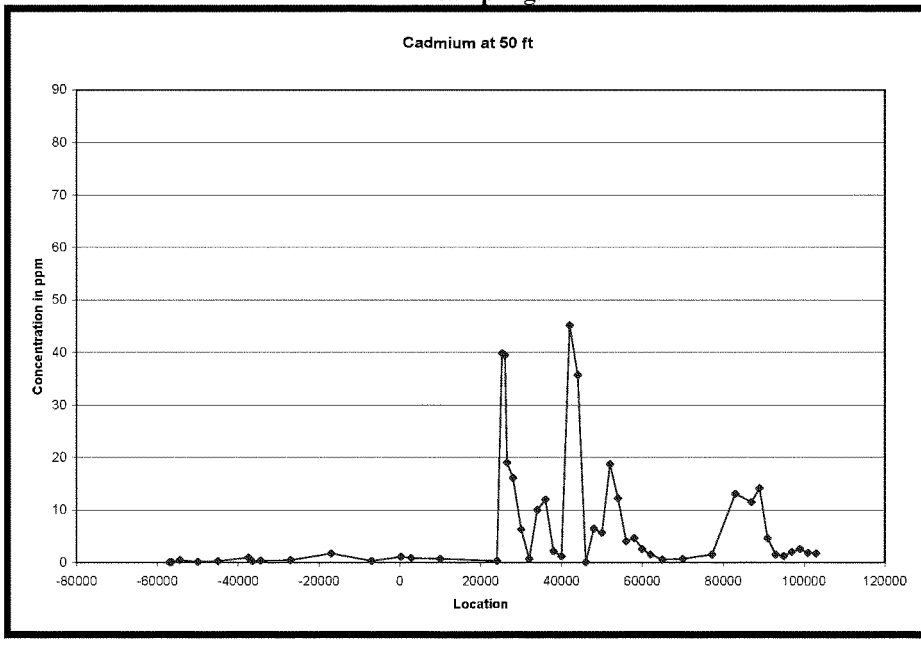

Figure 2. Cadmium distribution in the core segment from -48 to -50 feet MLW, 2005 sampling.

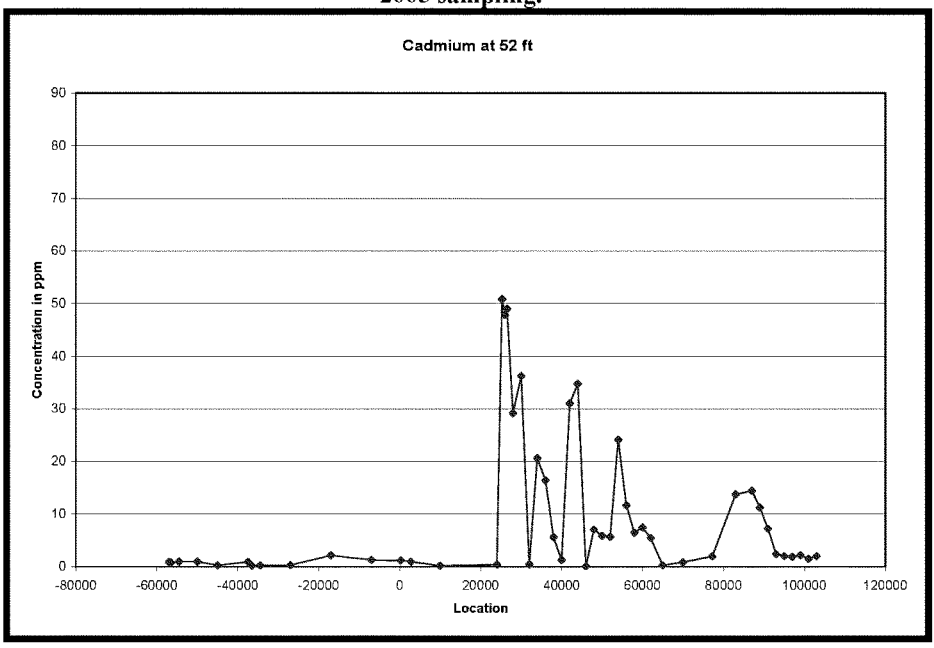

Figure 3. Cadmium distribution in the core segment from -50 to -52 feet MLW, 2005 sampling.

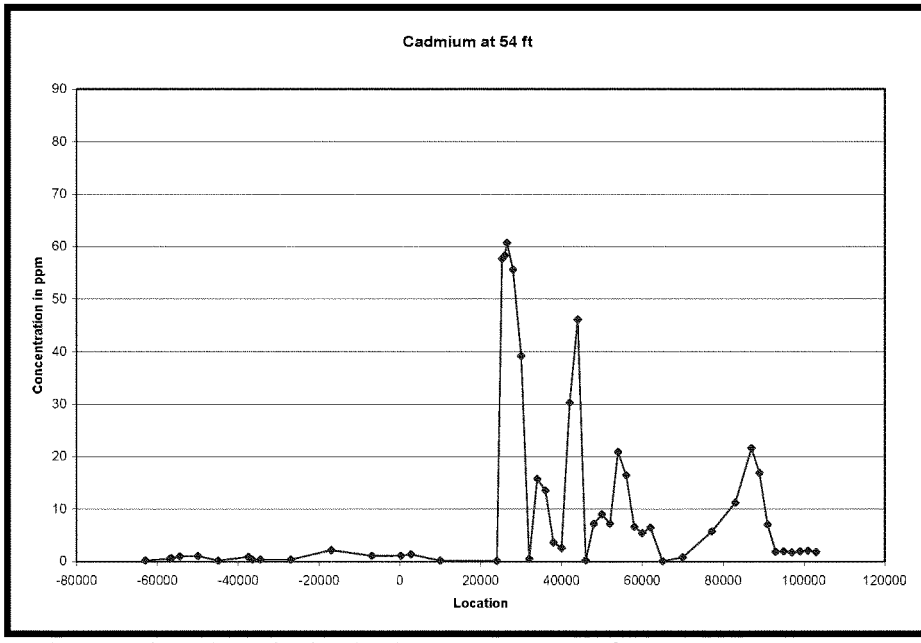

Figure 4. Cadmium distribution in the core segment from -52 to -54 feet MLW, 2005 sampling.

3.7 Expected Distribution of Miocene in the Channel Bottom Surface

Savannah District geologists examined several sources of information to determine where Miocene clays are currently exposed in the channel and where they are expected to be exposed after a 6-foot deepening (EN-G, 2006a). Within the inner harbor, most of the channel currently contains exposed Miocene, with gaps from Stations 0 to +25+000, and between Stations +65+000 and +85+000. Under Expansion, more of the channel would contain exposed Miocene, with a small gap at about Station +68+000, and another gap between Stations +5+000 and +15+000.

The 2005 core sampling was used to estimate the expected cadmium concentrations in surface Miocene clays forming the channel bottom sediments for both the existing condition and after SHEP (EN-G, 2006b). Expected changes in surface cadmium concentrations in the channel bottom sediments have also been identified. In general, cadmium concentrations in bottom sediments are expected to increase after Expansion, except in the reach from Stations +35+000 to +55+000, where some spots should increase and some decrease (EN-G, 2006b through e). Cadmium concentrations in the surface of river bottom sediments are discussed in the next section (3.8).

3.8 Expected Range in Cadmium Concentrations in the Surface Layer of Bottom Sediments by Reach

3.8.1 Use of Core Segment Data to Predict Ranges with Similar Channel Bottom Cadmium Concentrations

Table 18 shows the cadmium ranges expected in the parent material forming the bottom of the channel after SHEP. Ranges with the highest expected cadmium concentrations in bottom sediment are from Stations +94+000 to +80+000 and from Stations +45+000 to +16+000.

Table 18. Cadmium Concentrations of the Surface of Channel Bottom Sediments after SHEP Dredging, Station Ranges Selected According to Similarity of Sediment Cd Concentrations

Begin Station	End Station	Average Conc. (mg/kg)	Minimum-Maximum Core Segment Conc. (mg/kg)
103 + 000	94 + 000	1.9	1.8 – 2.0
94 + 000	80 + 000	13.3	9.2 – 20.1
80 + 000	45+000	7.4	ND-11.0
45 + 000	16 + 000	23.4	1.0 – 77.1
16 + 000	6 + 375	0.4	0.4
6 + 375	-63 + 000	0.9	ND – 2.4

3.8.2 Estimate of Reaches where Bottom Sediments are Exposed vs. Areas where Bottom Sediments Are Covered by Extensive O&M Sediments.

Using survey data from 2003 to 2006, District geologists identified areas of the channel experiencing scour and those areas experiencing fill (EN-G 2006f). In general, the upper end of the harbor down to about Station +79+000 experiences continual fill from deposition of O&M sediments. Scouring is the predominant characteristic from about Station +79+000 downstream to Station +49+000. From about Stations +49+000 downstream to Station +27+000, there are areas of scour and areas of fill. The reach from Stations +27+000 to +18+000 experiences predominantly scour. The area from Stations +18+000 to 0+000 experiences predominantly fill. According to the 2005 core data, areas expected to contain exposed bottom sediments with elevated cadmium levels occur from Stations +79+000 to +18+000. The data indicate that the area of major concern would be from Station +18+000 to Station +43+000 (this range includes all of the individual sample readings above 17 ppm Cd except for one 20.1 ppm reading at Station +87+000). A summary of these data is shown in Table 19.

Table 19. Cadmium Concentrations of the Surface of Channel Bottom Sediments after Expansion Dredging, Station Ranges Selected According to Expected Exposure of Bottom Sediments

Begin Station	End Station	Bottom Character	Average Conc. (mg/kg)	Minimum-Maximum Core Segment Conc. (mg/kg)
103 + 000	79 + 000	Covered with O&M Sediment	7.6	1.8 – 20.1
79 + 000	49 + 000	Scoured	7.9	4.1 – 11.0
49 + 000	27 + 000	mixed	17.9	ND- 77.1
027 + 000	18 + 000	scoured	29.4	12.9 – 57.9
18 + 000	0 + 000	Covered with O&M Sediment	1.1	0.4 – 1.6

3.9 Estimated Cadmium Concentrations of Sediments Proposed to be Dredged During SHEP

The 2005 core data show the distribution of cadmium within the proposed expansion sediments. These data are presented by elevation (2 foot lifts) in Figures 1-4, above. Average cadmium concentrations by station, based on data from each 1-2 foot lift within each core, are presented in Table 20. Table 21 shows the average cadmium concentration by reaches defined as containing similar levels of cadmium. There are no core data between Stations +10+000 and +24+000, hence the reach dividing point is listed as half-way between the two stations (Station +17+000). There are also no core data between Stations +2+750 and +10+000, hence the reach dividing point is again listed half-way between the two stations (Station SH00 +6+375). As discussed in the Phase 1 Evaluation (PD-E, 2006a), the 2005 sampling provided data by which reaches from Stations +103+000 to +94+000 and Stations +6+375 to -63+000B could be eliminated from further environmental concern due to low sediment cadmium concentrations within those reaches (PD-EC, 2006a).

Table 20. Average Sediment Cadmium Concentration (mg/kg) by Station

STATION	AVG CONC (mg/kg)	HIGHEST CONC (mg/kg)
+000 + 250	1.07	1.29
+002 + 750	1.03	1.65
+010 + 000	3.78	19.20
+24 + 000	16.85	63.48
+25 + 282	36.76	74.91
+26 + 000	39.37	72.94
+26 + 500	34.42	60.69
+28 + 000	27.15	55.61
+30 + 000	26.60	77.09
+32 + 000	0.58	1.02
+34 + 000	14.77	20.55
+36 + 000	15.69	20.07
+38 + 000	4.98	11.63
+40 + 000	7.10	26.16
+42 + 000	28.39	45.14
+44 + 000	23.57	40.06
+46 + 000	0.32	1.10
+48 + 000	6.76	9.66
+50 + 000	6.45	11.20
+52 + 000	9.25	18.71
+54 + 000	18.18	24.07
+56 + 000	8.42	16.43
+58 + 000	6.46	9.08
+60 + 000	6.44	9.02
+62 + 000	5.00	11.21
+65 + 000	2.94	10.09
+70 + 000	3.78	10.97
+77 + 250	2.99	5.46
+83 + 000	8.25	13.72
+87 + 000	11.91	21.58
+89 + 000	9.89	16.88
+91 + 000	5.02	10.64
+93 + 000	2.71	9.20
+95 + 000	1.77	2.00
+97 + 000	1.88	2.03
+99 + 000	2.16	2.55
+101 + 000	1.84	2.09
+103 + 000	1.57	1.98
-7+ 000	0.85	1.27
-17+ 000	1.95	2.36
-27+ 000	0.63	1.45
-34+ 500	0.38	0.53
-36+ 500	0.30	0.42
-37+ 500	0.84	1.04
-45+ 000	0.20	0.45
-50+ 000	0.63	1.07
-54+ 500	0.70	1.11
-56+ 500	0.40	1.31
-57+ 000	0.42	0.88
-63+ 000	0.21	<0.30

Table 21. Characterization of Cadmium Concentrations by Reaches as Initially Proposed*

Begin Station	End Station	Average Cadmium Conc (mg/kg)	UCL 95% Cheby-shev (mg/kg)	Minimum-Maximum Core Segment Conc. (mg/kg)	Approx 10^6 cu yds (total)	Environ-mental Concern Due to Cadmium?
+103 + 000	+94 + 000	1.83		1.12 – 2.52	2.4	No
+94 + 000	+45 + 000	6.67	10.5	0.04 – 24.07	8.9	No*
+45 + 000	+17 + 000	21.45	36.2	0.11 – 77.09	4.5	Yes*
+17 + 000	+6+ 375	3.78		0.15 – 19.20	1.0	No*
+6+ 375	-63+ 000	0.70		0.023 – 2.36	10.6	No

* Quantities include proposed advance maintenance from Stations +50+000 to +70+000 and passing lanes from Stations +55+000 to +58+000 and from +16+000 to +19+000. A bulking factor of 1.4 should be used to estimate required upland disposal area capacities.

These data indicate that 4.5 million cubic yards of SHEP sediments should average approximately 21.5 ppm cadmium and about 9 million cubic yards should average approximately 6.7 ppm cadmium.

An analysis of the latest sediment testing results indicates that a cadmium concentration of 14 mg/kg is the lowest concentration for which environmental impacts would be expected, see Sections 3.9 and 4.3.1.7. CESAS at first compared average cadmium concentrations by reach to this concentration of concern (Table 21). However, subsequent information became available on the deposition of clay-predominated sediments in DMCAs as clay balls. This information indicated that at least some of the clay sediments would not be expected to mix with other sediments but would tend to form clay balls. Therefore, determinations based on an assumption of sediments mixing to an average condition may not be appropriate where heavy clays are present. Because of the uncertainty surrounding how well clay balls will actually mix in the deposited materials, CESAS re-examined the individual lift data to determine if there are any areas not previously considered for management where the clay sediments could be expected to exhibit cadmium levels of 14 mg/kg or more. Sediments from the following stations (Table 21b) have certain depths where the cadmium occurs at a level of about 14 mg/kg or greater. Reaches with these stations (Stations 51+000 to 57+000 and 80+000 to 90+000) are now also proposed for management (covering) because of the potential for exposure of clay in an upland environment at levels of environmental concern.

Table 21b. Additional Stations Identified for Management

Station	Sample	Depth Interval (feet below MLW)	Cadmium (mg/kg)
10+000	A+B	42 to 46	0.3
	C	46 to 48	19.2
	D	48 to 50	0.7
	E	50 to 52	0.3
	F	52 to 54	0.3
	G	54 to 56	0.4
52+000	D	48 to 50	18.7
	E	50 to 52	5.7
	F	52 to 54	7.2
	G	54 to 56	7.5
	H	56 to 57	5.1
54+000	D	48 to 50	12.2
	E	50 to 52	24.1
	F	52 to 54	20.9
	G	54 to 56	20.9
	H	56 to 57	7.4
56+000	C	46 to 48	1.8
	D	48 to 50	4.1
	E	50 to 52	11.6
	F	52 to 54	16.4
	G	54 to 56	9.3
	H	56 to 57	6.2
83+000	A+B	42 to 46	1.4
	C	46 to 48	1.1
	D	48 to 50	13.1
	E	50 to 52	13.7
	F	52 to 54	11.2
	G	54 to 56	9.8
87+000	A+B	42 to 46	2.7
	C	46 to 48	5.3
	D	48 to 50	11.5
	E	50 to 52	14.4
	F	52 to 54	21.6
	G	54 to 56	20.1
89+000	A+B	42 to 46	1.8
	C	46 to 48	1.9
	D	48 to 50	14.2
	E	50 to 52	11.2
	F	52 to 54	16.9
	G	54 to 56	16.7

Sediments from the reach defined by Stations +94+000 to +45+000 (originally not proposed for management) are predicted to average 6.67 mg/kg cadmium. With the reaches from Stations +51+000 to 57+000 and +80+000 to 90+000 (reach boundaries determined to be half-way between adjacent sampling points) removed, the remaining portion of the reach from Stations +94+000 to +45+000 averages about 4.6 mg/kg cadmium. The highest cadmium concentration in any lift within this interval is 11.0 mg/kg. Not only is the average concentration within this combination of reaches (Stations +94+000 to +90+000, +80+000 to +57+000, and +51+000 to +45+000) well below the 14 mg/kg cadmium level of concern, but so is any single lift value. No management of these reaches is warranted. Sediments from the reach enclosed by Stations +17+000 to +6+375 contain a layer with a cadmium concentration of 19.2 mg/kg. This reach would also require management.

Table 21c. Table 21 Revised. Characterization of Cadmium Concentrations by Reach*

Begin Station	End Station	Average Cadmium Conc (mg/kg)	Minimum-Maximum Core Segment Conc (mg/kg)	Approx 10^6 cu yds (total)	Environmental Concern Due to Cadmium?
+103+000	+90+000	2.42	1.12 – 10.64	4.980	No
+90+000	+80+125	10.02	1.09 – 21.58	1.555	Yes
+80+125	+57+000	4.62	0.30 – 11.21	5.020	No
+57+000	+51+000	11.95	1.78 – 24.07	2.007	Yes
+51+000	+45+000	4.56	0.04 – 10.57	1.894	No
+45+000	+6+375	19.11	0.11 – 77.09	7.368	Yes
+6+375	-85+000	0.73	0.02 – 2.36	15.855	No

* Quantities for the 48-ft project include proposed advance maintenance from Stations +50+000 to +70+000 and passing lanes from Stations +55+000 to +58+000 and from Stations +16+000 to +19+000. A bulking factor of 1.4 should be used to estimate required upland disposal area capacities.

3.10 Availability of Cadmium

3.10.1 Complete Digestion vs. Standard Digestion.

One aspect of the Savannah Harbor Expansion Phase 2 testing (sampling 2005) involved a comparison of digestion techniques for metals -- the complete digestion technique used by ATM (fluoric acid) vs. standard digestion (nitric/hydrochloric acid). The concern was that the complete digestion technique might detect cadmium that was tightly bound in sediment minerals and not available to organisms, thus overestimating potential availability and environmental impacts.

A total of 34 sediment samples were compared using both digestions, with sediment cadmium levels ranging from non-detect (<about 0.2 ppm) to 74.92 ppm. For sediments where cadmium levels for both extractions were greater than 1 ppm, the standard extraction technique produced cadmium results averaging 0.2 ppm higher than the total extraction (n=24). For sediments where cadmium levels were less than or equal to 1 ppm for at least 1 extraction, the standard extraction technique produced cadmium results averaging 0.2 ppm lower than the total extraction technique (n=10). For all extraction data, the mean difference is (-0.26)(19) + (-0.06)(5) + (0.17)(10) = -0.1 mg/kg. These results indicate that there was essentially no difference in measured sediment cadmium levels produced by these two extraction techniques. This implied that the cadmium found in the clays might not be tightly bound within the clay structure. This finding led to a decision to investigate in greater detail how tightly cadmium was bound within the sediments to further assess potential bioavailability.

Table 22. Comparison of Digestions Methods Where Sediment Concentrations are Greater than 2.5 ppm

SAMPLE ID	CADMIUM RESULT (PPM)	MDL	PREP METHOD	DIFFERENCE[1]
SH010 + 000 (C)	19.20	0.337	EPA 3052	
SH010 + 000 (C)	12.06	0.037	EPA 3050B	7.14
SH025 + 282 (G)	74.92	0.382	EPA 3052	
SH025 + 282 (G)	71.99	0.043	EPA 3050B	2.92
SH026 + 000 (C)	5.41	0.391	EPA 3052	
SH026 + 000 (C)	4.59	0.041	EPA 3050B	0.82
SH026 + 500 (D)	19.05	0.532	EPA 3052	
SH026 + 500 (D)	20.09	0.059	EPA 3050B	-1.05
SH028 + 000 (E)	29.13	0.427	EPA 3052	
SH028 + 000 (E)	40.18	0.047	EPA 3050B	-11.05
SH030 + 000 (C)	9.17	0.325	EPA 3052	
SH030 + 000 (C)	5.06	0.035	EPA 3050B	4.11
SH034 + 000 (D)	10.02	0.459	EPA 3052	
SH034 + 000 (D)	10.65	0.051	EPA 3050B	-0.63
SH034 + 000 (Z)	7.49	0.401	EPA 3052	
SH034 + 000 (Z)	9.81	0.043	EPA 3050B	-2.32
SH036 + 000 (D)	11.99	0.317	EPA 3052	
SH036 + 000 (D)	19.63	0.05	EPA 3050B	-7.64
SH042 + 000 (G)	8.29	0.576	EPA 3052	
SH042 + 000 (G)	8.66	0.064	EPA 3050B	-0.38
SH048 + 000 (D)	6.46	0.56	EPA 3052	
SH048 + 000 (D)	4.95	0.06	EPA 3050B	1.51
SH050 + 000 (H)	10.57	0.516	EPA 3052	
SH050 + 000 (H)	11.20	0.056	EPA 3050B	-0.63
SH052 + 000 (H)	5.11	0.355	EPA 3052	
SH052 + 000 (H)	4.63	0.04	EPA 3050B	0.49
SH054 + 000 (G)	20.94	0.378	EPA 3052	
SH054 + 000 (G)	20.23	0.04	EPA 3050B	0.71
SH058 + 000 (F)	6.62	0.466	EPA 3052	
SH058 + 000 (F)	5.83	0.05	EPA 3050B	0.79
SH062 + 000 (G)	7.41	0.409	EPA 3052	
SH062 + 000 (G)	7.44	0.046	EPA 3050B	-0.02
SH065 + 000 (G)	9.40	0.433	EPA 3052	
SH065 + 000 (G)	10.09	0.049	EPA 3050B	-0.69
SH087 + 000 (F)	21.58	0.382	EPA 3052	
SH087 + 000 (F)	21.03	0.043	EPA 3050B	0.55
SH091 + 000 (D)	4.63	0.362	EPA 3052	
SH091 + 000 (D)	4.25	0.041	EPA 3050B	0.37

[1] This column shows the difference between the complete extraction (EPA 3052) and the standard extraction (EPA 3050B)

SAMPLE ID	CADMIUM RESULT (PPM)	MDL	PREP METHOD	DIFFERENCE[1]
			sum of differences	-5.00
			Mean difference	-0.26

3.10.2 TCLP Test Results

Savannah District's February 2006 Dredged Material Evaluation (2005 sampling) discussed the potential availability of cadmium in project sediments and concluded there is reason to believe that cadmium could be released from these sediments. The TCLP test was later conducted on some archived sediments from the 2005 sampling to gain further insight into the possibility for release of cadmium under certain conditions.

The TCLP procedures are designed to provide information concerning the mobility of a constituent in material (soil or other waste) by simulating the leaching of the material by slightly acidic groundwater. In this procedure, a sample of the soil or other material is tumbled with the leaching solution (an acetic acid-Sodium acetate buffer solution of pH close to 4.93) for 18 hours. The solids are allowed to settle and the liquid is separated from the solids by filtering through a 0.6 micron glass fiber filter. Centrifugation is not employed to separate the solids from the leachate. The solids are discarded.

The pH of the liquid (TCLP leachate) is measured and the leachate is then acidified to pH <2 with nitric acid. A known volume (25-mL) of the acidified leachate is digested in the same manner as an aqueous sample (EPA SW Method 6010/6020 for metals), adjusted to a final volume of 50-mL, and then filtered using a 0.45 micron filter only if suspended matter is present. Generally, this filtration step is not necessary for most of the TCLP leachates, since they are already filtered using the 0.6 micron filter prior to digestion. This filtration step is used for the sole purpose of preventing the digestate from clogging up the sample inlet when the original aqueous sample contains suspended matter. The analytical results obtained are the concentrations of the metals (or other substances) in the decanted leachate. The results of the TCLIP analyses performed on three archived 2005 samples are shown below.

Table 23. Results of TCLIP Analyses Performed for Cadmium in April 2006 on Archived Samples

Sample Number	Sediment Cd Concentration (mg/kg)	TCLP Cd Result (ug/l)
SH030+000(H)	77.057	56.8
SH091+000(F)	7.026	35.7
SH087+000(F)	21.58	62.5

These data provide further indications that cadmium could be released to the environment under certain conditions. This evidence supported the decision that a more detailed analysis of cadmium was warranted, including determining how the cadmium would be expected to behave under proposed dredging and dredged sediment handling alternatives.

3.10.3 Cadmium Concentrations in the High and Low Composites Created by EA (2008)

The final round of sediment sampling and testing for the SHEP was conducted in 2007. The scope of work called for collection of samples for porewater extraction and creation of "high" and "low" cadmium composites that would be subjected to a number of laboratory studies, including sequential extraction, bioaccumulation, and plant uptake. Cadmium concentrations of the two composites as revealed by several different analyses are listed below in Table 24.

Table 24. Cadmium Concentrations (in ppm) in Composites (EA, 2008)

Test	Low Cadmium Composite	High Cadmium Composite
Average of Sediment Composite and Duplicate	**15.0**	**29.8**
Microwave Digestion (ave of two samples)	13.05	30.95
Plant test sediment	15.1	26.2
Plant test dried sediment	13.5	32
Plant test washed & dried sediment	**15.4**	**36.9**
SEP total dried soil	16.6	43.1
SEP total washed & dried soil	15.0	36.8

3.10.4 Calculation of the Ratio of Simultaneously Extracted Metals to Acid Volatile Sulfide (SEM/AVS Ratio)

In low oxygenated environments, metals may precipitate with sulfides, rendering them unavailable for uptake by aquatic organisms. Therefore a SEM/AVS ratio less than one is an indication that the metals are not available. No acid volatile sulfide was detected in either the low or high cadmium composites from the 2007 sampling, so calculation of a ratio could not be made by EA (2008). These results leave open the possibility that metals in the sediment could be available.

3.10.5 Sediment Sequential Extraction Procedures (SEP)

3.10.5.1 Availability of Cadmium in SHEP Sediment. Sequential extraction procedures (SEP) were conducted on both the high and low cadmium composites produced from the 2007 sampling to determine what proportion of the cadmium was loosely bound (available). This procedure would provide information on how easily organisms would be expected to accumulate cadmium from the sediments. Metals in the exchangeable fraction are freely soluble and likely to be bioavailable. Metals in the

exchangeable and carbonate fractions are likely to be available with minor decreases in pH. Metals in the organic fraction may be available given moderate changes over time. Metals in the hydroxide and sulfide fractions are only available under extreme conditions (EA 2008, page 5-5). Results of the SEP investigation show that 76 to 78 percent of the cadmium in the Miocene clay sediment is relatively unavailable and no cadmium is freely available. Furthermore, because of the relatively large portion of cadmium in the organic fraction (20-22 percent), it appears that conditions that would degrade the organic fraction would be expected to increase availability of cadmium.

Table 25. Results of Sequential Extraction of Cadmium from Sediment

	Low Cd Comp	Low Cd Comp Dup	High Cd Comp	High Cd Comp Dup
Exchangeable	0%	0%	0%	0%
Carbonate	1.78%	2.02%	1.96%	1.56%
Organic	20.13%	21.94%	20.50%	20.64%
Hydroxide	74.18%	71.00%	73.52%	73.51%
Sulfide	3.91%	4.62%	3.51%	3.75%
Residual	0%	0.42%	0.50%	0.53%
Relatively Unavailable Hyroxide/Sufide/Residual	78.01%	76.04%	77.53%	77.79%
Total by Microwave Digestion (mg/kg)	13.1	13.0	29.7	32.2
Separate Sediment Analysis (mg/kg)	15.1	14.5	26.2	33.4

3.10.5.2 Availability of Other Metals. EA (2008) found arsenic, chromium, and nickel in the high and low cadmium composites above ERL levels, but not above ERM levels. Arsenic and chromium were not identified as contaminants of concern and are known to exhibit little bioaccumulation. Because of minimal environmental concern related to these two metals, they were not investigated further.

3.10.5.2.1 Nickel. The SEP results for nickel (Tables 26 and 27) show that about 58 to 64 percent of the nickel in the Miocene clays is relatively unavailable, while 7 to 9 percent is freely available. Furthermore, these data indicate nickel could become more available under conditions promoting the degradation of both carbonates and organics. Although nickel was not identified as a contaminant of concern, its potential for bioaccumulation led to the decision to investigate its availability under aquatic conditions in the bioaccumulation study performed by EA using *Macoma nasuta* and *Nereis virens*. Although nickel was found to bioaccumulate above reference, EA (2008) found tissue levels were below benchmarks, indicating no environmental concern (see Section 4.2.5 for further discussion).

Table 26. Results of Sequential Extraction of Nickel from Sediment (mg/kg dry wt)

	Low Cd Comp	Low Cd Comp Dup	High Cd Comp	High Cd Comp Dup
Exchangeable	2.5	2.3	1.9	2.4
Carbonate	2.5	2.6	2.2	1.9
Organic	7.4	7.5	6.7	5
Hydroxide	2.9	2.9	2.5	2.7
Sulfide	12.8	13.4	8.6	9.3
Residual	5.4	4.8	3.7	4.4
Relatively Unavailable Hyroxide/Sufide/Residual	21.1	21.1	14.8	16.4
Total by Microwave Digestion mg/kg	23.5	25.3	23.1	27
Separate Sediment Analysis mg/kg	21.6	20.5	17.4	19

Table 27. Results of Sequential Extraction of Nickel from Sediment, as Percent of Total Nickel

	Low Cd Comp	Low Cd Comp Dup	High Cd Comp	High Cd Comp Dup
Exchangeable	7.5	6.9	7.4	9.3
Carbonate	7.5	7.8	8.6	7.4
Organic	22.1	22.4	26.2	19.5
Hydroxide	8.7	8.7	9.8	10.5
Sulfide	38.2	40.0	33.6	36.2
Residual	16.1	14.3	14.5	17.1
Relatively Unavailable Hyroxide/Sufide/Residual	62.9%	62.9%	57.8%	63.8%

3.10.5.2.2 Zinc. Zinc was not identified as a contaminant of concern as a result of either the 1997 sampling or the 2005 sampling. However, because of its potential to bioaccumulate, it was investigated further by EA (2008) during the 2007 sampling and analyses. Zinc was found to become somewhat more available under dry oxidizing conditions (Section 2.1.5). Zinc uptake in the bioaccumulation tests (wet sediment) was found to be significantly different from reference only in the clam, and only in the low cadmium composite. The observed increase in uptake over reference (9.32 vs. 10.2 mg/kg wet weight) was less than 10 percent and should have no environmental significance. See further discussion at Section 4.2.5. Potential impacts under oxidizing conditions were assessed through the plant uptake test. Zinc uptake was significantly higher than reference for both the low and high cadmium composites, indicating zinc effects could add to potential cadmium effects identified for elevated cadmium sediments placed on the dikes. See further discussion at Section 4.3.1.6.

3.10.6 Sequential Extraction Procedures (SEP) for Cadmium on Washed and Dried Composites

Sequential extraction procedures (SEP) were conducted on washed and dried samples from both the high and low cadmium composites produced from the 2007 sampling to determine what proportion of the cadmium would be loosely bound after the sediments are oxidized.

As shown in the following two tables, SEP data from EA show there is a change in potential availability of cadmium between project wet sediment and dry "soil". Both composites show an increase in the carbonate fraction when dried. The low cadmium composite in addition showed a decrease in the hydroxide fraction. The high cadmium composite showed an increase in all fractions, making interpretation difficult. These changes do indicate cadmium should be more available in the dried soil than the wet sediment.

Table 28. Comparison of Wet and Washed/Dried Low Cadmium Composite SEP Results for Cadmium

	Wet Low Cd mg/kg	Wet Low Cd Dup mg/kg	Washed Dry Low CD mg/kg	Wet Low Cd %	Wet Low Cd Dup %	Washed Dry Low Cd %
Exchangeable	<0.105	<0.11	<0.11	0.60	0.63	0.63
Carbonate	0.31	0.35	2.5	1.77	2.01	14.26
Hydroxide	12.9	12.3	10.1	73.59	70.56	57.62
Organic	3.5	3.8	3.1	19.97	21.80	17.68
Sulfide	0.68	0.8	0.99	3.88	4.59	5.65
Residual	<0.0355	0.073	0.73	0.20	0.42	4.16
Total	17.5305	17.433	17.53	100.00	100.00	100.00

Table 29. Comparison of Wet and Washed/Dried High Cadmium Composite SEP Results for Cadmium

	Wet High Cd mg/kg	Wet High Cd Dup mg/kg	Washed Dry High Cd mg/kg	Wet High Cd %	Wet High Cd Dup %	Washed Dry High Cd %
Exchangeable	<0.095	<0.1	0.18	0.28	0.31	0.42
Carbonate	0.67	0.5	1.8	1.96	1.56	4.25
Hydroxide	25.1	23.5	28.2	73.32	73.28	66.54
Organic	7	6.6	8.9	20.45	20.58	21.00
Sulfide	1.2	1.2	2.9	3.51	3.74	6.84
Residual	0.17	0.17	0.4	0.50	0.53	0.94
Total	34.235	32.07	42.38	100.00	100.00	100.00

3.10.7 Sediment Porewater Analyses

Porewater measurements are often a better indication of potential risk in wet environments than total sediment concentration, as porewater concentrations are considered available to aquatic organisms. Porewater analyses were performed on intact sediment samples by the U.S. Geological Survey (USGS, 2007). The maximum detected cadmium porewater concentration was 0.12 mg/l (see Tables 30 and 31, below). This value is well below USEPA/SC chronic water quality criteria/standards of 9.3 mg/L (total) and 8.8 mg/L (dissolved). These results indicate there should be minimal concern related to potential environmental impacts associated with sediment cadmium in an aquatic environment.

Table 30. Core 8 Porewater Analysis, Station +26+000

Sample depth*1	Cadmium (ug/L)*2	Chloride (mg/L)	Mean Sediment Cd Concentration (mg/kg)
6"	0.06	14,523	31.8
18"	0.03	12,428	31.8
30"	0.02	10,689	49.0
42"	0.01	8,309	49.0
54"	0.00	7,042	53.5
66"	0.01	5,820	53.5

*1 Refers to location of pore-water sample, inches from top of core
*2 Refers to pore-water cadmium, dissolved, in micrograms per liter.

Table 31. Core 3 Porewater Analysis, Station +26+500

Sample depth*1	Cadmium (ug/L)*2	Chloride (mg/L)	Mean Sediment Cd Concentration (mg/kg)
6"	0.12	14,146	42.9
18"	0.01	9,968	42.9
30"	0.01	10,122	46.2
42"	0.06	8,344	46.2
54"	0.01	5,980	64.1
66"	0.01	6,705	64.1

*1 Refers to location of porewater sample, inches from top of core
*2 Refers to pore-water cadmium, dissolved, in micrograms per liter.

3.10.8 Comparison of Surface Water Concentrations to Benchmarks

Two predictions of potential cadmium concentrations in water were made, one based on elutriate results, and the other based on cadmium concentrations measured in the bioaccumulation study tanks (EA 2008, Chapter 10.4.1.c). The elutriate studies found very high total cadmium concentrations, but only 1.5 ug/l dissolved cadmium in the high cadmium composite elutriates (see Tables 33 and 34 for the standard elutriate results). Since it is primarily dissolved cadmium that is believed to be available, this again indicates little environmental concern for cadmium in the aquatic environment. Furthermore, the elutriate test artificially ensured the test sediments were completely suspended prior to testing. The high TSS used in the elutriate tests may not accurately reflect what would happen during the dredging project, as the dredging process would not be expected to result in suspension of a large fraction of the clay particles (EA 2008, Chapter 10.4.1.c).

In the water quality monitoring associated with the bioaccumulation studies, the highest dissolved cadmium concentration was found to be 5.8 ug/L. Since this reading is also below chronic water quality criteria, this is further evidence there should be minimal concern related to potential environmental impacts associated with cadmium in an aquatic environment.

Table 32. Metal Concentrations in Dredging Water (Savannah River) and Receiving Water (Field's Cut) (ug/L), from EA, 2008, Table 6.3

	EPA/SC Acute Criteria	EPA/SC Chronic Criteria	Dredging Water Total	Dredging Water Dissolved	Receiving Water Total	Receiving Water Dissolved
Arsenic	69	36	7.5	20.8	11.7	16.5
Cadmium	40/43	8.8/9.3	<0.074	<0.074	<0.074	<0.074
Chromium	1,100	50	2.4	0.85	2.6	1.5
Copper	4.8/5.8	3.1/3.7	1.6	**7.5**	1.7	1.9
Lead	210/220	8.1/8.5	0.71	0.69	0.3	0.31
Manganese			15.9	2.2	36.2	26.6
Mercury	1.8/2.1	0.94/1.1	<0.048	<0.048	<0.048	0.053
Nickel	745/75	8.2/8.3	<0.2	4.1	0.66	1
Selenium	290	71	29.6	**93.6**	50.6	**75.4**
Silver	1.9/2.3		<0.31	<0.31	<0.31	<0.31
Thallium			0.26	<0.059	0.29	<0.059
Zinc	90/95	81/86	4.4	14.7	4	6.1

3.10.9 Conduct of Animal Bioaccumulation Studies

The sediment bioaccumulation studies conducted on the project high and low cadmium wet sediment composites found accumulation of cadmium and nickel above reference by a polychaete (*Nereis virens*) and accumulation of nickel and zinc above reference by a clam (*Macoma nasuta*). EA (2008) found tissue levels to be below benchmarks and risk analyses found no reason for concern. See paragraph 4.2.5 for further discussion.

3.10.10 Conduct of Plant Bioaccumulation Studies

A plant bioaccumulation study was conducted on project washed (to remove salinity) and dried high and low cadmium composites. Test plants were found to accumulate cadmium, nickel, and zinc significantly above reference for both the low and high cadmium composites. Plant growth was inversely related to cadmium concentrations, but other factors may have been operative (availability of nutrients). See further discussion at Section 4.3.1.5.

4.0 Proposed Action and Identification of Pathways of Concern

It is assumed that the majority of the SHEP dredging will be by hydraulic cutterhead dredge. Production rates make other forms of mechanical dredging impracticable. Hopper dredging is generally not suitable for the highly consolidated new work sediments. However, material from Stations +4+000 to -50+000B is being considered for both pipeline and hopper dredging. Material from Stations -50+000B to -98+000B is being considered for only hopper dredging.

The present plans are for the SHEP inner harbor dredged sediments to be placed by cutterhead hydraulic dredge in a DMCA adjacent to the channel. This should be the least expensive disposal method for sediments with minimal potential environmental impacts. Clamshell or other mechanical dredging equipment may also be used. For sediments requiring management due to concern over cadmium concentrations, ocean disposal is not deemed an option. Cadmium is one of the contaminants specifically prohibited by EPA regulations from ocean disposal at levels greater than trace. EPA regulations at 40 CFR 227.6(b) state "These constituents will be considered to be present as trace contaminants only when they are present in materials otherwise acceptable for ocean dumping in such forms and amounts in liquid, suspended particulate, and solid phases that the dumping of the materials will not cause significant undesirable effects, including the possibility of danger associated with their bioaccumulation in marine organisms." Furthermore, bioaccumulation studies demonstrated accumulation of cadmium above reference for the high cadmium sediment composite and no method has been identified for limiting exposure of these sediments after placement in the ocean.

For the SHEP sediments requiring management due to elevated levels of cadmium, there are three primary dredged material placement alternatives: (1) deposit the sediments in a DMCA, with subsequent management in the rotation plan; (2) deposit the sediments in a DMCA with capping/covering; and (3) deposit the sediments in a DMCA with capping/covering and lining. Management alternatives are discussed in detail at Chapter 6.0.

4.1 Identification of Pathways of Concern

The Upland Testing Manual provides guidance on evaluating the potential for contaminant-related impacts from deposition of dredged sediments within an upland DMCA. This guidance includes details on identifying the pathways by which a contaminant may be released from a DMCA and impact the surrounding environment. In addition, because the Navigation Project DMCAs are managed in a wet state to produce wetland habitat values as part of a wetland mitigation plan, guidance in the Inland Testing Manual is also relevant. This evaluation of potential sediment contaminant-related impacts uses guidance from the both the Upland Manual and Inland Manual (where appropriate).

The proposed work contains two separate actions through which cadmium could be released to the environment: dredging and dredged sediment placement. The potential pathways associated with each of these actions are listed below. Assessment of these pathways involves determining if a complete pathway exists (is there a potential for movement of a contaminant and is a receptor of concern present) and then determining the potential for affect to that receptor.

4.2 Potential Pathways through Dredging

4.2.1 Release of Sediment to the Water Column during the Dredging Activity

Discharges of sediment to the water column during hydraulic dredging, seen as increased turbidity in the water column, are normally considered *de minimis*. However, in this case the dredged sediment is expected to contain elevated levels of cadmium. The presence of sediments with elevated levels of cadmium raises the potential for environmental impact. However, the Miocene clays thought to contain elevated cadmium are expected to remain relatively intact during the dredging process and form clay balls that would be deposited in the DMCAs. Relatively minor amounts of clay would be expected to be released to the river water column. Furthermore, standard elutriate analyses on the sediment composites found the dissolved fraction of only three parameters (selenium, nickel, and ammonia) to be above water quality criteria (Table 34). Cadmium was not one of them.

EA (2008) ran the standard elutriate preparation on both the high and low cadmium composites and compared the results to EPA and SC water quality criteria. Total concentrations for several metals were high (EA, 2008, Table 6-5), but are not expected to reflect conditions in the field. This is because the elutriates were made by totally suspending all sediment in a sample, creating extremely concentrated suspended sediment mixtures that would not be expected under normal dredging conditions. This is because most of the clay sediment is expected to remain in large particles when dredged, mostly as clay balls, and not suspended in the water column. EA (2008) suggests the dissolved fraction should be a better estimate of metals that would actually be available to aquatic organisms in the river.

The selenium concentration in the dredging water was 93.6 ug/l (Table 32), making it highly unlikely that selenium in the dredged sediment contributed to the selenium criterion exceedence by the high cadmium composite elutriate (119 ug/L). This water was taken from the Savannah River and was not mixed with any cadmium-enriched sediment. The results for cadmium show there is little expectation for an exceedence of water quality criteria. In the cases of nickel and ammonia, ammonia would require the greatest dilution to meet chronic water quality criteria (factor of 8.7) and acute criteria

Table 33. Standard Elutriate Total Fraction Exceeding Criteria (from EA 2008, Table 6-5)

	USEPA/SC Acute Criteria	USEPA/SC Chronic Criteria	Low Cd Composite	High Cd Composite
Ammonia as N	9.14	1.37	15.5	6.1
Arsenic	69	36	944	1,200
Cadmium	40/43	8.8/9.3	1,790	3,740
Chromium	1,100	50	6,840	11,600
Copper	4.8/5.8	3.1/3.7	660	1,160
Lead	210/220	8.1/8.5	289	510
Mercury	1.8/2.1	0.94/1.1	3.2	6.7
Nickel	74/75	8.2/8.3	1,510	1,740
Selenium	290	71	249	342
Silver	1.9/2.3		21.3	78.2
Zinc	90/95	81/86	9,510	15,400

Table 34. Standard Elutriate Dissolved Fraction Showing Cadmium Results Plus Metals Exceeding Criteria (from EA 2008, Table 6-5)

	USEPA/SC Acute Criteria	USEPA/SC Chronic Criteria	Low Cd Composite	High Cd Composite
Ammonia, mg/L	9.14	1.37	**11.9**	**5.2**
Nickel, ug/L	74/75	8.2/8.3	**17.1**	**29.2**
Selenium, ug/L	290	71	**56**	**119**
Cadmium, ug/L	40/43	8.8/9.3	<0.37	1.5

(factor of 1.3). A dilution factor of 1.3 for acute exceedences means that almost immediate dilution with river water should reduce ammonia levels below acute criteria. Moreover, dilutions of greater than 8 to 1 would be expected far before the 4-day chronic exposure criteria are exceeded. Therefore, there should be little environmental concern related to river water metal concentrations exceeding criteria due to Expansion dredging.

4.2.2 Movement of Cadmium from Sediment in the Water Column to Aquatic Resources within the River

Measurements of pore water cadmium from high Cd sediments (Tables 30 and 31), dissolved cadmium in standard elutriates of both low and high cadmium sediment (Tables 33 and 34), and measurements of cadmium concentrations found in the overlying water for the bioaccumulation tests (Section 3.10.8) were all less than water quality criteria.

These data show there should be little concern for dissolved cadmium to be released to the water column during dredging.

4.2.3 Exposure of Cadmium Containing Sediment within the Channel Banks and Bottom to the Water Column, with Movement of Cadmium from the Sediment to the Water Column and then to Aquatic Resources within the River

In order for a complete pathway to exist from cadmium-containing Miocene sediments to the water column, the Miocene clays have to be exposed to the water column, and cadmium must move from the clays to the water column. To estimate the portions of the channel where channel bottom surface clays would be expected to remain exposed to the water column, several different investigations were conducted. Several of these assessments are discussed at Section 3.8.2. When annual dredging volumes are examined by channel reach, the data show where the majority of dredging takes place. In those reaches with large annual volumes of maintenance sediments, the channel bottom would be expected to be covered by O&M sediments for most of the year. In such areas, there would be little potential for environmental impacts, even if the underlying sediments contained elevated cadmium. Average annual dredging volumes by reach are show below in Table 35. A volume of about 18,500 cu yds represents an average cover of about 1 foot of maintenance material in a 1,000-foot section of the channel. These data show the reach from Stations +16+000 to +34+000 to be the primary location where channel bottom sediments with elevated cadmium concentrations might be expected to be exposed for any period of time.

Table 35. Annual Volume Dredged by Station 1970 thru 1975, 1981 thru 1985, and 1997 thru 2004 (from *Sedimentation Analysis*, CESAW (Mike Wutkowski, 22 Feb 06)

Station	Annual Volume 1970 - 1975	Annual Volume 1981 - 1985	Annual Volume 1997 - 2004	Cadmium at Bottom Surface after SHEP (mg/kg)
0+000	11,001	8,797	9,683	1.16
1+000	11,001	15,079	9,683	
2+000	11,001	18,823	11,380	1.65
3+000	11,001	19,272	10,010	
4+000	11,001	19,272	21,153	
5+000	8,447	19,272	21,153	
6+000	8,447	19,272	21,367	
7+000	18,585	12,459	837	
8+000	22,019	22,587	1,995	
9+000	22,019	22,587	6,803	
10+000	22,019	22,587	6,659	0.42
11+000	22,019	12,459	4,355	
12+000	21,611	10,694	5,533	
13+000	13,036	10,694	5,621	
14+000	13,036	19,881	9,411	
15+000	13,036	16,709	12,069	
16+000	8,497	16,709	14,940	
17+000	8,497	16,709	15,306	
18+000	20,191	29,664	15,312	
19+000	20,606	22,080	12,786	
20+000	20,606	17,662	12,392	
21+000	8,912	14,832	7,948	
22+000	8,912	14,832	2,053	
23+000	8,912	14,832	1,516	
24+000	8,912	16,425	4,915	57.85
25+000	8,912	32,183	3,731	31.26
26+000	10,520	32,183	19,921	15.50
27+000	18,108	32,183	16,190	12.92
28+000	18,108	509	13,100	7.72
29+000	10,520	509	13,482	
30+000	45,568	9,155	10,411	77.09
31+000	45,568	9,155	10,738	
32+000	45,568	9,155	10,738	1.02
33+000	45,568	3,615	8,577	
34+000	28,481	3,084	5,382	16.86
35+000	14,103	57,629	34,378	

36+000	29,818	57,629	40,242	15.60
37+000	38,433	57,629	28,060	
38+000	40,495	46,069	19,905	6.53
39+000	33,758	46,069	20,292	
40+000	76,149	66,182	12,368	26.12
41+000	116,413	66,182	17,180	
42+000	124,529	66,182	26,794	26.05
43+000	128,368	54,853	34,487	
44+000	142,068	53,224	13,999	9.76
45+000	135,979	43,934	20,683	
46+000	106,296	53,275	16,493	0.06
47+000	133,497	39,085	20,828	
48+000	146,264	45,191	20,529	9.66
49+000	163,380	61,778	21,759	
50+000	141,880	61,778	18,002	10.57
51+000	174,377	71,137	20,598	
52+000	188,639	92,452	20,598	5.11
53+000	193,596	93,785	8,704	
54+000	190,299	115,300	9,277	7.38
55+000	161,113	76,769	5,096	
56+000	160,300	55,987	4,693	6.23
57+000	122,867	52,886	5,454	
58+000	109,962	49,485	4,906	9.08
59+000	133,168	57,258	37,995	
60+000	131,148	45,450	49,241	9.02
61+000	110,486	45,450	61,092	
62+000	106,426	45,551	39,164	10.47
63+000	89,087	53,840	30,262	
64+000	100,260	35,414	15,444	
65+000	101,008	25,862	15,243	5.96
66+000	106,589	16,393	34,283	
67+000	274,687	88,310	69,954	
68+000	266,254	118,417	81,214	
69+000	275,892	117,415	81,214	
70+000	48,582	8,586	74,633	10.97
71+000	48,582	8,586	77,856	
72+000	48,582	2,414	71,549	
73+000	37,644	2,414	8,005	
74+000	0	13,229	12,072	
75+000	0	16,478	17,602	
76+000	18,037	16,120	19,442	
77+000	18,037	17,767	15,030	4.07
78+000	18,037	1,647	15,030	
79+000	19,574	0	3,057	
80+000	20,826	6,988	2,415	

81+000	24,844	6,988	2,415	
82+000	28,076	143	8,156	
83+000	29,352	1,866	11,103	9.81
84+000	32,851	143	1,294	
85+000	27,249	143	1,294	
86+000	25,973	143	13,693	
87+000	22,059	0	30,111	20.14
88+000	36,358	357	51,888	
89+000	145,865	3,547	58,976	16.68
90+000	152,442	3,414	70,584	
91+000	177,433	3,414	74,601	10.64
92+000	32,716	534	44,419	
93+000	32,276	534	1,673	9.20
94+000	9,929	534	1,673	
95+000	9,929	0	1,673	1.93
96+000	23,753	0	1,381	
97+000	82,606	26,268	116,226	2.01
98+000	455,992	63,995	189,772	
99+000	459,867	63,995	399,576	1.76
100+000	434,603	100,592	308,948	
101+000	56,211	64,377	239,898	1.96
102+000	68,420	37,007	49,172	
103+000	90,052	29,667	41,306	1.80
104+000	76,625	9,392	42,106	
105+000	59,900	6,954	32,687	
106+000	16,264	776	2,191	
107+000	16,264	776	2,191	
108+000	16,264	1,256	2,191	
109+000	27,795	3,339	10,857	
110+000	62,488	17,082	17,411	
111+000	62,488	17,082	17,411	
112+000	51,033	17,082	18,226	
113+000	23,238	0	0	

EA (2008) used both sediment profile imaging (SPI) and side scan sonar imaging to assess how much of the channel bottom surface is currently exposed to the water column and how much is covered by O&M sediments. With these techniques, they were able to determine the distribution and proportion of exposed clays relative to other bottom habitat types. While small areas of exposed Miocene clays were identified in some specific portions of the target areas, these regions were isolated and discontinuous throughout the channel bottom (EA 2008, page ES-2).

Side scan sonar was used by EA to document the bottom characteristics between Stations +16+500 and +62+000. They found 28 percent of the channel bottom was comprised of compact clays, course sands and gravels. In addition, more intense side scan sonar investigations in the region between Stations +24+000 and +30+000 found active sand wave migration occurring on the order of 4 to 6 feet per tide cycle. The results of the SPI and side scan sonar investigations indicate that only a small portion of the channel bottom currently contains exposed Miocene clay and that the majority of the channel is covered by shifting bottom sediments. Because the District predicts little change in channel sedimentation patterns due to Expansion, this condition is expected to be characteristic of the channel bottom after Expansion dredging is completed. Therefore, between Stations +16+000 and +62+000, Expansion dredging is expected to result in a channel bottom where only a small portion of the bottom would consist of exposed Miocene clays. The channel bottom above Station +60+000 is not expected to contain any exposed Miocene, since high siltation rates are expected to result in a channel bottom covered with silts. In conclusion, the post-project condition is expected to include a channel bottom in which only a small area of Miocene clay would be exposed at any one time. Therefore, the potential for cadmium-related impacts to the water column due to exposed cadmium containing clays is expected to be minimal.

As further support for this expectation, the findings of both the porewater study (Section 3.10.7) and the bioaccumulation monitoring (Section 3.10.8) show cadmium-containing sediments release cadmium at levels below water quality criteria, indicating that if the high cadmium sediments were exposed to the river water column, release of cadmium would be expected to be minimal.

4.2.4 Colonization of Exposed Cadmium-containing Sediments by Benthic Organisms, with Movement of Cadmium through Benthics to the Aquatic Food Chain

Several factors could influence the degree to which cadmium might move from channel bottom sediment to benthics to the aquatic food chain: (1) Would clay sediment with elevated cadmium be exposed so that benthics growing in the clay could support an aquatic food chain? (2) Can Miocene clays support benthic organisms? (3) Would cadmium in the bottom sediments be available to benthic organisms such that the organisms would accumulate cadmium and pass it through the food chain?

EA (2008) conducted a benthic community assessment of the river bottom both inside and outside the channel. They found a substantial benthic community within the channel bottom. In addition, they found that the course sand/gravel/clay substrate was used by benthic organisms, although they were unable to determine to what extent benthic organisms might burrow into the clay. They found that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. However, the limited availability of exposed high cadmium sediments within the navigation channel, as discussed above, precludes more than minimal potential for clay dwelling benthic input to the riverine ecosystem. EA found that the clay substrate does support benthic organisms, but this substrate should be

exposed only between Stations +16+000 and +60+000 and should comprise less than 28 percent of the channel bottom between those stations. This finding indicates that benthic organisms residing in exposed Miocene clays should present a relatively small fraction of the benthic organisms within the channel ecosystem. Because of the predicted small fraction of available habitat, potential impacts through bioaccumulation of cadmium by benthic organisms within the Miocene clays appear to be minor, but not zero. To be conservative, the potential for bioaccumulation of cadmium by benthic organisms is addressed in the next section. The bioaccumulation studies discussed below show bioaccumulation in high cadmium sediments to be well below potential levels of effect. Therefore, potential environmental impacts through bioaccumulation of cadmium by benthic organisms is expected to be minimal.

4.2.5 28-day Bioaccumulation Studies Using Miocene Clay Composites

Aquatic Bioaccumulation Studies were performed by EA (EA 2008, Chapter 8). These studies were performed in accordance with EPA protocols for evaluation of dredged sediment proposed for placement in the ocean. The studies used sand worms (*Nereis virens*) and the blunt-nosed clam (*Macoma nasuta*) grown in both the low cadmium and high cadmium wet composites and reference sediment. Although the only contaminant of concern had at that time already been identified to be cadmium, a set of metals detected in the project sediments and deemed most likely to bioaccumulate were evaluated (cadmium, copper, lead, mercury, nickel, zinc) to address any potential concerns that might be raised by others. The results of that study are discussed below. The detailed results of that study are shown in EA, 2008, Table 8-7.

Tissue results significantly different from reference values are shown in Tables 36 and 37, below. The bioaccumulation study found that cadmium and nickel concentrations in the worm tissues statistically exceeded concentrations in reference site tissues for both the high cadmium and low cadmium wet sediment composites. Copper, lead, mercury and zinc tissue concentrations showed no significant difference from reference. The clam tissues showed no differences from reference for cadmium, but did find significant differences for nickel, using both composites. Zinc uptake in the clam was inconclusive, with the low cadmium composite tissues showing a significant but only slightly higher tissue zinc concentration when compared to reference, but the high cadmium composite tissues showing no difference. Given that the low cadmium composite contained 96 ppm zinc compared to 164 ppm zinc in the high cadmium composite, the observed significant difference from reference for zinc in the low cadmium composite is probably due to chance variation and should have no environmental significance. When compared to the clam results, higher uptake levels for cadmium and nickel were shown by the worm (Table 36) and those results (Table 37) are discussed here as the worst case scenario.

Table 36. Mean Tissue Metal Concentrations (mg/kg wet wt) from Bioaccumulation Study (EA 2008, Table 8-7), Showing Results Significantly Different from Reference (in Bold)

	Reference	Low Cd Composite	High Cd Composite
Worm Tissue Cd Conc	0.0164	**0.113**	**0.198**
Sediment Cd Conc	0.15	15	30
BCF	0.11	0.0075	0.0066
Worm Tissue Ni Conc	0.248	**0.678**	**0.694**
Sediment Ni Conc	4.6	21	18
BCF	0.054	0.032	0.039
Clam Tissue Ni Conc	0.368	**0.54**	**0.484**
Sediment Ni Conc	4.6	21	18
BCF	0.08	0.026	0.027
Clam Tissue Zn Conc	9.32	**10.2**	9.38
Sediment Zn Conc	25.8	96	147
BCF	0.36	0.11	0.064

Table 37. Worm Tissue Results from Bioaccumulation Study (EA 2008, Table 8-7), mg/kg wet wt.

	Reference	Low Cd Composite	High Cd Composite	NOAEL (ERED)
Cadmium	0.0164	0.113	0.198	1.12 *1
Nickel	0.248	0.678	0.694	2.0 *2

* 1 Lowest Cadmium NOAEL in ERED database for *Neanthes arenaceodentata*; NOAELs for other polychaetes (*Laeonereis acuta*) range from 0.14 to 0.48 mg/kg.
* 2 Rainbow Trout (lowest NOED/NOAEL for nickel in ERED database, except for a frog).

The sequential extraction and bioaccumulation results provide an expectation that, given the opportunity, some aquatic organisms would be expected to bioaccumulate cadmium and nickel. However, worm tissue levels observed in the bioaccumulation study for both cadmium and nickel were at or below most NOAELs published in the ERED database. The database does contain starfish LOEDs of 0.03 mg/kg Cd(gonad) in males and 0.14 mg/kg Cd(gonad) in females. Starfish are known from bioassay studies to be very sensitive organisms. These data, therefore, show the potential for borderline effects in very sensitive benthic organisms. Overall, these data show there should be minimal environmental concerns for benthic aquatic organisms exposed to the cadmium-containing sediments within the river.

To predict fish tissue levels, an overly conservative assumption that the BAcF=1 would predict fish tissue levels would be the same as worm tissue. This assumes the fish would feed entirely on worms living in the cadmium-containing sediments. The ERED database

shows a cadmium NOAEL of 0.3 mg/kg-wet wt. and an LOED of 0.9 mg/kg Cd for developmental impacts to the sheepshead minnow (*Cyprinodon variegates)*. Since the cadmium worm tissue concentration in the high cadmium composite was found to be about 0.2 mg/kg wet wt., there should be no environmental concerns related to fish living and feeding in the river.

For predicting potential effects to higher trophic level organisms, a wildlife ingestion model was used by EA (EA 2008, Section 10.2.1) to develop dose-based exposure estimates. The cadmium tissue uptake results were evaluated in a risk assessment by EA (EA 2008, Chapter 10) using winter flounder as a surrogate for short-nosed sturgeon, great blue heron, spotted sandpiper, osprey, river otter, and Canada goose and muskrat as surrogates for wetland herbivores. These estimates were compared to NOAELs and LOAELs. NOAELs were calculated as the geometric mean of NOAELs for growth and reproduction. For birds, the NOAEL endpoints ranged from 0.125 to 12.5 mg/kg-bw day and the geometric mean was 1.47 mg/kg-bw day. For bird LOAELs for growth and reproduction, the data range from 2.37 to 37.6 mg/kg-bw day, with a geometric mean of 5.88 mg/kg-bw day. The lowest bounded LOAEL, 2.37 mg/kg-bw day was selected as an unbiased estimate of the 95 percent LPL (Lower Prediction Limit, EA 2008, 10.3.3.a). Exposure estimates were generated for great blue heron, spotted sandpiper, osprey, and river otter for both low and high cadmium sediments as shown in the table below (from EA 2008, Table 10-13).

Table 38. Cadmium Exposure Estimates for Wet Sediments (from EA, 2008, Table 10-13, and Response to Comments, an Appendix to this Report), (mg/kg bw-day)

	Low Cd Composite	High Cd Composite
Great blue heron	0.212	0.418
Osprey	0.037	0.067
Spotted sandpiper	0.81	1.63
River otter	0.091	0.175

These data show the spotted sandpiper at 1.63 mg/kg bw day (high cadmium composite), slightly above the NOAEL of 1.47, but below the LOAEL of 2.37 mg/kg bw-day. Because of the conservative assumptions built into the consumption estimates, including the high improbability of any bird feeding on benthic organisms in contact with the high cadmium Miocene clays in the channel bottom, the District's overall assessment is that there would be no environmental concerns related to higher trophic level wildlife feeding along the Savannah River.

4.3 Potential Contaminant Pathways Associated with Dredged Sediment Placement in a DMCA

The Upland Manual contains Corps of Engineers guidelines for assessing the pathways by which a contaminant placed in an upland DMCA may impact the environment. These pathways are listed in the Upland Manual as effluent, surface runoff, leachate, volatiles, plant uptake, and animal uptake (USACE, 2003, page 2-3).

If there is a potential for the presence of a COC in the dredged sediment and an evaluation of pathways is deemed appropriate, the next step in the evaluation process is to identify the relevant pathways of concern (Upland Manual, sections 3.1 and 3.2). Exposure of workers is also a standard item of concern. Corps of Engineers experts in dredged sediment evaluation from ERDC and experts in risk assessment from the Hazardous, Toxic, and Radioactive Waste Center of Expertise (CENWO-HX-S) were consulted to perform screening level assessments of these pathways. Where insufficient evidence was available to make a determination of potential effect, Tier III assessment procedures were followed.

Under the District's rotation management plan, DMCAs are held in a wet state for 3 years and then dried for 3 years. While a DMCA is in a wet state, sediments are expected to remain essentially saturated and for the most part anoxic. In the dry state, sediments will be dry and oxidized. Contaminants can be expected to behave differently under these two sets of conditions. Therefore, contaminant pathways have been examined for both conditions.

The current management strategy for the DMCAs is to hold water in the areas while dredging is being conducted and after dredging is complete. The intent is to maintain the DMCAs in an aquatic state to generate wildlife habitats (as part of the LTMS wetland mitigation plan). After functioning in an aquatic state for a number of years (usually 3), the DMCAs are drained and ditched to dry the sediments. After one to two years of drying, sediments are excavated from the areas and used to raise the dikes. During the drying phase and subsequent placement on the dikes, the sediments oxidize and take on characteristics of soils. Because the availability of sediment cadmium may change as sediment dries and is oxidized, the potential movement of cadmium to the environment from a DMCA is addressed separately for the aquatic state and for the dry condition.

A Tier I assessment of environmental effects within a DMCA involves development of a conceptual model (Section 8.2.2 of the Upland Manual). Paragraph 8.2.3 states the following: "If a reasonable complete exposure route to a ROC population outside the DMCA exists, there is generally no risk of an effect unless there is potential for a sufficient number of individual organisms to be affected in a manner severe enough to threaten the long-term sustainability of viable local populations of the ROC outside the CDF." A conceptual model for the rotational use of the DMCAs is described in PD-EC, 2006. It includes effects within the DMCAs, because the DMCAs are managed to produce wetland habitat and the DMCAs attract large numbers of migratory birds. For any alternatives involving capping/covering of enriched sediments, the bioaccumulation

potential within the DMCAs would be minimal. However, this model clearly shows that with inclusion of enriched sediments in the rotation of the DMCAs, there are complete pathways for several ROCs that could potentially affect the long-term sustainability of local populations. The following sections discuss potential pathways for both the dry and wet scenarios, identify complete pathways of concern, and discuss potential risk to local populations of organisms.

4.3.1 Potential Cadmium Pathways for Drying and Dry Sediments within a DMCA

For drying sediments within a DMCA, the potential pathways by which cadmium could enter the environment outside the DMCA are as follows: volatilization, effluent, surface runoff, leachate, plant uptake (with movement to species that leave the DMCA), animal uptake (Upland Manual, page 2-3), and worker exposure.

4.3.1.1 Volatilization. There is little concern for volatilization of cadmium compounds at levels of potential environmental effect, since cadmium and the compounds in which it would occur in sediments are not volatile (see CENWO, 2006a). No further evaluation of this pathway is warranted.

4.3.1.2 Effluent. Appendix C of the Inland Testing Manual provides guidance on mixing zone evaluations and models to predict compliance with State Water Quality Criteria. The following information includes the available data on cadmium concentrations in waters associated with the Savannah Harbor project.

On September 12, 1997, a Savannah River background water sample was taken at Station -9+800 and found to contain cadmium at an estimated 0.544 ug/L (J flagged). A background water sample was taken at Station +36+200 on September 13, 1997 and found to contain cadmium at an estimated 0.652 ug/L (total fraction, J flagged)(111 mg/L TSS). An elutriate of the Area 1 (Station 36+200) composite (about 4.38 mg/kg Cd) was found to show 0.220 ug/L Cd (total fraction) and <0.208 ug/L Cd (dissolved fraction) (GEL, Dec. 1997, Advance Maintenance Sediment Testing Report).

Two samples of river water (taken from -35 feet MLW Oct-Nov 1997) at Stations +90+000 and +55+000 showed non-detect with a PQL of 0.001 ug/L (dissolved fraction)(Savannah Harbor Deepening, ATM 1998).

Savannah River water metals data were taken during the Agitation Dredging Study in Mar 2001. River samples (surface, mid-level, and bottom) unaffected by the agitation dredging plumes were all found to be non-detect for cadmium (about 55 samples) with a DL of 0.251 ug/L, except for one upcurrent sample that showed an estimated level of 0.45 ug/L (J flagged). About 9 samples downcurrent from the agitation dredging events showed estimated (J flagged) cadmium values ranging from 0.280 to 0.902 ug/L. These are thought to have been taken within the dredge plume. All of the samples were taken from about Stations +71+000 to +92+000 on March 7, 8 and 14, 2001 (ATM, 2002).

The Nov 2004 ENSR Savannah Harbor O&M Sediment Evaluation performed modified elutriate studies on 5 composites of inner harbor O&M sediments. These composites showed the following cadmium concentrations. These concentrations reflect expected cadmium concentrations in water standing in the DMCAs immediately following an O&M dredging event.

Table 39. Predicted Cadmium Concentrations in DMCA Water after an O&M Disposal

Station Composite	Sediment Cd Concentration (mg/kg dry wt)	Dissolved Cadmium (ug/L)	Total Cadmium (ug/L)
Kings Island TB	0.3 U	0.05 U	0.05
60+000 to 90+000	1	0.05 U	0.11
30+000 to 50+000	0.69	0.07	0.06
5+000 to 25+000	0.29 U	0.06	0.08
Sediment Basin	0.34	0.05 U	0.07

ERDC used existing data (including a bulk sediment cadmium concentration of 21 mg/kg) to conservatively estimate a DMCA effluent cadmium concentration for the SHEP of no more than 2.2 ug/L. The marine chronic water quality criterion for cadmium is 8.8 ug/L. The predicted effluent concentration is not likely to violate marine chronic water quality criteria, with no mixing zone required. They found it is not likely that DMCA effluent cadmium concentrations would cause environmental impacts and recommended no further evaluation of this pathway (ERDC, July 06).

To confirm this recommendation, EA conducted the effluent elutriate test on both the low cadmium and high cadmium sediment composites. The effluent elutriate test is designed to estimate contaminant concentrations that may occur within a DMCA and its effluent. The results of their analyses are shown in Table 40.

Table 40. Effluent Elutriate Dissolved Fraction (from EA 2008, Table 6-5)

	USEPA/SC Acute Criteria	USEPA/SC Chronic Criteria	Low Cd Composite	High Cd Composite
Ammonia	9.14 mg/L	1.37 mg/L	**9.7 mg/L**	**4.9 mg/L**
Nickel	74/75 ug/L	8.2/8.3 ug/L	**15.5 ug/L**	**21.7 ug/L**
Selenium	290 ug/L	71 ug/L	78.6 ug/L	**96.6 ug/L**
Cadmium	40/43 ug/L	8.8/9.3 ug/L	<0.37 ug/L	0.82 ug/L

As was the case for the standard elutriate results, ammonia estimates exceed both the acute (factor of 1.06) and chronic (factor of 7.1) water quality criteria. As discussed under the standard elutriate results, dissolved cadmium concentrations do not exceed criteria, and selenium exceedences are due to concentrations in the dredging water (see Section 4.1.1). Nickel concentrations exceed the chronic criteria by a factor of 2.6. These dilution factors indicate dilution of effluent in receiving waters should result in no exceedences of water quality criteria well before the 4-day chronic exposure time is met. Therefore, there should be little concern for environmental impacts due to effluent discharge.

Potential impacts associated with organisms living and feeding in ponded water within a DMCA are addressed under the ponded scenario (Section 4.3.2), below.

4.3.1.3. Surface Runoff. There is a run-off water quality screen at paragraph 5.3.1 in the Upland Manual. Using that screen, ERDC conservatively predicted the runoff cadmium concentration to be 26 ug/L, which is less than the Federal marine acute water quality criterion of 40 ug/l. They expected that this concentration would decrease over time as cadmium leaches from the soil, and would be expected to drop below the marine chronic criterion of 8.8 ug/l in a short time (ERDC, July 2006, page 18, par. 4). They concluded it is not likely that DMCA effluent cadmium concentrations would cause environmental impacts and no further evaluation of this pathway was necessary. EA (2008), conducted the SLRP test on both the low and high dried sediment composites to verify the ERDC conclusion. These data show violation of only the SC total criteria, and only for the highly unlikely event of runoff containing 5,000 mg/L TSS (see Table 41, below). Since that TSS level greatly exceeds the 500 mg/L standard that Savannah District uses for discharges from the DMCAs, violation of that criterion is not expected. Taking into consideration that the high cadmium sediment composite contained a much higher cadmium concentration (37.1 mg/kg) than the expected average cadmium concentration from the high cadmium reach from Stations +6+375 to +45+000 (19.1 mg/kg), these data confirm the prediction that runoff from dried sediment should not have an adverse effect on the environment.

Table 41. Results of SLRP (Simulated Runoff Procedure) on Dried High Cadmium Sediment Composite (from EA, 2008, Table 10-7)

	Units	EPA Criterion Acute/ Chronic	SC WQ Standard Acute/ Chronic	Low Suspended Solids	Moderate Suspended Solids	High Suspended Solids
TSS	mg/L			50	500	5000
Total Cadmium	ug/L		43/9.3	0.893	7.77	67.5
Dissolved Cadmium	ug/L	40/8.8		0.367	1.37	8.43

4.3.1.4 Leachate. A Leachate Water Quality Screen is described in paragraph 6.3.1 of the Upland Manual. Cadmium would be expected to leach from both unoxidized and oxidized sediment, but at different rates. Freshly dredged sediment and sediment maintained in a wet state would be expected to remain essentially unoxidized. ERDC conservatively estimated the pore water concentration of cadmium in unoxidized/reduced sediment to be 2.4 ug/L. Actual porewater measurements by USGS found porewater cadmium concentrations of no more than 0.12 ug/L (Section 3.10.7). The drinking water standard is 5 ug/L. Therefore, no environmental impacts should be expected due to leachate from unoxidized/reduced sediment.

If the cadmium-enriched sediments deposited within a DMCA were subsequently used to construct dikes, the cadmium would be expected to oxidize. ERDC conservatively estimated pore water cadmium concentration in oxidized sediments used directly to construct dikes (with no interim period of time where leaching would occur) to be 152 ug/L. Surficial seepage from sediment placed on the dike in that manner and maintained in an oxidized geochemical environment may impact ground water because its pore water concentration in oxidized material is conservatively estimated to be 152 µg/L. Seepage from the DMCAs would interact with foundation soils in the vadose zone and disperse in the surficial aquifer under the DMCA. With the sediment under oxidized conditions, it appears there is a potential for elevated concentrations of cadmium to enter the surficial aquifer in the distant future. However, the surficial aquifer is not used as a drinking water source. ERDC concluded that "No significant breakthrough of cadmium would be expected in thousands of years" (ERDC, July 2006, page 18, par. 2). ERDC evaluated sediments with cadmium levels of 28.4 to 60 mg/kg, although their conclusions are based on a sediment cadmium level of 21 mg/kg. Since they saw no reason for concern from this pathway using a cadmium level of 21 mg/kg, we assume that there would be no leachate concerns related to sediments containing less cadmium (including the reaches averaging about 4.6 mg/kg).

Savannah District geologists assessed the possibility of ground-water impacts from placing the cadmium-bearing soils in the proposed DMCA (EN-GG, 2006). A records search indicated that there are no historical data that show cadmium-bearing soils have impacted ground-water quality in the coastal Georgia region. According to the City of Savannah and the USGS, wells in the Savannah area and the coastal region, whether screened in the confined aquifer or surficial aquifer system, generally do not indicate presence of cadmium in ground water. The assessment also indicated that the physical characteristics and thickness of confining material underlying the DMCA would most likely severely inhibit any potential interactions with the underlying confined aquifer and that the volume of water associated with the cadmium-bearing soils was insignificant when compared with the daily yield of the confined aquifer. This indicates that even if ERDC's estimate of a porewater cadmium concentration of 152 ug/L under oxidized conditions is correct, the volume of water carrying this concentration is so small that there should be no cadmium-related environmental impacts, including no expectation of violation of the cadmium drinking water standard.

4.3.1.5 Plant Uptake in Dry DMCAs. Plant bioaccumulation in a dry soil environment is a pathway of concern with the rotational use of the DMCAs, since the conceptual model (PD-EC, 2006b) shows several species of birds that have plants found within the dry DMCAs as comprising a substantial part of their diet or supporting their food chain. A Tier II Plant Bioaccumulation Screen has been developed by the Corps of Engineers Waterways Experiment Station (same organization as ERDC). This is a procedure to extract metals from sediment using diethylenetriamine-pentaacetic acid (DTPA), with the data requiring analysis with the PUP model (Upland Manual, Appendix H, H.2). This procedure has been used to predict plant bioaccumulation from dredged sediments placed in terrestrial (wetland and upland) environments (Upland Manual, Section 9.3.2). An assessment would then be made of whether birds feeding on these plants or their herbivores are likely to be impacted through bioaccumulation of cadmium.

ERDC conducted the DTPA procedure on archived samples from the 2005 sampling. The results indicate some unusual responses in pH and redox potential, which are key controllers of cadmium availability. As such, the PUP estimates they calculated are considered unreliable for determining cadmium bioavailability through the plant pathway. The highest predicted plant concentration (8.77 mg/kg) which ERDC calculated exceeds the limitations in leafy vegetables and animal feeds set by the World Health Organization and the European Community ranging from 0.1 mg kg^{-1} (fresh weight) to 1.0 mg kg^{-1} (dry weight) (ERDC, 2006). Without further information, cadmium bioavailability through the plant pathway could not be ruled out as potentially resulting in impacts to birds feeding on plants within a DMCA. Plant bioassays were subsequently conducted by EA (2008) to provide more reliable quantitative information on which to judge the environmental effects of unrestricted placement of cadmium enriched sediments within a DMCA.

Capping/covering enriched sediments could negate the need for plant bioassays, if cadmium levels in the covering materials themselves are sufficiently low. Based on the plant tissue concentrations predicted by PUP (Table 4), and measured sediment concentrations, ERDC calculated allowable sediment concentrations (yielding a plant tissue concentration of 1 mg/kg dry weight). These data were found to be quite variable, and ERDC's analysis indicated that sediment cadmium concentrations for sediment which could be used as covering material range from 2.39 mg/kg to 77 mg/kg (depending on which data were used for the prediction). More definitive resolution of covering material criteria was not possible with the earlier data. Therefore, plant bioassays were chosen to address potential impacts for all dry sediments averaging over 2 ppm cadmium.

Potential pathways of concern for plant uptake in an upland environment include: (1) plant contact with soil; and (2) plant contact with water. These pathways lead to two pathways by which plant uptake can play a significant role in potential environment impact. These are (1) direct uptake by plants and animals living on dried dredged sediment, and (2) subsequent cycling through food webs both inside and outside the DMCAs. These latter two pathways were selected for evaluation of the dry soil upland placement scenario (EA 2008, Section 10.1.3). The endpoints selected by EA to assess these two pathways were as follows: 1) protection of plants from adverse impact due to

cadmium exposure from water and soil; 2) protection of wildlife (birds and mammals) from adverse impacts due to cadmium exposure from ingestion of water, sediment, and food resources. The results of the assessment of these two endpoints are discussed in the next two sections: Plant Uptake Test, and Animal Uptake in a Dry DMCA.

4.3.1.6 Plant Uptake Test.

As shown in the table below, SEP data from EA show there is a change in potential availability of cadmium between project wet sediment and dry "soil". In the dry "soil" condition, both composites show primarily a decrease in the hydroxide fraction, and an increase in the carbonate and exchangeable fractions. This change indicates cadmium should be more available in the dried soil than the wet sediment. This result confirms the appropriateness of the decision to conduct a plant uptake test on dried soil.

Table 42a. Percent Cd in each SEP Fraction of the Low Cadmium Composite (0 used for non-detects, from Tables 9-8 and 9-9, EA, 2008)

	Low Cd Comp "Wet"	Low Cd Comp Dup "Wet"	Low Cd Dried	Low Cd Dried Washed / Dried
Exchangeable	0.00	0.00	2.18	0.65
Carbonate	1.78	2.02	14.10	14.82
Hydroxide	74.18	71.00	59.60	59.86
Organic	20.13	21.94	19.23	18.37
Sulfide	3.91	4.62	4.42	5.87
Residual	0.00	0.42	0.47	0.43
Total Cd mg/kg	15.1	14.5	16.6	15

Table 42b. Percent Cd in each SEP fraction of the High Cadmium Composite (0 used for non-detects, from Tables 9-8 and 9-9, EA, 2008)

	High Cd Comp "Wet"	High Cd Comp Dup "Wet"	High Cd Dried	High Cd Dup Dried	High Cd Dried Washed Dried	High Cd Dup Dried Washed Dried
Exchangeable	0.00	0.00	1.32	1.34	0.42	0.37
Carbonate	1.96	1.56	4.60	5.23	4.25	4.35
Hydroxide	73.52	73.51	66.54	64.04	66.54	63.94
Organic	20.50	20.64	20.72	22.19	21.00	22.62
Sulfide	3.51	3.75	5.86	6.28	6.84	7.61
Residual	0.50	0.53	0.96	0.92	0.94	1.11
Total Cd mg/kg	26.2	33.4	43.1	NA	36.8	NA

The plant uptake test was conducted in accordance with the Upland Testing Manual (UTM) (USACE 2003) using *Cyperus esculentus*. Sediments were dried for 3 weeks before plants were introduced. Seven days after starting the test, the study was suspended because of low growth and begun again with a higher moisture regime. This second attempt was also stopped after 7 days because of low growth. Salinities ranging from about 25 to 28 ppt were determined to be the issue. After failure of the UTM wash procedure because of failure of the sediment to settle out, a wash procedure using centrifugation was used. After the washing process reduced the salinity to approximately 4 ppt, there was an additional 3 week period of grinding and drying before the test was begun. Tables 42 a and b, above, provide a comparison of the results of SEP procedures on the dried and washed/dried soils, showing the washing had minimal impact on soil cadmium levels. However, the table shows that the test soils did experience a small drop in cadmium when washed. The SEP analyses show this drop was primarily in the exchangeable fraction. In the low cadmium composite, the loss in the exchangeable fraction appears to have been approximately 10 percent of the total cadmium, although the loss did not show up in the total cadmium figures. The loss in the exchangeable fraction through washing is understandable since that fraction would be expected to dissolve in water. This loss does indicate that predictions based on the washed sediment results may not account for all cadmium originally present in the sediments. The washing also tended to affect nutrient levels, but not in a consistent pattern (EA, 2008, Chapter 9.2). This potential loss was taken into account during the final risk assessment for the dry "soil" condition (see discussion at Section 4.3.1.7).

The plant uptake test involved control sediment (potting soil), reference sediment (sediment exposed on the back of the DMCA 12B dike for several years), and the washed and dried low and high cadmium composites.

Cadmium, copper, lead, nickel, and zinc were evaluated in the plant bioaccumulation study due to their potential to bioaccumulate. Other metals were eliminated from further assessment because they do not readily bioaccumulate and were not found in the sediments at levels of potential concern. Tissue concentrations from plants grown in the washed and dried low and high cadmium composites were compared to tissue concentrations in plants grown in the control (potting soil), and the reference soils to determine the potential of project soils to support bioaccumulation of contaminants. The low and high cadmium composites generally produced tissue metal concentrations less than or equal to reference (copper and lead), or 2 to 5 times reference (nickel and zinc) The exception to those general relationships was cadmium (18 to 27 times higher than reference). These metal concentrations are shown in the table below. Mean plant tissue concentrations of cadmium, nickel, and zinc exposed to washed/dried soils statistically exceeded concentrations in tissues from plants grown in the reference soil for both the low and high cadmium composites. This indicates uptake of these three metals. A finding of plant uptake greater than reference, such as found for these three metals, requires assessment of the potential environmental impact on both plant growth and potential impacts to animals feeding on the plants. Animal uptake is addressed in the next section.

Table 43. Mean Plant Tissue Metal Uptake Compared to Reference (mg/kg dry wt). (EA 2008, Table 9-14)*

Analyte	Upland Reference	Low Cd Composite	High Cd Composite
Cadmium	0.383	**6.93**	**10.2**
Copper	1.48	0.790	1.10
Lead	0.0172	0.0169	0.0165
Nickel	0.0573	**0.120**	**0.223**
Zinc	14	**52.9**	**73.3**

* Bold indicates tissue sample concentration significantly greater than reference.

Table 44. Sediment Metal Levels in Composites in mg/kg (from EA 2008, Tables 5-6, and 8-8)

Analyte	High Cadmium Composite Average	Low Cadmium Composite Average	High Cadmium Composite Washed and Dried	Low Cadmium Composite Washed and Dried
Aluminum	14,600	16,000	17,600	17,000
Arsenic	12	11	12.5	12.6
Cadmium	30	15	36.9	15.4
Chromium	104	111	133	122
Copper	13	13	15.2	14.2
Lead	6	4.9	5.9	5.6
Manganese	198	177	207	185
Mercury	0.052	0.032	0.052	0.025
Nickel	18	21	21.7	24.4
Zinc	147	96	171	93.1

According to standard UTM guidance, environmental effects are only a concern if they extend outside the DMCA. Therefore, plant growth within a DMCA may not ordinarily be considered very important. However, the Savannah DMCAs are part of a wetland mitigation plan in which they are managed for shorebird and waterfowl habitat while they are in use. Therefore, potential impact to plant growth is an important consideration in this evaluation.

The high cadmium composite washed/dried soil contained 69 percent silt and clay, whereas the low cadmium composite contained 91 percent silt and clay. Except for cadmium and zinc, metal concentrations were generally similar in the two composites (see Table 43). The low cadmium composite washed/dried soil contained 15.4 ppm cadmium and 93.1 ppm zinc, whereas the high cadmium composite washed dried soil contained 36.9 ppm cadmium and 171 ppm zinc (EA 2008, Table 9-8). At the end of the growth period, laboratory controls showed the heaviest mean tissue wet weight (210.0 g),

followed by the reference (43.0 g), the low cadmium composite (30.0 g) and finally the high cadmium composite (10.9 g)(EA 2008, Table 9-5). The low growth in the high cadmium and low cadmium composites cannot be directly attributed to the high cadmium concentrations, but cadmium cannot be ruled out as the causative agent of the low growth.

The observed cadmium tissue concentrations can be compared to benchmarks to predict potential effects on plant growth. EA (EA 2008, Section 10.3.2) cites a USEPA Ecological Soil Screen Level for cadmium plant NOAELs and LOAELs of 32 mg/kg and a 10^{th} percentile of plant LOAEL values for dissolved cadmium in water by Oak Ridge National Labs of 100 ug/L. EA also cites an 8 mg/kg cadmium NOAEL and 11.4 mg/kg cadmium LOAEL for water hyacinth (wet weight) as appropriate tissue benchmarks for plants. These were converted to cadmium dry weight benchmarks (assuming a plant moisture content of 75%) of 32 mg/kg dry-wt. (NOAEL) and 45.6 mg/kg dry-wt. (LOAEL). The observed high composite cadmium tissue level (10.2 mg/kg dry wt) is substantially below the LOAEL for water hyacinth (45.6 mg/kg). This indicates that the observed tissue cadmium levels may not inhibit plant growth. A comparison between the high and low cadmium composites of BCFs for several metals shown in Table 44 indicates potential inhibition of uptake for some metals (Cd, Zn), but not others (especially Cu, and Ni). These results are not conclusive as to the potential for the high cadmium soil to inhibit plant growth. However, it is unlikely that cadmium concentration was the cause of the low growth. Additional information is provided in the Response to Comments section (responses to USFWS comments 11, 30, and 36) where other studies on cadmium toxicity to plants found no effect at cadmium sediment levels similar to those studied here.

Table 45. BCF Soil to Plant Tissue Cadmium Concentrations (Total washed/dried soil, dry wt. basis, Tissues Dry wt.mg/kg)(from EA 2008, Tables E-11, and 9-13)

Analyte	Control	Reference	Low Cd	High Cd
Cadmium	0.115	0.395	0.45	0.276
Copper	0.0506	0.221	0.0556	0.0724
Lead	0.00372	0.00239	0.00302	0.00280
Nickel	0.00546	0.0122	0.00492	0.0103
Zinc	0.548	0.534	0.568	0.429

When EA (2008) conducted the Simulated Effluent Runoff procedure on the high cadmium composite, the test predicted 8.43 ug/L dissolved cadmium in the runoff. EA (2008, Table 10-17) found potential dissolved cadmium in runoff to be well below the 100 ug/L plant benchmark. This in an indication that runoff would not be expected to inhibit plant growth.

In conclusion, the test plant species experienced less growth in the high cadmium composite soil than other tested media. However, predicted soil and water cadmium concentrations indicate there should be little concern that plant growth would be affected by cadmium levels present in the high cadmium soils.

4.3.1.7 Animal Uptake in a Dry DMCA. A conceptual model was developed by District biologists predicting the pathways by which cadmium could enter the environment through the animal uptake pathway during the drying phase (PD-EC, 2006b). Past observations within the DMCAs have identified only a few reptiles within the DMCAs during the drying phase, primarily a few anoles, fence lizards, snakes (including diamond-backed rattlesnake), alligators and very few amphibians (primarily southern toads, green tree frogs and leopard frogs). A number of mammals inhabit the drier portions of the DMCAs, including deer, hogs, raccoons, opossums, rabbits, armadillos, bobcats, various rodents, and an occasional coyote. There are also a few reports of large cats. However, the primary vertebrates on the site are various species of birds. Birds occur in much higher numbers than mammals and are much more likely to leave the DMCAs and move out into the surrounding environment.

The District model identified the primary classes of birds that dominate the drying DMCAs to be wintering sparrows and insectivores. Primary wintering birds within the dry DMCAs are sparrows. There are lesser numbers of frugivores and insectivores, including mimic thrushes, wrens, and yellow-rumped warblers. A small number of other warblers and vireos are also present. Because the drying sediments do not have time to develop into a structured soil, soil-based prey do not appear to play a significant role in the food chains of the dried areas. For example, birds are rarely seen probing into the soils for food items. Because winter sparrows are by far the most abundant wintering birds within the DMCA dry habitats, those species were judged to be a significant pathway that should be evaluated. Migratory and summering species within the DMCA dry habitats appear to be mostly foliage gleaning insectivores, of which migratory warblers and vireos form the largest segment. Summer insectivores include mostly species that are partial insectivores such as red-winged blackbirds and boat-tailed grackles, mimic thrushes, cardinals, towhees, Carolina wrens, painted buntings, and indigo buntings. No toxicity / bioaccumulation tests are available to directly assess these pathways. Since the pathways all appear to be plant based, the plant uptake test was used to predict plant uptake of cadmium and a consumption model was used to predict the subsequent movement of cadmium through herbivores (primarily insects) to insectivores such as warblers. The consumption model results were compared to tissue benchmarks to predict potential environmental impact.

EA (EA 2008, Section 10.1.4.c) developed a conceptual model in which they selected the Song Sparrow, meadow vole, Marsh Wren, short-tailed shrew, red-tailed hawk, and red fox as representative/or surrogate species for evaluation. They considered the following modes by which animals could uptake cadmium in developing their consumption / exposure model.

- Wildlife dermal contact with soil (normally considered insignificant, EA 2008)
- Wildlife ingestion of soil
- Wildlife inhalation of soil (normally considered insignificant, EA 2008)
- Wildlife dermal contact with water (normally considered insignificant, EA 2008)
- Wildlife ingestion of water
- Wildlife ingestion of plant material
- Wildlife ingestion of herbivores

Exposures were calculated by including estimates for consumption of water, soil, and food. They used estimates of soil ingestion, water ingestion, and food ingestion to calculate exposure. The formula EA (2008) used is shown starting at their Figure 10-2. These estimated exposures were then compared to benchmarks to assess potential environmental effect (EA 2008, Section 10.2.1). EA (2008) selected two benchmark end points for cadmium bird exposure rates using the EPA EcoSSL database -- the geometric mean of NOAELs (1.47 mg/kg-bw day), and the lowest bounded LOAEL (2.37 mg/kg-bw-day, EA 2008, 10.3.3.a).

Exposure estimates are detailed in EA (2008), Figures 10-8 through 10-13, and Tables 10-20 through 10-26. For the high cadmium composite, exposure estimates for the song sparrow (2.94/2.97 mg/kg-day) and marsh wren (3.72/3.75 mg/kg-day) under exposures to both effluent and runoff waters exceed the bird LOAEL benchmark. In addition, the exposure estimate for the meadow vole (1.01 mg/kg-day) exceeded the mammal NOAEL of 0.770 mg/kg-day and the exposure estimate for the shrew (2.29/2.262 mg/kg-day) exceeded the mammal LOAEL benchmark of 2.06. These estimates are based on a soil cadmium concentration of 36.9 mg/kg (washed dried soil), derived from the high cadmium sediment with a 29.8 mg/kg cadmium concentration. These estimates are shown below in Table 46 for the runoff exposure estimate (slightly larger than the effluent exposure estimate). These results indicate an expectation of impact to both birds and mammals feeding within dried portions of a DMCA containing sediments similar to the high cadmium sediment composite.

The CENWO-HX-S (CENWO, 2006A) risk assessment found the cadmium sediment data to be non-parametric and advised that the 95% Chebyshev (Mean, Sd) UCL be used in evaluating each reach. The reach with the highest average cadmium concentration (21.5 mg/kg) was found to have a 95% Chebyshev UCL of 36.2 mg/kg cadmium concentration. This value was used for their risk assessment. Their selection of 36.2 mg/kg cadmium as an appropriate value for the risk assessment for the high cadmium sediments shows that the use of 36.9 mg/kg by EA for the washed sediment exposure assessment is appropriate for the risk estimate for the high cadmium reach. This is

further indication that adverse impacts to both birds and mammals could be expected should the high cadmium sediments enter the DMCA's rotation management plan.

Table 46. Dose Predictions for the High Cadmium Composite Under Dry DMCA Conditions, mg/kg bw-day

	Effluent Exposure	Runoff Exposure	NOAEL mg/kg bw-day	LOAEL mg/kg bw-day
Song sparrow	2.97	2.94	1.47	2.37
Meadow vole	1.01	0.990	0.770	2.06
Marsh wren	3.75	3.72	1.47	2.37
Shrew	2.29	2.263	0.770	2.06
Red-tailed Hawk	.000061	.000061	1.47	2.37
Red Fox	0.169	0.160	0.770	2.06

EA also calculated exposure estimates for the low cadmium composite under both effluent and runoff water exposures. These exposures are shown in Table 47, below, for the potential effluent water exposure route and runoff exposure route and compared to benchmarks.

Table 47. Dose Predictions for the Low Cadmium Composite Under Dry DMCA Conditions, mg/kg bw-day

	Effluent Exposure	Runoff Exposure	NOAEL mg/kg bw-day	LOAEL mg/kg bw-day
Song sparrow	1.93	1.784	1.47	2.37
Meadow vole	0.797	0.639	0.770	2.06
Marsh wren	2.48	2.27	1.47	2.37
Shrew	1.52	1.354	0.770	2.06
Red-tailed Hawk	.000048	.000048	1.47	2.37
Red Fox	0.131	0.066	0.770	2.06

These estimates are based on a sediment cadmium total of 15.4 mg/kg and a calculated bioavailable cadmium total of 14.6 mg/kg, a water concentration based on the cadmium effluent total for the low cadmium composite (761 ug/L), 45% uptake by plants from soil based on results of the low cadmium composite plant uptake test, and 110% uptake by invertebrates from plants based on literature review. Only the marsh wren is shown to exceed the LOAEL, and only by 5%. Using the relationship between the 15.4 mg/kg total cadmium sediment level and predicted exposure level for the Marsh Wren of 2.48 mg/kg bw-day, the sediment level associated with the LOAEL of 2.37 mg/kg bw-day should be 14.7 mg/kg cadmium. However, when taking into consideration that the washing procedure may have removed the exchangeable fraction of cadmium (up to 10% of total cadmium), potential additive effects from nickel and zinc, and variability in the measured amount of cadmium in the test sediment, the lowest effect level should be

applicable to sediments containing about 14 mg/kg cadmium. One can also use the cadmium bioavailable level (14.6 mg/kg cadmium) to estimate a bioavailable sediment level associated with the 2.37 mg/kg bw-day LOAEL to be 14.0 mg/kg cadmium. Those estimates led to the selection of 14 mg/kg as the lowest sediment cadmium level expected to have environmental impacts when associated with drying dredged sediments.

4.3.1.8 Worker Exposure. There is a potential risk to workers handling and working in potentially-contaminated dredged sediments. The CENWO-HX-S conducted a Human Health Risk Assessment (CENWO, 2006b). Their assessment assumed exposure to an occupational worker for 10 hrs per day, for 300 days per year, over a 15-year period. It concluded "the calculated non-cancer hazards and cancer risks indicate that exposure to the cadmium-enriched dredged material does not pose a concern for adverse non-carcinogenic or carcinogenic health effects for the occupational worker scenario, and therefore, does not present a risk to human health." Therefore, this pathway was not evaluated further.

4.3.2 Potential Aquatic Effects From Placement of Cadmium Sediments in a DMCA Where Water is Ponded

There are two major pathways by which cadmium could affect the aquatic ecosystem through placement of cadmium containing sediments within a DMCA: (1) cadmium toxicity to invertebrates feeding within the containment areas; (2) bioaccumulation of cadmium by shorebirds and waterfowl feeding within the containment areas.

4.3.2.1 Cadmium Toxicity to Invertebrates Feeding within the Containment Areas. This pathway is of little concern since it will for the most part not be complete. Should organisms within a DMCA not be able to survive due to cadmium toxicity, they would not serve as food for birds and waterfowl feeding within the DMCA. Since no organisms associated with this pathway would leave the site, there would be no impact on the outside environment.

4.3.2.2 Bioaccumulation of Cadmium by Shorebirds and Waterfowl Feeding within the Containment Areas. This pathway is of concern since large numbers of shorebirds and waterfowl feed in the wet areas within the containment areas (see Conceptual Model, PD-EC, 2006b). No Tier II evaluation techniques are available for heavy metals, but may become available in the future (Upland Manual Sections 8.2.3 and 8.3.1). Therefore, the Corps' Hazardous and Toxic Waste Center of Expertise (shown as CENWO-HX-S) was enlisted to conduct a screening level risk assessment for the bioaccumulation pathway within a DMCA (see CENWO, 2006a). The purpose of the risk assessment was to identify the pathways that contain more than minimal risk of adverse effects. Additional Tier III assessments of the bioaccumulation potential would be required for any pathways that remain of concern.

There are other vertebrates on the site that were not evaluated for potential cadmium impacts since they are thought to occur in only small numbers or are not expected to move off site . These include amphibians (primarily tree frogs), reptiles (anoles, various

snakes, including the diamond-backed rattlesnake, fence lizards, turtles, and alligator), and various fish (mosquito fish, striped mullet, sheepshead minnow, and killifish). Based on Planning Division's conceptual model identifying birds as the primary receptors of concern, CENWO-HX-S was asked to evaluate potential effects on birds.

4.3.2.3 Ecological Risk Assessment by CENWO-HX-S. In evaluating the high cadmium reach, CENWO-HX-S (CENWO, 2006a) found that aquatic nesting birds were most likely to be impacted by cadmium, should the dredged sediments be held in an aquatic state where nesting shorebirds would feed. They estimated a daily dose (DI) of cadmium would be about 6.5 mg/kg-body wt/day. This value was compared to a toxicity reference (TRV) value of 1.45 mg/kg-body wt/day (a level found to produce reproductive effects in captive mallard ducks). The ratio of these two values (DI/TRV) is defined as an ecological quotient (EQ). Where conservative assumptions are made, "EQs between 1 and 10 have some small potential for adverse effects" (CENWO, 2006a). They calculated an EQ for the high cadmium sediment to be 4.5. Because they believed their assumptions in calculating the dose value were conservative, they concluded "it is not of significant project-wide concern". There are several indications that this estimate may be closer to a reasonable expectation than a conservative estimate. For example, ERDC felt that the estimate was not conservative (ERDC, 2006). Other evidence that the estimate is not conservative is discussed below.

4.3.2.4 Discussion of Conservative Assumptions in the CENWO-HX-S EQ Estimate.

The CENWO-HX-S (CENWO, 2006a) listed four factors that "were maximized to maintain the conservative nature of this evaluation." These are discussed below, to ascertain the true "conservative" extent of the EQ estimate.

a. Area Use factor. Assumed to be 100% within the contaminated area. For nesting black-necked stilts, this is not particularly conservative, since adults appear to spend most of their time within the containment areas, and young flightless birds spend all of their time there (see the conceptual model, PD-EC, 2006b). For the 3-5 month nesting and rearing season, black-necked stilts could easily spend all of their time within the DMCAs. Black-necked stilts have been observed flying from one DMCA to another to feed. Since the project would most likely deposit the enriched sediments in only one DMCA and should have other DMCAs flooded at the same time, we expect flying stilts would conduct some of their feeding in areas in which the enriched sediments have not been placed.

b. Bioavailability. Assumed to be 100%. Food was considered to have the same concentration as the sediment. A bioaccumulation factor (BAF) is defined as the ratio of the concentration of the contaminant in the tissues of the organism to the sediment concentration to which the organism is exposed. These appear to be somewhat variable, depending on the species. ERDC found that "When considering the bioaccumulation of cadmium in both freshwater and estuarine invertebrates, a BAF of 1.0 appears reasonable for invertebrate species in both freshwater and estuarine portions of Savannah Harbor"

(see ERDC, July 2006). Therefore, this assumption should be considered reasonable (not conservative) for invertebrates within the DMCAs.

c. Estimates of Body Weight and Food Ingestion. Estimates of body weight and food ingestion rates of the ROCs were made conservatively to maximize the dose (i.e., the intake of cadmium-enriched dredged sediment). CENWO-HX-S used published average consumption rates (based on Spotted Sandpiper data) and body weights in estimating doses. This estimate should also be considered reasonable (and not conservative). A conservative assumption would be use of consumption rates beyond normal expectations.

d. Dietary Composition. "Assumed 100% of diet consists entirely of the most contaminated dietary component (i.e., food and dredged material)." Lacking specific data, it is reasonable to assume that the food and dredged sediment would have the same concentration of cadmium. The CENWO-HX-S (CENWO, 2006a) calculated a 95 percentile distribution UCL for the reach with the highest concentration to be 36.2 mg/kg cadmium and used this value in their assumptions, rather than an average value of about 21.5 mg/kg. This is a conservative procedure. However, the food consumption rate (for the Spotted Sandpiper) does not appear to include incidental soil ingestion. Furthermore, the calculated dose does not include ingestion of water. Lack of inclusion of these elements in the dose calculation brings uncertainty into the conservative extent of the dietary composition assumptions.

e. Other Factors. There are other factors that indicate there may be additional uncertainty in the ingestion rate assumption and EQ estimate. For example, feeding rates for the EQ calculation are based on published estimates for the Spotted Sandpiper, derived from a published regression equation for all birds. The Spotted sandpiper has about ¼ the body weight of the species of concern (Black-necked Stilt). Although the estimated Black-necked Stilt rate is adjusted for body weight, it is not clear that the two species would have the same body weight adjusted feeding rate. Furthermore, the stilt uses an entirely different foraging method (feeds mostly wading), whereas the sandpiper feeds mostly by gleaning food from the surface of damp substrates. This hints that the food composition of the two species is likely to be entirely different. Finally, the toxicity reference value used is based on effects on a much larger and unrelated species (the Mallard Duck). This may be the best available toxicity reference value, but it is uncertain how conservative is the use of such a toxicity reference value. An analysis may be conservative for one species, but we have no information concerning how other species may compare in their feeding rates, body weights, etc., so we may not be able to say it is conservative for all species that use the DMCAs.

4.3.2.5 Decision to Proceed with Additional Risk Assessment. Risk assessments were performed by CENWO-HX-S (CENWO, 2006a) for birds feeding in sediments containing two different levels of cadmium (10.5 mg/kg and 36.2 mg/kg). These levels were the 95 percentile of the cadmium levels for two different reaches (averaging 6.67 mg/kg and 21.45 mg/kg). Daily doses were calculated and compared to a reference toxicity value, and the resulting ratio defined as an EQ (ecological quotient). The EQ calculated by the CENWO-HX-S for the 10.5 mg/kg cadmium reach was 1.3, and the EQ

for the 36.2 mg/kg cadmium reach was 4.5. As mentioned earlier, CENWO considers EQs between 1 and 10 to have some small potential for adverse effects. Because the calculated EQ for the reach averaging 6.67 mg/kg cadmium was found to be only slightly above 1 (at 1.3) based on the 95 percentile UCL, they found there is at most only a small potential for adverse effects from birds feeding on these sediments. Therefore, they found that placement of these sediments (reach averaging 6.67 mg/kg cadmium) within a DMCA would be expected to have minimal and acceptable environmental impacts.

In contrast, since the calculated EQ (4.5) for the reach averaging 21.45 mg/kg (based on a 95 percentile concentration of 36.2 mg/kg) is 4.5 times the toxicity reference value of 1.45 mg/kg-bw day, and this value appears to be based mostly on expected average or standard conditions, sediments from this reach have a much greater potential for adverse effects than the other reaches. As discussed above, it was concluded by the District that these potential effects could not be discounted.

It was determined by the District that additional toxicity and bioaccumulation testing would be necessary before it could be concluded that there would be minimal risk to birds feeding within a DMCA where sediments average 21.45 mg/kg cadmium. Since the calculated daily cadmium dose for Black-necked Stilts feeding within the disposal area was found to be 4.5 times a published toxicity value, it appeared that there was a reasonable potential for adverse effects should the higher cadmium sediments be exposed in an aquatic state within the DMCAs. This prediction was part of the basis for the decision to conduct further assessment using Tier III Bioaccumulation procedures.

Tier III Bioaccumulation assessment using ocean disposal protocols was deemed appropriate to assess potential wet phase impacts from placement of high cadmium sediments within the DMCAs, since most of the water in the DMCAs is expected to be brackish water pumped into the areas during the dredged sediment placement operations. This analysis selected *Nereis* and *Macoma* as test organisms because they thrive in brackish conditions. Results of the bioaccumulation study are discussed at Section 4.2.5.

4.3.2.6 Risk Assessment by EA (2008). EA (2008) conducted the additional sampling and analyses and used their data to conduct a risk assessment of direct uptake by animals living in the river in high cadmium exposed clay within the channel. That assessment found minimal risk associated with the aquatic pathway. The analyses applied to the situation that would occur within the channel after Expansion deepening would also apply to wet sediments held within a DMCA, with the exception that at least some shorebirds could be expected to feed almost entirely on prey organisms within the wet sediments. EA also conducted a risk assessment of direct uptake by plants and animals living on sediment held in a wet condition within the containment areas. These assessments are discussed below along with the assessment by CENWO-HX-S.

The first risk assessment was conducted by CENWO-HX-S. They began by analyzing the sediment cadmium data to determine appropriate concentrations to use in their predictions. They found the sediment cadmium data to be non-parametric and advised that the 95% Chebyshev (Mean, Sd) UCL be used in evaluating each reach. The reach

with the highest average cadmium concentration (21.5 mg/kg) was found to have a 95% Chebyshev UCL of 36.2 mg/kg cadmium concentration. This value was used for their risk assessment of the high cadmium sediments. The reach with an average cadmium concentration of 6.67 mg/kg cadmium was found to have a 95% Chebyshev UCL of 10.5 mg/kg cadmium. This value was used in their risk assessment for that reach. The results of their assessment are discussed at Sections 4.3.2.3 through 4.3.2.5.

EA conducted their risk assessments based on the results of the bioaccumulation testing of the low and high cadmium composites. The 29.8 mg/kg cadmium total for the high cadmium composite is slightly less than the 36.2 mg/kg cadmium average CENWO-HX-S found to be appropriate for assessment of the high cadmium sediments. Decisions based on the high cadmium composite concentration could therefore slightly underestimate overall potential impacts.

EA conducted high cadmium (29.8 mg/kg) sediment exposure estimates including food, sediment, and effluent water exposure for great blue heron, osprey, spotted sandpiper, Canada goose, river otter, and muskrat. The predicted consumption exposure of 1.63 mg/kg-bw day for the spotted sandpiper is above the mean NOAEL cited by EA (1.47 mg/kg bw day) but below the LOAEL of 2.37 mg/kg bw-day. Estimates for the other species were below NOAELs. These results are shown in Tables 10-15 to 10-19 in EA, 2008. It should be recognized that the assumptions leading to this estimate reflect more the expected state, rather than being conservative, especially for young birds feeding within the DMCAs. For example, in the case of young black-necked stilts raised within the DMCAs, they would be expected to spend 100 percent of their time feeding on prey that are in continual contact with cadmium-containing sediments. If the bird LOAEL cited by CENWO-HX-S (1.45 mg/kg bw-day) is used as a benchmark, then the sandpiper estimate slightly exceeds the LOAEL benchmark.

4.3.2.7 Conclusion Regarding Birds Feeding Within a DMCA in an Aquatic State. The cadmium exposure prediction by EA (2008) for birds feeding 100 percent of the time in high cadmium sediments within the DMCAs is 1.63 mg/kg bw-day for spotted sandpiper. This is less than the original prediction by CENWO-HX-S (CENWO, 2006a) of 6.5 mg/kg bw-day, which did not include ingestion of water in the estimate. EA included ingestion of water in its estimate, but the exposure from water was found to be small. EA used a food ingestion rate (0.294) expressed as kg food (wet wt.) per kg body wt. per day. CENWO-HX-S used a food intake rate (0.0077) expressed as kg food per day. Using the spotted sandpiper body weight of 0.0425 kg cited by CENWO-HX-S, the feeding rate described in their assessment for the spotted sandpiper converts to 0.273 kg wet wt. per kg body weight-day. This indicates both groups used similar feeding rates in their calculations. The difference in exposure estimates can be explained by how the food and sediment ingestion exposures were estimated. The CENWO-HX-S calculation is overly conservative in that it assumes food and sediment would have the same concentration of cadmium (36.2 mg/kg). EA (2008, Chapter 10) used the bioaccumulation results for *Nereis* grown in the high cadmium composite to predict benthos in the spotted sandpiper diet would have a cadmium concentration that was 0.664 percent of the cadmium present in the sediment. In other words, EA used site-specific

information to conclude that a lower cadmium intake should be expected for the spotted sandpiper.

A difference in evaluation criteria led to different conclusions by CENWO-HX-S and EA. CENWO-HX-S used the lowest published bird LOAEL value of 1.45 mg/kg bw-day as a benchmark. EA used the lowest "bounded" LOAEL of 2.37 mg/kg bw-day and the geometric mean of the NOAEL data (1.47 mg/kg bw-day) in the ERED database as benchmarks. However, the major difference in evaluation criteria was the calculation of an ecological quotient "EQ", in accordance with Interim EPA superfund guidance (CENWO, 2006a). The next paragraph provides an explanation of the use of the "EQ" from CENWO-HX-S.

"Ecological risk should be interpreted based on the severity of the effect reported and the magnitude of the calculated EQ (EPA, 1997). For example, EQs between one and 10 have 'some small potential' for adverse effects, EQs between 10 and 100 have 'significant potential' for adverse effects, and EQs greater than 100 indicate 'expected' adverse effects (Menzie et al., 1992). The EQs associated with the risk of cadmium for this project in both cadmium reaches are greater than one, but less than 10, for both ROCs, and therefore, it is not of significant project-wide concern."

It is our conclusion that the exposure estimate (1.63 mg/kg bw-day) for shorebirds feeding within the ponded area of a DMCA containing sediment cadmium levels similar to those in the high cadmium composite shows a level slightly above the lowest published LOAEL for birds (1.45 mg/kg bw-day). Because the DMCAs are managed to produce wildlife habitat for birds, impacts to feeding birds would be unacceptable. Since this exposure estimate is based on birds feeding within a DMCA 100 percent of the time, this estimate would apply only to birds feeding within the DMCAs 100 percent of the time (nesting black-necked stilts and their young). Using the high cadmium sediment composite level of 30 mg/kg cadmium as equating to an exposure level of 1.63 mg/kg bw-day, a 1.45 mg/kg bw-day exposure level would equate to a 27 mg/kg wet sediment cadmium level as the lowest wet sediment level of potential concern within a DMCA.

4.3.2.8 Worker Exposure During Dredging. Although the risk assessment conducted previously CENWO-HX-S concluded that occupational workers' exposure to the cadmium-enriched dredged material would not pose a concern for adverse non-carcinogenic or carcinogenic health effects, the District conducted an additional assessment to confirm those findings.

Workers associated with the dredging and sediment placement operations could experience some exposure as the new work sediments are removed from the channel and deposited within the DMCA. The duration of this potential exposure is not certain, but would extend only during the period of construction. Large dredges expected to be used for this construction could be expected to move along the channel at a rate of about 50 feet per day. At that rate, it should take a dredge 560 days to deepen the 28,000-foot length of channel enriched with cadmium at levels averaging 21 mg/kg. Workers at the DMCAs may experience exposure for a longer period, as the Contractor is typically

responsible to decant the DMCA, a process which often takes 30 days. For those workers, the total exposure time would lengthen to 590 days (560 + 30 days).

A dredge can be expected to operate for 24-hours per day, so two 12-hour shifts would perform the work. The work time for a given worker could be as much as 6,720 hours (560 days X 12 hours/day). The exposure for occupational workers on a dredge would be for a much shorter period of time than the exposure found by CENWO-HX-S to have no effect (6,720 hours rather than 45,000 hours). Similarly, for the Contractor's workers at the DMCAs, the total exposure time would be 7,080 hours. This is also much shorter than what CENWO-HX-S concluded would have no effect.

Therefore, the conclusion for workers during the dredging and sediment placement operations would be the same: exposure to the cadmium-enriched dredged sediment does not pose a concern for adverse non-carcinogenic or carcinogenic health effects.

5.0 Conclusions.

5.1 Potential Contaminants of Concern

Cadmium has been identified as the only contaminant of concern for the Savannah Harbor Expansion Project. Cadmium concentrations within new work sediments have been found to be elevated above levels normally encountered in sediments and soils. An assessment of potential availability of cadmium and associated risk has identified scenarios with little environmental concern and others where environmental concerns dictate management to minimize risk.

5.2 Project Extent

Cadmium sediment concentrations within the channel were investigated from Station +103+000 to the end of the project in deep water in the Atlantic Ocean at Station -63+000B. Extension of the proposed work to Station -98+600B is believed to have no additional sediment contaminant-related impacts since the tested bar channel sediments were found acceptable and the additional length would extend further into the ocean and away from possible sources of contaminants.

5.3 Cadmium Concentrations

As discussed in Section 4.2.5, the lowest cadmium level of potential concern in wet sediments within the DMCAs is approximately 27 mg/kg (dry wt).

As discussed above (Sections 3.9 and 4.3.1.7), a sediment cadmium concentration of 14 mg/kg has been identified as the lowest concentration warranting environmental concern when sediments are placed in a dry environment. This level was used in determining

which reaches contained sediments require management. The highest observed cadmium concentration is 77.1 mg/kg in the -56 to -58 foot (MLW) layer at Station +30+000. The Station with the highest sediment cadmium average (39.4 mg/kg) is Station +26+000. The reaches where potential contaminant-related environmental impacts have been identified and sediment management is required include inner harbor Stations +90+000 to +80+125, +57+000 to +51+000, and +45+000 to +6+375. Average cadmium concentrations associated with each of these reaches is shown in Table 21c.

In response to concerns raised by the USFWS, the District agreed that a cadmium "trigger" level should be identified for this project below which there should be no contaminant concerns associated with a proposed cover/cap. In deriving this "trigger" level, the District used the dose (exposure) prediction procedure discussed at 4.3.1.7, data from the low cadmium composite, and very conservative assumptions to predict an exposure estimate for the Marsh Wren (the most sensitive target species investigated by EA). Those assumptions included: all sediment cadmium would be bioavailable (15.4 mg/kg cadmium dry wt), cadmium concentration in water would be the total effluent concentration from the low cadmium elutriate study (761 ug/L), a sediment to plant transfer factor of 1, and a plant to invertebrate transfer factor of 1.1. The Marsh Wren cadmium exposure under these conditions was estimated to be 4.81 mg/kg bw-day. By relating this exposure level to the total cadmium sediment level of 15.4 mg/kg, the predicted cadmium sediment level associated with the lowest published effect level of 1.45 mg/kg bw-day would be 4.64 mg/kg dry wt. sediment cadmium. Acknowledging there is some degree of uncertainty associated with this prediction, the District determined the dry sediment level associated with no effect on birds could be considered with a high degree of certainty to be no more than 4.0 mg/kg cadmium. Therefore, 4.0 mg/kg dry wt. cadmium was selected as the cover criterion below which environmental concerns should be minimal.

5.3 Contaminant Concerns Related to Water Quality

Potential adverse contaminant impacts on water quality related to the required dredging were found to be minimal.

5.4 Potential Contaminant Impacts within the Savannah River

Potential contaminant impacts associated with exposed high cadmium sediments within a deepened channel have been found to be minimal, primarily because sediment cadmium was found to be unavailable and bioaccumulation tests found cadmium uptake below levels of concern. The essentially anoxic state of the channel sediments should preclude significant movement of cadmium to the environment. Furthermore, it is expected that exposure of the riverine environment to high cadmium clays would be restricted since the majority of the exposed clays are expected to be covered by O&M sediments

5.5 Potential Contaminant Impacts associated with Dredged Sediment Placement

Potential contaminant impacts related to sediments held in a wet state within a DMCA were found to exist only for birds that feed within a DMCA 100 percent of the time. This would refer primarily to nesting black-necked stilts and their young. To minimize environmental risk, high cadmium sediments should be managed in a way that excludes exposure to nesting black-necked stilts.

5.6 Other DMCA Pathways

Potential impacts associated with other pathways by which a contaminant might leave a DMCA (leachate to groundwater, runoff, effluent, volatilization) were found to be minimal.

5.7 Potential Impacts Associated with the DMCA Rotation Management Plan

The DMCA rotation management plan involves keeping a DMCA flooded for 3 years and then maintaining the DMCA in a dry state for the next 3-years. During the "dry" cycle, sediments within a DMCA dry for 2 years, and then the dried sediments are relocated to the dikes in the third year. Studies found that drying the sediment changed the behavior of cadmium in the sediment. Sequential extraction procedures on washed and dried sediment showed that cadmium becomes more available in the dried sediment and a plant uptake study found that plants can accumulate cadmium from dried sediments. Exposure models found that both bird and mammals exposed to the dry high cadmium sediments are likely to accumulate cadmium at levels shown to cause impacts. To minimize potential contaminant risk, high cadmium sediments within the DMCAs should not be allowed to be dried and exposed to a degree that allows plant growth and feeding by birds and mammals. In addition, the high cadmium sediments should not be placed so that they would be exposed on the surface of the containment area dikes.

5.8 Nearshore Placement of Bar Channel Sediments

No contaminants of concern were found to exist for new work sediments oceanward of Station +6+375. Therefore, there should be no contaminant-related environmental concerns associated with proposed placement of new work entrance channel sediments in the ODMDS, nearshore submerged berms, or nearshore feeder berms. The placement of dredged material into the nearshore sites has been removed from the project.

6.0 Placement Alternatives for High Cadmium Sediments

6.1 Project Dredged Sediment DMCA Placement Alternatives

There are four primary dredged sediment placement alternatives for the Expansion Project sediments containing elevated levels of cadmium: (1) Deposit the sediments in a DMCA, with subsequent management in the rotation plan; (2) Deposit the sediments in a DMCA, with isolation of the sediment through capping/covering; (3) Deposit the sediments in a DMCA, with isolation through capping/covering and lining; and (4) Deposit the sediments in the Sediment Basin or other open water site.

6.2 Deposit the Sediments in a DMCA, with Subsequent Management in the Rotation Plan

This alternative is unacceptable because of the potential environmental impacts associated with accumulation of cadmium by birds and mammals feeding within the DMCA.

6.3 Deposit the Sediments in a DMCA, with Isolation within One or More DMCAs with Capping/Covering

This alternative is acceptable from an environmental perspective since it would preclude movement of cadmium from sediments to populations of concern outside the DMCAs, including birds and mammals.

6.4 Deposit the Sediments in a DMCA, with Isolation within One or More DMCAs with Capping/Covering and Lining

This alternative is acceptable but appears to be unnecessary. A liner would be appropriate to prevent cadmium movement to groundwater as leachate, should the leachate contain cadmium at levels of concern. Studies discussed in this assessment found cadmium to be tightly bound within wet sediments and clay porewater concentrations were found to be very low. Therefore, movement of cadmium through leachate is expected to be minor and of minimal environmental concern.

6.5 Deposit the Sediments in a Sediment Basin or Other Open Water Site

Under our current level of understanding, elevated cadmium sediments placed in an anoxic open water site would be expected to release minimal cadmium to the environment. However, placement of these sediments in the high current Back River Sediment Basin with a pipeline dredge could not guarantee the sediments would be localized in one area and remain anoxic. Movement of these sediments throughout the estuary could result in future unforeseen impacts. Potential environmental impacts make this alternative unacceptable with pipeline dredging. Clamshell dredging with bulk placement of the sediments would reduce sediment resuspension and subsequent offsite spread of those sediments. This could render this option acceptable, but further consideration of potential impacts would be necessary before confirming that determination.

7.0 Recommendations

7.1 Isolate High Cadmium Sediments

New work sediments from Stations +90+000 to +80+125, +57+000 to 51+000, and +45+000 to +6+375 should be isolated within a DMCA and capped/covered with sediment from another reach. More than one DMCA may be needed to store the volume of new work sediments resulting from some channel depth alternatives. The high cadmium sediments should not be disturbed further and should not be allowed to be later excavated and placed in any exposed upland area.

7.2 Potential Method of Isolation

Once a DMCA is selected to receive the sediment, the high cadmium sediments should be pumped into the area first. Once placement of sediments from this reach is completed, markers should be placed on the surface of the sediment to allow easy determination of when the proper cap/cover depth has been attained. At least 2 feet of additional sediment from another reach (the cover material) should then be placed in the area as soon as practicable, but as part of the SH Expansion Project, to ensure minimal environmental impacts from birds feeding within the DMCA. Once the sediments have consolidated, a covering of crushed limestone, coal or similar marking material should then be placed on the surface of the area to ensure that the surface of the cover can be located in the future and the cover left undisturbed.

7.3 Monitoring and Contingency Plan

7.3.1 Placement of Dredged Material

An hydraulic dredge will be used to place material averaging approximately 14 ppm cadmium or greater into Dredged Material Containment Areas (DMCAs) 14A and/or 14B. Material placed in the DMCAs will remain in a "ponded" state (inundated) until the material is covered/capped by placing an approximately 2-foot layer (i.e., cap) of dredged material averaging ≤ 4.0 ppm cadmium. It should be noted that the dredged material containing 14 ppm cadmium will not be allowed to dewater and/or desiccate to the point that it would come into contact with the atmosphere. Cadmium-laden sediments would not be diluted with other sediments to reduce concentration during dredging nor allowed to mix substantially with cap/cover material when the cap/cover sediments are placed.

To ensure even distribution of dredged material throughout the disposal area, a floating discharge with a spreader may be required to allow the head section to be relocated as necessary using a system of wenches and cables as heavier material will fall out and tend to accumulate close to the head section. Bulldozers adapted to aqueous work would be required to keep dredged material submerged to minimize contact with the atmosphere and ensure a level surface. After a period of 3-6 months, the cap material would be placed using the same approach as the cadmium material was placed. Prior to deposition of the cover/cap material, light-weight settlement plates or other appropriate settlement measuring devices will be distributed across the disposal area in a grid and marked so that the contractor will able to tell when 2 feet of covering sediment has been deposited.

Another approach for actual placement of material is also under review. This approach would use a float hose with a y-valve and an operator at the end of the line, which could control the discharge by directional pumping. This method would require first depositing material closest to the weirs and piping off to move the head section to the front of the disposal area. Discharge would begin near the front of DMCA 14A near the weirs and then shift away to allow suitably clear water to be discharged. Deposition would progress toward the rear of the disposal area, around the finger dike, and back to the front of the disposal area. Assuming a 47' project, the remainder of the cadmium material to be managed would most likely be placed in DMCA 14B using the same approach as identified with DMCA 14A. With respect to this alternative approach, a 2-foot covering layer would still be used.

7.3.2 Monitoring Sediments During Placement in DMCA

The goal of this analysis is to characterize the cadmium concentrations that are actually deposited in the confined disposal area. Samples of the sediment slurry would be collected from the head section discharge pipe on a weekly basis and analyzed for total cadmium. Total solids would be reported on a g/L basis and cadmium concentration would be reported on a dry-weight basis (mg/kg). If clay balls are being discharged, a typical clay ball would be collected on a weekly basis at the same time the slurry sample is collected and the total cadmium concentration reported for both the slurry and clay ball on a dry-weight basis (mg/kg).

7.3.3 Sampling of Effluent During Placement of Sediment in DMCA

The goal of this analysis is to ensure effluent from the DMCA satisfies TSS limits and cadmium water quality standards. At the beginning of the deposition of new work sediments in the DMCA, the contractor would construct a 500mg/L TSS standard and determine turbidity (in NTU's) associated with the standard. The contractor would then visually compare effluent turbidity at each of the discharging weirs to the standard on a daily basis. The contractor would measure turbidity on a weekly basis at each outfall pipe with a discharge. Measurements would include dissolved oxygen, salinity, conductivity, temperature, and turbidity. Measurements would be made with a Hydrolab or similar instrument. At the same time the turbidity measurement is made, every two weeks the contractor would collect a water sample for chemical analysis. Sample would be obtained from the outfall pipe. Analyses would include NTUs, total suspended solids (TSS) in mg/L and cadmium concentration in ug/L (dissolved). Should the effluent dissolved cadmium concentration be found to be higher than the State standard (i.e., 8.8 ug/L for South Carolina), sampling would be repeated within two days and would include both the outfall pipe sample and a receiving water sample taken approximately 100 feet down-current of the point at which the effluent enters the receiving water. Should the receiving water sample be found to violate the State standards, corrective action would be undertaken to eliminate the violation. Any violations of the turbidity or TSS standards would be immediately addressed by corrective action to eliminate the violation. Corrective action may include boarding up the weir to reduce or eliminate effluent discharge, or reducing sediment discharge rate into the disposal area.

7.3.4 Sampling of Cadmium-Laden Sediments

Once placement of cadmium-laden sediments has been completed in a DMCA, grab samples would be collected to characterize the cadmium levels of the surficial sediments. This would occur prior to placement of the sediment cover/cap. Approximately 86 grab samples would be collected from the top 15 cm of the surface of each disposal area used to deposit sediments containing $\geq$14 ppm cadmium. It is expected that this sampling will require use of a water craft, since the area must remain inundated until the high cadmium material is covered by cap/cover material. Samples would be evenly spaced across the DMCA. A sampling depth of 15 cm would be used for these saturated sediments as cadmium transfer to the water column or other organisms should be minimal below this

depth. These samples would also be analyzed for cadmium concentration on a dry-weight basis (mg/kg).

7.3.5 Sampling of Capping/Covering Layer

Eighty-six grab samples would be collected after the cover has been placed on the DMCA in order to characterize the cadmium levels of the exposed, surficial "capping" sediments. The same procedure for sample collection would be used as previously described. Approximately 86 samples would be collected from the top 30 cm of the cover/cap for each disposal area used to deposit sediments containing an average of $\geq$14 ppm cadmium. These samples would be evenly spaced across the DMCA and the location of these sites recorded using a GPS system. These samples would be analyzed for cadmium concentration on a dry-weight basis (mg/kg). If the distribution of sediments with cadmium concentration $\geq$ 4 ppm extends over a cumulative area of 25 acres or greater, then O&M sediments will be placed over the cap/cover, at the earliest possible time. Once the layer of O&M material has been placed in the DMCA, the surface sediments (to a depth of 30 cm) will be sampled (86 grab samples) and analyzed for cadmium. The process of placing O&M material in the DMCA and testing for cadmium would be repeated until the cadmium concentration in the surface sediments is less than 4 ppm.

7.3.6 Wildlife Use of the DMCAs

The District would perform monthly wildlife use surveys of the DMCAs used for placement of cadmium-laden sediments. These one-day surveys would record all birds and other major vertebrates seen within each of the appropriate DMCAs. Weekly monitoring of target species to determine arrival dates and ensure capture within two weeks of arrival will be conducted, most likely in April and September. Monitoring would be performed during placement of sediment (including any required cover) and for 3 years after any required placement is complete. If there is a concern about the number of birds or other animals or a particular species using the DMCA, some type of hazing may be appropriate. Any hazing decisions would be coordinated with the USFWS.

7.3.7 Vegetation Sampling

Should analyses of the cap/cover material show that concentrations of cadmium are equal to or exceed 4 ppm in a cumulative area of 25 acres or more, vegetation sampling will be required. This vegetation sampling would be conducted on a quarterly basis. Sampling of vegetation would be initiated in defined "hot spots" to determine cadmium uptake by plants. Samples collected from the DMCA of interest would be compared to control samples derived from other, cadmium-free environments found in adjacent DMCAs. Where at all possible, vegetation comparisons to reference will be by species and sampling will include all dominant species growing on the cover/cap (where dominant species are determined by the specie exhibiting the highest stem count or percent cover plus all other species equaling at least 20 percent of the total). If vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to

eradicate vegetation and/or place additional, low-cadmium sediments over the original covering layer. These contingency measures would eliminate wildlife exposure should vectors for cadmium uptake be identified. Once an additional layer of material has been placed on the covering layer, then soil/sediment sampling would resume. When sampling confirms that all the amended covering layer contains sustained cadmium concentrations of <4 ppm, the vegetation monitoring requirements would be complete. Specific details on the vegetation monitoring are described below at Section 7.4.3.1.4.

7.3.8 Tissue Monitoring

The District does not expect to encounter large numbers of birds feeding in elevated cadmium sediments during the dredged material disposal operations. This is because the proposed disposal design calls for sediments to be placed in an area where water is being held above the level of the placed sediments. Avian access to these inundated sediments is expected to be limited to birds that feed by swimming and diving. The species expected to be encountered in the highest numbers in the inundated areas include American Coot, Common Moorhen, Mottled Duck, feral Mallard Duck, Double-crested Cormorant, and in winter only, Northern Shoveler, Green-winged Teal, Ruddy Duck and Pied-billed Grebe.

Tissue monitoring would be conducted during placement of cadmium-laden sediments and the cap/cover and for 3 years after the placement is complete. Since the DMCAs will reenter the rotation program after the covering sediments are placed, the DMCAs may be dry or wet, depending on the year. Their hydrologic condition would drastically alter their bird use, as different species use the DMCAs in those two conditions. The season also drastically affects bird use of the DMCAs.

If/when the DMCAs are dry, individuals from two species would be sampled at the beginning and end of the nesting season (April and August) chosen from the following nesting species: Red-winged Blackbird, Mourning Dove, Eastern Towhee (white or yellow-eyed), Brown Thrasher, and Northern Mockingbird. Similarly, if/when the DMCAs are dry, individuals from two species would be sampled at the beginning and end of the wintering season (October/November and March/April) chosen from the following wintering species: Eastern Towhee (white or yellow-eyed), Brown Thrasher, Northern Mockingbird, House Wren, Song Sparrow, and Savannah Sparrow.

If/when the DMCAs are wet, migratory birds predominate at the sites. Sampling would be timed to correspond when the majority of each species arrives and is about to depart, which corresponds to approximately April and September. Sampling in April should maximize exposure time for wintering species (September through April), while sampling in about September should maximize exposure time for summer nesting species (April through September). Individuals of two species would be sampled in April and September. The proposed species to be sampled under wet conditions are the following: Northern Shoveler (open-water winter species), Avocet (edge-feeding winter species), Mottled Duck (open-water summer species), and Black-necked Stilt (edge-feeding summer species). The proposed species to be sampled under dry conditions are the

following: Red-winged Blackbird (summer nester), Mourning Dove (summer nester), Savannah Sparrow (winter), and House Wren (winter). Other species listed above in the first paragraph may be substituted for one of these species upon mutual agreement between the District and the USFWS.

One of two types of tissue monitoring may be used. Liver and other tissue may be collected from three individuals of each target species. Blood/feather monitoring is currently deemed to be the appropriate method as it will allow collection of higher numbers of tissue samples. Specific details of the blood/feather monitoring are provided at Section 7.4.3.1.2.

7.3.9 River Bottom Sampling of Cadmium: Post-Construction Mapping

At the end of construction, sediment samples would be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc). Samples would be cores taken to a depth of 15 cm. Where both O&M and new work sediments appear in the core, each would be analyzed separately. Samples would be taken within the channel every 2,000 feet from Stations +100+000 to 0+000 (26 samples) randomly selecting either the center line of the green side or red side. Five stations would be randomly selected to have two adjacent samples collected, from both the red and green side (10 samples). These last samples would be used to define the variability in bottom sediment metal concentrations across the channel. In addition, 5 samples would be run in duplicate (lab duplicates). Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediment at the sediment water interface.

7.4 Summary of Cadmium Management and Monitoring

7.4.1 Placement of Cadmium-laden Sediments

All cadmium-laden sediments would be placed in DMCAs 14A and/or 14B. Material would be placed so that it remains covered with water until after placement of the cover is completed. This material would not be allowed to dewater and/or desiccate to the point that it would come in contact with the atmosphere until placement is complete.

7.4.2 Placement of Cover/Cap

The covering material should come from reaches averaging less than 4 ppm cadmium. A capping layer of at least 2 feet of sediment should be placed above the cadmium-laden sediments. Once the cover has been determined to be sufficient, a marking layer (limestone, coal, etc.) would be placed on the surface. These sediments are not to be exposed in the future.

7.4.3 Required Cadmium Monitoring

7.4.3.1 Biological Monitoring

The District would perform monthly wildlife and avian/abundance surveys and avian blood tissue monitoring at the DMCAs used for placement of cadmium-laden sediments. Avian liver tissue monitoring and vegetation monitoring would take place only if results from the proposed blood/feather monitoring and or sediment cap monitoring indicate specific criteria are exceeded.

7.4.3.1.1 Wildlife and Avian Abundance Surveys

The District proposes to conduct these surveys monthly to monitor avian and terrestrial wildlife (large mammals) use of the DMCAs. This monitoring would be conducted independent of cadmium concentrations in the deposited sediments (in the two DMCAs that will receive the cadmium-laden sediments). Weekly monitoring of target species to determine arrival dates and ensure capture within two weeks of arrival will be conducted, most likely in April and September. The monitoring would be conducted during SHEP construction and would continue for at least 3 years after sediment placement is complete. Wildlife and avian monitoring will be extended as necessary until results from cadmium monitoring of sediment, vegetation, avian tissue and effluent indicate that cadmium concentrations are below levels of concern for 3 years post-construction. Cadmium levels of concern are considered to be 4.0 mg/kg sediment dry wt., chronic water quality criteria and standards within a DMCA or receiving water after mixing, 5.0 mg/kg plant tissue dry weight, avian blood tissue concentrations significantly greater than reference, and 45 ug/g wet liver tissue weight.

7.4.3.1.2 Avian Blood Tissue Monitoring

This monitoring will also be conducted independent of the concentrations of cadmium in the cover/cap and will be conducted both during and for 3 years after construction. It would be extended as necessary to ensure monitoring results are below levels of concern for 3 years post-construction.

The District believes that the overall purpose of the cadmium tissue monitoring is to ensure that the proposed sediment placement does not impact biota within the DMCAs, with concern focused on birds since they are thought to be the most important class of vertebrates that lives both inside and on the periphery of the DMCAs. This class is also important because most species move into and out of the areas at least during migrations. The District proposes that this monitoring be conducted primarily by analysis of blood collected from target species. A baseline data set would be collected, with a target of 30 blood samples from two target species from each season (approximately 120 blood samples) prior to commencement of dredging in the inner harbor in DMCAs 14A and 14B. The Corps may also collect additional baseline data upon the migratory arrival of the species in a given year. The actual number of baseline and project blood samples

may vary depending on the ease with which each species can be captured, but should not be less than 10 per species. The baseline data set would provide information on ambient or background blood tissue cadmium levels. Project sampling events would be performed each year on the target species at mid-season in the DMCA (at least 10 samples) and the resulting data compared to the baseline data set for identification of any potential effects from their use of the DMCAs. This sampling procedure would be repeated during each year of construction and for 3 years following construction. Should the project samples show a significant difference from the baseline data (95% confidence interval) for any species, liver tissue sampling would be performed on that species. Target species must be collected prior to their departure from the DMCA. This procedure would be repeated for any species and any season where significant differences in cadmium blood levels are observed.

Of prime importance for this monitoring is the establishment of baseline blood tissue data for comparison to levels observed prior to a species leaving the DMCAs each year. There appears to be two potential methods for establishing these data: (1) collect the baseline data prior to construction, or (2) collect the baseline data upon arrival of species in the DMCAs. There are advantages and disadvantages for each as outlined below:

Collect baseline data prior to construction

Advantages: Ensures collection of adequate data prior to construction. The ease with which collection of bird blood samples can be accomplished at the sites is currently unknown. Sampling before construction occurs would allow refinement of collection techniques without the time restraints associated with collection at the arrival of the target species. This method would still require a small number of confirmatory samples (at least 3 to 5) at the beginning of the arrival of each species in the areas. This yearly confirmatory sampling should remove uncertainty in whether target species have been influenced by site cadmium levels prior to their yearly arrival to the DMCA.s If the confirmatory samples differ from the baseline data (at 95% C.I.), then additional baseline data would be obtained. This eventuality is not considered likely and is not included in Appendix D.

Disadvantages: Adds uncertainty to the results due to potential yearly variation in cadmium concentrations within target species when they arrive at the DMCAs. There is the potential for selected target species to not return to the DMCAs in a given year during construction in sufficient numbers, thus requiring selection of an alternate species.

Collect baseline data upon arrival of species

Advantages: Accounts for potential yearly variation in cadmium concentrations within species. Ensures target species are actually present at the construction site during construction.

Disadvantages: Requires adequate data be collected in a short period of time (soon after arrival at the DMCAs each year). Failure to collect adequate data in a given year could

result in collection of inadequate baseline monitoring data. Since arrival dates for target species can only be estimated, target species could begin arrival prior to detection and begin uptake of cadmium prior to their capture. This potential adds uncertainty to whether baseline data collected in this manner are actually baseline.

The selected method of baseline data collection for the bird blood tissue monitoring is a combination of the two methods described above. A baseline data set will be collected the year before start of the inner harbor dredging. This will include all target wet and dry species. In addition, at least 3-4 samples of target species will be collected within two weeks of their arrival within the DMCAs. For resident dry species targeted for sampling (Red-winged Blackbird and Mourning Dove), augmenting baseline samples could only be taken the first year. These samples will be compared to the baseline dataset. Should the new samples fall outside the original dataset (95%CI), that would be considered an indication of population changes in tissue cadmium levels occurring outside the influence of the DMCAs. Should the results indicate such changes are occurring, a new baseline dataset would have to be established in consultation with the USFWS.

7.4.3.1.3 Potential Avian Liver Tissue Monitoring

Should data for cadmium blood levels for any bird species be shown to be significantly different from the baseline data (95% confidence level), six liver tissue samples would be collected for that species and cadmium concentrations compared to lowest published avian liver cadmium toxicity levels (screening level). These levels are currently thought to range from 45 to 70 ug Cd/g wet weight liver tissue (Cadmium in Birds, Mark Wayland and Anton M. Scheuhammer, in Environmental Contaminants in Biota, Jekker Frederick Warne &Co.). Liver values significantly above these screening values would trigger additional management options. The District may also choose to collect baseline liver tissue data to which project liver tissue data would be compared. Project liver tissue data would have to significantly exceed baseline data and the threshold value to trigger additional management options.

Blood tissue monitoring would continue until 3 years have passed where either no blood tissue samples are found statistically significantly above the baseline or no liver samples have been found statistically significantly above both baseline and screening values.

The District concurs with the USFWS recommendation that 45 ug Cd/g wet weight liver be the threshold concentration that would trigger additional management options. While the citation listed above provides a threshold toxicity range, that range includes values that indicate potential toxicity to other organs such as kidneys or testes. Eisler (1985) has stated that cadmium residues in vertebrate kidney or liver that exceeds 10 ppm fresh weight should be viewed as evidence of probable Cd contamination. Also, Furness (1996) suggested that 40 ppm in the liver should be viewed as a tentative threshold tissue concentration above which cadmium poisoning in birds might be expected. The District believes that the combined evidence of elevated Cd blood concentrations and Cd liver concentrations at or above published toxicity threshold concentrations (using 45 ug Cd/g

as the most recently published lower threshold concentration) should warrant management action.

7.4.3.1.4 Potential Vegetation Tissue Monitoring

Vegetation sampling would be conducted on a quarterly basis should areas of elevated cadmium be found in the covering sediment. This monitoring is not included in Appendix D because it is not certain that it will be required. Should sampling of the cover show areas with cadmium concentrations greater than or equal to 4.0 mg/kg dry wt. and representing a total cumulative area of 25 acres or greater of the covering layer (not necessarily contiguous), such areas would be considered "hot spots". Vegetation sampling would be conducted at each sampling point within a "hot spot" where the cover sediment cadmium concentration is equal to or greater than 4.0 mg/kg dry wt. Vegetation sampling would be conducted in these defined "hot spots" to determine the potential for cadmium uptake by plants.

A plant tissue threshold can be derived from avian uptake benchmarks. Since the primary movement of cadmium into birds is expected to occur through seed eaters (winter sparrows including the Song Sparrow) or insectivores (Marsh Wren) consuming insects feeding on plants, either the Song Sparrow or Marsh Wren could be considered appropriate species to model.

The values and calculations for determining the plant tissue threshold are the same as those used for the Savannah Harbor Expansion Project Phase II Risk Assessment and are based on using the cadmium washed/dried sediment composite and effluent' scenario. For a total cadmium uptake dose to not exceed the No Observable Adverse Effect Level (NOAEL) benchmark of 1.47 mg/kg body wt/day (using the same assumptions regarding food, water, and incidental soil ingestion rates, cadmium bioavailability, and soil-to-plant bioaccumulation of cadmium), the cadmium concentration in plant material (e.g., seeds) for the Song Sparrow would have to be $\leq$5 mg/kg dry wt (assuming the same cadmium uptake from water at a concentration of 0.1517 mg/kg body wt/day based on the low cadmium composite effluent).

Using the Marsh Wren, a plant tissue concentration of 4 mg Cd/kg dry weight as a threshold for further action can be derived from comparing the predicted exposure to a Marsh Wren of 3.75 mg/kg bw-day from a high cadmium sediment concentration of 10.2 mg/kg to the NOAEL exposure of 1.47 mg/kg bw-day (a no effect level). To be conservative, we have chosen the Marsh Wren exposure to establish the plant tissue concentration threshold as 4 mg Cd/kg dry weight plant tissue.

Samples collected from DMCAs 14A and/or 14 B (or any other area receiving cadmium laden sediments) would be compared to control samples from other, cadmium-free environments found in adjacent DMCAs, and to the cadmium plant tissue threshold level of 5 mg/kg (dry wt.). If vegetation samples have significantly elevated cadmium concentrations with respect to both control and the plant tissue threshold level, efforts

would be initiated to eradicate vegetation, and/or place an additional covering sediment layer in the DMCA, and or conduct hazing of species inhabiting the "hot spots".

Proposed Vegetation Tissue Monitoring Plan.

1. Vegetation sampling will only occur if sediment sampling of the cover/cap layer finds a "hot spot".
2. A "hot spot" is a cumulative area of 25 or more acres, not necessarily contiguous, in which the cadmium sediment concentration is equal to or greater than 4.0 mg/kg dry wt. as determined by 30 cm core samples, each representing approximately 9 acres.
3. Vegetation to be monitored includes higher plants that could for the basis of movement of cadmium to species of concern (birds), either through support of potential herbivore prey or seed production.
4. Monitoring would occur at each sampling point determined to be within a "hot spot" where the sediment cadmium concentration is equal to or greater than 4.0 mg/kg dry wt.
5. Sampling of vegetation would occur within a radius of approximately 350 feet of the sampling point.
6. Dominant higher plant species would be determined by stems in contact with randomly placed straight lines through the site or by either areal coverage or stem counts within randomly placed 1 meter squares. Enough lines or squares would be used until the dominant species are evident. All dominant species (the most dominant species and any additional species comprising at least 20% of the samples) would be collected.
7. For each dominant species, above ground tissues will be collected, dried, and homogenized into one sample for each species. Sufficient tissue would be collected to perform all required tests.
8. This pattern would be completed for each identified "hot spot sampling point".
9. Cadmium vegetation tissue concentrations (in both wet wt. and dry wt.) would be determined for all dominant higher plant species (as defined in Par. 1). Analytical standards would be in accord with EPA Region IV/COE Southeast Regional Implementation Manual for Section 103 Evaluations (SERIM).
10. Control samples of the same species (at least 5 samples) would be collected from other areas with low cadmium content found in adjacent DMCAs.
11. Data from all sampling points within a "hot spot" would be assembled by species and the average of each species compared to the control samples and the 5 mg/kg dry wt. plant tissue threshold. Should species-specific tissue data from a "hot spot" be significantly higher at the 95% confidence level than both the control samples and the plant tissue threshold, additional management action by the District would be required.

7.4.3.2 DMCA Sediment Sampling During Placement

Samples would be taken weekly from the inflow during placement operations and analyzed for cadmium. Sampling could include a slurry sample and clay ball sample (if clay balls are being discharged).

7.4.3.3 DMCA Sediment Sampling Following Placement of Cadmium-Laden Sediments

Following placement of cadmium-laden sediments within a DMCA (and before placement of the cap), eighty-six (86) grab samples would be collected from a depth of 15 cm to characterize the cadmium levels of surface sediments. Samples would be evenly spaced across the DMCA, and they would be analyzed for cadmium concentration on a dry weight basis.

7.4.3.4 Cover/Cap Sampling

A cover/cap of sediments obtained from areas of the channel where concentrations of cadmium are believed to be 4 mg/kg or less would be placed on the cadmium-laden sediments in DMCAs 14A and/or 14 B. Following placement of the cover, eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium.

In summary, the District would sample the deposited cadmium-laden sediments when the DMCAs are still inundated. These grab samples would be collected to a depth of 15 cm. To speed the collection of the next round of sampling (after placement of the covering sediments), the District would also likely sample the completed cover when the DMCAs are still inundated. These grab samples would be collected to a depth of 30 cm. If the DMCA is drained and the sediments are allowed to dry, the cover sampling would still be taken to a depth of 30 cm.

7.4.3.4.1

If the analysis of the sediment samples taken from the cover indicates that concentrations of cadmium are less than 4 mg/kg, monitoring of the cover is complete.

7.4.3.4.2

If the analysis of the sediment samples taken from the cover indicate that concentrations of cadmium are equal to or exceed 4 mg/kg in a cumulative area of 25 acres (not necessarily contiguous) or more of the covering layer, then three actions would be required irrespective of when any additional cover is placed. In addition, if there is a concern about the number of birds or other animals or a particular species using the DMCA, then some type of hazing may be appropriate. Hazing techniques would require the approval of the USFWS prior to implementation. The three required actions are as follows:

1. The DMCA would be kept flooded to keep the sediments wet/moist.
2. The DMCA would receive a cover of O&M material at the earliest possible time. Once the layer of O&M material has been placed in the DMCA, the surface sediments (to a depth of 30 cm) will be sampled (86 grab samples) and analyzed for cadmium. The process of placing O&M material into the DMCA and testing for cadmium would be repeated until cadmium concentrations in the surface sediments are less than 4 mg/kg.
3. Vegetative monitoring would begin.

7.4.3.5 Water Quality Monitoring Requirements for Cadmium-Laden Sediments

The effluent from all DMCAs would be monitored during dredging operations. The effluent from DMCAs 14A and/or 14B would be specifically monitored for cadmium levels. All DMCA 14A weirs discharge to the Savannah River. The main weir for DMCA 14B discharges to Fields Cut. It is possible that minor discharges to Wright River could occur from the other weirs in DMCA 14B. Cadmium concentrations in the effluents from DMCAs 14A and/or 14B from all weirs discharging at 0.1 cfs or greater would be monitored weekly. Should one of the constituents exceed State water quality standards, the additional sampling procedure outlined in the DEIS for sampling effluent during placement of sediment in DMCAs (Appendix M, 7.3.3) would be followed.

The District would perform a quarterly metals scan (including ammonia) on the cadmium-laden DMCA effluent at each outfall pipe discharging at 0.1 cfs or greater. This monitoring would cease one year after installation of the final cover unless a metal constituent is found to exceed chronic water quality criteria or standards. In that case, monitoring for metals would occur on a quarterly basis until no chronic criteria are violated at the outfall pipe for one year.

A copy of all sampling results will be provided to the USFWS.

Monitoring of the effluent from DMCAs 14A and/or 14B would continue as long as a discharge is present and until all sediments have been covered, dewatered, and stabilized. Following the installation of a clean cover, cadmium would be monitored in the effluent on a monthly basis for one year.

7.4.3.6 Other Monitoring Requirements

7.4.3.6.1

At the end of construction, sediment samples would be taken to 15 cm from the exposed river channel bottom sediment surface and analyzed for grain size and metals (including cadmium). This would provide an assessment of cadmium concentrations in sediment at the sediment-water interface that are exposed at the end of deepening, before normal sedimentation occurs.

7.4.3.6.2

As requested by Georgia DNR-EPD, sediment analysis would be required prior to maintenance dredging in channel reaches with cadmium–laden sediments. Samples are to be taken and analyzed for cadmium from two locations for at least two maintenance dredging cycles and furnished to Georgia DNR-EPD at least 45 days prior to dredging.

Steve Calver
Biologist
Planning Division
U.S. Army Engineer District, Savannah
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FOR CONTINUATION OF HOUSE DOCUMENT 112-153

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CHATMAN CO., GEORGIA & JASPER CO., S. CAROLINA:
FINAL GENERAL RE-EVALUATION REPORT AND
ENVIRONMENTAL IMPACT STATEMENT

SEE PART 14