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

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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.

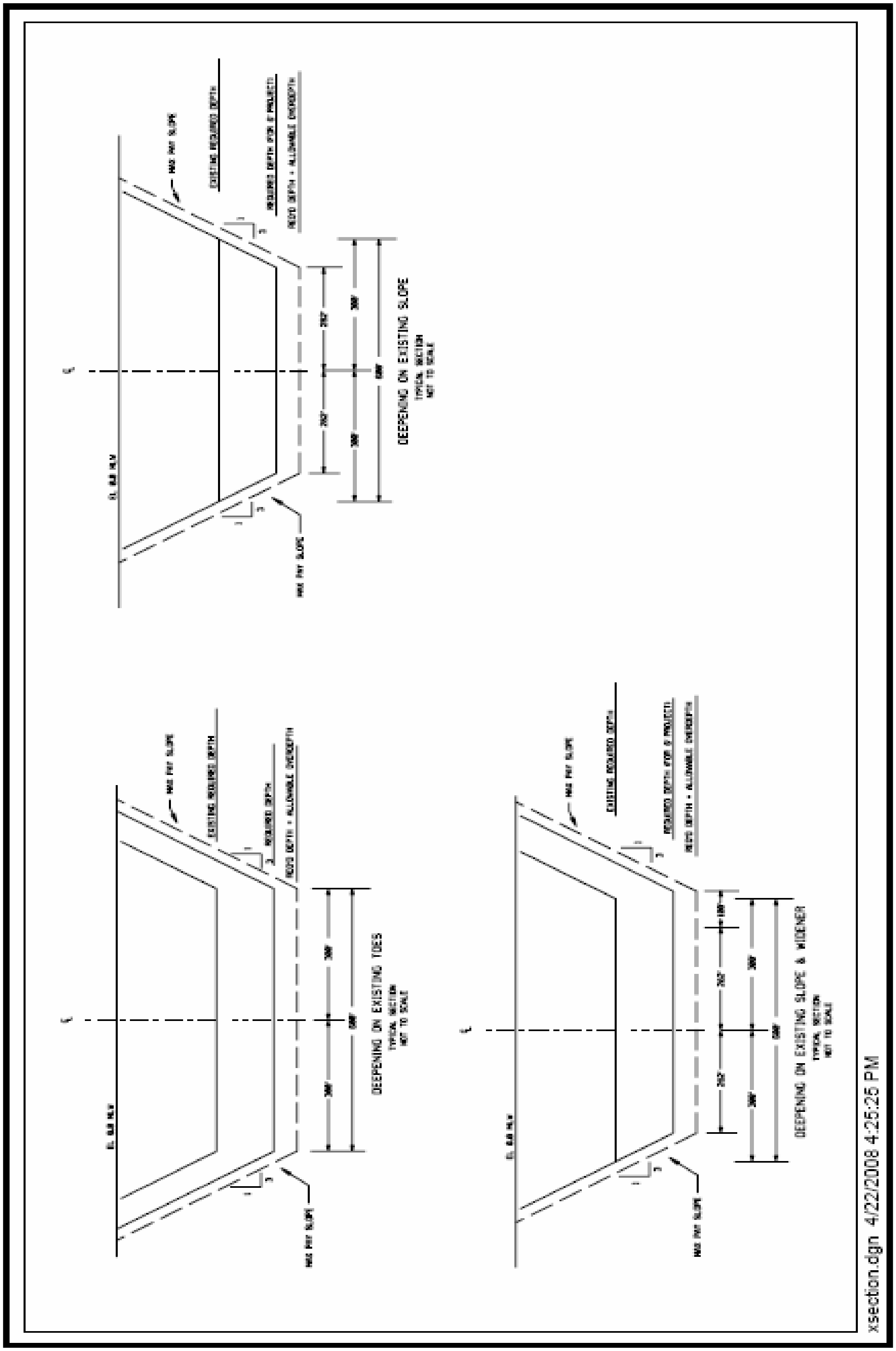


Figure 1. Conceptual channel designs.

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

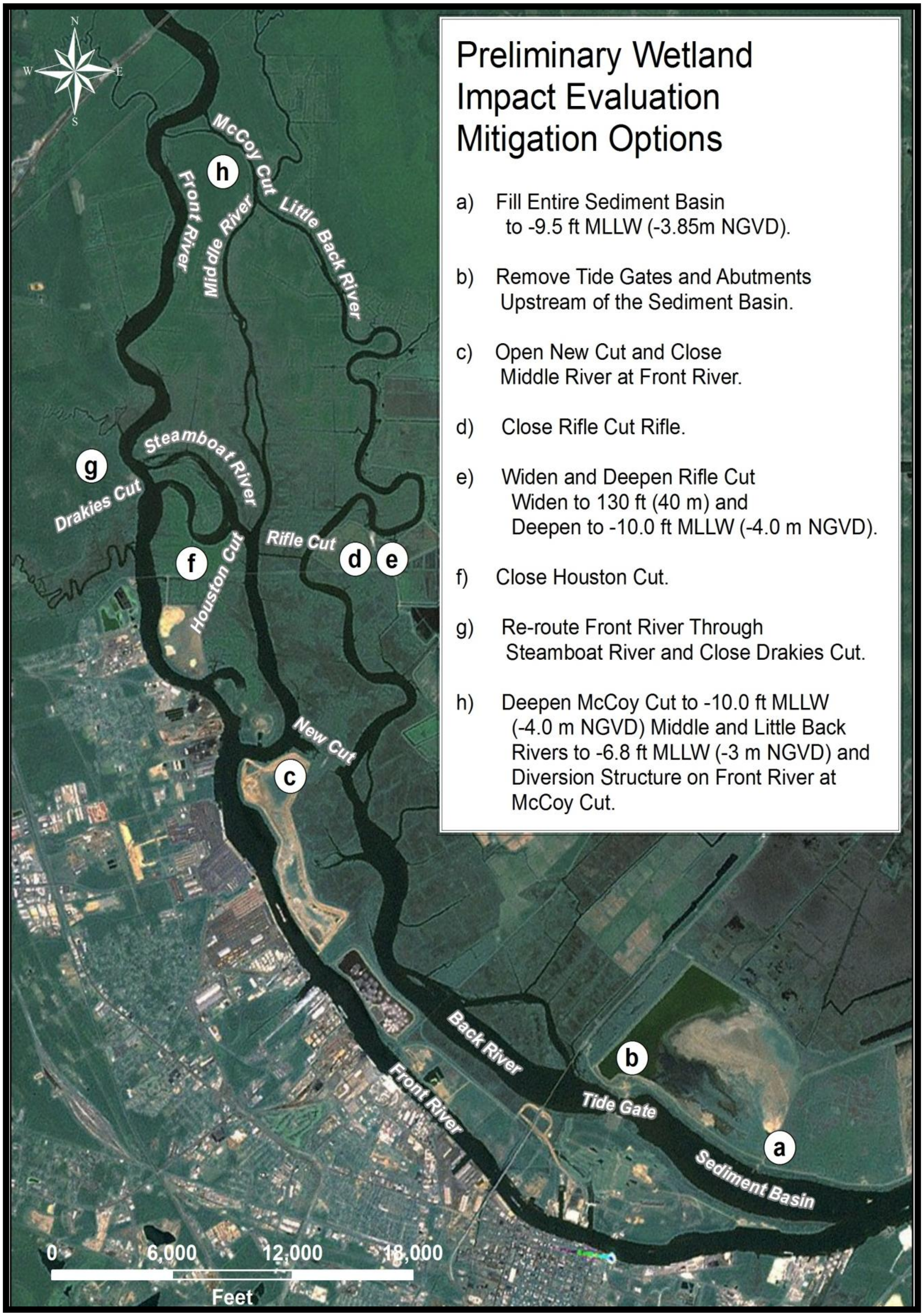


Figure 3. Potential flow-altering mitigation measures.

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.

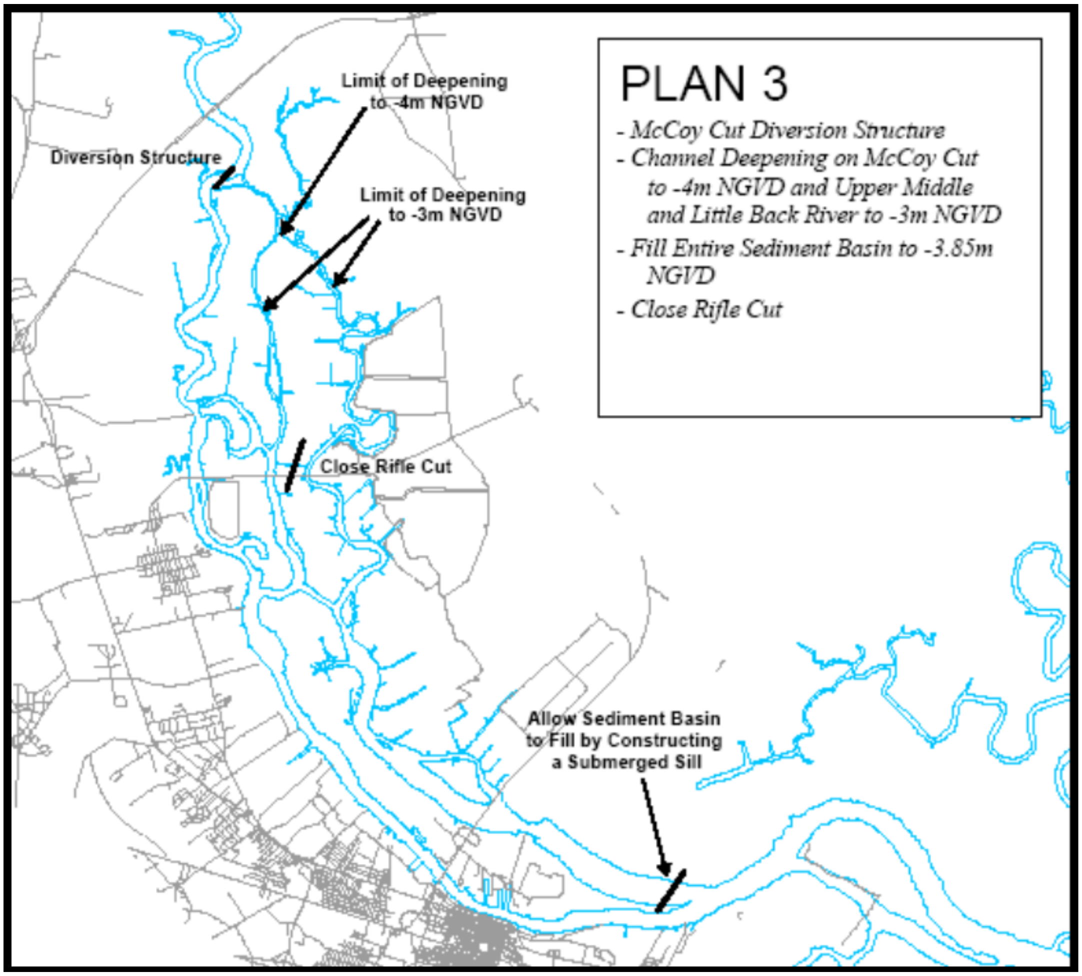


Figure 4. Plan 3

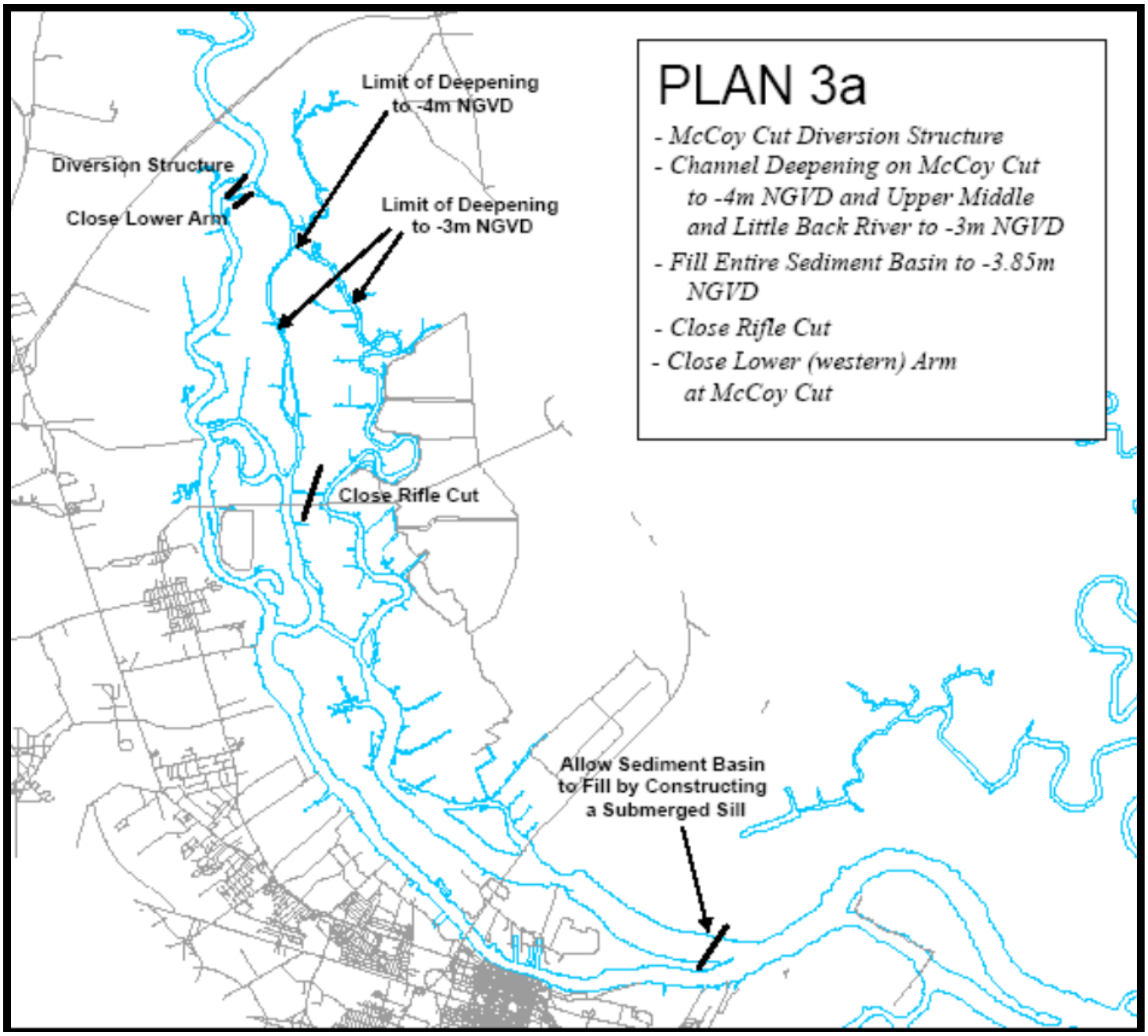


Figure 5. Plan 3a

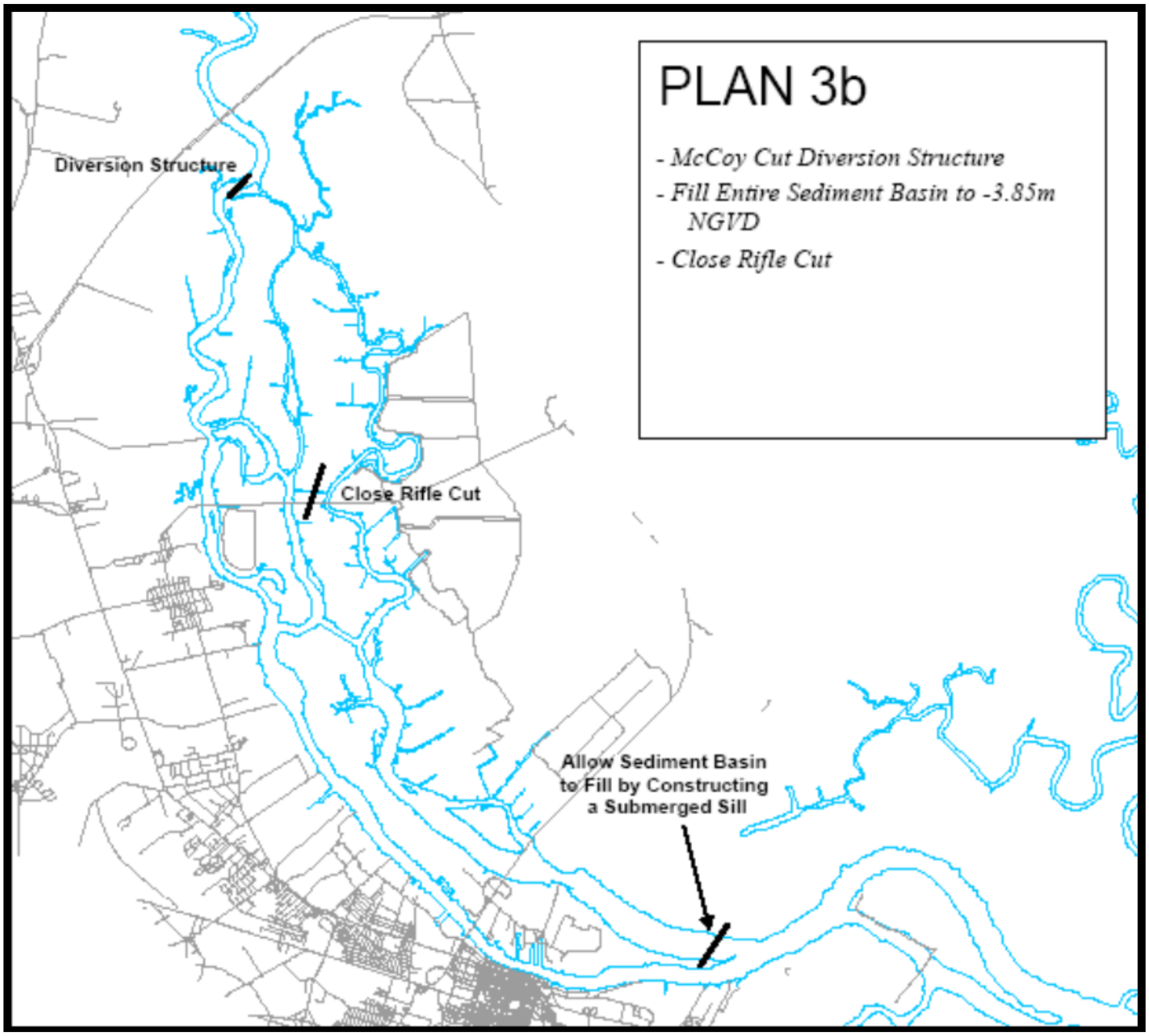


Figure 6. Plan 3b

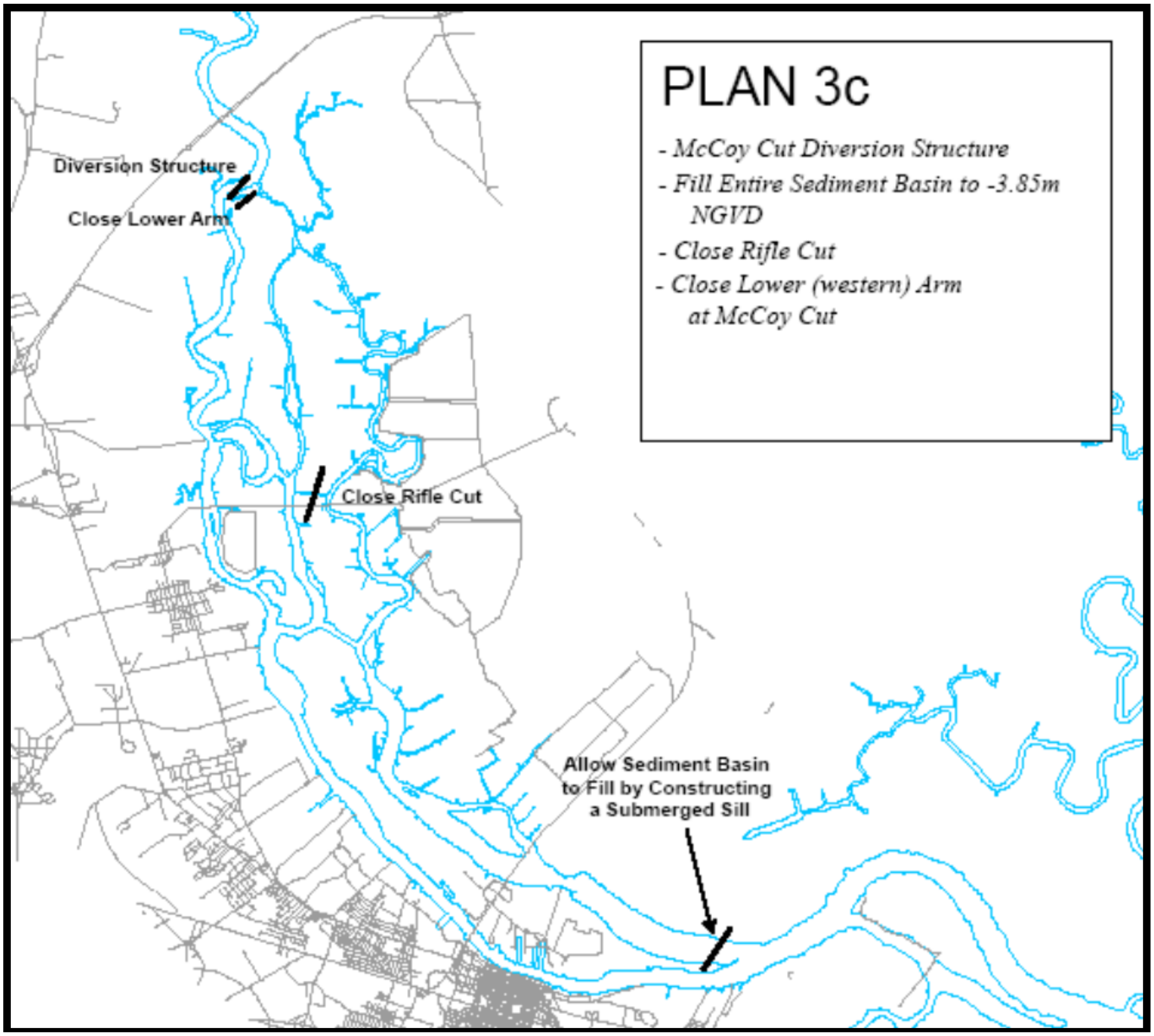


Figure 7. Plan 3c

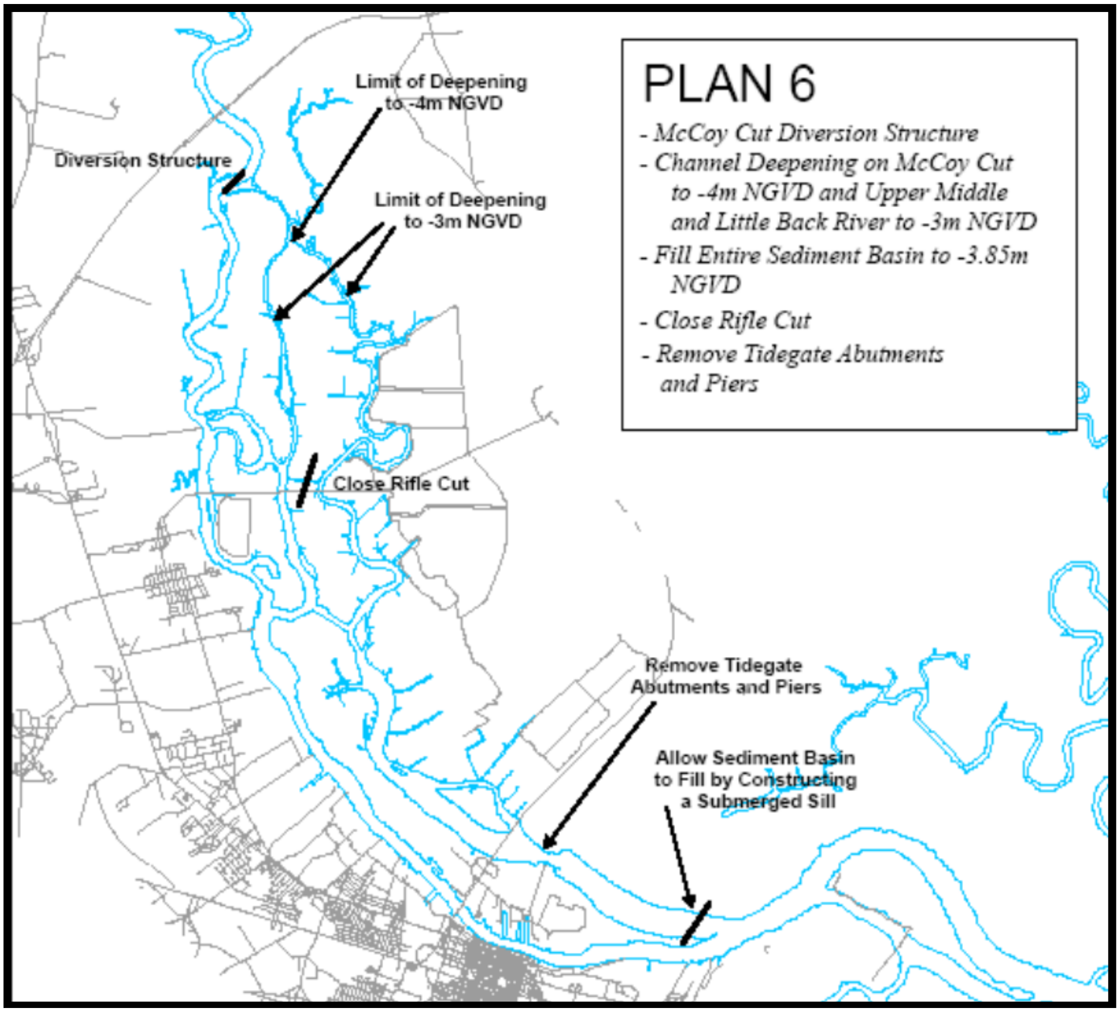


Figure 8. Plan 6

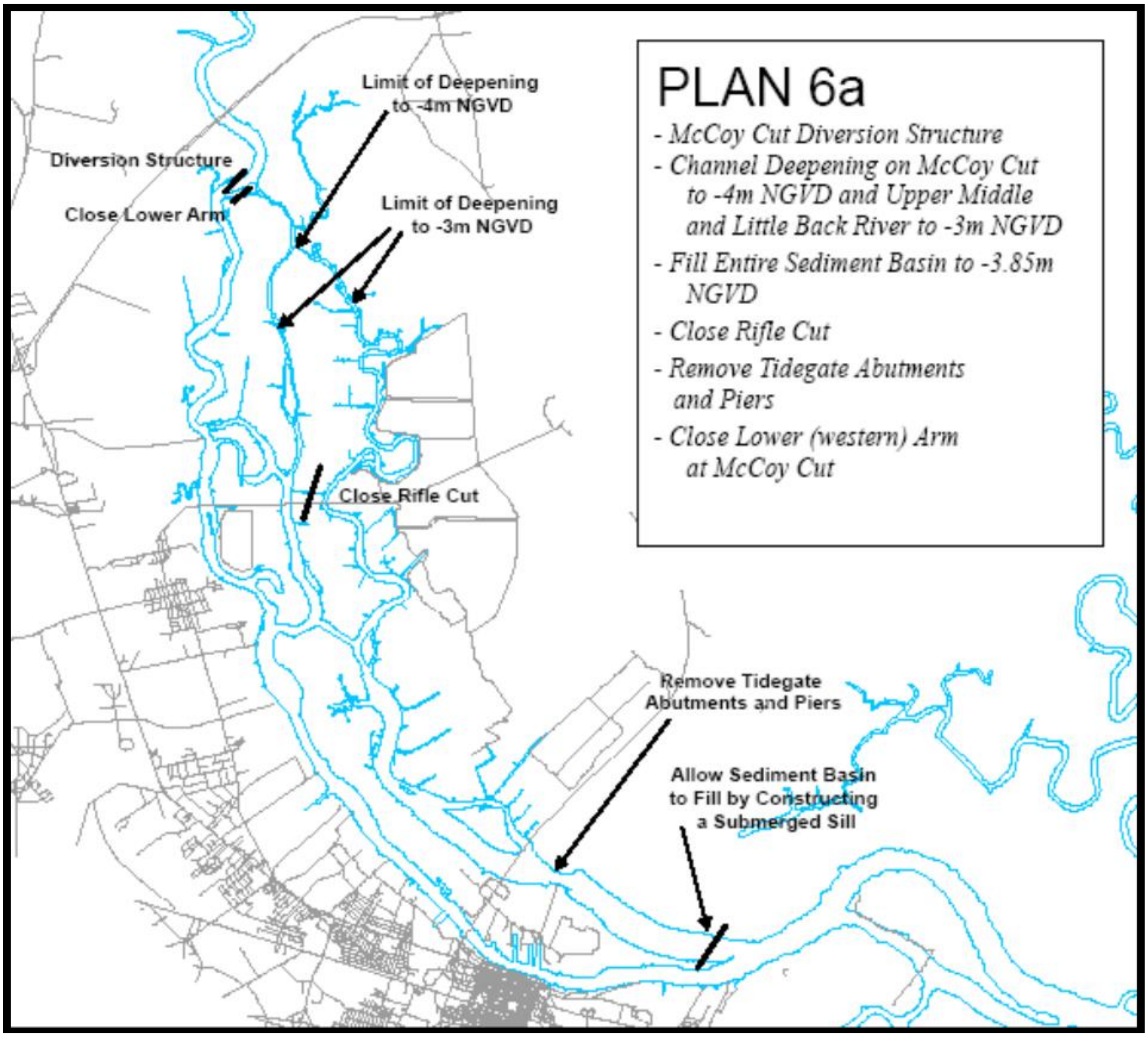


Figure 9. Plan 6a

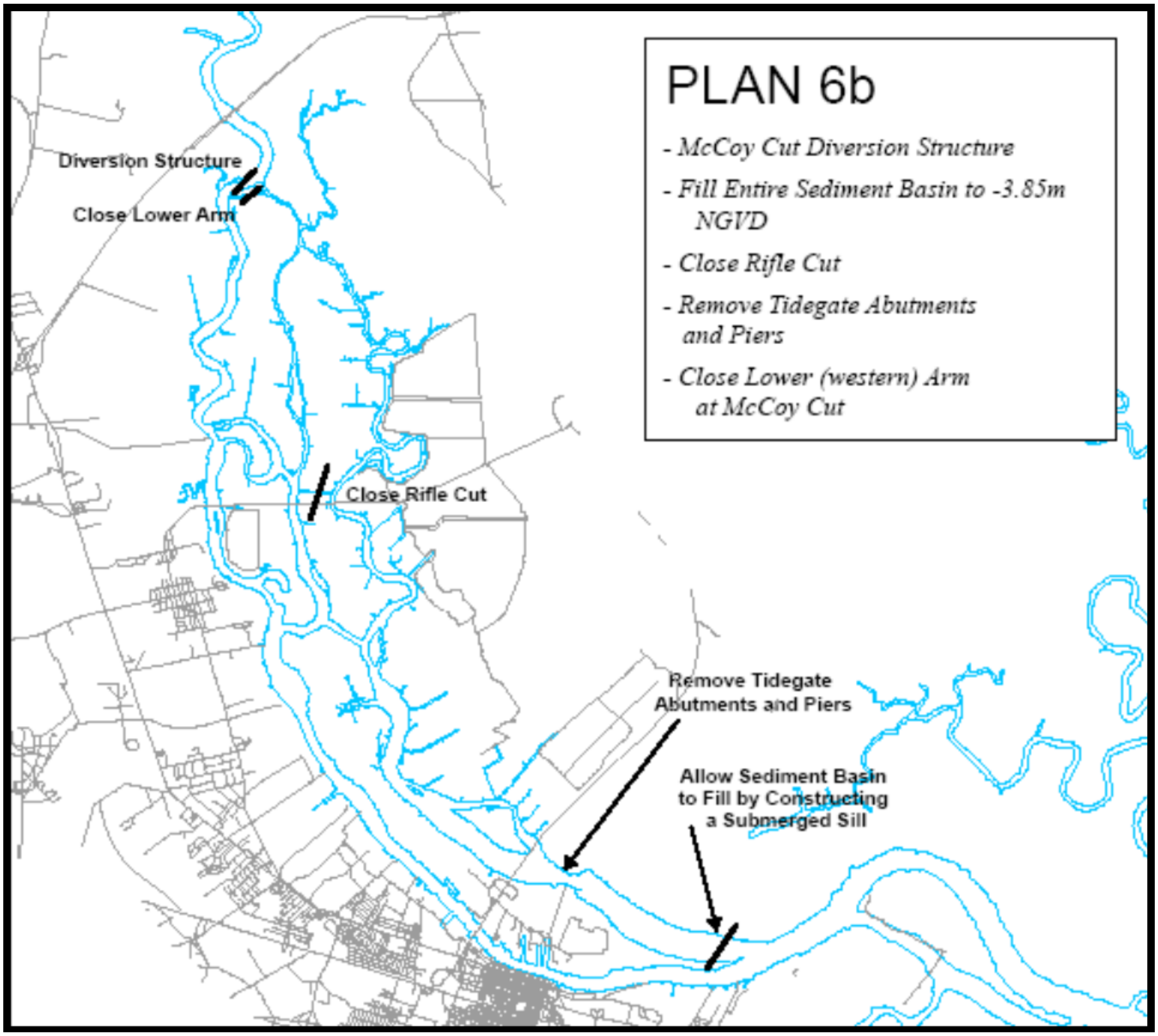


Figure 10. Plan 6b

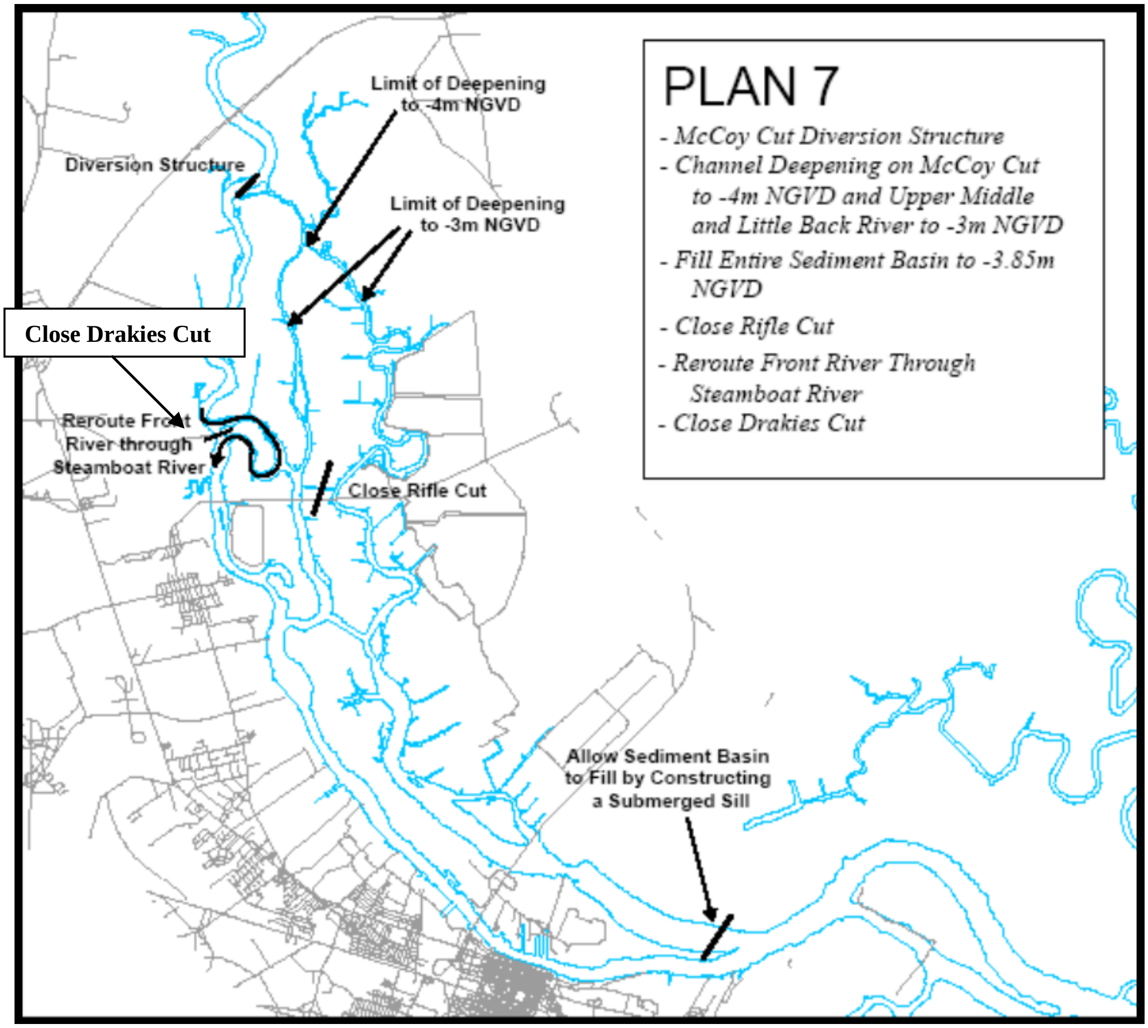


Figure 11. Plan 7

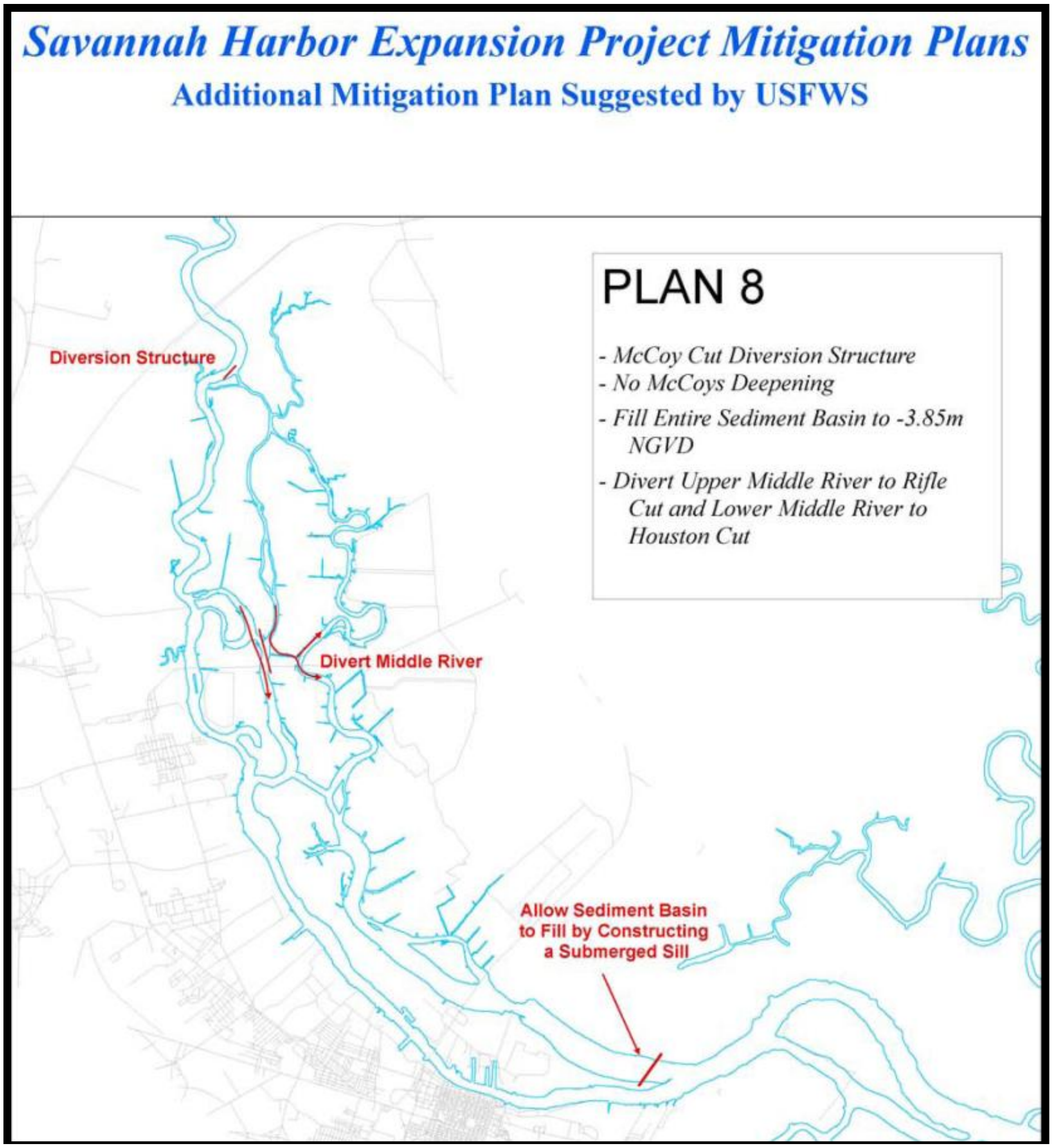


Figure 12. Plan 8

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).

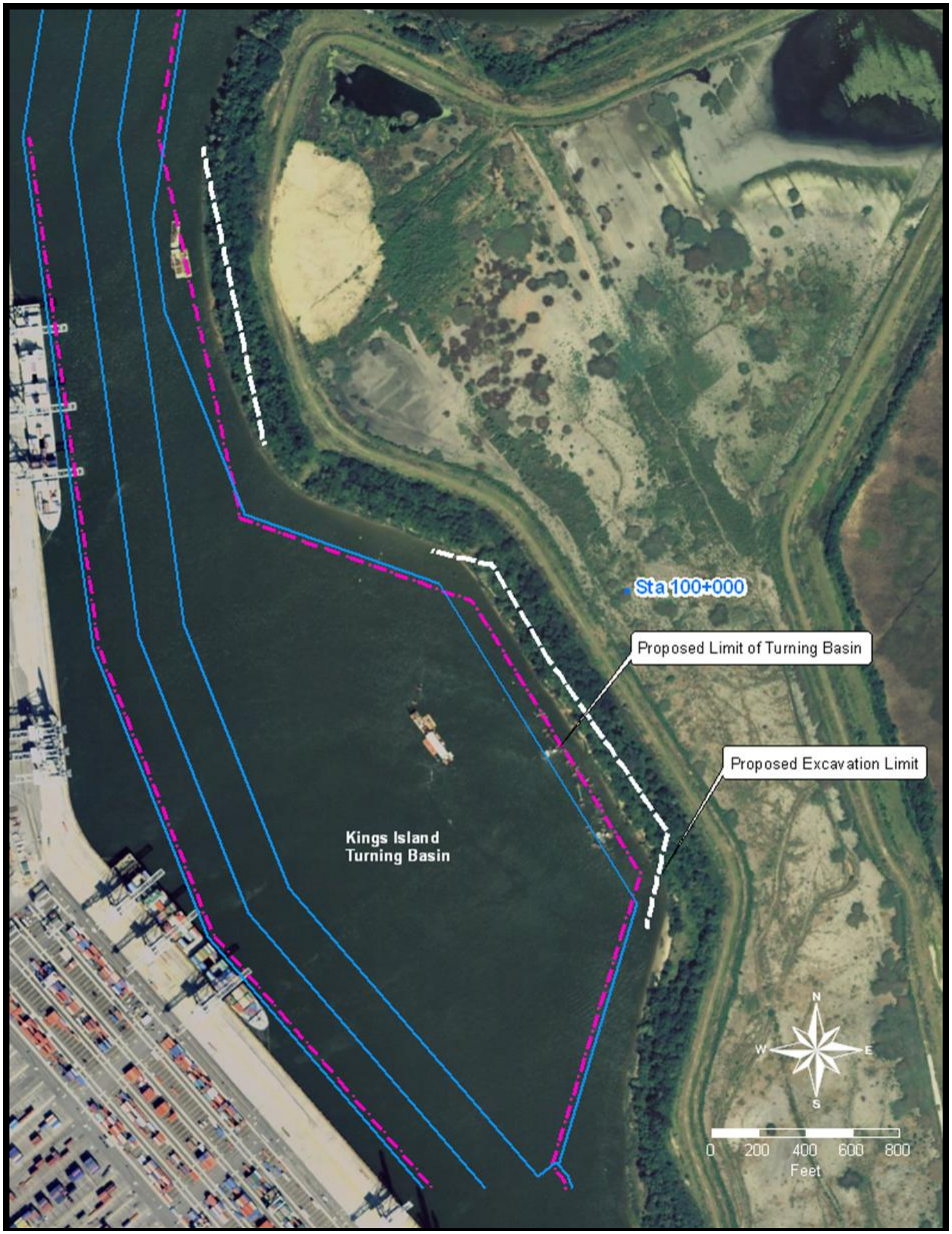


Figure 13. Excavation areas near Kings Island Turning Basin.

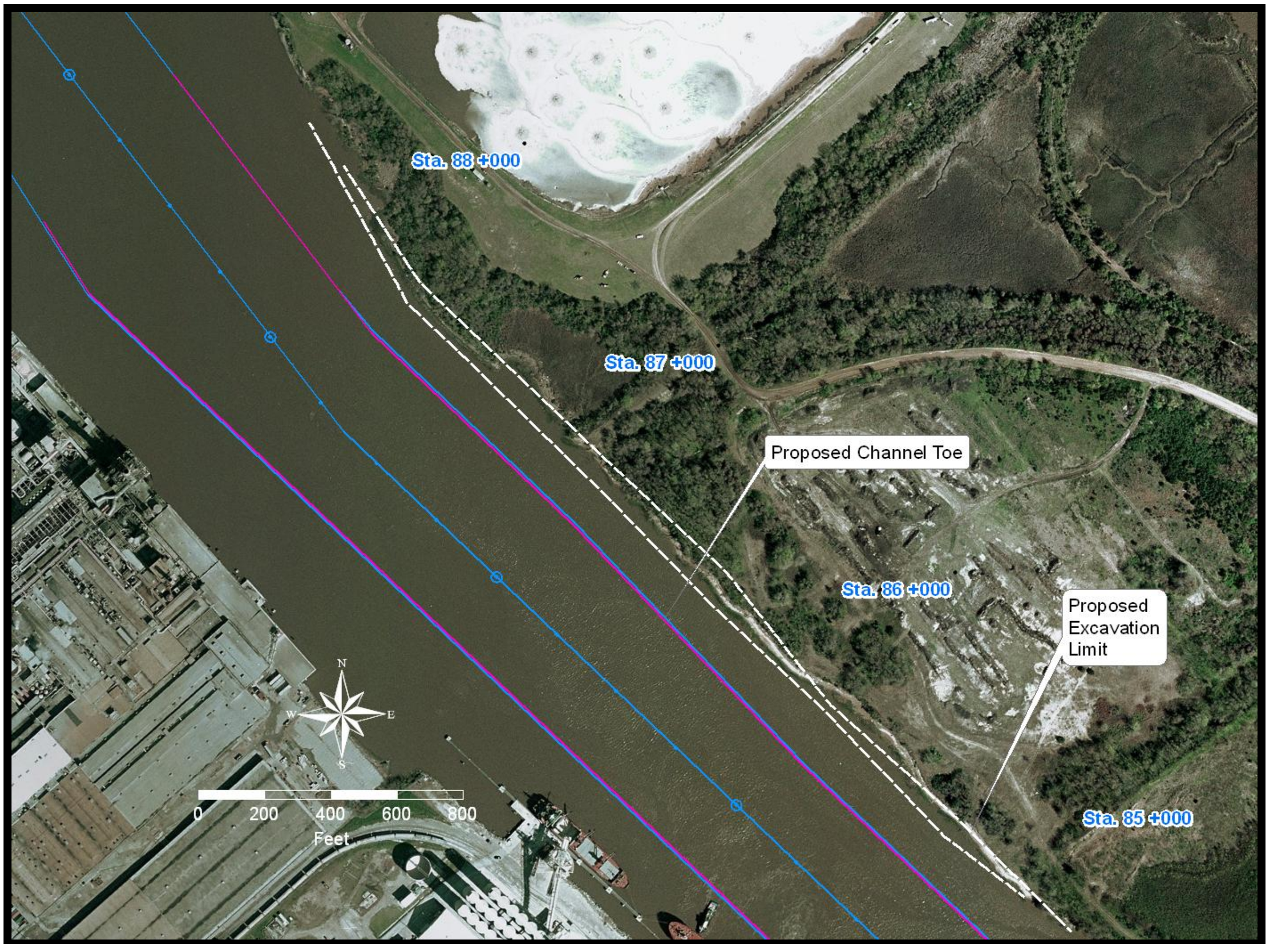


Figure 14. Excavation areas near Hutchinson Island.

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.

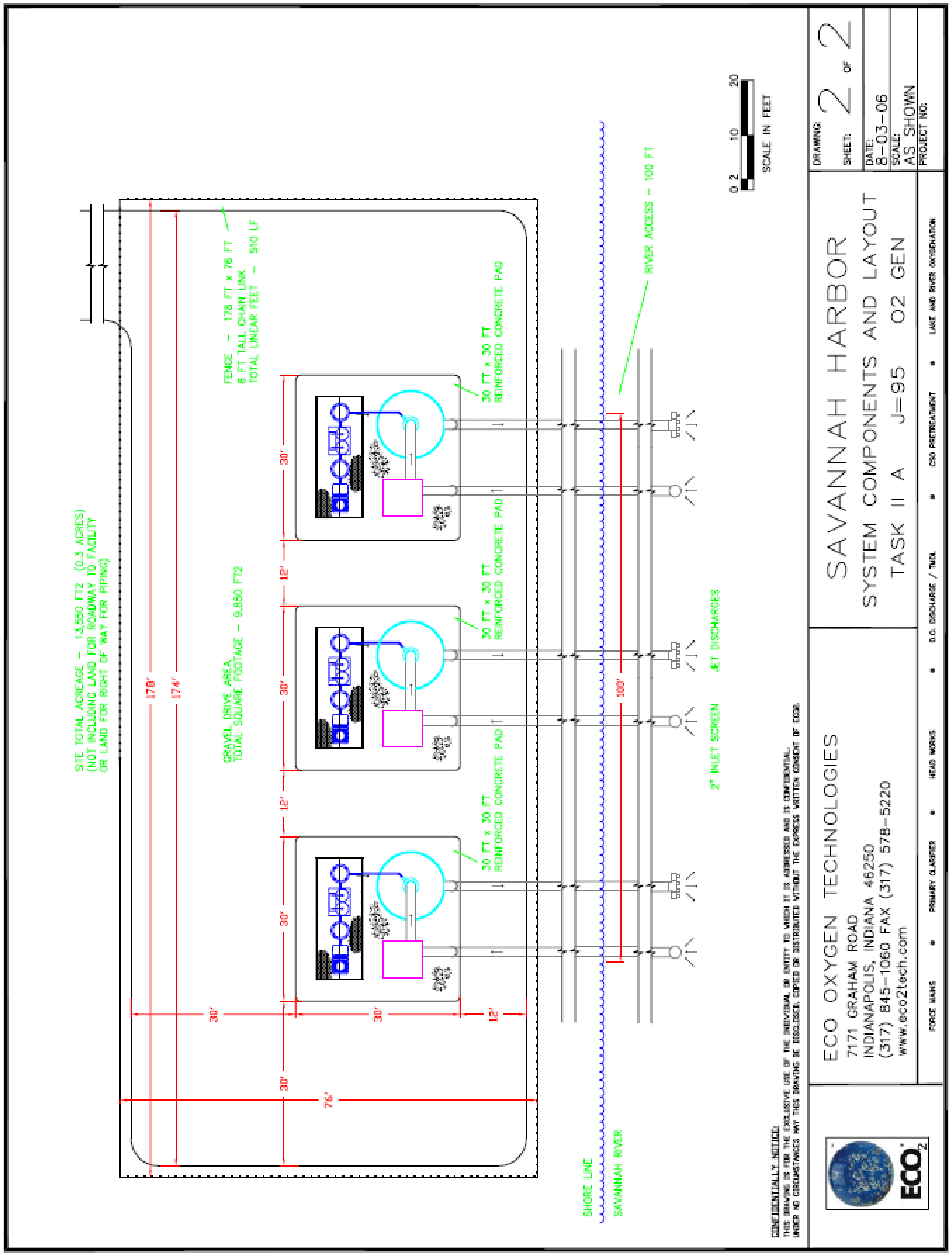


Figure 17. Typical site design for dissolved oxygen injection system.

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.

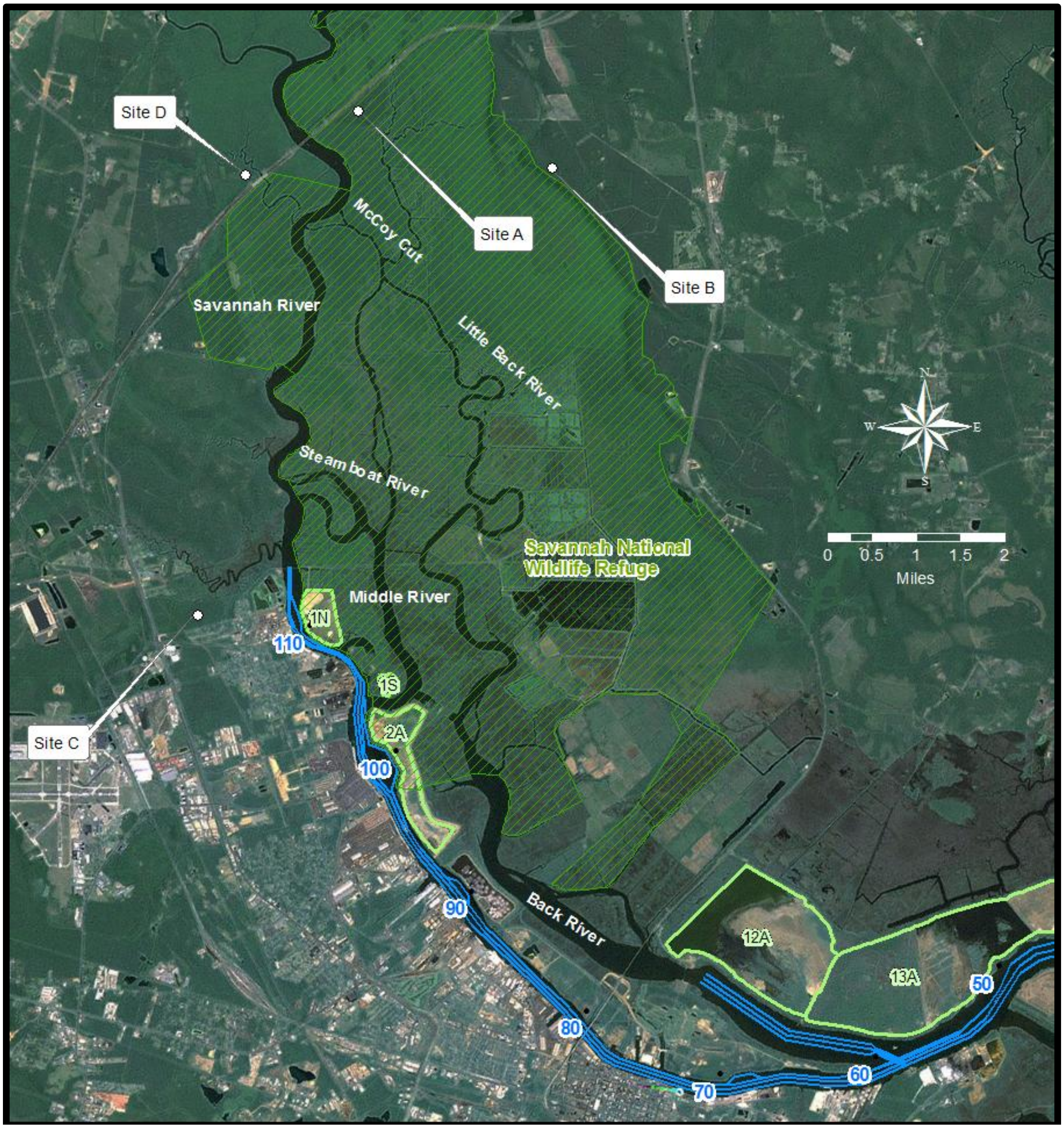


Figure 18. Potential wetland restoration and creation sites.

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 <u>Spartina alterniflora</u> (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 <u>Spartina alterniflora</u> 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).

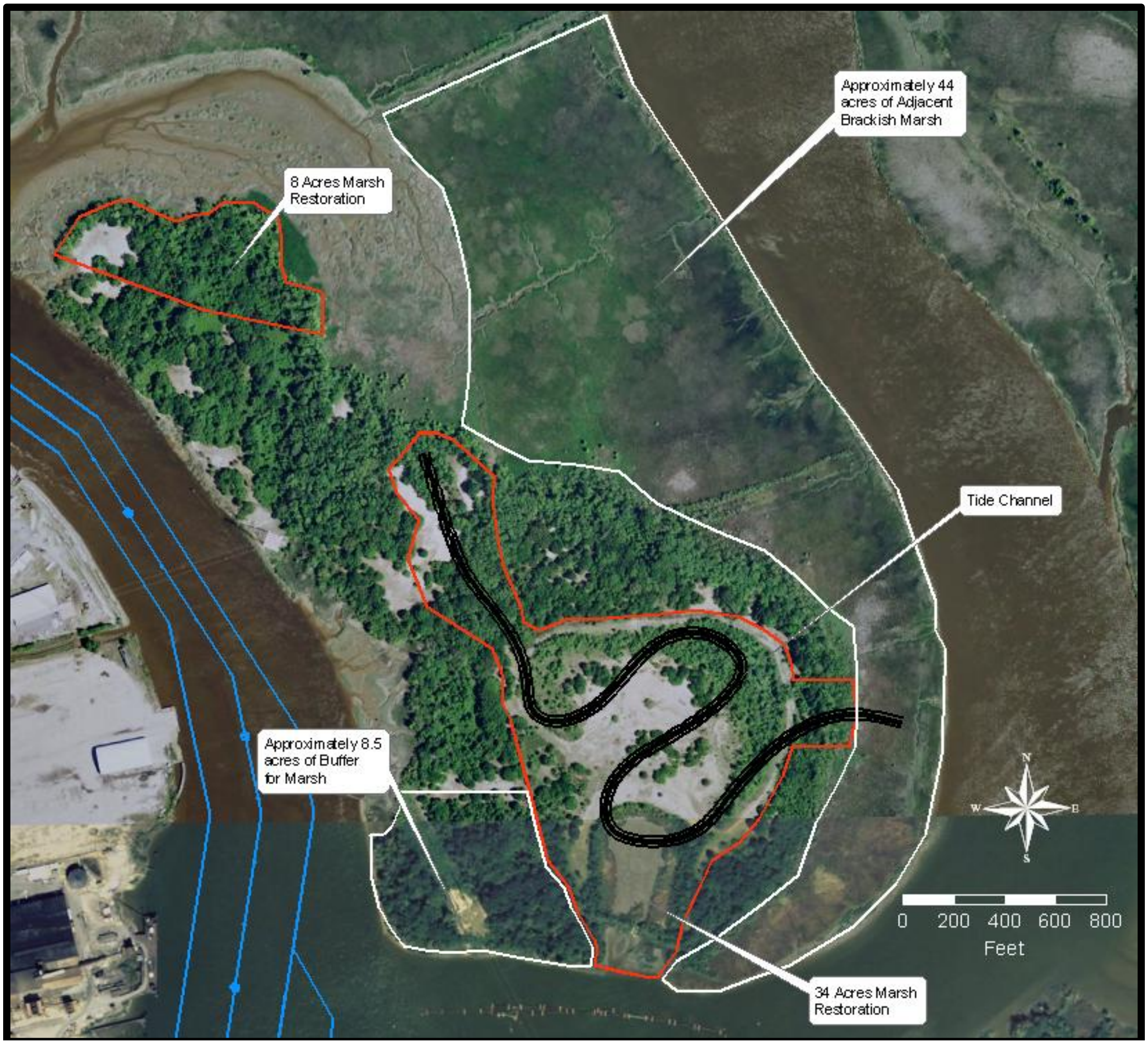


Figure 19. Proposed wetland restoration site at Disposal Area 1S.

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.

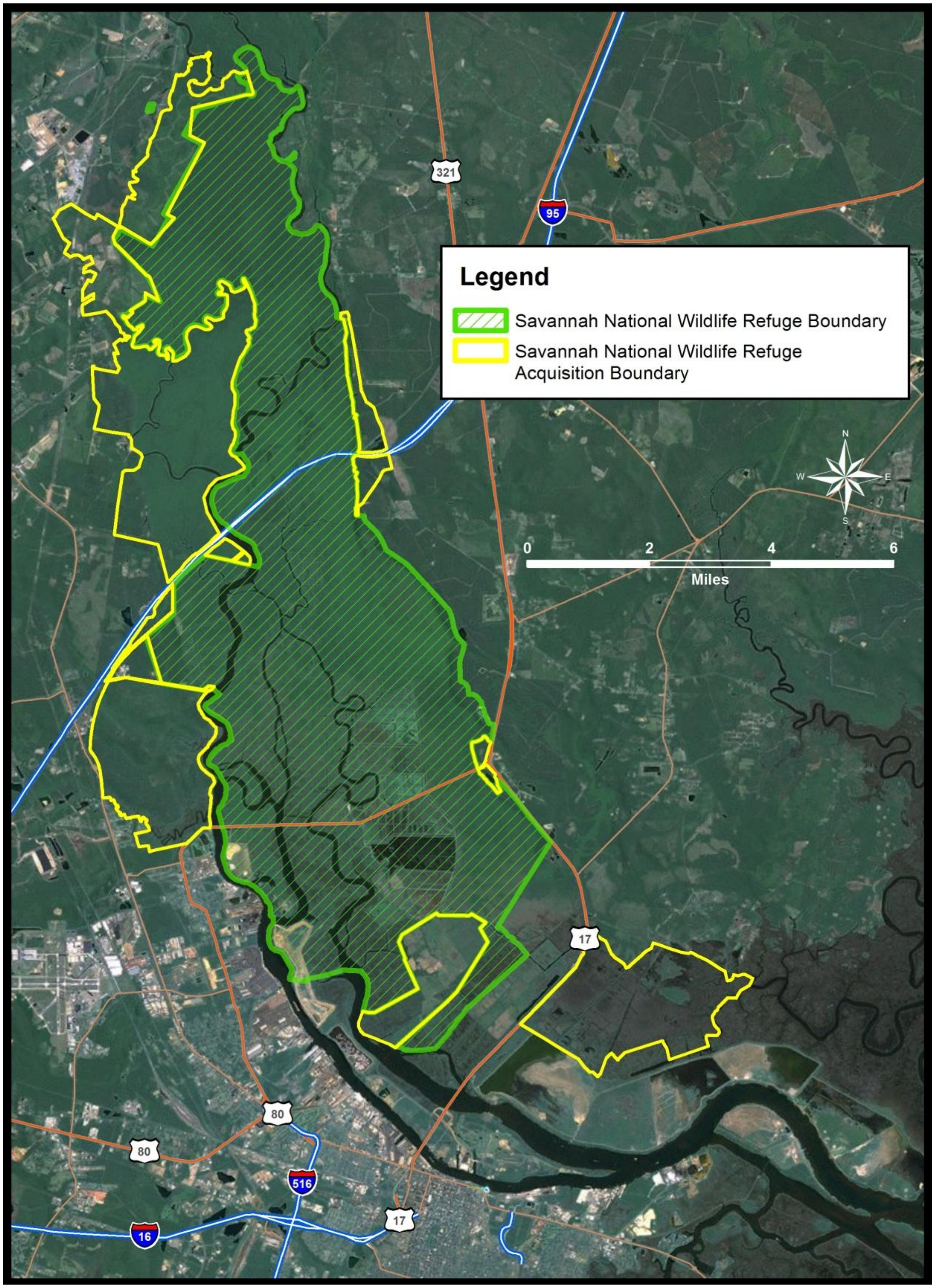


Figure 20. SNWR acquisition boundary.

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 Due 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.

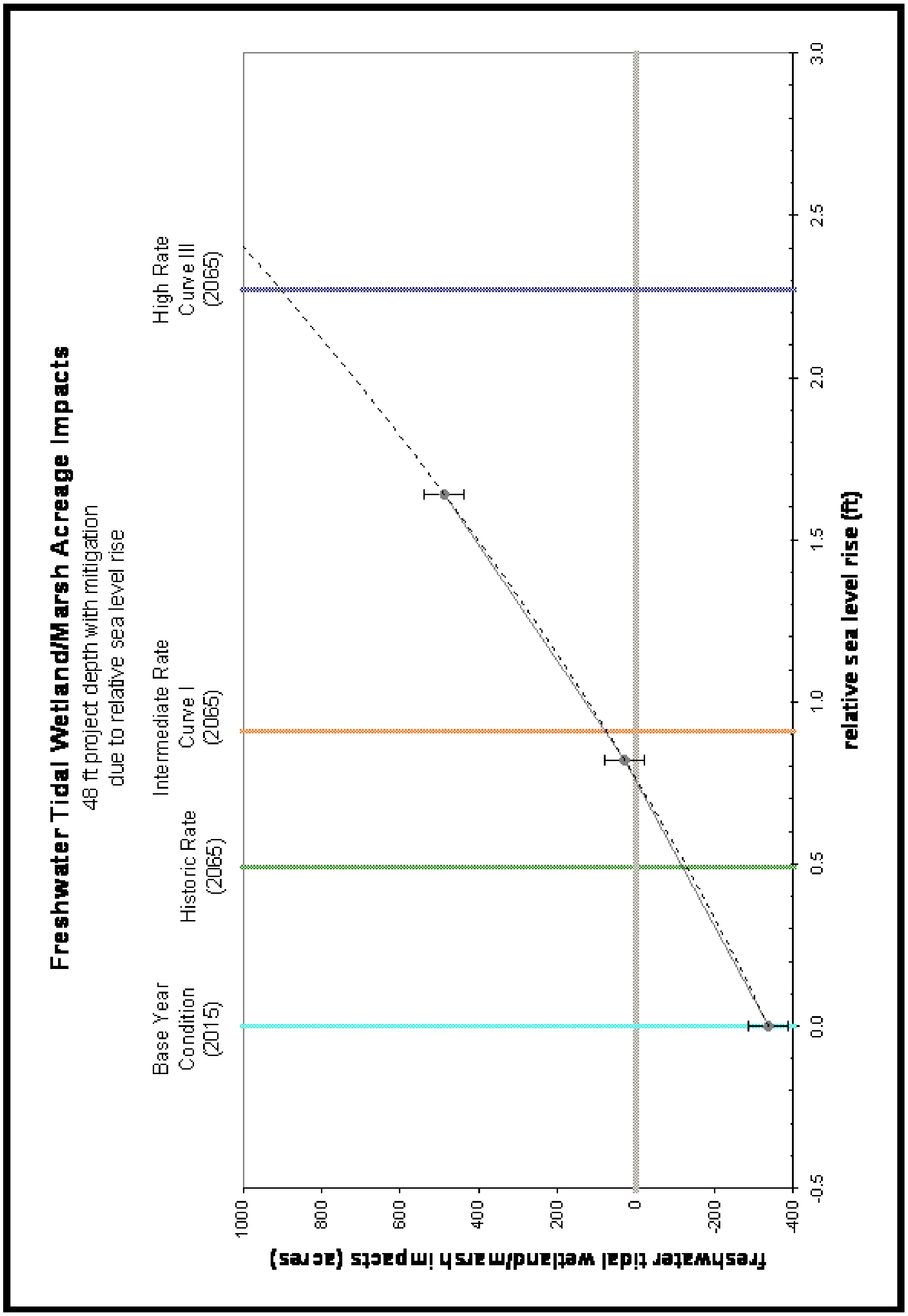


Figure 21. Freshwater tidal marsh impacts for the 48 foot channel.

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.

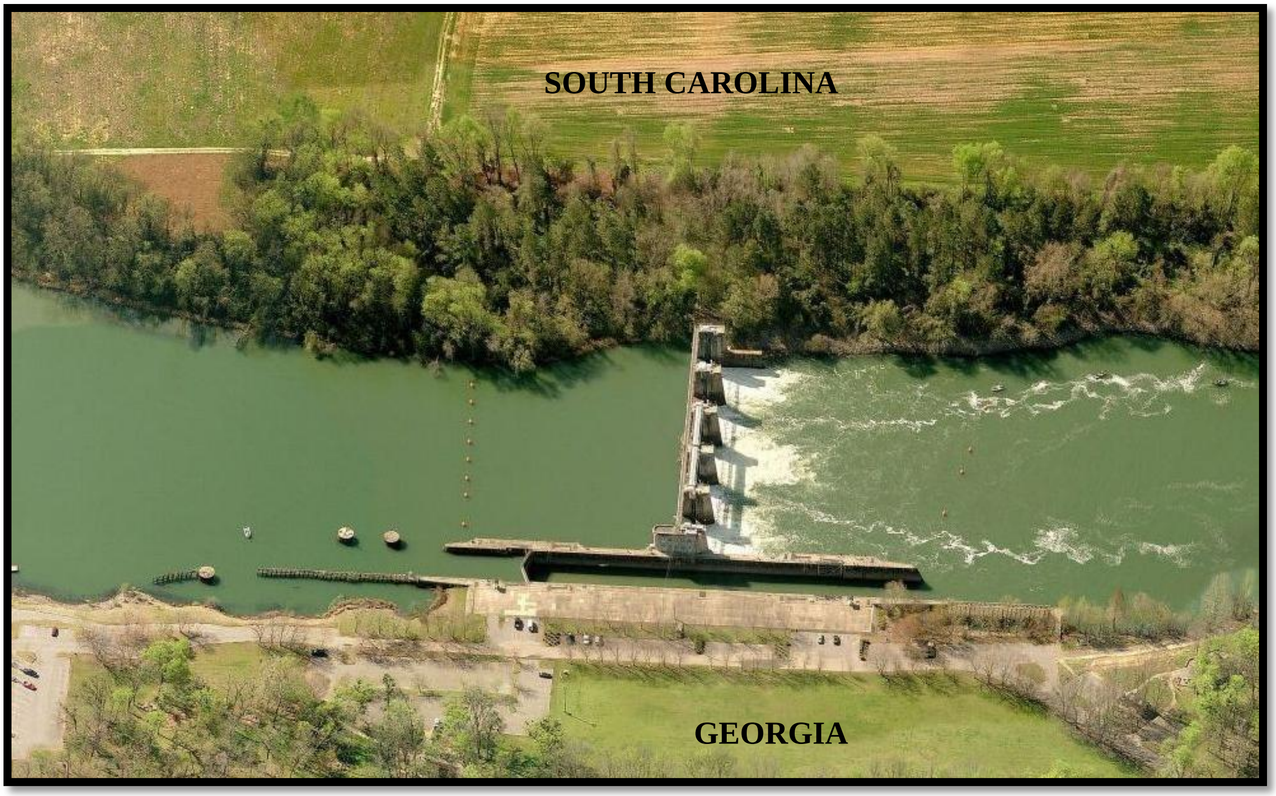


Figure 22. Aerial view of New Savannah Bluff Lock and Dam.

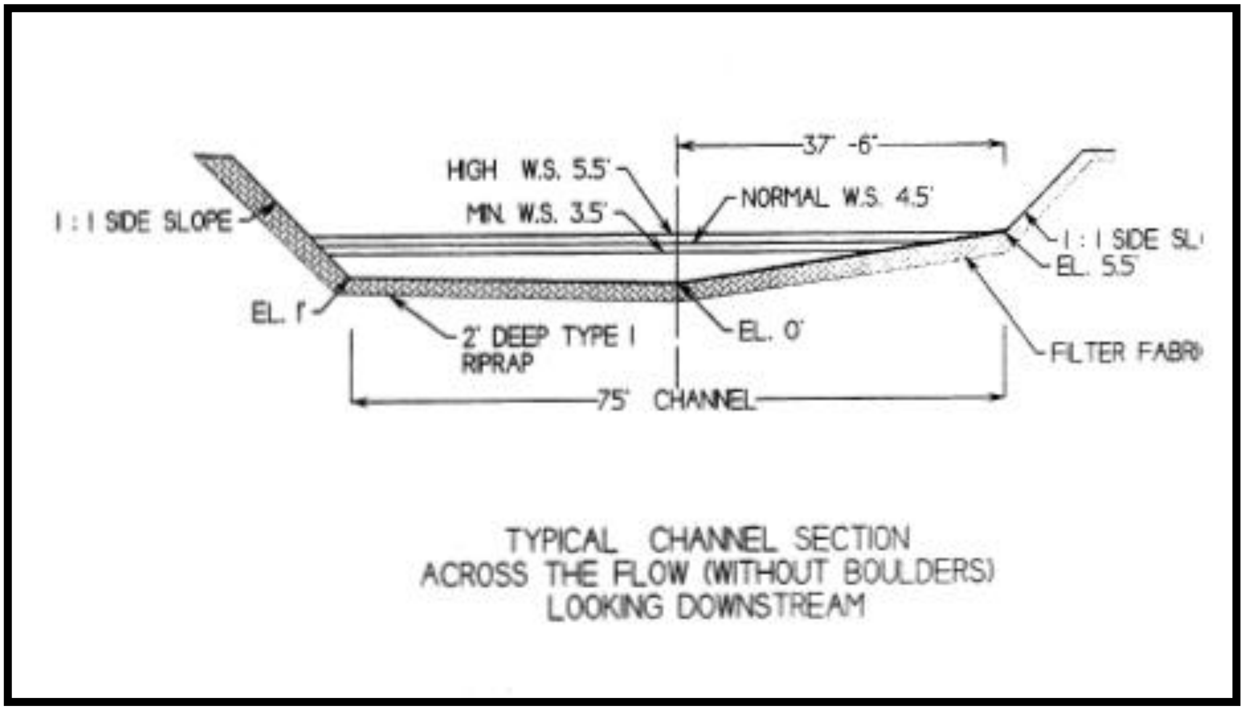


Figure 23. Typical cross-section of rock weir.

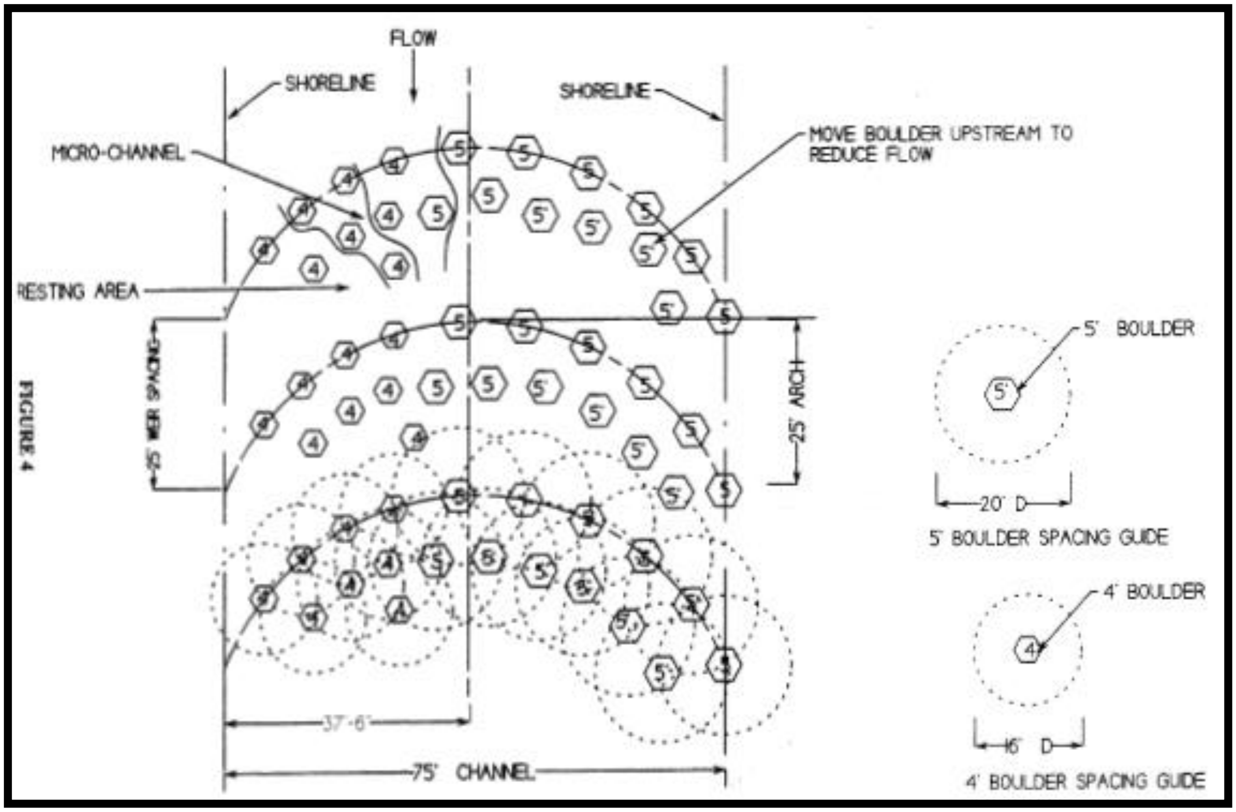


Figure 24. Plan view of boulder layout for rock weirs.

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 **<u>Full River Rock Ramp</u>** (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.

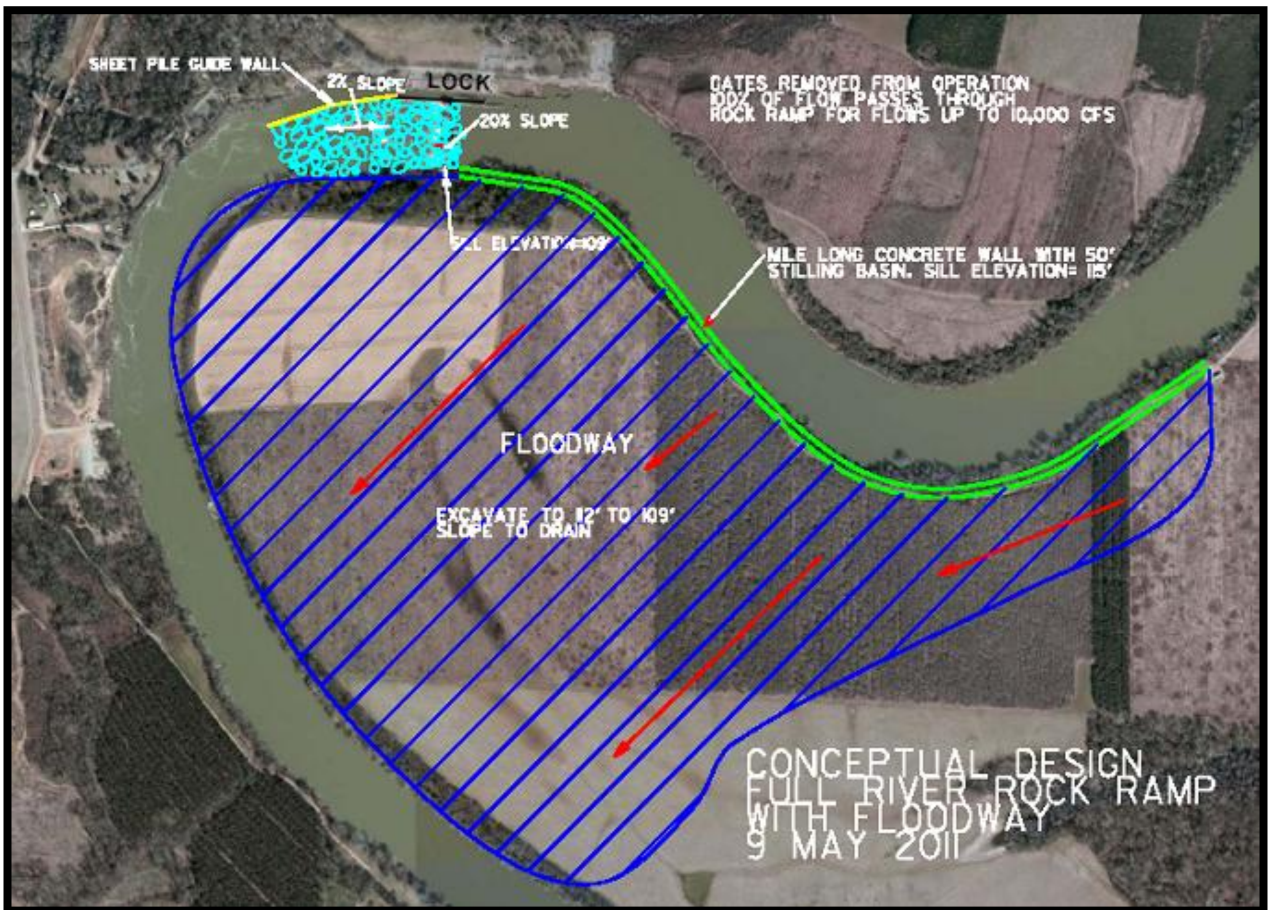


Figure 25. Conceptual design for full river rock ramp.

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.

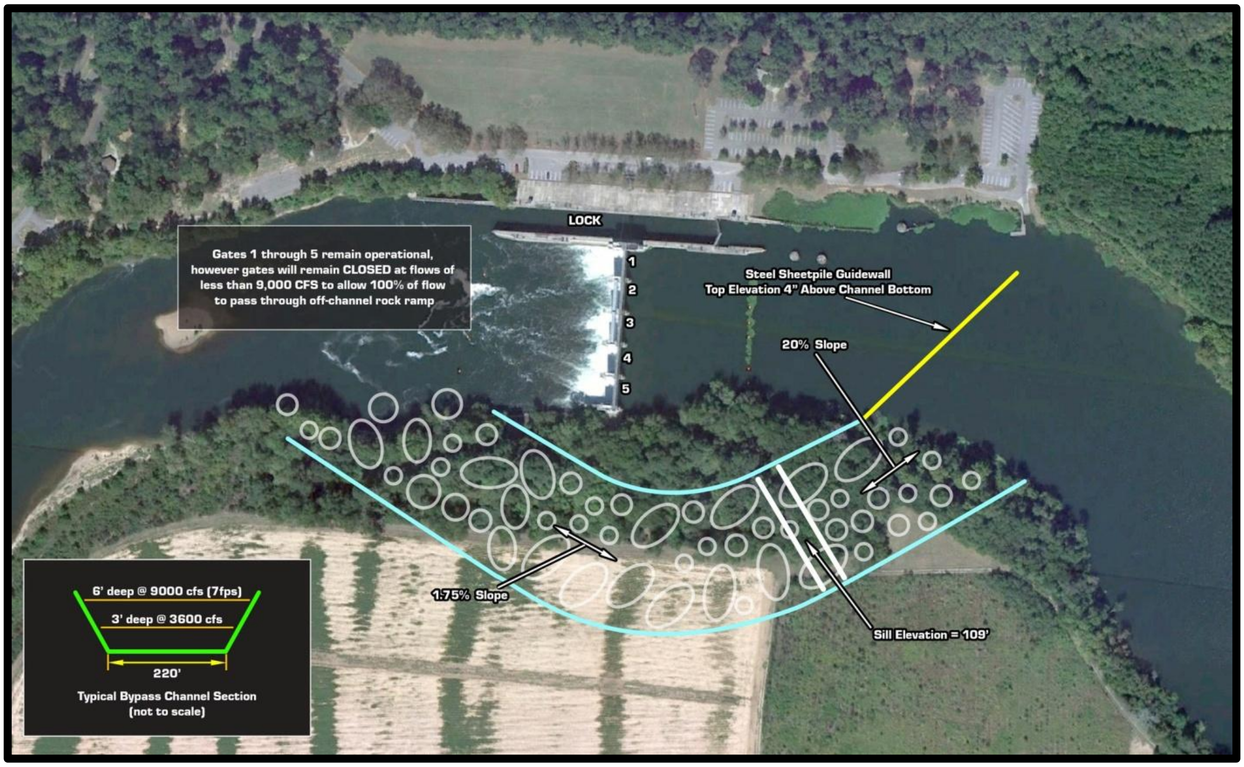


Figure 26. Conceptual design for off-channel rock ramp.

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.

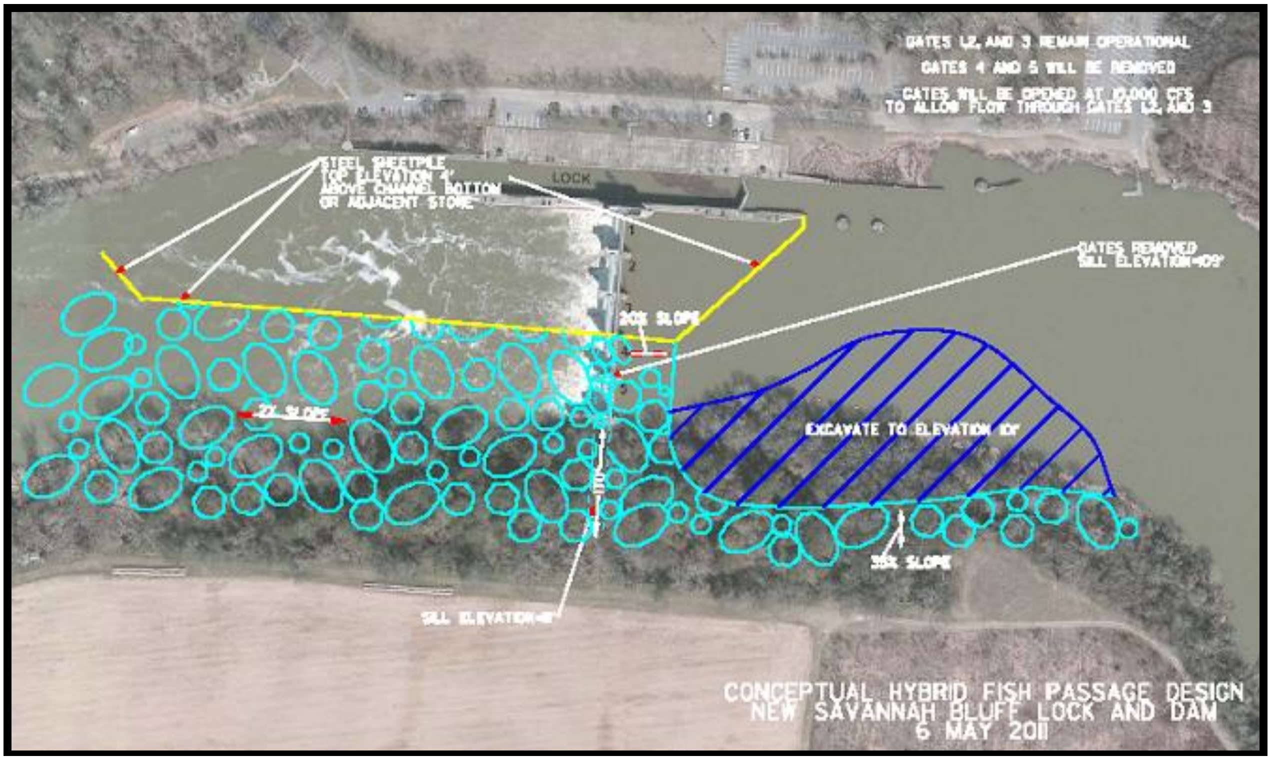


Figure 27. Conceptual design for hybrid rock ramp.

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 <u>(Hybrid Rock Ramp)</u> 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)

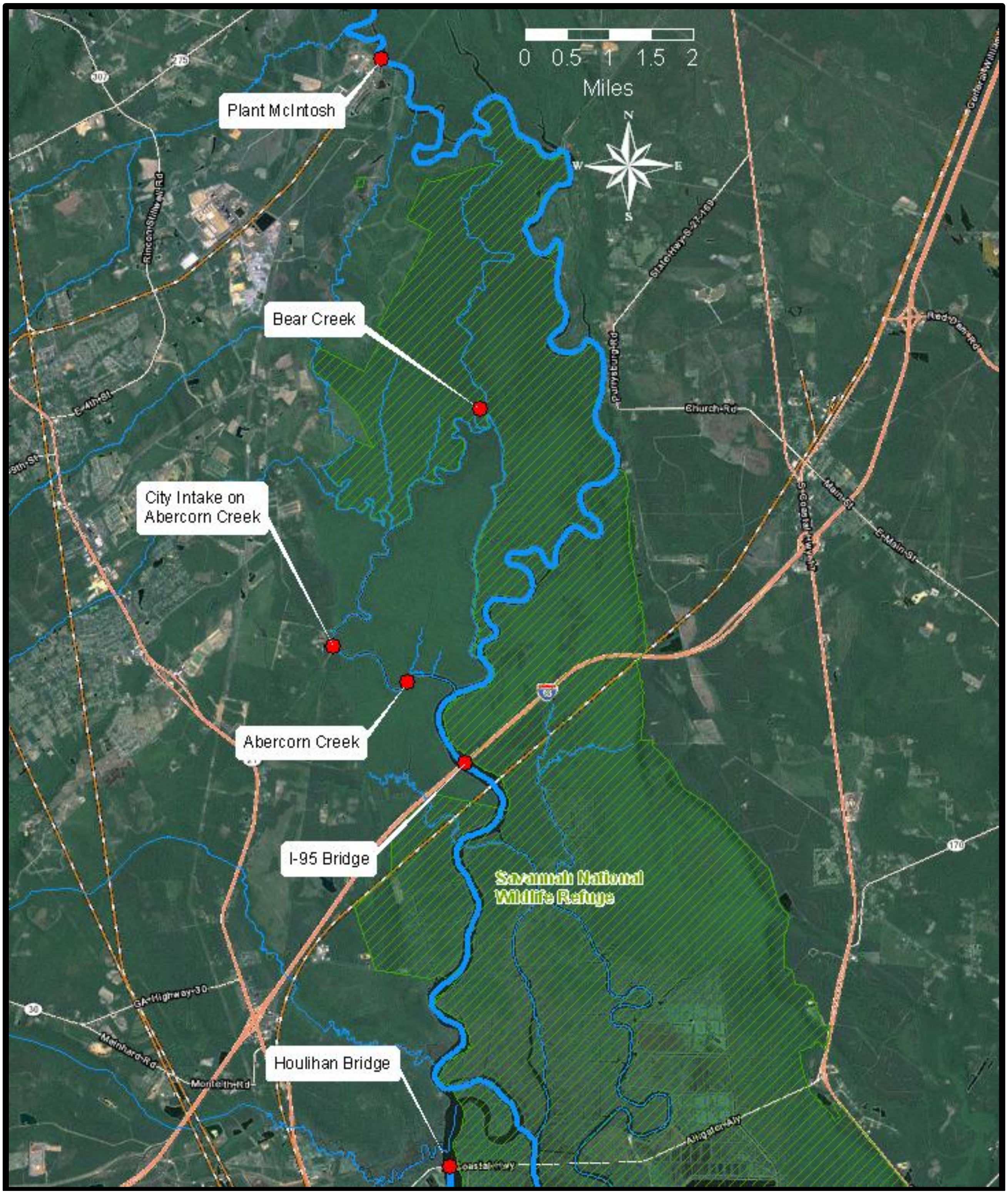


Figure 29. Chloride data collection 2009-2010.

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.

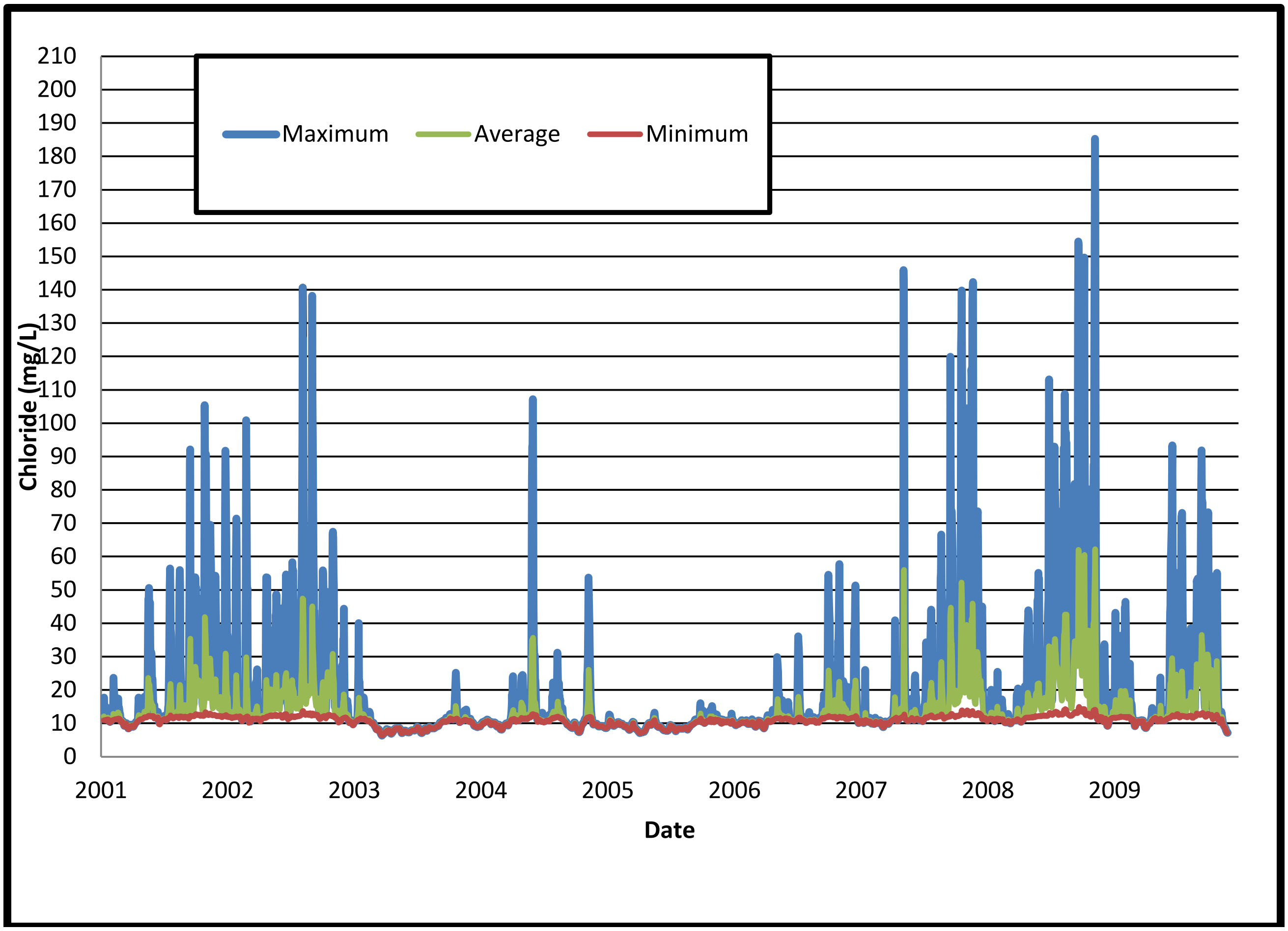


Figure 30. Hourly output from EFDC model, 47 ft. NED Plan with mitigation.

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)

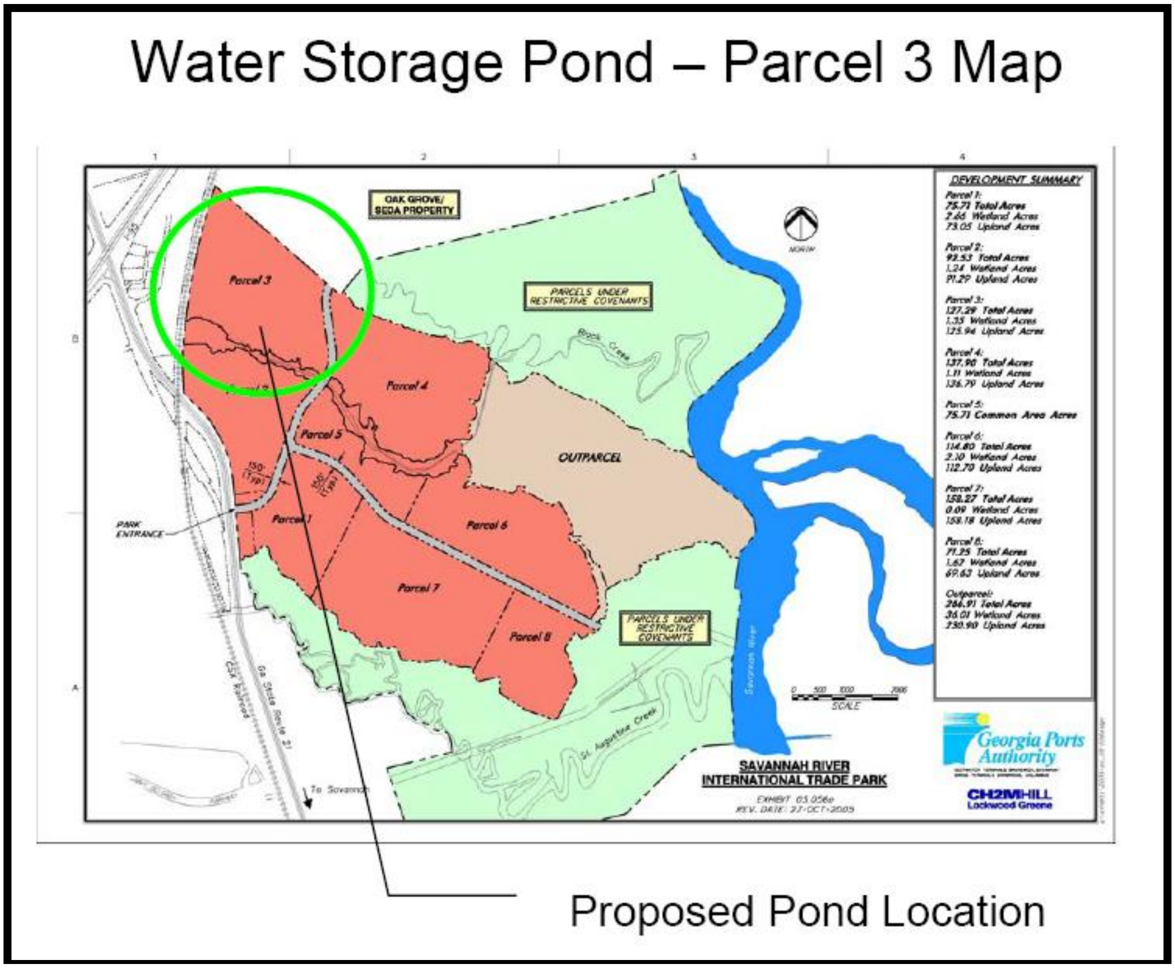


Figure 33. Water storage pond – parcel 3 map

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.

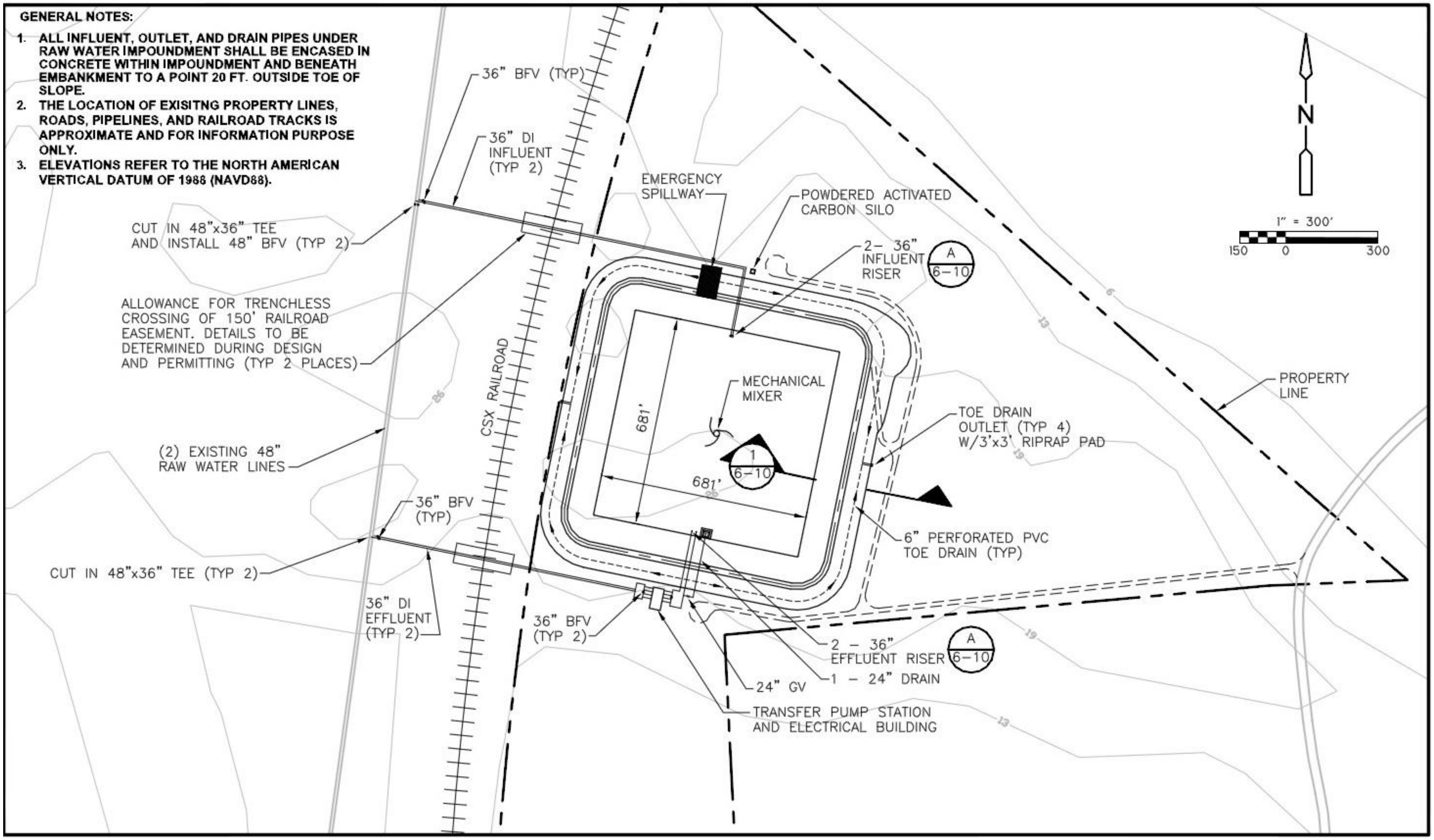


Figure 35. Raw water impoundment conceptual site layout

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.

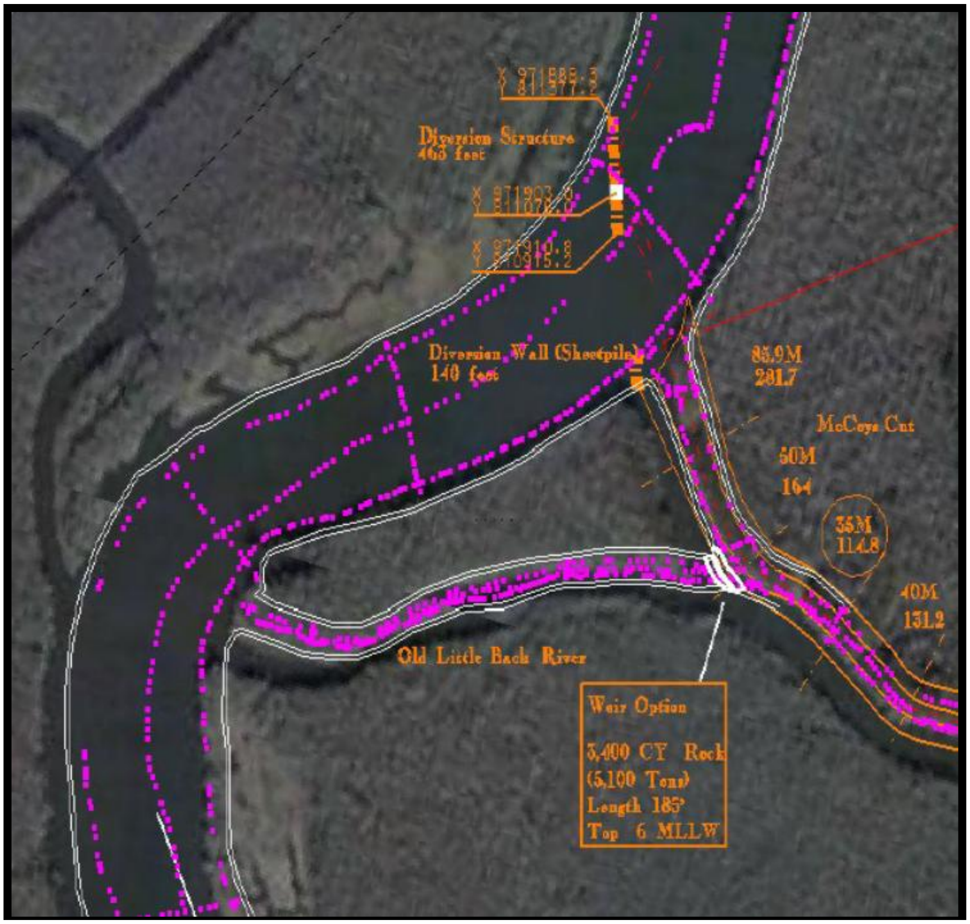


Figure 36. McCoys Cut diversion structures and weir

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

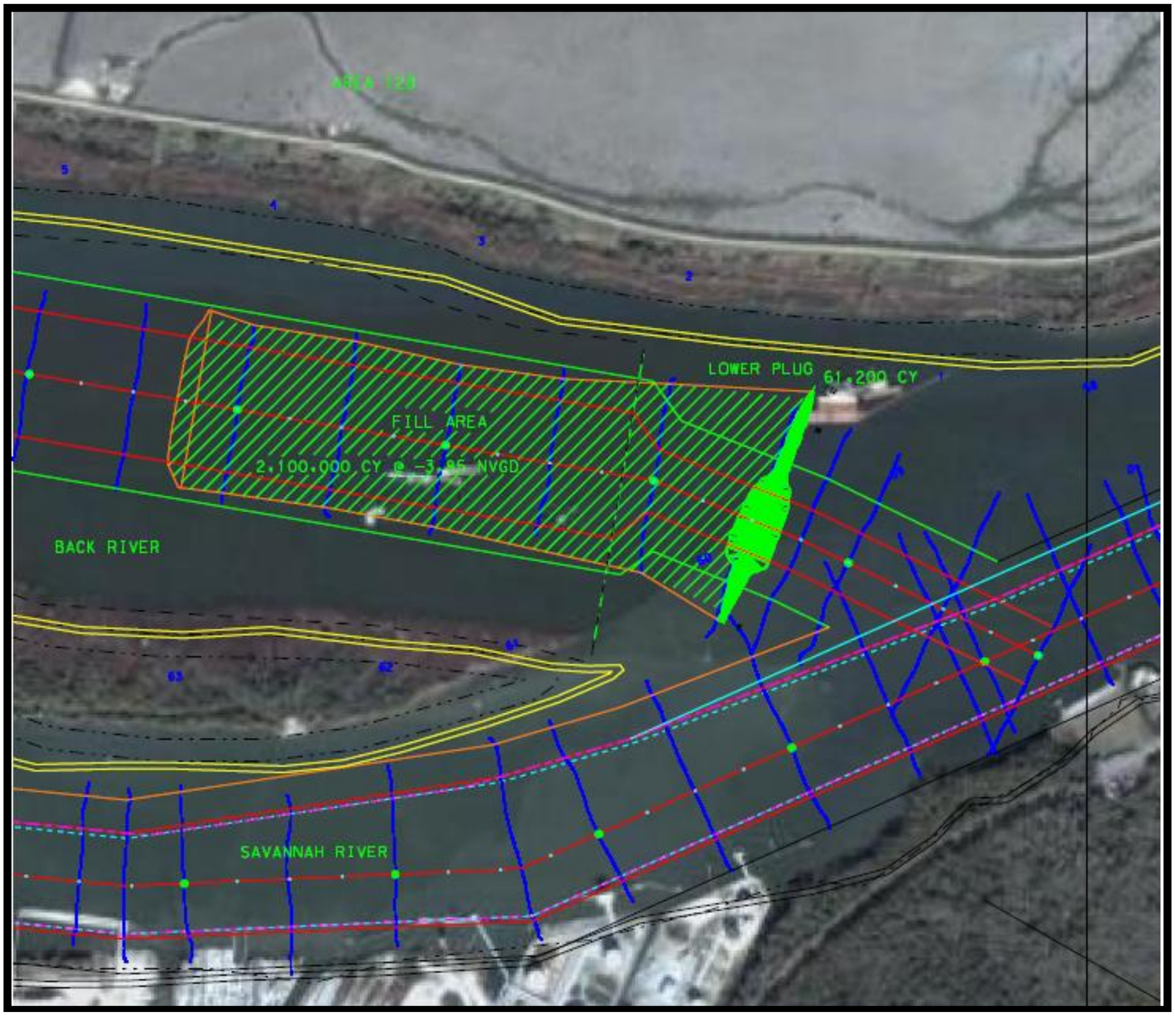


Figure 40. Construct submerged weir across Back River to elevation -3.85 meters MLLW.

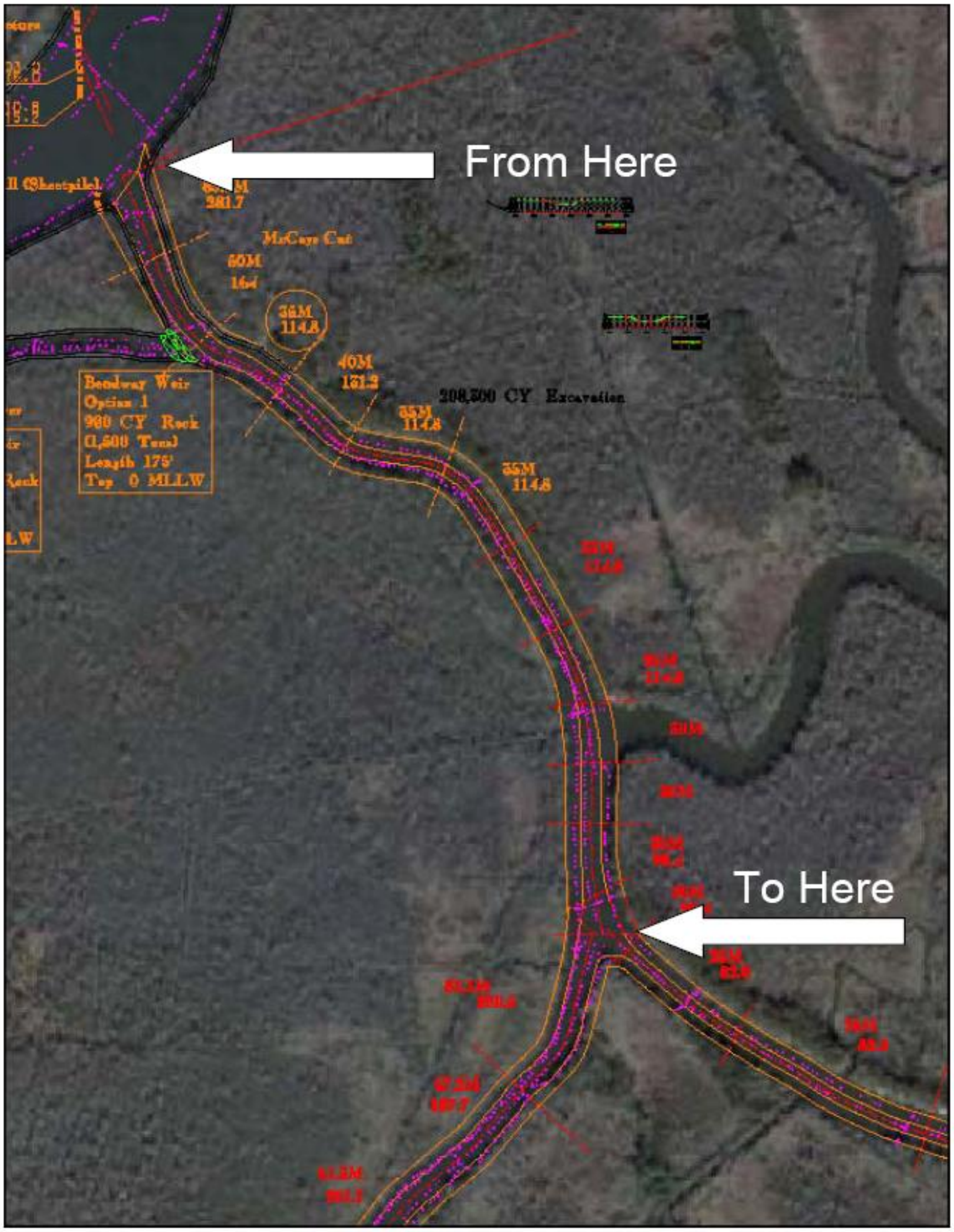
Weir Elevation = -3.85 meters MLLW (-12.6 feet MLLW)

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.

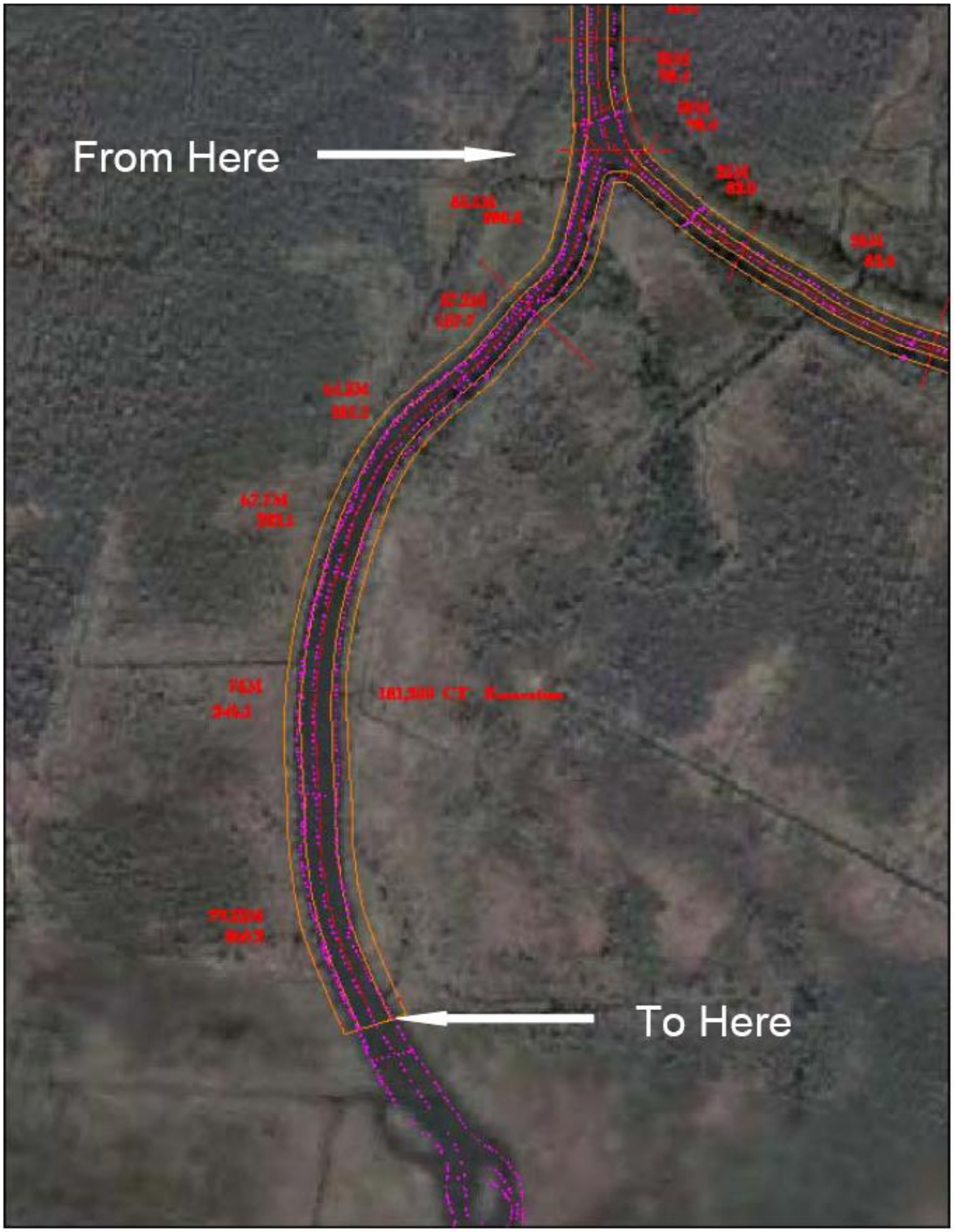
McCoys Cut Deepened to -4M



Distance 1,600 Meters Deepened to -4M, 104,000 CY Excavation

Figure 41

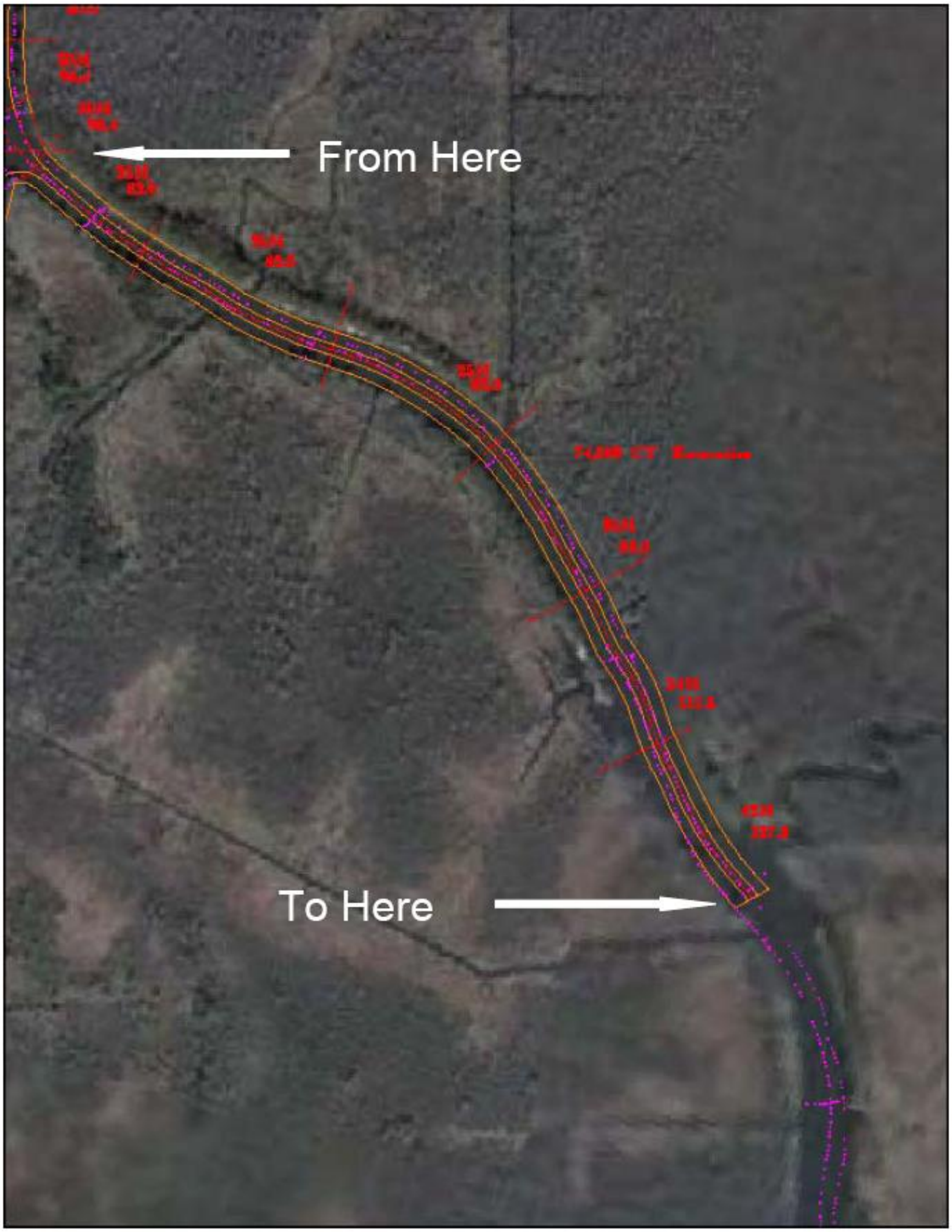
Middle River Deepened to -3M



Distance 1,700 Meters Deepened to -3M, 181,200 CY Excavation

Figure 42

Back River Deepened to -3M



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.

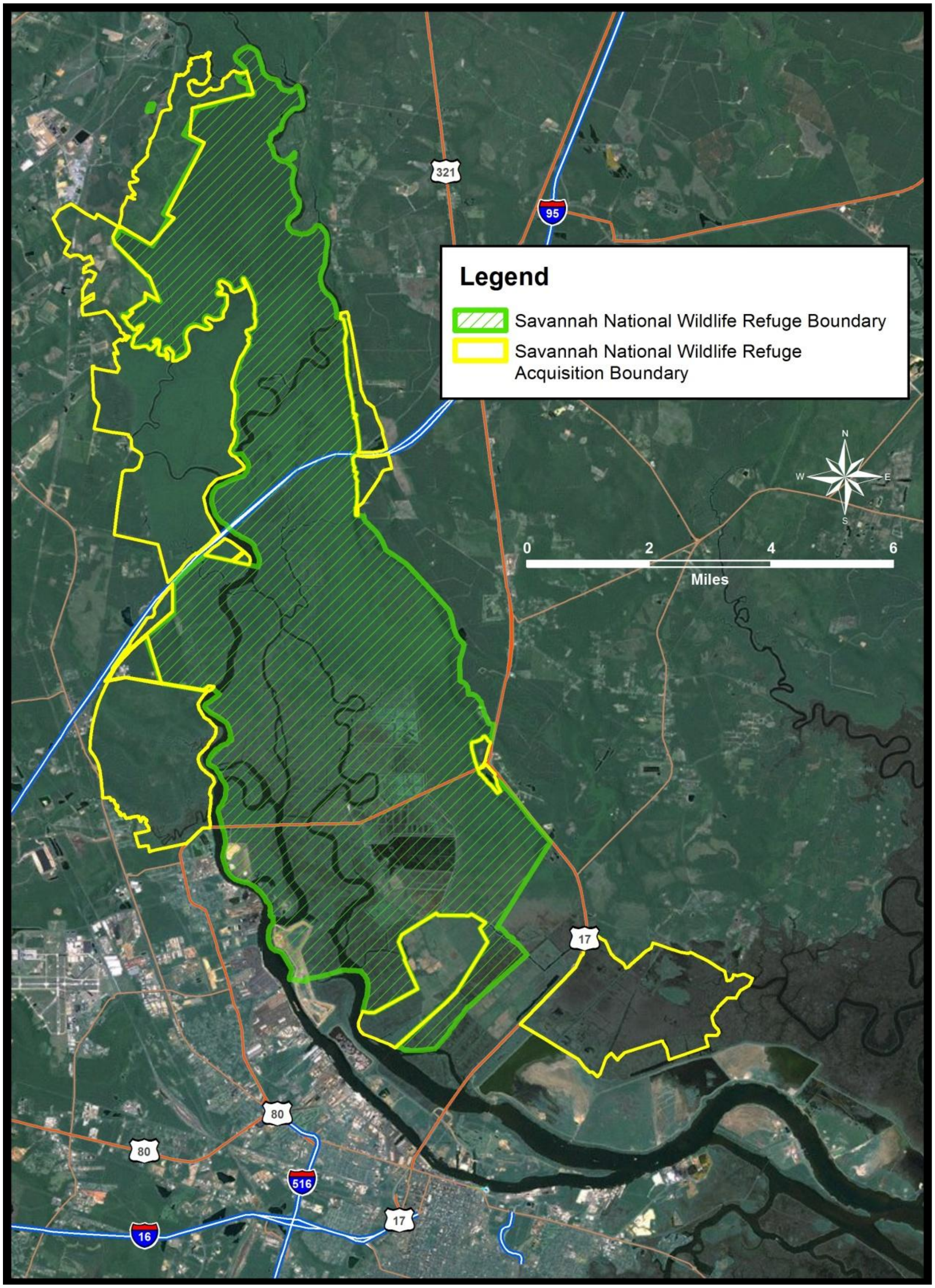


Figure 44. Savannah Wildlife Refuge

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.

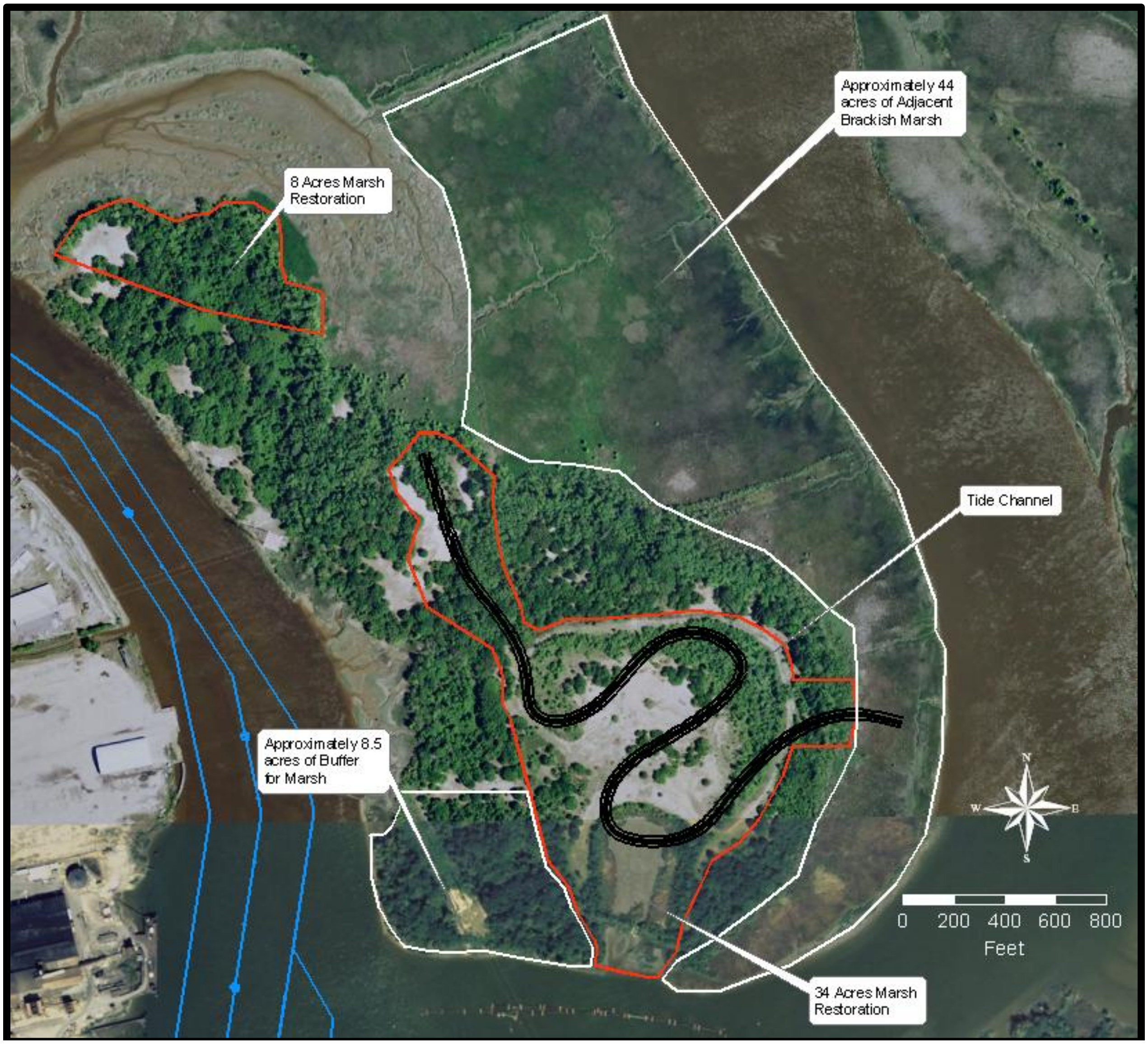


Figure 45. Wetland restoration at 1S

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.

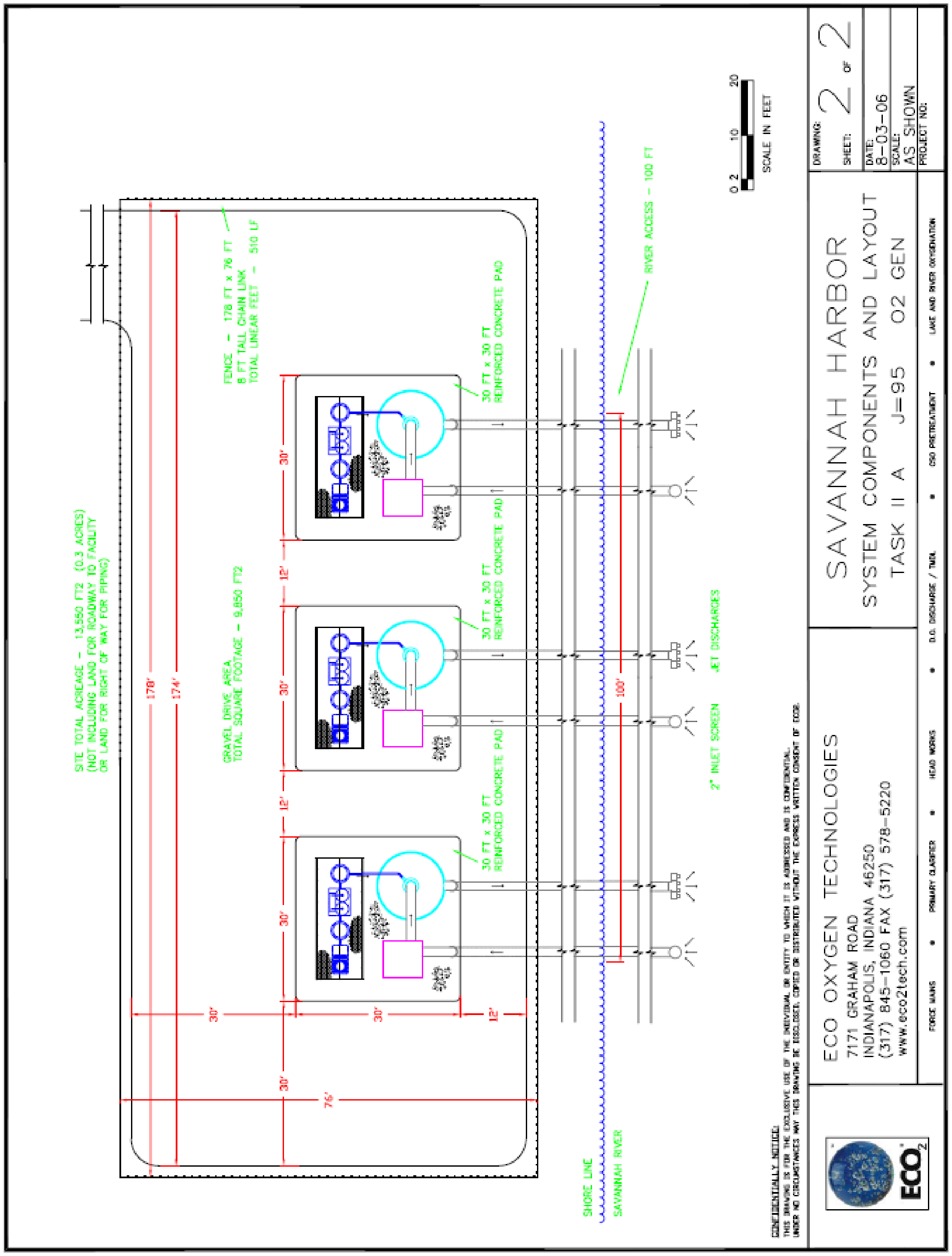

SITE TOTAL ACREAGE – 13,550 FT2 (0.3 ACRES)
(NOT INCLUDING LAND FOR ROADWAY TO FACILITY
OR LAND FOR RIGHT OF WAY FOR PIPING)
GRAVEL DRIVE AREA
TOTAL SQUARE FOOTAGE – 9,850 FT2
FENCE – 178 FT x 76 FT
8 FT TALL CHAIN LINK
TOTAL LINEAR FEET – 510 LF
30 FT x 30 FT
REINFORCED CONCRETE PAD
RIVER ACCESS – 100 FT
SHORE LINE
SAVANNAH RIVER
2" INLET SCREEN
JET DISCHARGES
SCALE IN FEET
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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.

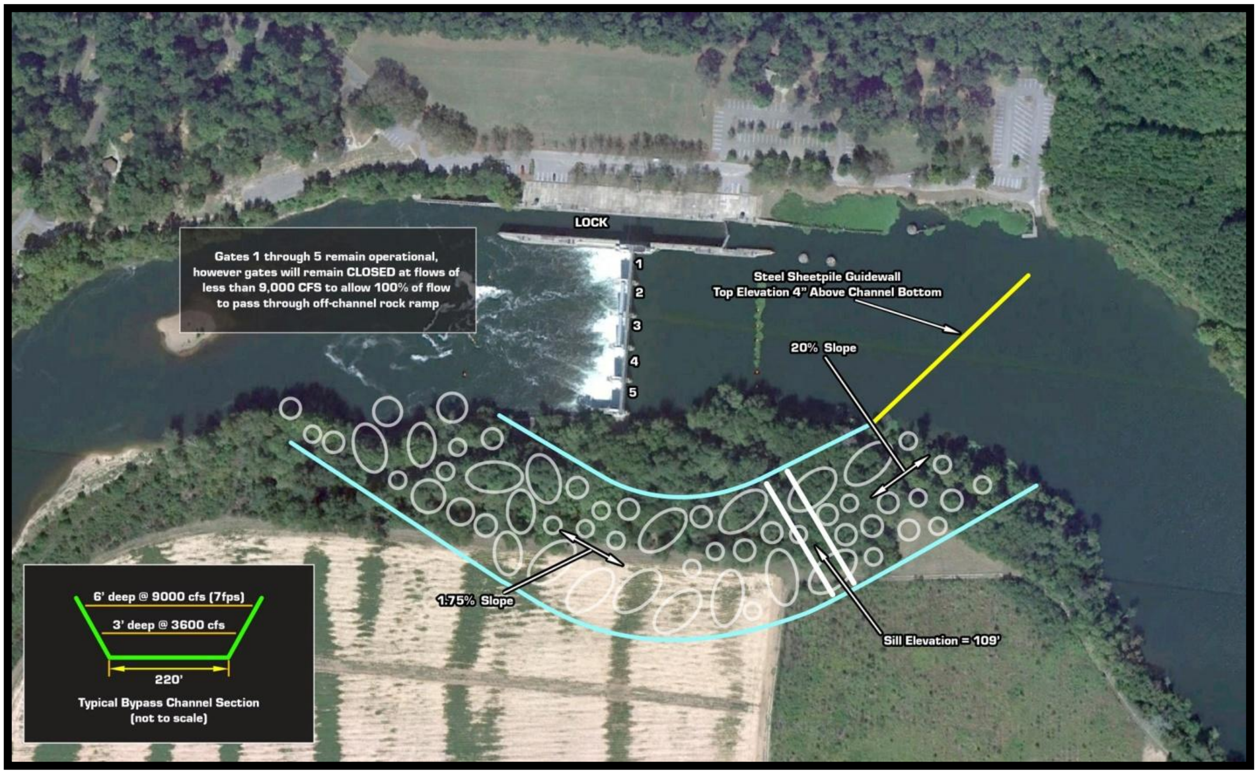

LOCK
Gates 1 through 5 remain operational, however gates will remain CLOSED at flows of less than 9,000 CFS to allow 100% of flow to pass through off-channel rock ramp
1
2
3
4
5
Steel Sheetpile Guidewall
Top Elevation 4" Above Channel Bottom
20% Slope
1.75% Slope
Sill Elevation = 109'
6' deep @ 9000 cfs (7fps)
3' deep @ 3600 cfs
220'
Typical Bypass Channel Section
(not to scale)

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.

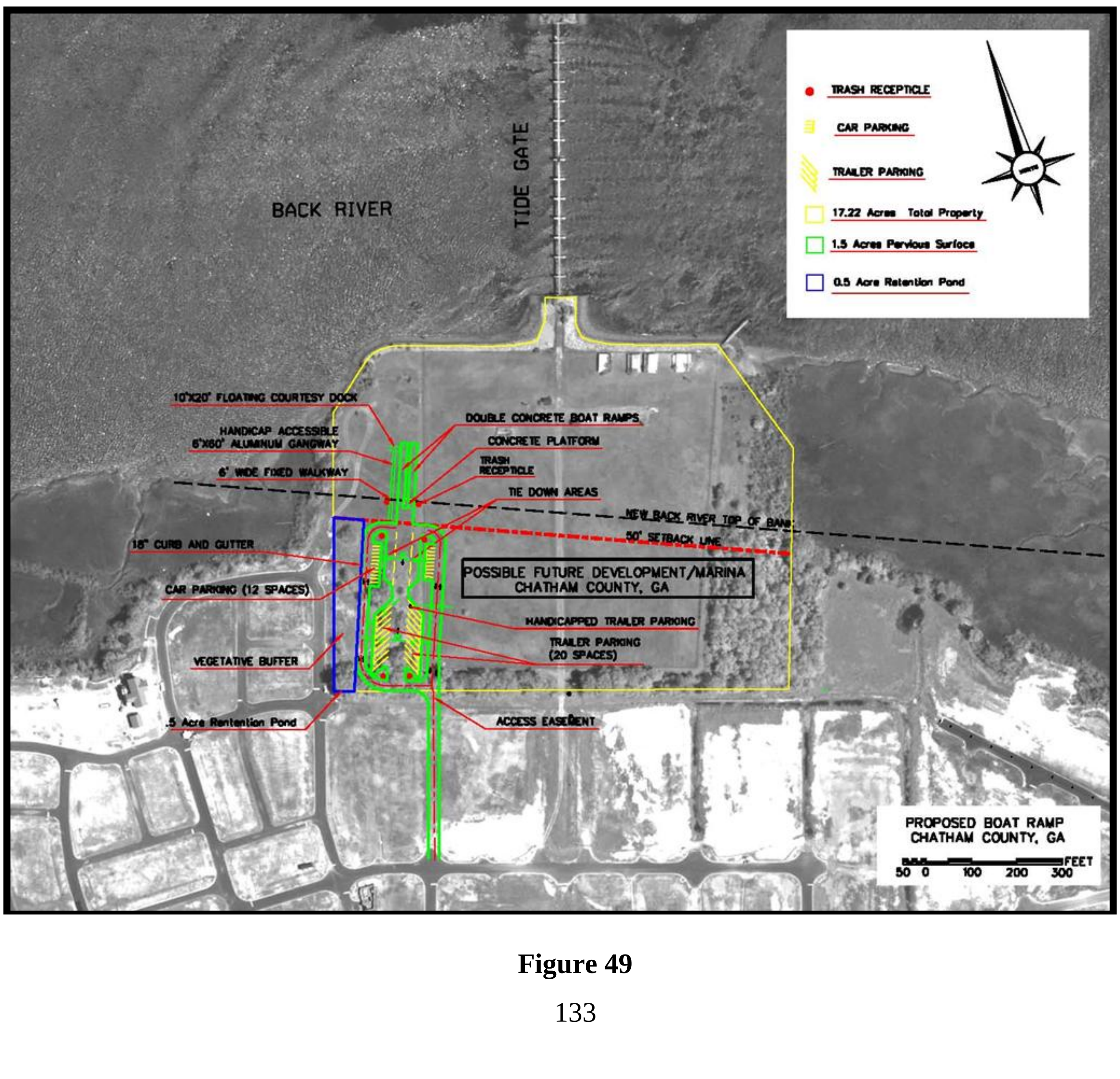


Figure 49

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 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 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).

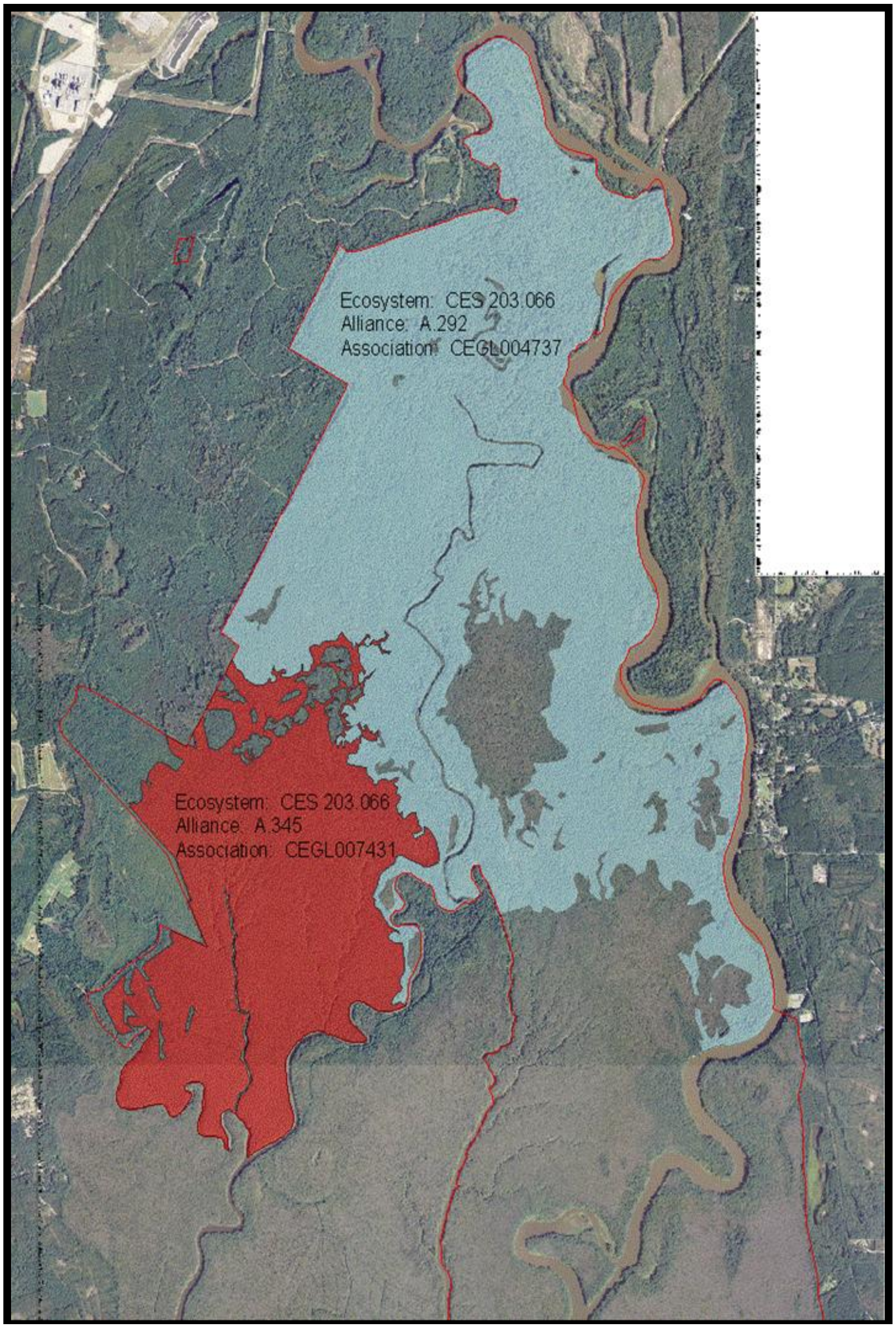


Figure 50.

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).

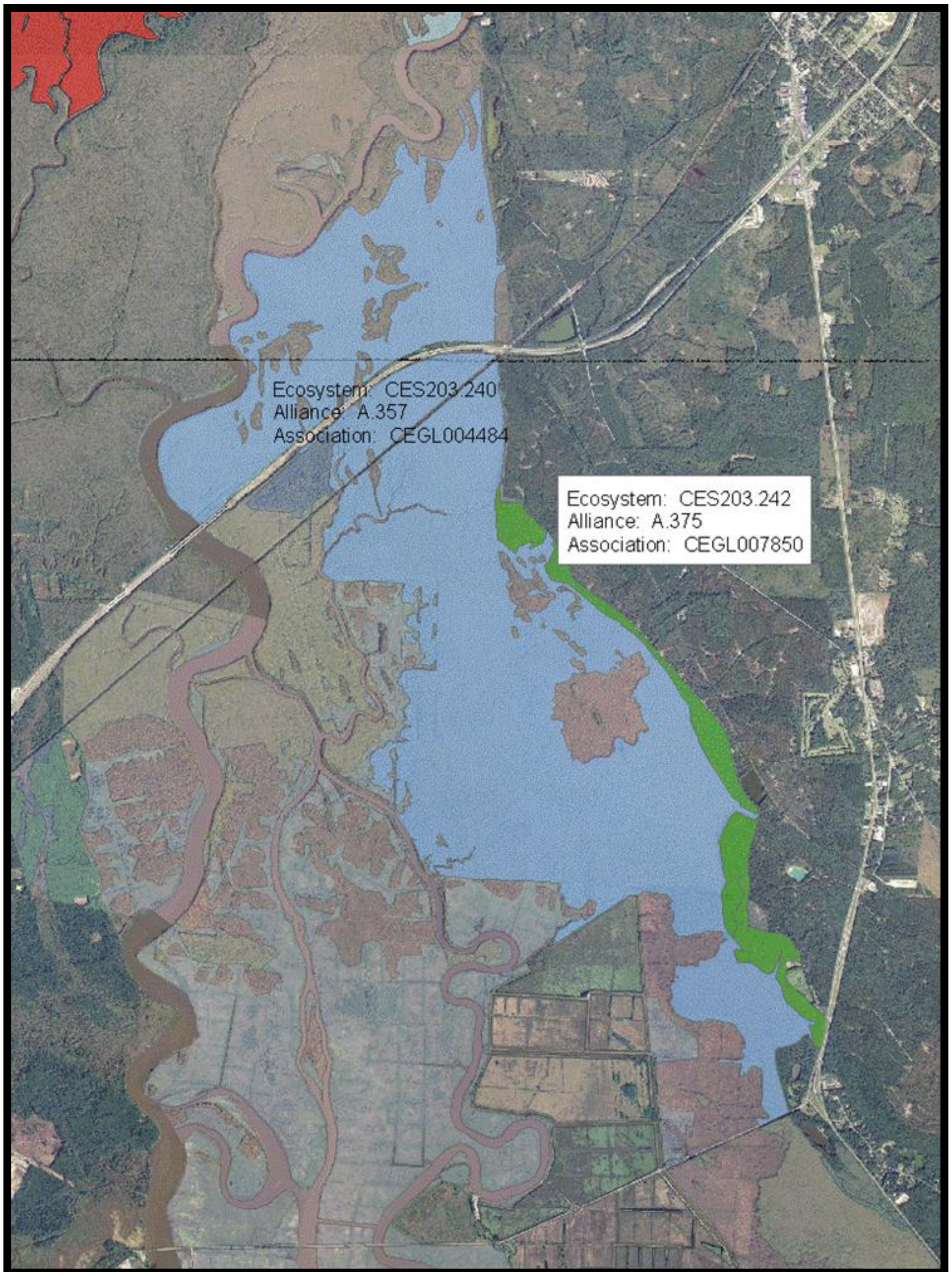


Figure 51

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.

<u>Association: CEGL007850</u>
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* <u>*compensatory mitigation site should be chosen to replace lost functions*</u> *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, **s**patial 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.

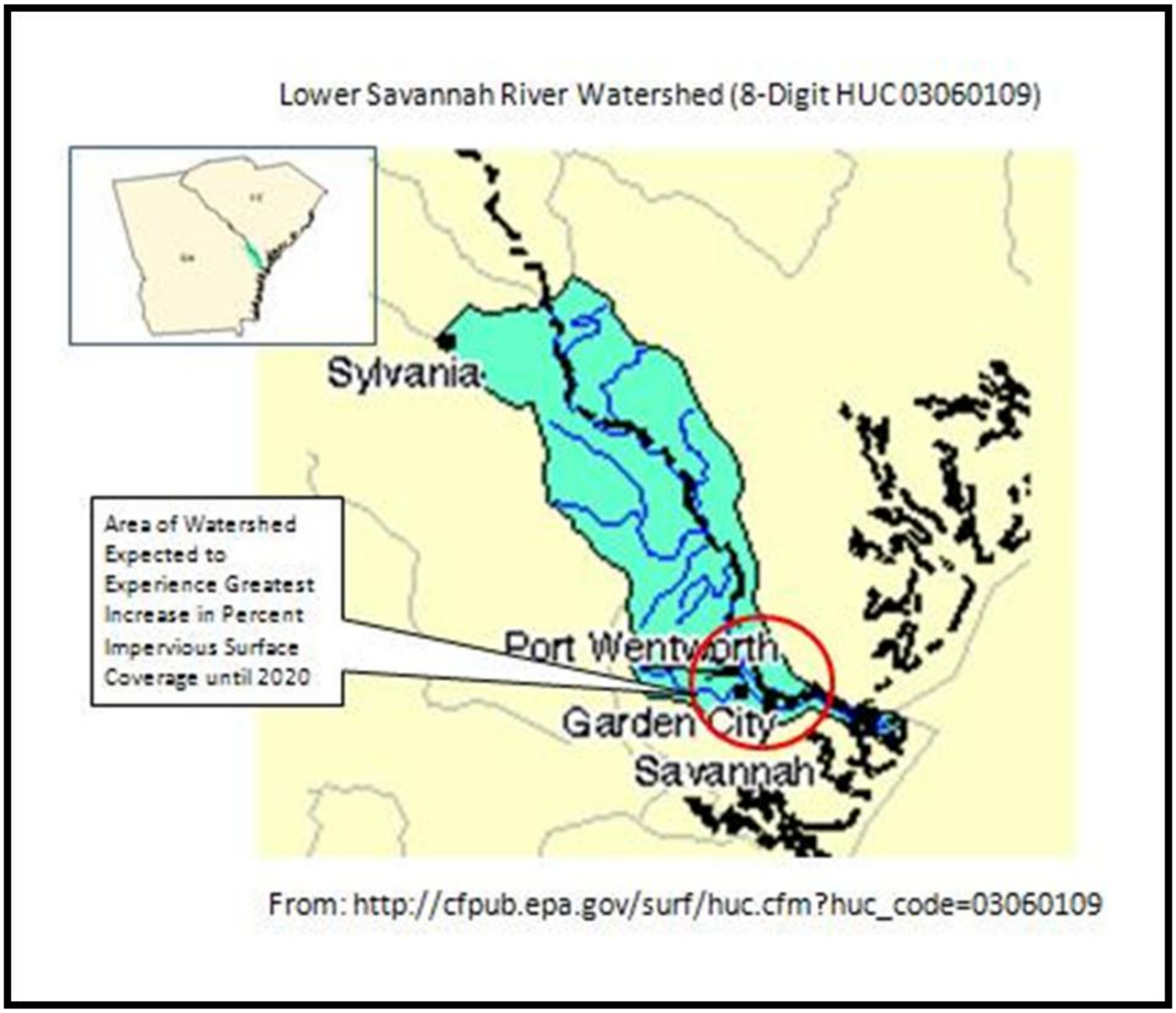


Figure 52. Lower Savannah Watershed identified with area of greatest percent increase in percent impervious surface coverage.

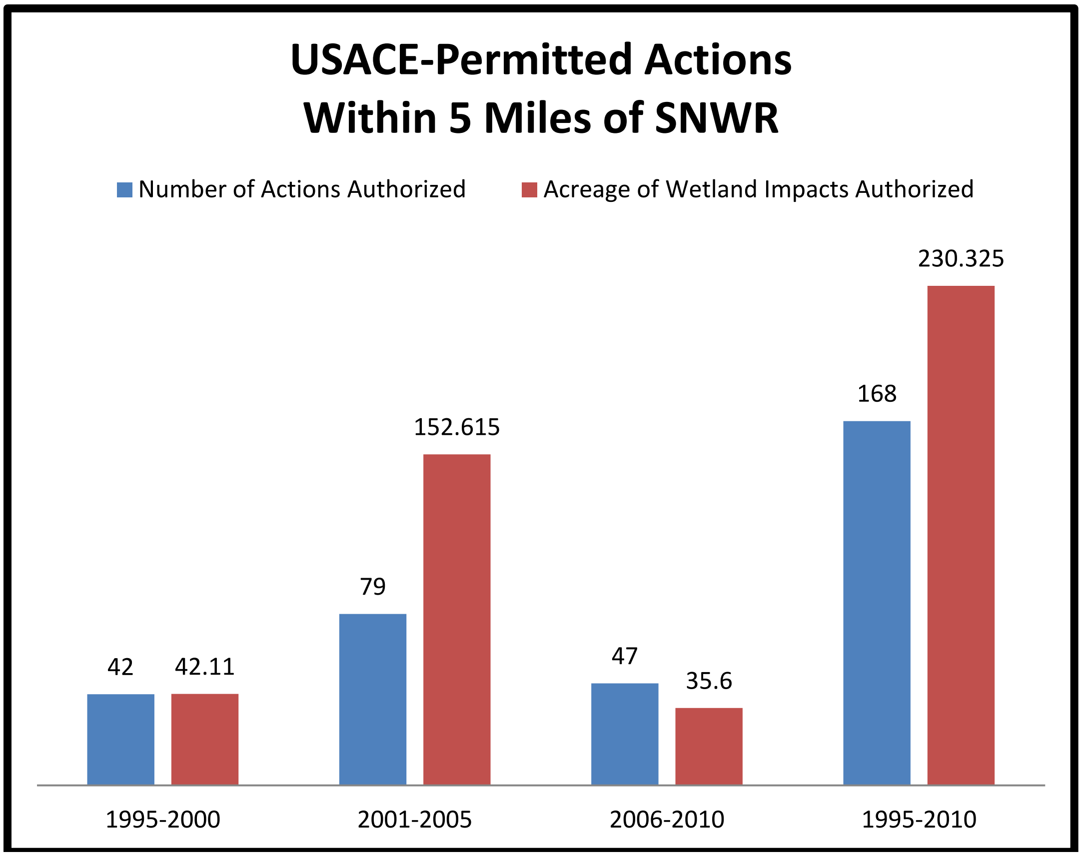


Figure 53. Number of USACE-permitted actions and acreage of wetland impacts authorized during the past 15 years within 5 miles of SNWR.

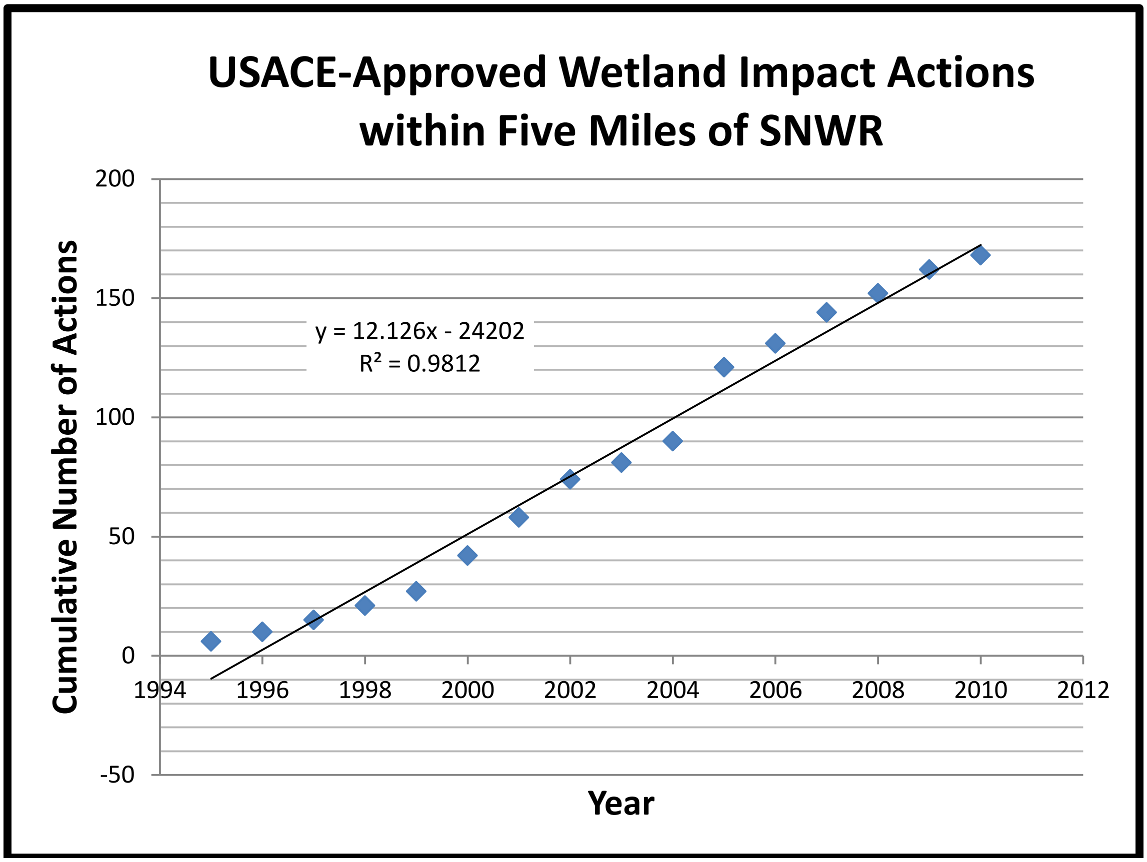


Figure 54. Cumulative number of USACE-permitted actions over time.

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.

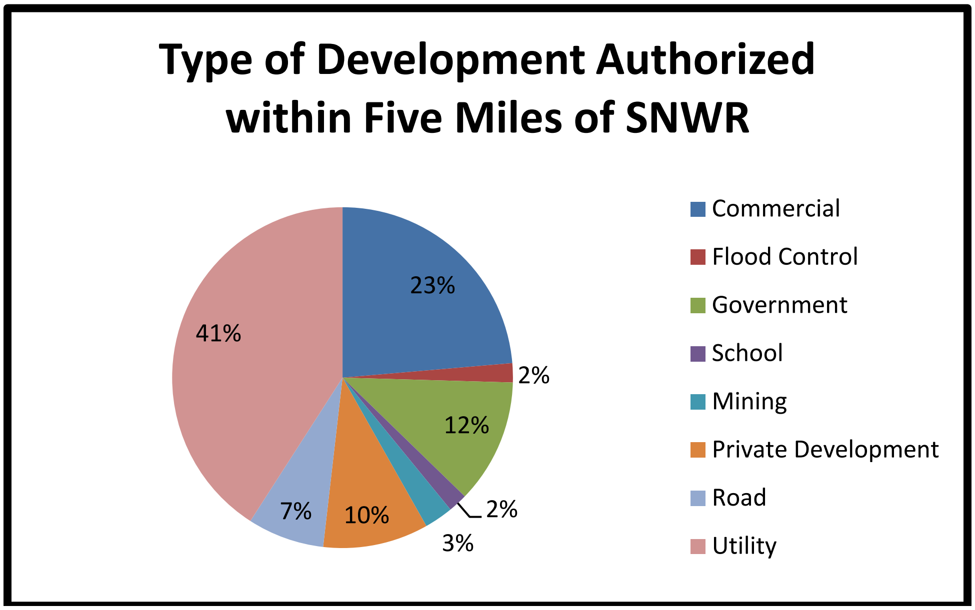


Figure 55

- 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.

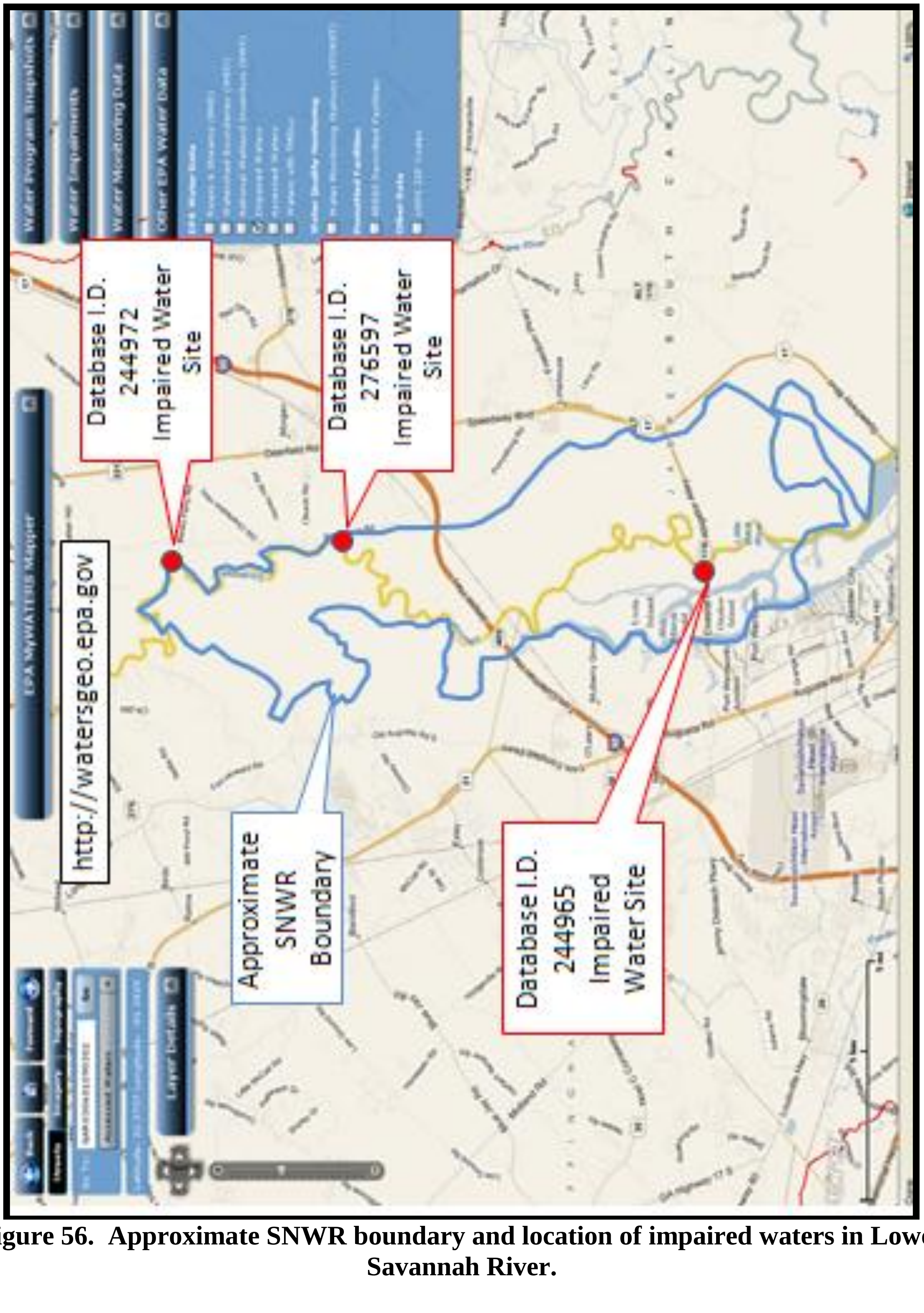


Figure 56. Approximate SNWR boundary and location of impaired waters in Lower Savannah River.

- 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.

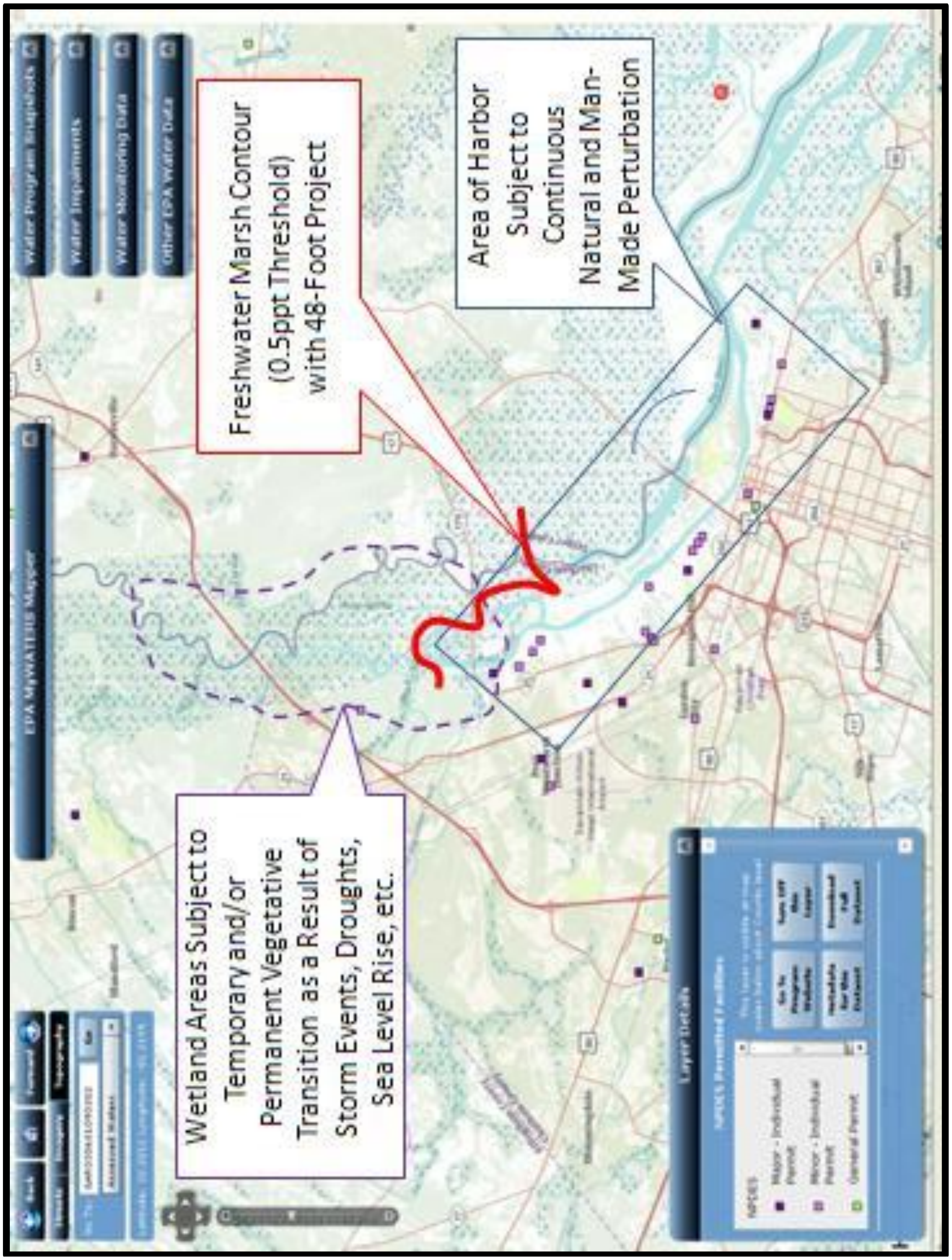


Figure 57. Project-related impacts, existing land use, and other influences on vegetative shifts in the Savannah Harbor.

- 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, **s**patial 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.

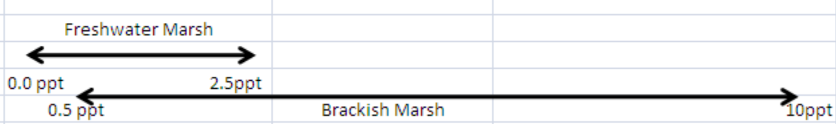
- The Corps prepared a wetland comparative analysis when considering the SHEP-derived conversion of freshwater wetland, wetland threats reported for the Lower Savannah River Watershed, function of wetland systems, opportunities for mitigation, and long term sustainability (Table 56). The comparative 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).

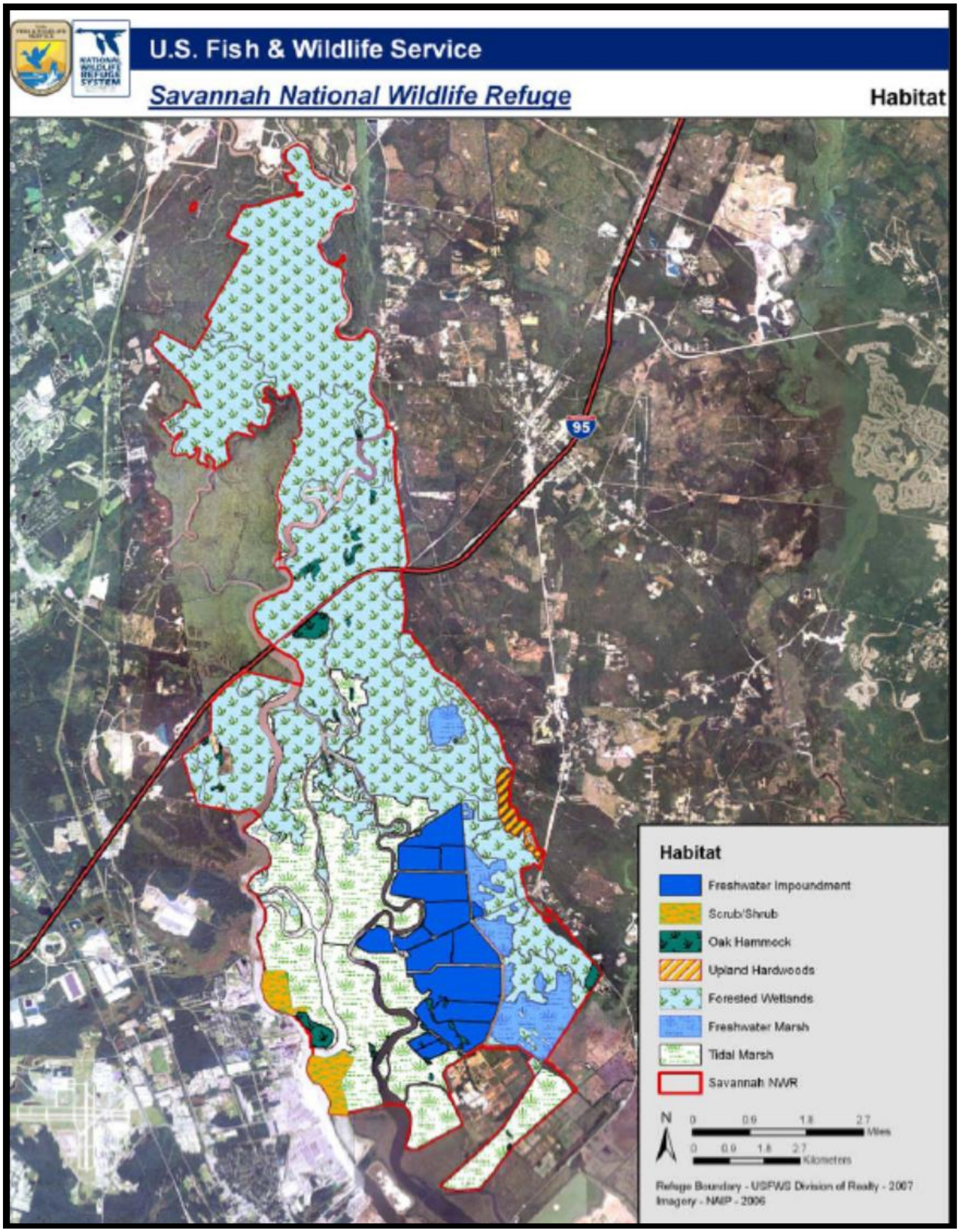


Figure 58. Habitat types within SNWR boundaries.

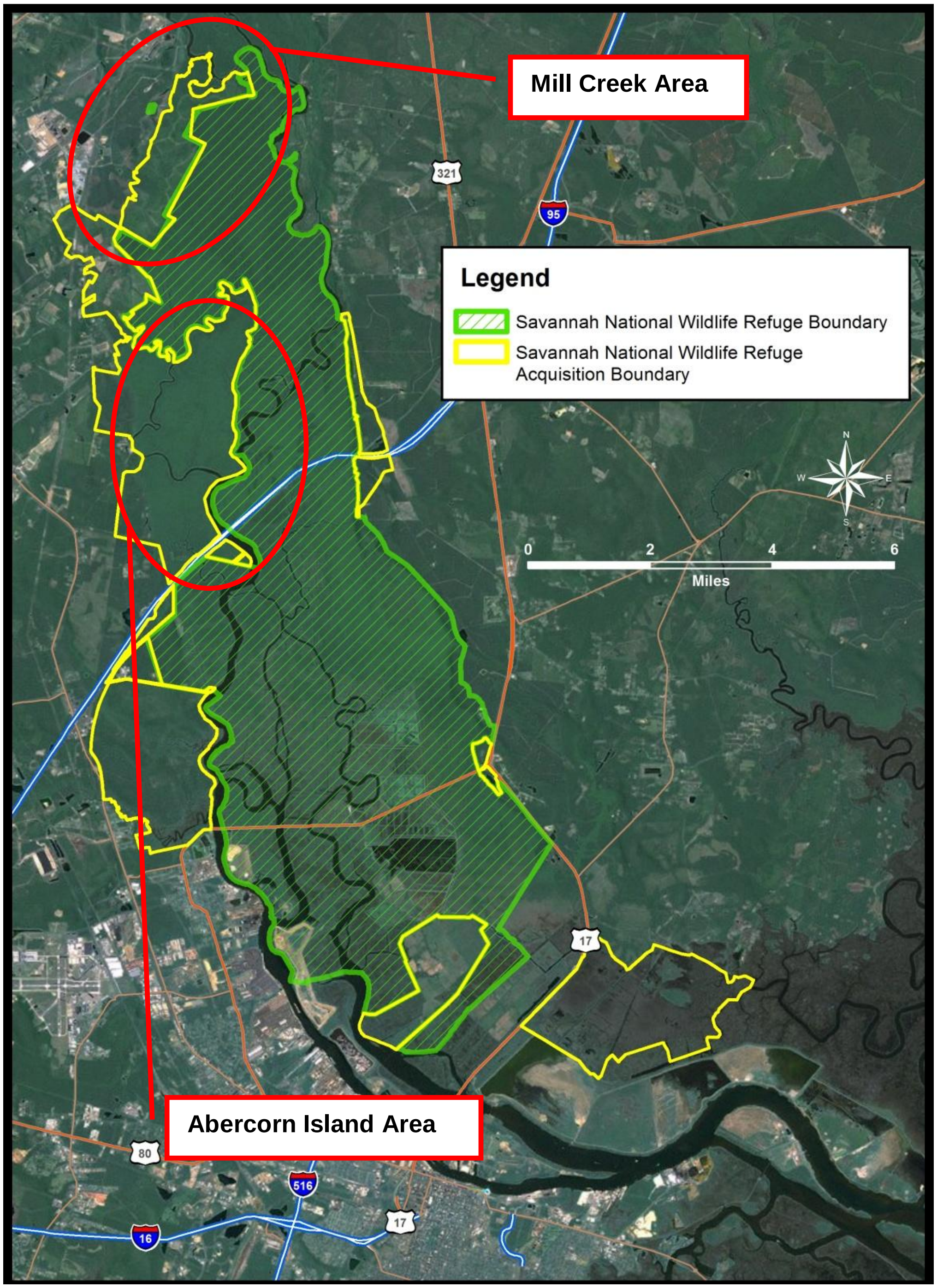


Figure 59. SNWR acquisition boundary.

- 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.

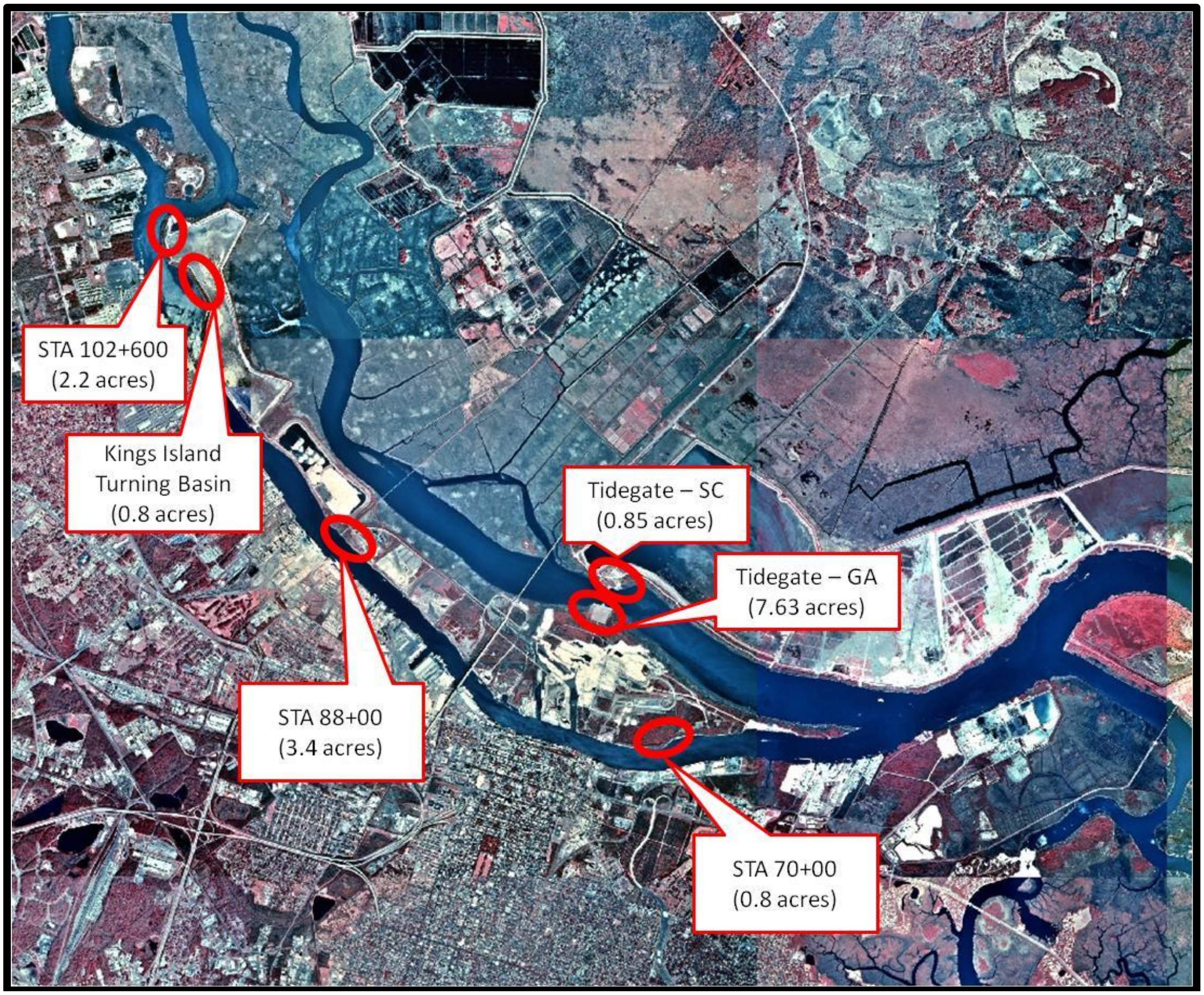


Figure 60. Location of direct impacts to brackish marsh within the Savannah Harbor

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 C*onsiderations* 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.

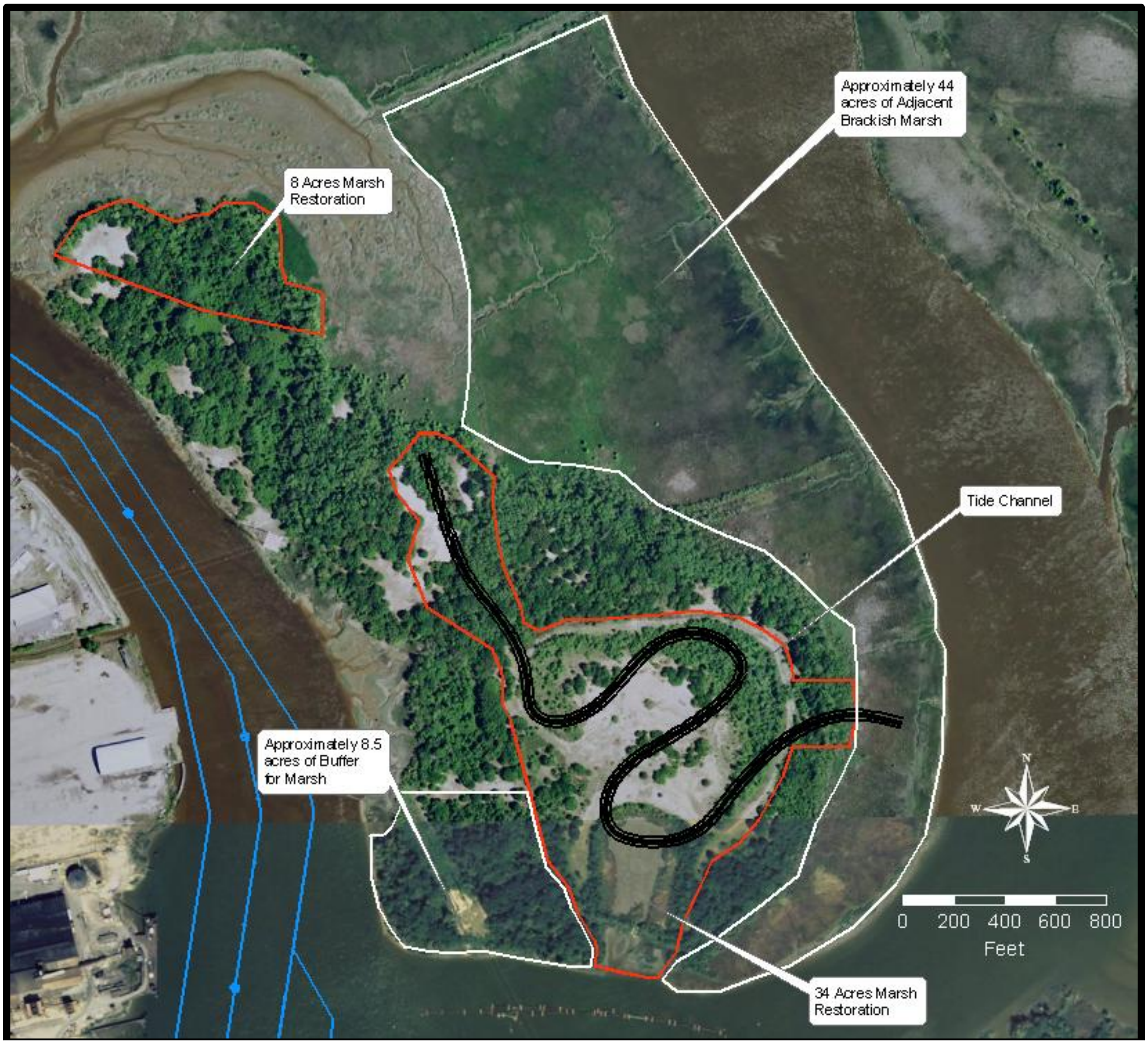


Figure 61. Location of restored brackish marsh in Lower Savannah River Watershed.

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.

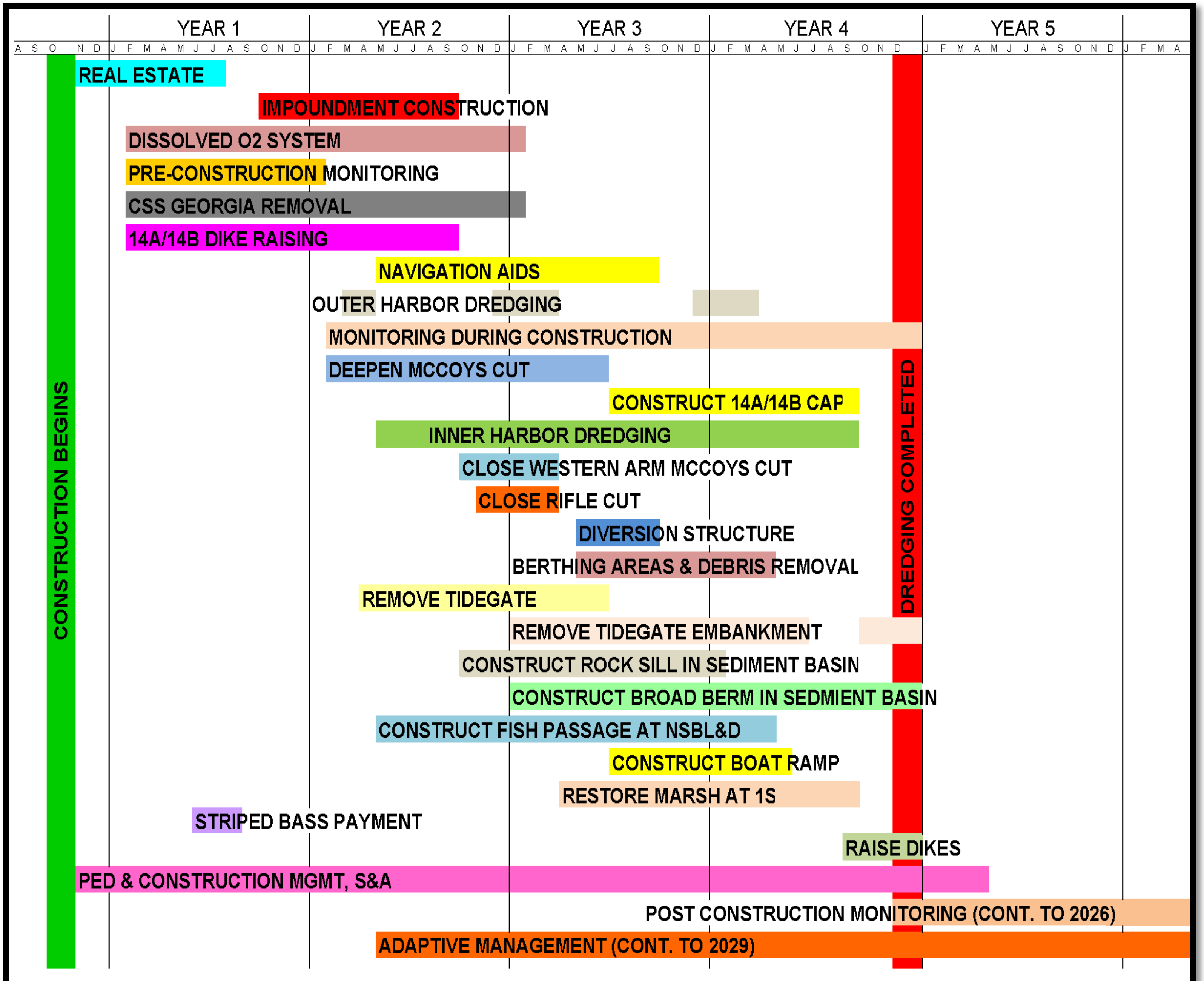


Figure 62. Timing of construction.

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

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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 tl 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).

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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		---------------------
	RANGE	**FRESHWATER MARSH 0 to 0.5**	**BRACKISH MARSH 0.6 to 4.0**	**SALTMARSH > 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 = $\sum$ (R × AA) = **5587.2**

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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 × 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 ------------------------------ 1.4 Complete Restoration				
Net Improvement Hydrology	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
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 = $\sum$ (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 = Σ (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 = $\sum$ (R × AA) = **6653.8**

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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 = $\sum$ (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 ------------------------------ 1.4 Complete Restoration				
Net Improvement Hydrology	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
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 = $\sum$ (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 = $\sum$ (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 = $\sum D_{1-5}$= [ ]

* 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 = $\sum$ (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 × 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 ------------------------------ 1.4 Complete Restoration				
Net Improvement Hydrology	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
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	$A_1 =$	$A_2 = 964$	$A_3 =$	$A_4 =$	$A_5 =$
$M \times A =$		4048.8			

Total Restoration/Enhancement Credits = $\sum (M \times A)$ = **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 = $\sum$ (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 × A) = [ ]

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WETLANDS AND OPEN WATERS
MITIGATION WORKSHEETS
48 Foot Depth Alternative

RESTORATION/ENHANCEMENT MITIGATION FACTORS

Factor	Options				
Net Improvement Vegetation	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
Net Improvement Hydrology	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
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 = $\sum (M \times A)$ = **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 = $\sum$ (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 = Σ (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 ------------------------------ 1.4 Complete Restoration				
Net Improvement Hydrology	Minimal Enhancement 0.1 ------------------------------ to ------------------------------ 1.4 Complete Restoration				
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 = $\sum (M \times A)$ = **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 = $\sum$ (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 = $\sum D_{1-5}$= ______

* 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